Age-Stratified Prevalence of Malaria and Ascariasis Co-Infection in Akungba- Akoko, Ondo State, Nigeria

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ABSTRACT

Co-infection with malaria and ascariasis poses a significant public health concern, especially in regions where both parasites are endemic. These infections disproportionately affect vulnerable populations such as children, where the impact of co-infection can be more severe due to compromised immunity and increased environmental exposure. This study assessed the prevalence and age-specific distribution of Malaria and *Ascaris lumbricoides* co-infections among 200 individuals aged 3 to 26 years in Akungba Akoko, Ondo State, Nigeria. Participants were categorized into six age brackets: 3–6, 7–10, 11–14, 15–18, 19–22, and 23–26 years. Malaria infection was diagnosed using rapid diagnostic tests (RDTs), while stool samples were collected and analyzed using the formalin-ethyl acetate concentration method for detecting *A. lumbricoides*. Statistical analysis using chi-square tests was performed to determine variations in co-infection rates across age groups. An overall co-infection prevalence of 11% was recorded, with the highest rate (30.0%) observed among children aged 3–6 years. A significant association was found between age and co-infection prevalence ($\chi^2 = 16.97$, $p = 0.005$), indicating a strong age-related susceptibility pattern. These findings emphasize the critical need for targeted, age-specific public health interventions, including deworming programs, malaria prevention, improved sanitation, and health education. Such efforts are especially essential for younger children in endemic areas to reduce the burden and long-term impact of these co-existing parasitic diseases.

Keywords: Prevalence, Co-infection, Malaria, Ascariasis and Parasite.

INTRODUCTION

Malaria is one of the most important public health problem in term of morbidity and mortality, causing more than 200 million cases and 655,000 deaths every year (Nwakaogor *et al*., 2024). There are five *Plasmodium* species that cause malaria in humans, all transmitted through the bite of infected female *Anopheles* mosquitoes. These are *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium vivax*, *Plasmodium ovale*, and *Plasmodium knowlesi*. Among these, *P. falciparum* is the most deadly and is the most prevalent in sub-Saharan Africa (Miezan *et al.*, 2023). Malaria has a particularly severe impact on young children and pregnant women (CDC, 2024). Its symptoms range from mild fever and chills to severe conditions that can lead to organ failure and death (CDC, 2024). Environmental factors such as regional conditions, temperature, and mosquito population significantly influence malaria incidence (WHO, 2023). Malaria continues to be a major public health concern, with Nigeria alone contributing a large share of the global malaria burden and associated deaths—especially among children under the age of five (WHO, 2023). According to the World Health Organization, Nigeria accounted for 38.5% of global malaria deaths in children under five in 2022 (WHO, 2023).

Human ascariasis is one of the most important neglected tropical diseases (NTDs) worldwide (Hailu *et al*.,2020). It is caused by the intestinal nematode of the genus *Ascaris* a soil-transmitted helminth (STH) (Else *et al*., 2020). *Ascaris* infection is prevalent and has been estimated to affect ~819 million people. The intensity of A*scaris* infection is highest in children of 5 to 15 years of age, and has an over-dispersed or aggregated distribution, with most individuals harboring light infections, and a relatively small proportion of the population harboring heavy infection. Furthermore, there is consistency in the pattern of re-infection or predisposition in humans (Alexander and Blackburn, 2019). Ascaris infections are widespread throughout Nigeria, with prevalence rates varying across different states (Oyeyemi and Okunlola, 2023). Transmission occurs primarily through ingestion of eggs via contaminated food or water (Edoa *et al.*, 2024). While mild infections are often asymptomatic, severe cases can cause anemia, vitamin A deficiency, malnutrition, loss of appetite, and stunted growth (Aklilu *et al.*, 2022). Studies indicate that children infected with *Ascaris lumbricoides* are particularly vulnerable to anemia and have lower hemoglobin levels compared to uninfected children (Maulana *et al*., 2022 : Wijaya *et al*., 2021).

Parasitic co-existence is common with increased potential for co-infection, which may adversely impact the outcome of the diseases they cause commonly in many afro-tropical countries (Dike-Ndudim *et al*., 2022). Due to environmental and host factors which favors transmission of these parasitic infections, *Plasmodium falciparum* and soil-transmitted helminths (STH), including *Ascaris lumbricoides, Trichuris trichiura,* and hookworms, co-exist in many parts of the world, predominantly in sub-Saharan Africa (SSA) (Afolabi *et al*., 2022), where they are most prevalent.

