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Malaria and soil-transmitted helminthes coinfection in a rural community of Kwara State, North Central Nigeria

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Abstract. Malaria and soil-transmitted helminthes (STH) are common in most developing countries especially Nigeria. The aim of this study was to assess the rate of occurrence of *Plasmodium falciparum* and STHs coinfection and to determine the associated risk factors. A community based study was conducted on 300 individuals living in Oke-Oyi a rural community in Kwara State, North Central Nigeria, between January and June 2014. Blood samples were collected by finger prick to determine malaria parasitaemia using thick and thin film method while stool samples were processed using formalin-ether sedimentation technique and examined microscopically for intestinal parasites. Well structured questionnaire was administered to ascertain socio-economic characteristics of the subjects. The prevalence of malaria was 56.7% while the prevalence of STHs/malaria coinfection was 40.1%. The age group 1-10 was found to be the most infected (74.3%) while males (60.7%) were more infected than females (51.8%). *Ascaris lumbricoides* Linnaeus, 1758 was the most prevalent (60.5%) STHs infection followed by *Trichuris trichiura* (Linnaeus, 1771) (57.6%). Multiple infections were more pronounced in the age group 1-10 (40.1%). Subjects that were farmers were more prone to coinfection. Intestinal parasitic infection and malaria coinfection is a serious health challenge in Oke-Oyi Area of Kwara State, North Central Nigeria. Therefore, concerted efforts such as mass deworming, improved sanitation, provision of toilet facilities and health education is encouraged.

Keywords: *Plasmodium falciparum*; Soil-transmitted helminthes; Coinfection; Nigeria.

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Introduction

Parasitic diseases have been found to be among the most widespread of all chronic human infections all over the world. About half of the world's population live in malaria-endemic areas where an estimated 214 million cases and 438,000 deaths are recorded annually (WHO, 2015). Malaria caused by *Plasmodium falciparum* (William H. Welch, 1897) inflicts the largest burden amongst the different parasitic diseases with a third of the Africa population inflicted at any one time (Snow et al., 2005). Nigeria bears 25% of the malaria disease burden in Africa, where 11% of maternal mortality, 25% of infant mortality and 30% of under five mortality (RBM, 2012) are attributed to malaria. Soi-transmitted helminthes (STHs), on the other hand, are a group of common parasites that infect more than a billion people worldwide of whom 400 million suffer associated severe disease (Bethony et al., 2006). STH may cause up to 135,000 deaths a year and are a major cause of chronic morbidity resulting in stunted growth and poor pregnancy outcomes in pregnant mothers (WHO, 2008). In Nigeria and other developing countries, STHs could be caused by hookworm *Ascaris lumbricoides* Linnaeus, 1758, *Trichuris trichiura* (Linnaeus, 1771) and are widely spread in parts of the country with variable prevalence's (Akogun and Badaki, 1998; Asaolu et al., 2002; Dagana et al., 2011). In many parts of the world, malaria and STH have been found to be co-endemic, making coinfection a common occurrence particularly in Africa (Briand et al., 2005). Polyparasitism is common in Nigeria, and interactions that affect disease severity may occur (Egwunyenga et al., 2011; Ojurongbe et al., 2011). It has been observed that malaria, and the major soil-transmitted helminthes share not only geographical distribution, but also the human hosts, and individuals who harbor multiple parasite species have increased risk of severe morbidity and mortality. Studies have demonstrated that about a quarter of African school children are concurrently infected with *P. falciparum* and hookworms (Brooker et al., 2006). The overlapping distribution of various parasites is an important factor in considering the risk of coinfections and comorbidity in the population. A study conducted in Nigeria demonstrated that pregnant women coinfected with *P. falciparum* and helminthes produced children with lower birth weight compared to those inflected with *P. falciparum* alone (Egwunyenga et al., 2001). Individuals coinfected with more than one parasite species are not only at the risk of illness associated with each parasites species, but also the risk of developing frequent and more severe disease due to interactions among the infecting parasite species (Tschikuka et al., 1996; Howard et al., 2001). An important aspect of malaria and helminthes coinfections is their joint contribution to anaemia, which affects 50% of all children and pregnant women in developing countries (Ojurongbe et al., 2011).

Though there has been a growing interest to investigate coinfections and their related clinical consequences worldwide, there have been very few longitudinal community based studies that have attempted to investigate the interactions between *P. falciparum* malaria and STH infections (Egwunyenga et al., 2001; Mwangi et al., 2006). This study is in an effort in that direction and is aimed at providing baseline data on coinfection of malaria and STH in Oke-Oyi Community, Ilorin East Local Government Area of Kwara State, North Central Nigeria.

