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Epidemiology of soil-transmitted helminth and malaria parasite infections in a rural community in Lagos state

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ABSTRACT

Objective: Soil-transmitted helminthiasis is a neglected tropical disease more commonly associated with poverty. Malaria on the other hand ravages children when exposed to infected female anopheles mosquito resulting to infection, illness and death. These infections are of public health importance in Nigeria especially in impoverished communities. The aim of this study was to determine the prevalence and intensity of soil-transmitted helminths (STH), malaria and anaemia among children and adults in Ijede LCDA, Lagos State.

Methodology and Results: A cross-sectional study was conducted among 1684 children and adults in Ijede community. Stool and blood samples were collected and analysed for STH parasites using Kato Katz technique, malaria parasite using Giemsa stain and anaemia by haematocrit concentration method respectively. Questionnaire was used to elicit information on socio-demography, and various risk attributes of these infections. Data was analysed using SPSS version 26. Overall, 78 (5.4%) of 1447 persons tested for malaria had a positive blood result. Light to moderate helminth infection was detected in 10 (1.8%) of 543 stool samples. The helminth infections comprised 1 (0.2%) case of *Echinostoma*, 2 (0.4%) cases of *Trichuris trichiura*, 1 (0.2%) case of *Strongyloides stercoralis* and 6 (1.1%) cases of *Ascaris lumbricoides*. More male than female was infected in both MP ($P<0.05$) and STH ($P>0.05$). *E. histolytica* was the only enteric protozoa seen. Anaemia was prevalent in 121 (9.8%) individuals with MP contributing 2.8% of all anaemia cases ($P>0.05$). Among different communities studied, Ijede had highest prevalence of MP (3.9%) while Okeletu had highest prevalence of STH (3.2%). High percentage of underweight was recorded among individuals infected with STH. Malaria and *Ascaris spp* is the most prevalent parasite infections.

Conclusion and application of results: This study shows reduced prevalence of parasites compared to those seen in the same region in the past. Routine screening, drug administration, and health education on hygiene and nutrition are therefore recommended.

INTRODUCTION

Globally, intestinal parasitic infections are among the most common of infections that affect the poorest and most deprived communities. (WHO, 2020). It is a public health problem caused by helminths and intestinal protozoa (Hotez *et al*., 2015, Turkeltaub *et al*., 2015, Visvesvara *et al*., 1997). The soil-transmitted helminths *Ascaris lumbricoides*, hookworm, *Trichuris trichiura* and the protozoan *Entamoeba histolytica*, *Giardia intestinalis* and *Cryptosporidium* sp. are the most common intestinal parasites, world over (David *et al*., 2015). World Health Organisation (WHO) estimated that over 1.5 billion individuals are infected and 450 million are ill because of these parasitic infections (WHO, 2020). The incidence of these intestinal parasitic infections is 50% in developed countries, whereas it reaches up to 95% in developing countries (WHO, 2020). The rate of infection is remarkably high in Sub-Saharan Africa where over 267 million preschool-age children and 568 million school-age children are at risk (WHO, 2020). The parasites are transmitted by eggs present in human faeces, which in turn contaminate the soil in areas where sanitation is poor. In Nigeria, intestinal helminth infections have persisted due to low living standards, inadequate environmental sanitation, and ignorance of simple health-promoting behaviours (Iduh et al., 2015). These infections are most common in school-aged children and likely to be more severe in this age group (Iduh *et al*., 2015) and have been linked to an increased risk of nutritional anaemia, protein-energy malnutrition, and growth deficiencies (Sackey *et al*., 2003). Several environmental and socioeconomic factors have been implicated in the persistence of intestinal parasite infections in children. The worms increase malabsorption of nutrients and roundworms may possibly compete for vitamin A in the intestine. Some soil-transmitted helminths can also cause loss of appetite and, therefore, a reduction of nutritional intake and physical fitness. In particular, *T. trichiura* can cause diarrhoea and dysentery (WHO, 2020). Malaria is another parasitic disease that causes morbidity and mortality in Nigeria. According to Global Malaria Report, there were 241 million cases of malaria in 2020 compared to 227 million cases in 2019 (WHO, 2021). The estimated number of malaria deaths stood at 627 000 in 2020 – an increase of 69 000 deaths over the previous year. While about two thirds of these deaths (47 000) were due to disruptions during the COVID-19 pandemic. In 2020, it was estimated that 95% of global malaria cases were in the WHO African Region, which is an estimated 200 million cases (WHO, 2021). Nigeria tops the list and accounts for 25% of global malaria cases followed by four other African countries (WHO, 2021). In areas with high transmission of malaria, children under five are usually vulnerable to infection, illness, death, and account for about 80% of all malaria death in the region.

