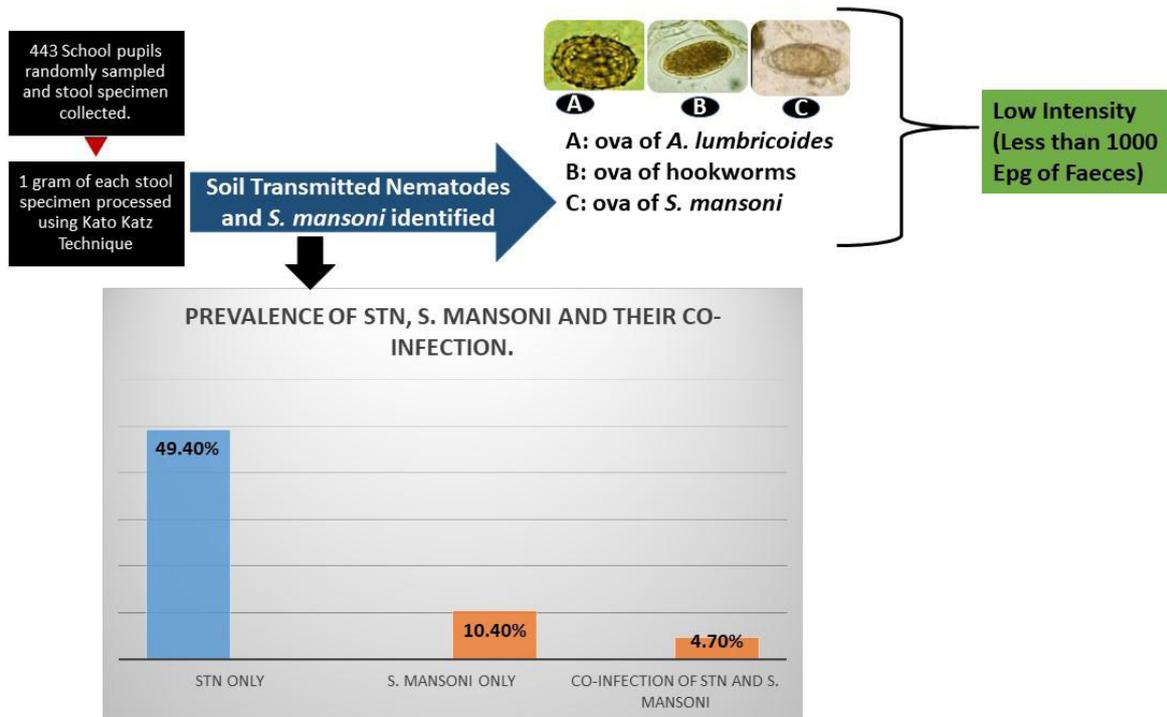


Concurrent Intestinal Schistosomiasis and Soil-Transmitted Nematode Infections in Primary School Children, Benue State North Central Nigeria

R.T. Ikpe, O.O. Taiwo, L.D. Edungbola, A. Nyamngee and E.C. Amaechi



Highlights

- Coinfection of STN and *S. mansoni* was observed in the study
- Deworming programme and health education were lacking in the study area
- Ignorance and poverty were found to be major contributory factors to the increasing rate of the infection.

RESEARCH ARTICLE

Concurrent Intestinal Schistosomiasis and Soil-Transmitted Nematode Infections in Primary School Children, Benue State North Central Nigeria

R.T. Ikpe¹, O.O. Taiwo¹, L.D. Edungbola¹, A. Nyamngee¹ and E.C. Amaechi^{2,*}

¹Department of Medical Microbiology and Parasitology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Ilorin, Ilorin, Nigeria.

²Department of Zoology, Faculty of Life Sciences, University of Ilorin, Ilorin, Nigeria.

Received: 12/07/2019; Accepted: 30/06/2020

Abstract: Intestinal schistosomiasis and soil-transmitted nematode (STN) infections are among the major public health problems globally, especially in sub-Saharan Africa, Nigeria inclusive. School-aged children carry the highest burden of both infections with significant morbidities in Nigeria. Data on co-endemicity of these infections especially amongst internally displaced persons (IDP) is scarce. To fill this gap, we performed a school-based cross sectional study in three rural communities in North Central Nigeria in which internally displaced persons co-existed. The study aimed to determine the co-endemicity of *Schistosoma mansoni* and soil-transmitted nematodes infections among primary school children in six primary schools in Guma Local Government area, Benue State, north central Nigeria. Four hundred and forty three primary school pupils were included in the study between January and March 2018 by using simple random technique. A single stool specimen was collected from each participant, and a portion about 1 gram of each specimen was processed by Kato Katz technique. Of the 443 pupils examined, 219(49.4%) were found positive for the characteristic egg of at least one STN. Of the total children, 46(10.4%) had *Schistosoma mansoni* infection. Co-infection of at least one STN and *S.mansoni* occurred in 21(4.7%) of the 443 pupils sampled. Co-infection of *Schistosoma mansoni* and *Ascaris lumbricoides* was observed in 11(23.9%) while *Schistosoma mansoni* and hookworm occurred in 10(21.7%) of the children. There was higher intensity in the total egg count among the males (51.99±60.67) than the females (48.42±59.89) in both genders. The intensity of egg count was highest in age group 7-9 years (55.27±65.03). The lowest intensity was observed in age group 13-15 (41.47±46.08). Integrated interventions such as health education, school feeding program for improved nutrition and mass chemotherapy is advocated.

