



Science Forum (Journal of Pure and Applied Sciences)



Journal Homepage: <https://atbuscienceforum.com.ng/index.php/jpas>

Prevalence of Malaria and Plasmodium Parasite Speciation in Selected Local Government Areas of Gombe North, Gombe State, North Eastern Nigeria

Ishaku M.¹, Pukuma S. M.², Chessed G.³, Ahmanullah A. A.⁴, Abdurrauf T. U.⁴

^{1&4}Department of Zoology and Wildlife ecology, Faculty of Science, Gombe State University, Gombe, Gombe State Nigeria

^{2&3}Department of Zoology, Faculty of Life Science Modibbo Adama University Yola, Adamawa State, Nigeria

Abstract

Malaria remains a major public health challenge in Nigeria, driven by sustained transmission intensity, the emergence of antimalarial drug resistance, and the circulation of multiple *Plasmodium* species. This study evaluated the prevalence of malaria and the distribution of *Plasmodium* species in Gombe, Kwami, and Funakaye Local Government Areas (LGAs) of Gombe North Senatorial District, Nigeria. A cross-sectional epidemiological study design was employed across the three LGAs. A total of 1,152 participants were screened for *Plasmodium* infection using standard parasitological procedures. Thick and thin blood smears were prepared, stained, and microscopically examined for malaria parasite detection and species identification. Data were analyzed using descriptive statistics and chi-square tests, with statistical significance established at $p < 0.05$. The overall malaria prevalence across the study area was 62.41%, with significant spatial variation among the LGAs ($\chi^2 = 10.61$, $p = 0.005$). Kwami LGA recorded the highest prevalence rate (69.01%), followed by Funakaye (60.16%) and Gombe LGA (58.07%). Although malaria infection was prevalent across all age categories, the highest burden was observed among children aged 0-10 years and individuals aged 16-20 years; however, age-associated differences were not statistically significant ($p = 0.182$). Gender-based analysis revealed significantly higher infection rates among males (67.34%) compared to females (57.95%) ($\chi^2 = 10.74$, $p = 0.001$). *Plasmodium falciparum* was the predominant species, accounting for 92.71% of infections, whereas *P. malariae* (3.39%), *P. ovale* (2.26%), and *P. vivax* (0.69%) occurred at comparatively lower frequencies. The findings demonstrate sustained malaria transmission in Gombe North and underscore the urgent need for strengthened malaria control strategies, improved treatment compliance, enhanced vector management, and continuous epidemiological surveillance.

Keywords

Malaria, Prevalence, Speciation, Plasmodium, Cross-sectional, Transmission

ISSN 1119-4618



1119 4618

JPAS



Faculty of Science, ATBU Bauchi

Introduction

The far-reaching impact of malaria on Nigeria's health, economic development and social well-being underscore its status as a major public health issue. Malaria is associated with significant morbidity and mortality rates in the country, particularly among pregnant women and children under the age of five (NMEP, 2021) leading to a detrimental effect on healthcare expenses, productivity and socioeconomic progress.

In 2023, malaria caused an estimated 263 million cases and 597,000 deaths worldwide, with a significant increase in cases compared to 2022. Factors contributing to the rise include climate-related disasters, population growth, and conflicts, leading to a disproportionate impact on children under five (WHO, 2024). The African Region bore the brunt of this, accounting for about 94% of cases and 95% of deaths predominantly in countries like Nigeria and the Democratic Republic of Congo. Nigeria alone continues to carry the largest burden worldwide, accounting for 25.9% global estimated cases and about 31% of global deaths as well as 55% of West Africa cases in 2023.

The predominant etiological agent of malaria in Nigeria is the *Plasmodium falciparum* parasite, which is found in over 95% of cases (Alonso et al., 2019). The virulent form of the malaria parasite, *P. falciparum*, is associated with malaria complications such as cerebral malaria and severe anaemia (Kwenti, 2018). According to a study by Akintunde et al. (2016), *P. falciparum* is more likely than other Plasmodium species to develop antimalarial drug resistance. This poses a significant challenge for malaria control and eradication initiatives in Nigeria. Although less prevalent

than *P. falciparum*, Nigeria also harbours additional Plasmodium species, such as *P. ovale* and *P. malariae* (Morakinyo et al., 2018), even though the extent of endemicity may differ among the different geographic zones of the country, systematic study indicates that *P. falciparum* is consistently prevalent in all regions (Nmadu et al., 2015). A comprehensive understanding of the distribution patterns of Plasmodium species in Nigeria is crucial for monitoring the emergence and dissemination of drug-resistant parasites and devising specific strategies to manage the disease.