In the tropics especially in Nigeria, helminthiasis and malaria constitute a major public health problem, as these areas are often characterized by favourable conditions that allow the parasite to thrive. Humid climate, poor sanitary conditions, lack of clean portable water, and poor environmental sanitation and socioeconomic status are some of these factors. The diseases are a major cause of morbidity and mortality, especially in semi-urban resource-limited settings like Ijede local government development area (LCDA), a health surveillance demographic system for NIMR and the site of this study. Education, personal hygiene, environmental sanitation and preventive chemotherapy in targeted at risk groups are applicable control measures in both parasitic diseases. This includes periodic deworming or mass drug administration (MDA) to reduce worm burdens in STH while seasonal malaria chemoprevention (SMC),

perennial malaria chemoprevention (PMC) and intermittent preventive treatment in pregnancy (IPTp) are the updated policy to control malaria in endemic regions (WHO, 2022). To apply these control measures appropriately, it is important to appreciate the burden and spread of this disease to advice intervention. To address this gap, this study aims to measure the prevalence and intensity of intestinal and malaria parasite infections in different communities in Semi-Urban Ijede LCDA in Ikorodu LGA in Lagos State, Nigeria.

MATERIALS AND METHODS

Study area and population: Ijede is an LCDA, in Lagos State, Nigeria. An LCDA is the smallest administrative unit in Nigeria. It is bounded in the East by Imota LCDA, in the North by Ikorodu North LCDA, in the West Ikorodu Central and Igbogbo Bayeku LGA and in the south by Lagos Lagoon. . It is situated in Mainland, Lagos, with geographical coordinates are 6° 34' 0" North, 3° 36' 0" East (Figure 1). The population of Ijede LCDA is around 1,600,000 according to the 2006 census. It is made up of about 15 communities headed by an executive chairman and divided into 4 political wards- Ward A, B, C and D. A Primary Health Centre (PHC) is present in each of the wards. The people of Ijede are predominantly Ijebus, a Yoruba-speaking tribe but with several other tribes from all over Nigeria residing in the communities. Ijede LCDA has many tourist attractions, such as Odoro Spring Water, Lagos Lagoon. It can boast of the biggest Power Station in the West African Sub region; The Egbin Power Station. The inhabitants are predominantly farmers and retail traders (David *et al*., 2020). Non-purified borehole constitute the major source of water with about 15.4% using uncovered pit latrines (David *et al*., 2020). Data collection was carried out in January 2022 in four semi-urban communities (Figure 1).

