EPIDEMIOLOGY OF CO-INFECTION OF SOIL-TRANSMITTED HELMINTHS AND *PLASMODIUM FALCIPARUM* IN SCHOOL CHILDREN OF OKOROMBOKHO, EASTERN OBOLO LOCAL GOVERNMENT AREA, AKWA IBOM STATE

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ABSTRACT
Intestinal parasite co-infections are major public health problems of children in developing countries causing under nutrition, anaemia obstruction, mental and physical growth retardation. This study was conducted to assess the prevalence of malaria and soil transmitted helminths (STHs) co-infection among primary school children in Okorombokho, Eastern Obolo Local Government Area, Akwa Ibom state, Nigeria. A total of 120 blood and stool samples were collected from the primary school children in June 2021. The samples were from children of both sexes whose age ranges from <5 to16 years old. The samples were analysed for malaria and soil-transmitted helminths using standard parasitological methods of diagnosis. The overall prevalence of malaria was 87(72.5%) which was higher inmales 56(74.4%) than females 31(68.9%) (p<0.493). An overall prevalence of STHs was 29(24.2%, while that of various soil-transmitted helminthswere; *A. lumbricoides* 17(14.2%), hookworms 7(5.8%) and *Taenia* sp. 7(5.8%).Co-infection of STHs and Malaria was 22(18.3%). Infection was detected in all age groups examined, with the 11-13 years age group recording the highest 13(35.1%). Based on these findings, there is a need to implement effective malaria and intestinal parasite control measures in this community.

INTRODUCTION
Infections with four species of nematodes namely; roundworms (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and the hookworms (*Necator americanus* and *Ancylostoma duodenale*) collectively referred to as soil-transmitted helminths (STHs) are among the most common neglected tropical diseases (NTDs) worldwide (WHO, 2011). Malaria and STHs are the most prevalent parasitic diseases in Sub-Saharan Africa and children are the most vulnerable groups (Brooker *et al*., 2007; Kepha *et al*., 2015; Njunda *et al*., 2015; Flavio *et al*., 2021). They are particularly more prevalent in rural communities and closely associated with poverty.

In the tropics, malaria and STHs co-infection constitute a major public health problem as these areas are often characterized by all the conditions favouring the transmission of these infections including, a humid climate, unsanitary environment and poor socio-economic condition (Molyneux *et al*., 2005; Nwangi *et al*., 2006; Yaro *et al*., 2021). The overlapping distribution of those parasitic infections results in a high rate of co-infection. Co-infection causes varying effects in the host. Concomitant infections in children have been shown to adversely affect their development and learning capabilities (Ezeamama *et al*., 2005; Makoge *et al*., 2012; Yaro *et al*., 2020) and have been associated with increased susceptibility to other infections (Nacher *et al*., 2002; Sokhna *et al*., 2004; Hillier *et al*., 2008). Co-infection with malaria and STHs is also associated with anaemia, school absenteeism and disability adjusted life years (DALYs) lost (Bethony *et al*., 2006; Njunda *et al*., 2015).

Malaria is associated with a decrease in the amount of haemoglobin, increased destruction of parasitized red blood cells (RBCs), shortened lifespan of non-parasitized RBC, and decreased production of RBC in the bone marrow (McDevitt *et al*., 2004; Sumbele *et al*., 2020). In Nigeria, malaria and STH infection is a threat to public health among school children

(Adeoye*et al*., 2017; Ojurongbe*et al*., 2011; Opara *et al*., 2012; Dada-Adegbola*et al*., 2013; Afolabi *et al*., 2021). Malaria caused by *Plasmodium falciparum* occurs throughout the country with varying degrees of endemicity. The transmission is stable, perennial and holoendemic (Nworgu and Orajaka, 2011). The epidemiology of this co-infection and their implication on children's health has not been fully evaluated especially in the coastal communities, where poor housing, improper waste disposal system and lack of potable water prevail.The present study was carried out to investigate the distribution pattern of malaria and soil-transmitted helminths co-infection in school children in coastal communities of Akwa Ibom State, Nigeria.

MATERIALS AND METHODS

Study Area

The present study was conducted in Okorombokho Government Primary school in Eastern Obolo Local Government Area of Akwa Ibom State, Nigeria (Figure 1. Eastern Obolo is located in the central southern part of the country lying between longitude 4053'5'' and latitude 7053'8''. It is bounded to the north by MkpatEnin LGA, northeast by Onna, West by IkotAbasi, southeast by Ibeno LGA and in the south by the Atlantic Ocean. The area is a coastal community in the state under great tidal influence from the bight of Bonny. It occupies a land mass of 117,000km comprising 32 villages with two major clans; Okoroette and Iko and an estimated shoreline of 184km long. There are two distinct seasons in the area: wet season and dry season. Eastern Obolo has a population of about 60,543 people(National Population Census, 2006) who are predominantly fishermen with over 85% involved in active fishing. Crop farming activities are also done in the study area, such as cassava, maize, plantain, yam, citrus and pineapple. The study population was composed of primary school children from Okorombokho Government Primary school in the area.