Effective antimalarial drugs are critical for treating and preventing malaria, and their use is necessary for the country's efforts to control and eliminate the disease. However, the persistence and spreading of antimalarial drug resistance pose a considerable threat to these strategies. Recognizing the high occurrence of drug-resistant malaria parasites in Nigeria has led to the adoption of artemisinin-based combination therapies (ACTs) as the first treatment option for early disease cases (Akintunde et al., 2016). In 2005,

The Nigerian Federal Ministry of Health selected artemisinin-based combination therapies (ACTs) as the primary drug for treatment of uncomplicated malaria following the identification of widespread chloroquine resistance (NMEP, 2021). ACTs contain an artemisinin derivative that works quickly and a complementary drug like lumefantrine or amodiaquine that works for a longer or shorter time. The idea behind this combination is to use artemisinins' ability to kill parasites quickly and companion medicine's ability to work for a longer time to stop recurrence and

slow the development of resistance (Eastman & Fidock, 2009).

Materials and Methods

Study Site/Design description

Two communities each of Gombe (Pantami and Tudun wada), Funakaye (Bajoga and Ribadu) and Kwami (Malan Sidi and Bojude) Local Government Areas (LGAs) of Gombe North,

Gombe State, were purposively selected due to their high malaria burden and their representation of the ecological and socio-economic diversity of the region. These LGAs lie within the Sudan-Sahel savannah zone, characterized by a tropical continental climate with a long dry season and a short rainy season, conditions that strongly influence mosquito breeding patterns and malaria transmission.