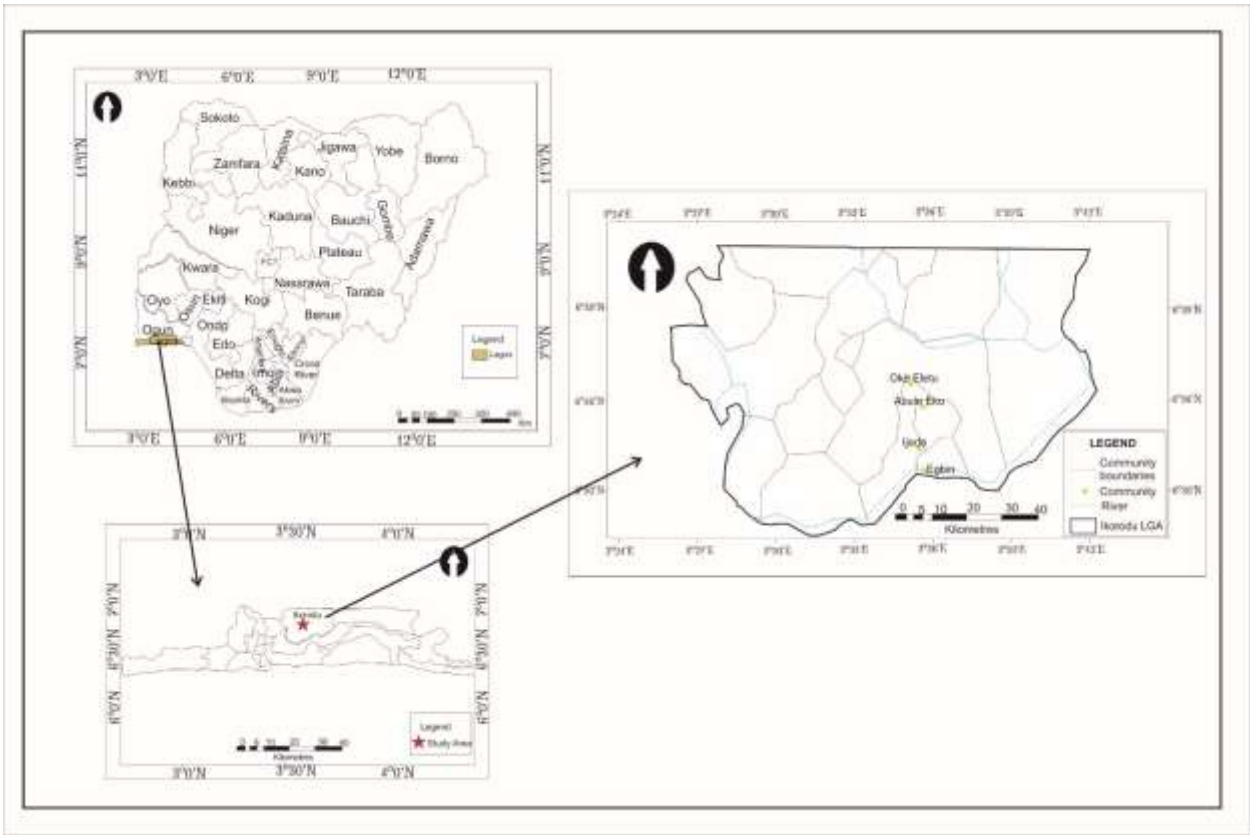


Figure 1: Map of Lagos State showing Ijede Local Council Development Area.

Ethical Clearance: Approval for the study was obtained from Institutional Review Board of Nigerian Institute of Medical Research. The director of public health services in the LCDA and coordinators of the Primary Health Centres in each community sampled were notified about the study; they assisted in the sensitization and mobilization of the inhabitants. Informed consent forms were distributed to the participants of the study; the forms were verbally translated to the participants (parents, caregiver and other adults) in their local language; only those who consented by signing the consent form or appending their thumbprint were recruited into the study.

Study Design and Sampling Procedures: This survey is a cross-sectional study involving the demographic data capture of the participants (children/mothers/caregivers/ adults) and the collection of their blood and stool samples for laboratory analysis to check for malaria parasite, blood packed cell volume (PCV) and intestinal parasite infections. Samples were collected from four communities including Oke Eletu, Abule eko, Ijede and Egbin communities. Individuals (children and adults) who consented to be part of the study were recruited into the study. Sampling was carried out in January 2022 in Ijede area of Ikorodu LGA in Lagos State.

Data Collection and Laboratory Methods

Stool Samples: Sterile universal bottle(s) were given to consenting parents/guardians/adults for submission of their fresh stool samples; some individuals produced stool samples at the spot. Those who took the bottles home returned it in the morning hours of the next day, which were later transported to the laboratory where assessment was carried out. Formol water was added to the stool samples and were later analysed using the WHO approved method, the Kato-Katz method for the presence of intestinal parasite cysts, eggs,

and ova (Barenbold *et al*., 2017). This method was employed to increase the sensitivity of detecting helminth and protozoan ova in stools as well as to preserve the sample prior the time of laboratory microscopic assessment. Intensity of infection for intestinal helminths was expressed as the mean eggs per gram of faeces (epg). Quality control was performed by re-examining 10% randomly selected Kato smears by an experienced independent laboratory scientist. Blood Samples: Blood samples were collected by finger pricking and examined for the presence of malaria parasites using malaria Rapid Diagnostic Test (RDT), SD Bioline Malaria Ag Pf. Blood Packed cell volume was also estimated from the blood using haematocrit capillary tube for sample collection, haematocrit centrifuge for centrifugation and the haematocrit reader for reading of the PCV value expressed in percentage (Wintrobe, 1929). Anaemia was defined as PCV of <33% and PCV 33-45% as non- anaemic.

