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Soil Transmitted Helminthiasis in Relation with Anaemia among Individuals Living in Igbo-Ora, Oyo State

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Authors' contributions

This work was carried out in collaboration between all authors. Author AGI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OAO and RIN managed the analyses of the study. Author RIN supervised the study. All authors read and approved the final manuscript.

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ABSTRACT

Sub-Saharan Africa is endemic with soil transmitted helminthes and they have detrimental effects on humans. This study aimed to evaluate the prevalence of Soil Transmitted helmithiasis, its risk factors and its effect on Haemoglobin concentration among individuals at Igbo-Ora, Oyo State. A cross-sectional study involving 274 individuals at Igbo-Ora was conducted from March to August 2013. Intestinal helminthic infections were diagnosed using Kato-Katz technique and anaemia was determined by measuring the Packed Cell Volume (PCV) using the haematocrit centrifuge and reader. Among the participants, 28.8% were infected with intestinal helminthes and the overall prevalence of anemia was 12.8% ranging from individuals with no infection to individuals with single

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and multiple infections. Species-wise, prevalence of single STH infections was 23%, 17.2%, 2.6% and 0.4% for hookworms, *Ascaris lumbricoides, Strongyloides stercoralis* and *Trichuris trichiura* respectively while double helminthic infections were *A. lumbricoides*+hookworm 10.6% and hookworm+*Strongyloides* 1.5%. Level of education, hand washing after using the toilet, age and shoe wearing habit were significantly associated with risk of getting STH infections. *A. lumbricoides*, hookworm and triple multiple infections were associated with an increased risk of anaemia (OR= 0.999, 95% CI 0.39, 2.561), (OR= 0.817, 95% CI 0.339, 1.971) and (OR= 9.145, 95% CI 4.578, 18.269), respectively, but they were not statistically significant.

Keywords: Soil transmitted helminth; packed cell volume; anaemia; Igbo-Ora.

1. INTRODUCTION

Soil-transmitted helminthes (STHs) are a group of parasitic nematode worms that are transmitted to humans by faecally contaminated soil. In Sub-Saharan Africa, helminthiases are major public health problems in both rural and urban areas especially in communities where poverty, inadequate sanitation, lack of access to health care, and overcrowding are entrenched [1,2,3]. In addition, certain habits such as bare feet on sand, eating unwashed fruits and vegetables, socioeconomic status among others also encourage the transmission of helminthic infection [4,5]. These habits are practiced in rural communities and urban slums in resource challenged and developing countries including Nigeria. World Health Organization (WHO, 2010) [6] estimation indicated that over 5 billion people are at risk; more than 2 billion people are infected with one or more soil-transmitted helminthes, mainly *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* [7,8]. An estimated 5.2 million disability-adjusted life years (DALYs) is attributed to the global burden to these intestinal nematode infections [9]. In 2010, an estimated 819.0 million people were infected with *A. lumbricoides*, 438.9 million with Hookworm and 464.6 million with T. trichiura [10]. Light infections of STHs usually have no symptoms. However, heavier infections cause a variety of symptoms such as anaemia, malnutrition, malabsorbition, abdominal pain, cramping and tiredness, and impaired cognitive and physical development.

Anaemia is a global public health problem affecting 1.62 billion people, which is 24.8% of worldwide population [11]. Anaemia is mainly caused by iron deficiency, which, in turn, can result from a wide range of factors such as low dietary iron content, less bioavailable iron, poor absorption of iron due to concurrent ingestion of inhibitors such as cereals and grain [12]. Additionally, iron may be lost because of infection by parasites that destroy red blood cells, such as malaria-causing *Plasmodium* species, or by blood-feeding parasites, such as the soil-transmitted helminths (STHs) [12,13].