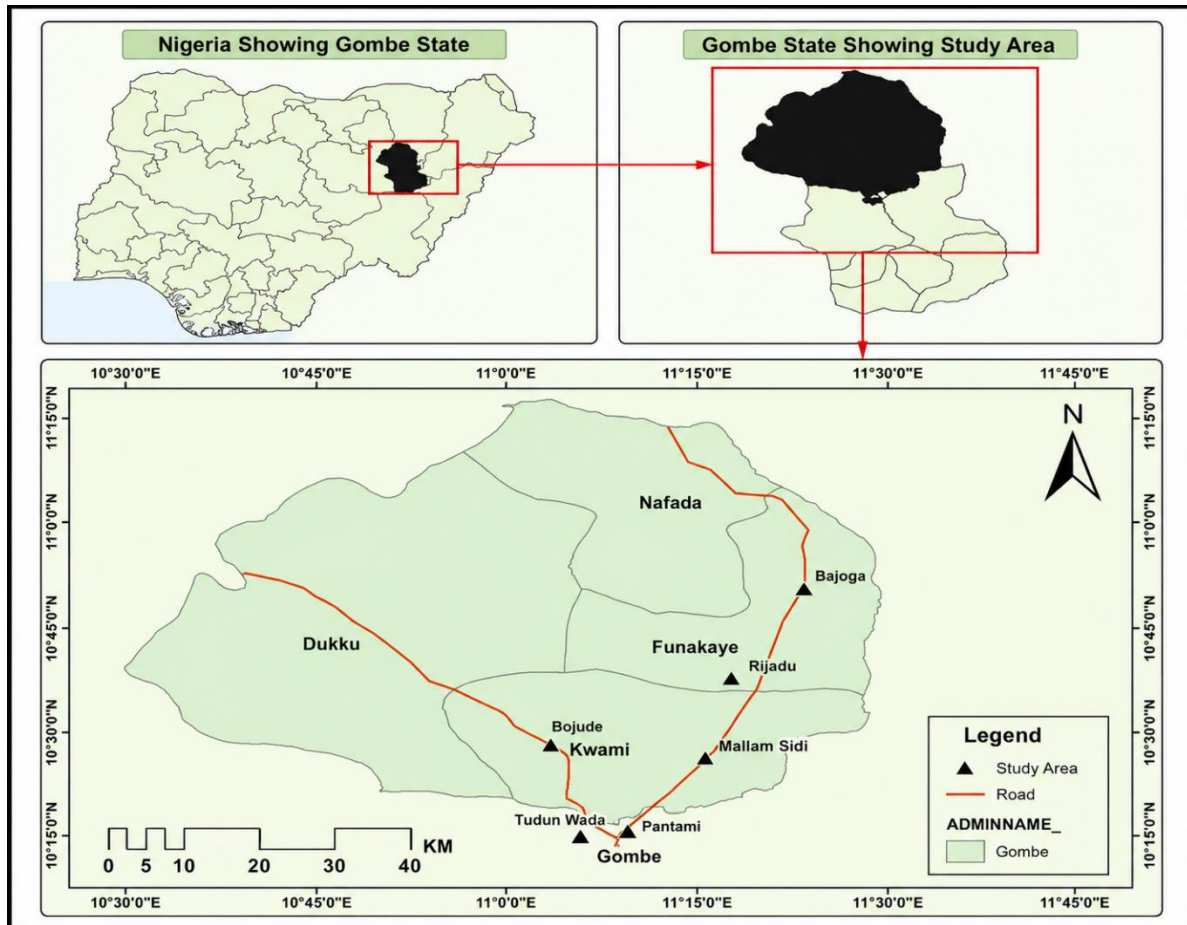


Figure 1. Sketch Map of Gombe State showing the study areas

Sample size determination

A total of 1,152 samples were collected for this study, with 384 samples allocated to each LGA. The sample size was determined using the standard formula for prevalence studies as described by Naing & Winn (2006), ensuring adequate statistical power and representation across the study locations.

$$n = (Z^2 \times p \times (1 - p)) / d^2$$

Where:

n = required sample size

Z = Z-score corresponding to 95% confidence level (1.96)

p = prevalence of malaria (from pilot studies) of 50%

d = precision or margin of error of 5% (0.05)

Ethical consideration

Approval to conduct the study was obtained from Gombe State Ministry of health and a copy of the approval letter was given to the concerned hospital management. Informed verbal consent was obtained from patients and/or their care givers before blood collection.

Inclusion criteria

Patients of all ages and gender who reported to the selected primary health care facility in the study area with symptoms of malaria and referred to laboratory for malaria diagnosis during the time of sample collection were considered eligible for the study.

Exclusion criteria

Patients were considered ineligible for the study if they had taken any antimalarial drug in the preceding 24hrs or showed clinical or laboratory evidences of other diseases.

Blood sample collection

Blood sample was collected for malaria screening and study through venipuncture technique to check the presence of *Plasmodium* parasites in the peripheral smear of patient's blood. The blood collection was done in the health facility by laboratory technician. About 2-5 ml of blood was drawn from the patient with a 5ml sterile disposable syringe and transferred into a heparinized centrifuge tube. The blood sample was transported to the laboratory at 4°C for further analysis.

Determination of positive sample and speciation

Thick and thin film stained with Giemsa was prepared for microscopic examination of the malaria parasite. The thin films was fixed with methanol and all films was stained with 3% Giemsa stain of pH 7.0 for 30 min as

recommended by WHO (2000). Blood film was examined microscopically using ×100 (oil immersion) objectives as described by Cheesbrough (2000). The thick film was used to determine the parasite densities while thin film was used to identify the parasite species. The results from the blood sample thick and thin smears were used to determine the prevalence of malaria in the study area.

Data Analysis

Variables were summarized as frequencies and compared using Pearson chi-square test. The level of significance was set and considered at $P \leq 0.05$.

