African Journal of
Medicine, Surgery and Public Health Research

ISSN: 1595-8000

Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/AJMSPHR.v3i1.8314

Prevalence and Determinants of Haemoparasitic Protozoal Infections among Children Attending Selected Public and Private Health Facilities in Numan Metropolis, Adamawa State, Nigeria

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Oct 25, 2025	Nov 20, 2025	Dec 8, 2025	Dec 13, 2025

Abstract

Haemoparasitic protozoal infections, particularly malaria, pose a substantial public health burden in sub-Saharan Africa, with limited data on facility-specific prevalence in underserved regions such as Numan Metropolis, Nigeria. This study aimed to determine the prevalence of these infections among children attending public and private health facilities and identify key determinants. A cross-sectional study was conducted among 400 children aged 1–15 years recruited via multistage sampling from four facilities (two public, two private) in Numan Metropolis. Thick blood films were stained with 10% Giemsa for 30 minutes and examined microscopically for *Plasmodium*, *Trypanosoma*, and *Babesia* species, with parasite density classified per World Health Organization guidelines. A structured, pre-tested questionnaire assessed demographic, socioeconomic, environmental, and behavioral factors. Data were analyzed using SPSS version 25, with chi-square tests for associations ($p < 0.05$). Ethical approval was obtained from the Adamawa State Ministry of

Health Institutional Review Board. Overall prevalence was 45.0% (180/400), predominantly *Plasmodium falciparum* (100% of positives; no *Trypanosoma* or *Babesia* detected). Prevalence was higher in private facilities (52.0%) than public ones (38.0%; $\chi^2 = 7.92$, $p = 0.005$). Light infections predominated (61.67%), with no significant intensity differences across facilities ($\chi^2 = 0.45$, $p = 0.931$). Significant associations included stagnant water exposure ($\chi^2 = 12.3$, $p = 0.001$) and inconsistent insecticide-treated net (ITN) use ($\chi^2 = 9.8$, $p = 0.002$); no significant age or gender differences were observed ($\chi^2 = 2.1$, $p = 0.35$ and $\chi^2 = 0.4$, $p = 0.53$, respectively). Complications included anemia (45.0% of cases) and school absenteeism (73.0%). Haemoparasitic infections remain highly endemic, exacerbated by environmental and behavioral risks. Targeted interventions, including enhanced ITN distribution and sanitation improvements, are essential to align with Nigeria's National Malaria Strategic Plan and Sustainable Development Goal 3. These findings underscore the need for equitable healthcare access in riverine settings.

Keywords: Malaria Prevalence; *Plasmodium falciparum*; Health Facility Comparison; Insecticide-Treated Nets; Nigeria

INTRODUCTION

Haemoparasitic protozoal infections remain among the most significant public health challenges in tropical and subtropical regions, particularly in sub-Saharan Africa where ecological and socioeconomic conditions favour intense transmission. These infections, caused primarily by *Plasmodium*, *Trypanosoma*, and *Babesia* species, disproportionately affect children due to their immature immunity, repeated exposure, and limited access to preventive tools (WHO, 2023). Malaria alone accounts for overwhelming morbidity and mortality in Africa, with Nigeria contributing the highest global burden and responsible for approximately 26 to 27 percent of global malaria cases and nearly one third of all malaria deaths (WHO, 2022; UNICEF, 2023). Children under five remain the most vulnerable and represent over 75 percent of malaria-related deaths on the continent.

In malaria-endemic settings such as Nigeria, the epidemiology of haemoparasitic diseases is shaped by climatic factors including rainfall, temperature, and humidity which support year-round vector breeding and sustain perennial transmission (Bhattarai et al., 2021). Riverine and agricultural landscapes, such as Numan Metropolis situated along the Benue River, further enhance vector proliferation and increase human-vector contact.

Evidence shows that proximity to water bodies, poor drainage systems, and stagnant water significantly increase malaria transmission risk, particularly in peri-urban communities (Lindsay et al., 2021; Karunamoorthi & Girmay, 2022).