Malaria and helminths infections are widespread and they both have similar geographical distribution in developing countries with anaemia being a possible consequence. Helminth and Plasmodium infections are prone to spread under favorable climatic and environmental conditions, particularly among the poorest groups that lack vital utilities such as clean water and sanitation (Caldrer *et al*., 2022). It is estimated that over a 1:3% of the world's population, mainly those individuals living in the tropics and subtropics, are infected by parasitic intestinal helminths or one or more of the species of Plasmodium (Agudelo *et al*., 2021).

According to some studies, the co-infection of *Plasmodium falciparum* and soil-transmitted helminths, particularly *Ascaris lumbricoides,* in a single host can have severe immunologic repercussions (Easton *et al*., 2020). Co-infection can also change the clinical appearance of some of these disease, can also aggravate their symptoms, and complicate the identification and management of such parasitic infections (Zargaran *et al*., 2023). Also, for an example, most parasitic helminth infections can stimulate the human immune system, affecting malaria susceptibility and antimalarial medication efficacy. However, malaria-induced anemia and immunosuppression may exacerbate the morbidity associated with helminth infections (Lebu *et al*., 2023).

METHODS

Study Area

This study was carried out in Akungba Akoko, a typical pre-urban neighborhood. Akungba Akoko is located in Ondo State, Nigeria's southwestern region. It is located at GPS coordinates 7.4718° North latitude and 5.7352° East longitude. Akungba is a small, linear village. Akungba Akoko is located in a tropical environment with distinct wet (April-October) and dry (November-March) seasons, with an average annual rainfall of more than 1,100 mm. The population is primarily Yoruba, with a small number of Igbo and Hausa residents. The religious makeup is diverse, with over 70% identifying as Christians, 25% as Muslims, and the remaining 5% following traditional African religions. Agriculture is the primary source of income in the village, with many individuals working as peasant farmers. Cassava, maize, yams, and different vegetables are among the most often produced crops. Although agriculture is the mainstay, some community residents engage in small-scale trading and artisanal crafts.

Sanitation in Akungba Akoko is often poor, with many residences missing suitable toilets and ventilation. Waste management presents a substantial challenge because refuse dumps are frequently placed near residential areas, creating health dangers to residents. Infrastructure development is restricted, with only a few residences having access to power, and a stable water supply remains a major concern for most locals.

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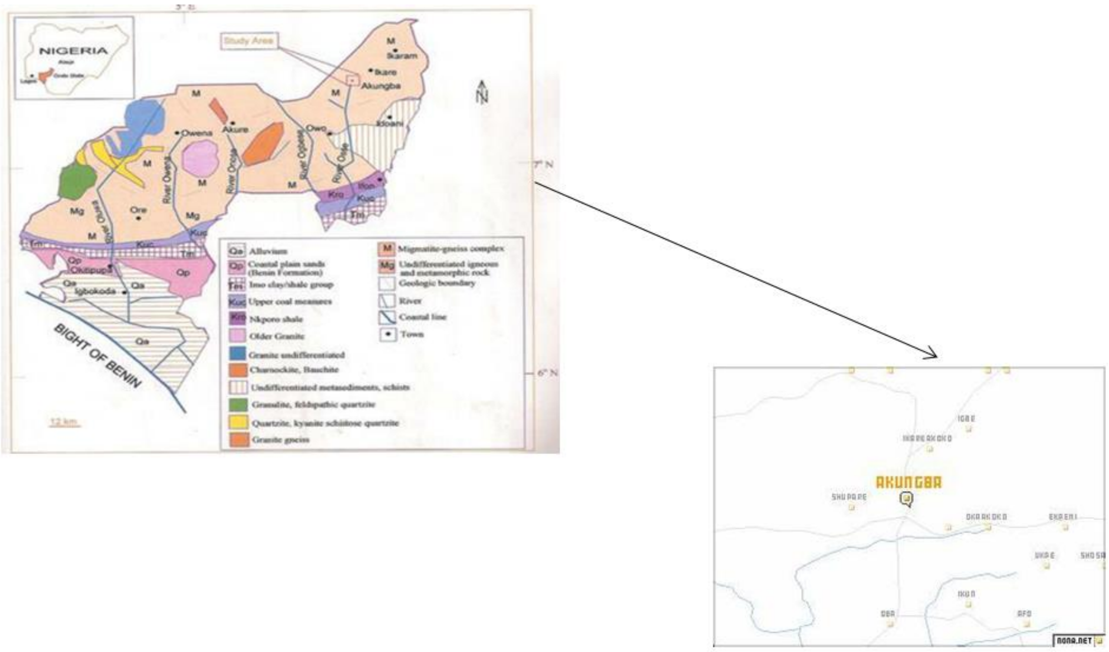