Some studies have reported that anaemia is strongly associated with moderate and heavy STHs infections [14-16], while some studies indicated that the presence of STH infections did not signifcantly associate with low haemoglobin (Hb) levels [11,17,18], warranting further study in different settings. This study was therefore conducted to determine the prevalence of soil transmitted helminthes, associated risk factors and its effect on packed cell volume among individuals living in Igbo-Ora, a semi-urban community in Oyo-State, Nigeria.

2. MATERIALS AND METHODS

Study area: Igbo Ora is the administrative headquarters of Ibarapa Central Local Government. There are six main communities in the town: Idofin, Sagaun-un, Isale-Oba, Iberekodo, Pako and Igbole. Majority of the residents are of Yoruba descendant and farming is the predominant occupation.

Study design: The study, which was a subset of another study, was a cross sectional study carried out between April to August, 2013. Participants were recruited from house to house. The inclusion criteria were: the individual residing in the community for at least 12 months, and the participant were willing and able to give consent, in case of minor, the parent or guardian were willing to give consent on his/her behalf. While the exclusion criteria were: the person attend school or work full-time outside the study area, received anthelminthic treatment within the last 3 months.

Ethical approval: The ethical clearance for the study was obtained from the University of Ibadan/University College Hospital Ethical

Review Board (UI/EC/12/0267). Community consent was obtained from the traditional head of the communities and family heads. Individual signed consent was obtained from participants and parents or guardians of minors before any related procedure was carried out.

Parasitological analysis: A clean, dry, leak-proof universal bottle was given to the participants for a collection of freshly passed stool specimen the next day. The stool sample was examined using normal saline wet preparation for identification of motile parasite and then Kato-Katz technique was used for both identification and quantification. Quantification of intestinal helminthes was expressed as the number of eggs per gram of stool, for each helminth, arithmetic mean of the helminth species specific egg counts from Kato-Katz thick smears was counted and multiplied by a factor of 24 to obtain a standardised measure of infection intensity expressed as eggs per gram of stool (EPG).

Determination of anaemia status: Heparinised capillary tubes were used to collect blood for haematocrit estimation. Capillary tubes were filled to mark, sealed and spun for 15 min in a Hawksley micro-haematocrit centrifuge at 1500 rpm. The haematocrit was then determined using a Hawksley micro-haematocrit reader. According to WHO (1994), the normal blood range for the different age groups were as follows: 0-15yrs (33-36%), adult men (39%), pregnant and non-pregnant women (33-36%). For this study participants whose PCV were less than 32% were considered anaemic.

Statistical analysis: The data was analysed using SPSS version 20 statistical packages software and statistical comparison was done using Chi-square (X^2) test. A stepwise Spearman's correlation was done for the determination of a possible association between helminthic infection and anaemia. Descriptive statistics was used to assess the prevalence of each infection. Values were considered statistically significant when p-values < 0.05.

3. RESULTS

3.1 Prevalence and Intensity of Intestinal-helminthes Infection

A total of 274 participants were recruited and their demographic characteristics are represented in Table 1. A total number of 79 individuals (28.8%) had helminthes ova detected in their stool. The most frequent intestinal helminthes present within the population were hookworm, *Ascaris lumbricoides*, *Strongyloides stercoralis* and *Trichuris trichiura.* The female participants, 168 (61.3%), were more infected than the male participants 106 (38.7%), but this difference was not statistically significant (P = 0.864). In this study, participants who never washed their hands after using the toilet were 11.4%, and this was statistically significant (P=0.01) (Table 1). Considering the level of education in this study, the prevalence of soil-transmitted helminthiasis was highest among primary school children (41.6%), followed by those without any formal education (26.6%) and this was statistically significant (P=0.009) (Table 1). Among those infected, hookworm infection had the highest prevalence 63 (23%), followed by *Ascaris lumbricoides (A. lumbricoides), Strongyloides stercoralis (S. stercorlis)* and *Trichuris trichiura (T. trichiura),* 47(17.2%), 7(2.6%) and 1 (0.4%) respectively. There were records of double and triple helminthiasis. For instance, the prevalence of *A. lumbricoides* and hookworm as well as hookworm and *Strongyloides* were 29(10.6%) and 4(1.5%) respectively while *Ascaris*-hookworm-*Strongyloides* triple helminthiasis was 2 (0.7%) (Table 2).

