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PREVALENCE OF MALARIA AND INTESTINAL HELMINTHES CO-INFECTION IN DELTA STATE, NIGERIA

***[1]Agbure, P. A., [2]Nmorsi, O. P. G., [3]Odogu, K. I., [4]Ogwezzy, P. I. and [5]Ogudu, E. O.**

[1]Department of Science Laboratory Technology, Delta State University, Abraka.
[2]Department of Animal and Environmental Biology, Delta State University, Abraka.
[3]Department of Biology, College of Education, Warri, Delta State
[4]Department of Animal and Environmental Biology, Southern Delta University, Ozoro, Delta State
[5]National Arbovirus and Vectors Research Center, Enugu State

*Corresponding author's email: *agburepascal200@delsu.edu.ng*

ABSTRACT

Intestinal helminth, and *Plasmodium* infections remain major public health challenges in tropical regions, where overlapping transmission patterns increase the likelihood of co-infections. This study investigated the prevalence of intestinal helminthes, and Plasmodium co-infections in Delta Central, Delta State, Nigeria. A total of 400 blood samples were collected from the volunteer participants, fifty (50) samples from each of the eight hospitals selected for the study. *P. falciparum* was detected using the conventional PCR technique. Co-infection, prevalence rate, and seasonal distribution patterns were determined. Statistical analysis included ANOVA, t-tests, and Pearson's correlation to assess species association and seasonal trends. Among the 800 participants, helminth infection alone was the most prevalent, affecting 38.8% of participants, followed by malaria-only infection at 30.4%. Seasonal analysis revealed that malaria infection was generally higher among males during the dry season (41.5%). For helminths, infection rate was higher among males during the rainy season for *Trichuris* (60.6%) and hookworm (81.3%), while for *Ascaris,* infection rate was higher among females (69.2%) during the rainy season, and also higher among females for *Schistosoma* (83.4%) during the dry season. Co-infection of helminth + malaria, was common, suggesting overlapping risk factors and the need for integrated control approaches. Overall, the results underscore a pressing need for strengthened public health interventions, improved sanitation, sustained vector control measures, and routine surveillance to reduce the burden of these infections.

Keywords: Malaria, Plasmoium, Intestinal helminth, *Ascaris, Trichiuris trichiuria,* Hookworm and *Schistosoma*

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INTRODUCTION

Malaria is a life-threatening parasitic disease that remains a major public health challenge worldwide, particularly in tropical and subtropical regions. It is caused by protozoan parasites of the genus *Plasmodium* and is transmitted to humans through the bite of infected female *Anopheles* mosquitoes. Globally, malaria accounts for millions of cases and hundreds of thousands of deaths annually, with the highest burden occurring in sub-Saharan Africa. Children under five years of age and pregnant women are the most vulnerable groups due to reduced immunity (Agarwal *et al*., 2017). Malaria is caused by five *Plasmodium* species known to infect humans, namely *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale*, and *Plasmodium knowlesi*. Among these, *P. falciparum* is the most virulent and is responsible for the majority of severe cases and deaths in Africa. Transmission is influenced by several risk factors, including climatic conditions such as rainfall and temperature, human behaviors, population movement, and inadequate vector control measures. *Anopheles* mosquitoes thrive in stagnant water bodies such as ponds, puddles, irrigation channels, and poorly drained environments, which serve as breeding sites and facilitate sustained malaria transmission in endemic areas (Akanbi *et al*., 2025).

Intestinal helminth infections are another group of neglected tropical diseases that pose a significant global health burden, particularly in low- and middle-income countries. These infections are caused by parasitic worms that inhabit the human gastrointestinal tract and other tissues. Intestinal helminths are widely distributed in regions with poor sanitation, unsafe water supplies, and limited access to healthcare. Transmission typically occurs through ingestion of parasite eggs or larvae in contaminated food, water, or soil, or through skin penetration by infective larvae. Billions of people globally are infected with one or more species of intestinal helminths, with school-aged children disproportionately affected (Lynch and Grencis, 2025).

The most common intestinal helminths of public health importance include *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms (*Ancylostoma duodenale* and *Necator americanus*), and *Schistosoma* species. These parasites are associated with chronic morbidity such as anemia, malnutrition, impaired physical and cognitive development, and reduced work capacity. Major risk factors for intestinal helminth infections include poor personal hygiene, open defecation, walking barefoot, consumption of contaminated food or water, overcrowding, and low socioeconomic status. In endemic communities, repeated exposure often leads to chronic infections that may persist for years (Degarege *et al.*, 2022).

In many malaria-endemic regions, particularly in sub-Saharan Africa, individuals are frequently exposed to both malaria parasites and intestinal helminths, resulting in co-infection. Several studies conducted in Africa, including Nigeria, have reported varying prevalence rates of malaria and intestinal helminth co-infection, especially among children and rural populations. Co-infection may influence host immune responses, disease severity, and treatment outcomes, with some evidence suggesting that helminth infections can modulate susceptibility to malaria or exacerbate malaria-related anemia. (Afolabi *et al.*, 2021). Therefore, understanding the prevalence of malaria and intestinal helminth co-infection is essential for developing integrated control strategies,

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improving case management, and reducing the overall disease burden. This study aims to evaluate the prevalence of malaria and intestinal helminthes co-infection in Delta State, Nigeria.