Result

Overall malaria prevalence in relation to age group, gender and study area

Table 1 showed overall malaria prevalence in relation to age group, gender and study locations. A total of 1,152 individuals were examined, resulting in 719 positive cases and an overall malaria prevalence of 62.41%. The prevalence varied but remained high across all age group, specifically, 150 out of 228 children in the 0-5 age group were positive (65.79%), while the 6-10 age group showed the highest prevalence with 126 positive cases out of 191 examined (65.97%). In the 11-15 age group, 128 out of 214 individuals were infected (59.81%), and in the 16-20 age group, 109 out of 167 individuals tested positive (65.27%). The lowest prevalence was found among those above 20 years where 206 out of 352 individuals were positive (58.52%). A Chi-square analysis of these findings ($\chi^2 = 6.24$, $df = 4$) resulted in a p-value of 0.182, indicating that the differences across age groups are not statistically significant.

It was observed that 369 out of 548 males were positive, leading to a prevalence of

67.34%. Whereas, 350 out of 604 females were positive, resulting in a lower prevalence of 57.95%. The Chi-square test showed ($\chi^2 = 10.74$, $df = 1$) yielding a p-value of 0.001, demonstrating that the higher rate of infection among males is statistically significant.

Malaria prevalence in relation to the study area indicates that Kwami showed the highest prevalence at 69.01% (265 of 384), followed by Funakaye at 60.16% (231 of 384), and Gombe at 58.07% (223 of 384) with ($\chi^2 = 10.61$, $P = 0.005$), indicating that the variation in malaria prevalence between the study areas is highly statistically significant.

Prevalence of malaria in relation to age group and gender in Funakaye LGA

The age and gender related distribution of malaria infection in Funakaye LGA is shown in Table 2. Of the 384 individuals examined, 231

were positive for malaria yielding prevalence of 60.16%. The highest prevalence was observed among individuals above 20 years of age, with 25 out of 35 testing positive, corresponding to a prevalence of 71.43%, this was followed by the 0-5 years age group which recorded a prevalence of 64.13% (59 positive out of 92 tested). Individuals aged 16-20 years also showed a high prevalence of 63.77% (44 positive out of 69 tested). Lower prevalence were recorded among children aged 11-15 years and 6-10 years, with prevalence of 56.14% (64 positive out of 114) and 52.70% (39 positive out of 74), respectively.

The prevalence of malaria by gender shows that of the 195 males examined, 124 were positive resulting in a prevalence of 63.59%. Females recorded a lower prevalence of 56.61%, with 107 positive cases out of 189 examined.

Table 1: Overall malaria prevalence in relation to age group, gender and study area

Age group	No. Examined	No. Positive	Prevalence	χ^2 - Cal.	P-value
0-5	228	150	65.79	6.24	0.182
6-10	191	126	65.97		
11-15	214	128	59.81		
16-20	167	109	65.27		
Above 20	352	206	58.52		
Gender					
Male	548	369	67.34	10.74	0.001
Female	604	350	57.95		
Location					
Funakaye	384	231	60.16	10.61	0.005
Gombe	384	223	58.07		
Kwami	384	265	69.01		
Total	1,152	719	62.41		

Table 2: Prevalence of Malaria in Relation to Age Group and Gender in Funakaye LGA

Age group	No. Examined	No. Positive	Prevalence	X ² - Cal.	P-value
0-5	92	59	64.13	5.32	0.256
6-10	74	39	52.70		
11-15	114	64	56.14		
16-20	69	44	63.77		
Above 20	35	25	71.43		
Gender					
Male	195	124	63.59	1.67	0.196
Female	189	107	56.61		
Total	384	231	60.16		

Prevalence of malaria in relation to age group and gender in Gombe LGA

The distribution of malaria infection across age groups and gender in Gombe LGA is presented in Table 3. Out of the 384 individuals examined, 223 tested positives for malaria parasites, resulting in an overall prevalence of 58.07%. The highest prevalence was recorded among children aged 0-5 years with 53 positive cases out of 81 examined (65.43%). This was followed by individuals aged 11-15 years and 6-10 years with prevalence rates of 62.79% (27 positive out of 43 tested) and 62.00% (31 positive out of 50 tested) respectively.

Participants aged 16-20 years recorded a prevalence of 61.11% (33 positive out of 54), while the lowest prevalence was observed among individuals above 20 years of age, with 79 positive cases out of 156 examined (50.64%). Malaria prevalence by gender indicates that among the 149 males examined, 90 were positive for malaria, giving a prevalence of 60.40%. Females recorded a slightly lower prevalence of 56.59%, with 133 positive cases out of 235 examined.

