

Malaria and soil transmitted helminth coinfection among school-aged children in MkpátEnin Local Government Area, Akwa Ibom State, Nigeria

ABSTRACT

Malaria, caused by *Plasmodium falciparum*, and soil-transmitted helminths (STHs) caused by *Ascaris lumbricoides*, *Trichuris trichiura*, and *Ancylostoma duodenale* are prevalent parasitic infections of significant public health concern in Nigeria. Coinfection with these parasites can intensify health challenges, particularly in children. Understanding the prevalence and impact of such coinfections is essential for developing effective public health strategies. This cross-sectional study investigated the prevalence of malaria and soil-transmitted helminth co-infections among primary schoolchildren in MkpátEnin Local Government Area (LGA), Akwa Ibom State. Between May and July 2024, finger-prick blood and stool samples were randomly collected from 348 children aged 4–15 years from four primary schools. Malaria parasites were detected using thin-film microscopy of air-dried blood smears, whereas stool samples were analysed for STH ova using the formalin-ether concentration method. The prevalence of *Plasmodium falciparum*, *Ascaris lumbricoides*, *Trichuris trichiura*, and *Ancylostoma duodenale* was 21.5%, 9.5%, 5.7%, and 2.6%, respectively. The overall rate of co-infection with malaria and STHs was 7.8%, and significant associations were observed between these infections ($p < 0.05$). Malaria prevalence was slightly higher in males (21.8%) than in females (21.3%), whereas STH infections were more prevalent in females (19.6%) than in males (15.8%). However, the differences in prevalence between sexes were not statistically significant ($p > 0.05$). Age-wise, children older than 14 years exhibited the highest malaria prevalence (29.4%), whereas those aged 9–13 years had the highest prevalence of STH infections (19.4%). This study underscores the substantial burden of malaria and STH infections among primary school children in MkpátEnin LGA, with notable variations in infection rates based on age and sex. These findings highlight the importance of targeted interventions that address parasitic infections while considering the demographic factors influencing the prevalence.

Keywords: Malaria, Soil-transmitted helminths, Co-infection, Prevalence, Akwa Ibom State.

INTRODUCTION

Concomitant parasitic infections occur when two or more parasites coexist within a host, potentially altering the immune response to individual parasites and modifying the clinical outcomes. For instance, helminths can influence malaria severity by either mitigating or exacerbating its clinical manifestations [1] Malaria, a febrile disease caused by protozoan parasites of the genus *Plasmodium*, is transmitted via the bite of infected female *Anopheles* mosquitoes [2].

Soil-transmitted helminthiasis (STHs), one of the most prevalent Neglected Tropical Diseases (NTDs) in Nigeria, remains a significant global health challenge, particularly in impoverished and underserved communities where control measures are difficult to implement [3,4,5 & 6].

According to the 2023 World Malaria Report, there was approximately 249 million cases of malaria in

2022 and a slight increase from 244 million in 2021. Malaria-related deaths were estimated at 608,000 in 2022, compared to 610,000 in the previous year [7]. Globally, 1.7 billion people are infected with one or more STHs. A 2003 survey reported that over 1.2 billion individuals were infected with *Ascaris lumbricoides*, with more than half of these cases occurring in China. Additionally, the prevalence of *Trichuris trichiura* is estimated at 795 million, and hookworm infections affect approximately 740 million people [8, 9]. Despite increasing interest in understanding the dynamics of malaria helminth co-infections, particularly their prevalence, clinical implications, and risk factors, longitudinal, community-based studies remain scarce. This is especially true in rural areas, such as MkpátEnin Local Government Area, Akwa Ibom State, Nigeria. This study aimed to address this gap by exploring the prevalence and interactions of malaria and helminth co-infections in this region [2, 10].

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in four primary schools in the MkpátEnin Local Government Area, Akwa Ibom State. MkpátEnin is located at longitude 8°30' and latitude 5°30' in the Southern region of Nigeria; it covers an area of 42km² (Fig. 1). Most of the people living in MkpátEnin are civil servants and farmers.

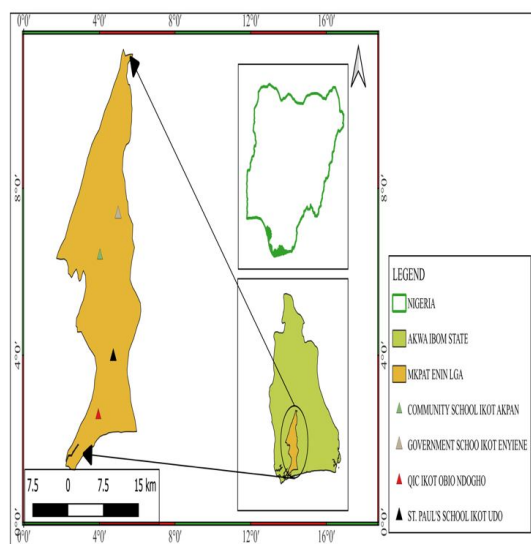


Fig 1 :Map of MkpátEnin Local Government Area, showing the study location.