According WHO (2002), parasite intensity for hookworm, *A. lumbricoides* and *T. trichiura* infections were determined using direct egg per gram count (epg). 55 (20.1%) and 1 (0.4%) participants had light and moderate hookworm infection respectively in this study, for *A. lumbricoides* infection, 43 (15.7%) and 5 (1.8%) participants had light and moderate infections respectively while 1 (0.4%) was recorded for *T. trichiura.* There was no record of heavy infection found for the three STH. Mean intensity of infections were 219 eggs/g (epg) with a range of 24–12000 and 55egg/gram (epg) (range: 24-2400) for *A. lumbricoides* and hookworm respectively.

3.2 Associations of Selected Risk Factors of STH in Relation to Anaemia

In this study, STH infections in relation with anaemia showed no significant associations with sex, marital status, and types of toilet (P > 0.05) (Table 1). There were significant associations with STH infections in relation with anaemia with shoe wearing habit at home, level of education and washing of hands after toileting (P < 0.05).

However, the prevalence STHs among 16–20 age group children was slightly lower than other age groups and anaemia was high among children aged 0-5 but low in aged 11-20 and 16-20, this was statistically significant (P=0.003) (Fig. 1). In general, there were significant associations of STH infections with age, level of education and hand washing habit after using the toilet as well as the occurrence of anaemia (Table 1).

3.3 The Association between STH and Anaemia

As shown in Table 2, participants who were infected with STH infection were at risk for anaemia than non-infected (OR= 0.701, 95% CI 0.304, 1.618). *A. lumbricoides*, hookworm and triple multiple infections were associated with an increased risk of anaemia (OR= 0.999, 95% CI 0.39, 2.561), (OR= 0.817, 95% CI 0.339, 1.971) and (OR= 9.145, 95% CI 4.578, 18.269), respectively, but they were not statistically significant. In this study, 12.8% was the overall prevalence of anaemia ranging from individuals with no STH infection to individuals with one/two STH infections. As reported by Ibrahim et al. [3], there were individuals who were infected with *A. lumbricoides* and hookworm yet were not anaemic , but this was not statistically significant (P= 0.675 and 0.830 respectively).

4. DISCUSSION

The results from this study showed the prevalence of intestinal helminthes among individuals in Igbo-Ora community. This study recorded a prevalence of 79 (28.8%) for STH infections with hookworm having the highest prevalence of 23% followed by *A. lumbricoides*, *S. stercolaris* and *T. trichiura,* 17.5%, 2.6% and 0.4% respectively. This was much lower than the prevalence recorded in Osun state (43.6%) [19], Honduras (72.5%) [20], Kenya (22%-71%) [21], and in Ibadan (35.9%) [22] but were higher than the prevalence reported from the study conducted in Ethiopia [23]. Such variations in the prevalence of helminthic infections are attributable to several risk factors, including low standard of living, poor personal hygiene, poor socioeconomic status, environmental sanitation, human behaviour, urbanisation, household clustering, occupation and climate. Moreover, Absence of public health education, source of drinking water, deworming history as well as absence of latrine can add to different positive cases [24].

In this study, the analysis showed that the prevalence of STHs infection was significantly associated with age and this outcome is similar with previous studies [25,26]. However, the disease prevalence varies among females (59.5%) and males (40.5%), but this is not significantly significant. This is in agreement with the study by Mekonnen et al. [26]. Besides, the prevalence in this study was statistically significant with the hand washing habit after using the toilet. In this study, Individuals who claimed never to wash their hands after using the toilet had prevalence 11.4% compare to those who regularly or occasionally washed their hands (Table 1). This is in agreement with Novianty et al. [27] but in contrast to Terefa et al. [28].