Prevalence of malaria in relation to age group and gender in Kwami LGA

The prevalence of malaria infection among the study population in Kwami LGA across different age groups and gender is seen in table 4. Out of the 384 individuals examined, 265 were positive for malaria parasites, giving an overall prevalence of 69.01%. The highest prevalence was observed among children aged 6-10 years, with 56 out of 67 individuals testing positive corresponding to a prevalence of 83.58%. This is followed by individuals aged 16-20 years who recorded a prevalence of 72.72% (32 positive out of 44 tested). Children aged 0-5 years also showed a high prevalence of 69.09% (38 positive out of 55 tested). Lower prevalence was observed among individuals aged 11-15 years and those above 20 years, with prevalence of 64.91% (37 positive out of 57 tested) and 63.35% (102 positive out of 161 tested) respectively.

Distribution of malaria prevalence by gender showed that of the 204 males examined, 155 were positive for malaria, resulting in a prevalence of 75.98%. In contrast, females recorded a lower prevalence of 61.11%, with 110 positive cases out of 180 examined

Table 1: Prevalence of Malaria in Relation to Age Group and gender in Gombe LGA

Age group	No. Examined	No. Positive	Prevalence	X ² - Cal.	P-value
0-5	81	53	65.43	6.25	0.181
6-10	50	31	62.00		
11-15	43	27	62.79		
16-20	54	33	61.11		
Above 20	156	79	50.64		
Gender					
Male	149	90	60.40	0.543	0.461
Female	235	133	56.59		
Total	384	223	58.07		

Table 4: Prevalence of malaria in relation to age group and gender in Kwami LGA

Age group	No. Examined	No. Positive	Prevalence	X ² - Cal.	P-value
0-5	55	38	69.09	9.79	0.044
6-10	67	56	83.58		
11-15	57	37	64.91		
16-20	44	32	72.72		
Above 20	161	102	63.35		
Gender					
Male	204	155	75.98	9.20	0.002
Female	180	110	61.11		
Total	384	265	69.01		

Distribution of *Plasmodium* species among malaria-positive samples across study locations in Gombe State

Table 5 showed that a total of 1,152 malaria positive samples were examined across the three study locations (Gombe, Kwami, and Funakaye) with 384 samples collected from each site. In Gombe, *Plasmodium falciparum* was the predominant species, detected in 365 samples representing (95.05%), followed by *P. malariae* 8(2.08%) and *P. ovale* 6(1.56%). Mixed-species infections were observed in 5 samples (1.30%), while *P. vivax* was not detected.

In Kwami, *P. falciparum* remained the most prevalent, found in 346 samples (90.10%). Other species identified included *P. malariae* 19(4.95%), *P. ovale* 12(3.13%), and *P. vivax* 4(1.04%). Mixed infections occurred in 3 samples (0.78%). Similarly, in Funakaye, *P. falciparum* dominated with 357 samples (92.97%), followed by *P. malariae* 12(3.13%) and *P. ovale* 8(2.08%). *P. vivax* occurred in 4 samples (1.04%), and mixed infections were recorded in 3 samples (0.78%).

When the results from all sites were combined, *P. falciparum* accounted for 1,068 (92.71%) of all infections, confirming it as the

dominant malaria parasite species across the study area. Non-*falciparum* species collectively represented 7.3% of infections, with *P.*

malariae (3.39%), *P. ovale* (2.26%), *P. vivax* (0.69%), and mixed infections (0.96%) contributing relatively small proportions.

