



Prevalence of *Schistosoma haematobium* and Malaria Parasite Co-infections in Ebonyi State Nigeria

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ABSTRACT

In sub-Saharan Africa, *Schistosoma haematobium* and malaria parasites are still a great public health problem and can coexist in the same endemic areas, and create serious health problems in its endemic species. This study was carried out to determine the prevalence of *S. haematobium* and Plasmodium parasites single and co-infections in Ebonyi Local Government Area, Ebonyi State, Southeastern Nigeria. A community based cross sectional survey was undertaken of 1110 people who were screened with urinalysis reagent strips for hematuria and proteinuria. 269 people who were positive for the tests were then further examined for parasitological confirmation. The eggs of *S. haematobium* were identified and quantified by urine centrifugation and microscopy; the blood smears were stained with Giemsa followed by oil immersion microscopy for the detection of Plasmodium species. Data for demography and risk factors were gathered using structured questionnaires. Data were analyzed statistically using SPSS version 20.0 at 5% significance level and Chi-square test was used. Out of 269 confirmed cases (47.58% male and 52.42% female), the prevalence of single infection with *S. haematobium* was 11.9% and that of Malaria parasite was 21.9%, and co-infection was 33.1%. Males exhibited a higher *S. haematobium* prevalence (14.8%) compared to females (9.2%), though the difference was not statistically significant ($\chi^2 = 2.025, p = 0.188$). Malaria prevalence was similar between males (22.0%) and females (21.9%) ($\chi^2 = 0.000, p = 0.982$). Co-infection rates exceeded 30% across the 6–25 age brackets, with no significant variation across age groups ($\chi^2 = 4.474, p = 0.613$). The high level of co-endemicity of the parasites of *S. haematobium* and malaria in Ebonyi State indicates high level of co-endemicity of the parasites. The result of this study reinforces the importance of integrated vector control, dual mass drug administration, proper sanitation and safe distribution of water in order to effectively decrease the burden of co-infections in the region.

Keywords: *Schistosoma haematobium*, Malaria, Co-infection, Prevalence, Ebonyi State, Nigeria.

Introduction

Co-infection of *Schistosoma haematobium* and malaria (usually *Plasmodium falciparum*) is a major public health problem in endemic tropical and subtropical countries. Diseases have a high burden in sub-Saharan Africa, where children, pregnant women and other vulnerable groups are at a high risk of having both diseases due to geographical overlap. For effective control measures, it is important to understand the epidemiology, immunological interactions and clinical outcomes of this parasitic synergy.

Concurrent infections are associated with common environmental and socio-economic risk factors, as shown by epidemiological investigations. The *Anopheles*

mosquito vector of malaria and *Bulinus* fresh-water snail intermediate host of *Schistosoma haematobium* are ideal hosts and vectors that thrive in tropical climate conditions. The local communities are at risk of being exposed to cercaria-contaminated water sources due to poor sanitation, limited access to clean water, and agricultural activities, and are also at risk of being bitten by mosquitoes. High prevalence rates of co-infection have been recorded from epidemiological surveys performed in rural and peri-urban settlements on a regular basis. A cross-sectional survey was carried out in Nigeria where significant co-infection was reported in school-age children, and was associated with high level of contact with freshwater and poor levels of vector control (Dawaki et al., 2016). Likewise, Sumbele et al. (2014) reported in Cameroon that children with mixed infection of the two parasite species had a more severe degree of anemia than children infected with one type of parasite.

The dynamics of interactions between *S. haematobium* and *P. falciparum* is complex and regulated through immune response pathways that are different. A predominant T-helper 1 (Th1) pro-inflammatory response is the primary factor in *Plasmodium* infection, involving high levels of interferon-gamma and interleukin-12, which are important for eliminating intraerythrocytic stages of the protozoan. In contrast, *Schistosoma haematobium* eggs in the urogenital tract trigger robust production of T-helper (Th) 2 anti-inflammatory cytokines, such as interleukin-4, interleukin-5 and interleukin-10. Chronic urogenital schistosomiasis would lead to immune modulation which may affect host susceptibility and defense mechanisms to malaria. Hartgers and Yazdanbakhsh (2006) pointed out that helminth-induced Th2 polarization and activation of regulatory T cells may cause a reduction in the efficacy of Th1 mediated parasite clearance and contribute to increased densities of malaria parasites. But there is conflicting evidence as some observational cohorts have indicated that helminth infections may have a protective effect against the pathogenesis of severe malaria by dampening hyper-inflammatory cascades (Thomas et al., 2026).