MATERIALS AND METHODS

Study area

This study was conducted in Delta State, located in the South–South geopolitical zone of Nigeria. Delta State lies approximately between latitudes 5°00′ and 6°30′ North and longitudes 5°00′ and 6°45′ East. It is bordered by Edo State to the north, Anambra State to the east, Bayelsa State to the south, and Ondo State to the west, with the Atlantic Ocean forming part of its southern boundary. The state is characterized by a tropical rainforest and mangrove swamp vegetation, with a humid climate, high rainfall, and extensive river networks, including the River Niger and its distributaries. Delta State has a mixed urban and rural population, with farming, fishing, and trading as major occupations, making it a suitable setting for studying malaria and intestinal helminth co-infection.

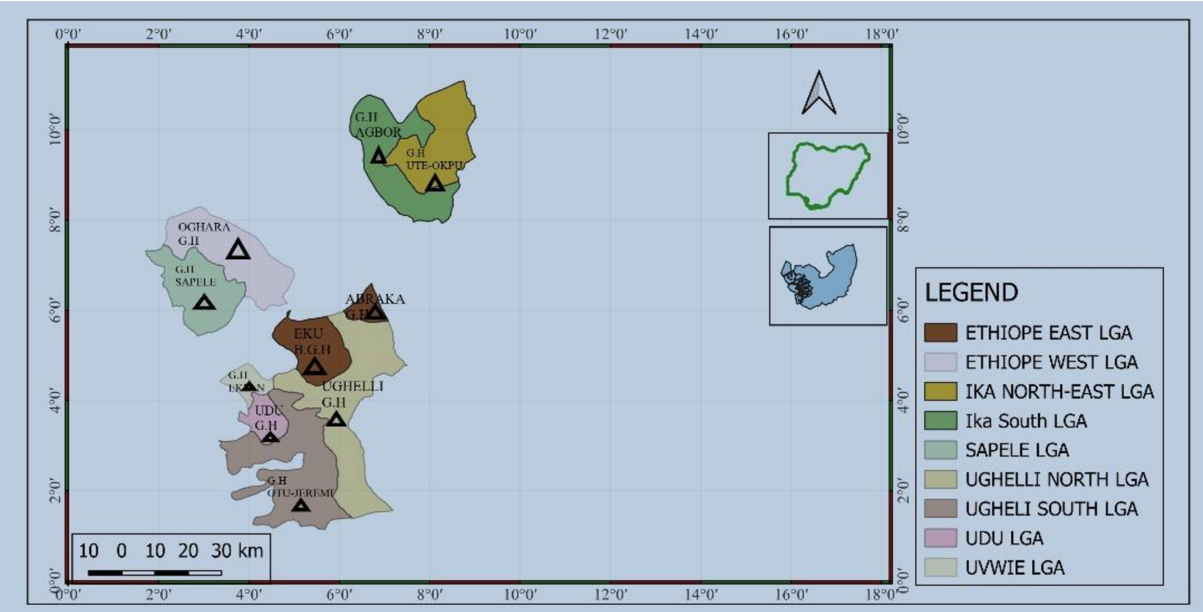

Figure 2.1: Map of Study Developed using QGIS

Study design

This study adopted a longitudinal survey design and was carried out among patients attending selected hospitals, including Udu General Hospital, Abraka General Hospital, Ughelli General Hospital, Central Hospital Sapele, Central Hospital Agbor, General Hospital Ute-Okpu, and General Hospital Ekpan. Sample collection was conducted at the laboratory units of the respective hospitals, which served as the designated sampling locations. Relevant demographic and clinical information were gathered from participants using a well-structured questionnaire. A total of 400 blood samples were obtained from consenting participants, with fifty (50) samples collected from each of the selected hospitals, in line with the approach described by Taherdoost (2022).

Ethical Approval

Ethical clearance for this study was obtained from the Faculty of Science Ethical Committee, Delta State University, Abraka, as well as the Delta State Ministry of Health, Asaba. Informed consent was obtained from all participants prior to sample collection. The purpose and procedures of the study

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were clearly explained to each participant in a language they understood. In cases where a participant was unable to provide consent personally due to speech or hearing impairment, consent was obtained from a legally authorized representative, such as a relative or a person designated by the participant, before sample collection was carried out.

Collection and analysis of samples

Approximately 3 ml of whole blood was aseptically collected from each participant through venipuncture using a sterile 5 ml syringe and transferred into a properly labeled sterile EDTA container. The blood samples were transported to the National Arbovirus and Vectors Research Centre (NAVRC), Enugu, for laboratory processing and analysis. For microscopic examination, a Pasteur pipette was used to place a drop of blood on a clean glass slide, which was then spread in a circular motion using a micropipette tip. The smear was air-dried and subsequently stained for parasite detection. The slide was placed on a staining rack and flooded with 3% Giemsa stain, allowing it to stand for 45–60 minutes. After staining, the slide was gently rinsed with slow-running water to remove excess stain, placed vertically on a drying rack, and allowed to air-dry. The stained blood film was examined under a ×100 oil immersion objective microscope for the identification of malaria parasites, following standard procedures as described by Kolluri et al. (2018).

Labeled clean plastic universal containers for stool, cellophane, newspaper, and plastic coverings were distributed for fecal sample collection. Instructions on how the fecal material was collected were properly given and discussed with the volunteers. On submission of the fecal specimen, 10% formalin was added immediately to these samples and subsequently transported to the Laboratory for analysis. Stool samples were prepared for microscopic and molecular analysis by homogenizing them in saline solution. The Nexted Polymerase Chain Reaction (nPCR) technique was used for the analysis of stool samples.