Materials and methods

Study area

The study was carried out in Oke-Oyi Community, Ilorin East Local Government Area of Kwara State, North Central Nigeria. It is located at an elevation of 316 m above sea level with a population of 113,841 hab. It is located between latitude 8° 5" N and longitude 4° E. Its coordinate are 8.58333 and 4.71667. The climatic condition of the municipallity is characterized by two distinct seasons; wet and dry season, respectively. The vegetation is Guinea Savanna with annual rainfall of 113.8 mm. The sanitation status of the community is very poor as bushes and waste disposal sites are located close to residential area, basic amenities such as potable water are lacking.

Collection and examination of samples

Three hundred (300) people comprising 163 male and 137 female voluntarily participated in the study and were examined for malaria and STH infections between January and June 2014. Blood and stool samples were collected for malaria and STH examinations, respectively, for malaria examination, a thin and thick smear were prepared from a drop of blood on the microscope slide while Kato-Katz Technique was used to determine helminthes egg count in the stool (Howard et al., 2001). Each stool sample was labeled in a container and given an identification number. Fresh stool samples were immediately transported to the parasitological laboratory where they were processed using the methods as outlined by Idris and Al-Jabri (2001) for parasite identification. A fixed quantity of sewed 41.7 mg of stool was obtained by filling a punched template. It was then deposited on a glass slide, covered with malachite green/glycerin impregnated cellophane, and left to clear for about 45 min. The slides were examined for hookworm, *A. lumbricoides* and *T. trichura* eggs. However, hookworm eggs were counted within an hour to avoid clearing. Egg-counts were expressed as number of eggs/g of stool by multiplying the total eggs with 24 (WHO, 2008).

A semi structured questionnaire addressing the individual's socio-economic/environmental information, use of malaria and STH preventive measures, housing conditions, their knowledge and attitude concerning malaria and soil-transmitted helminthes transmission and other related issues were administered to assess/identify some possible risk factors for the coinfection.

Ethical consideration

Before commencement of the study, approval was granted by the authorities of the University of Ilorin Teaching Hospital. The researchers made it clear to the participants that the study was voluntary and that it was possible to withdraw at will.

Statistical analysis

All statistical analysis was performed using statistical package for social science (SPSS), version 16.0. Differences in the prevalence and intensity of infection between age and sex were tested using the chi-square (X^2) and one-way ANOVA test, respectively.

Results

Table 1 shows that prevalence rate of malaria infection was highest in the age group 1-10 (74.3%), followed by age group 31-40 (64.5%), age group 11-20 (61.8%) and decreased drastically to 38.3% in age group 51-60.

Table 2 shows that a total of 210 stool samples were examined for *A. lumbricoides* egg out of which 127 (60.5%) was found to be infected which comprises of 49 (38.6%) males and 78 (61.4%) female. 110 (35.5%) were infected with hookworm egg comprising of 45 (40.9%) male and 65(59.1%) female. 121 (57.6%) were infected with *T. trichiura* eggs comprising of 46 (38.0%) male and 75 (62.0%) females. The result shows that *A. lumbricoides* (60.5%) and *T. trichiura* (57.6%) shared a somewhat similar prevalence pattern. The prevalence shows that female are more infected with the highest level of prevalence observed in *T. trichiura* (62.0%) followed by *A. lumbricoides* (61.4%). The prevalence of STH with respect to sex is not significant ($P > 0.05$).

Table 3 shows that infection was higher in individuals living close to bushes with a prevalence of 88.9% than in those living far away from bushes (33.3%).

Malaria infection was more in individuals who had not taken anti-malarial drugs in the last 3 months with a prevalence of 72.9% than those who took anti-malarial drugs within one month with a prevalence of 50.0% lower prevalence of infection (36.6%) occurred in those that use herbs whenever they are ill compared to those that do not use it at all. The prevalence of infection is not significant (P > 0.05)

Table 4 shows that individual sources of water for drinking can also aid the spread of the disease. Those who drink water from well, rivers and other unclean water had the highest occurrence of STH, 83.3% in *A. lumbricoides,* 75.0% in Hookworm and 87.5% in *T. trichiura,* but the infection rate was low in those who drink pipe-borne water. A similar trend was also observed in the type of toilet facility used. A low prevalence of STH was observed in those that use cress-pit toilets; 42.9% Ascaris, 28.6% hookworm and 62.9% *T. trichiura*. Distance of habitation to waste disposal site was another factor that influenced transmission in the study. Those that live less than 20m away from disposal site had the highest prevalence of STH infection (87.0%) *A. lumbricorides,* 80.9% hookworm and 83.5% *T. trichiura.* Those who took anti-helminthic drugs in less than three months had low prevalence of STH infections as compared to those who took the drugs over a year ago.

