

## Original Research Article

# MALARIA AND INTESTINAL HELMINTH PARASITES INFECTIONS AMONG CHILDREN OF AGE UNDER 15 YEARS IN ISUANIOCHA COMMUNITY AWKA NORTH LGA ANAMBRA STATE

## ABSTRACT

Malaria parasites and helminth infections have long been recognized as major contributors to anaemia in endemic countries. This study investigated malaria and intestinal helminth infections among children of under fifteen years in 10 villages in Isuaniocha Community Awka North Local Government Anambra State Nigeria. The study was a cross-sectional survey of blood and faecal samples collected from 390 randomly selected under 15 years old children. The study was conducted between June and July 2018 in 10 villages in Isuaniocha. Blood and stool samples were collected from participants in a clean Ethylene Diamine Tetra acetic Acid (EDTA) and dry capped containers respectively and stored in a ice pack for transportation to the laboratory for testing. The blood samples were analyzed using microscopy (thin and thick smears) the test for the presence of the malaria parasite while the stool samples were analyzed using the Kato-Katz method for the presence of helminth. The overall prevalence of malaria and helminth co-infection was 9.49%. The prevalence of malaria parasites was 38.23% and the prevalence of helminth infections was (17.44%). The prevalence of co-infection of malaria parasites and helminth parasites among children under 15 years showed that there is no significant difference ( $P>0.05$ ) among age under 15. Children below 5 years of age were more susceptible to malaria and anaemia.

*Keywords: Malaria parasites; Intestinal Helminths; Co-infection; Ethylene Diamine Tetra Acetic Acid (EDTA); Endemic countries; Isuaniocha*

## 1. INTRODUCTION

Malaria has been known over the years as one of the most intractable public health problems widely co-endemic with intestinal helminths infections, most especially in children who live in the endemic regions of sub-Saharan Africa resulting in a high rate of co-infection. Malaria epidemics have increased in frequency and intensity in most sub-Saharan African populations due to the emergence of drug resistance over the last two decades [1]. While the prevalence of symptomatic malaria infection is well documented [2], there seems to be a lack of data on asymptomatic malaria infection [2]. Many of these asymptomatic infections go undetected as well as untreated while causing little or no manifestation in affected individuals. The extent of asymptomatic parasitemia could be said to be inversely related to a population's susceptibility to clinical disease [3,4], as, asymptomatic or sub-clinical symptom people are major reservoirs of infection [4,5].

The co-infection of Malaria and intestinal helminths is commonly seen in sub-Saharan Africa because of the environmental factors that support their coexistence and survival. A prominent factor that favours the transmission of soil-transmitted helminths (Geo-helminths) which makes them widely distributed in rural communities can be said to be the inadequacy or non-existent of sanitary facilities [6,7]. Some major

predictors of malaria and helminth infection have been noted in previous studies, including greater susceptibility of females, lack of toilets, non-working status of parents, lower socioeconomic status, younger age, household crowding, lower level of education, religion, non-use of footwear, defecation practices, pig ownership, and lack of access to clean water [8,9]. Another possible factor is subsistence farming, which is widely practiced in rural communities in Africa, which exposes populations to geo-helminths infections. It can be said that through a number of interventions, there has been a global decline in the prevalence of *Ascaris lumbricoides*, *Trichuris trichiura* and the hookworms (*Ancylostoma duodenale* and *Necator americanus*) in the Americas and Asia, the situation in sub-Saharan Africa remains stagnant [10]. The health outcomes of intestinal parasitic infections include malnutrition, growth stunting, intellectual retardation, and cognitive as well as educational deficiencies [11]. However, the interference to nutrient uptake by intestinal helminths can lead to anaemia, malabsorption, impaired physical and mental development which poses a serious threat to children's long-term health, their education, and productivity [12]. Developing countries are known to harbour a considerable morbidity and mortality, especially among children due to intestinal helminthiasis, especially the soil transmitted helminths infections [12]

## 2. MATERIAL AND METHODS

### 2.1. The Study Area

The Study Area is Isuaniocha in Awka North Local Government Area of Anambra State, southeast Nigeria. Isuaniocha community is a rural town located at the outskirts of Awka, the capital of Anambra State. It is located approximately at latitude N6°16'14" and longitude E7°02'37". The population census of the community of study concerning the creation of Anambra state in 1991, as projected by 3% to 2013 was 7,631 [13]. The study area is within the tropical rainforest zone and has marked wet and dry seasons. The wet season (March-October) is about 8 months while the dry season (October-February) is about 4 months. The relative humidity averages 70%, reaching 80% during the rainy season with an annual rainfall of about 2000-3000 mm. The temperature ranges from 26°C-35°C in the dry season and 22°C-30°C in the wet season. The community has 10 villages which are: Umuomite, Umudunu, Umueze, Otoko, Adama, Umuneri, Umuelom, Agwu Albert, Ekeagba and Ifite-isu. Isuaniocha is predominated mostly by the tribe called Igbos with few people from other ethnic groups in Nigeria like the Kogi's. Most of the inhabitants are farmers, with some petty traders, civil servants, students and technicians. The community has streams which serve as a source of domestic and drinking water supply to them. Isuaniocha is contiguous with Mgbakwu, Awka, Achalla, and Urum.