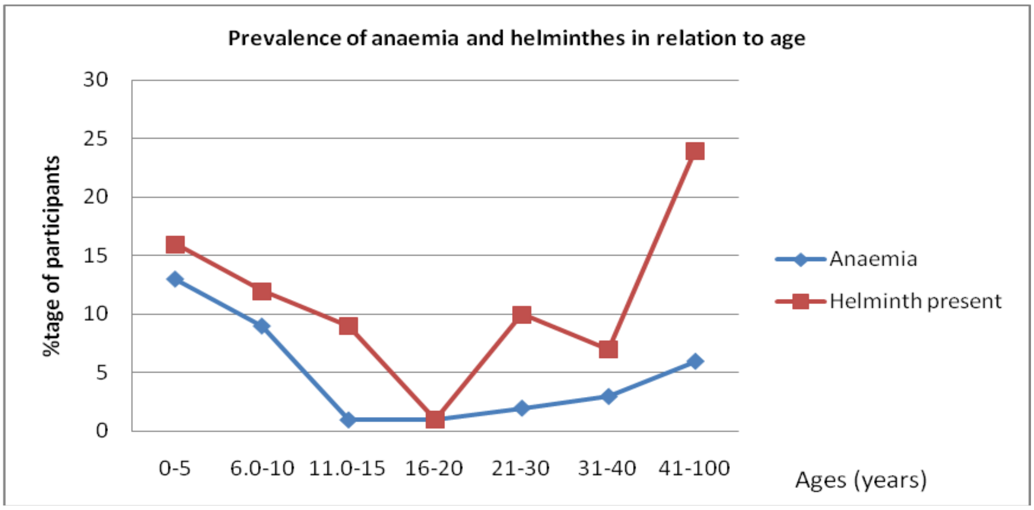

Fig. 1. The prevalence of anaemia and helminthes in relation to ages
(P=0.003)

Table 1. Socio-demographic characteristics of participants, their intestinal helminthes infection and PCV status

Characteristics		**Intestinal helminthes**		**PCV**		X^2	**P-value**	**O.R (95% CI)**
		All 274 N (%)	**Present N (%)**	**Anaemic (%)**	**Non-Anaemic (%)**			
Sex	Male	106 (38.7)	32 (40.5)	14 (40)	92 (38.5)	0.029	0.864	1.065(0.516,2.199)
	Female	168 (61.3)	47 (59.5)	21 (60)	147 (61.5)			
Level of education	Primary	111 (41.0)	32 (41.6)	22 (62.9)	89 (37.3)	13.632	**0.009**	
	Secondary	61 (22.5)	18 (23.4)	1 (2.9)	60 (25.1)			
	Tertiary	24 (8.9)	8 (10.4)	1 (2.9)	23 (9.6)			
	None	78 (28.5)	21 (26.6)	11 (31.4)	67 (28.0)			
Marital Status	Single	140 (51.1)	41 (51.9)	24 (68.6)	116 (48.5)	6.162	0.104	
	Married	116 (42.3)	30 (38.0)	11 (31.4)	105 (43.9)			
	Widow	14 (5.1)	7 (8.9)	0 (0)	14 (5.9)			
	Separated	4 (1.5)	1 (1.3)	0 (0)	4 (1.7)			
Access to toilet	Yes	135 (49.3)	32 (40.5)	16 (45.7)	119 (49.8)	0.619	0.376	0.835(0.410,1.702)
	No	139 (50.7)	47 (59.5)	19 (54.3)	120 (50.2)			
Types of toilet	Water closet	65 (23.7)	14 (17.9)	10 (28.6)	55 (23.0)	2.218	0.529	
	Pit latrine	69 (25.2)	17 (21.5)	6 (17.1)	63 (26.4)			
	Nylon	137 (50.0)	48 (60.8)	19 (54.3)	118 (49.4)			
	Bush around the house	3 (1.1)	0 (0.0)	0 (0.0)	3 (1.2)			
Hand washing before eating	Regularly	227 (82.8)	69 (87.3)	28 (80.0)	199 (83.3)	0.799	0.671	
	Sometimes	43 (15.7)	10 (12.7)	7 (20.0)	36 (15.1)			
	Never	4 (1.5)	0 (0.0)	0 (0.0)	4 (1.6)			
Hand washing after toileting	Regularly	191 (69.7)	54 (68.4)	16 (45.7)	175 (73.2)	15.066	**0.01**	
	Sometimes	57 (20.8)	16 (20.2)	16 (45.7)	41 (17.2)			
	Never	26 (9.5)	9 (11.4)	3 (8.6)	23 (9.6)			
Long finger nails	Yes	36 (13.1)	11 (13.9)	3 (8.6)	33 (13.8)	0.392	0.290	0.585(0.169,2.021)
	No	238 (86.1)	68 (86.1)	32 (91.4)	206 (86.2)			
Dirty nails	Yes	107 (39.1)	33 (41.8)	15 (42.9)	92 (38.5)	0.634	0.383	1.190(0.580,2.442)
	No	167 (60.9)	46 (58.2)	20 (57.1)	147 (61.5)			
Age	0-5	43 (15.7)	16 (20.3)	13 (37.1)	30 (12.6)	20.090	**0.03**	