Statistical Analysis

Data generated from the study were analyzed using descriptive statistical methods, including frequencies and percentages, to summarize the findings. Associations between categorical variables were assessed using the Chi-square test, and statistical significance was determined at a p-value of less than 0.05.

RESULTS

Among 800 individuals (319 males and 481 females), helminth infection alone was the most prevalent, affecting 38.8% of participants, followed by malaria-only infection at 30.4%. Co-infection was observed between helminths and malaria (23.8%), with females (62.3%) more affected than males (37.4%), and the difference was statistically significant ($p = 0.021$).

Malaria infection was most commonly recorded among children aged 0–9 years (37.6%) and adults between 21 and 39 years (35.9%), while the lowest rate was found in individuals aged 60 years and above (17.9%). However, the differences across age groups were not statistically significant ($p = 0.866$). When analyzed by occupation, drivers (60.0%), artisans (57.7%), and students (57.1%) exhibited the highest rates of infection, whereas traders (15.2%) and civil servants (21.6%) had the lowest, though the variation was not significant ($p = 0.205$). In terms of educational attainment, individuals with primary school education showed the highest infection rate (43.8%), followed by secondary school graduates (32.1%) and uneducated participants (24.0%), while those with tertiary education had the lowest prevalence (20.7%), with no significant differences observed ($p = 0.419$). Across most demographic groups, low and moderate levels of parasitemia were

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predominant, whereas high parasitemia was comparatively rare.

The seasonal pattern of malaria cases was examined by age group and sex among 800 participants, with 400 individuals surveyed in each season. Overall, malaria infection was higher in males during the dry season (41.5%). In the rainy season, males also showed a slightly higher infection rate (30.0%) compared to females (27.9%), while females aged 21–39 years recorded the highest infection rate of 40.8% among all age groups. During the dry season, male participants continued to have higher infection rates (41.5%) than females (25.7%), with males aged 10–20 years showing the peak rate of 59.4%. The lowest infection rates were observed in females aged 60 years and above during the rainy season, and in males of the same age group during the dry season, both recording 0%. Despite these observed variations across seasons, sexes, and age groups, the differences were not statistically significant (p = 0.344).

Ascaris lumbricoides infection was higher among females (63.8%) than among males (56.4%). The highest prevalence was observed among males and females aged 10 - 20 years (81.3% and 85.1%, respectively), while the lowest occurred in those ≥ 60 years, 16.7% and 18.8% for males and females, respectively. The p-value of 0.532 suggests that the observed differences in infection rates across age groups were not statistically significant.

Children aged 10–20 years had the highest no of *Trichiuris trichiuria* infections of 87.5% and 79.8% for males and females respectively, followed by children aged 0 - 9 years (80% and 56.7% respectively for males and females), while the age group ≥60 years had the lowest no. of infection of 16.7% and 6.3% for males and females respectively. Overall, males showed a higher prevalence of 48.9% while females showed a lower prevalence of 43.7%, with a statistically non-significant p-value of 0.221

The prevalence of hookworm decreased with age, with the lowest rates observed in adults aged 60 years and above (50.0% in males and 56.3% in females) and the highest in individuals aged 10 - 20 years (85.9% in males and 86.2% in females). The total prevalence across all ages is high, at 73.0% for males and 73.8% for females, and the p-value of 0.652 indicates no statistically significant difference between males and females across all age groups

The highest prevalence of *Schistosoma* infection was observed among individuals aged 10–20 years, with 92.2% of males and 95.7% of females infected, followed closely by those aged 0 - 9 years (81.7% and 83.5%, respectively). The lowest infection rates occur in adults aged ≥ 60 years, with 33.3% of males and 31.3% of females infected. Overall, females consistently showed a higher prevalence of 69.2% than males, 66.8%. The p-value of 0.022 indicates a statistically significant difference between sexes, suggesting that gender may influence infection rates.

The seasonal distribution of helminth infections among males and females across both rainy and dry seasons showed varying levels of infection. For *Ascaris* infection, males and females had similar infection patterns between seasons, with slightly higher prevalence during the rainy season (59.4% and 69.2% compared to the dry season (53.5% and 58.5%). *Trichuris* infection showed a higher proportion of infected females (50.6%) during the dry season compared to males (36.7%), whereas the rainy season recorded 60.6% in males and 36.7% in females. For *Hookworm*, 81.3% (males) and 77.5 (females) were infected during the rainy season, while 64.8% (males) and 70.1% (females) during the dry season. *Schistosoma* infection

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demonstrated a higher prevalence during the dry season for both sexes (76.7% males and 83.4% females) compared to the rainy season (56.9% males and 55.0% females).

The prevalence and intensity of helminths among males and females revealed that Hookworm infection had the highest prevalence in both males (73%) and females (73.8%), while *Trichuris* showed the lowest prevalence among males (48.9%) and females (43.7%). The number of eggs per slide and mean egg/gram were generally higher in females than in males. *Ascaris* had the highest number of eggs per slide for both males and females 1,297 and 1,680, respectively, while *Schistosoma* had the least number of eggs per slide for males (46). *Ascaris* infection exhibited the highest intensity in both sexes, with females (40,320) having a much greater intensity than males (15,564). In contrast, *Schistosoma* had the lowest intensity values, indicating lighter infections despite its high prevalence.

