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Co-infections with *Schistosoma haematobium* and soil-transmitted helminths among school-aged children in Saki, Oyo State, Nigeria

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A cross-sectional study was conducted to determine the prevalence and intensity of soil-transmitted helminthiasis and urinary schistosomiasis and the co-infection of these intestinal helminths among school children in Saki town, Oyo state, Nigeria. Early morning stool samples were collected and a Kato-Katz thick smear technique was used to examine and count parasitic load.Urine samples were also collected and examined for *Schistosoma haematobium* ova using sedimentation technique. A pre-tested structured questionnaire was used to collect socio-demographic data, knowledge attitude and practice of individuals towards disease transmission and control. The study was conducted between August and October, 2011; out of 1537 children examined, 956 (62.2%) of the study participants were infected with one or more parasites. *Ascaris lumbricoides* was the most frequently observed soil-transmitted helminths with a prevalence of 39.6% followed by hookworm (18.3%) and *Trichuris trichiura* (12.9%). *S. haematobium* was detected in 32.7% of the school children. Multiple infections were pronounced with 54.3% having double infections and 17.7% having triple infections. The most common double infections were *Ascaris* and *S. haematobium* (28.9%), while the most common triple infections were *Ascaris*, hookworm and *S. haematobium* (10.6%). Prevalence and intensity of soil-transmitted helminth and *S. haematobium* was high and there is the need for urgent intervention programmes against these parasites in the study area.

Key words: Soil-transmitted helminthiasis, schistosomiasis, epidemiology, prevalence, *Schistosoma haematobium*, Nigeria.

INTRODUCTION

Soil-transmitted helminthic infections and schistosomiasis are among the widely spread chronic infections in the world. Globally, two billion individuals are infected with helminths, out of the majorities living in resource-poor settings (Noyer and Brandt, 1999; WHO, 2002). World Health Organization (WHO) estimated that 1.45 billion people are infected with *Ascaris lumbricoides*, 1.3 billion with hookworms and 1.05 billion with *Trichuris trichiura* (WHO, 2002). Schistosomiasis is endemic in 76 countries and also it is one of the public health concerns in developing countries. Approximately 90% of the estimated 207 million cases of human schistosomiasis living in sub-Saharan Africa (Hotez and Kamath, 2009), with *Schistosoma haematobium* the most widespread of

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the causative parasites (Steinmann et al., 2006). Within sub-Saharan Africa, Nigeria is the country with the most cases of human schistosomiasis, about 29 million in 2008 (Hotez and Kamath, 2009).

The occurrence of helminthic infections is associated with socio-economic, environmental and other factors like ignorance of simple health promoting factors and overcrowding, limited access to clean water, tropical climate and low altitude (WHO, 2002). School-aged children are one of the groups at high risk for intestinal parasitic infections. Factors like poor development of hygienic habits, immune system and over-crowding contributes for infection (Jarabo et al., 1995). School-aged children are the most severely affected by polyparasitism with intestinal parasites and *Schistosoma haematobium* and continue to bear the greatest health burdens due to the infections (Drake and Bundy, 2001). The adverse effects of intestinal parasites among children are diverse and alarming. Intestinal parasitic infections have detrimental effects on the survival, appetite, growth and physical fitness, school attendance and cognitive performance of school age children (Nokes and Bundy, 1993; Stephenson et al., 1993; de Silva et al., 1997; Hadidjaja et al., 1998).

In Nigeria, intestinal parasitic infections and urinary schistosomiasis continue to constitute a major public health and developmental challenge especially among school-aged children. Several reports illustrated that ascariasis is the most prevalent intestinal parasitic infection in different communities usually occurring together with trichuriasis. Intervention against soil-transmitted helminths (STH) and *Schistosoma* infections are based on regular anti-helminthic treatment, improved water supply, sanitation and health education (World Bank, 2003; Albonico et al., 2006). Polyparasitism of STH and *Schistosoma* infections have been reported from various epidemiological settings in Africa (Tchuem Tchuenté et al., 2003; Mazigo et al., 2010; Alemu et al., 2011).