Table 5 shows that those involved in faming as occupation had higher multiple infection of all the parasites (98.0%) when compared with all other groups. The frequency of multiple infections with respect to age, socio-economic and socio-environmental factors shows that children in the age group 1-10 were most susceptible to disease (40.1%). Thus, multiple infections are more pronounced in this age group than any other combination of two infections (malaria and *Ascaris* (0%), malaria and hookworm (0%), malaria and *Trichuris* (0%)). Families that are more than 6 had significantly higher multiple infections in all the combinations.

Table 1. Prevalence of *Plasmodium falciparum* infections with respect to age.

Age group (yrs)	No. examined	No. infected (%)
1-10	35	26 (74.3)
11-20	55	34 (61.8)
21-30	62	30 (48.4)
31-40	31	20 (64.5)
41-50	44	24 (54.5)
51-60	34	13 (38.2)
≥ 61	39	23 (59.0)
Total	**300**	**170 (56.7)**

Table 2. Prevalence of STH infections with respect to age and sex.

Age		*Ascaris lumbricoides*	Hookworm	*Trichuris trichiura*
1-10	No. Examined (N)	40	40	40
	Male infected (%)	16 (40.0)	7 (17.5)	6 (15.0)
	Female infected (%)	20 (50.0)	13 (32.5)	12 (30.0)
11-20	No. Examined (N)	29	29	29
	Male infected (%)	10 (34.5)	7 (24.1)	9 (31.0)
	Female infected (%)	12 (41.4)	16 (55.2)	12 (41.4)
21-30	No. Examined (N)	32	32	32
	Male infected (%)	8 (25.0)	12 (37.5)	19 (59.4)
	Female infected (%)	15 (46.9)	8 (25.0)	9 (28.1)

Table 2. Continued.

Age		*Ascaris lumbricoides*	Hookworm	*Trichuris trichiura*
31-40	No. Examined (N)	30	30	30
	Male infected (%)	6 (20.0)	8 (26.7)	5 (16.7)
	Female infected (%)	9 (30.0)	10 (33.3)	9 (30.0)
41-50	No. Examined (N)	36	36	36
	Male infected (%)	8 (22.2)	7 (19.4)	4 (11.1)
	Female infected (%)	10 (27.8)	8 (22.2)	20 (55.6)
51-60	No. Examined (N)	23	23	23
	Male infected (%)	0 (0)	4 (17.4)	3 (13.0)
	Female infected (%)	8 (34.9)	9 (39.9)	10 (43.5)
≥61	No. Examined (N)	20	20	20
	Male infected (%)	1 (5.0)	0 (0)	0 (0)
	Female infected (%)	4 (20.0)	0 (0)	3 (15.0)
Total	No. Examined (N)	210	210	210
	Male infected (%)	49 (38.6)	45 (40.9)	46 (38.0)
	Female infected (%)	78 (61.4)	65 (59.1)	75 (62.0)
	No. infected (%)	127 (60.5)	110 (35.5)	121 (57.6)
	X^2 value	**2.000**	**2.000**	**2.000**
	P value	**0.157**	**0.157**	**0-157**

Table 3. Relationship between socio-environmental factors and malaria infection in Oke Oyi community.

Variables	**∑fx No. Examined**	**No. infected (%)**
Last treatment for malaria:		
> 6 months ago	120	65 (54.2)
< 3 months ago	96	70 (72.9)
< 1 months ago	84	42 (50.0)
X^2 value	**6.000**	
P value	**0.199**	
Bushes around habitation:		
Yes	225	200 (88.9)
No	75	25 (33.3)
X^2 value	**2.000**	
P value	**0.157**	
Use of herbs during illness:		
Yes	205	75 (36.6)
No	95	72 (75.8)
X^2 value	**2.000**	
P value	**0.157**	

Table 4. Relationship between socio-environmental factor and soil-transmitted helminthes (STH) infections amongst infected donor in the community.