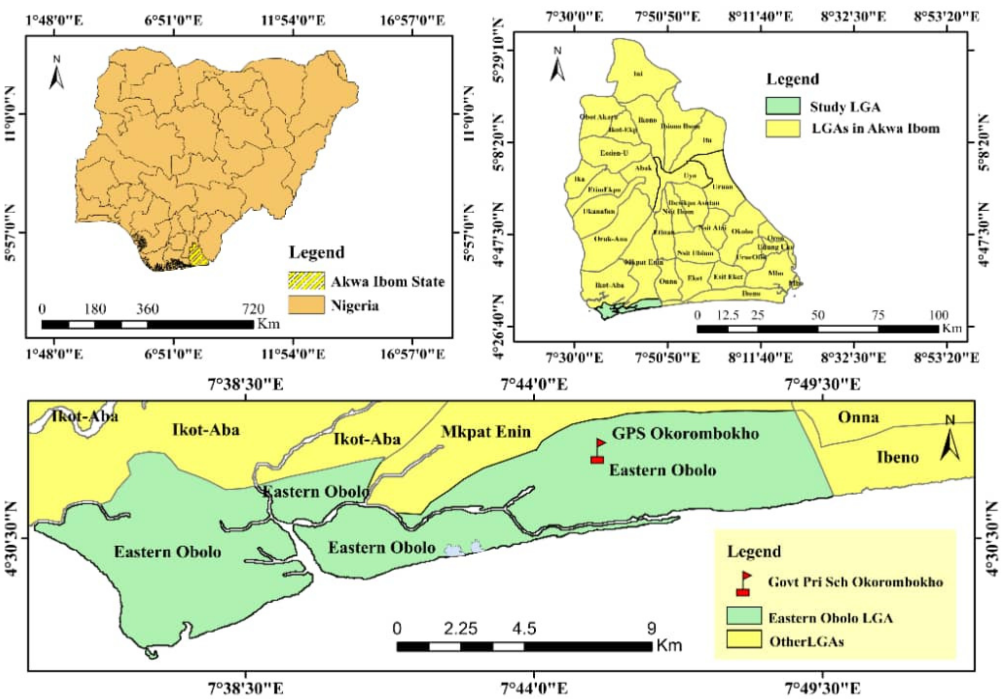

Figure 1: Map of Eastern Obolo LGA showing the Study Area

Study Design

This study was cross-sectional and participants were selected randomly.

Selection of children

A total of 100 school children were randomly recruited from primary 1 to 6. Eligible participants were children aged 10 years and below who resided in the communities and were not on antimalarial or antiparasitic drugs for at least two weeks prior to the study commencing (WHO, 2011). The coordinates of the school were obtained using a hand held global positioning system (GPS) device.

Ethical clearance
The ethical clearance for the study was obtained from Akwa Ibom State Ministry of Health ethical review committee.

Community mobilization
Before the commencement of study, the research team had meetings with leaders, teachers and community members of all selected villages schools. During the meeting, the objectives of the study including the study procedure to be followed, samples to be taken, study benefits and potential risks and discomfort were explained, informed consent were obtained from parents and guardians of school children who participated in the study.

Collection of samples
Blood sample
A trained laboratory technician collected blood samples through venipuncture (a procedure in which a needle is used to take blood from vein)into sterile bottles. Whole blood collection was employed in the sample collection. The non-dominant arm was massaged to increase blood flow and to identify the prominent vein and was then wiped with a 70 % alcohol swipe pad. With a sterilized 2ml syringe and needle, an incision was made parallel to the direction of the vein, and the bevel was ensured to face down during the collection. The collected blood was then transferred into a labelled EDTA blood sample bottles used for slide preparation.

Stool samples
Well labelled screw cap sample bottles were distributed to the selected volunteers with their identification number attached to them. They were instructed on how to collect the faecal specimens. All samples were collected in the morning of the same day. Pupils were advised to use the specific method by the World Health Organization (which is, the stool was to be passed on a clean paper first before collecting a little quantity into the clean sample bottles using a clean dry stick and the bottle be tightly covered after the process). Faecal samples were gotten from the pupils and were transported to the laboratory for examination. The samples collected on each occasion were all examined at the University of Uyo Health Center.

Microscopic Examination
Thick/thin blood films preparation
The methods of slide preparations of Cheesbrough (2009) were adopted. A small drop of blood was placed on a clean greased-free microscopic slide at the centre of the slide and a large drop of blood about 15mm to the edge, to make thick and thin films on the slide at the same time. The thin film was spread using a smooth edge slide spreader, without delay the drop of blood was also spread to make a thick smear but considerably larger than the one that was used for thin film. The thick smear was made to cover and spread evenly on the area of the slide about 15 x 15mm. Then the slides were labelled with the subject's serial number. The blood was air dried with the slide in a horizontal position on a staining rack and placed in a safe place to avoid contaminants or flies. A small drop of methanol was added to the thin film, making sure the alcohol did not touch the thick film, this was done to prevent lysis of red cells and to make the thin film unreadable. The thin film was fixed for 1-2 minutes, while the thick film was stained with an already prepared Giemsa stain for about 30-40 minutes. The slides were washed by placing the film in buffered water for 3 minutes and air dried in a vertical position. The film was then examined under oil immersion lens for detection of malaria parasites.