Table 1: Co-infection patterns of intestinal helminths, malaria, dengue, and yellow fever

	No. Examined (%)			No. Infected (%)			
Infections	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**p-value**
Malaria only	800	319 (39.9%)	481 (60.1%)	243 (30.4%)	114 (46.9%)	129 (53.1%)	–
Helminth only	800	319 (39.9%)	481 (60.1%)	310 (38.8%)	122 (39.4%)	188 (60.6%)	–
Helminth + Malaria	800	319 (39.9%)	481 (60.1%)	190 (23.8%)	71 (37.4%)	119 (62.3%)	0.021*

A p-value less than 0.05 is typically considered statistically significant.

Table 2: Prevalence of malaria according to demographic characteristics

				Level of parasitemia			
Characteristics	**No. Examined (n = 800)**	**No. Infected (n = 243)**	**Prevalence (%)**	**Low**	**Moderate**	**High**	**p-value**
Gender							
Males	319	114	35.7	28	26	11	0.188
Females	481	129	26.8	37	32	9	
Age group							
0–9	157	59	37.6	16	15	6	0.866
10–20	158	51	32.3	36	31	7	
21–39	237	85	35.9	10	9	5	
40–59	220	43	19.5	3	3	2	
≥60	28	5	17.9	0	0	0	
Occupation							
Students	98	56	57.1	10	8	3	0.205
Farmers	66	32	48.5	6	8	3	
Drivers	25	15	60.0	2	2	1	
Traders	230	35	15.2	14	12	4	
Civil Servants	102	22	21.6	10	8	4	

Characteristics	No. Examined (n = 800)	No. Infected (n = 243)	Prevalence (%)	Level of parasitemia Low	Moderate	High	p-value
Others	253	68	26.9	20	19	4	
Artisans	26	15	57.7	3	1	1	
Level of Education							
Uneducated	50	12	24.0	8	7	1	0.419
Primary	210	92	43.8	15	12	4	
SSCE	240	77	32.1	22	20	9	
Tertiary	300	62	20.7	20	19	6	

p-value less than 0.05 is typically considered statistically significant

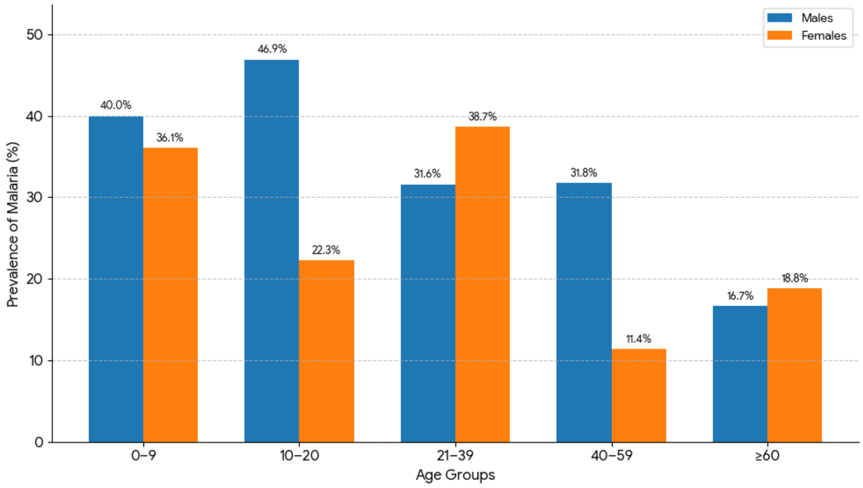

Figure 2: Prevalence (%) of malaria infection by age group and gender.

Table 3: Seasonal distribution of malaria cases

Season	Age group	No. Examined Male	Female	No. infected (%) Male	Female	Non-infected (%) Male	Female	p-value
Rainy	0–9	30	48	10 (33.3%)	18 (37.5)	20 (66.7%)	30 (62.5%)	**0.344**
	10–20	32	47	11 (34.4%)	12 (25.5%)	21 (65.6%)	35 (74.5%)	
	21–39	47	71	13 (27.7%)	29 (40.8%)	34 (72.3%)	42 (59.2%)	
	40–59	44	66	12 (27.3%)	8 (12.1%)	32 (72.7%)	58 (87.9%)	
	≥60	6	8	2 (33.3%)	0 (0.0%)	4 (66.7%)	8 (100%)	
	Total	159	240	48 (30.0%)	67 (27.9%)	111 (69.8%)	173 (72.1%)	
Dry	0–9	30	49	14 (46.7%)	17 (34.7%)	16 (53.3%)	32 (65.3%)	
	10–20	32	47	19 (59.4%)	9 (19.1%)	13 (40.6%)	38 (80.9%)	
	21–39	48	71	17 (35.4%)	26 (36.6%)	31 (64.6%)	45 (63.4%)	
	40–59	44	66	16 (36.4%)	7 (10.6%)	28 (63.6%)	59 (89.4%)	
	≥60	6	8	0 (0.0%)	3 (37.5%)	6 (100%)	5 (62.5%)	
	Total	160	241	66 (41.5%)	62 (25.7%)	94 (58.8%)	179 (74.3%)	
Total		319	481	114 (46.9%)	129 (53.1%)	205 (64.3%)	352 (73.2%)	

p-value less than 0.05 is typically considered statistically significant

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Table 5: Prevalence of *Ascaris lumbricoides* by age group and gender

