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Analytical Overview of the Prevalence of Malaria in the Federal Capital Territory Abuja Nigeria

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Abstract

***Background*:** Malaria continues to be a significant public health concern, particularly in sub-Saharan Africa and other regions with high endemicity. Despite ongoing efforts to control the disease, the malaria parasite remains a global health issue, presenting persistent challenges for individuals and healthcare systems in affected areas. ***Methods*:** This study investigated the distribution, prevalence, and molecular characteristics of *Plasmodium falciparum* among febrile patients in various healthcare facilities within the Federal Capital Territory (FCT), Nigeria. A combination of retrospective and cross-sectional designs was employed to analyse 428 blood samples collected from febrile patients across selected government hospitals. Malaria parasitaemia was detected through Giemsa-stained thick and thin blood smears, with parasite density calculated per 200 leukocytes. RDT-prevalence wax determined using a rapid lateral flow. ***Result*:** A total of 428 individuals participated in the study, comprising 49.0% males (n=210) and 50.9% females (n=218), with no statistically significant difference in gender distribution (p>0.05). The age distribution showed that participants aged ≥41 years represented the largest group at 34.3% (n=147), while those aged <10 years accounted for 14.0% (n=60), 11–20 years for 16.1% (n=69), 21–30 years for 19.2% (n=82), and 31–40 years for 16.4% (n=70). Microscopic examination revealed a malaria infection rate of 32% (n=137) among participants, with the highest prevalence in those aged <10 years (33.6%, n=46) and the lowest in the 31–40 age group (8.8%, n=12). Gender-based analysis indicated a higher prevalence in males (52.6%) compared to females (47.4%). Facility-based prevalence was significantly higher in Wuse (30.0%, n=41) compared to other locations, with Zuba showing the lowest prevalence (8.0%, n=11). Rapid Diagnostic Test (RDT) results indicated a prevalence of 20.1%, with Wuse again exhibiting the highest rate at 38.6% (n=27/70). Age-related RDT prevalence showed the highest seroprevalence in the <10 years age group (65.0%, n=39/60), followed by 11–20 years (24.6%, n=17/69), 21–30 years (12.3%, n=10/81), and ≥41 years (8.8%, n=13/147). ***Conclusion*:** The findings reveal a slight predominance of females over males, indicating that women may be more inclined to seek medical attention for malaria-related symptoms. The malaria prevalence rate of 32.0% underscores the urgent need for effective strategies to combat the disease.

Keywords: Prevalence, Malaria, federal capital, Territory, Parasites.

INTRODUCTION

Malaria remains one of the major public health concerns particularly in sub-Saharan Africa (SSA) and other regions with high endemicity (Obasohan *et al.*, 2021). Despite several continuing efforts to curb malaria, the parasite remains a global health issue, posing continuing challenge to people and healthcare systems in endemic areas. The World Health Organisation (2022) estimated 249 million cases of malaria across 85 malaria-endemic countries in 2022: resulting in a case incidence rate of 58 per 1,000 people. This represents an increase from 2019 when 229 million cases were reported. The prevalence of malaria in 2022 was higher than the targets set by the Global Technical Strategy for Malaria, highlighting the significant challenges in reducing malaria prevalence globally.

Of the 249 million cases reported in 2022, 94% (233 million cases) were reported in the WHO African Region; four countries, Nigeria, The Democratic Republic of Congo, Uganda and Mozambique accounted for about half of the reported cases. Of the four countries, Nigeria had the highest number of cases—Nigeria (27%), followed by the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%). Reports indicate that Pakistan experienced the largest increase in malaria cases from 2021 to 2022, with an estimated 2.6 million cases in 2022, up from 500,000 cases in 2021.

Globally, malaria caused an estimated 608,000 deaths in 2022, resulting in a mortality rate of 14.3 deaths per 100,000 people at risk. Majority of the reported mortality as a result of malaria occurred in the four most endemic countries in SSA; with Nigeria accounting for the highest (31%), the Democratic Republic of the Congo (12%), Niger (6%), and Tanzania (4%). Around 70% of the global malaria burden is concentrated in 11 countries: Burkina Faso, Cameroon, the Democratic Republic of Congo, Ghana, India, Mali, Mozambique, Niger, Nigeria, Uganda, and Tanzania.