Table 2: Distribution of *Plasmodium* species among malaria-positive samples across study locations in Gombe State

Location	No. of Samples	<i>P. falciparum</i>	<i>P. ovale</i>	<i>P. malariae</i>	<i>P. vivax</i>	Mixed species
Gombe	384	365(95.05%)	6(1.56%)	8(2.08%)	0(0.0%)	5(1.30)
Kwami	384	346(90.10)	12(3.13%)	19(4.95%)	4(1.04%)	3(0.78)
Funakaye	384	357(92.97%)	8 (2.08%)	12(3.13%)	4(1.04%)	3(0.78)
Total	1,152	1,068(92.71%)	26(2.26%)	39(3.39%)	8(0.69%)	11(0.95%)

Discussions

The findings of this study provide a comprehensive assessment of the malaria prevalence across Funakaye, Gombe, and Kwami LGAs of Gombe North (Tables 4.1), revealing an overall prevalence of 62.41%. This high infection rate classifies the region as hyper-endemic, a status that significantly exceeds the national average of 15.54% reported by Agboola et al., (2025). Such a disparity suggests that the ecological zone of Gombe State continues to facilitate more intense transmission dynamics. It is worth noting that Umar (2006) observed an even higher prevalence of 94% in Gombe children nearly two decades ago. This indicates that while the burden remains critically high, there may be a long-term downward trend resulting from sustained intervention efforts in the country.

Overall age-related prevalence showed children aged 6-10 years and 0-5 years exhibited the highest burdens (65.97% and 65.79%, respectively). These results are

consistent with the observations of Mbanugo and Ejim (2000), who documented that pediatric populations remain the most vulnerable due to their gradually developing immunity. Notably, while these findings showed a significant male predominance in infection (67.34% and 57.95% respectively), which Oseghale, (2025) attribute to occupational outdoor exposure in rural settings,

The findings of overall malaria prevalence across the three study sites further indicates the endemic status in the region, with the statistically significant variation ($\chi^2 = 10.61$, $P = 0.005$) highlighting Kwami (69.01%) as the most burdened site. This high prevalence aligns with the findings of Idris et al., (2025), who reported a prevalence of 61.1% in similar ecological zones of Northwestern Nigeria, attributing such high rates to the presence of irrigation dams and agricultural activities that provide year-round breeding sites for *Anopheles* mosquitoes. The significantly lower

prevalence in Gombe LGA (58.07%) compared to Kwami likely reflects the "urban advantage," where better housing quality and improved drainage systems reduce vector-human contact, a phenomenon documented by Olorunniyi et al., (2019) in their comparative study of urban and peri-urban malaria communities in Ikiti State. Additionally, the localized data from this study suggests that rural and semi-urban hubs in the Savannah remain high-risk zones (Akinola et al., 2019). This underscores the necessity of sub-national tailoring of intervention strategies, as the environmental and landscape of Kwami appears to facilitate higher transmission cycles than the more developed Gombe metropolis.

The age-related prevalence data across the three study sites (Tables 4.2, 4.3, and 4.4) reveals a high malaria burden, particularly among school-aged children and children under five. In Kwami, children aged 6-10 years reached a prevalence of 83.58%, while in Gombe, the 0-5 age group led with 65.43%. This trend is strongly corroborated by Simon-Oke, 2019, who found that children under 10 years remain the primary reservoir for malaria in Nigerian communities due to incomplete clinical immunity and high vector exposure.

Furthermore, the high prevalence in the 6-10-year group in Kwami supports the findings of Gebretensae et al., (2025), who argued that school-aged children are often overlooked in intervention programs (which typically focus on children under five), leading to high asymptomatic carriage and transmission in this specific demography. Interestingly, findings in Funakaye that adults above 20 years had the highest prevalence of (71.43%) provides a unique contrast; this aligns with

research by Ozodiegwu et al., (2025), which noted that in certain rural agrarian settings, adult males and females involved in late-night outdoor activities or early-morning irrigation farming face higher exposure than stay-at-home children.

Gender-related prevalence showed a consistent pattern of male predominance, most notably in Kwami where males recorded a prevalence of 75.98% compared to 61.11% in females. This significant disparity is supported by Isiko et al., (2021), who observed that males often exhibit higher infection rates due to cultural habits, such as sleeping outdoors during heatwaves or staying out late for community social activities, which increases their exposure to the *Anopheles* mosquito's vector. Additionally, Fatunla et al., (2022) and Olapeju et al., 2018 observed in their studies that while women often have better access to and usage of insecticide-treated nets (ITNs) through maternal health programs, men frequently neglect net use, contributing to their exposure to malaria vector.