	No. Examined (n=800)		No. Infected (n=487)		Prevalence (%)		
Age Groups	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	p-value
0–9	60	97	48	79	80.0%	81.4%	0.532
10–20	64	94	52	80	81.3%	85.1%	
21–39	95	142	45	80	47.4%	56.3%	
40–59	88	132	33	65	37.5%	49.2%	
≥60	12	16	2	3	16.7%	18.8%	
Total	**319**	**481**	**180**	**307**	**56.4%**	**63.8%**	

p-value less than 0.05 is typically considered statistically significant

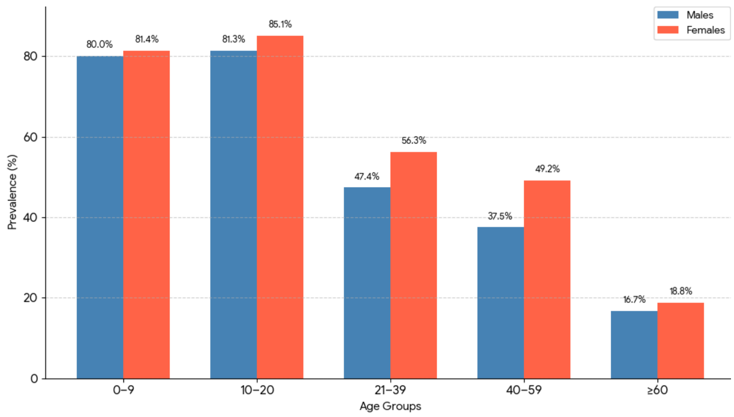

Figure 3: Prevalence (%) of *Ascaris lumbricoides* infection by age group and gender.

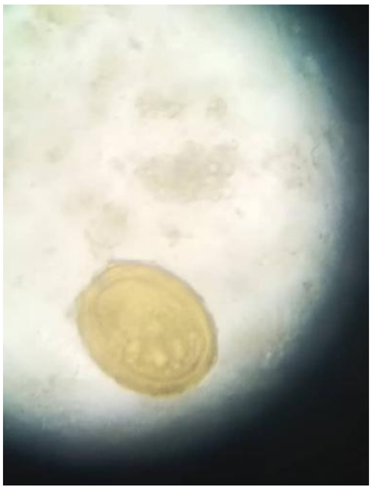

Plate 1: *Ascaris lumbricoides* egg at 40× objective

Table 6: Prevalence of *Trichiuris trichiuria* by age group and gender

	No. Examined (n=800)		No. Infected (n=366)		Prevalence (%)		
Age Groups	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**p-value**
0–9	60	97	48	55	80.0%	56.7%	0.221
10–20	64	94	56	75	87.5%	79.8%	

	No. Examined (n=800)		No. Infected (n=366)		Prevalence (%)	
21–39	95	142	33	49	34.7%	34.5%
40–59	88	132	17	30	19.3%	22.7%
≥60	12	16	2	1	16.7%	6.3%
Total	**319**	**481**	**156**	**210**	**48.9%**	**43.7%**

p-value less than 0.05 is typically considered statistically significant

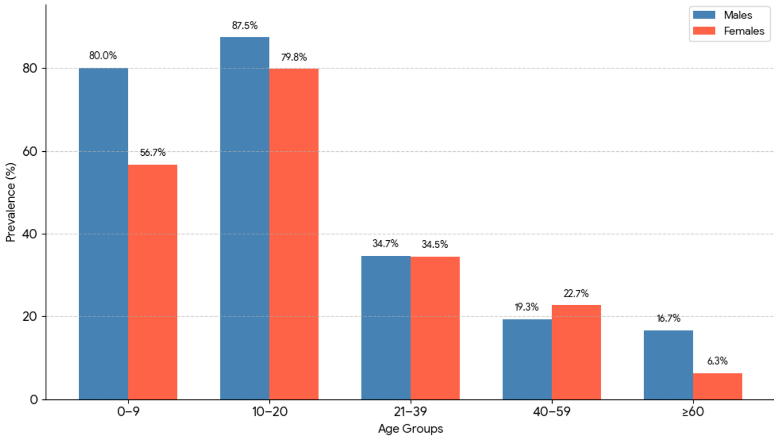

Figure 4: Prevalence (%) of *Trichuris trichiura* infection by age group and gender.

Plate 2: *Trichiuris trichiuria* egg at 40× objective

Table 7: Prevalence of Hookworm by age group and gender

	No. Examined (n=800)		No. Infected (n=588)		Prevalence (%)		
Age Groups	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**p-value**
0–9	60	97	50	79	83.3%	81.4%	0.652
10–20	64	94	55	81	85.9%	86.2%	
21–39	95	142	64	101	67.4%	71.1%	
40–59	88	132	58	85	65.9%	64.4%	
≥60	12	16	6	9	50.0%	56.3%	