2.2: Study Design

The study was a cross-sectional, school-based investigation involving 348 pupils recruited over three months using a multistage sampling technique. The sample size was proportionately distributed across the four selected schools considering the total pupil population in each school. Participants were selected through simple paper balloting, where students picked slips marked “YES” or “NO”; those who picked

“YES” were included in the study. A total of 348 stool and blood samples were collected from pupils of the four schools. Specifically, 87 stool samples were collected from each school. The schools randomly selected for the study were Community School, Ikot Akpan, and St. Paul’s School, Ikot Udo; Government School, Ikot Eyiene; and QIC School, Ikot Obio Ndoho.

2.3: Study population and Sample size estimation

All children aged 4 -15 years who consent to parent/guardian consent were included in this study.

A sample size of 348 was determined using

$$n = z^2pq / d^2$$

where n=required sample size, Z=confidence interval at 95% (standard value=1.96), P=estimated prevalence, q (1-p)= expected non-prevalence, and d=margin of error at 5% (0.05) or the maximum tolerable error. An estimated prevalence of 24% (P = 0.024) was used. The minimum number of participants in the study was 343.

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2.4 Collection of Blood Samples and Microscopic Examination

Blood samples were collected using sterile procedures by a trained laboratory technician. After cleaning the middle or ring finger with a 70% alcohol-moistened swab, the finger was dried with clean cotton and pricked with a disposable lancet. The collected blood was examined for the presence of malaria parasites using blood smear microscopy [10]. For the thin blood film, a small drop of blood was placed at one end of a clean slide and spread using another slide held at an angle, ensuring that the blood ran along the edge of the spreader. The slide was then pushed forward to spread blood into a thin film. For a thick film, three drops of blood were placed at the opposite end of the slide and spread evenly with an applicator. Slides were air-dried and transported to the laboratory in a slide box. Fixation was performed using methanol, and staining was performed with 10% Giemsa solution for 10 min. The slide was washed with distilled water, air-dried, and examined under a microscope using a x100 oil immersion lens [11].

2.5 Collection and Examination of Stool Samples

Stool samples were collected from participants in clean, leak-proof, sterile containers, and preserved in 10% formalin. The samples were processed using the formalin-ether concentration method. Specifically, 2 ml of preserved stool was added to a clean conical centrifuge tube containing 7 ml of 10% formalin water. The mixture was filtered through a sieve into a 15 ml conical centrifuge tube, followed by the addition of 4 ml of diethyl ether. The contents were centrifuged at 300rpm for 1 min, and the supernatant was discarded. Smears were prepared from the sediment on sterile slides with three slides created for each participant [12]. The slides were examined microscopically by two experts using 10x and 40x objective lenses to identify the helminth ova and cysts.

2.6 Data Analysis

The collected data were stored in Microsoft Excel and validated before the analysis. Statistical analyses were performed using IBM SPSS version 21 (IBM SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequencies and percentages, were used to summarise the variables. Chi-square tests were used to assess the associations between malaria and helminth co-infections and their related risk factors.

Additionally, Pearson's correlation test was used to evaluate the strength of the associations between variables. Statistical significance was set at $p < 0.05$.

3. RESULTS

A total of 348 stool and 348 blood samples were collected from pupils of four primary schools for examination, of which 184 were female and 165 were male. The sociodemographic characteristics of the participants are presented in Table 1. The prevalence of soil-transmitted helminths and malarial parasites is shown in Table 2. *Plasmodium falciparum* had the highest prevalence 75(21.6%). $p = .01$. Three species of soil-transmitted helminths were detected in the study: *A. lumbricoides*, 33(9.5%); *T. Trichiura*, 20(6.0%); *A. duodenale*, 9(2.6%); and total helminth infection, 62(17.8%); $p = .00$. The prevalence of coinfection among the four schools is shown in Table 3, where St Paul School, Iket Udo had the highest prevalence of malaria 25 (28.7%) and the highest rate of coinfection (Government School, Iket Eyenene) had the highest rate of helminth infection 21 (24.1%).