### 2.2. Study Population

The study population comprised of children under 15 years. The sample size was 390 children which was determined using the formula as cited by [14] as shown below:

$$n = \frac{N}{1 + Ne^2}$$

n=Size of Sample  
N=Size of population  
e=level of precision (usually 0.05)

### 2.3. Study Design

The study was a cross-sectional community-based survey and involved the collection of blood and stool samples from children below 15 years to determine malaria and helminth co-infection respectively in the 10 villages in Isuaniocha community, Awka North LGA Anambra. The population sizes of the 10 villages, the presence of markets, churches and the topographical nature of the communities inform the selection distribution across villages. For every household, a maximum of 2 children were sampled. Children who showed signs of fever and frequent stooling were selected for the study. The services of the nurses from the primary health care centres in the communities were engaged in sample collection.

### 2.4. Collection of Blood Samples

Blood was collected with a 5ml syringe from the participants and stored in an EDTA container and was used for the preparation of thin and thick blood films on a microscopic slide and in the filling of a heparinized capillary tube for the determination of packed cell volume. Thin and thick blood smears were made on a slide

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and allowed to air-dried [15], and viewed under the microscope to determine the presence of the malaria parasite.

## 2.5. Collection of Faecal Samples

A clean and well labeled stool containers were given to the caregivers with instructions on how to collect the children's stool samples the next morning. These stool samples were collected between 8.00 and 10.00 am and using the Kato-Katz method to determine the presence of intestinal helminth eggs [16, 17].

## 2.6. Examination of Blood Samples for Malaria Parasites

### 2.6.1. Preparation of thick blood film

Two drops of the participant's blood were placed on a welllabelled grease-free microscopic slide. The blood was homogenously spread in a circular motion using the edge of a spreader slide to make an even smear. The smear was allowed to air dry and placed in a slide box away from flies, dust and heat.

### 2.6.2. Preparation of thin blood film

A drop of the participant's blood was placed at the centre of a welllabeled grease-free microscopic slide. A smooth-edged spreader slider was placed at an angle of 45°C with the horizontal slide in front of the drop of blood. The drop of blood was allowed to run along the edge of the spreader slider. The spreader was pushed gently but firmly along the horizontal slide to make a thin smear of the blood. Care was taken to ensure even contact between the spreader and the surface of the horizontal slide. The film was allowed to air dry on a slide rack and later placed in a slide box away from flies, dust and heat.

### 2.6.3. Staining of the Blood films

Thick blood films were stained by holding the slide with the dried thick film facing downwards and dipped into Field's stain A for 5 seconds. The excess was drained off by touching a corner of the slide against the side of the container. The slide was washed gently in clean water for about 5 seconds and dipped into Field's Stain B for 3 seconds. The excess was drained off and the slide was washed in clean water. The back was wiped clean and placed in an upright position on a draining rack for the film to air dry. The thin blood films were first fixed in absolute methanol for two minutes. Using a pipette, each film was covered with diluted Fields stain B and an equal volume of Field's stain A was added immediately and mixed well using the pipette. The film was left to stain for one minute, washed off with clean water, and placed upright on a draining rack to air dry.

### 2.6.4. Microscopic Examination of the Blood films

When the stained thin and thick films were completely dried, a drop of immersion oil was added to each slide and examined under the microscopic using an x100 objective lens. The thick film was used to detect the presence of malaria parasites while the thin film was used to identify the species. The results were recorded against the names and numbers of the participants. The intensity of malaria was recorded using the plus sign thus: Mild infection (+) or 1-10 parasites per 100 high power fields. Moderate infection (++) or 11-100 parasites per 100 high-power fields. Heavy infection (+++) or 1-1000 parasites per high power field [17].