Fig. 1: Map of Nigeria showing Ondo state and Akungba-Akoko

(https://www.researchgate.net/publication/329365574/figure/fig1/AS:699717755346949@1543837121929/Map-of-Nigeria-showing-Ondo-state-and-Akungba-Akoko-Source.ppm)

Study Population

The study population comprised of children, teenagers and young adults based on age group and gender across various social class (Table 1)

Ethical Clearance

The ethical permission / Clearance was obtained from Ondo State Ministry of Health ((OSHREC 23/11/2023/599) before the commencement of the field study. Informed consent was obtained from the parents or guardians of the participants. Additionally, for children who were ≥ 10 years, an additional assent was obtained.

Sample collection and processing

Malaria Diagnosis

Malaria infection was assessed in all participants using the ParaHit® ver1.0 Rapid Diagnostic Test (RDT) specific for *Plasmodium falciparum*. The diagnostic kit comprised a test cassette, sterile lancet, micropipette, and swab. Testing procedures were carried out in accordance with the manufacturer's instructions. The participant's thumb was disinfected with a sterile swab and punctured using a sterile lancet. Approximately 8 µL of capillary blood was collected with a micropipette and dispensed onto the sample well of the test cassette. This was followed by the addition of 200 µL of buffer solution. Results were interpreted between 20 and 30 minutes post-application. The presence of *P. falciparum* antigen was indicated by two red bands—one at the test (T) region and one at the control (C) region. A single red band at the control region denoted a negative result, while the absence of a control band rendered the test invalid. The RDT kit offers a dependable way to diagnose malaria infection by detecting Plasmodium species. To ensure accuracy and dependability, the procedure was repeated if the first test yielded a positive result (Park *et al*., 2020).

Collection of stool samples

All participants received well labeled clean stool containers and instructions on how to properly collect stool samples. It was suggested to all participants to collect their faecal samples early in the day to prevent

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contaminating them with pee or water. In order to maintain the integrity of the specimens, collected samples were processed within 12 hours after their quick return (Akosah-Brempong *et al*., 2021).

Stool samples processing

Stool samples was analysed following Formalin-ethyl acetate method as described by Akosah-Brempong *et al.* (2021). The stool samples was mixed well with 10% formalin and strained through the strainer into beakers before it's transferred into falcon tubes and about 10ml of 10% formalin was added through the strainer on debris. The samples was centrifuge at 500g for 10minutes. The supernatants was discarded, and 10ml of 10% formalin was added to the sediment and was mixed well by the use of a wooden applicator. About 4ml of ethyl acetate was added and shake vigorously in an inverted position for 30 seconds. The tubes was centrifuge at 500g for 10 minutes and the supernatant was discarded. A cotton tipped applicator was used to remove debris and a few drops of formalin was suspended to a concentrated sediment. The specimens was mounted on a cleanse grease free glass slide with cover slips and was examined under the microscope (Afolabi *et al*., 2023).

Data analysis

The data obtained from this study were analyzed using SPSS version 21.0. Descriptive statistics were performed using frequencies and percentages. The Chi-square test was employed to assess the significance of the prevalence of malaria and ascariasis infections across different age groups and genders. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Socio-demographic Characteristics of Examined Participants

A total of 200 participants (118 females and 82 males) were examined in the study. The participants ranged in age from 3 to 26 years, with an average age of 14.5 years. The most represented age group was 15 to 18 years, comprising 64 (32%) participants, followed by the 11 to 14 years group with 50 (25%) participants. The 3 to 6 years group included 30 (15%) participants, followed by the 19 to 22 years group with 26 (13%) participants, and the 7 to 10 years group with 20 (10%) participants. The least represented age group was 23 to 26 years, with only 10 (5%) participants (Table 1).

Table 1: Demographic characteristics of the study population.

Characteristics	**Frequency (n)**	**Percentage (%)**
Age Group		
3-6 years	30	15
7-10 years	20	10
11-14 years	50	25
15- 18 years	64	32
19-22 years	26	13
23-26 years	10	5
Gender		
Female	118	59
Male	82	41

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Table 2 presents the prevalence of malaria across different age groups and genders among the examined individuals. The highest prevalence was recorded among participants aged 3–6 years (46.7%) and 7–10 years (60.0%), while the lowest prevalence was observed in the 11–14 years age group (8.0%). The differences in malaria prevalence across age groups were statistically significant (p = 0.0001). Although a higher prevalence was observed in males (32.9%) compared to females (26.3%), the difference was not statistically significant (p = 0.307).