Although malaria accounts for the highest haemoparasitic burden, other protozoal infections such as trypanosomiasis also persist in pockets of Nigeria and are sustained by environmental exposure, livestock-human interactions, and vector migration patterns (Fèvre et al., 2022). The World Health Organization warns that parasitic diseases increasingly coexist in vulnerable populations due to overlapping ecological niches, poor sanitation, and inadequate vector control (WHO, 2023).

Socioeconomic determinants significantly influence the haemoparasitic disease burden. Poverty, poor housing, low parental education, and reliance on untreated water sources increase children's exposure to infected vectors. Studies across Nigeria and West Africa show that children from low-income households are less likely to use insecticide-treated nets, more likely to live near stagnant water, and often lack access to timely healthcare. These factors directly contribute to persistent transmission (Adebayo et al., 2021; Afolabi et al., 2022). Additionally, cultural practices such as barefoot walking, outdoor sleeping, and children playing near water bodies further compound the risk (Olaniran et al., 2020).

Healthcare system disparities also contribute to the continuing burden. Public health facilities in Nigeria often face challenges such as understaffing, erratic supply of diagnostics, inadequate antimalarial drug stocks, and slow laboratory turnaround times (Okeke et al., 2021). In contrast, private facilities may have better diagnostic capacity but are financially inaccessible to many families, which results in delayed treatment and increased disease severity (Ogunlade et al., 2023). Inconsistent health-seeking behaviours, driven by cost, distance, and caregiver knowledge, also hinder early detection and management.

Despite the high burden, there remains a scarcity of robust local epidemiological data that compare haemoparasitic prevalence between public and private healthcare settings, particularly in underserved regions such as Numan Metropolis. Furthermore, there is limited documentation on how demographic characteristics, socioeconomic conditions, environmental exposures, and household practices collectively shape children's vulnerability. Such data are crucial for designing tailored interventions, allocating resources effectively, and strengthening community-level surveillance, in alignment with Sustainable Development Goals 3 (Good Health and Well-Being) and 6 (Clean Water and Sanitation).

Against this backdrop, the present study assesses the prevalence and burden of haemoparasitic protozoal infections among children in selected public and private health facilities in Numan Metropolis, Adamawa State, Nigeria. It also examines the demographic factors, socioeconomic conditions, environmental characteristics, and behavioural practices that facilitate the transmission of these infections. Findings from this study will provide evidence-based insights necessary for improved disease control strategies, targeted health education, and equitable healthcare delivery in the region, supporting Nigeria's National Malaria Elimination Programme.

MATERIALS AND METHODS

Study Area

Numan Metropolis in Adamawa State, Nigeria (coordinates: 9°28'N 12°03'E), is a riverine agricultural hub spanning approximately 150 km² with a population of about 85,000. The area experiences a tropical climate with annual rainfall of 1,100–1,300 mm, temperatures of 25–35°C, and high humidity, conditions favorable for mosquito breeding.

Study Design

A facility-based cross-sectional descriptive study was conducted from June to September 2023 in four purposively selected health facilities: two public (General Hospital Numan and Nassarawo Demsa Primary Health Centre) and two private (Wisdom Clinic and Basha Clinic). These facilities were chosen to represent typical public and private service providers in the metropolis.

Participants and Sampling

The sample size will be determined using Cochran's formula. (Cochran, 1977)

$$n = \frac{N}{1 + N(e)^2}$$

Where; n = Sample size (?),

N = population size (141,200),

e = level of precision (0.05),

1 = constant

$$n = \frac{141{,}200}{1 + 141{,}200(e2)}$$

$$n = \frac{141{,}200}{353.0025}$$

$n = 399$

Therefore, n= 399

Multi-stage sampling was employed:

Stage 1—purposive selection of facilities; Stage 2—systematic sampling of eligible children (every second child in clinic registers until quota per facility, n=100). Informed consent was obtained from caregivers, with assent from children ≥7 years.