The rates of co-infection by age are shown in Table 4. *Ascaris* and *Plasmodium* infection had the highest rate of coinfection, among others 14(4.0%); children aged 4-9 had the highest rate of *Ascaris* and *Plasmodium* coinfection 6(4.7%), aged 10-15 had the highest rates of *Trichuris* and *Plasmodium* infection 5(2.3%). The prevalences of malaria and helminth infections are shown in Table 4.5. Malaria was more prevalent among males 36(21.8%) than females 39(21.3%), and there was no significant difference between males and females ($p = .92$). Conversely, STH infection was more prevalent in females 36(19.6%) than males 26(15.8%), and there was no significant difference in coinfection between males and females ($p = .54$).

The rate of coinfection by sex is shown in Figure 1, there was a high occurrence of *Plasmodium*, *Trichuris* and *Ascaris* coinfection in females 4(2.2%), males had the highest *Trichuris* and *Plasmodium* coinfection 4(2.4%).

Table1: Showing the socio-demographic variables of primary school children sampled for the study

Parameters	No. Examined
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Parameters		No. Examined
Sex	Female	183 (52.6%)
	Male	165 (47.4%)
Age	4-9	129 (37.1%)
	10-15	219 (62.3%)
Schools	COMMUNITY SCHOOL IKOT AKPAN	87 (25.0%)
	ST PAUL'S SCHOOL IKOT UDO	87 (25.0%)
	GOVERNMENT SCHOOL, IKOT EYIENE	87 (25.0%)
	QIC IKOT OBIO NDOHO	87 (25.0%)

Table 2: Prevalence of malaria parasites and soil-transmitted helminths

Parasite	Number examined	<i>Plasmodium falciparum</i>	<i>Ascaris lumbricoide</i> s	<i>Trichuris trichiura</i>	<i>Ancylostoma duodenale</i>	Total Helminths
Positive	348	75	33	20	9	62
Negative	348	273	268	327	339	286
Total	348	75 (21.6%)	33(9.5%)	20(6.0%)	9(2.6%)	62(17.8%)
P value		0.01*	0.003*	0.004*	0.0001*	0.002*

Table 3: Prevalence of soil-transmitted helminths among pupils according to school

Name of school	Total number examined	Total number infected with Malaria	Total number with any STHs	Mixed Infection (Malaria & Helminth)
Community school Ikot Akpan	87	19 (21.8%)	14 (16.1%)	5 (5.7%)
St Paul's School, Ikot Udo	87	25 (28.7%)	11 (12.6%)	8 (9.2%)
Government School Ikot Eyennene	87	18 (20.7%)	21 (24.1%)	7 (8.0%)
QIC Ikot Obio Ndoho	87	13 (14.9%)	16 (18.4%)	5 (5.7%)

Table 4: Showing the prevalence of co-infection by age

Age	No. examined	Ascaris + Plasmodium	Ascaris + Trichuris + Plasmodium	Trichuris + Plasmodium	Ancylostoma + Ascaris
4-9	129	6 (4.7%)	2 (1.6%)	1 (0.8%)	0
10-15	129	8 (3.7%)	3 (1.4%)	5 (2.3%)	2 (0.9%)
Total	348	14 (4.02%)	5 (1.4%)	6 (1.7%)	2 (0.6%)
P-value		0.74	0.75	0.74	0.75

Table 5 : Showing the prevalence of parasites by sex and age

Sex	No. examined	<i>Plasmodium</i>	<i>Ascaris</i> <i>lumbricoide</i> <i>s</i>	<i>Trichuris</i> <i>trichiura</i>	<i>Ancylostom</i> <i>a</i> <i>duodenale</i>
Female	183	39 (21.3%)	19 (10.4%)	11 (6.0%)	6 (3.3%)
Male	165	36 (21.8%)	14 (8.5%)	9 (5.5%)	3 (1.8%)
Total	348	75 (21.6%)	33 (9.5%)	20 (5.7%)	9 (2.6%)
P-value		0.92	0.53	0.82	0.38
Age					
4-9	129	26 (20.2%)	15 (11.69%)	11 (8.5%)	3 (2.3%)
10-15	219	49 (22.4%)	18 (8.2%)	9 (4.16%)	6 (12.7%)
P-value		0.63	0.73	0.75	0.74