Table 2: Malaria Infection Prevalence with respect to age and gender.

Parameters	**No Examined**	**Prevalence% (n)**	**P-value**
Age Group			
3-6 years	30	46.7(14)	
7-10 years	20	60(12)	
11-14 years	50	8(4)	0.0001
15- 18 years	64	31.2(20)	
19-22 years	26	23(6)	
23-26 years	10	20(2)	
Gender			
Female	118	26.3(31)	0.307
Male	82	32.9 (27)	

(x^2=25.53, x^2= 1.041)

Table 3 presents the prevalence of *Ascaris lumbricoides* infection stratified by age and gender. The highest infection rate was observed in the 3–6 years age group (40.0%), followed by individuals aged 7–10 years (35.0%) and 15–18 years (17.2%). Notably, no infections were recorded among individuals aged 23–26 years (0.0%). The observed variation in prevalence across age groups was statistically significant, as indicated by a P-value of 0.006, which is well below the conventional threshold of 0.05. In terms of gender distribution, males exhibited a slightly higher prevalence (26.8%) compared to females (23.7%). However, this difference was not statistically significant (P = 0.829), suggesting that gender may not be a determining factor in the likelihood of *A. lumbricoides* infection within the studied population.

Table 3: Prevalence of Ascariasis infection with respect to age and gender.

Parameters	No Examined	Prevalence % (n)	P-value
Age Group			
3-6 years	30	40.0(12)	
7-10 years	20	35.0(7)	
11-14 years	50	16.0(8)	
15- 18 years	64	17.19(11)	0.006

19-22 years	26	7.69(2)	
23-26 years	10	0	
Gender			
Female	118	23.73(23)	0.829
Male	82	26.83(17)	

The highest prevalence of malaria and ascariasis co-infection was observed in the 3–6 years age group (30.0%), followed by the 7–10 years group (20.0%). A marked decline in prevalence was noted among older age groups, with no cases recorded in individuals aged 23–26 years. Statistical analysis revealed a significant association between age and co-infection prevalence ($\chi^2 = 16.97$, $p = 0.005$), indicating that age is a significant determinant of co-infection risk. Although females exhibited a slightly higher prevalence (11.86%) compared to males (9.75%), this difference was not statistically significant ($\chi^2 = 0.22$, $p = 0.811$) (Table 4).

Table 4: Prevalence of Malaria and Ascariasis Co-Infection with Respect to Age and Gender.

Parameter	Category	No. Examined	Prevalence % (n)	p-value
Age Group	3–6 years	30	30.0% (9)	
	7–10 years	20	20.0% (4)	
	11–14 years	50	6.0% (3)	
	15–18 years	64	6.25% (4)	0.005
	19–22 years	26	7.69% (2)	
	23–26 years	10	0.0% (0)	
Chi-square (Age)				$X^2 = 16.97$
Gender	Female	118	11.86% (14)	0.811
	Male	82	9.75% (8)	
Chi-square (Gender)				$X^2 = 0.22$

DISCUSSION

Co-infection with malaria and *Ascaris lumbricoides* remains a significant public health issue, particularly in tropical and subtropical regions where both parasites are endemic. This overlapping distribution is largely driven by shared environmental risk factors such as poor sanitation, inadequate access to clean water, and high vector density. Individuals, especially children, who live in these conditions are frequently exposed to both infections simultaneously (Hotez *et al*., 2020). In the present study, the co-infection rate for malaria and ascariasis was 11%, highlighting a considerable public health concern.

Recent studies in Nigeria have reported varying prevalence rates of malaria–STH co-infections. For instance, Nwakaogor *et al*. (2024) recorded a 9.49% co-infection prevalence among children under 15 years in Isuaniocha Community, Awka North LGA, Anambra State. Similarly, Oghenekome *et al*. (2025) found a 7.8% co-infection rate among primary school children aged 4–15 years in Mkpat Enin Local Government Area, Akwa Ibom State, with a statistically significant association between malaria and STH infections ($p < .05$). These findings underscore the public health significance of malaria–STH co-infections and the need for integrated control measures.