Recent studies on intestinal helminthiases and schistosomiasis from Nigeria include those of Agbolade et al. (2007), Ugbomoiko and Ofoezie (2007) and Uneke et al. (2008), however, current prevalence of STH and schistosomiasis was not well addressed in different parts of Nigeria including our present study area. Therefore, the aim of this study was to determine the prevalence and intensity of soil-transmitted helminths and *S. haematobium* infection among school children in Saki town, Oyo State Southwest Nigeria. It is hoped that the findings of the investigation will contribute to effective disease control planning and implementation in the area of study and others in Nigeria and other tropical countries with similar heavy burdens of infectious disease.

MATERIALS AND METHODS

Study site

Saki is a town in Saki-West Local Government located on longitude 3°24´´ East and latitude 8°40´´ North with an altitude of 400 m above the sea level. The town has an estimated population of 388,255 (NPC, 2006). The climate of the area is typically tropical with a distinct dry (November-March) and rainy (April-October) seasons and a mean annual temperature of 27°C, a mean annual rainfall of 1100 mm and a mean relative humidity of 85% (Ayoade, 1982). The inhabitants are predominantly Yoruba speaking people with a mixture of different ethnic groups in Nigeria. Farming is the main occupation but some are traders, transport workers, artisans and civil servants. Although there are public taps available in the community; however, their rarity and spread mean that many of the inhabitants still depend on wells, boreholes as their primary sources of water.

Study design

The study was carried out between August and October 2011 among school children of ages 3 to 16 years from five schools selected randomly in Saki. The children were invited to participate in the study and were registered only after the purpose of the study had been explained to them and to their parents or guardians, and full informed consent obtained. To avoid any bias, all the available children attending the selected schools were examined; almost all were permanent residents and no mass anthelminthic had been conducted in the town before this study. Faecal and urine samples were obtained from 1537 pupils. The composition of the study population by school and sex is summarized in Table 1.

Ethical consideration

Ethical clearance for the study was given by the Ethical Committee of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile- Ife, Osun State, Nigeria. Prior to the commencement of the study, permission was sought and obtained from the Local Educational Authority of the Saki West Local Government Area.

Sample size determination

The sample size for this study was calculated using single proportion formula at 95% confidence interval (CI) level ($Z(1-\frac{1}{2}\alpha) = 1.96$), an expected prevalence of 50% since there was no study conducted regarding this topic in the area and 5% marginal error. Then, the sample size was calculated as $n = (Z(1-\frac{1}{2}\alpha)2P(1-P)/d^2$, where n = sample size, P = proportion problem in the study area, $Z(1-\frac{1}{2}\alpha)$ = CI of 95%, d = Marginal error to be tolerated. By adding 10% of contingency, 1537 pupils were included in our study.

Collection of stool samples and parasitological examination

A pre-labelled wide-mouthed screw capped plastic container with a clean wooden spatula for collection of faeces was given to each selected child with explanation on how to handle faecal samples. Urine samples were collected in pre-labelled 50 ml plastic screw-cap vials between 10.00 and 14.00 h. Stool and urine samples were collected from each pupil and transported to a laboratory at the Obafemi Awolowo University, Department of Zoology. Each urine sample was agitated to ensure adequate dispersal of eggs. 10 ml of urine were examined by microscopy for the presence of *S. haematobium* eggs. Stool samples were preserved in 10% formaldehyde and examined by a simple thick smear technique using a 41.7 mg Kato-Katz technique (WHO, 1994).

Table 1. Composition of the study population by age and gender.

Age (Years)	Male	%	Female	%	Total
3-4	100	48.5	106	51.5	206
5-6	137	39.6	209	60.4	346
7-8	175	43.5	227	56.5	402
9-10	137	48.8	144	51.2	281
11-12	81	46.6	93	53.4	174
13-14	43	57.3	32	42.7	75
15-16	32	60.4	21	39.6	53
Total	705	45.9	832	54.1	1537

Table 2. Prevalence and Intensity of Soil-transmitted helminths and *S. haematobium* in relation to gender.

Parasite	Male (n=705)	Female (n=832)	Both sexes	P-value
Schistosome				
Schistosoma haematobium	33.9(27.3±3.1)	31.7(22.1±2.2)	32.7(24.5±1.9)	ns (ns)
Soil-transmitted helminth				
Ascaris lumbricoides	39.9(2902.2±350.8)	39.4(2007.6±172..2)	39.6(2417.9±186.2)	ns (ns)
Hook worm	18.2(184.3±26.8)	18.5(200.2±27.5)	18.3(192.9±19.3)	ns (ns)
Trichuris trichiura	10.8(123.1±21.3)	14.7(149.4±27.5)	12.9(137.4±17.8)	0.02 (ns)

ns: Not significant at 5% level of significance; n: number examined.