	No. Examined (n=800)		No. Infected (n=588)		Prevalence (%)	
Total	**319**	**481**	**233**	**355**	**73.0%**	**73.8%**

p-value less than 0.05 is typically considered statistically significant

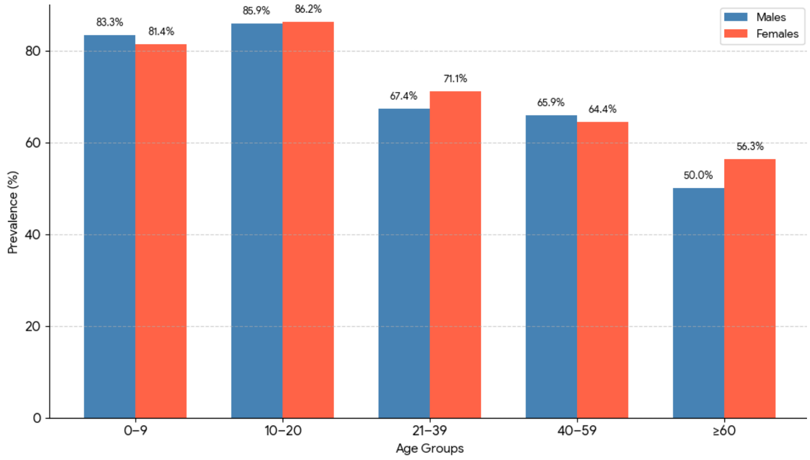

Figure 5: Prevalence (%) of Hookworm infection by age and gender.

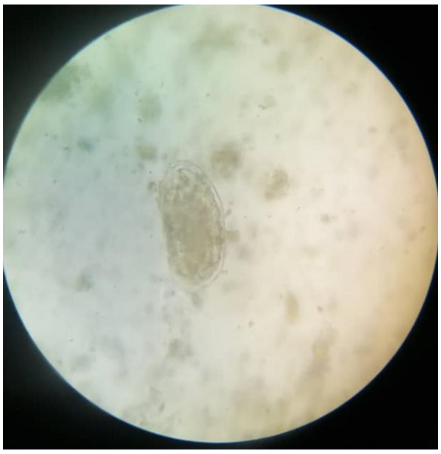

Plate 3: *H*ookworm egg at 40× objective

Table 8: Prevalence of *Schistosoma* by age group and gender

Age Groups	No. Examined (n=800)		No. Infected (n=546)		Prevalence (%)		p-value
	Males	**Females**	**Males**	**Females**	**Males**	**Females**	
0–9	60	97	49	81	81.7%	83.5%	0.022
10–20	64	94	59	90	92.2%	95.7%	
21–39	95	142	60	92	63.2%	64.8%	
40–59	88	132	41	65	46.6%	49.2%	
≥60	12	16	4	5	33.3%	31.3%	
Total	**319**	**481**	**213**	**333**	**66.8%**	**69.2%**	

p-value less than 0.05 is typically considered statistically significant

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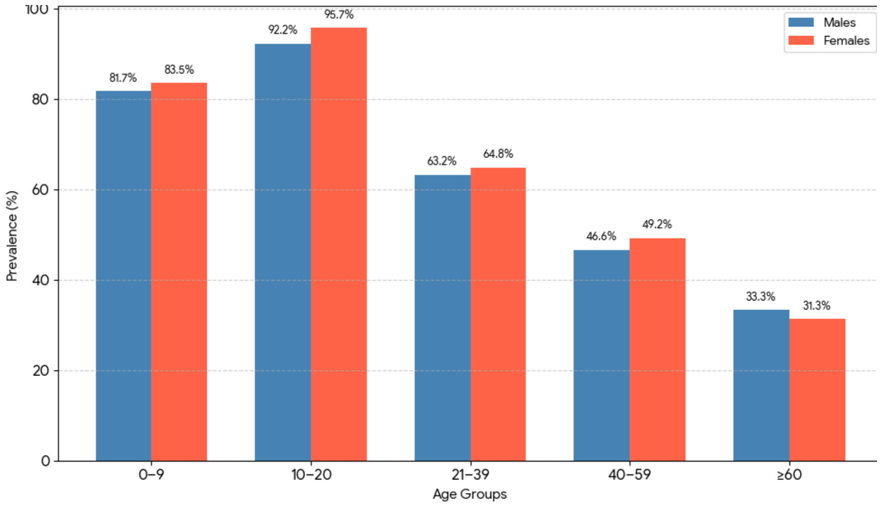

Figure 6: Prevalence (%) of *Schistosoma* infection by age group and gender.