Over the past two decades, SSA countries have implemented various malaria control interventions. These include vector control measures such as long-lasting insecticide-treated nets (LLINs) and indoor residual spraying; preventive chemotherapy, including intermittent preventive treatment for pregnant women (IPTp), intermittent preventive treatment for infants (IPTi), and seasonal malaria chemoprevention (SMC) for children under five; and case management through rapid diagnostic testing (RDT) and treatment with Artemisinin-based combination therapy (ACT) (Kesteman *et al*., 2017). More recently, the introduction of the malaria vaccine has added another layer of protection. However, despite the impact of these interventions, the WHO African Region did not meet the 2020 Global Technical Strategy milestones, falling short by 25% in reducing malaria mortality and by 20% in reducing morbidity (WHO, 2022).

Malaria is closely linked with poverty, and the high poverty levels in SSA, coupled with inadequate economic policies, are major contributors to the increasing malaria threat in the region (Badmos *et al*., 2021). Poor living conditions often promote mosquito breeding, and those living in such areas frequently have limited or no access to adequate healthcare. Additionally, the climatic conditions in SSA, including abundant rainfall and high temperatures, create an ideal environment for the reproduction and spread of female Anopheles mosquitoes (Ryan *et al*., 2020).

Moreover, the growing resistance of mosquitoes to pyrethroids used in insecticide-treated nets (ITNs) and the resistance of parasites to antimalarial drugs present further challenges in controlling the disease (Lindsay *et al*., 2021). The health systems in SSA are also hindered by limited access to medical services and products, a shortage of human resources, and a general lack of functional health facilities (Oleribe *et al*., 2019).

The challenge of Malaria is felt in all the regions in Nigeria including the Federal Capital Territory (Okoroiwu *et al*., 2021; Jas *et al*., 2021). Recent studies in Abuja, Nigeria's Federal Capital Territory, reveal a high prevalence of malaria. Okoroiwu (2021) and Jas *et al*., (2021) reported a 54% prevalence in Abuja Municipal Area Council, with children aged 2-10 years most affected (76.9%). Ezeonu *et al*., (2019) found a 45.8% prevalence among blood donors in FCT, highlighting the risk of transfusion-transmitted malaria. The studies consistently show higher infection rates in younger age groups. This study was carried out to determine the prevalence of malaria in communities in the Federal capital territory. The outcome of this study will highlight malaria prevalence trends within the FCT giving insight for policy making and strengthening of existing policies on malaria prevention within the FCT.

MATERIALS AND METHODS

Study Are

This study was conducted in some of the selected Government Hospitals, (General Hospital) in the six-area council Abaji, Abuja Municipal (AMAC), Bwari, Gwagwalada, Kuje, and Kwali, in the Federal Capital Territory in Nigeria. The FCT is located in the north-central geo-political zone which is located just north of the confluence of the Niger River and Benue River. It is bordered by the states of Niger to the West and North, Kaduna to the northeast, Nasarawa to the east and south and Kogi to the southwest. The current estimated metro area population of Abuja in 2021 is 3,464,000, a 5.67% increase from 2020. The metro area population of Abuja in 2020 was 3,278,000, a 5.91% increase from 2019. The metro area population of Abuja in 2019 was 3,095,000, a 6.03% increase from 2018. It is the least populated State in Nigeria. There is usually a humid rainy season from April to September with temperature ranging from 22°C to 30°C, and brief period of harmattan from October to December. The annual total rainfall ranges from 1100mm to 1600mm and altitude is 476m. Malaria is endemic in the area. As a rapidly growing capital city, almost all tribes in Nigeria are represented in Abuja.

