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Socio-Demographic Correlates and Infection Intensity of *Schistosoma haematobium* and Malaria Co-infection in Ebonyi State Nigeria

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ABSTRACT

Schistosoma haematobium and Plasmodium species are still a major public health problem in sub-Saharan Africa, where they coexist in the bodies of the same people and cause similar signs and symptoms in humans. The socio-demographic correlates, prevalence and intensity of S. haematobium and malaria parasite co-infection among the residents of Ebonyi Local Government Area, Ebonyi State Nigeria was investigated. Malaria and Schistosoma haematobium co-infections were studied in Ebonyi Local Government Area (LGA), Nigeria, using the methodology. We approached 1,110 people for an ethical clearance and to obtain their consent to be screened using a urine test. Questionnaires were given and blood and urine specimens were taken for 269 positive cases. Standardized microscopic techniques and hematocrit techniques were used for the evaluation of parasitic infections and blood parameters, respectively, followed by SPSS statistical analysis. Educational status revealed the highest prevalence of S. haematobium single infection (18.2%) and co-infection (45.5%) among participants with no formal education, whereas individuals with tertiary education exhibited the highest malaria single infection prevalence (40.0%), though associations were not statistically significant (P>0.05). Occupationally, co-infection prevalence was highest among those in fishing (100.0%) and trading (62.5%), with non-significant statistical association (P>0.05). The overall mean infection intensities were 2.16±0.21 eggs/10 mL urine for S. haematobium and 6.51±0.48 for malaria parasite, showing no significant variation across age or sex groups (P>0.05). Co-infection of S. haematobium and malaria parasite is prevalent in the study area, with heightened exposure noted among individuals with lower education levels and water-contact occupations. Integrated disease control strategies incorporating vector management, targeted health education, safe water supply, and mass drug administration are recommended to reduce transmission in endemic rural communities.

INTRODUCTION

The distribution of *Schistosoma haematobium* and *Plasmodium* falciparum in sub–Saharan Africa results in a complicated public health problem where chronic urogenital schistosomiasis and acute malaria are intertwined. It is important to understand the socio-demographic factors that underlie this co-infection and the resulting intensity of the parasite to develop effective interventions. The rural and peri-urban communities are more affected than other groups due to the overlap of environmental conditions, freshwater bodies, and vector breeding habitats. The study by Venter et al (2022) emphasizes that helminths and *Plasmodium* parasites share ecological niches and socio-demographic vulnerabilities, resulting in complex disease interactions. Social factors at the individual, household, and community levels are strong mediators of the intensity of *S. haematobium* infection (based on urinary egg output) and malaria parasite density.

Age is one of the most consistent socio-demographic factors that affect not only the prevalence of infection but also the parasite density. The age group with the highest risk of heavy *S. haematobium* infection intensity and high *Plasmodium* parasitemia is school-aged children (5-15 years). (Sumbele et al, 2021) Peak egg excretion in urine may be at early adolescence, when there is peak water-contact activities occurring at home and in recreational settings. Clearance rates are often low and systemic parasite levels are high in younger children as they often lack acquired immunity to the parasites. The intensity of infection decreases as people age, even under high transmission conditions, due to the gradual development of acquired immunity over time as people change their daily exposure routines (Tokplonou et al., 2020).

The exposure to vector mosquitoes and intermediate snail hosts is significantly affected by gender and sex-differentiated roles in rural communities. Swimming, fishing and cattle watering are common activities undertaken by males, particularly among school aged boys and these habits often lead to higher urinary egg counts for *S. haematobium* because they tend to have access to more surface water that is infested (Havens et al, 2020). Females, on the other hand, are typically exposed to water throughout their lives, associated with household activities such as fetching water, washing clothes and preparing food in open water locations. Although *Plasmodium* infection is a risk for both males and females, a potential increase in vector biting rates during dusk and dawn increases the risk for young males in certain agricultural environments.

Household infrastructure, as well as socio-economic status, are the underlying structural factors that influence co-infection intensity. Household income is low, and two-thirds of households do not have adequate housing standards, with open streams, ponds and rivers as sources of water that contain the Bulinus snail vector (Babbitt et al, 2023). Lack of sanitation facilities, e.g. no pit latrines allow open defecation and urination, thus continuing the cycle of *S. haematobium* in human-water contact environments. Likewise, houses without window screens or mosquito nets increase the risk for mosquito entry and pose a higher malaria transmission risk for the susceptible children (Bako et al., 2026).