The most noticeable pathological effects of *S. haematobium* and malaria co-infections are heavy anemia and cognitive impairment. The two parasites degrade the hemoglobin in different ways. The following are direct steps that *Plasmodium* species take to cause disruption of infected red blood cells, splenic killing of uninfected red blood cells, and dyserythropoiesis in the bone marrow. *Schistosoma haematobium* leads to chronic haematuria, mucosal ulceration and systemic inflammation which leads to impaired iron absorption. Synergic effect of concurrent infection causes more rapid blood loss and inhibits erythropoiesis. In a recent systematic meta-analysis, McManus et al. (2014) showed that *Plasmodium* and helminth co-infections had a significantly higher risk of anemia than either infection alone. In children, chronic anemia, which is associated with low-grade systemic

inflammation, has a profound effect on physical growth, cognitive function and educational achievement.

Combination disease burden can only be reduced by integrated control measures. Combination therapy for schistosomiasis and malaria (MAL-SEM) based on the use of praziquantel and artemisinin-based combination therapies (ACT) is effective. Long-lasting insecticidal nets (LLINs) and snail habitat management are examples of vector control methods that offer double protection. Ongoing monitoring and empirical research are still essential for understanding local patterns of co-infection and informing interventions and public health strategies. *Schistosoma haematobium* and *Plasmodium falciparum* co-infections in Ebonyi State, Nigeria are important to study because of significant gaps in the epidemiology reported in regional and national literature. Despite the high pooled prevalence of co-infection from national meta-analyses there is a huge regional variability that shows that disease may be different across states and local empirical data is needed to cull the generalizations. Current research on adult populations in the Southern Nigerian region mainly include agrarian areas (Olayinka et al., 2020) or multi-disease co-infection syndemics as opposed to standalone pediatrics co-infection metrics that focus on viral co-infections.

Recent study findings in Ogun and Ondo states highlight the grave impact on children, such as increased anemia risks and nutritional deficiencies in school-going children (Amoo et al., 2025; Ola et al., 2025). The results from the Southwest, however, fail to bridge a geographical gap in knowledge of the agrarian environment of the South East of Nigeria which has extensive rice farming which provides ideal breeding grounds for *Bulinus* snail and *Anopheles* mosquito. A targeted prevalence study in Ebonyi State will help fill these empirical gaps and provide location-specific information needed to plan integrated region-specific mass drug administration and vector control interventions.

2. Method

2.1 Study Area

Ebonyi State is one of the five states that make up the South East geopolitical zones of Nigeria. It has interstate boundaries with Abia State to the South, Benue State to the North, Enugu State to the West and Cross River State to the east. Its capital is Abakiliki. Ebonyi State covers an area of 6,421.2 square kilometers it lies approximately between latitudes 6°19' - 6°30' north and longitude 8°00' - 8°10' east. It has a population of 2,176,947 (2006 census figures). Ebonyi Local Government Area is one of the thirteen (13) local government areas that make up Ebonyi State, with its headquarters at Ugbodo town. It has an area of 443km² and a population of 126,837 (2006 census figure). The natives/residents of Ebonyi Local Government

Area are prominently farmers but also engage in trading as well as public and civil service.