Determination of Sample Size: The sample size for this study was determined by the Fischer's formula (West &

Okari (2018), using a previously reported prevalence of 35% (Tafida 2022).

$$n = \frac{Z^2 P\ (1-P)}{d2}$$

Where,

n = sample size of subjects required for the study
Z-statistic for a level of 95% confidence interval = 1.96
P = Prevalence rate = (Tafida, 2022) (Prevalence of malaria in Abuja)
d = precision (allowable error) = 5%=0.05

A total of four hundred and twenty-eight (428) blood samples were collected in the current study.

Blood Sample Collection and Thin file preparation: Whole blood of 3mls was collected from individual participant by venipuncture phlebotomy into a vacuum tube containing EDTA anticoagulant. Each EDTA bottle was clearly labelled with the Patient's unique identification number, age, sex and date of collection. A drop of the fresh blood was placed on two clean microscope glass slides, which was used to make a thick and thin blood smear respectively.

Determination of Malaria Parasite Cases: The spread out thin and thick smear on the microscope glass slide was dried and stained to give the parasite a distinctive appearance. The thick and thin smear films were stained using the already prepared working 5% Giemsa Stain. The malaria parasites were identified by viewing the stained slides under the microscope using a x100 oil immersion objective. Specie determination was partly made based on the morphological characteristics of the four species of human malaria parasite and the infected red blood cells.

Determination of MP density: The density of parasite was derived by determining of the number of asexual parasites against 200 leukocytes in the film of thick blood. A slide was regarded 'negative' by a medical laboratory scientist upon the recording of 500 leukocytes in a count. In the event of a 'positive' remark on thick films, the thin films were used to detect the species. Going by an 8000 leukocyte/µL assumption (WHO, 1991), the parasite density was derived with the formula below:

$$\text{Parasites}/\ \mu\text{L blood} = \frac{\text{Number of counted parasites x 8000 leukocytes}/\ \mu\text{L}}{\text{Number of leucocytes}}$$

Determination of Malaria Prevalence by RDT:

A rapid lateral flow immunochromatographic test kit (CareStart™ by Access Bio Inc., USA) was used in the current study for detecting *Plasmodium falciparum* infection in blood samples. This test identified the HRP2 (Histidine Rich Protein 2) antigen specific to *P. falciparum*. Blood samples were collected using a micro-pipette provided with the kit, and approximately 5 µl of the sample was added to the "S" well of the test device. Subsequently, 60 µl of assay buffer solution was added to the "A" well. Results were read after 20 minutes. The test's diagnostic sensitivity and specificity were assessed following World Health Organization standards, and the positive and negative predictive values were determined based on the manufacturer's guidelines.

Data Analysis

Data collected for this study was analysed using Analysis of Variance (ANOVA) and the Chi-square test, both conducted at a 95% confidence interval with a significance level set at $p<0.05$. The statistical analyses were performed utilizing STATA 18 software (StataCorp LLC, College Station, TX, USA).

RESULTS

Distribution of Population studied

In the current study, a total of 428 individuals participated, with 49.0% (n=210) being males and 50.9% (n=218) females. Although the number of females was higher, there was no statistical significance ($p>0.05$) in the distribution. Analysis of the distribution of participants based on age reveals a distinctly higher number of participants aged ≥ 41 (34.3%, n=147). Specifically, 14.0% (n=60) were aged <10 years, 16.1% (n=69) were in the age group 11 – 20 years, 19.2% (n=82) were in the age group 21 – 30 years, and 16.4% (n=70) were in the age group 31 – 40 years (Figure 1).

The Distribution of the Participants based on gender (Fig 2) in the different facilities studied indicates that Kuje stands out with the highest proportion of male participants at 10.00%, while Kwali and Abaji show a higher percentage of female participants at 8.90% and 8.60% respectively. The analysis shows that there's a consistent trend of slightly higher female representation across the facilities, with percentages ranging from 7.50% to 8.90% thus suggesting potential variations influenced by factors such as demographic composition and facility accessibility.