Direct wet mount
Physical examination of the faecal sample was first carried out. This includes the appearance, consistency, odour, presence of mucous, and quantity. Thereafter direct wet mount of each sample was done. Clean dry grease free microscope slides were labelled corresponding to the

identification tag on the sample bottles, a drop of normal saline was made on the centre half of each of the labelled slide and a small quantity of the stool was picked with the aid of an applicator stick and a smear was done on the slide. Food particles and debris were carefully removed from the smear (this was done to eliminate erroneous identification). The smear was made to be thin, transparent and light to enhance clarity. Cover slips were carefully placed over the smear avoiding air bubbles and were viewed under the compound microscope. Microscope magnification of x10 was used to focus while x40 was used to view parasite's ova and cyst. Thereafter, the stools were subjected to formol-ether sedimentation technique as describe by Cheesbrough (2006).

Identification of Parasites

Malaria parasites

Each blood smear was observed under the oil immersion objective of the microscope. The thick smear was used to determine whether the malaria parasite was present or not after observing 100 fields of vision. The thin smear was used to identify the type of plasmodium species (Cheesbrough, 2009).

Helminthes parasites

Diagnosis was based on the identification of helminth ova and protozoan cyst in the sample during microscopic analysis. Identification was done with the aid of parasitology atlas. A child was considered to have a polyparasitic infection if they were found to be positive for more than one species.

Data Analysis

Data collected from the study were analysed using percentages. Differences in the prevalence of infection based on ages and sexes were determined by chi square test (χ^2) from the contingency tables. The analysis was done using Microsoft Excel software of 2016 version.

RESULTS

Prevalence of Soil Transmitted Helminth Parasites and Malaria According to Sex

An overall prevalence of 29(24.2%) was observed for STHs in primary school children of Government school Okorombokho. Three species of STHs were detected in the study; *A.lumbricoides*, hookworm and *Taenia*sp with the prevalence of 17(14.2%), 7(5.8%) and 7(5.8%) respectively. Comparison of the prevalence between male and female reviewed no significant difference (P=0.956).Males had higher prevalence of *A.lumbricoides* with the prevalence of 13 (17.3%) while females had higher prevalence of *Taenia*sp with the prevalence of 5(11.1%).

An overall prevalence of 87(72.5%) was observed for malaria in school children of Government school Okorombokho. Males had higher prevalence of malaria with the prevalence of 56(74.7%) than females with the prevalence of 31(68.9%), though the difference was not statistically significant (P=0.493) (Table 1).

Prevalence of Soil Transmitted Helminth Parasites and Malaria According to Age Groups

A total of 29(24.0%) children were infected with STHs. The prevalence of these parasites was highest in the age group of 11-13years with the prevalence of 13(35.1%) followed by the age groups of <5, 8-10 and 5-7 years with the prevalence of 1(25.0%), 9(20.9%) and 5(18.5%) respectively while the least prevalence 1(11.1%) was observed in the age group of 14-16 years. The differences within the age groups were not significant (P=0.408) (Table 1).

A total of 87(72.5%) children were infected with malaria. The prevalence of these parasites was highest in the age group of 5-7 years and 14-16 years with the prevalence of 21(77.8%) and 7(77.8%) followed by age group of 11-13 and 8-10 years with the prevalence of 27(73.0%) and 30(69.8%) respectively while the least prevalence is of 2(50.0%) was observed in the age group of <5 years. None of these showed significant difference (P=0.794). (Table 1).

Table 1: Prevalence of soil-transmitted helminth parasites and malaria according to sex and age groups (p<0.05)