Variables	**∑fx No. Examined**	***Lumbricoides* No. infected (%)**	**Hookworm No. infected (%)**	**T. *trichuira* No. infected (%)**
Source of water for drinking				
Pipe-borne	56	20 (35.7)	16 (28.6)	24 (42.9)
Bore-hole	172	126 (73.3)	132 (76.4)	129 (75.0)
Well, river, others	72	60 (83.3)	54 (75.0)	63 (87.5)
X^2 value		**6.000**	**6.000**	**6.000**
P value		**0.199**	**0.199**	**0.199**
Toilet facility type				
Cress-pit	35	15 (42.9)	10 (28.6)	22 (62.9)
Latrine	83	56 (67.5)	52 (62.7)	43 (51.8)
Others	182	150 (82.4)	139 (76.4)	122 (67.0)
X^2 value		**6.000**	**6.000**	**6.000**
P value		**0.199**	**0.199**	**0.199**
Distance of habitation to waste disposal site				
≤ 20 m away	230	200 (87.0)	186 (80.9)	192 (83.5)
≤ 50 m away	83	35 (68.6)	23 (45.1)	25 (49.0)
≤ 100 m away	182	8 (42.1)	12 (63.2)	4 (21.1)
X^2 value		**6.000**	**6.000**	**6.000**
P value		**0.199**	**0.199**	**0.199**
Ever treated for intestinal worm				
Yes	199	98 (49.2)	77 (38.7)	82 (41.2)
No	101	45 (44.6)	64 (63.4)	53 (52.5)
X^2 value		**2.000**	**2.000**	**2.000**
P value		**0.157**	**0.157**	**0.157**
Last treatment for STH				
> 1 year ago	203	126 (62.1)	130 (64.0)	143 (70.4)
< 6 months ago	43	26 (60.5)	16 (37.2)	31 (72.1)
< 3 months ago	54	33 (61.1)	3 (5.5)	9 (16.7)
X^2 value		**6.000**	**6.000**	**6.000**
P value		**0.199**	**0.199**	**0.199**
Use of prescribed drugs for STH				
Yes	212	101 (47.6)	112 (52.8)	120 (56.6)
No	88	26 (29.5)	43 (48.9)	36 (40.9)
X^2 value		**2.000**	**2.000**	**2.000**
P value		**0.157**	**0.157**	**0.157**

Table 5. Prevalence of malaria and STH coinfection in Oke-Oyi Community.

Overall prevalence	**(Mal + Asc) %**	**(Mal + Hkw) %**	**(Mal + Tri) %**	**(Mal + Asc + Hkw) %**	**(Mal + Asc + Tri) %**	**(Mal + Hkw + Tri) %**	**Mal + Asc + Hkw + Tri) %**
Age							
1-10	0 (0)	0 (0)	0 (0)	1 (30.0)	3 (8.9)	2 (10.0)	62 (40.1)
11-20	1 (19.5)	2 (10.0)	0 (0)	3 (8.6)	5 (13.5)	0 (0)	45 (31.5)
21-30	4 (80.0)	0 (0)	0 (0)	4 (40)	2 (51.0)	1 (10.0)	11 (8.5)
31-40	4 (85.0)	0 (0)	11 (6.3)	13 (35.1)	8 (21.6)	0 (0)	2 (20.0)
41-50	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (50.0)	2 (1.5)
51-60	1 (10.0)	0 (0)	0 (0)	2 (20.0)	0 (0)	2 (20.0)	0 (0)
≥ 61	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Table 5. Continued.

Overall prevalence	(Mal + Asc) %	(Mal + Hkw) %	(Mal + Tri) %	(Mal + Asc + Hkw) %	(Mal + Asc + Tri) %	(Mal + Hkw + Tri) %	Mal + Asc + Hkw + Tri) %
Family size							
<6	2 (24.0)	0 (0)	0 (0)	2 (50.0)	4 (10.8)	1 (5.0)	12 (8.1)
>6	6 (77.5)	0 (0)	10 (100)	3 (65.O)	33 (89.2)	9 (90.0)	132(92.9)
Sex							
Male	1 (12.5)	0 (0)	2 (30.0)	2 (50.0)	14 (37.8)	3 (50.0)	12 (14.3)
Female	0 (0)	4 (80.0)	7 (70.0)	1 (25.0)	33 (89.2)	4 (30.0)	83 (57.7)
Education							
Pri. School	4 (12.5)	6 (20.0)	4 (40.0)	9 (75.2)	6 (17.2)	8 (20.0)	42 (32.2)
Sec. school	3 (37.5)	3 (60.7)	5 (50.0)	0 (0)	10 (54.1)	4 (50.0)	8 (12.5)
Illiterate	3 (75.0)	1 (20.0)	0 (0)	1 (25.0)	11 (27.6)	0 (0)	81 (54.0)
Occupation							
Wage earner	4 (37.4)	0 (0)	5 (8.1)	1 (10.0)	0 (0)	1 (20.0)	3 (2.0)
Unemployed	0 (0)	0 (0)	0 (0)	0 (0)	1 (2.7)	3 (50.0)	0 (0)
Farming	6 (62.5)	8 (100.0)	10 (90.0)	4 (100)	34 (89.2)	6 (50.0)	148(98.0)

Key: Mal = Malaria (*Plasmodium falciparum*), Asc = *Ascaris lumbricoide*s, Hkw = Hookworm, Tri = *Trichuris trichiura*.