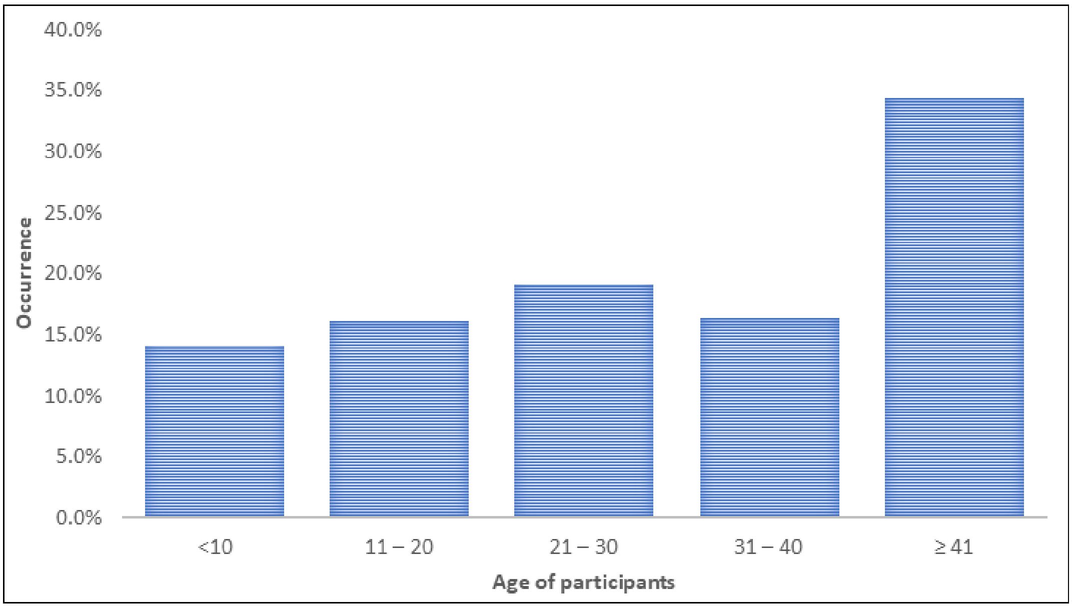

Figure 1: Distribution of participants based on Age

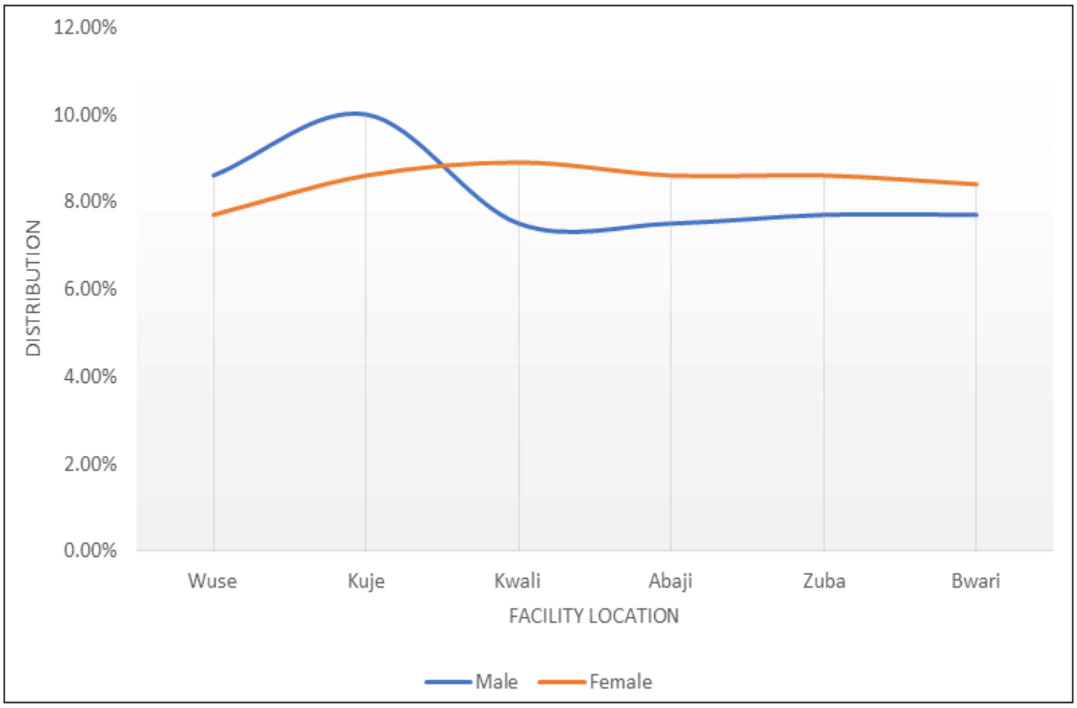

Figure 2: Distribution of Participants based on Gender

Prevalence of Malaria Parasite

In the current study, microscopic examination of participants blood samples for the presence of malarial parasite revealed that of the 428 participants, 137 persons were infected with the parasite, bringing the infection rate to 32%. The age-related prevalence revealed that participants aged <10 years had a significantly higher infection rate (33.6%, n=46). While the least prevalence was observed in the age group 31 – 40 years (8.8%, n=12); other age groups reported moderately high infection rate. The rate was 21.2% (n=29) for participants older than 40 years, 18.9% (n=26) for participants between 11 – 20 years and 17.5% (n=24) for those aged between 21 – 30 years (Figure 3).