Categories	Number Examined	*Ascaris lumbricoides*	Hook worms	*Trichuris trichiura*	*Taenia* sp	STHs	Malaria
Sex		No(%)					
Male	75	13 (17.3)	4 (5.3)	0 (0.0)	2 (2.7)	18 (24.0)	56 (74.7)
Female	45	4 (8.9)	3 (6.7)	0 (0.0)	5 (11.1)	11 (24.4)	31 (68.9)
Total	**120**	**17 (14.2)**	**7 (5.8)**	**0 (0.0)**	**7 (5.8)**	**29 (24.2)**	**87 (72.5)**
Chisquare		1.649	0.091	NA	3.651	0.003	0.471
Df		1	1	NA	1	1	1
p Value		0.199	0.763	NA	0.056	0.956ns	0.493ns
Age Groups							
< 5 years	4	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	2 (50.0)
5 - 7 years	27	5 (18.5)	0 (0.0)	0 (0.0)	0 (0.0)	5 (18.5)	21 (77.8)
8 - 10 years	43	5 (11.6)	3 (7.0)	0 (0.0)	1 (2.3)	9 (20.9)	30 (69.8)
11 - 13 years	37	6 (16.2)	4 (10.8)	0 (0.0)	5 (13.5)	13 (35.1)	27 (73.0)
14 - 16 years	9	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	1 (11.1)	7 (77.8)
Total	**120**	**17 (14.2)**	**7 (5.8)**	**0 (0.0)**	**7 (5.8)**	**29 (24.2)**	**87 (72.5)**
Chisquare		2.648	4.249	NA	7.313	3.983	1.684
Df		4	4	NA	4	4	4
p Value		0.618	0.373	NA	0.120	0.408	0.794

NA – Not applicable.

Co-infection of Soil Transmitted Helminths and Malaria

The co-infection of *A. lumbricoides* + Hookworm was 1(0.8%).The co-infection was observed in males with the prevalence of 1(1.3%). Comparison between sex of school children in co-infection of *A. lumbricoides* and Hookworm was not significant (P=0.437). The co-infection of *A. lumbricoides* and *Taenia* sp was only observed in females with the prevalence of 1(2.2%). No co-infection of *A. lumbricoides* and *Trichuris trichiura*, hookworm and*Trichuris trichiura*, and hookworm and*Taenia sp*in this study (Table 2).

Table 2: Co-infection of soil-transmitted Helminths according to sex and age groups (p<0.05)

Categories	Number Examined	No(%)					
		A. lumbricoides + Hook worms	*A. lumbricoides + Trichuris trichiura*	*A. lumbricoides+ Taenia sp*	Hook worms + *Trichuris trichiura*	Hook worms + *Taeniasp*	*Trichuris trichiura + Taeniasp*
Sex							
Male	75	1 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Female	45	0 (0.0)	0 (0.0)	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)
Total	**120**	**1 (0.8)**	**0 (0.0)**	**1 (0.8)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
Chisquare		0.605	NA	1.681	NA	NA	NA
Df		1	NA	1	NA	NA	NA
p Value		0.437	NA	0.195	NA	NA	NA
Age Groups							
< 5 years	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
5 - 7 years	27	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
8 - 10 years	43	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
11 - 13 years	37	1 (2.7)	0 (0.0)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)
14 - 16 years	9	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	**120**	**1 (0.8)**	**0 (0.0)**	**1 (0.8)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**
Chisquare		2.262	NA	2.262	NA	NA	NA
Df		4	NA	4	NA	NA	NA
p Value		0.688	NA	0.688	NA	NA	NA

NA – Not applicable.

The co-infection of *A. lumbricoides* and hookworms was only observed in the age group 11-13 years with the prevalence of 1(2.7%). No co-infection was observed in the age groups of<5 years, 5-7 years, 8-10 years and 14-16 years. *A. lumbricoides* and *Taenia* sp was only observed in the age group11-13 years with the prevalence of 1(2.7%). No co-infection was observed for *A.lumbricoides* +*Trichuris trichiura,* Hookworm + *Trichuris trichiura*, Hookworm+*Taenia* sp and *Trichuris trichiura* + *Taenia* sp. There is no significant difference (P=0.688) among the co-infection, (Table 2).

The overall prevalence of co-infection of STHs and malaria according to sex was 22(18.3%). Females had the highest co-infection with the prevalence of 10(22.2%) than males with the prevalence of 12(16.0%) which was statistically not significant (P=0.394). Males had the highest co-infection of *A.lumbricoides* +malaria with the prevalence of 10(13.3%) than females with the prevalence of 4(8.9%). The co-infection of Hookworm + malaria was higher in females 2(4.4%) than males 1(1.3%) respectively. The co-infection of *Taenia* sp. + malaria was higher in females 5(11.1%) than in males 1(1.3%) respectively. The co-infection of *Trichuris trichiura* + malaria was not observed in this study (Table 3).

The age group <5 years had the highest co-infection of 1(25.0%), followed by 11-13 years, 8-10 years and 5-7 years with the prevalence of 9(24.3%), 7(16.3%) and 4(14.8%) respectively while the age group 14-16 years had the least prevalence of 1(11.1%). No statistically significant difference in the coinfection of STHs and malaria among the age groups (P=0.797). *A. lumbricoides* + malaria co-infection was highest in the age group <5 years with the prevalence of 1(25.0%) followed by 5-7 years and 11-13 years with the prevalence of 4(14.8%) and 5(13.5%). Age group 8-10 years had the least prevalence of 4(9.3%). No significant difference (P=0.646). Hookworm + malaria was observed in two age group with the age group 8-10 years having the highest prevalence of 2(4.7%) while the least prevalence was observed in age group 12-13 years with the prevalence of 1(2.7%). No significant difference (P=0.764). *Taenia*sp. + malaria was observed in three age groups. The age group 14-16 years had the highest prevalence of 1(11.1%) followed by age group 11-13 years with the prevalence of 4(10.8%), the least prevalence was observed in age group 8-10 years 1(2.3%). No significant difference (P=0.230).The co-infection of *Trichuris trichiura* + malaria was not observed in this study (Table 3).