The *Plasmodium* parasitological profile of the study area revealed in table 4.5 confirms the overwhelming dominance of *Plasmodium falciparum*, which accounted for 92.71% of the total samples examined. This finding is in direct alignment with the Federal Ministry of Health (FMOH, 2015) national data, which identifies *P. falciparum* as the agent responsible for approximately 98% of clinical malaria cases in Nigeria. This dominance is further corroborated by Nassai et al., (2022), who identified it as the principal driver of transmission within Gombe State.

However, the detection of minor species, including *P. malariae* (3.39%), *P. ovale* (2.26%),

and *P. vivax* (0.69%), highlights a level of parasitic diversity that is often overlooked in urban-centric studies. For instance, Mbanugo and Ejim (2000) identified exclusively *P. falciparum* in Awka, Anambra State, suggesting that the ecological conditions in the Northeast by extension may support a broader range of *Plasmodium* species, which has significant implications for diagnostic and treatment protocols, proper diagnostic tools is important in identification of the parasite species for a specific or targeted treatment (Oyeyemi et al., 2019).

Conclusion

This study establishes that Gombe North is an endemic region for malaria with an overall prevalence of 62.41%, with the highest burden found in Kwami LGA (69.01%) and among children less than ten years of age. While *Plasmodium falciparum* is the dominant species at 92.71%, the presence of *P. malariae*, *P. ovale* and *P. vivax* indicates a parasitic diversity that necessitates specialized diagnostic attention.

References

- Agboola, H. O., Ajibola, O., Lasisi, A. J., Adebayo, F., Aremu, O., & Khan, S. (2025). Sociodemographic Factors Associated with Malaria Infection among Under-Five Children in Nigeria. *Nigerian Medical Journal*, 66(3), 1002-1011
- Akinola, O. O., Bodomu, O. I., Olukosi, Y. A., Idowu, E. T., Oyebola, M.K., and Otubanjo, O.A., (2019). Malaria transmission and distribution in the geographical zones of Nigeria. *Nigerian Journal of Parasitology*, 40(2), 162-172.
- Akintunde, S., Kazeem, A., Adejumo, I. A., Godwin, N., Elsie, O. A., Bayo, F., Temitope, A. (2016). Therapeutic efficacy and effects of artesunate-amodiaquine and artemether-lumefantrine on malaria-associated anaemia in Nigerian children aged two years and under. *Infectious Diseases of Poverty*, 5, 70.
- Cheesbrough, M. (2000). *District laboratory practice in tropical countries: Part 2*. Cambridge University Press.
- Eastman, R. T., & Fidock, D. A. (2009). Artemisinin-based combination therapies: A vital tool in efforts to eliminate malaria. *Nature Reviews Microbiology*, 7(12), 864-874. <https://doi.org/10.1038/nrmicro2239>
- Fatunla, O. A. T., Olatunya, O. S., Ogundare, E. O., Fatunla, T. O., Babatola, A. O., Adeniyi, A. T., & Oyelami, O. A. (2022). Malaria prevention practices and malaria prevalence among children living in a rural community in Southwest Nigeria. *The Journal of Infection in Developing Countries*, 16(02), 352-361. <https://doi.org/10.3855/jidc.14894>
- Federal Ministry of Health (FMOH). (2015). *National guidelines for the diagnosis and treatment of malaria* (3rd edition). Abuja, Nigeria.
- Gebretensae, D., Agegnehu, W., Zewdia, W., Gebretensae, Y, Debebe, S., Asres, A. (2025). The Burden of Asymptomatic Malaria Infection in Children in Sub-Saharan Africa: A Systematic Review and Meta-Analysis Exploring Barriers to Elimination and Prevention. *Journal of Epidemiology and Global Health*. 15. 10.1007/s44197-025-00365-2.
- Isiko, I., Nyegenye, S., Bett, D. K., Asingwire, J. M., Okoro, L. N., Emeribe, N. A., Koech, C. C., Ahgu, O., Bulus, N. G., Taremwa, K., Mwesigwa, A. (2021) Factors associated with the risk of malaria among children: analysis of 2021 Nigeria Malaria Indicator Survey. *Malaria Journal* 23(1):109. doi: 10.1186/s12936-024-04939-6. PMID: 38632581; PMCID: PMC11025242.
- Kwenti, T. E. (2018). Malaria and HIV coinfection in sub-Saharan Africa: prevalence, impact, and treatment strategies. *Frontiers in Public Health*, 6, 15. <https://doi.org/10.3389/fpubh.2018.00015>
- Mbanugo, J. I., & Ejim, Q. C. (2000). *Plasmodium falciparum* infection among children in Awka,