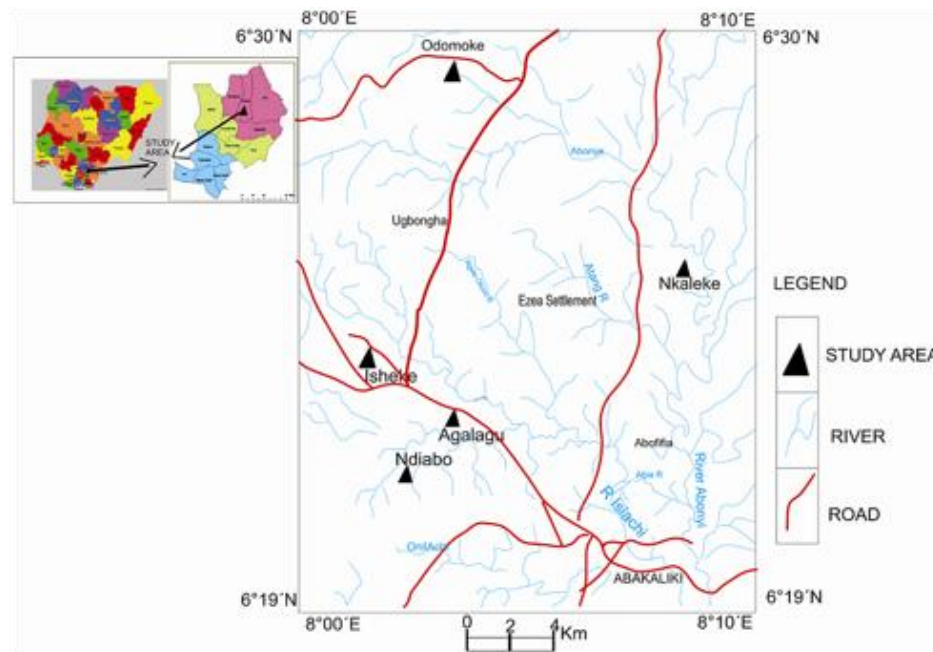


Figure 1: Map of the Study Area Showing the Study Locations

2.2 Ethical Clearance

Ethical clearance was obtained from University of Nigeria Teaching Hospital-Ituku-Ozalla, Enugu. Prior to the collection of samples, subjects were educated on malaria and schistosomiasis diseases co-infection to get their full co-operation. Consent forms were also issued to the subjects which those who volunteered to be tested signed after going through them.

2.3 Study Design

A survey design method was adopted for the study; one thousand, one hundred and ten subjects of different age groups were screened using urine analysis reagent strips (Medi-test combi 9) to test for proteinuria and haematuria. Two hundred and sixty nine respondent were positive of proteinuria and haematuria and were given questionnaire that covers their personal data (serial numbers, sex, age, village, town and local government area), social-demographic data (education status and occupation), health data (if they have had malaria before, the type of medication they use, if they use treated bed net, if their windows and doors are covered with net, if they visit river/stream for anything, if river was the main source of their domestic water supply, if they have had blood in their urine, if they visited hospital as a result of the blood in their urine, if they took drug for it, the type of drug/medication they took, if they have had skin reaction resulting to rashes after visiting the river/stream, if the rashes lasted up to one week, if they have experienced any abdominal pain within the period of bloody urine, if they experienced pain when urinating and if the sickness affects their occupation). Their

weight and height were also measured. The blood of those that had positive haematuria and proteinuria was collected. The weight and height of the subjects were also measured.

2.4 Parasitological Examination

2.4.1 Collection of urine and blood samples

Clean dry wide mouthed container was given to those subjects after instructing them on how to collect the urine. The urine of those positive for haematuria and proteinuria were fixed with 4% formaldehyde. Two ml of venous blood was collected using 5ml disposable syringes and put into EDTA bottle from those positive for haematuria and proteinuria noting their serial numbers on the bottles. The blood and urine were transported to the laboratory for parasitological examination.

2.4.2 Examination of urine samples

Urine analysis reagent strips were used to test for haematuria and proteinuria. Urine with positive blood and protein was recorded variously as positive (+); (++) (+++); or negative (-). Ten (10) ml of urine from each sample was collected after shaking and centrifuged at 20,000rpm for 30 minutes. The supernatant was discarded and the sediment was placed on the slide, covered with cover slips and then examined using X10 objective for eggs of *Schistosoma haematobium*. The number of eggs were counted and recorded as eggs/10ml urine. The characteristics used to identify the egg include

1. Pale yellow-brown, large and oval in shape.
2. Small spines on one end (terminal spine)
3. Fully developed miracidium inside the egg.

2.4.3 Examination of blood

Thick smears of blood samples were prepared following the standard parasitological produce. Giemsa stain diluted with 3% solution of buffered water was used for 30 minutes staining. The prepared slides were washed with clean water after 30 minutes and allowed to dry. Each slide was examined under the X100 objective microscope with oil immersion. The slides were recorded as positive with the presence of any characteristic stages of *Plasmodium* trophozoites (rings); schizonts and gametocytes and negative where none of the characteristic appears. Capillary tube, sealant and haematocrit centrifuge were used to measure the Packed Cell Volume (PCV) of those blood samples. Haematocrit reader was used to determine the reading.