### 2.6.5. Determination of Packed Cell Volume

Blood-filled microhematocrit tubes were collected and centrifuged using a microhematocrit rotor for 5 minutes at 10,000g. PCV values  $\leq$  31% to determine anaemia, which was classified as mild (21–30%), moderate (15–20%), or severe ( $\leq$ 15%) [18, 2]

## 2.7. Examination of Faecal Samples for Helminths Parasites

Kato-Katz technique was used for the detection of helminths in the stool samples. A well-labelled glass slide with the sample number and a template placed on top of it was used. 1 Gram (1.0g) of faecal sample was placed on a newspaper with a piece of nylon screen mesh pressed on top. A spatula was used to scrape the sieved faecal material through the screen mesh so that only the debris remained. Some of the sieved faeces were scrapped up to fill the hole in the template (disc). Air bubbles were avoided and excess faeces were removed. Care was taken while lifting off the template (disc). After this, a piece of cellophane which had

been soaked overnight in methylene blue glycerol solution was placed over the faecal sample. Then a clean slide was placed over the top and pressed evenly downwards to spread the faeces in a circle and then the slide was carefully removed and observed under **the microscope** using x10 and x40 objectives [19].

## 2.8. Determination of the Risk Factors

A structured questionnaire **was** administered to all the 390 study **participants** with consent from their parents. The information contained **includes** their demography and behavioural hygiene, the occupation of the parents, the use of long lasting insecticide nets, household sanitary facility, licking of fingers, walking barefooted, hand washing after **a visit to the toilet**, foot wearing habit and frequency of deworming were the variables determined using the structured questionnaire.

## 2.9. Data Analysis

The data collected was entered into EPI data 3.1 statistical packages and analyzed using Statistical Package for the Social Sciences (SPSS) version 16.0. The outcome of the variables measured were; malaria, **parasitemia**, helminthiasis and malaria and intestinal helminths co-infection. Descriptive statistics such as frequencies, proportions, means and confidence intervals were used to summarize the data. While the categorical data were compared using the Chi-square test or **Fisher's exact** test, as appropriate, a p-value of < 0.05 of the study was considered for statistical significance.

## 3. RESULTS

### 3.1. Prevalence of Co-infections of malaria and intestinal helminth infection among children of under fifteen years in Isuaniocha Community Anambra

The overall prevalence of malaria and helminth parasites co-infection was (9.49%) while the prevalence of malaria parasites was (38.23%) and the prevalence of helminth infections was (17.44%). Of the 390 participants for the study, (9.14%) of the **males** had malaria and intestinal helminth parasites co-infection and about 26.34% **were** anaemic. About (9.80%) of the female participants had malaria and intestinal helminth parasites co-infection with (52.49%) of the **femalesbeing** anaemic. The **aged** 11 - 15 years had the highest malaria and helminth co-infection of 11.38% with anaemia of (24.55%) (TABLE 1). There is no significant difference ( $p=0.41$ ,  $p>0.05$ ) in the prevalence of malaria **andhelminth** parasite co-infection among under fifteen children of Isuaniocha Community.

**Table 1. Prevalence of Co-infections of malaria and intestinal helminth infection among children of under fifteen years in Isuaniocha Community Anambra**

Variables:	Number	Number for	Number	Number Co-	Number	X <sup>2</sup>	P-	df	
Gender/Age	Examined	malaria	for	infected with	Anaemic		value		
(in years)	(%)	Positive (%)	helminth	malaria and	(%)				
			Positive	helminths Co-					
			(%)	infection (%)					
3.2. Prevalence of Malaria and Helminth Parasites infections among children below fifteen years by Occupation	Male	186 (47.69)	69(37.10)	32 (17.20)	17 (9.14)	49 (26.34)	0.679	0.410	1
	Female	204 (52.31)	84 (41.20)	36 (17.65)	20 (9.80)	52 (52.49)			
	Total	390	153 (39.23)	68 (17.44)	37 (9.49)	101 (25.90)			
3.2. Prevalence of Malaria and Helminth Parasites infections among children below fifteen years by Occupation	≤5 years	45 (11.54)	18 (40.00)	14 (31.10)	4 (8.89)	18 (40.00)	0.558	0.756	2
	6-10 years	178 (45.64)	73 (41.00)	21 (11.80)	14 (7.87)	42 (23.60)			
	11-15 years	167 (42.82)	62 (37.13)	33 (19.80)	19 (11.38)	41 (24.55)			
Total	390	153 (39.23)	68 (17.44)	37 (9.49)	101 (25.90)				

infection of Malaria and Helminth Parasites infections among children below fifteen years by Occupation

Occupation of parents of participants showed a high co-infection of malaria and helminth parasite infections (12.60%) with the least among parents of participants that were public servants (5.80%) (TABLE 2). The prevalence of co-infection of Malaria parasites and Helminth infections among children below fifteen years by parent's occupation shows that there is a significant difference ( $p=0.001$ ,  $P<0.05$ )

**Table 2. Prevalence of Co-infection of Malaria and Helminth parasite infections among children below fifteen years by Occupation**