Table 3: Co-infection of soil-transmitted helminth parasites and malaria to sex and age (p<0.05) groups

Categories	Number Examined	No(%)				
		***A. lumbricoides* + Malaria**	**Hookworms +Malaria**	***Trichuris trichiura* + Malaria**	***Taenia* sp + Malaria**	**STHs + Malaria**
Sex						
Male	75	10 (13.3)	1 (1.3)	0 (0.0)	1 (1.3)	12 (16.0)
Female	45	4 (8.9)	2 (4.4)	0 (0.0)	5 (11.1)	10 (22.2)
Total	**120**	**14 (11.7)**	**3 (2.5)**	**0 (0.0)**	**6 (5.0)**	**22 (18.3)**
Chisquare		0.539	1.117	NA	5.661	0.727
Df		1	1	NA	1	1
p Value		0.463	0.291	NA	0.017*	0.394
Age Groups						
< 5 years	4	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)
5 - 7 years	27	4 (14.8)	0 (0.0)	0 (0.0)	0 (0.0)	4 (14.8)
8 - 10 years	43	4 (9.3)	2 (4.7)	0 (0.0)	1 (2.3)	7 (16.3)
11 - 13 years	37	5 (13.5)	1 (2.7)	0 (0.0)	4 (10.8)	9 (24.3)
14 - 16 years	9	0 (0.0)	0 (0.0)	0 (0.0)	1 (11.1)	1 (11.1)
Total	**120**	**14 (11.7)**	**3 (2.5)**	**0 (0.0)**	**6 (5.0)**	**22 (18.3)**
Chisquare		2.494	1.848	NA	5.617	1.664
Df		4	4	NA	4	4
p Value		0.646	0.764	NA	0.230	0.797

DISCUSSION

Malaria and soil transmitted helminth co-infect children in endemic regions such as Nigeria where there are numerous factors promoting high transmission. Among the factors inducing both transmissions are environmental and climatic conditions. The overall prevalence of STHs, malaria and STH co-infection and malaria infection observed in the present study stood at 24.2%, 72.5% and 18.3% respectively. Flavio *et al.* (2021) observed lower prevalence of 9.36%, 28.8% and 6.90% for STHs, malaria and co-infection of both in Cameroon, they reported lower prevalence than the current study. The differences in prevalence might be due to differences in geographical location as well as the effectiveness of control programmes. *Ascaris lumbricoides* was the most frequently observed parasite with prevalence of 14.2%; followed by hookworms with prevalence of 5.8% while none was observed for *T. trichiura.* This observation is in agreement with the findings of previous researchers who reported more frequent infection of *Ascaris* than other helminth parasites (Usip and Ita, 2017; Usip and Ita,2017; Babamale *et al.,* 2018; Tuasha *et al.,* 2019; Ntonifor *et al.,* 2021). There was no significant difference of infection based on sex (p>0.05), male and female children had equal prevalence of infection, 24.0% and 24.4% respectively. This is an indication that children of both gender are predisposed to infection with these parasites as observed in this study. This is in agreement with the findings of Boltena *et al.* (2021). The reason behind this observation might be due to the fact that both genders had same exposure tendencies to parasitic contamination as they both reside in the same location where infection of STH abounds. Children less than 5 years of age had the highest prevalence of STH infection (25%) while the least prevalence was reported among children of 14-16 years (11.1%). Nevertheless, this was not significant statistically (p>0.05), suggesting equal chances of STH infection with respect to age. Similar reports were made by Gebretsedik and Gabreyohannes (2016) while Sitotaw *et al.* (2019) reported contrary. The older age group might have developed immunity against such infection due to previous exposure to same parasite (Baer*et al.*, 2017) and knowledge on the prevention and control of STH infection might be among the factors responsible for low infection among them. Children less than five had the highest prevalence rate due to the faded immunity which is conveyed on them by the mother which only protects children within the first 12 months on life (Albrecht and Arck, 2020), therefore it is possible that the reduced or waning away of that component had predisposed them to a number of parasitic infections.

Malaria infection prevalence stood at 72.5% which was reportedly high. Similar result observation was made by Tuasha *et al.* (2019) and Babamale *et al.* (2018) in their studies, they reported a prevalence of 69.6% and 63.7% respectively. A lower prevalence of 25.6% was observed by Ojurongbe *et al.* (2011), 31.6% by Degarege *et al.* (2012) and 28.8% by Flavio *et al*. (2021). Males were more infected than females for malaria parasites, 74.7% and 68.9% respectively. The behavioural activities of the male involving more domestic and outdoor activities must be predisposing them to more parasitic infection. This agrees with the findings of Usip and Ita (2017) who observed higher infection prevalence in male than female children. However, the result of this study showed that gender had no significant influence on infection (p>0.05), suggesting that malaria parasite is a public health problem. Children of age group 14-16 years were more infected than other age groups. This however contradicts the claims that malaria is most prevalent among children of less than 5 years of age (WHO, 2020; Nwokeji‐Onwe*et al.,* 2019).