Data Capturing: Information of the participants was carefully collected on the study booklet. Demographic data, age, sex was collected from the participant. The results of the blood tests, the malaria parasite result and the packed cell volume (PCV) as well as the stool test results were also documented using the data-capturing tool.

Data Analysis: Data obtained from the participants and parasitological investigations were entered into Microsoft Excel version and analysed using IBM Statistical Package for Social Sciences (SPSS) version 26.0. PCV was categorized into anaemic (PCV value of <33%) and non- anaemic (PCV value of 33-45%). Descriptive statistics such as proportion and percentages was computed for demographic data while associations and relationship between PCV, age, sex and disease outcome as tested using chi-square and regression analysis at 95% confidence level. Intensity of infection was calculated for intestinal helminths.

RESULTS

Study Population: A total of 1684 participants were recruited for the study; 1630 (96.8%) met the inclusion criteria by providing either stool samples or blood specimens. While 596(36.6%) were males, 1034(63.4%) were females between the ages of 1 and 89 years (Table 1). In other words, male to female ratio is 1:1.7. Age group 5-18 is of highest preponderance with the four communities well represented in the study. The Ijede LCDA studied are majorly Christians and of Yoruba ethnic group. Secondary education was the most obtained certificate for both parents and the main occupation was casual work with mothers' mostly petty traders. Average family income for the community members was ≤ 50,000 living in multifarious/multi compounds/shirk squatter houses (table 1). Their source of drinking water was borehole. Community members are mostly obese with majority of participants having normal blood level (table 2).

Table 1: socio-demographic and clinical characteristics of study participants

Socio-demography	***Frequency (%)***
Gender (N= 1630)	
Male	596(36.6)
Female	1034(63.4)
Age group (N = 1623)	
< 5 years	82 (5.1)
5-18 years	683 (42.1)
19-40 years	333 (20.5)
>40 years	525 (32.3)

Community (N = 1119)	
Abule Eko	547 (48.9)
Egbin	136 (12.2)
Ijede	342 (30.6)
Okeletu	94 (8.4)
Tribe (N = 1119)	
Hausa	18 (1.6)
Igbo	94 (8.4)
Yoruba	991 (88.6)
Others	16 (1.4)
Religion (N = 1119)	
Christianity	592 (52.9)
Islam	515 (46.0)
Traditional	12 (1.1)
Mother's level of Education (N = 1119)	
No formal Education	66 (5.9)
Primary	191 (17.1)
Quranic Education	8 (0.7)
Secondary	649 (58.0)
Tertiary	205 (18.3)
Father's level of Education (N = 905)	
No formal Education	33 (3.6)
Primary	91 (10.1)
Quranic Education	7 (0.8)
Secondary	533 (58.9)
Tertiary	241 (26.6)
Maternal Occupation (N = 1119)	
Artisan	215 (19.2)
Civil servant	60 (5.4)
Housewife	54 (4.8)
Professional	63 (5.6)
Student	32 (2.9)
Trader/ Business/ Marketing	627 (56.0)
Unemployed	51 (4.6)
Skilled worker	4 (0.4)
Retiree	13 (1.2)
Paternal Occupation (N = 905)	
Artisan	427 (47.2)
Civil servant	60 (6.6)
Housewife	4 (0.4)
Professional	106 (11.7)
Student	12 (1.3)
Trader/ Business/ Marketing	209 (23.1)
Unemployed	61 (6.7)
Skilled worker	1 (0.1)
Retiree	25 (2.8)
Average Family income (N = 1684)	
≤ 50,000	1481 (87.9)
51,000 – 100,000	159 (9.4)
>100,000	44 (2.6)

Type of Housing (N = 1119)	
A room self –contain	182 (16.3)
Boys quarter/ Room and Parlour	319 (28.5)
Duplex	6 (0.5)
Multicompounds/ Multifarious/ Shirk squatter	612 (54.7)
Source of Drinking water (N = 1119)	
Borehole	982 (87.8)
Bottle water	1 (0.1)
Pipe-borne water	59 (5.3)
River/stream	1 (0.1)
Sachet water	63 (5.6)
Well water	13 (1.2)