Parent's occupation	Number Examined (%)	Number Positive for co-infection of Malaria parasite and helminth infection (%)	X <sup>2</sup>	P-value	df
Trader	139 (35.64)	10 (7.19)	13.080	0.001	2
Farmer	182 (46.67)	23 (12.6)			
Public Servant	69 (27.54)	4 (5.80)			
<b>Total</b>	<b>390</b>	<b>37</b>			

**3.3. Prevalence of Co-infection of Malaria Parasites and Helminth infections among children below fifteen years by Villages in Isuaniocha Community Anambra**

Among villages in Isuaniocha, Adama village had the highest number of children below fifteen with co-infection of malaria and helminth parasite infections (16.22%) while the least co-infection of malaria and helminth parasite infections were recorded in Umueze village (4.00%) (TABLE 3). The prevalence of co-infection of Malaria parasites and Helminth infections among children below fifteen years by Villages shows that there is no significant difference ( $p=0.685$ ,  $P>0.05$ ) among children below fifteen years in the Isuaniocha community.

**Table 3. Prevalence of Co-infection of Malaria Parasites and Helminth infections among children below fifteen years by Villages in Isuaniocha Community Anambra**

Villages	Number Examined (%)	Number of Positive Malaria Parasite and Helminth infection (%)	X <sup>2</sup>	P-value	df
Adama	37 (9.49)	6 (16.22)	6.538	0.685	9
Agwu Albert	27 (6.92)	2 (7.41)			
Ekeagba	36 (9.23)	2 (5.56)			
Ifite Isu	44 (11.28)	3 (6.82)			
Otoko	34 (8.72)	4 (11.76)			
Umudunu	43 (11.03)	4 (9.30)			
Umuelom	43 (11.03)	4 (9.30)			
Umueze	50 (12.82)	2 (4.00)			
Umuneri	34 (8.72)	5 (14.71)			
Umuomite	42 (10.77)	5 (11.90)			
<b>Total/</b>	<b>390</b>	<b>37</b>			

### nd co-infection of Malaria and Helminth parasites infections among children under fifteen years in Isuaniocha Community Anambra

A high percentage of the participants who were anaemic (54.14%) had a co-infection of Malaria parasites and Helminth infections (43.53%) (Table 4). There is a significant difference in the prevalence of anaemia and co-infection of Malaria and Helminth parasite infections among children below fifteen years of age ( $p=0.000$ ,  $P<0.05$ ) in Isuaniocha community.

**Table 4. Prevalence of Anaemia and co-infection of Malaria and Helminth parasites infections among children under fifteen years in Isuaniocha Community Anambra**

Anaemia	Number Anaemic (%)	Number Positive for co-infection of Malaria parasite and helminth infection (%)	X <sup>2</sup>	P-value	df
Yes	85 (54.14)	37 (43.53)	37.733	0.000	1
No	72 (45.86)	1 (1.39)			
<b>Total</b>	<b>157</b>	<b>38</b>			

#### 4. DISCUSSION

This study reported a prevalence of 38.23% of malaria parasites, which is lower than the high 91.3% and 50.6% prevalence rate reported by Efunshile et al. (2015)[20] in Ilero and Kunihya et al. (2016)[21] in Yola respectively. The study shows a prevalence of 17.44% for helminth infections which was higher than the observed prevalence of 6.02% in Anambra state [Aribodor et al 2021][22] but lower compare to 52.50% gotten from Ogbaru Local Government Area of Anambra State (Uchenna et al., 2018)[23] and the recorded prevalence rates of 89% [Okereke et al 2015] [24], 44.7%[Onyido et al 2016][25] and 10.18% [Mbanugo et al 2015][26] all in Anambra State.

The study reported that females had the highest prevalence of malaria parasites than male, 41.20% and 37.10% respectively. This disagrees with Ezeigbo et al. (2014) [27] and Kiggundu et al., 2013[28] in Uganda, which showed that confirmed malaria was lower among girls 52.3% than boys 57.3% and also the findings of Benisheikh et al. (2014)[29] as well as Umaru and Uyaiabasi (2015)[30] which reported higher prevalence rate in males than their female's counterparts but had no bearing on the effect of helminth co-infection. This difference was of significance and had no borderline. This varied finding may be explained by Abdullahi et al. (2009)[31] and Okonkwo et al. (2012) [32] who stated that there is no scientific evidence to prove higher prevalence is related to gender as susceptibility to malaria infection is not influenced by gender. This implies that malaria infection depends on the person's exposure to infectious bites of mosquito vectors. However, children and pregnant women are biologically more susceptible to malaria; there are compounded gender differences due to sociocultural norms and expectations that influence patterns of exposure, decision making, and economics (Ministry of Health Malaria Control Unit, 2015)[33].