Keywords: Soil-transmitted nematodes, school children, co-infection, intestinal schistosomiasis, Nigeria.

INTRODUCTION

Soil-transmitted nematodes (STN) and *Schistosoma mansoni* infections are among the leading causes of global health problems especially in the poorest and most deprived communities of sub Saharan Africa (Aribodor *et al.*, 2018). Schistosomiasis is second to malaria as the most devastating disease in the world and remains the most prevalent parasitic

infection affecting about 77 developing countries of the world. It is estimated that over 240 million individuals are infected, with about 700 million people worldwide at serious risk of infection (Hotez *et al.*, 2012). It is estimated that 1.5 billion are reported to be infected with soil transmitted nematodes (STNs) all over the world. Nigeria harbors the highest number of cases with schistosomiasis in Sub Saharan Africa with about 29 million infected people (Adenowo *et al.*, 2015). Soil transmitted nematode infections are highly endemic in Nigeria with prevailing prevalence's amongst the different geo-political and epidemiological settings (Amali *et al.*, 2013; Nzeako *et al.*, 2013). STN and *S. mansoni* infections are often co-endemic and co-infection is a common place especially in endemic communities of Sub Saharan Africa (Aribodor *et al.*, 2018). Reports from various researchers have confirmed that school-aged children in the range of 5-20 years of age are most infected with both schistosomiasis and soil transmitted nematode infections. Poor personal and environmental hygiene coupled with frequent water contact behavior of school aged children are reported as risk factors that render them most vulnerable to both STN and *S. mansoni* infections. Chronic infection with intestinal schistosomiasis and STNs causes impaired physical, intellectual and cognitive developments in children (Ademowo *et al.*, 2015). Following the World Health Assembly resolution of 2001 to control schistosomiasis and soil-transmitted nematode infections amongst school aged children, governments and international organizations have been making concerted efforts at prevention and control of these infections in many endemic countries. Proper identification of communities where co-infections prevail will assist proper implementation of control programs. For proper control of schistosomiasis and STHs, especially for groups at risk, World Health Organization (WHO) recommends the use of Praziquantel and aldendazole/mebendazole. However in Nigeria, the insurgent activities of Boko Haram in the past six years have forced over a million people to flee their homes. Furthermore, inter-communal clashes resulting from ethno-religious disputes, tensions between Fulani herdsmen and farmers have resulted in over 700,000 people being displaced from the North Central region of Nigeria (Eme *et al.*, 2016). There was no deworming programme targeted at the prevention and control of these intestinal helminth infections in the study area. The low uptake of preventive chemotherapy among school aged children in

*Corresponding Author's Email: ebubeamechi@yahoo.com

 <https://orcid.org/0000-0002-0032-8837>



the study area has serious consequence on the prevalence and intensity of the infections. Data on co-infection of STNs and *S.mansoni* infections among school children in the study area is lacking, therefore the current study was aimed at determining co-infection of STNs and *S. mansoni* infections among school children. The result of the study will be useful to policy makers involved in control of the disease to target such population in order to effectively control the disease.

MATERIALS AND METHODS

Study area

The study was conducted in three communities (Abinsti, Ukpiani and Daudu) in Guma Local Government Area of Benue State. It is located on 7°20'N and 8 °45'E in the North Central region of Nigeria. The population of Guma Local Government Areas was 191, 599 (NPC, 2006). The major ethnic group in Guma Local Government Areas is Tiv. Others include: Jukun; Kabawa; Alogo; Idoma; Hausa; Egbira; Ibo and other ethnic groups in Nigeria. The vegetation is guinea savanna, which is characterized by trees, shrubs and grass. Climate is tropical humid. Like other parts of the State, Guma Local Government Area experiences two seasons, rainy and dry season. The rainy season lasts from April to October, with annual rainfall of 100-200mm. The dry season begins from November and ends in March. Temperature fluctuates between 21-37°C throughout the year. The main occupation in the area is farming. Others include: fishing, trading and civil service. There are community health care centres, primary and secondary schools and electricity in Guma, however, the Local Government Areas, lack piped borne water and good roads. Most homes get water from nearby streams and wells. The internally displaced persons have been in the area for about six years. The general sanitation status of the area under study is poor.