- Anambra State, Nigeria. *The Nigerian Journal of Parasitology*, 21(1), 31-38.
- Morakinyo, O. M., Balogun, F. M., & Fagbamigbe, A. F. (2018). Housing type and risk of malaria among under-five children in Nigeria: Evidence from the malaria indicator survey. *Malaria Journal*, 17(1), 1-11. <https://doi.org/10.1186/s12936-018-2463-6>
- Nassai, I., Pukuma, M. S., Chessed, G., Kunihya, I. Z., Seni, J. B., Kure, N. H., & Godwin, P. (2022). Malaria Infection: Knowledge, Attitude and Perception among the Inhabitants of Shongom Local Government Area, Gombe State, Nigeria: <https://dx.doi.org/10.4314/njpar.v43i2.10>. *Nigerian Journal of Parasitology*, 43(2), 276-285. Retrieved from <https://njpar.com.ng/index.php/home/article/view/225>
- National Malaria Elimination Programme (NMEP). (2021). *Nigeria Malaria Indicator Survey 2021: Final Report*. Abuja, Nigeria: Federal Ministry of Health.
- Nmadu, P. M., Peter, S., Alexander, P., Kwasau, S. A., & Uni, Z. (2015). The prevalence of malaria in children between the ages 2-15 visiting Gwarinpa General Hospital Life-Camp, Abuja, Nigeria. *Journal of Health, Medicine and Nursing*, 16, 48-52.
- Olapaju, B., Choiriyah, I., Lynch, M., Acosta, A., Blaufuss, S., Filemyr, E., Harig, H., Monroe, A., Selby, R. A., Kilian, A., and Koenker, H., (2018). Age and gender trends in insecticide-treated net use in sub-Saharan Africa: A multicountry analysis. *Malaria Journal*, 17(1), 1-12.
- Olorunniyi, O., Idowu, O., Idowu, A. B., Pitan, O., Samuel, B. (2019). Malaria Parasite Infection in Some Periurban and Rural Communities in Ekiti State, Nigeria. *Journal of Advances in Biology & Biotechnology*. 1-11. 10.9734/jabb/2019/v22i330118.
- Oseghale, O. E. (2025). Gender Disparities in Malaria Outcomes amongst Residents of Edo South Senatorial District, Edo State, Nigeria. *Journal of Applied Sciences and Environmental Management*, 29(2), 483-488. <https://doi.org/10.4314/jasem.v29i2.18>
- Oyeyemi, O. T., Ogunlade, A. F., and Oyewole, I. O., (2019). Comparative assessment of microscopy and rapid diagnostic test (RDT) as malaria diagnostic tools. *Research Journal of Parasitology*, 14, 1-8.
- Ozodiegwu, I., Legris, G., Chiziba, C., Mhlanga, L. (2025). Agricultural Work, Malaria Prevalence, and Mediating Factors: A Cross-Sectional Analysis of Data from 15 Sub-Saharan African Countries to Inform Risk Stratification and Intervention Planning. 10.1101/2025.07.21.25331926.
- Simon-Oke, A. (2019). Prevalence of Malaria Parasites among Pregnant Women and Children under Five years in Ekiti State, Southwest Nigeria.. *Journal of Biomedicine and Translational Research*. 5. 5. 10.14710/jbtr.v5i1.3711.
- Umar M. M (2006). NCE thesis on prevalence of malaria in Gombe Local Government Area.
- World Health Organization. (2000). *Basic malaria microscopy: Part I. Learner's guide*.
- World Health Organization. (2024). *World malaria report 2024*. Geneva: World Health Organization. <https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2024>