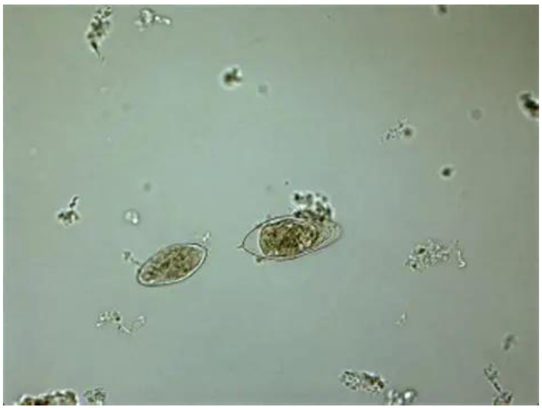

Plate 4: *Shistosoma* egg at 40× objective

Table 9: Seasonal distribution of helminth infections

Helminth	Season	No. Examined		No. infected (%)		Non-infected (%)		p-value
		Males	Females	Males	Females	Males	Females	
Ascaris	Rainy	160	240	95 (59.4%)	166 (69.2%)	65 (40.6%)	74 (30.8%)	0.822
	Dry	159	241	85 (53.5%)	141 (58.5%)	74 (46.5%)	100 (41.5)	
	Total	319	481	180 (56.4%)	307 (63.8%)	139 (43.6%)	174 (36.2%)	
Trichuris	Rainy	160	240	97 (60.6%)	88 (36.7%)	63 (39.4%)	152 (63.3%)	0.873
	Dry	159	241	59 (37.1%)	122 (50.6%)	100 (62.9%)	119 (49.1%)	
	Total	319	481	156 (48.9%)	210 (43.7%)	163 (31.7%)	271 (56.3%)	
Hookworm	Rainy	160	240	130 (81.3%)	186 (77.5)	30 (18.8%)	54 (22.5%)	0.114
	Dry	159	241	103 (64.8%)	169 (70.1%)	56 (35.2%)	72 (29.9%)	
	Total	319	481	233 (73.0%)	355 (73.8%)	86 (27.0%)	126 (26.2%)	
Schistosoma	Rainy	160	240	91 (56.9%)	132 (55.0%)	69 (43.1%)	180 (75.0%)	0.084
	Dry	159	241	122 (76.7%)	201 (83.4%)	37 (23.4%)	155 (64.3%)	
	Total	319	481	213 (66.8%)	333 (69.2%)	106 (33.2%)	335 (69.6%)	

p-value less than 0.05 is typically considered statistically significant

Table 14: Prevalence and intensity of helminths in the study area

Helminths	No. Infected (% prevalence)		No. of eggs per slide		Mean egg/gram		Intensity	
	Males	Females	Males	Females	Males	Females	Males	Females
Ascaris	180 (56.4%)	307 (63.8%)	1,297	1,680	86.47	131.34	15,564	40,320
Trichuris	156 (48.9%)	210 (43.7%)	200	264	30.77	30.17	4,800	6,336
Hookworm	233 (73.0%)	355 (73.8%)	157	286	16.17	19.34	3,768	6,864
Schistosoma	213 (66.8%)	333 (69.2%)	46	187	5.18	13.45	1,104	4,488

DISCUSSION

The results revealed that helminth-only infections were the most common (38.8%), followed by malaria-only infections (30.4%). Helminth + malaria infection had 23.8% prevalence rate, with females (62.3%) being significantly more affected than males (37.4%) (p = 0.021). The occurrence of helminth–malaria co-infection may be linked to overlapping ecological and socioeconomic factors, such as poor sanitation and mosquito breeding environments that promote concurrent transmission. Similarly, but slightly lower than this study, Akanbi *et al*. (2025), who examined the detection of malaria co-infection in Bayelsa State, reported that 6.5% of participants were co-infected with malaria and helminths. Likewise, Babamale *et al*. (2018) highlighted that the overlap of malaria and helminths in Nigeria is driven by shared ecological and behavioral risk factors. Conversely, a study by Bempah *et al*. (2025) in Ghana found no significant association between helminth and malaria co-infections, concluding that host immunity and deworming interventions may have weakened the interaction, pointing to regional differences in infection dynamics.

The data showed that malaria prevalence was higher among males (35.7%) than among females (26.8%), and most cases involved low to moderate parasitemia. The highest infection occurred among males in the 10 - 20 years group and those with a primary level of education, while farmers and civil servants recorded the highest occupational risk. The reduced infection among older adults may reflect improved preventive practices among caregivers or sample distribution. The higher prevalence among males and farmers could be linked to greater outdoor exposure to mosquitoes. These findings are consistent with the report of Awosolu *et al*. (2021), who found higher malaria prevalence among males and individuals with lower education in Nigeria. Likewise, Kendie *et al*. (2021) observed that occupation and educational level were key determinants of malaria risk in Ethiopia, supporting the patterns observed in this study. In another study, Michael *et al.* (2023) investigated the detection of Dengue virus IgM seropositivity and malaria co-infection among individuals resident on the banks of the River Niger in Anambra State, Nigeria. They reported that 36.5% of their study participants tested positive for malaria, which is similar but slightly higher than the report of this study, which was 35.7%.

The study showed an overall high prevalence of *Ascaris lumbricoides* infection (60.9%), which reveals that intestinal helminthiasis remains a major public health concern in the study area. The significantly higher prevalence among females (63.8%%) than males (56.4%) (p<0.001) may result from greater environmental exposure among women,

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particularly those engaged in outdoor labor and poor hand hygiene. The highest infection rates among children aged 10 - 20 years could be due to weakened immunity and long-term cumulative exposure to contaminated environments. The high prevalence is similar to the findings of Osaiyuwu *et al*. (2025), who reported *Ascaris* as the most common soil-transmitted helminth in Edo State, with significantly higher infection among females. However, these results differ from the study of Asemota *et al*. (2014), who observed a higher prevalence among children under 15 years, reflecting that age-related immunity and hygiene behavior may influence transmission in different populations.

The overall prevalence of *Trichuris trichiura* infection (45.6%) indicates a substantial level of intestinal helminth transmission in the study areas. The significantly higher rate among males (48.9%) than females (43.7%) ($p<0.027$) may be attributed to gender-based exposure differences, such as increased contact with contaminated environments during domestic or agricultural activities. The remarkably high prevalence among children aged 10–20 years (87.5% and 79.8% for males and females, respectively) suggests poor hygiene practices and frequent hand-to-mouth contact typical of young children, which facilitates ingestion of infective eggs. The finding that female students were more affected may reflect varying sanitation levels at workplaces and differences in personal hygiene habits. These findings align with the work of Asaolu *et al*. (1992), who reported a high prevalence of *Trichuris* among adults in southeastern Nigeria, particularly females, linking the trend to water and sanitation challenges. In contrast, Kepha *et al*. (2024) reported higher infection rates among school-aged children in Kenya, underscoring that age-related exposure varies by locality.