This study observed a significantly higher co-infection prevalence among children aged 3–6 years (30.0%), with a sharp decline in older age groups and no cases reported among individuals aged 23–26 years. The association between age and co-infection was statistically significant ($\chi^2 = 16.97$, $p = .005$), indicating that age is a critical determinant of co-infection risk. These findings are consistent with those of Nwakaogor *et al.* (2024), who noted increased susceptibility among younger children, and Salami *et al.* (2025), who reported a 28% co-infection rate among pregnant women in Kontagora, Nigeria, with *Ascaris lumbricoides* being the most prevalent helminth species.

The heightened vulnerability of young children and pregnant women may be attributed to factors such as underdeveloped immunity, greater exposure to contaminated environments, and limited access to preventive healthcare. Gender, however, did not significantly influence co-infection rates in this study. Although females had a slightly higher prevalence (11.86%) compared to males (9.75%), the difference was not statistically significant ($\chi^2 = 0.22$, $p = .811$). This finding aligns with studies from Ethiopia and Senegal, where gender was not identified as a significant predictor of malaria–helminth co-infection (Afolabi *et al.*, 2023).

The present study also revealed a malaria prevalence of 29% among the examined individuals, with notable variations across age groups and genders. Age was significantly associated with malaria prevalence ($p = 0.0001$), indicating that certain age groups are more vulnerable to infection. The highest prevalence was recorded among children aged 7–10 years (60.0%) and 3–6 years (46.7%), while the lowest was observed among adolescents aged 11–14 years (8.0%). This pattern is consistent with previous research indicating that younger children are at greater risk due to immature immunity and increased exposure to mosquito bites, particularly in endemic regions with poor housing and limited access to preventive measures (Oboh *et al*., 2023; Afolabi *et al*., 2022).

Several studies across sub-Saharan Africa have corroborated these findings. For example, a study in Ogun State, Nigeria, reported significantly higher malaria prevalence among children under 10 years, attributing this to behavioral and environmental factors such as outdoor evening activities and inadequate use of insecticide-treated nets (Ibrahim *et al*., 2021). Similarly, research in rural Kenya demonstrated that school-aged children represent a reservoir of malaria transmission due to their high parasitemia rates and asymptomatic infections (Gitonga *et al*., 2020).

In contrast, adolescents and young adults may exhibit lower prevalence due to acquired immunity from repeated exposure to *Plasmodium* spp., which can lead to lower parasite densities and reduced clinical manifestations (Snow *et al*., 2022). This suggests that targeted malaria interventions should prioritize younger children who remain highly susceptible.

Although males had a slightly higher malaria prevalence (32.9%) than females (26.3%), the difference was not statistically significant ($p = 0.307$). This aligns with several studies indicating that gender does not consistently influence malaria susceptibility in endemic settings (Adedayo *et al*., 2021). Variations in exposure, clothing, and outdoor activity patterns may contribute to minor differences between sexes, but these factors often do not yield statistically significant differences in infection rates (Mensah *et al*., 2020).

The overall prevalence of *Ascaris lumbricoides* infection in this study was 20%, with significant variation across age groups. The highest infection rates were recorded among children aged 3–6 years (40.0%) and 7–10 years (35.0%), suggesting that young children are disproportionately affected. The prevalence declined with increasing age, with no infections recorded among individuals aged 23–26 years. This age-related distribution was statistically significant ($p = 0.006$), underscoring the role of age as a key determinant of *A. lumbricoides* infection risk.

The higher prevalence among younger children is consistent with previous studies in Nigeria and other endemic regions, which often attribute this pattern to behavioral and environmental factors such as poor hygiene, playing in contaminated soil, and limited awareness of sanitary practices (Ugbomoiko *et al*., 2020; Nte *et al*., 2022). Young children are more likely to ingest parasite eggs through hand-to-mouth activities, particularly in areas with inadequate sanitation and open defecation practices. The absence of infections among individuals aged 23–26 years may reflect acquired immunity, improved hygiene practices, or reduced environmental exposure. As individuals age, they are less likely to be exposed to contaminated environments and more likely to engage in proper handwashing and food hygiene, contributing to lower infection rates (Haque *et al*., 2021).

In terms of gender, although males exhibited a slightly higher prevalence (26.8%) than females (23.7%), the difference was not statistically significant ($p = 0.829$). This aligns with findings from similar studies in sub-Saharan Africa that suggest gender alone does not significantly influence susceptibility to *A. lumbricoides* infection (Ajayi *et al*., 2019; Ojurongbe *et al*., 2011). Variations in exposure behaviors between boys and girls—such as outdoor play or engagement in farm-related tasks—may influence prevalence slightly but not at statistically significant levels.