This study shows that a higher prevalence of malaria parasites among aged 6 years and above contradicts the usual trends of malaria epidemiological findings (WHO, 2012)[34]. Children 6 and above often show a low prevalence of malaria with a high prevalence of malaria found among under 5 years (Efunshile et al., 2015)[20], but this corroborates with the work of Aina et al. (2013)[35] in Lagos which shows high prevalence of malaria parasite among age 5-14 years, this may be as a result of a range of factors such as fewer numbers of under 5 years that showed up for the exercise and their clinical stage at the time of conducting the test. Also, the high helminth infections 31.10% from the study among the under 5 years may have conferred immunity against malaria (Efunshile et al., 2015) [20]. These findings strengthen the worries that regular deworming of children in endemic areas could potentially be putting the children at increased risk of malaria (Specht and Hoerauf, 2007)[36] as it was particularly seen that the protective effect of helminth co-infection was seen in the youngest children under 5 years who are at the highest risk of malaria compared to other ages, as deworming is now a routine biannual public health intervention in Nigeria (Strunz, 2011) [37]. It is very unlikely that permission would be granted to conduct a randomized trial of the effect of deworming on malaria risk. Furthermore, historical controls cannot be used to compare malaria risk before and after deworming in a

treatment series, because malaria transmission changes with season and annual variation. However, this study raises the question of whether deworming should routinely be combined with intermittent preventive treatment of malaria in children (IPTc) (Midzi et al., 2011) [38] or other interventions aimed at reducing malaria risk.

With regards to parent's occupations of the children who participated in the study, their knowledge of the use of nets, a high prevalence of malaria parasites among children whose parents' occupations were farmers 43.96% which was expected considering the low educational level of the group with a high significant difference ( $p=0.000$ ). Although it was expected that children of parents working as public servants should be more knowledgeable on the cause and prevention of malaria parasites.

Locations with many bushes around its surrounding tend to have a high prevalence of malaria parasites and helminth co-infections owing to the conducive breeding environment for the female mosquitoes and the helminth parasites as seen in the study which showed that Adama, Otoko, Umuneri and Umuomite villages have 16.22%, 11.76%, 14.71% and 11.90% respectively.

From the study by Uchenna et al. (2018) [23], the effect of malaria parasitaemia on anaemia using the mean and standard deviation of Hb and PCV of the children with malaria parasite showed no significant difference between malaria which conforms with this study which also did not show significance difference ( $p=0.510$ ) among under 15 years. Okafor et al. (2001) [39] and Cheesbrough (2010) [40] reported anaemia as the commonest complication of malaria among 1-5 age groups contrary to what this study reflects which shows 33.33% of severe parasitaemia levels across the various age range. This study shows that anaemia can be a result of other causes other than malaria since confirmed malaria cases is often recorded in ages 1-5 years. By gender, females had the most severe parasitaemia level (1000-10,000 parasites/ul) 66.67% against males 33.33%.

This study recorded an overall prevalence of 17.44% for helminth infections, which is low and corroborates with the findings from Mirisho et al. (2017) [41] in Ghana which also showed a low prevalence of 17.33% compared to other studies done among children in different countries with a prevalence of 41.46% in a district in Northern Ethiopia (Abera and Nibret, 2014) [42] and 31% from rural Kenya (Nguhiu, et al., 2009)[43]. The result shows that helminth parasites are highly prevalent in rural communities due to poor sanitary conditions prevailing in most of these areas (Hotez and Kamath, 2009)[44]. This low intensity and prevalence of intestinal parasites in the suaniocha community could be attributed to the bi-annual deworming campaigns that the government implemented in the region.

## 5. CONCLUSION

Children less than 5 years old were more susceptible to malaria and anaemia as well as helminth infections. Multiple risks probably contributed to the prevalence of co-infection of malaria and helminth. In addition, nutritional factors probably also contributed especially to the anaemia observed. Studies assessing the effect of helminth infections on the course of malaria are very important in targeting malaria vaccine trial communities. The recent biannual vaccination exercise in the country may probably be a result of previous research findings on their co-infection. Well-structured longitudinal studies investigating the underlying immune mechanisms involved in malaria-helminths co-infection are very important in this regard. Efforts should be made to develop a behavioural change model for communication on the use of LLINs and other interventions that will forestall absolute compliance. These results also indicate that employing the proper intervention in a combined malaria-helminth cost-effective approach will yield timely results in endemic communities.

## CONSENT

Authors declare that written informed consent was obtained from the patient and parents.

## ETHICAL APPROVAL

The study was approved by the ethical review committee of Chukwuemeka Odimegwu Ojukwu Teaching Hospital, Awka Anambra, Nigeria. An advocacy visit to the State Ministry of Health with a letter of introduction from the head of the Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka, Anambra State was made to secure their approval. An advocacy visit with a copy of the approval letter from the State Ministry of Health was conducted to the Medical Director of the Health facilities, the community heads and parents to get their support and cooperation.