Education of the mother and father is very important protective factor against transmission of parasites in the household. Parental education is directly related to understanding the ways in which diseases are transmitted, better hygiene, and adherence to preventive measures such as mass drug administration programs (Abdissa et al, 2024). Adequately educated caregivers are more likely to seek prompt medical diagnosis for febrile illnesses and hematuria, which decreases the duration and severity of untreated co-infections in children.

Pathophysiologically, when *S.* haematobium and *Plasmodium* species coexist, there is cross-modulation of the immune system which results in a modification of host defense mechanisms. Helminth infections elicit a predominant T-helper 2 (Th2) immune response, which can negatively regulate the pro-inflammatory T-helper 1 (Th1) immune response that is needed for the clearance of intra-erythrocytic *Plasmodium* parasites (Lei et al., 2021). Therefore, co-infected persons may have a higher density of malaria parasites or have a longer period of parasitemia. Chronic urinary blood loss in schistosomiasis combined with Plasmodium-induced hemolysis leads to severe anaemia, stunted growth and cognitive impairment in school-aged children.

Public health strategies to tackle the burden of *S. haematobium* and malaria co-infection must be integrated and consider both biomedical and socio-demographic factors. Combining praziquantel for schistosomiasis treatment with artemisinin-based combination therapies (ACTs) for malaria is critical for decreasing parasite reservoirs in the community (Angrisano & Robinson, 2022). To achieve sustainable control, however, it is required to invest in potable water supply, sanitation facilities, vector control and community health education in high-risk socio-demographic groups over the long term. Co-infection is a major ecological and clinical challenge, as different pathogens can interact, leading to changes in the disease dynamics and host immunity (Venter et al., 2022). The pattern of co-occurrence is complex in sub-Saharan Africa, with urogenital schistosomiasis shown to modulate *Plasmodium* falciparum parasite density and host antibody response leading to varying levels of immunity. (Tokplonou et al., 2020) Moreover, despite control measures, polyparasitism has been found to occur in parallel with socio-demographic vulnerabilities (Sumbele et al., 2021). The motivation of this study was the gaps in the ecology and epidemiology of *S. haematobium* and malaria co-infection intensity in Ebonyi State, Nigeria, which is influenced by socio-demographic factors.

METHOD

The methodological approach for the research began with a detailed study of the study area. The investigation was conducted in the South East geopolitical zone of Nigeria in one of the 5 geopolitical zones of Nigeria, namely, Ebonyi State. The state had a population of 2,176,947 as counted during the National Census of 2006, and an area of 6,421.2 km², bounded by Benue State to the north, Cross River State to the east, Abia State to the south and Enugu State to the west. Geographical coordinates assigned the area roughly between latitude 6°19'N to 6°30'N and longitude 8°00'E to 8°10'E with the capital city located at Abakaliki. This larger territory was studied more specifically in Ebonyi Local Government Area which has a headquarter at Ugbodo town, an area of 443km² and a documented population of 126,837 people. The major occupation of the local people was Agriculture, besides commercial trading and jobs in public and civil services.

Ethical aspects were discussed before field interactions. The University of Nigeria Teaching Hospital in Ituku-Ozalla, Enugu gave the official ethical clearance. Prior to the commencement of sample collection, the participants were given information about malaria and schistosomiasis co-infections, to obtain their understanding and cooperation. Written consent forms were given to the participants and only participants who willingly agreed to participate signed the forms before diagnostic evaluation.

This study used a controlled survey design with a baseline sample of 1,110 people in the study spanning a range of age groups. Participants were tested for proteinuria and hematuria using urinalysis reagent strips (Medi-test combi 9). Of the 269 people who tested positive for both markers, 97 of them had a permanent tracheostomy.Of the 269 people who tested positive for both markers, 97 of them had a permanent tracheostomy. The positive respondents were then presented with a detailed questionnaire to obtain information on demographic, socio-economic, physical, and health history data such as serial identification numbers, sex, age, village, town, local government area, educational status, occupation, height, weight and other relevant health history. The health assessment included inquiries about the patient's previous malaria diagnoses, therapeutic choices, possession and use of ITNs, window and door net coverage, dependence on natural water sources for household water, frequency of hematuria, seeking medical care, dermatological reactions to water exposure, abdominal discomfort, dysuria, and the effect of illness on work productivity.

Biological sample collection procedures were adopted for the 269 people presenting with hematuria and proteinuria. Wide-mouthed containers were provided and given detailed instructions for urine collection to all subjects. The urine samples were preserved with 4% formaldehyde on collection. At the same time, the subjects were given 5 mL disposable syringes to obtain 2 mL of venous blood which was collected into EDTA-coated tubes, marked with each subject's identification number, and sent to the laboratory with the urine samples for parasitological examination.