Characteristics		**Intestinal helminthes**		**PCV**		X^2	**P-value**	**O.R (95% CI)**
		All 274 N (%)	**Present N (%)**	**Anaemic (%)**	**Non-Anaemic (%)**			
	6-10	46 (16.8)	12 (15.2)	9 (25.7)	37 (15.5)			
	11-15	33 (12.0)	9 (11.4)	1 (2.9)	32 (13.4)			
	16-20	12 (4.4)	1 (1.3)	1 (2.9)	11 (4.6)			
	21-30	33 (12.0)	10 (12.7)	2 (5.7)	31 (13.0)			
	31-40	27 (9.9)	7 (8.9)	3 (8.5)	24 (10.0)			
	>40	80 (29.2)	24 (30.4)	6 (17.1)	74 (31.0)			
Living together	1-3	122 (44.5)	32 (40.5)	12 (34.3)	110 (46.0)	5.546	0.236	
	4-6	142 (51.8)	44 (55.7)	22 (62.9)	120 (50.2)			
	7-9	5 (1.8)	2 (2.5)	0 (0.0)	5 (2.1)			
	10-12	3 (1.1)	1 (1.3)	0 (0.0)	3 (1.3)			
	>12	2 (0.7)	0 (0.0)	1 (0.4)	1 (0.4)			
Wear shoes at home	Yes	106 (38.7)	34 (43.0)	8 (22.9)	98 (41.0)	4.239	**0.028**	0.426(0.186,0.978)
	No	168 (61.3)	45 (57.0)	27 (77.1)	141 (59.0)			

P-values in bold are statistically significant (≤ 0.05)