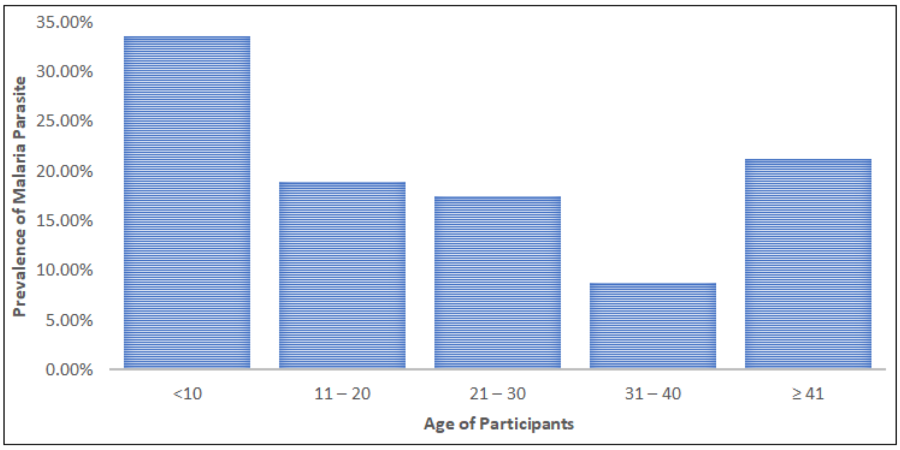

Figure 3: Age-based Prevalence of Malaria Parasite

For gender-based prevalence, analysis revealed that males had a prevalence of 52.6% which was slightly higher than the prevalence of 47.4% recorded from the female counterparts.

For facility-based prevalence (Fig 4), Wuse exhibited a significantly higher prevalence compared to other areas studied ($p<0.05$). Analysis showed that Wuse had a prevalence of 30.0% (n=41), followed by a prevalence of 21.9% (n=30) in Bwari. The lowest prevalence was recorded in Zuba (8.0%, n=11). However, in Kwali, the prevalence was 15.3% (n=21), while in Kuje, it stood at 13.1% (n=18), and in Abaji, it was 11.7% (n=16) (Figure 4).