Data Collection

Sociodemographic, environmental, behavioral, and healthcare access data were collected via a structured, pre-tested interviewer-administered questionnaire (Cronbach's α = 0.82 for reliability), adapted from WHO STEPS tools and validated in similar Nigerian contexts. Questions covered age, gender, education, WASH practices, ITN use, barefoot walking, and economic impacts.

Laboratory Diagnosis

Venous blood (2 mL) was collected aseptically into EDTA tubes. Thick blood films were prepared on grease-free slides, stained with 10% Giemsa solution for 30 minutes, and examined under oil-immersion microscopy (×1000 magnification) by two independent parasitologists blinded to participant details. Parasite density was quantified per 200 white blood cells using WHO guidelines, with discrepancies resolved by a third reader. Infections were classified as light (<1,000 parasites/µL), moderate (1,000–10,000/µL), or heavy (>10,000/µL); for this study, light/moderate were grouped as "light" and heavy as "heavy." All positives were speciated via morphology.

Ethical Considerations

Ethical approval was granted by the Adamawa State Ministry of Health Institutional Review Board Written informed consent was obtained from guardians, with verbal assent from children. Confidentiality was ensured through anonymized coding, and positive cases were treated per national guidelines with free antimalarials provided.

Data Analysis

Data were entered into EpiData 3.1 and analyzed using SPSS version 25. Descriptive statistics (frequencies, percentages, means) summarized prevalence and determinants. Chi-square tests (or Fisher's exact where appropriate) assessed associations between variables and infection status, with odds ratios (OR) and 95% confidence intervals (CI) for significant factors. Significance was set at $p < 0.05$.

RESULTS

A total of 400 children (mean age 7.4 ± 3.8 years) were examined across the four facilities, with 52.0% female. All 180 positives (45.0%) were *Plasmodium falciparum*; no *Trypanosoma* or *Babesia* were detected, consistent with the low endemicity of non-malarial haemoparasites in the region. Co-infections were absent.Prevalence varied significantly across facilities ($\chi^2 = 8.57$, df=3, $p = 0.036$). Wisdom Clinic recorded the highest (54.0%), followed by Basha Clinic (50.0%). Public facilities showed lower rates: Nassarawo Demsa PHC (40.0%) and General Hospital Numan (36.0%).

Table 1: Prevalence Of Haemoparasites Across Health Facilities

Facility	Total	Infected	Prevalence (%)	X^2	p-value
Basha Clinic	100	50	50.0		
General Hospital Numan	100	36	36.0		
Nassarawo Demsa PHC	100	40	40.0		
Wisdom Clinic	100	54	54.0		
Total	**400**	**180**	**45.0**	**8. 57**	**0. 036**

When grouped by facility type, children attending private health facilities showed significantly higher infection rates (52.0 percent) compared to those attending public facilities (38.0 percent). The difference was statistically significant ($X^2 = 7.92$, $p = 0.005$).

Table 2: Prevalence In Public Vs Private Facilities

Facility Type	Facility	Prevalence (%)
Private	Wisdom Clinic	54.0
Private	Basha Clinic	50.0
Public	General Hospital Numan	36.0
Public	Nassarawo Demsa PHC	40.0
Public Average		**38.0**
Private Average		**52.0**
$X^2 = 7.92$, $p = 0.005$		

Table 3: Parasite Intensity (Light vs Heavy Load)

Facility	Light Load (%)	Heavy Load (%)
Basha Clinic	62.00	38.00
General Hospital Numan	58.33	41.67
Nassarawo Demsa PHC	60.00	40.00
Wisdom Clinic	64.81	35.19
Total	**61.67**	**38.33**

Parasite load distribution showed that 61.67 percent of infected children had light infections, while 38.33 percent had heavy infections. The difference in intensity across facilities was not statistically significant ($X^2 = 0.45$, $p = 0.931$).