## REFERENCES

1. Breman JG. The ears of the hippopotamus: manifestations, determinants, and estimates of the malaria burden. *Am. J Trop Med Hyg.* 2001;64(1-2):1-11.
2. Ojuronbe O, Adegbayi AM, Bolaji OS, Akindele AA, Adefioye OA, Adeyeba OA. Asymptomatic falciparum malaria and intestinal helminths co-infection among school children in Osogbo, Nigeria. *J Res and Med Sci.* 2011;16:680–86.
3. Bereczky S, Liljander A, Rooth I, Faraja I, Granath F, Montgomery M. Multiclonal asymptomatic Plasmodium falciparum infections predict a reduced risk of malaria disease in a Tanzanian population, *Microbes Infect.* 2007;9(1):103-10.
4. Mwangi TW, Fegan G, Williams TN, Kinyanjui SM, Snow RW, Marsh K. Evidence for over-dispersion in the distribution of clinical malaria episodes in children, *PLoS One.* 2008; 3(5): e2196.
5. Bousema JT, Gouagna LC, Drakeley CJ, Meutstege AM, Okech BA, Akim IN. Plasmodium falciparum gametocyte carriage in asymptomatic children in Western Kenya, *Malar J.* 2004;3:18-21.
6. De Silva NR, Brooker S, Hotez PZ, Montresor A, Engels D, Savioli L. Soil transmitted helminth infections: updating the global picture, *Trends Parasitol.* 2003;19(12);547–51.
7. Hung L, Vries P, Giao P, Binh T, Nam N, Kager P. Anemia, Malaria and Hookworm Infections in a Vietnamese Ethnic Minority, *Southeast Asian J. Trop. Med. Public Health.* 2005;36(4):816-21.
8. Al-Mekhlafi MH, Surin J, Atiya AS, Ariffin WA, Mahdy AKM, Che HA. Pattern and predictors of soil-transmitted helminth reinfection among aboriginal schoolchildren in rural Peninsular Malaysia, *Acta Trop.* 2008;107(2):200–4.
9. Traub RJ, Robertson ID, Irwin P, Mencke N, Thompson RCA. The prevalence, intensities and risk factors associated with geohelminth infection in tea-growing communities of Assam, India. *Trop. Med. Int. Health.* 2004;9(6):688–701.
10. Pullan R, Smith J, Jasrasaria R, Brooker S. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010, *Parasite Vect.* 2014;7(37); 19-37
11. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, et al. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm, *Lancet.* 2006;367(9521):1521–32.
12. Aribodor DN, Bassey SA, Yoonuan T, Sam-Wobo SO, Aribodor OB, Ugwuanyi IK Analysis of schistosomiasis and soil-transmitted helminths mixed infections among pupils in Enugu State, Nigeria: Implications for control. *Infect Dis Health* 2019;24(2):98–06. <https://doi.org/10.1016/i.idh.2018.12.003>.
13. National Population Census, Nigerian population statistics. National Bureau of Statistics. 1991.
14. Uzoagulu AE. Practical guide to writing research project reports in tertiary institutions. Cheston Limited, Enugu; 2011;57-58
15. World Health Organization, Malaria Microscopy Quality Assurance Manual. (2016) Available: [http://apps.who.int/iris/bitstream/10665/204266/1/9789241549394\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/204266/1/9789241549394_eng.pdf)
16. Idris .MA, Al-Jabri AM. Usefulness of Kato-Katz and trichrome staining as diagnostic methods for parasitic infections in clinical laboratories, *Journal for Scientific Research Medical Sciences of Sultan Qaboos University Hospital,* 2001;3:65–8.
17. Cheesbrough M. Parasitological tests. In: *District Laboratory Practice in Tropical Countries.* Tropical Health Technologies Cambridge, 2005.