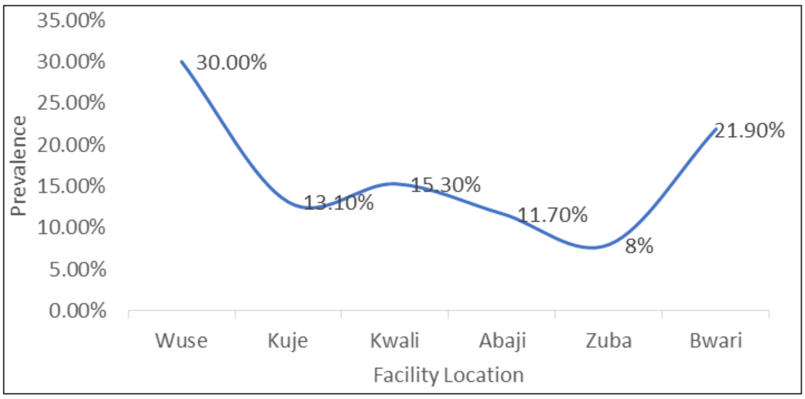

Figure 4: Facility-based Prevalence of Malaria Parasite

RDT Prevalence of Malaria

Analysis of the result of malaria determined using rapid Diagnostic Kits (RDK) showed a prevalence of 20.1%. However, a facility specific prevalence indicated that Wuse had the highest prevalence with a rate of 38.6% (n=27/70); followed by Bwari (26.1%, n=18/69) and Abaji (20.3%, n= 14/69), the least was recorded in Zuba (7.1%, n= 5/70); seroprevalence of 17.1% (n=12/70) and 12.5% (n=10/80) was reported in Kwali and Kuje respectively (Figure 5).

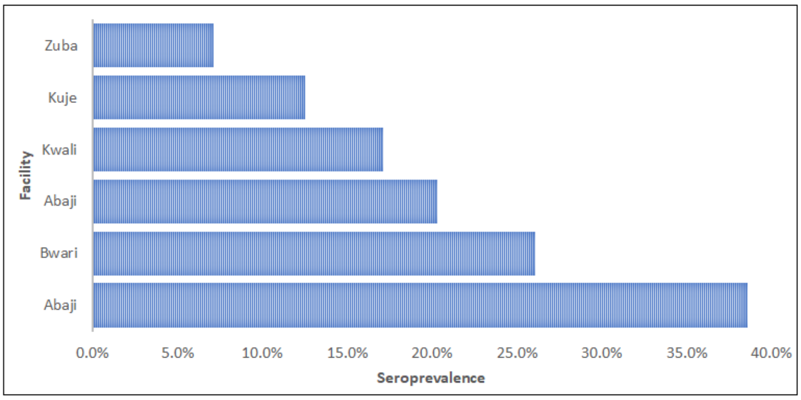

Figure 5: Facility based Seroprevalence of Malaria

For age related RDT prevalence, the age group <10 years had the highest malaria seroprevalence (65.0%, n=39/60) followed by 11 – 20 years (24.6%, n=17/69), 21 – 30 years (12.3%, n=10/81) and ≥ 41 years (8.8%, n=13/147) (Figure 6).