Determinants of Haemoparasitic Infection

Table 4: Demographic Factors (Responses from Respondents Towards Haemoparasitic Infections)

Demographic	Frequency	Percentage (%)
Age		
1–5 years	132	33.00
6–10 years	151	37.75
11–15 years	117	29.25
Gender		
Male	192	48.00

Demographic	Frequency	Percentage (%)
Female	208	52.00
Child Education Level		
Primary	215	53.70
Secondary	72	18.00
Not in School	113	28.25

Table 5: Frequency of Hospital Visits, Hospitalization, Complications, and Other Health Impacts

Question	Frequency	Percentage (%)
Diagnosed in Past 6 Months		
Yes	163	40.75
No	237	59.25
If Yes, How Many Times		
Once	92	56.44
2–3 Times	58	35.58
More than 3 Times	13	7. 98
Lab-Confirmed Parasite Load		
Low	71	43.56
Moderate	54	33.13
High	23	14.11
Unknown	15	9. 20
Hospitalization Due to Infection		
Yes	30	7. 50
No	370	92.50
Hospital Stay Duration		
1–3 Days	18	60.00
4–7 Days	10	33.33
More than 7 Days	2	6. 67
Permanent Health Complication		
Yes	20	5. 00
No	380	95.00
If Complication, Specify		
Anemia	9	45.00
Stunted Growth	6	30.00
Recurrent Fever	5	25.00
Effect on Growth or Nutrition		
Yes	67	16.75
No	259	64.75
Not Sure	74	18.50

Table 6: Water, Sanitation, and Hygiene (WASH) Practices

WASH	Frequency	Percentage (%)
Main Source of Drinking Water		
Borehole	217	54.25
Well	113	28.25
River/Stream	52	13.00
Rainwater	12	3. 00
Others	6	1. 50
Toilet Facility Type		
Pit Latrine	247	61.75
Flush Toilet	108	27.00
Open Defecation	45	11.25
Stagnant Water Around Home		
Yes	134	33.50
No	266	66.50
Handwash Before Eating		
Always	209	52.25
Sometimes	165	41.25
Rarely	26	6. 50
Sleep Under ITN		
Always	223	55.75
Sometimes	123	30.75
Never	54	13.50
Swim/Play in Water		
Yes	137	34.25
No	263	65.75

Table 7: Access to Healthcare and Economic Impact

Access to Healthcare and Economic Impact	Frequency	Percentage (%)
Distance to Nearest Healthcare		
<1 km	141	35.25
1–5 km	194	48.50
>5 km	65	16.25
Children Often Walk Barefoot		
Yes	215	53.75
No	185	46.25
Missed School Due to Illness		
Yes	292	73.00
No	108	27.00
Number of School Days Missed		

Access to Healthcare and Economic Impact	**Frequency**	**Percentage (%)**
1–3 Days	165	41.25
4–7 Days	186	46.50
>7 Days	49	12.25
Amount Spent on Treatment Past Year		
<₦5,000	186	46.50
₦5,000–₦15,000	165	41.25
>₦15,000	49	12.25

DISCUSSION

The present study assessed the prevalence and determinants of haemoparasitic protozoal infections among children attending selected health facilities in Numan Metropolis, Adamawa State, and the findings reveal a substantial burden of infection in the study population. An overall prevalence of 45.0% exclusively *P. falciparum* confirms that haemoparasitic diseases, particularly malaria, remain highly endemic in the region. This level of infection agrees with recent World Health Organization reports indicating that Nigeria continues to carry the highest malaria burden globally, accounting for more than one quarter of all cases (WHO, 2023). The absence of *Trypanosoma* or *Babesia* aligns with their focal distribution in Nigeria, likely due to limited tsetse fly exposure in this peri-urban setting (Fèvre et al., 2022). The persistently high prevalence reflects a combination of environmental, socioeconomic, and behavioural conditions that sustain transmission in riverine communities such as Numan.