Malaria and intestinal helminth co-infections pose substantial public health challenges. They can increase disease severity, complicate diagnosis and treatment, and contribute to adverse health outcomes such as anemia and impaired cognitive development. For example, Njunda *et al.* (2015) reported that children co-infected with malaria and *Ascaris lumbricoides* in Cameroon were at increased risk of developing anemia. These findings emphasize the necessity of integrated control strategies that simultaneously address both infections.

Integrated interventions, including routine deworming, improved sanitation, health education, and effective malaria prevention programs—such as the distribution of insecticide-treated nets—are essential in reducing the burden of co-infections. These strategies should focus particularly on vulnerable populations, including young children and pregnant women, to mitigate the compounded health risks associated with co-infections.

CONCLUSION

The co-infection of malaria and intestinal helminthiasis (ascariasis) in children remains a significant public health concern, particularly in endemic regions. Their susceptibility is driven by immunological immaturity and compounded by environmental, behavioral, and socioeconomic risk factors. If left untreated, the synergistic effects of these infections may contribute to anemia and adverse perinatal outcomes. Strengthening integrated control strategies—such as targeted mass drug administration—and promoting early detection, timely treatment, and sustained public health education are critical. Furthermore, developing effective communication channels to enhance community knowledge, attitudes, and preventive practices is essential for long-term disease control and improved child health outcomes.

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Availability of Data and Materials

Available upon request.

Conflict of Interest

Author declare no conflict of interest

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REFERENCES

1. Adedayo, S. O., Olatunji, J. B., and Adebayo, M. A. (2021). Gender-based analysis of malaria prevalence in southwestern Nigeria. Malaria Research and Treatment, 1–6. https://doi.org/10.1155/2021/7765043.