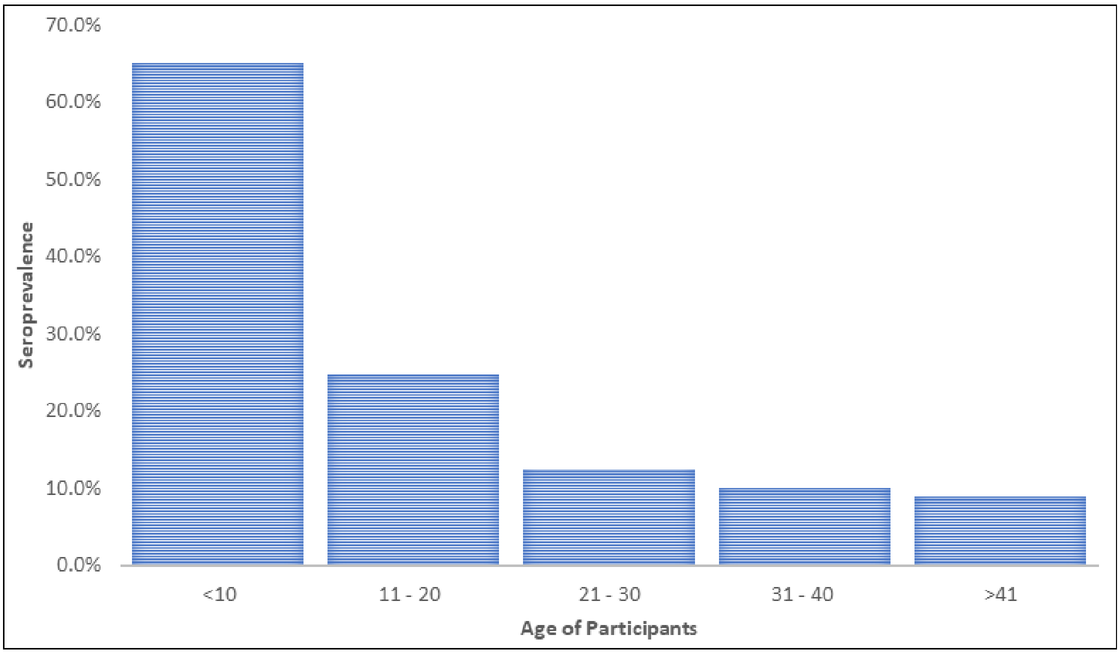

Figure 6: Age-based Seroprevalence of Malaria

Malaria Parasite Density:

The malaria parasite density is shown in Table 4.4. Analysis revealed that the highest parasite density in the age group <10 years is observed in Bwari, with a mean of 8142.1 ± 1502.9, followed by Kwali (6894.4 ± 3427.2) and Kuje (6354.5 ± 2420.0). Abaji shows the lowest density in this age group, with a mean parasite density of 2164.0 ± 2074.5.

For the age group 11 – 20 years, Bwari again has the highest parasite density (6374.3 ± 902.2), followed closely by Kwali (5502.3 ± 894.0) and Abaji (5285.3 ± 2062.1). These densities are significantly higher than those in Wuse (2553.3 ± 2014.1) and Kuje (3074.0 ± 1299.0). In the age group 21 – 30 years, Abaji reports the highest parasite density (4224.0 ± 0.02), which is significantly higher than in other areas. Kwali (1291.5 ± 383.5) and Zuba (1312.5 ± 213.7) have the lowest densities. For the age group 31 – 40 years, Bwari and Zuba report high parasite densities, with Bwari at 5644.0 ± 1062.3 and Zuba at 5560.5 ± 2824.0. Kuje and Kwali have the lowest densities in this age group. In the age group 41 years and above, Abaji reports the highest density (5040.0 ± 3770.8), followed by Bwari and Kuje. Kwali records the lowest density in this age group.

Table 4.4: Malaria Parasite Density

AGE (Years)	FACILITY					
	WUSE	**KUJE**	**KWALI**	**ABAJI**	**ZUBA**	**BWARI**
<10	5606.0 ± 1911.7	6354.5 ± 2420.0	6894.4 ± 3427.2	2164.0 ± 2074.5	4599.0 ± 3910.9	8142.1 ± 1502.9
11 – 20	2553.3 ± 2014.1	3074.0 ± 1299	5502.3 ± 894.0	5285.3 ± 2062.1	3330.3 ± 2628.5	6374.3 ± 902.2
21 – 30	1654.2 ± 570.0	2357.0 ± 1889.8	1291.5 ± 383.5	4224.0 ± 0.02	1312.5 ± 213.7	3671.4 ± 1425.5
31 – 40	3169.8 ± 1747.7	877.0 ± 0.0	648.2 ± 132.5	3987.0 ± 2618.6	5560.5 ± 2824.0	5644.0 ± 1062.3
≥ 41	3281.3 ± 2607.8	3684.7 ± 989.5	1261.6 ± 775.2	5040.0 ± 3770.8	3485.4 ± 1989.0	4685.8 ± 1560.2

Data is mean ± Standard Deviation of malaria parasite density

DISCUSSION

This study investigated the distribution of Plasmodium species among 428 malaria-suspected cases in the Federal Capital Territory (FCT), analysing demographic factors such as age, gender, and the health facility attended by the patients. The results showed a slight predominance of females (50.9%) over males (49.0%). This marginally higher participation of females may indicate that they are more likely to seek healthcare services for malaria-related symptoms than males, aligning with findings by Okiring *et al*., (2022). Additionally, this trend may be influenced by the societal role of females in many parts of the world, where they often have primary responsibility for household care. Pregnant women, in particular, might be diagnosed with malaria incidentally while seeking care for other reasons, such as antenatal visits or accompanying a sick child (Quaresima *et al*., 2021).