18. Nkuo-Akenji TK, Chi PC, Cho JF, Ndamukong KK, Sumbele I. Malaria and helminthes co-infection in children living in a malaria endemic setting of mount Cameroon and predictors of anemia, *J Parasitol.* 2006;92(6):1191-5.
19. Katz N, Chaves A, Pellegrino J. A sample device for quantitative stool thick smear technique in *Schistosoma mansoni*. *Rev Inst Med Trop Sao Paulo.* 1972;14(1):397-400
20. Efunshile M, Olawale T, Stensvold CR, Kurtzhals J and König B. Epidemiological Study of the Association Between Malaria and Helminth Infections in Nigeria. *Am j trop med hyg.* 2015;92. 10.4269/ajtmh.14-0548.
21. Kuniya IZ, Samaila AB, Nassai I, Sarki A. and Haruna MY. Prevalence of Malaria Infection among Children Attending Specialist Hospital Yola, Adamawa State, Nigeria *J Med Biol Sci.Res* 2016;2 (8):136-142.
22. Aribodor OB, Ekwunife CA, Sam-Wobo SO, Aribodor DN, Ejiolor OS, Ugwuanyi IK, et al. Status of Intestinal Helminth Infection in Schools Implementing the Home-Grown School Feeding Program and the Impact of the Program on Pupils in Anambra State, Nigeria. *Acta Parasitologica* 2021;DOI: 10.1007/s11686-021-00429-w
23. Uchenna MO, Ifeoma ME, Ochiabuto OMTB, Obi MC, Emmanuel O, Ekelozie IS. Intestinal Parasites, Malaria and Anemia among School Children in Some Flood Affected Areas of Ogbaru Local Government Anambra State, Nigeria. *Arch Clin Microbiol.* 2018;9(2):80
24. Okereke JN, Obasi KO, Nwadike PO, Ezeji EU, Udebuani AC Geo-helminthes associated with geophagic pupils in selected primary schools in Oyi, Anambra State. *Sci J Public Health* 2015;3(5):45. <https://doi.org/10.11648/j.sjph.s.2015030501>.
25. Onyido AE, Anumba JU, Ezechukwu GC, Ugha C, Umeanaeto PU, Iwueze MO. Intestinal helminth infections among primary school pupils in Nimo community, Njikoka local government area, Anambra State, Southeastern Nigeria. *J Adv Res Biol Pharm Res* 2016;1(4):44-8.
26. Umeh C, Mbanugo JI, Nwachukwu E. Prevalence of intestinal helminthes parasite in stools of nursery and primary schools pupils in Uga, Anambra State. *Nigeria Sky J Microbiol Res* 2015;3(1): 6-10
27. Ezeigbo OR, Osuagwu MC, Ezike MN, Ibegbulem ZO, Kalu S. Malaria Parasitaemia in Children Aged 1-5 Years in Aba, South Eastern Nigeria. *US Open Genl. Microbiol. J.* 2014; 1(1):1-6.
28. Kiggundu VL, O'Meara WP, Musoke R, Nalugoda FK, Kigozi G, Baghendaghe E, et al. High Prevalence of Malaria Parasitemia and Anemia among Hospitalized Children in Rakai, Uganda. *PLoS ONE* 2013 8(12): e82455. <https://doi.org/10.1371/journal.pone.0082455>
29. Benisheikh AAG, Biu AA, Awana AU, Shehu BB, Isiak MT. Epidemiology Survey of Malaria Infection among Patients attending General Out-Patient Department of Borno State Specialist Hospital Maiduguri, Borno State. *J. Sci. Multidisc. Res.*, 2014; 6(10): 119- 23.
30. Umaru ML, Uyaiabasi GN). Prevalence of malaria in patients attending the General Hospital Makarfi, Makarfi Kaduna- State, North-Western Nigeria. *Am. J. Infect. Dis. Microbiol.*, 2015 3(1):1-5.
31. Abdullahi K, Abubakar U, Adamu T, Daneji AI, Aliyu RU, Jiya NN, et al. Malaria in Sokoto, North Western Nigeria. *Afr. J. Biochem.* 2009;8(24): 7101-5.
32. Okonkwo IO, Adejuwon AO, Okeretungba PO, Frank-Peterside N. Plasmodium falciparum and HIV-1/2 coinfection among children presenting at the Out-Patient Clinic of Oni Memorial Children Hospital in Ibadan, Southwestern Nigeria. *Natr. Sci.* 2012;10(8): 94-100.
33. Ministry of Health Malaria Control Unit. Gender and malaria in Kenya. 2015; pp. 2-11.
34. World Health Organization. World Malaria Report 2012; Geneva: World Health Organization. 2012
35. Aina OO, Agomo CO, Olukosi YA, Okoh HI, Iwalokun BA, Egbuna KN, et al. Malariometric survey of ibeshe community in Ikorodu, Lagos state: dry season. *Malar Res Treat.* 2013;2013:487250. doi: 10.1155/2013/487250. Epub 2013 May 23. PMID: 23766924; PMCID: PMC3676961.
36. Specht S, Hoerauf A. Does helminth elimination promote or prevent malaria?. *Lancet.* 2007;369: 446-7. 10.1016/S0140-6736(07)60210-4.
37. Strunz E. Expanding the Deworming Program in Nigeria. Available at: <http://www.childrenwithoutworms.org/>. Accessed 2011 November 6, 2014.
38. Midzi N, Mtapuri-Zinyowera S, Sangweme D, Paul NH, Makware G, Mappingure MP, et al. Efficacy of integrated school based de-worming and prompt malaria treatment on helminthes-Plasmodium falciparum co-infections: a 33 months follow up study. *BMC Int Health Hum Rights.* 2011;11: 9.
39. Okafor HU, Nwaiwu K. Anaemia of Persistent malarial parasitemia in Nigerian children. *J Trop Pediat.* 2001;47: 271-5.
40. Cheesebrough M. District Laboratory practice in tropical countries. Part 2. Cambridge University 2010; Press 22: 156.
41. Mirisho R, Neizer ML, Sarfo B. Prevalence of Intestinal Helminths Infestation in Children Attending Princess Marie Louise Children's Hospital in Accra, Ghana. *J Parasitol Res.* 2017;2017:8524985. doi: 10.1155/2017/8524985. Epub 2017 Sep 5. PMID: 29057116; PMCID: PMC5605797.