Table 2. PCV of soil-transmitted helminthes infected participants

Variables		**Packed Cell Volume (PCV)**			**P - values**	**O.R (95% CI)**
	Parasite	**No (%)**	**Anaemic (%)**	**Non-anaemia (%)**		
STH infection					0.403	0.701(0.304,1.618)
Yes		79 (28.8)	8(10.1)	71(89.9)		
No		195 (71.2)	27(13.8)	168(86.2)		
Single helminthic infection	*Ascaris*	47 (17.2%)	6 (2.2%)	41 (15.0%)	0.999	0.999(0.390,2.561)
	Hookworm	63 (23.0%)	7 (2.6%)	56 (20.4%)	0.652	0.817(0.339,1.971)
	Trichiuris	1 (0.4%)	0 (0%)	1 (0.4%)	0.201	1.147(1.096,1.200)
	Strongyloides	7 (2.6%)	0 (0%)	7 (2.6%)	0.305	1.151(1.098,1.206)
Double helminthic infection	*Ascaris* + Hookworm	29 (10.6%)	4 (1.5%)	25 (9.1%)	0.889	9.145(4.878,18.269)
	Ascaris + *Strongyloides*	2 (0.7%)	0 (0%)	2 (0.7%)	0.788	1.973(0.371,10.491)
	Hookworm + *Strongyloides*	4 (1.5%)	0 (0%)	4 (1.5%)	0.763	4.701(1.023,21.591)
Triple helminthic infection	*Ascaris* + Hookworm + *Strongyloides*	2 (0.7%)	0 (0%)	2 (0.7%)	0.788	9.145(4.578,18.269)

Anaemia, a condition where low serum iron was identified [29], is one of the most widespread and common health condition afflicting individuals living in the tropics, it contributes to 23% of nutrition-related disability adjusted life years [1]. The consequences of anaemia are particularly severe for children and pregnant women [30,31]. In developing countries, although mild anaemia occurs commonly among the general population, moderately severe anaemia is most frequently seen in areas where infections can cause or exacerbate anaemia [32]. In this study, 12.8% was the overall prevalence of anaemia ranging from individuals with no infection to individuals with one/two infection(s). It should be noted that anaemia may be confounded by genetic, socio-economic, malaria and nutritional factors and that the effects of co-infection may vary by helminth transmission intensities. For instance, in this study there were people who harbor single and multiple infection(s) and yet were not anaemic whereas those people without infection were anaemic. Additionally, haemoglobinopathies [33], sickle cell disease [34] as well as HIV status [35] may be contributing factors to anaemia. It is therefore imperative to investigate these confounding factors that may be responsible for anaemia.

The associations of STH infections with anaemia in this study showed that infected participants with hookworm, A. lumbricoides and mixed infections were more likely to develop anaemia. These infections can directly or indirectly affect Hb level, which might have led to iron deficiency anaemia. For example, hookworms are blood feeders, hence they cause iron deficiency anaemia through the process of intestinal blood loss [36], Arinola et al. [37] also reported that hookworm infection was shown to cause mechanical laceration and enzymatic damage to the small intestine mucosa, which could cause blood loss in which millions of erythrocytes will be eliminated, and the iron could not be reused [38]. *A. lumbricoides* on the other hand is said to have little impact on iron deficiency [39], but it indirectly leads to anaemia through reduction of appetite and nutrition uptake in the intestine and obstructing the jejunum. While some previous studies observed significantly higher prevalence of anaemia only among hookworm-positive cases [25,40], others found both hookworm and ascaris to be associated with anaemia [14,16]. More so, other studies have documented that presence of hookworm and ascaris infections [18], ascaris and trichuris infections [25] as well as all of the three STHs [17] did not significantly associate with reduction in Hb values [41]. However, Ngui et al. [42] indicated blood loss due to *T. trichiura* infection which inhabited upper caecum and colon and the presence of *A. lumbricoides* in the duodenum and jejunum which could impair iron absorption demonstrated a significant association with iron status [11].

5. CONCLUSIONS

This study observed high prevalence of soil-transmitted helminthic infection and an association between the increase in the intensity of helminth infection and anaemia amongst individuals living in Igbo-Ora in Oyo State, Nigeria. There is therefore the need for safe sewage disposal systems, improve hygienic condition and health education as a way of curbing STHs. There is also a need for routine regular deworming to reduce the burden of soil transmitted helminthiasis.

CONSENT

Community consent was obtained from the traditional head of the communities and family heads. Individual signed consent was obtained from participants and parents or guardians of minors before any related procedure was carried out.

ETHICAL APPROVAL

The ethical clearance for the study was obtained from the University of Ibadan/University College Hospital Ethical Review Board (UI/EC/12/0267).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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