The provision of an insecticidal net for children below 5 years of age at the community health Center might also be responsible for a low prevalence of malaria recorded among children below 5 years. Usip and Ita (2017) reported that the use of LLINs has the potential of reducing transmission risk and limiting malaria episodes in subjects. Elderly children must have been in the open field, see shore where there are human-biting mosquitoes thus exposing them to malaria vectors.

The prevalence of co-infection 22(18.3%) observed in this study is in consonant with the prevalence observed by Afolabi *et al.* (2021) who reported 17.7% for malaria and helminth co-infection among children living in endemic countries. Similar trends were reported by Ntonifor *et al.* (2021) who reported 17.4%, Degarege *et al.* (2012), 19.4%. However the prevalence of co-infection in the study differs from that reported by Adedoja*et al.* (2015) and Ojurongbe *et al.*

(2011) who reported a result lower than that observed in the study; 14.4% among school aged children in rural communities of Kwara State, Nigeria and 4.3% for *falciparum* malaria and intestinal helminths co-infection among school children in Osogbo, Osun, Nigeria respectively. Conversely, the prevalence for co-infection in the present study seems lower when compared to 33.96% reported by Tuasha *et al.* (2019), 63.0% by Babamale *et al.* (2018), and 60.0% by Jafari *et al.* (2016). The disparity in the prevalence reported by previous researchers and the current study might be attributed to differences in geographical region, sampling population/size, parasitological/laboratory method employed, environmental and climatic conditions. However, the prevalence of co-infection observed was significantly low. This might be due to the scale up in control interventions in the study area.

CONCLUSION

Malaria and soil-transmitted helminth infections are serious public health problems in developing regions of the world. Nigeria is having a good share in the prevalence of both infection owning to the availability of wide environmental and conditions favouring transmission. The pooled prevalence of malaria, STH and malaria/STH infection observed in the study was 72.5%, 24.2% and 18.3% respectively. The prevalence of malaria reported in the study was high; however, co-infection of malaria and STH was relatively low in the study. In all cases, there was neither significant difference of infection with respect to age and sex of the subjects, suggesting that infection does not depend on the age nor sex of children. The findings of the present study indicate that, control interventions are needed in the study area to curb the high transmission of infection among school aged children.

REFERENCES

Adedoja, A., Tijani, D. B., Akanbi, A. A., Ojurongbe, T. A., Adeyeba, O. A. and Ojurongbe, O. (2015). Co-endemicity of *Plasmodium falciparum* and Intestinal Helminths Infection in School Age Children in Rural Communities of Kwara State Nigeria. *PLOS Neglected Tropical Diseases*. 9(7): e0003940. doi:10.1371/journal. pntd.0003940

Adeoye, G. O., Osayemi, C. O., Oteniya, O. and Ontenekeiha, S. O. (2017). Epidemiological studies of intestinal helminthes and malaria among children in Lagos, Nigeria. *Pakistan Journal of Biological Sciences*, 10(13):2208-2212.

Afolabi, M. O., Ale, B. M., Dabira, E. D., Agbula, S. C., Bustinduys, A. L., Ndiaye, J. A. and Greenwood, B. (2021). Malaria and helminth co-infections in children living in endemic countries: A systematic review with meta-analysis. *PLOS Neglected Tropical Diseases.* 15(2): e0009138. doi.10.1371/journal.pntd.0009138

Albrecht, M. and Arck, P. C. (2020). Vertical Transferred Immunity in Neonates: Mothers, Mechanisms and Mediators. *Frontiers in Immunology*,11: 555. doi: 10.3389/fimmu.2020.00555.

Babamale, O. A., Ugbomoiko, U. S. and Heukelbach, V. (2018). High prevalence of Plasmodium falciparum and soil-transmitted helminth co-infections in a periurban community in Kwara State, Nigeria. *Journal of Infection and Public Health* 11: 48–53.

Baer, K., Klotz, C. and Kappe, S. H. (2017). Release of hepatic Plasmodium merozoites into the pulmonary microvasculature. *PloS Pathogens* (11): e171.

Bethony, J. R., Brooker, S., Albonico, M., Geiger, M., Loukas, A., Diemert, D. and Hotez, P. J. (2006). Soil transmitted helminth infections ascariasis, trichuriasis and hookworm. *Lancet,* 367:1521-1532.