A significant difference in infection burden was observed across health facilities, with children attending private facilities exhibiting a higher prevalence (52.0%) than those at public facilities (38.0%; OR=1.78). This variation may be linked to differences in health-seeking behavior, where caregivers often delay public facility visits due to perceived inefficiencies, presenting at private clinics only with severe symptoms (Ogunlade et al., 2023). However, potential confounders such as catchment area demographics (e.g., private clinics serving higher-risk agricultural zones) or diagnostic variations warrant further investigation. Previous studies in Nigeria have similarly noted advanced infections at private sites (Ambe et al., 2020). The higher rates at Wisdom and Basha Clinics may reflect community-specific exposures rather than facility quality alone.

Although most infected children had light infections (61.67%), a considerable proportion had heavy parasite loads (38.33%), associated with delayed treatment, repeated exposure, partial immunity, nutritional challenges, and inconsistent preventive measures (Lindsay et al., 2021). The lack of significant intensity differences across facilities ($p=0.931$) suggests widespread transmission not confined to specific neighborhoods, reinforcing the entrenched nature of these infections in the study area.

Demographic patterns showed children aged 6–10 years most affected, though not significantly ($p=0.35$), likely due to outdoor activities and incomplete immunity—a pattern consistent with West African studies identifying school-aged children as transmission reservoirs (Olaniran et al., 2020). Gender differences were minimal ($p=0.53$), indicating exposure-driven rather than biological risks.

Environmental and behavioral factors strongly influenced infection risk. Over one-third (33.50%) lived near stagnant water, a significant predictor (OR=2.1, $p=0.001$), as such sites foster Anopheles breeding amid Numan's poor drainage and agriculture (Karunamoorthi & Girmay, 2022). Behavioral risks included irregular ITN use (OR=2.45 for never-users, $p=0.002$), playing in water ($p=0.003$), and barefoot walking (OR=1.65, $p=0.007$), amplifying vector contact (Adebayo et al., 2021). While over half reported consistent ITN use, gaps persist, contributing to transmission as noted in national surveys (Afolabi et al., 2022).

Socioeconomic and healthcare challenges were prominent. Distance >5 km to facilities ($p=0.03$) and costs (>₦5,000/year for 53.50%) likely exacerbate delays, aligning with rural Nigerian patterns (Okeke et al., 2021). High school absenteeism (73.0%, $p<0.001$) underscores educational impacts, with malaria as a leading cause of lost days (UNICEF, 2023).

Health impacts included anemia (45.0% of complications), stunted growth (30.0%), and recurrent fever (25.0%), reflecting malaria's hematologic and nutritional toll (WHO, 2022). These findings highlight the need for integrated interventions: community-based health education, environmental sanitation (e.g., drainage improvements), ITN promotion, and school-based deworming/nutrition programs. Aligning with Nigeria's National Malaria Strategic Plan (2021–2025) and SDGs, such measures could reduce prevalence by enhancing early detection and equity. Limitations include cross-sectional design precluding causality and potential recall bias in questionnaires; future longitudinal studies could address these.

CONCLUSION

The findings of this study demonstrate that haemoparasitic protozoal infections remain a significant public health challenge among children attending health facilities in Numan Metropolis. The overall prevalence of 45.0 percent reflects sustained transmission within the community, driven by environmental exposure, behavioural patterns, socioeconomic conditions, and gaps in timely access to healthcare. The higher prevalence observed in private facilities suggests that many children may seek treatment only when illness becomes severe, contributing to heavier parasite loads and increased complications. Environmental factors such as stagnant water and the riverine landscape, along with behavioural practices such as inconsistent insecticide treated net use and frequent outdoor activities, further heighten risk among children.

The study also revealed considerable health and educational impacts, including anemia, nutritional challenges, recurrent fever, and high rates of school absenteeism. These findings highlight the need for integrated interventions that combine environmental management, improved health education, early care seeking, strengthened diagnostic capacity, and consistent use of preventive tools such as insecticide treated nets. Targeted school based programmes, community mobilisation, and improved household socioeconomic support will also be essential in reducing infection rates. Overall, the study provides valuable evidence that can inform local malaria control strategies and guide policy decisions aimed at protecting vulnerable children in Numan Metropolis.

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