Most homes do not have toilets and proper ventilation. Dumpsites are located close to human habitation. The communities all house internally displaced persons making cooking a general thing. The hygiene conditions of the area are unfavorable.

Ethical consideration

The protocol used in this study was approved by the Ethical Review Committee of the University of Ilorin, Nigeria (UERC/ASN/2017/1090). Prior to the study, informed consent of parents and guardians of the school children was obtained after a detailed explanation of the study protocol. Following the ethical review regulation, patients who were found to be positive for the tested infections were given treatment.

Study population and sample size

This study was conducted between January and March, 2018. A total of six primary schools; two from each Abinsti, Daudu and Ukpiani communities were selected. All the schools in the area were coded with even and odd numbers.

It was then balloted and schools with odd numbers were chosen for the study. The schools were from communities where internally displaced persons camp existed.

The sample size used in the study is determined using the method of Thrushfield, 1997.

$$n = \frac{z^2 pq}{d^2}$$

Where

n = sample size

p = expected prevalence = 50% (no known prevalence).

q = 1 – p

d = desired absolute precision of 5% (0.05)

Z= 1.96

$$n = \frac{1.96^2 \times 0.5 (1-0.5)}{0.05^2}$$

n = 384.

The minimum sample size (n) was calculated to be 384. Given the inclusion of 443 children for the study satisfied the minimum requirement. A registration list of pupils (aged 5-16years) from each selected school was obtained. Subsequently, a simple random sampling method was used to select pupils from each school and class. When a selected pupil was absent, a student before or after this student was selected as a replacement.

Sample Collection

Sample collection was done during school hours. From each of the selected schools, fifteen or more pupils were selected from each class by simple random sampling technique. Each pupil was provided with a clean labeled plastic universal bottle with screw cap. The children were instructed to pass faeces the following morning on a sheet of paper or leaf and to use a stick to transfer enough of the faeces to fill half of the bottle and then to cover the bottle tightly with screw cap. Faecal samples were collected the same day in the morning and fixed immediately by adding 10mls of 10% formalin and mixed thoroughly with a wooden applicator stick (Salawu *et al.*, 2014). Specimens collected for each class were put in different bags for easy transportation. The samples were analyzed immediately at the laboratory.

Laboratory examination of samples

The Kato-Katz technique was used in preparing the stool samples. The slide was placed under a compound microscope and examined in a systematic zigzag pattern. The number and each characteristic egg or larvae of each species was recorded appropriately against the sample number. The parasites were identified using an Atlas by Ash and Orihel (2007). Each distinctive parasite egg or larvae was counted, using a tally hand counter. The intensity of

each helminthes observed was determined by multiplying the number of eggs of the species counted by 24 to obtain the number of eggs per gram of faeces (Epg) (WHO, 1991).

Data analysis

Data such as age, sex and other socio-economic characteristics obtained from questionnaires and laboratory analysis was entered into Microsoft excel and analysed using SPSS version 20.00 California, USA. Statistical analysis was carried out at the significance level of $P=0.05$. Chi square was used to compare the prevalence by age, sex and school.

RESULTS

Over all prevalence of soil transmitted nematode infections

A total of 443 stool specimens were collected in six primary schools in Guma Local Government Areas of Benue State and examined between January and March, 2018. The pupils sampled were between the age of 4-18 years. Of the 443 pupils whose stool specimen were examined, 271 (61.2%)

were males while 172 (38.8%) were females. Of the 443 pupils examined, 219 (49.4%) were positive for the characteristic egg of at least one STN (*Ascaris lumbricoides* and Hookworms) (Table 1).

Prevalence of Soil Transmitted Nematode infections by Gender

Of the 271 males examined 141 (52.0 %) were positive while 78 (45.3%) of the 172 females were also positive. There was no significantly difference in prevalence among males and females ($p=0.005$) (Table 2).

Overall prevalence of *schistosoma mansoni* infection

In the course of stool examination, 46 (10.4%) of the pupils were found to be positive for the characteristic egg of *S. mansoni* as shown in Table 3. There was higher prevalence in females (11.6 %) than in males (9.6 %). (Table 4). There was no significant difference in prevalence between both sexes ($p=0.006$). Community Daudu had the highest prevalence (15.6%) while Liberty Foundation Ukpiani had the least prevalence (3.4 %). (Table 3).

Table 1: Over all prevalence of STN infections among the 443 pupils examined.

Schools	No. Examined	No. (%) Infected
St. Francis, Ukpiani	97	47 (48.5)
LGEA, Abinsti	78	45 (57.7)
Divine Dove, Abinsti	74	36 (48.6)
Lobethas, Daudu	72	30 (41.7)
Community, Daudu	64	31 (48.4)
Liberty Foundation, Ukpiani	58	30 (51.7)
Total	443	219 (49.4)

Df=5, $X^2=5.5$, $P>0.05$

Table 2: Prevalence of Soil Transmitted Nematode infections by Gender.