Boltena, M. T., El-Khatib, Z., Kebede, A. S., Asamoah, B. O., Boltena, A. T., Yeshambaw, M. and Mulatui, B. (2021). Comorbidity of Geo-helminths among Malaria Outpatients of the Health Facilities in Ethiopia: Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health.* 18, 862 doi.org/10.3390/ijerph18030862.

Brooker, S., Akhwale, W., Pullan, R., Estambale, B., Clarke, S. E., Snow, R. W. and Hotez, P. J. (2007). Epidemiology of *Plasmodium*-Helminth co-infection in Africa: populations at risk, potential impact on anaemia and prospects for combining control. *American Journal of Tropical Medicine and Hygiene*, 77(6):88-98.

Centre for Disease Control and Prevention CDC, (2020). Malaria Death. Available at https://www.cdc.gov/parasites/malaria/index.html (Accessed on August 2nd, 2021).

Cheesbrough M. (2009). District Laboratory Practice in Tropical Countries Part 2. United Kingdom: Cambridge University Press, Cambridge. pp. 434. https://doi.org/10.1017/CBO9780511543470

Cheesbrough, M. (2006). District laboratory practice in Tropical Countries. Second ed. Cambridge: Cambridge University Press, Cambridge. pp. 1-454.

Dada-Adegbola, H., Cluwatoba, O. A. and Falade, C. O. (2013). Asymptomatic malaria and intestinal helminth co-infection among children in a rural community in southwest Nigeria. *Malarial World Journal*, 4:18.

Degarege, A., Legesse, M., Medhin, G., Animut, A. and Erko, B. (2012). Malaria and related outcomes in patients with intestinal helminths: a cross-sectional study. *BMC Infectious Disease*, 12:291. http://www.biomedcentral.com/1471-2334/12/291

Ezeamama, A. E., Friedman, J. F., Acosta, L. P., Bellinger, D. C. and Langdon, G. C. (2005). Helminth infection and cognitive impairment among Filipino children. *American Journal of Tropical Medicine and Hygiene*, 72(5): 540-548.

Federal Ministry of Health (FMOH) (2015). Report on Epidemiological Mapping of Schistosomiasis and Soil Transmitted helminthiasis in 19 States and the PCT, Nigeria.

Flavio, A., Cedric, Y., Nadia, N. A. C. and Payne, V. K. (2021). Malaria and Helminth Coinfection among Children at the Douala Gyneco-Obstetric and Pediatric Hospital. *Journal of Tropical Medicine*, Article ID 3702693. https://doi.org/10.1155/2021/3702693

Gebretsadik, S. and Gabreyohannes, E. (2016). Determinants of Under-Five Mortality in High Mortality Regions of Ethiopia: An Analysis of the 2011 Ethiopia Demographic and Health Survey Data. *International Journal of Population Research*, Article ID 1602761, 7 pages. http://dx.doi.org/10.1155/2016/1602761

Hillier, S. P., Booth, M., Mughangi, I., Nkurunziza, P. and Khihembo, M. (2008). *Plasmodium falciparum* and helminth Co-infection in semi-urban population of pregnant women in Uganda. *Journal of Infectious Diseases*, 198: 920-927.

Jafari, R., Sharifi, F., Bagherpour, B. and Safari, M. (2016). Prevalence of intestinal parasites in Isfahan city, central Iran, 2014. *Journal of Parasitic Diseases*,40(3): 679-682.

Kepha, S., Nuwaha, F., Nikolay, B., Gichuki, P., Edwards, T. and Allen, E. (2015). Epidemiology of co-infection with soil transmitted helminths and *Plasmodium falciparum* among school children in Bumula District in Western Kenya. *Parasites and Vectors*, 8:314. https://doi.org/10.1186/s13071-015-0891-5

Makoge, V. D., Mbah, G. A., Nkengazorg, L., Sahfe, N. E. and Moyou, R. S. (2012). *Falciparum* malaria, helminth infection and anaemia in asymptomatic pupils in four villages in Cameroun. *European Journal of Biological Research*, 1(2): 54-59.

McDevitt, M. A., Xie, J., Gordeuk, V. and Bucala, R. (2004). The anaemia of malaria infection. The role of inflammatory cytokines. *Current Haematological Research*, 3:97-106.

Meneridez, C., Fleming, A. F. and Alonsco, P. L. (2000). Malaria related anaemia. *Parasitology Today*, 16: 469-476.

Molyneux, D. H., Hotez, P. J. and Frenwick, A. (2005). "Rapid-impact interventions": how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor.. *PLOS Medicine,* 2(11): e336.

Nacher, M., Singhasivanon, P., Treeprasertsuk, S. and Vannaphan, S., Traore, B., Looareesuwan, S. and Gay, F. (2002). Intestinal helminths and malnutrition are independently associated with protection from cerebral malaria in Thailand. *Annal of Tropical Medicine and Parasitology*, 96: 5-13.

National Population Census (2006). Population of Akwa Ibom by LGAs. https://nigeria.opendataforafrica.org/ifpbxbd/state-population-2006. (Accessed May 6th, 2021).