2.5 Data Analysis

Data analysis was done using SPSS (version 20.0). The prevalence of malaria parasite and *Schistosoma haematobium* was determined using chi-square test. The intensity of malaria parasite and *Schistosoma haematobium* by age, education and occupation was determined using ANOVA while T-test was used to determine their

intensity by sex. Packed cell volume and Body Mass Index (BMI) of those infected and uninfected with *S. haematobium*, malaria single infection, and those co-infected were determined using T-test. A frequency of questionnaire response was calculated using simple frequency and percentage frequency calculations. All analysis was done at 5% level of significance.

3. Results

3.1 Overall and Sex Prevalence of Single and Co-infection of *S. haematobium* and Malaria

Out of 269 individuals sampled, males and females accounted for 47.58% and 52.42% respectively. Overall prevalence of *S. haematobium* infection was 11.9%. Males and females had prevalence of 14.8% and 9.2%, respectively but the difference in prevalence was not statistically significant ($\chi^2=2.025$, $P=0.188$). Malaria parasite was found in 21.9% of the study population with the difference between sexes not significant ($\chi^2=0.000$, $P=0.982$). Co-infection of *S. haematobium*-malaria was recorded in 33.1% of the sample population. The difference in the prevalence of co-infection between sexes was also not significant ($\chi^2=0.372$, $P=0.604$) (Table1).

Table 1: Overall and sex prevalence of single and co-infection of *S. haematobium* and malaria

Variables	Number examined (%)	Single <i>S. haematobium</i>	Single Malaria Parasite	Co-infection
		No (%) Positive (%)	No (%) Positive (%)	No (%) Positive (%)
Overall	269	32 (11.9)	59 (21.9)	89 (33.1)
Sex				
Male	128(47.58)	19 (14.8)	28 (22.0)	40 (31.2)
Female	141(52.42)	13 (9.2)	31 (21.9)	49 (34.8)
χ^2		2.025	0.000	0.372
P value		0.188	0.982	0.604

3.2 Prevalence of Single and Co-infection of *S. haematobium* and Malaria Parasite by Age in the Study Area

As shown in Table 2, no individual in age group 26-30 years had single *S. haematobium* and malaria parasite infection. Prevalence of *S. haematobium* and malaria parasite single infection were highest in age groups >5years and above 30 years, respectively. The difference in prevalence of *S. haematobium* ($\chi^2=8.091$, $P=0.231$) and malaria parasite ($\chi^2=7.877$, $P=0.247$) infections in relation to age was not significant. Prevalence of *S. haematobium* and malaria co-infection of above 30% was recorded in age groups 6-10 years, 11-15 years, 16-20 years and 21-25 years.

There was also no significant difference in the prevalence of malaria parasite and *S. haematobium* co-infection among those sampled ($P > 0.05$).

Table 2: Prevalence of single and co-infection of *S. haematobium* and malaria parasite by age in the study area

Variables	Number examined	Single <i>S. haematobium</i> No Positive (%)	Single Malaria Parasite No Positive (%)	Co-infection No positive (%)
Age				
Less than 5	6	2 (33.3)	1 (16.7)	1 (16.7)
6-10	88	6 (6.8)	25 (28.4)	27 (30.7)
11-15	68	7 (10.3)	13 (18.1)	24 (35.3)
16-20	66	11 (16.7)	9 (13.6)	25 (37.9)
21-25	13	3 (23.1)	2 (15.4)	4 (30.8)
26-30	1	0 (0)	0 (0)	1 (100)
Above 30	27	3 (11.1)	9 (33.3)	7 (25.9)
χ^2		8.091	7.877	4.474
P value		0.268	0.247	0.613

Discussion

The overall prevalence of *S. haematobium* was found to be 11.9% in this study. This finding was in line with Amoo et al (2025) which reported low to moderate prevalence of urogenital schistosomiasis among children in Ogun state, Nigeria. There was no significant difference in the prevalence of *S. haematobium* between males (14.8%) and females (9.2%) ($p=0.188$). Dawaki et al. (2016) also noted that male children were more exposed to schistosomiasis than female children because they spend more time in water than their female counterparts do in rural communities in Nigeria where they participate in different water-contact activities such as swimming and farming. Concerning age distribution, the highest numbers of *S. haematobium* infections were found in the <5 years group (33.3%). Conversely, Ola et al. (2025) and Amoo et al. (2025) found that older school aged children (OSAC) had the highest prevalence of schistosomiasis in their studies, which they blamed on the high level of exposure to recreational water.