Laboratory processing was carried out in accordance with standard procedures. The urinalysis strip results were reported categorically as positive (+, ++, +++) or negative (-). Ten mL aliquots of homogenized urine were centrifuged at 20,000 rpm for 30 minutes to detect *Schistosoma haematobium* eggs. The supernatant was removed and the sediment was mounted on microscope slides and covered with a coverslip and viewed with a 10x objective lens. The intensity of the parasites was expressed as eggs per 10 mL of urine, and diagnosed morphologically, including pale yellow-brown coloration, large oval shape, terminal spine and a fully developed miracidium.

Thick blood smears were prepared for blood examination for the detection of *Plasmodium* parasites. Slides were stained for 30 minutes with Giemsa stain diluted in 3% buffered water, washed in clean water, air dried and examined under oil immersion objective lens of 100 times. Characteristic stages of *Plasmodium* (ring-form trophozoites, schizonts or gametocytes) were identified in the samples, which were then declared as positive. Further, capillary tubes, micro hematocrit centrifuges and readers were used to determine Packed Cell Volume (PCV) of the blood samples.

The statistical analysis was carried out at 5% level of significance with SPSS software (Version 20.0). The prevalence of malaria parasite and *Schistosoma haematobium* infection was determined by using chi square tests. The level of infection was compared by age, education and occupation groups by analysis of variance (ANOVA) and differences in intensity between sexes were compared by independent t-test. In addition, t-tests were used to compare PCV and Body Mass Index (BMI) for uninfected individuals, single-infection and co-infected individuals. Simple frequencies and percentages were calculated to analyze the responses of the questionnaire.

RESULTS

Prevalence of Single and Co-infection of *S. haematobium* and Malaria Parasite in Relation to Educational Status

As shown in Table 3, the prevalence of *S. haematobium* single infection (18.2%) and co-infection (45.5%) was highest among those with no formal while those with tertiary education had the highest prevalence in single malaria parasite (40.0%). For single infections and co-infection, educational status was not significantly associated (P > 0.05).

Table 3: Prevalence of single and co-infection of *S. haematobium* and malaria parasite by education in the study area

Variables	Number examined	Single *S. haematobium* No Positive (%)	Single Malaria Parasite No Positive (%)	Co-infection No Positive (%)
Educational Status				
No formal education	11	2 (18.2)	4 (36.4)	5 (45.5)
Primary education	159	15 (9.4)	39 (24.5)	47 (29.6)
Secondary education	89	14 (15.7)	12 (13.5)	35 (39.3)
Tertiary education	10	1 (10.0)	4 (40.0)	2 (20.0)
χ^2		2.617	7.581	3.992
P value		0.455	0.056	0.262

Prevalence of Single and Co-infection of *S.haematobium* and Malaria Parasite by Occupation

None in the farming and fishing occupation had single *S.haematobium* infection while for malaria parasite infection; none in the fishing and trading occupation were infected. The prevalence of *S.haematobium* and malaria parasite co-infection varied in the different occupations, with fishing occupation having 100% prevalence of co-infection. Single and co-infection of both parasites were not associated (P>0.05) with occupation (Table 4).

Table 4: Prevalence of single and co-infection of *S.haematobium* and malaria parasite by occupation in the study area

Variables	No Examined	*S. haematobium* (%)	Malaria Parasite (%)	Co-infection (%)
Occupation				
Farmer	11	0 (0)	5 (63.9)	3 (27.3)
Fishing	1	0 (0)	0 (0)	1 (100)
Trader	8	1 (12.5)	0 (0)	5 (62.5)
Students	237	29 (12.2)	51 (21.5)	77 (32.5)
Civil servant	12	2 (6.7)	3 (25.0)	3 (25.0)
χ^2		1.910	6.173	5.709
P value		0.752	0.187	0.222

Mean Intensity of Single Infection of *S. haematobium* and Malaria Parasite by Sex and Age in the Study Area

The overall mean intensities of *S.haematobium* and malaria parasite were 2.16 $\pm$ 0.21 egg/10ml urine and 6.51 $\pm$ 0.48, respectively. Comparing intensity between sex and among age groups, there was no significant difference for both parasites (P>0.05).