The study reported a malaria prevalence rate of 32.0%, which is consistent with the prevalence reported by Nwaneli *et al*., (2020). Previous studies have suggested a higher prevalence of Plasmodium parasites in post-adolescent males compared to females (Newell *et al*., 2016; Houngbedji *et al*., 2015). Contrary to these findings, our study observed a higher burden of malaria in adult females attending these health facilities.

The greater representation of male individuals above 40 years old among participants may indicate a higher susceptibility to malaria infection or a greater likelihood of seeking medical attention for malaria symptoms in this age group. This observation is consistent with studies from hyperendemic and hypoendemic areas outside Africa, which also noted a male bias in parasite prevalence among adolescents and adults (Newell *et al*., 2016; Houngbedji *et al*., 2015). Factors contributing to this male bias include higher bed net usage among reproductive-age females, behavioural differences such as alcohol and tobacco consumption that increase male attractiveness to mosquitoes, and sex-specific biological differences including post-pubertal hormonal changes (Lefèvre *et al*., 2010). These differences in parasite prevalence between sexes may result from variations in infection incidence or the duration of individual infections.

The distribution of participants across various health facilities, particularly Wuse District Hospital, highlights the importance of understanding local healthcare-seeking behaviours. It underscores the need for equitable access to healthcare services across different demographics. However, this study had several limitations. First, parasitaemia was not assessed in the communities around the health facilities, preventing the evaluation of associations between gender and the risk of asymptomatic parasitaemia or symptomatic malaria in the presence of parasitaemia. Second, the study did not assess biological factors that might explain the differences in malaria burden between females and males (Lotter *et al*., 2019; Klein *et al*., 2016). Third, estimates of malaria incidence were based on cases diagnosed at the health facilities, excluding episodes of malaria not captured by the health facility-based surveillance system.

Despite these limitations, the large sample size, the magnitude of the observed differences, and the consistency of findings across multiple study sites support the robustness of the main study findings. Retrospective studies revealed that many women visiting health facilities were pregnant, confirming the association between female gender and an increased burden of malaria, especially during peak fertility ages. Numerous studies have demonstrated that pregnant women are at increased risk of Plasmodium falciparum infection and experience higher parasite densities and rates of clinical malaria than non-pregnant women (Danwang *et al*., 2020).

While certain trends were observed in gender and age distributions, no statistically significant differences were found. This suggests that malaria healthcare-seeking behaviours may not vary significantly based on gender or age within the studied population, aligning with the findings of Gunture *et al*., (2021) in their cross-sectional malaria study in Indonesia.

The distribution of Plasmodium species among malaria-suspected cases in the FCT shows various patterns concerning age, gender, and health facility utilization. Understanding these distributions is crucial for tailoring effective malaria prevention and control strategies, ensuring equitable access to healthcare services, and addressing specific needs within different demographic groups. Further research is warranted to explore the underlying factors driving these distributions and to inform targeted interventions.

CONCLUSION

This study provides insights into prevalence of malaria in the Federal Capital Territory (FCT) of Nigeria, with a focus on demographic factors such as age, gender, and healthcare utilization. The findings of this study indicated a slight predominance of females over males, suggesting that women may be more proactive in seeking healthcare for malaria-related symptoms. The observed malaria prevalence rate of 32.0% indicates that relevant strategies must be put in place to curb malaria. Given the limitations of the study, including the absence of community-level parasitaemia assessments and biological factor evaluations, further research is essential to explore the underlying factors influencing these distributions and to enhance the effectiveness of malaria interventions in the FCT.

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