42. Abera A, Nibret E. Prevalence of gastrointestinal helminthic infections and associated risk factors among schoolchildren in Tilili town, northwest Ethiopia. *Asian P J Trop Med.* 2014;7(7):525–30. doi: 10.1016/S1995-7645(14)60088-2.
43. Nguhiu PN, Kariuki HC, Magambo JK, Kimani G, Mwatha JK, Muchiri E et al. Intestinal polyparasitism in a rural kenyan community. *East Afr Med J.* 2009;86(6):272–8.
44. Hotez PJ, Kamath A. Neglected Tropical Diseases in Sub-Saharan Africa: Review of Their Prevalence, Distribution, and Disease Burden. *PLoS Negl Trop Dis.* 2009;3, e412. <http://dx.doi.org/10.1371/journal.pntd.0000412>

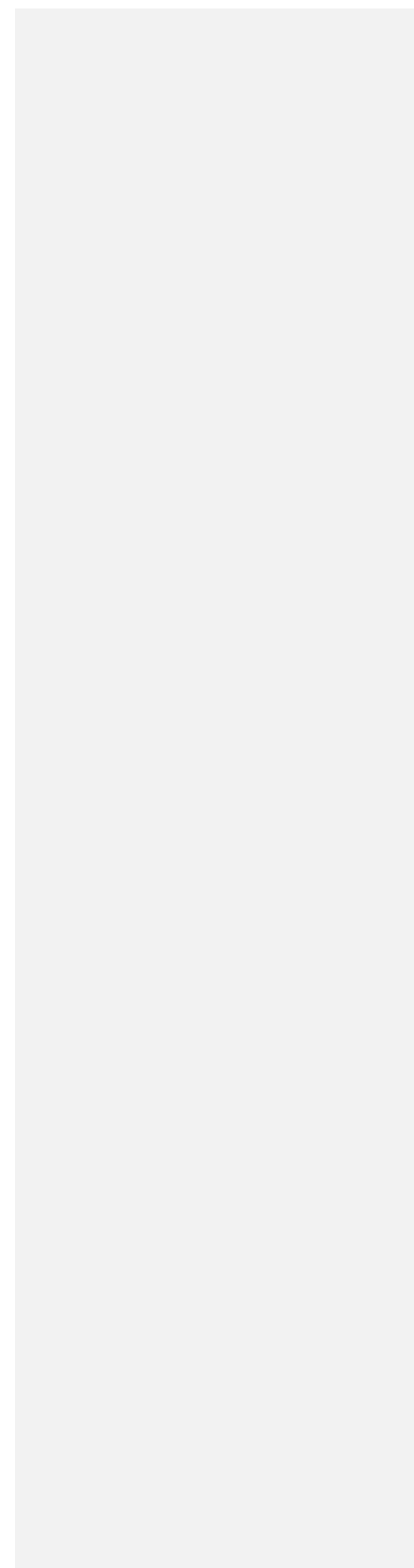
#### **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

Asymptomatic (sub-clinical) malaria infection: refers to the presence of malaria parasites in the blood without symptoms, usually provides a reservoir for transmission, and is an antecedent to symptomatic malaria

Parasitemia: Parasitaemia is the quantitative content of parasites in the blood. It is used as a measurement of parasite load in the organism and an indication of the degree of an active parasitic infection

Morbidity and Mortality: Morbidity is when you have a specific illness or condition. Some examples of common morbidities are heart disease, diabetes, and obesity while mortality is the number of deaths due to a specific illness or condition

Ethylene Diamine Tetra Acetic Acid (EDTA): It is an anticoagulant for blood samples for complete blood count (CBC), also known as a full blood count (FBC), where the EDTA chelates the calcium present in the blood specimen, arresting the coagulation process and preserving blood cell morphology.



UNDER PEER REVIEW