Statistical analysis

Differences in the prevalence of each parasite infection among subgroups were determined using chi-squared values from the contingency tables. Variations in mean egg counts between dichotomous variables were assessed with the student-test and One-way analyses of variance (One way-ANOVA) for explanatory variables with more than two levels. All analyses were performed using SPSS for windows version 17.

RESULTS

Overall infection patterns

The composition of the study population by school and sex is summarized in Table 1. In total, 956 (62.2%) children harboured at least one parasitic infection. Four species of intestinal helminths, namely, *A. lumbricoides*, hookworm, *T. trichiura* and *S. haematobium* were recovered from the children investigated. The overall prevalence of *A. lumbricoides*, hookworm, *T. trichiura* and *S. haematobium* were 39.6, 18.3, 12.9 and 32.7%, respectively with corresponding intensities of 2417.9±186.2, 192.9±19.3, 137.4±17.8 eggs per gram of faeces and 24.5±1.9 eggs per 10 ml (Table 2).

Children from LA Primary School, Ape-Abe recorded the highest prevalence of intestinal helminth infection (70.4%) which was significantly higher than the prevalence of other schools (χ^2=17.942 df=4, p=0.001). The lowest prevalence of helminth infection (55.0%) was recorded among the children attending LA Primary School, Taba. There was no significant difference in the overall prevalence of infection between the genders (prevalence in males=61.3%; females=63.0%).

Infection patterns relative to gender and schools

Children attending LA Primary School, Isia had the highest prevalence of ascariasis (48.0%) while the lowest prevalence of 33.2% was recorded among children attending LA Primary School, Agolabi (Table 3). There was a significant difference in prevalence and intensity of *Ascaris* infection between males and females among the children attending primary school at Apa-Abe and Isia ($P < 0.05$). Also, differences in the prevalence reached significant levels for hookworm in both sexes among children attending LA Primary School, Agolabi. The prevalences and intensities of other infections were comparable within each school (Table 3).

The pattern of schistosome infection was such that the prevalence and intensity were higher in males than in females (although the differences were not statistically significant) among children attending schools at Isia, Sango and Taba, while reverse was the case for children attending schools at Apa-Abe and Agolabi (Table 3).

Age and gender patterns of infection

The age and gender distribution of intestinal helminth

Table 3. Prevalence and intensity of intestinal helminths in relation to gender and schools attended by the children in Saki Town, Osun State, Nigeria.