There was no difference between males (22.0%) and females (21.9%) in the single prevalence of malaria ($p=0.982$). This result supported the one obtained by Sumbele et al. (2014) who showed that there was no difference between the sexes when ambient exposure and vector contact is equal. The highest prevalence of malaria infection was found among the older age group (above 30 years, 33.3%) and

the 6-10 years age group (28.4%). Ojo et al. 2019, on the other hand, highlighted that when clinical malaria occurs in endemic areas, it tends to occur mostly among young children of less than 5 years of age, which is attributed to lack of protective immunity in these age groups.

Overall, the co-infection rate *S. haematobium* and malaria infection was 33.1%, and there were no significant differences between sex ($p=0.604$), and age groups ($p=0.613$). Co-infection rates exceeded 30% across the 6–10, 11–15, 16–20, and 21–25 age brackets. This finding corroborates Ojo et al. (2019) and Olayinka et al. (2020) who emphasized the high prevalence of the parasitism co-endemicism in the south western part of Nigeria. In a similar study, Hartgers and Yazdanbakhsh (2006) found that helminth-driven immune modification could modify the susceptibility of the host to *Plasmodium* infection. Moreover, this study concurred with Thomas et al. (2026) who found that coinfection of malaria and helminth parasites were among the most potent drivers of systemic T-cell activation and exhaustion phenotypes in children with malaria in Nigeria.

The results of the study that identified an overall prevalence of *Schistosoma haematobium* infection of 11.9%, prevalence of malaria of 21.9% and a significant co-infection rate of 33.1% in Ebonyi State have far-reaching multi-sectoral implications. The high prevalence of *Schistosoma haematobium* and malaria co-infection, particularly affecting school-aged children, carries severe educational implications. Chronic parasite infections induce anemia, cognitive deficits, and absenteeism, directly impairing academic achievement and student motivation (Ezeanyagu et al., 2023). Addressing these health barriers requires active, hands-on health literacy; employing experiential learning strategies (Muogbo et al., 2025) and technological gamification (Enem et al., 2025) in science instruction can foster engagement and hygiene awareness among learners. Teachers must possess high computer literacy (Nneka & Okafor, 2013) to utilize digital health education resources effectively. Furthermore, since age-related developmental stages influence how learners comprehend disease transmission and scientific phenomena (Okafor, 2019), health curricula must address misconceptions. Bridging these health challenges is essential, much like overcoming learning difficulties in quantitative subjects (Ugonwa, 2015), ensuring a healthier, more receptive student population capable of optimal academic performance.

In addition to the well-recognized biomedical burden, the vulnerability of the host and disease control in poor rural communities overlap with economic resilience and risk management skills. Health education and public outreach (Ogechukwu et al., 2023) can be achieved by utilizing modern digital tools, e-library resources and search engine literacy as means of effective mitigation of transmission. Likewise, the use of doodly produced multimedia instructions can greatly improve the public understanding and education of prevention measures.

In conclusion, structural community change is needed to address these health inequities; this idea of changing the structure of communities in ways that resist systemic distress and inspire revolutionary social action, which also permeates modern African literature (Ume & Agoha, 2025).

Conclusion

This study has revealed that *Schistosoma haematobium* and malaria parasites are still significant public health problems in Ebonyi State, Nigeria as both had an overall prevalence of 11.9%, while 33.1% were co-infections. No demographic variables (sex or age group) were found to be statistically associated with parasite prevalence; this suggests high prevalence in all age groups and sexes. High co-infection prevalence underscores the fact that there are common environmental, biological and behavioral risk factors that enable co-infection between vector-borne and water-borne pathogens. This dual disease-burden necessitates moving away from disease-control programs and into a public health approach. The interventions implemented in Ebonyi should include mass drug administration (MDA) (Praziquantel and ACT), vector control, provision of clean potable water, targeted health education and the enhancement of the rural sanitation infrastructure. Longitudinal studies are recommended in the future in order to measure the long-term immunological interactions, clinical severity and socioeconomic impact of *S. haematobium* and malaria co-infections in endemic agrarian populations.

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