Discussion

This study may be considered the first study conducted on the prevalence and association of malaria and STH coinfections in Oke-Oyi Community, as no published record exists. Knowledge of the distribution of the distribution of malaria and STH infections in a given community is vital for planning, designing and evaluating integrated health intervention programs (Dada-Adegbola et al., 2013). According to the Roll Back Malaria Initiative of Nigeria, almost the entire population of Nigeria is at risk of contracting malaria, thus making malaria a severe public health issue. Despite the continuous efforts geared at eliminating malaria during the past decade, infections with malaria remains high (56.7%). The current study in Oke-Oyi tends to reflect the same notion, with a very high prevalence rate of malaria due to *P. falciparum*. The high rate of malaria recorded in the study area tends to call on a review of the present malaria control program as to improve to reduce the prevalence rate in the study area. In this study, prevalence rate of malaria infection was highest in the age group 1-10 (74.3%). This may be due to the fact that these age groups are mainly children with low immunity to combat malaria parasites. In Nigeria, *A. lumbricoides*, *T. trichiura* and hookworm, with a prevalence of 60.5%, 57.6% and 35.5%, respectively. The high occurrence of *A. lumbricoides*, Hookworm and *T. trichiura* has been widely reported in children and adults by various authors in the region (Akogun and Badaki, 1998; Egwunyenga et al., 2001; Ojurongbe et al., 2011; Dada-Adegbola et al., 2013). *Ascaris lumbricoides* was the most commonly encountered infection, having a prevalence of 60.5%. This is in consonance with what had been observed in various communities in Nigeria (Akogun and Badaki, 1998; Dagana et al., 2011). This could be due to high fecundity rate of the parasite as well as the ability of the eggs to withstand adverse weather condition (Akogun and Badaki, 1998). The prevalence of *A. lumbricoides* was highest among children between 1-10 of age. The above observation also agrees with the result of (Akogun and Badaki, 1998) and this is ascribed to the exposure pattern in view of the fact that this group exhibits geophagy, adventurous and mindless unhygienic habit.

From results of the study, socio-environmental factor determines malaria infections to a large extent. This is because short distance to bushes and waste disposal site may predispose inhabitant to frequent malaria vector attack. In this study, it reveals that those who live close to bushes had high infection of malaria parasite with a prevalence of 88.9%.

The high prevalence of STH and malaria infections shows that proximity to bushes and waste disposal sites and major risk factors. This was also observed in earlier studies on coinfection of malaria and helminthes in holoendemic regions of Sub-Saharan Africa (Howard et al., 2001; WHO, 2002; Brooker et al., 2006).

A significant association between malaria infection and ascariasis, hookworm and trichiuriasis were found in this study as seen (Table 5). The co-occurrence of these four parasites was highest in those that engaged in farming as occupation with prevalence of 98.0% and this may be due to the reason that farming exposes them to vectors that carry malaria parasite and soil that harbor STH parasites. The observed occurrence of parasites species may be attributed to similar adaptation of parasites to common environmental niche. Coinfection may reflect concurrence of common socio-economic and/or environmental risk factors promoting survival of both species (Mwangi et al., 2006). Biological association may enhance the survival of both infections, whereby the presence of one species promotes or inhibits the establishment and survival of the second parasites.

In all, the present study has established the coinfection of malaria and soil-transmitted helminthes in Oke-Oyi Community in Ilorin, Kwara State, Nigeria, but there is still scarce information on the consequence of malaria-worm (STH) coinfection and the precise mechanism at play. More research is needed to explain the underlying immunological mechanisms behind the high overlapping distributions of malaria and STHs in the study area.

Conclusion

The findings of the present study has shown a high rate of occurrence of malaria and STHs coinfection in Oke Oyi community of Kwara State, north central Nigeria. The occurrence was more pronounced in the age group 1-10 years where persons who practiced farming as their occupation were more prone to the coinfection of the parasites. Public health education programs on personal hygiene, proper use of latrines and improved sanitation should be provided to prevent and reduce the rate of the infections in the study community.

Conflicts of interest

Authors declare that they have no conflict of interests.

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