School	Gender	n	Prevalence % (Mean ± SEM)			
			Ascaris lumbricoides	Hook worm	*Trichuris trichiura*	*Schistosoma haematobium*
LA Pry School, Ape-abe	M	169	47.3 (7687.3±1357.2)	26.0 (396.5)	16.6 (245.2±64.2)	45.6(65.8±10.8)
	F	159	33.3 (3572.7±712.6)	23.3 (464.3±127.9)	20.1 (350.7±134.0)	46.5(51.8±7.7)
	P-value		0.01 (0.005)	ns (ns)	ns (ns)	ns (ns)
	Total	328	40.5 (5686.6±785.8)	24.7 (429.5±78.9)	18.3 (296.3±72.9)	43.9 (59.0±6.7)
LA Pry School, Agolabi	M	129	31.8 (1869±369.2)	7.8 (184.6±26.8)	7.0 (123.3±21.3)	25.6 (27.4±6.8)
	F	151	34.4 (200.5±27.5)	23.8 (200.5±27.5)	10.6 (149.4±27.6)	33.8(39.4±7.5)
	P-value		ns (ns)	0.001 (ns)	ns (ns)	ns (ns)
	Total	280	33.2 (1565.4±205.0)	16.4 (193.2±19.3)	8.9 (137.4±17.8)	30.0 (33.9±5.1)
LA Pry School, Isia	M	138	37.7 (1390.8±196.5)	18.8 (193.8±55.8)	6.5 (85.0±27.7)	29.0 (13.9±3.0)
	F	162	56.8 (2861.5±402.5)	14.8 (111.7±28.8)	13.0 (139.3±30.7)	23.5 (9.8±2.7)
	P-value		0.001 (0.001)	ns (ns)	ns (ns)	ns (ns)
	Total	300	48.0 (2184.9±238.8)	16.7 (149.5±30.0)	10.0 (114.3±20.9)	26.0 (11.7±2.0)
LA Pry School, Sango	M	117	40.2 (1342.4±221.3)	15.4 (67.3±16.6)	11.1 (75.5±30.3)	35.0 (5.9±0.9)
	F	192	42.2 (1651.6±183.0)	18.2 (110.3±22.3)	17.7 (87.5±15.5)	31.8 (5.5±0.7)
	P-value		ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	309	41.4 (1534.5±141.3)	17.2 (93.9±15.2)	15.2 (83.0±14.9)	33.0 (5.6±0.5)
LA Pry School, Taba	M	152	40.1 (1081.7±169.6)	19.7 (107.0±20.6)	11.2 (105.4±52.5)	31.6 (13.0±2.1)
	F	168	29.8 (740.8±119.4)	13.1 (87.4±19.2)	11.3 (65.3±16.6)	28.0 (10.2±2.4)
	P-value		ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	320	34.7 (902.8±102.4)	16.2 (96.7±14.0)	11.2 (84.4±26.4)	29.7 (11.5±1.6)

ns: Not significant at 5% level of significance; n: number examined.

infections in the schools investigated are presented in Table 4. Prevalence values of the four observed parasites, that is, *A. lumbricoides* (23.3 to 48.8%), hookworm (12.6 to 24.0%), *T. trichiura* (5.7 to 16.7%) and *S. haematobium* (22.6 to 39.3%), were more of age than gender dependent. While gender-dependent distribution of infections was comparable and followed no clear cut patterns in all age groups except those in 9 to 10 years old and 13 to 14 years for *T. trichiura* and hookworm, respectively, and age dependent patterns were pronounced. For both *Ascaris* and hookworm infections, the prevalence increased from the youngest age-group to a peak in the 7 to 8 years old for *Ascaris* and 13 to 14y ears for hookworm. While for *T. trichiura* and *S. haematobium*, the lowest prevalence of infection was recorded in the oldest age group (15 to 16 years old). There was no definite pattern of intensity of infection. A significant gender-dependent intensity pattern was recorded for hookworm and *T. trichiura* infections among 13 to 14 years old and 15 to 16 years old, respectively ($P < 0.05$).

Multiple infection patterns

More than half (62.2%) of children were infected with at least one of the four parasites, while 35.5% had single infection, 54.3% had double infections, 17.7% had triple infections and 3.1% had four parasites. From the infected children, 57.0, 87.2, 28.5 and 4.9% harboured single, double, triple and four parasites, respectively. The most common double infection was the *Ascaris* and *S. haematobium* combination which accounted for 28.9%. This was followed by *Ascaris*/hookworm (16.3%) and *Ascaris*/*T. trichiura* (12.3%). The least occurring combination for hookworm and *T. trichiura* accounted for 7.9%. Of 272 (28.5%) observed triple infections, *Ascaris*, hookworm and *S. haematobium* combination accounted for 10.6%. Each of the combination of *T. trichiura*, hookworm and *S. haematobium*; and *Ascaris*, *T. trichiura* and hookworm accounted for 4.7%. The only four parasite species infection of *Ascaris*, hookworm, *T. trichiura* and *S. haematobium* combination accounted for 4.9%. The prevalence of dual infections did not differ

Table 4. Prevalence and intensity of intestinal helminths in relation to gender and age of school children in Saki town, Oyo State, Nigeria.