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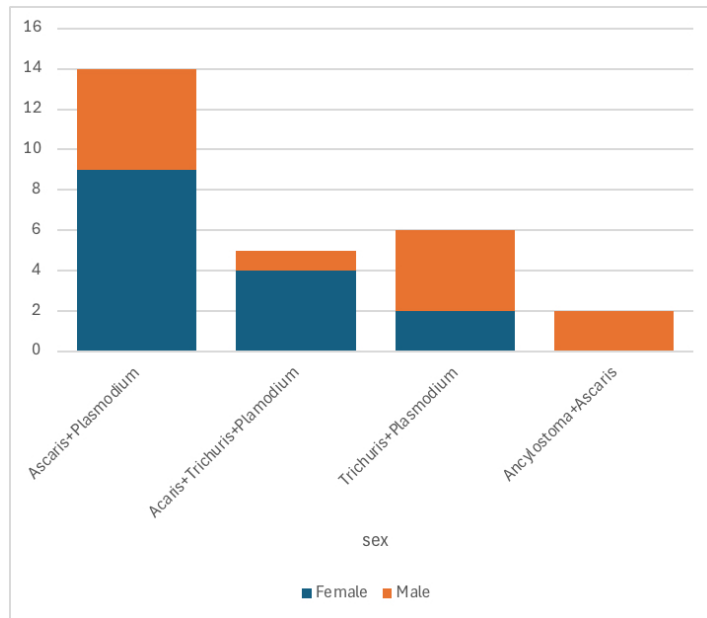


Figure 2: A graph showing the rate of coinfection by sex

5. Discussion

Children in endemic regions, such as Nigeria, often experience co-infections with malaria and soil-transmitted helminths, driven by various factors that contribute to high transmission rates. Key among these factors are the prevailing environmental and climatic conditions that favour the spread of both infections [13]. The co-infection rate for malaria and STH in this study was 7.8%. This rate is higher than the 5.9% reported by [14] in Osogbo, Nigeria, but lower than the 9.49% reported by [9]. A significant association was found between malaria and STH coinfection in this study ($p = .05$).

The prevalence of malaria parasites was 21.5%, which is lower than the 27.3% reported by [15] in Ajagba, Southwestern Nigeria, but higher than the 11.1% prevalence reported by [16] in Ethiopia. The prevalence of malaria showed no significant variation between males (21.8%) and females (21.3%) ($p = .92$), consistent with previous studies [17-18]. This suggests that both sexes are equally exposed to factors influencing malaria infections, confirming that sex is not a determinant of susceptibility [19]; children aged > 10 years had the highest prevalence of malaria (22.4%).

Soil-transmitted helminthiasis (STH) caused by *Ascaris lumbricoides*, hookworms, and *Trichuris trichiura* was observed in this study, consistent with findings from other researchers [5,20,21]. The overall prevalence of STH infections was 17.8%, which was lower than the 45.3% reported by [22] in Itu Local Government, Akwa Ibom State, but slightly higher than the 17.44% reported in Akwa North LGA, Anambra State [9]. This is also lower than the 24.2% recorded in Eastern Obolo, Akwa Ibom State [13]. The relatively low prevalence of parasitic infections observed in this study may be

attributed to improved environmental sanitation, mass distribution of mosquito nets, routine use of anti-helminthic drugs, and government-led mass-deworming campaigns. Among the three helminths detected, *Ascaris lumbricoides* was the most prevalent, accounting for 53.2% of all the infections. *Trichuris trichiura*, followed by 32.3%, whereas hookworms were the least common (14.5%). The high prevalence of *A. lumbricoides* may be due to the community's poor water supply and sanitation facilities, which create favourable conditions for its transmission. Children aged 4–9 years had the highest prevalence of STH (22.5%). Younger children are more likely to play in contaminated environments and may lack awareness of proper hygiene practices, increasing their risk of STH infection. Conversely, STH infection was more prevalent in females (19.6%) than in males (15.8%). This finding aligns with the reported higher prevalence rates among females (51.9%) than males (45.3%) in Ethiopia [23]. The higher prevalence among females could be attributed to behavioural, biological, or social factors that make them more susceptible to infection although there was no significant difference in this study ($p = .73$)

6. Conclusion

This study highlights the significant prevalence of malaria and STH infections among primary school children in MkpateEnin LGA. Infection rates varied by age but not by sex. The main identified parasites were *Plasmodium falciparum*, *Ascaris lumbricoides*, *Trichuris trichiura*, and *Ancylostoma duodenale*. A coinfection rate of 7.8% was recorded among the 348 pupils examined. *A. lumbricoides* (9.5%) was the most prevalent helminth, while *P. falciparum* (21.6%) was the most common malaria

Consent

As per international or university standards, respondents' written consent was collected and preserved by the author(s).

Ethical consideration

Ethical clearance and approval (HREC, No. AKHREC/30/05/24/218) was obtained from the Department of Research and Education Ethical Committee of the State Ministry of Health, to collect specimens from primary school pupils in MkpateEnin LGA. Written informed consent was obtained from the parents before samples were collected.

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