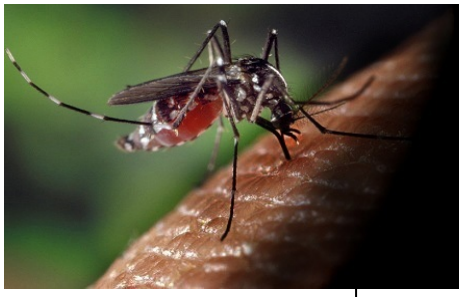

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Assessment of malaria parasite burden among under-five children across pre-urban and rural Mbaise communities

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Abstract
Malaria remains a leading morbidity and mortality cause in children under the age of five years. This study established the malaria infection prevalence in this age group in selected health centres and hospitals in Mbaise, Nigeria. The study enrolled 350 children aged 1–5 years. Venipuncture was used to collect blood samples, which were then screened using Giemsa-stained thick films. Data were analyzed using SPSS v21. The Mann-Whitney U and Kruskal-Wallis tests were used to compare proportions; P<0.05 was considered significant. Malaria prevalence varied significantly among age groups (χ^2 = 0.004, P<0.05). Male children were more prevalent (91.1%) than females (70.0%) (χ^2 = 0.000, P<0.05). With regard to the birth order, infection rates were: first-born (93.9%), second (71.4%), third (80.0%), and fourth (75.0%) (χ^2 = 0.021, *P*<0.05). Malaria infection remains highly prevalent among children under the age of five in Mbaise. Targeted interventions are necessary to stem this burden.

Keywords: Malaria, neonates, Mbaise prevalence under 5

Introduction
Malaria is among the major public health concerns globally, with Africa having the largest burden. In 2020, there were 241 million malaria cases and 627,000 deaths recorded across the world, where 90% of the cases and most of the deaths were reported in Africa (WHO, 2022; Obasohan et al., 2021) [20, 10]. Children under the age of five years (UN5) are particularly vulnerable, contributing to over two-thirds of malaria-related deaths in sub-Saharan Africa (Sarfor et al., 2023) [6].

In Nigeria, malaria is holo-endemic in rural and meso-endemic in urban areas, with all-year-round transmission (Nworgu and Orajaka, 2011). It remains one of the key reasons for children's admission (WHO, 2021) [19]. Children aged five and younger remain susceptible because they have lost their maternal immunity and have imperfect adaptive immune responses. For instance, malaria is responsible for more than 30% of child deaths below five years in Nigeria and more than 10% in Tanzania (Jacob et al., 2023) [21]. Malaria transmission in Nigeria is high and constant because the attack rate is constant throughout the year; while the intensity of malaria endemicity, as measured, relies on the attack rate in children (WHO, 1951).

Early treatment is crucial to the control of malaria. WHO recommends parasitological confirmation before treatment except when diagnostic facilities are unavailable or more than two hours delayed (WHO, 2021; 2022) [19, 20]. Despite progress, malaria accounts for an estimated 1.4 to 1.6 million deaths annually, mostly in African children (Curtis & Lewis, 2000). The reason for the continued existence of malaria is more dependent on mosquito vector behavior—lifespan and feeding pattern—than on the pathogenicity of the parasite (WHO, 2014) [18].

The aim of the research is to study and report the prevalence of malaria infection in children aged less than five years in Mbaise, by gender, age groups, birth order, and blood group. The findings will serve as a baseline on which interventions will be designed and the control of malaria in vulnerable populations in the area will be enhanced.

Study Area

The research was carried out in Mbaise, southeastern Nigeria, which consists of three local government councils: Ahiazu, Aboh, and Ezinihitte Mbaise. These areas are situated within the humid tropical rainforest belt with dense cover of vegetation such as deeply rooted tall trees, grasses, shrubs, and climbing plants. The vegetation gives perfect shaded conditions for mosquito breeding all year round. Most residents' economic activities come from subsistence farming, although a smaller number engage in small-scale business. The open nature of these activities has the tendency of increasing the exposure risk to bites by the vector, and hence the spread of malaria.

Ethical Considerations

The Department of Animal and Environmental Biology, Postgraduate Committee, Imo State University, Owerri, gave ethical clearance for the study. Additional ethical clearance was given by the Ezinihitte, Aboh, and Ahiazu Mbaise Local Government Area Health Departments. Community meetings were organized using local leaders to sensitize the people to the purpose of the study and procedure. Parental or guardian consent was given by all the children that participated.

Sample Collection/Analysis

Venous blood (3–4 mL) was collected from all the children in EDTA tubes. Malaria parasitemia (MP) was assessed by microscopy of Giemsa-stained thick blood film, stained for 20–30 minutes with a 3% stain solution of Giemsa (1.5 mL stain in 50 mL pH 7.2 buffered water). MP was graded by parasite density per microscopic field: scanty (±), low (+), moderate (++), and high (+++), corresponding to severity of infection.

Laboratory tests were done within 2–3 hours of sample collection. Data were processed using SPSS software version 21 (Chicago, IL, USA). Comparison between proportions was made using Mann-Whitney U test and Kruskal-Wallis test. p-value ≤ 0.05 was taken as a measure of significance. Confidence level was 95%.