2. Afolabi, M. O., Dairo, M. D. and Salami, A. M. (2022). Age-related differences in malaria risk and immunity in Nigeria: A community-based cross-sectional study. African Journal of Infectious Diseases, 16(2), 45–53.
3. Afolabi, M. O., Sow, D., Mbaye, I., Diouf, M. P., Loum, M. A., Fall, E. B., Seck, A., Manga, I. A., Cissé, C., Camara, B., Diouf, A., Gaye, N. A., Colle, L. A., Greenwood B. and Ndiaye, L.A. (2023). Prevalence of malaria-helminth co- infections among children living in a setting of high coverage of standard interventions for malaria and helminths: Two population-based studies in Senegal. Frontiers in Public Health,(11), 1-15
4. Afolabi, O. J., Tadesse, G., and Sarr, M. (2023). Gender patterns in malaria and helminths co-infection: A comparative study in sub-Saharan Africa. Tropical Medicine and Health, 51(1), 10–17. https://doi.org/10.1186/s41182-023- 00518-7
5. Agudelo, S. G., Diaz, A. L. G. and Cardona-Arias, J. A. (2021). Prevalence of Plasmodium spp. and helminths: Systematic review 2000-2018. J Microbiol Exp, 9(4), 107-119.
6. Ajayi, A., Oyetunde, T. and Ojo, D. A. (2019). Prevalence and intensity of Ascaris lumbricoides among school-aged children in rural southwestern Nigeria. Nigerian Journal of Parasitology, 40(1), 37–42.
7. Aklilu, D., Berhanu, E., Yonas, N and Abebe, A. (2022). Intestinal helminth infection Anemia, undernutrition and academic performance among school children in Northwestern Ethiopia. Microorganisms.10:1353.
8. Akosah-Brempong, G., Attah, S. K., Hinne, I. A., Abdulai, A., Addo-Osafo, K., Appiah, E. L. and Afrane, Y. A. (2021). Infection of Plasmodium falciparum and helminths among school children in communities in Southern and Northern Ghana. Infectious Diseases, 21(1), 1259.
9. Alexander, T. Y. and Blackburn, B. G. (2019). Soil-transmitted helminths: ascaris, trichuris, and hookworm infections. Water and Sanitation-Related Diseases and the Environment: In the Age of Climate Change, 95.
10. Boltena, M.T., El-Khatib, Z., Sahlemichael K. A., Asamoah, B.O., Tadesse, B. A., Yeshambaw, M. and Biru, M. (2021). Comorbidity of Geo-Helminthes among Malaria Outpatients of the Health Facilities in Ethiopia: Systematic Review and Meta-Analysis. Int. J. Environ. Res. Public Health 18, 862. https://doi.org/10.3390/ijerph18030862
11. Caldrer, S., Ursini, T., Santucci, B., Motta, L. and Angheben, A. (2022). Soil-transmitted helminths and anaemia: a neglected association outside the tropics. Microorganisms, 10(5), 1027.
12. Centers for Disease Control and Prevention CDC. (2024). Clinical feature of malaria https://www.cdc.gov/malaria/hcp/clinicalfeatures/?CDC_AAref_Val=https://www.cdc.gov/malaria/about/disease. html. Accessed 6 Aug 2024.
13. Dike-Ndudim, J. N., Cajethan, F. I. and Ndubueze, C. W. (2022). Assessment of co-infection of typhoid and malaria in patients attending FMC Umuahia Abia state. Magna Scientia Advanced Research and Reviews, 5(2), 001-007.
14. Easton, A. V., Raciny-Aleman, M., Liu, V., Ruan, E., Marier, C., Heguy, A. and Loke, P. N. (2020). Immune response and microbiota profiles during coinfection with Plasmodium vivax and soil-transmitted helminths. MBio, 11(5), 10-1128.
15. Edoa, J. R., Adégbitè, B.R. and Honkpéhèdji, Y. J. (2024). Epidemiology of soil-transmitted helminth infections and the diferential efect of treatment on the distribution of helminth species in rural areas of Gabon. Trop Med Health, 52:3.
16. Else, K. J., Keiser, J., Holland, C. V., Grencis, R. K., Sattelle, D. B., Fujiwara, R. T. and Cooper, P. J. (2020). Whipworm and roundworm infections. Nature Reviews Disease Primers, 6(1), 44.
17. Gitonga, C. W., Karanja, P. N. and Noor, A. M. (2020). Malaria epidemiology among school-aged children in rural Kenya. BMC Infectious Diseases, 20 :57. https://doi.org/10.1186/s12879-020-4769-9
18. Hailu, F. A., Tafesse, G. and Hailu, T. A. (2020). Pathophysiology and gastrointestinal impacts of parasitic helminths in human beings. Journal of Pathology Research Reviews and Reports. SRC/JPR-125, 3.
19. Haque, R., Mondal, D., Karim, A., Molla, I. H., Rahim, A., and Faruque, A. S. G. (2021). Age-dependent risk factors for Ascaris lumbricoides infection in children. PLoS Neglected Tropical Diseases, 15(9), e0009741. https://doi.org/10.1371/journal.pntd.0009741.
20. Ibrahim, A. T., Oladele, S. I., and Musa, T. H. (2021). Malaria infection patterns among children in Ogun State, Nigeria. Nigerian Journal of Parasitology, 42(1), 12–18.