Njunda, A. L., Fon, S. G., Assob, J. C. N. and Nsagja, D. S. (2015). Co-infection with malaria and intestinal parasites and its association with anaemia in children in Cameroon. *Infectious Diseases of Poverty*, 4:43.

Ntonifor, H. N., Chewa, J. S., Oumar, M. and Mbouobda, H. D. (2021). Intestinal helminths as predictors of some malaria clinical outcomes and IL-1β levels in outpatients attending two public hospitals in Bamenda, North West Cameroon. *PLOS Neglected Tropical Diseases,* 15 (3): doi.org/10.1371/journal.pntd.0009174.

Nwangi, T. W., Bethony, J. and Brooker, S. (2006). Malaria and helminth interactions in humans an epidemiological viewpoint. *Annal of Tropical Medicine and Parasitology*, 100(7): 551-570.

Nwokeji‑Onwe, L., Onwe, A. B., Kenechukwu, K. I., Muoneke, U., Omeje, N. K., Iloh, O. and Osuorah, C. D. I. (2019). Incidence and Predictors of Neonatal Malaria among Newborns admitted 28 days of Life to a Tertiary Healthcare Facility in south-East Nigeria. *Journal of Clinical Neonatology*, 8(2): 96-101.

Nworgu, O. C. and Orajaka, B. N. (2011). Prevalence of malaria among children 1-10 years old in communities in Awka north Local Government Area, Anambra State, South East Nigeria, *African Research Review,* 5(5): 264-281. https://doi.org/10.4314/afrrev.v5i5.21

Ojurongbe, O., Adegbayi, M. A., Bolaji, S. O., Akindele, A. A., Adefioye, O. A. and Adeyeba, O. A. (2011). Asymptomatic falciparum malaria and intestinal helminths co-infection among children in Osogbo, Nigeria. *Journal of Research in Medical Sciences*, 16:680-686.

Opara, K. N., Udoidung, N. I., Opara, D. C., Okpok, E. D., Edosomwan, U. E. and Udoh, A. J. (2012). The impact of intestinal parasitic infections on the nutritional status of rural and urban school aged children in Nigeria. *International Journal of MCH and AIDS*, 1:68-75.

Sitotaw, B., Mekuriaw, H. and Damtie, D. (2019). Prevalence of intestinal parasitic infections and associated risk factors among Jawi primary school children, Jawi town, north-west Ethiopia. *BMC Infectious Diseases*, 19: 341. https://doi.org/10.1186/s12879-019-3971-x

Sokhna, C., Le Hesran, J-Y., Mbaye, P. A., Akiana, J., Camara, P., Diop, M., Ly, A. and Druilhe, P. (2004). Increased Malaria attack among children presenting concomitant infection by *S. mansoni* in Senegal. *Malaria Journal*, 3:43. https://doi.org/10.1186/1475-2875-3-43

Sumbele, I. U. N., Nkan A. J., Ning, T. R., Anchang-Kimbi, J. K. and Kimbi, H. K. (2020). Influence of malaria, soil-transmitted helminths and malnutrition on haemoglobin level among school-aged children in Muyuka, Southwest Cameroon: a cross-sectional study on outcomes. *PloS One*, 15(3): e0230882.

Tuasha, N., Hailemeske, N., Erko, B.and Petros, B. (2019). Comorbidity of intestinal helminthiases among malaria outpatients of Wondo Genet health centers, southern Ethiopia: implications for integrated control. *BMC Infectious Diseases*19:659 doi.org/10.1186/s12879-019-4290-y.

Usip, L. P. E. and Ita, A. E. (2017). Comparative prevalence of intestinal parasites among children in public and private schools in Calabar South, Calabar, Cross River State, Nigeria. *American Journal of Research Publication.* 5(1): 80-97.

World Health Organization (WHO) (2020). Malaria in Infants. Available at http//www.who.int/malaria/publications/malaria_in_infants/en. (Accessed on May 6th, 2021).

World Health Organization (WHO) (2011). Helminth control in school-age children: a guide for managers of control programmes, 2nd ed. World Health Organization. https://apps.who.int/iris/handle/10665/44671(Accessed on May 6th, 2021).

Yaro, C. A., Kogi, E., Luka, S. A. and Kabir, J. (2020). School-based Cross-sectional Survey on Soil-transmitted Helminths in Rural Schools of Kogi East, Nigeria. *Dr. Sulaiman Al Habib Medical Journal*, 2(1): 10-19. https://doi.org/10.2991/dsahmj.k.200211.002

Yaro, C.A., Kogi, E., Luka, S. A., Nassan, M. A., Kabir, J., Opara, K. N., Hetta, H. F. and Batiha, G.E-S. (2021). Edaphic and climatic influence on the distribution of soil transmitted helminths in Kogi East, Nigeria. *Scientific Reports*, 11: 8490. https://doi.org/10.1038/s41598-021-88020-1