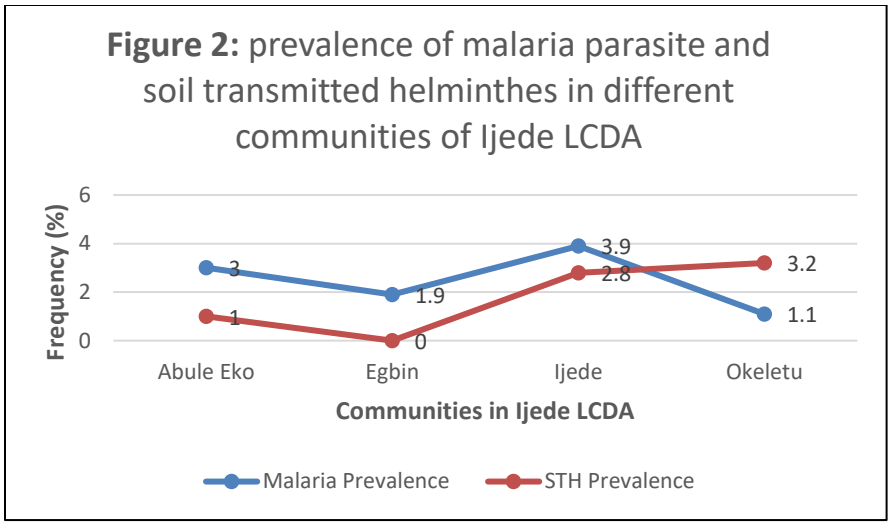
Table 2: clinical characteristics of study participants

Clinical Characteristics	***Frequency (%)***	**95% CI**
Body Mass Index (BMI) (N= 1116)		0.0500 - 0.0796
Underweight	71(6.4)	0.0327 - 0.0576
Normal weight	49 (4.4)	0.0468 - 0.0756
Overweight	67 (6.0)	0.8092 – 0.8539
Obese	929 (83.2)	
Packed Cell Volume (PCV) (N= 1241)		0.0816 - 0.1154
Anaemic	121 (9.8)	0.8846 - 0.9184
Normal	1120 (90.2)	

Prevalence of Malaria and Intestinal Parasite Infections: prevalence of malaria parasite infection and STH in the communities was 5.4% and 1.8% respectively; 1.1%, 0.4%, 0.2% and 0.2% for *A. lumbricoides*, *T. trichiura*, *Echinostoma* and *Strongyloides stecoralis* respectively. *E. histolytica* (1.1%) was the only protozoan parasite recorded in the stool samples from the study and there were no parasitic co-infection between malaria and STH (Table 3). No significant difference ($p > 0.05$) was observed between malaria parasite infections and intestinal parasitic infections in the communities. More males than females were infected with both malaria ($P<0.05$) and STH infection ($P>0.05$) (Table 4). These communities respectively, than in the other communities(Figure 2). The underweight participants haboured the most STH (Figure 4infections were most prevalent in age group 1-18 years (malaria infection) and age group 5-40 years (STH) (Table 4). Higher prevalence of malaria (3.9%) and STH (3.2%) were recorded in Ijede and Okeletu).

Table 3: Intensity of soil transmitted helminths

Parasite	***Frequency (N=543)***	***Percentage(%)*** *(95% CI:LL – UL)*	***Mean Parasite Count (epg)***	***Intensity of Parasite***
Ascaris lumbricoides	6	1.1(0.0 – 0.012)	6,896	Moderate
Trichuris trichuria	2	0.4(0.0 – 0.0068)	348	Light
Echinostoma	1	0.2(0.0 – 0.0068)	-	-
Strongyloides stercoralis	1	0.2(0.0 – 0.0068)	-	-
Entamoeba histolytica	6	1.1(0.0 – 0.012)	-	-