The study shows an overall hookworm prevalence of 73.5%, demonstrating widespread soil-transmitted helminth infection in the study area. Although females (73.8%) showed a slightly higher prevalence than males (73%), the difference was not statistically significant ($p=0.221$), suggesting similar exposure risk between sexes. The highest prevalence among individuals aged 10–20 years (87.5% and 79.8% for males and females, respectively) reflects greater outdoor activities, barefoot walking, and occupational exposure, while the lower prevalence among older adults may result from limited outdoor contact. Similarly, findings in Ethiopia by Setegn *et al*. (2024) showed that hookworm was more concentrated among children, suggesting that local sanitation practices shape epidemiological trends.

The very high *Schistosoma* prevalence (84.3%) recorded in the study population highlights an alarming level of transmission in Delta Central. The slightly higher rate among females (69.2%) compared to males (66.8%) ($p=0.028$) suggests gender-related exposure through domestic water use, such as washing and bathing in infested streams. The infection was most prevalent among children aged 10–20 years (92.2% of males and 95.7% of females), indicating early-life exposure to contaminated water bodies. These findings corroborate the study of Ojo *et al*. (2021), who reported very high *Schistosoma* prevalence in southwestern Nigeria, particularly among adults frequently exposed to rivers and streams. Similarly, Ezeh *et al*. (2019) found that females were disproportionately affected due to their role in domestic water collection and laundry. Contrastingly, Manz *et al*. (2020) in Tanzania found that school-aged children bore the highest burden, reflecting local differences in exposure behavior and public health interventions.

The result showed that malaria infection was slightly higher among males during the dry season (41.5%), while in the rainy

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season, males (30%) recorded higher infection. Female participants aged 21 - 39 years had the highest malaria infection rate of 40.8%. Despite these variations, the differences were statistically insignificant (p = 0.344). The seasonal fluctuation in malaria prevalence can be attributed to vector breeding patterns, as *Anopheles* mosquitoes thrive better during periods of moderate rainfall and stagnant water availability. These findings align with the observations of Yusuf *et al*. (2024), who reported that malaria prevalence in rural communities of Southwestern Nigeria showed no significant seasonal difference due to perennial transmission. Similarly, Hussaini *et al.* (2025) noted that malaria burden persisted in both wet and dry seasons in Northern Nigeria, largely driven by environmental factors and vector adaptation. In contrast, Dakorah *et al*. (2022) found significantly higher malaria prevalence during the rainy season in Ghana, attributing it to increased mosquito breeding following heavy rainfall, which highlights how ecological variation influences seasonal malaria trends.

The findings revealed varying helminth infection rates between sexes and seasons. *Ascaris* and Hookworm infections were slightly more prevalent during the rainy season, while *Trichuris* and *Schistosoma* showed higher prevalence during the dry season. Notably, *Schistosoma* infection peaked at 76.7% in males and 83.4% in females during the dry season, suggesting enhanced transmission linked to human-water contact in stagnant or shrinking water bodies. These patterns may be influenced by seasonal environmental changes affecting parasite survival and exposure levels. The observation that males generally exhibited marginally lower infection rates could be linked to differences in hygiene practices or occupational exposure. These findings are consistent with Oyewole and Simon-Oke (2022), who reported that soil-transmitted helminths persisted across seasons in Southwestern Nigeria due to poor sanitation practices. Similarly, Karshima (2018) observed that *Schistosoma haematobium* prevalence increased slightly in dry months when communities depended more on river water. Contrary to this, Adu-Gyasi *et al*. (2018) found higher helminth transmission during rainy seasons in Ghana, attributing it to favorable moisture conditions for egg survival, suggesting that ecological context strongly shapes seasonal dynamics of helminth infections.

The result indicates that hookworm showed the highest prevalence in both males (73%) and females (73.8%), while *Trichuris* showed the lowest prevalence among males (48.9%) and females (43.7%). The higher prevalence and intensity of Hookworm among females could be linked to increased exposure through domestic water-related activities such as bathing and washing in contaminated water sources, which are common transmission routes (Akindele *et al.*, 2020). The high egg counts and mean egg/gram observed in *Ascaris* infections, particularly in females, may be attributed to poor sanitation and fecal contamination of the environment that favors parasite transmission (Idowu *et al.*, 2019). The overall higher infection rates among females compared to males could also be due to gender-related behavioral and occupational exposure patterns, consistent with the findings of Enudi *et al*. (2024) in Delta North agricultural zone, Nigeria, who reported a significantly higher helminth prevalence among females. Similarly, Yaro *et al*. (2018) observed a dominance of *Schistosoma haematobium* infections in rural areas with poor access to clean water.

CONCLUSION

The findings reveal that helminth infections remain highly prevalent, with *Ascaris* and *Schistosoma* being the most widespread, and malaria continues to impose a significant

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burden across all locations, with transmission occurring year-round. Co-infections of helminth + malaria was common, suggesting overlapping risk factors and the need for integrated control approaches. Overall, the results underscore a pressing need for strengthened public health interventions, improved sanitation, sustained vector control measures to reduce the burden of these infections.

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