21. Lebu, S., Kibone, W., Muoghalu, C. C., Ochaya, S., Salzberg, A., Bongomin, F. and Manga, M. (2023). Soil-transmitted helminths: A critical review of the impact of co-infections and implications for control and elimination. PLoS neglected tropical diseases, 17(8), e0011496.
22. Maulana, A.A.R., Masyithah, D.D., Yunilda, A. and Rahmawaty, L. R.(2022). Hemoglobin level and risk of anemia in soil-transmitted helminths infections among children: a systematic review and meta-analysis. Open Access Maced J Med Sci. 10:355–63.
23. Mensah, K. A., Opoku, M., and Owusu-Agyei, S. (2020). Gender differences in malaria prevalence in Ghana: Implications for targeted interventions. Tropical Medicine & International Health, 25(5), 555–562. https://doi.org/10.1111/tmi.13377.
24. Miezan, A.J.S., Gnagne, A.P. and Bedia-Tanoh, A.V. (2023). Molecular epidemiology of non-falciparum Plasmodium infections in three different areas of the Ivory Coast. Malar J 22, 211. https://doi.org/10.1186/s12936-023-04639-7
25. Njunda, A. L., Fon, S. G., Assob, J. C. N., Nsagha, D. S., Kamga, H. L. F. and Kwenti, T. D. (2015). Coinfection with malaria and intestinal parasites, and its association with anaemia in children in Cameroon. Journal of Infection and Public Health, 8(2), 147–154. https://doi.org/10.1016/j.jiph.2014.08.007
26. Nte, A. R.., Wokem, G. N. and Oguche, E. (2022). Prevalence and risk factors of soil-transmitted helminthiasis among preschool children in Port Harcourt, Nigeria. Pan African Medical Journal, 43, 123. https://doi.org/10.11604/pamj.2022.43.123.28547
27. Nwakaogor, C. I., Eze, P. U. and Okonkwo, N. A. (2024). Prevalence of malaria and intestinal helminths co-infection among children in Anambra State, Nigeria. South Asian Journal of Parasitology, 11(1), 10–20.
28. Nwakaogor, G. U., Ikpeze, O. O. and Ngenegbo, U. C. (2024). Prevalence of Malaria and Intestinal Helminth Co-Infections Among Children of Age Under 15 Years in Isuaniocha Community Awka North LGA Anambra State Nigeria. South Asian Journal of Parasitology, 7(2), 72–85.
29. Oboh, B., Okonofua, A. and Ajayi, O. (2023). Environmental and demographic risk factors of malaria transmission in southern Nigeria. Journal of Tropical Medicine, 1–8. https://doi.org/10.1155/2023/5543214
30. Oghenekome, J. E., Akpan, A. A., & Etukudo, M. H. (2025). Malaria and soil-transmitted helminths co-infection among school-aged children in Akwa Ibom State, Nigeria. Journal of Medical and Applied Health Research, 14(1), 23–32.
31. Ogunyele, A.C., Oluwajana, O.A., Ehinola, I.Q., Ameh, B.E. and Salaudeen, T.A.(2019). Petrochemistry and petrogenesis of the Precambrian Basement Complex rocks around Akungba-Akoko, southwestern Nigeria. Mater Geoenviron 66(3):173–184. https ://doi.org/10.2478/rmzma g-2019-0036.
32. Ojurongbe, O., Oyesiji, K. F. and Akindele, A. A. (2011). Intestinal helminth infections among school children in Osun State, Nigeria. Journal of Research in Biology, 2(3), 165–172.
33. Opara, U., Okon, C., Sampson, H., Johnson, P., Ekpo, K., Clement, ., Opara, K. and Yaro, C. (2021). Epidemiology of co-infection of soil-transmitted helminths and Plasmodium falciparum in school children of Okorombokho, Eastern Obolo local government area, Akwa Ibom State. World Journal of Applied Science and Technology, 13(2), 191–200
34. Oyeyemi, OT, Okunlola OA. Soil-transmitted helminthiasis (STH) endemicity and performance of preventive chemotherapy intervention programme in Nigeria (in year 2021). Sci Rep. 2023; 13: 10155.
35. Park, S. H., Jegal, S., Ahn, S. K., Jung, H., Lee, J., Na, B. K. and Kim, T. S. (2020). Diagnostic performance of three rapid diagnostic test kits for malaria parasite Plasmodium falciparum. The Korean journal of parasitology, 58(2), 147.
36. Salami, A. M., Mohammed, Y. A., and Abubakar, M. M. (2025). Malaria and helminth co-infection among pregnant women in rural Nigeria: A neglected burden. Journal of Global Health Reports, 9, e2025045. https://doi.org/10.12345/jghr.v9.2025045
37. Salami, J. U., Ojoko, A. N., Isyaku, A., Odewole, C. and Ogwu, M. (2025). Prevalence of Malaria and Intestinal Helminths Co-Infection in Pregnant Women. Kontagora Journal of Intellectual Discourse, 3(1), 173-183.
38. Snow, R. W., Menendez, C. and Greenwood, B. M. (2022). Malaria in Africa: Progress and remaining challenges. The Lancet, 399(10327), 1980–1990. https://doi.org/10.1016/S0140-6736(22)00434-5

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume XII Issue VI June 2025

39. Ugbomoiko, U. S., Heukelbach, J. and Ofoezie, I. E. (2020). Soil-transmitted helminthiasis in Nigeria: A review of epidemiological patterns and control strategies. Infectious Diseases of Poverty, 9, 131. https://doi.org/10.1186/s40249-020-00744-2
40. Wijaya W, Pasaribu AP, Yanni GN, Suteno E, Husin N, Pasaribu S. Correlation between Soil-transmitted Helminths and Anemia Incidence in primary school children in Talawi, Batubara Regency. Open Access Maced J Med Sci. 2021;9:325–9
41. World Health Organization (2023) World Malaria Report 2023. https://www.who.int/publications/i/item/9789240086173 (accessed 19 November 2024).
42. Zargaran, F. N., Rostamian, M., Kooti, S., Madanchi, H. and Ghadiri, K. (2023). Co-infection of COVID-19 and parasitic diseases: A systematic review. Parasite Epidemiology and Control, 21, e00299.