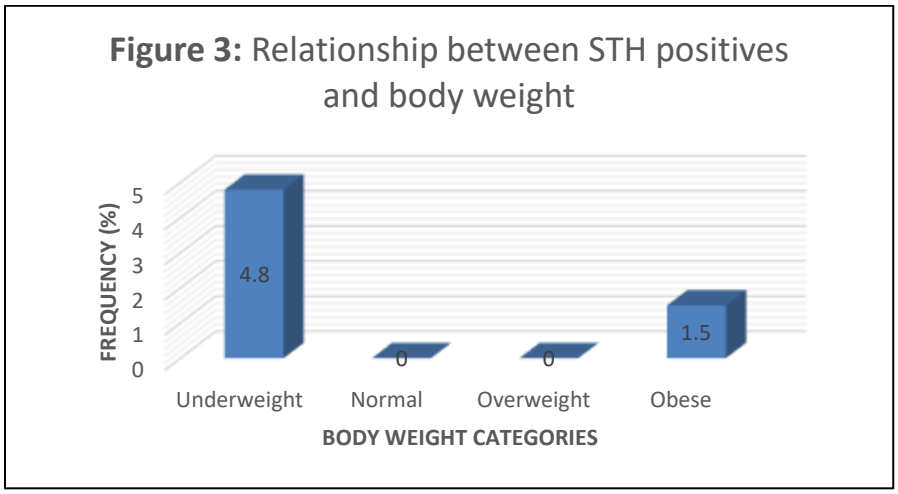


Table 4: Prevalence of malaria parasite and Soil transmitted helminths by age and sex

Characteristics	No of participants	No of infections	Prevalence (%) (95% CI:LL -UL)	p-value
Malaria parasite	N = 1447	N = 78	5.4%	
Gender				
Male	527	36	6.8 0.0483 – 0.0933)	P<0.05
Female	920	42	4.6(0.0331-0.0612)	
Age (year)	N= 1440			
1-4	65	6	9.2 (0.0346-0.1902)	P<0.05
5-18	591	57	9.6 (0.0739-0.1231)	
19-40	303	6	2.0 (0.0073-0.0426)	
>40	481	9	1.9 (0.0086-0.0352)	
Soil Transmitted Helminth				
Gender	N=543	10	1.8 (0.0089-0.0336)	
Male	192	4	2.1 (0.0057-0.0525)	P>0.05
Female	351	6	1.7 (0.0063-0.0368)	
Age(year)	N=540			

1-4	17	0	0	P>0.05
5-18	230	5	2.2 (0.0071-0.0500)	
19-40	86	2	2.3 (0.0028-0.0815)	
>40	207	3	1.4 (0.0030-0.0418)	

Table 5: Association of anaemia with infection level

PCV level	***Malaria POS***	***Malaria NEG***	***P- value***	***STH POS***	***STH NEG***	***P- value***
Anaemia N = 121 (9.8%)	3(2.8)	106(97.2)	> 0.05	0(0)	34(100)	>0.05
Normal N = 1120 (90.2%)	62(6.0)	975(94.0)	>0.05	7(1.8)	382(98.2)	

Prevalence of anaemia and association with infection status: Out of 1241 participants, 121 (9.8%) were anaemic. MP contributed to 2.8% of anaemia cases seen (P> 0.05) with no significant association while STH had zero contribution to anaemia from this study (P>0.05) (Table 5). There was no significant difference in the prevalence of anaemia between infected children with MP or STH and uninfected children.

Predictors of anaemia: Multivariate logistic regression analysis was performed to identify predictors of anaemia. Variables included were age group, sex, malaria infection, STH infection, level of income, BMI (table 6). There was no significant predictor of anaemia from this study.

DISCUSSION

This investigation, studied the epidemiology of STH and *P. falciparum* infections in four communities of Ijede, a peri-urban LCDA in Ikorodu LGA of Lagos state and we observed light to moderate intensity of STH infection amongst the investigated. A meta-analysis of data published between 1980 and 2015 across 19 Nigerian states showed that 54.8% of children aged 0-17 years were infected with one or more species of STHs with *Ascaris lumbricoides* being the most prevalent species (44.6%, 95% CI: 44.0-45.2) and South-western region being the high risk zone for STH infections (Karshima, 2018) The observed low prevalence of 5.4% STH observed in our study in Ijede LCDA is contrary to the high reports in the Nigerian metanalysis review and also different from what was observed in other countries ranging from 15.7%, 20.9%, 33.3% in 70.3%, in, Gabon, Afghanistan Thailand, South-West Ethiopia, Myanmar (Aung *et al.*, 2022, Kamdem *et al.*, 2022, Edoa *et al.*, 2024) and the Philippines, North-West Ethiopia respectively(Babamale *et al*., 2018, Tekalign *et al*., 2019, Goshu *et al*., 2021). Parasitic infections are closely associated with poor and under-privileged communities. This is because of activities that create favourable conditions and environment for the development of STH ova and mosquito breeding sites. The observed variations could be due to differences in study settings, climate, diversity in geographic area and the fact that this study was undertaken during the dry season. Evidence of available good sources of drinking water recorded in this study site might have led to reduction in helminth infection documented in the study area, also level of education, personal hygiene behaviour, eating habits and occupation of the participants may have affected the prevalence of helminths in the area. Furthermore, these communities have been under intense public health research and intervention in the past years and which could have reduced the susceptibility level of the population to these