Age group (years)	Gender	n	Prevalence % (Mean ± SEM)			
			Ascaris lumbricoides	Hook worm	*Trichuris trichiura*	*Schistosoma haematobium*
3-4	M	100	21.0(1877.3±628.6)	9.0 (135.1±50.5)	8.0 (27.6±11.2)	28.0 (23.7±6.6)
	F	106	25.5(1628.3±464.3)	16.0 (159.4±45.8)	5.7 (52.8±21.3)	18.9 (12.4±4.3)
	P-value		ns(ns)	ns (ns)	ns (ns)	ns (ns)
	Total	206	23.3(1749.2±410.5)	12.6 (147.6±33.9)	6.8 (40.6±12.2)	23.3 (17.9±3.9)
5-6	M	137	40.1 (4569.4±1227.6)	19.7 (178.2±40.7)	12.4 (166.3±51.7)	38.7 (29.2±6.7)
	F	209	36.4 (2117.3±464.3)	12.4 (104.7±22.7)	13.9 (94.6±21.3)	27.8 (16.4±3.3)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	346	37.9 (3088.2±563.8)	15.3 (133.8±21.2)	13.3(123.0±24.2)	32.1 (21.5±3.3)
7-8	M	175	49.1 (2837.4±574.2)	17.1 (194.5±80.7)	14.9 (175.9±55.5)	36.6 (32.0±6.0)
	F	227	48.5 (2360.5±303.6)	23.3 (319.4±86.0)	18.1 (228.6±86.8)	41.4 (33.9±5.3)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	402	48.8 (2568.1±302.9)	20.6 (265.1±60.0)	16.7 (205.7±54.6)	39.3 (33.1±4.0)
9-10	M	137	48.2 (3007.0±868.2)	21.2 (227.0±58.1)	8.8 (98.5±46.9)	38.0 (34.5±9.8)
	F	144	43.1 (1934.4±242.3)	20.8 (182.8±43.4)	20.1 (182.7±41.1)	27.1 (19.9±5.6)
	P-value		ns(ns)	ns (ns)	0.02 (ns)	ns (ns)
	Total	281	45.6 (2457.3±441.4)	21.0 (204.4±36.0)	14.6 (141.6±31.1)	32.4 (27.1±5.6)
11-12	M	81	33.3 (2039.1±535.3)	24.7 (191.3±62.3)	8.6 (132.4±58.9)	30.9 (17.8±7.4)
	F	93	32.3 (1440.4±287.3)	15.1 (100.4±30.1)	14.0 (120.5±39.8)	41.9 (21.3±5.5)
	P-value		Ns (ns)	ns (ns)	ns (ns)	ns (ns)
	Total	174	32.8 (1719.1±292.6)	19.5 (142.7±33.3)	11.5 (126.1±34.6)	36.8 (19.7±4.5)
13-14	M	43	44.2 (2147.3±1028.4)	18.6 (136.7±55.7)	9.3 (62.0±32.1)	23.3 (10.5±4.1)
	F	32	53.1 (2904.9±1052.5)	31.2 (459.8±194.3)	9.4 (13.5±13.5)	28.1 (20.9±11.1)
	P-value		ns(ns)	0.002 (ns)	ns (ns)	ns (ns)
	Total	75	48.0 (2470.6±737.6)	24.0 (274.6±90.0)	9.3 (158.7±107.8)	25.3 (15.0±5.2)
15-16	M	32	21.9 (2071.4±805.8)	15.6 (171.1±87.4)	6.2 (112.5±112.5)	21.9 (20.1±11.1)
	F	21	28.6 (662.9±307.1)	19.0 (234.5±114.5)	4.8 (13.5±13.5)	23.8 (22.2±20.5)
	P-value		ns (ns)	ns (ns)	ns (0.035)	ns (ns)
	Total	53	24.5 (1513.3±507.2)	17.0 (196.5±69.0)	5.7 (73.3±68.0)	22.6 (20.9±10.4)

ns: Not significant at 5% level of significance; n: number examined.

significantly by gender ($p>0.05$). Male children had the highest prevalence of triple infections (29.6%) compared to 27.4% of the females.

DISCUSSION

The findings from the current study confirm that Saki town in Southwest Nigeria is highly endemic for urinary schistosomiasis and soil-transmitted helminthiasis (STH). Although intestinal helminth parasites particularly STH and schistosomes infections are neglected diseases that occur predominantly in rural areas, the deplorable social and environmental conditions as well as inadequate basic amenities in the urban poor communities and the so-called peri-urban areas of developing countries including Nigeria are ideal for the persistence of these parasites (Drake and Bundy, 2001; WHO, 2002).