Table 5: Mean intensity of single infection of *S.haematobium* and malaria parasite by sex and age in the study area

Variables	*S. haematobium*	Malaria Parasite
Overall	**2.16 ± 0.21**	**6.51 ± 0.48**
Sex		
Male	5.03 ± 0.53	10.76 ± 0.75
Female	4.64 ± 0.41	12.78 ± 0.865
P value	0.395	0.078
Age		
< 5	2.33 ± 0.88	12.00 ± 8.00
6 – 10	4.64 ± 0.58	12.13 ± 0.96
11 – 15	4.52 ± 0.51	12.71 ± 1.28
16 – 20	5.67 ± 0.76	11.18 ± 1.07
21 – 25	4.29 ± 0.84	8.17 ± 1.58
26 – 30	3.0 ± 0.00	3.0 ± 0.00
> 30	4.78 ± 1.51	12.0 ± 2.05
P value	0.675	0.661

Discussion

Educational status was seen to affect the prevalence of parasites including the highest prevalence of *Schistosoma haematobium* single infection (18.2%) and co-infection (45.5%) among participants with no formal education and the highest prevalence of single malaria infection (40.0%) among participants with tertiary education, respectively (P>0.05). In the same research, Sumbele et al. (2021) found that a lower level of education is often associated with a higher burden of co-infection, as this factor is linked to a lack of awareness on preventive measures. However, Abdissa et al. (2024) highlighted that, even with low baseline education, targeted social and behavior change communication can be a huge factor in reducing NTD burden.

Occupational variations revealed that more than half of the people involved in fishing (100.0%) and trading (62.5%) were co-infections, but no statistically significant relationship was observed (P>0.05). This was consistent with Babbitt et al. (2023) who showed that occupations with frequent water contact (e.g. fishing) significantly increase exposure to Bulinus snail habitats with *S. haematobium* cercariae. However, Bako et al. (2026) suggested that primary occupation is not the only determinant of malaria vector exposure, as exposure can be driven by factors such as vector control coverage. These underlying host-parasite dynamics are consistent with that of Venter et al. (2022) who emphasized the importance of multiple environmental exposures in creating polyparasitism and complex host-pathogen interactions.

When considering the intensity of infection, *S. haematobium* eggs/10 mL urine was found to be 2.16±0.21 while the overall mean intensity for malaria was 6.51±0.48, with no significant differences between and within sex and age groups (P>0.05). This result is consistent with that of Tokplonou et al. (2020) who found that *S. haematobium* infections control the density of *Plasmodium* falciparum and antibody response, thereby stabilizing parasite burden among the various demographic groups. In endemic environments, however, Angrisano and Robinson (2022) observed that due to physiological reservoirs and immune differences, there are generally unique age-specific parasitic profiles.

Whereas high co-infection rates in Nigeria are associated with socio-demographic vulnerabilities, the implications of this have consequences in wider socio-economic, educational and governance systems. This is in line with Morah (2023) and Ogechukwu et al. (2023 / Akudike et al. 2023) who highlight the need for education and e-library access as important instruments in the empowerment of the marginalised and reducing vulnerabilities in society. New educational approaches that respond to these health challenges, like the innovative approach of Johnson et al. (2026) using digital multimedia technologies to enhance engagement in learning and health literacy, are needed. In addition, the consequences of chronic polyparasitism for local productivity and human capital are significant at the end jeopardizing small-scale trading and rural occupations such as eco-tourism (Offiong et al., 2026). Not only do micro-entrepreneurs have to deal with high financial risk, due to lack of health stability, but also with the lack of necessary digital marketing skills, which can block their access to entrepreneurial opportunities (Okoro et al., 2025), and poor debt management and risk management in small businesses (Emeasoba et al., 2026).

In the end, chronic co-infections are indicators of systemic failure in governance. Social structures like mobilizing youth for political participation and good governance (Mezieobi et al., 2022) and the use of revolutionary cultural media (Ume & Agoha, 2025; Ilukwe & Ume, 2025) exist to demand targeted infrastructure, equitable healthcare and rural development in Ebonyi State.

CONCLUSION

This study showed that there was a significant burden of *Schistosoma haematobium* and malaria co-infections in Ebonyi Local Government Area, Nigeria. There was a consistent association between lower educational status and higher co-infection rates, as well as water-contact occupations, such as fishing and trading, with disease transmission higher, reflecting the importance of socio-economic vulnerability and direct environmental exposure. The overall high prevalence of parasites indicates ongoing transmission of both parasites in the area, although some differences in prevalence between demographic categories were not statistically significant. The fact that these findings point to factors that cannot be achieved through single treatment strategies underlines the need to have a more comprehensive approach to disease control. Rather, integrated public health interventions are needed to combat polyparasitism, including mass drug administration, increased availability of clean water infrastructure, vector control, and targeted social behavior change communication. It is important to control underlying socio-demographic risk factors to decrease intensity of parasitic co-infection and overall health effect in endemic communities of Ebonyi State.

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