parasitic infections. In our study, the most common intestinal soil-transmitted helminths found was *Ascaris* with a prevalence of 1.1%. In Kwara State, Nigeria, Babamale *et al*, (Babamale *et al*., 2018) reported high prevalence of 63.1%. Sumbele *et al* (Sumbele *et al*., 2017) reported higher prevalence of 18.8% in a rural community in Cameroon. In Ethiopia also, high *Ascaris* prevalence of 16.4% was reported (Tekalign *et al*., 2019), 4.2% prevalence in Douala, Cameroon (Flavio *et al*., 2021) and similar prevalence of 1.5% Ascariasis in Ghana (20). In this study, most of the Ascariasis infections were moderate in intensity while light infection was reported by Adu-Gyasi *et al.*, (Adu-Gyasi *et al*., 2018) in Ghana. The STH prevalence in males was slightly higher than in females with non-significant association. Similar finding has been reported in Nigeria where males were highly infected (Fleming *et al*., 2006, Ibidapo & Okwa, 2008,Yatich *et al*., 2009, Ugbomoiko *et al*., 2012). This might be due to differing healthcare-seeking behaviour and disease-related exposure. In similar studies, sex difference was not significantly associated with STH infection (Mamo, 2014). The occurrence of STH was observed to peak in the adult group of 19–40 years, contrary to evidence from other studies with higher cases in the younger age group (Babamale *et al*., 2018). It is possible that past intervention has concentrated on the younger age group leaving out adults who has now become the repository of these infections. Future campaigns should be all encompassing in other to arrest the present trend. Soil transmitted helminths have been linked and had adversely affected the nutritional status of infected individuals, greater percentage of STH positives are underweight but with zero contribution to anaemia from this study. This could be related to low prevalence with moderate intensity of infections, and absence of hookworm and *Schistosoma* infection in the studied individuals. Overall malaria prevalence is low (5.4%), which demonstrates a continuing reduction of malaria burden in this part of Nigeria despite control strategies in place. This also reiterates report of WHO on evidence of a substantial reduction in malaria transmission in many parts of sub-Saharan Africa in the past two decades although this has stalled in recent years (WHO, 2022). Previous investigations have reported that malaria prevalence ranged from 41.7%-86.7% in Nigeria (Dawaki *et al*., 2016, Odikamnoro *et al*., 2017, Ali *et al*., 2019). The malaria risk map estimated that prevalence in Nigeria varied from less than 20% to more than 70% (Onyiri, 2015). Malaria parasites infections have been linked to anaemia of affected victim in 2.8% of cases. Higher significant prevalence was recorded among males than females and in younger age groups. This might be due to frequent exposures and other cultural determinants as observed in males. However, other studies had contrasting results in Nigeria, which might suggest strongly that malaria risk factors are highly heterogeneous and complex. Low prevalence of anaemia was reported compared to other studies. This might reflect a changing pattern in anaemia prevalence or in the distribution and intensity of helminths and malarial parasites that causes anaemia. Majority of STH infections were moderate in intensity chiefly contributed by *Ascaris*, which does not cause anaemia directly. Although etiology of anaemia is multifactorial, parasitic infections are known as a major cause, while malaria parasite causes anaemia by destruction of parasitized red blood cells. There was no co-infection of parasites from this study. Studies have shown that in addition to the known effect of single parasite species on anaemia, multiple parasite infections can interact to enhance the risk of anaemia.

CONCLUSION AND APPLICATION OF RESULTS

In conclusion, malaria and STH has reduced in Ijede LCDA, Lagos State. The morbidity of soil-transmitted helminths is associated with the rate of infection and surveillance that help in understanding the epidemiology of these infections within the communities is essential in the design and targeting of control strategies so that resources are optimally utilised. Our study observed associated infection of STH with underweighted participants in our study and so requires that underweight individuals in Ijede community be targeted for intervention deworming. This calls for action will prevent heavy worm-load in infected individuals and further transmission in the community.

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