From the study, about two out of every three school children in the town were infected with one or more parasitic infections (ascariasis, hookworm, trichuriasis and schistosomiasis). In terms of prevalence and intensity, ascariasis appears the most important public health problem in the area of study. Its overall prevalence

(39.6%) is more than double the national average (18%) (Crompton et al., 1989). However, while the patterns of infection of hookworm, trichuriasis and schistosomiasis suggest a lesser public health importance, in reality they have a serious public health implication for the community. For instance, an overall prevalence of 32.7% for *S. haematobium* infection is more than 2.5 times for the national average (13.1%) (Ofoezie, 2002).

A cross-sectional survey conducted on STH among pre-school and school-aged children in Ile-Ife, Osun State, Nigeria (Sowemimo and Asaolu, 2011) reported that the overall prevalence of infection was 34.4% which is lower than the prevalence of 51.2% recorded in this study. Other study conducted on intestinal helminthic infections in school-aged children in Ilie in Olorunda Local Government Area of Osun State, Southwest Nigeria (Adefioye et al., 2011) reported overall prevalence of 52.0% for STH infection which is comparable to 51.2% recorded in this study. *A. lumbricoides* was reported to be the most prevalent parasite (36.2%) followed by hookworms (10.5%). This is similar to the result obtained in this study where *Ascaris* (39.6%) was the most frequently encountered parasite. The differences in prevalence among the different communities might be associated with environmental sanitation, water supply and socioeconomic status of households, although this needs to be verified in more extensive follow up studies. Other factors related to macro- and micro-environment, time of study, method of examination, etc., do also contribute to the differences in the prevalence and distribution of these intestinal helminths. No significant difference was obtained in infection rates between the genders of schoolchildren under consideration. This denotes a similar exposure risk to infection by these helminths and it is in agreement with previous study from Ethiopia (Alemu et al., 2011).

The high prevalence of STH and *S. haematobium* infections recorded among school children of the study area raises a serious concern. It signifies the fact that children are the highest risk groups in the community and serve as sources of infection and transmission. These parasites are well known to be associated with lowered work capacity and productivity both in children and adults and increased susceptibility to other infections. Helminths also impair the mental and physical development of children (Jardiam-Batelho et al., 2008). Again majority of wormy children are not only infected with one species of worm, but they also tend to harbour the heaviest burdens and almost two-thirds of children were infected with one or more helminths.

In this study, STH and *S. haematobium* were co-endemic in the study area. Previous studies have clearly documented the relationship between intestinal helminth infections, polyparasitism and cognitive functions, growth and malnutrition among school children (Partnership for Child Development, 2002; Jardian-Batelhoet al., 2008). Children with multiple parasitic infections especially those with heavy infections intensity tend to experience more severe cognitive outcomes and other health problems such as malnutrition than children with only one helminth infection (Sakti et al., 1999; Jardian-Batelho et al., 2008). Studies conducted throughout Africa and China indicate that most parasitic infections do not occur singly, but as co-infections (Raso et al., 2004; Ugbomoiko and Ofoezie, 2007; Steinmann et al., 2008). Hence, co-infections of soil-transmitted helminths and *S. haeamtobium* could partly be attributed to the co-endemicity of these intestinal helminths in the study area and poor sanitations.

In this study, the most common double infection was the combination of *Ascaris* and *S. haematobium* with a prevalence of 28.9%. This is in contrast with the observation of Agbolade et al. (2007) who reported the combination of *Ascaris* and hookworm to be the most common double infection. Agbolade et al. (2007) also reported that the most common triple infections were the combination of *Ascaris*, hookworms and *Trichuris*. This is in contrast with the findings in this study where the combination of *S. haematobium*, *Ascaris* and hookworm were the most common triple infection. This finding indicates that *S. haematobium* is more endemic than *T. trichiura* in the area of study.

In conclusion, the prevalences of STH and *S. haematobium* were quite high and they account for major health problem in the study area. There is the need for a control measures such as deworming programmes coupled with provision of improved water supplies and sanitation to be put in place in order to bring about reduction in the prevalence level of both diseases. There is also an urgent need for concerted efforts towards ensuring adequate control of intestinal helminthiasis and schistosomiasis in Saki town, Oyo State by the authority concerned and the community at large.

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Conflict of interest

The author declared he has no conflict of interest.

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