Results

A total of 350 children aged 1 day to 5 years were recruited for the study (Table 1). There were 180 (51.4%) males and 170 (48.6%) females. Socioeconomic distribution was 183 (52.3%) in the middle class, 117 (33.5%) in the lower class, and 50 (14.3%) in the upper class. Age distribution was 20 (5.8%) neonates, 130 (37.2%) infants, and 150 (42.9%) older children (≤5 years). Malaria incidence in children age groups ≤ 5 years is presented in Table 2. The age categories encompass neonates. (1-28days) intentions 28days to 12 months and aged children (> 12 to 5 years). The prevalence of malaria in neonates was 3 (15%), Infents 101 (77.7% and 89.5% in children ≤ 5 years). The variation in malaria infection prevalence was significant in the age group (X2 = 0.004, P<0.05). Overall, 164 (91.1%) of 180 male respondents were infected with malaria, compared to 119 (70.0%) of 170 female respondents, a significantly higher prevalence among males (χ^2 = 0.000, p<0.05). Malaria prevalence by birth order was highest among first-born children (93.9%), followed by third-born (80.0%), fifth-born (75.0%), and second-born (71.4%) (Table IV). First-born children were significantly more susceptible to malaria compared to children of other birth orders (χ^2 = 0.021, p<0.05). Blood group analysis was conducted on malaria-positive samples only. As can be seen from Table V, the highest malaria prevalence occurred among children belonging to blood group O (46%), while the lowest occurred among blood group AB (9%). Malaria prevalence (overall) was higher among Rh-positive blood groups compared to Rh-negative blood groups. It was observed that blood group O positive was the most susceptible (46%), whereas AB negative had the lowest prevalence (4%).

Table 1: Socio demographic characteristics of the study participants

Characteristics	Frequency	Percentage (%)
Gender		
Male	180	51.4
Female	170	48.6
Socioeconomic classification		
Upper class	50	14.3
Middle class	183	52.3
Lower class	117	33.5
Age group		
Neonates (1-28 days)	20	5.8
29 days – 12 months	130	37.2
> 12 months – 5 years	150	42.9
Order of birth		
1st	99	28.3
2nd	56	16.0
3rd	75	21.4
4th	120	34.3

Table 2: Prevalence of Malaria Infection among Age Group of children ≤ 5 years

Age groups	No Examined	No infected	Prevalence (%)
Neonates (age 1 – 28day)	20	3	15
Infants children (29days to 12 month)	130	101	77.7
<1-5 years	200	179	89.5
Total	350	283	

Table 3: Prevalence of malaria infection between Genders of children ≤ 5 years

Gender	No Examined	Infected	Prevalence (%)
Male	180	164	91.1
Female	170	119	70%
Total	350	283	

Table 4: Prevalence of malaria Infection among birth orders in children ≤ 5 years

Birth order	Number Examined per birth order	No infected	Prevalence (%)
Birth order 1	99	93	93.9
Birth order 2	56	40	71.4
Birth order 3	75	60	80.0
Birth order > 4	120	90	75
Total	350	283	

Table 5: Percentage Distribution of malaria infection among the Blood groups

Blood Group	Infected	Malaria Distribution %
Group A^+	43	15
Group A^-	37	13.1
Group B^+	31	11.0
Group B^-	16	5.71
Group AB^+	22	7.82
Group AB^-	4	1.42
Group O^+	70	24.7
Group O^-	60	21.2
Total	283	

Discussion

This study assessed the prevalence of malaria among children below five years in the Mbaise area of Imo State. The overall prevalence (91%) was much higher than Cameroonian (24.1%) and Gabonese (25.4%) reports (Obasohan et al., 2021) [10], but within the range of 52.4–65.8% from other sub-Saharan African countries such as Côte d'Ivoire and Zambia (Ugonate Bureau of Statistics, 2015). Variations may be due to environmental factors (rainfall, temperature, humidity, soil moisture) (Opara & West, 2017) [12], socioeconomic status, hygiene and sanitation levels, and differences in diagnostic techniques. The high figure in Mbaise may be due to the rainforest ecology of the region, having high rainfall and relatively low temperature and humidity, which are conducive to malaria transmission. This suggests that the region is highly endemic for malaria.

Among neonates, malaria prevalence was 15%, consistent with previous observations (Opara & West, 2017; Etuk et al., 2008) [12, 4]. The lower rate may be explained by the føtal hemoglobin and maternal IgG protective effects which disrupt cytoadherence of parasitized red blood cells early in life (Ceesay et al., 2015; Oluwafemi, 2023) [1, 11], though small sample size may also be a contributing factor. For comparison, infants aged 1–12 months had a prevalence of 77.7%, likely as a result of greater exposure and waning maternal immunity. Prevalence in children aged >1 to 5 years was 89.5%, comparable with past findings in Ghana (Etuk et al., 2008) [4], pointing to greater susceptibility with advancing age due to greater exposure and loss of maternal antibodies.

Male children were shown to have a significantly higher rate of malaria than females, which is in agreement with previous reports that males are more susceptible to infections overall since they possess a single X chromosome carrying fewer immune-related genes than the double X chromosomes found in females.

Malaria infection was decreased with birth order, the first birth order being the most infected (93.9%), followed by the second birth order (80.2%), with the fourth and last birth orders showing the lowest infection. This is similar to earlier observations in Calabar (Ekanem et al., 2008) [3]. Susceptibility of firstborns can be explained on the basis of physiological changes and reduced immunity in first pregnancies, which tend to enhance parasitemia in fetus and mother (Serya et al., 2007) [13].

Blood group analysis revealed the highest number of children with malaria in blood group O (45.9%), O-positive. This may be due to the absence of A and B antigens, where there are more free receptors for the parasite to attach (Ufale et al., 2017) [14]. Groups A, B, and AB, with red blood cells coated with antigens, may have fewer binding sites for the attachment of the parasite. The least prevalence was observed in blood group AB negative (4%).

In summary, malaria prevalence in the present study increased with age, was higher in males, decreased with birth order, and was most prevalent in children with blood group O—identifying significant demographic and genetic risk factors for targeted intervention strategies.

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