Gender	No. Examined	No. (%) Infected
Males	271	141 (52.0)
Females	172	78 (45.3)
Total	443	219(49.4)

Df=1, $X^2=3.6$, $P>0.05$

Table 3: Overall Prevalence of *S. mansoni* by School.

Schools where stool samples were collected	No. Examined	No. (%) Infected
St. Francis, Ukpiani	97	9(9.3)
LGEA, Abinsti	78	9(6.5)
Divine Dove, Abinsti	74	7(9.5)
Lobethas, Daudu	72	9(12.5)
Community, Daudu	64	10(15.6)
Liberty Foundation, Ukpiani	58	2(3.4)
Total	443	46(10.4)

Df=1, $X^2=2.8$, $P>0.05$

Table 4: Prevalence of *S. mansoni* infection by Gender.

Gender	No. Examined	No. (%) Infected
Males	271	26 (9.6)
Females	172	20 (11.6)
Total	443	46(10.4)

Table 5: Prevalence of *S. mansoni* infection and co-infections with STN by Gender.

<i>S. mansoni</i> and STN Infections	Males No. (%) Infected	Females No. (%) Infected	Total No. (%) Infected
<i>S. mansoni</i>	13 (50.0)	12 (60.0)	25 (54.3)
<i>S. mansoni</i> and <i>A. lumbricoides</i>	6 (23.1)	5 (25.0)	11(23.9)
<i>S. mansoni</i> and Hookworms	7 (26.9)	3 (15.0)	10(21.7)
Total	26 (56.5)	20 (43.5)	46 (100.0)

Table 6: Prevalence of *S. mansoni* infection and co-infections with STN by School.

<i>Schistosoma mansoni</i> and STN Infections	St. Francis, Ukpiam. No. (%) Infected	LGEA, Abinsti. No. (%) Infected	Divine Dove, Abinsti. No. (%) Infected	Lobethas, Daudu. No. (%) Infected	Community, Daudu. No. (%) Infected	Liberty Foundation, Ukpiam. No. (%) Infected	Total. No. (%) Infected
<i>S. mansoni</i>	6 (66.7)	1 (11.1)	4 (57.1)	6 (66.7)	7 (70.0)	1 (50.0)	25 (54.3)
<i>S. mansoni</i> and <i>A. lumbricoides</i>	2 (22.2)	5 (55.6)	2 (28.6)	2 (22.2)	0 (0.0)	0 (0.0)	11 (23.9)
<i>S. mansoni</i> and Hookworms	1 (11.1)	3 (33.3)	1 (14.3)	1 (11.1)	3 (30.0)	1 (50.0)	10 (21.7)
Total	9 (19.6)	9 (19.6)	7 (15.2)	9 (19.6)	10 (21.7)	2 (4.3)	46 (100.0)

D.f=5, X²=7.9, p>0.05**Table 7:** Intensity of Soil Helminthiasis and Intestinal Schistosomiasis by Gender.

Gender	No. infected	<i>Ascaris lumbricoides</i> egg count (Mean Epg)	Hook worms egg count (Mean Epg)	<i>Schistosoma mansoni</i> egg count (Mean Epg)	Total Egg count (Mean Epg)
Male	155	7200 (26.57±46.92)	4728 (17.45±30.35)	1176 (4.34±12.76)	13104 (51.99±60.67)
Female	99	3698 (21.49±37.89)	2760 (16.05±28.91)	888 (5.16±13.1)1)	7346 (48.42±59.89)
Total	254	10898 (24.60±43.66)	7488 (16.90±29.77)	2064 (4.66±12.78)	20450 50.60±60.33

Prevalence of *S. mansoni* infection and co-infections with STN

A total of 46 pupils (10.4%) of the 443 pupils were infected with *S. mansoni*, out of which 25 (54.3%) had infection of *S. mansoni* only. Co-infections was found in 21 (4.7%) of the 443 pupils. Co-infection with *A. lumbricoides* was seen in 11 (23.9%) pupils while 10 (21.7) had co-infections with hookworms (Table 5) There was no significant difference in prevalence of schistosomiasis and soil transmitted nematode infections. (P=0.006)

Prevalence of *S. mansoni* infection and co-infections with STN by School

Based on the schools examined, Community Daudu had the highest prevalence of *S. mansoni* infections with 10 (21.7%) pupils infected. The least prevalence was seen in Liberty Foundation Primary school where 2 pupils (4.3%) were infected. There was no significant difference however. (P=0.126). (Table 6).

Table 8: Intensity of Soil Transmitted Nematode and *S. mansoni* Infections by Age group (N=219).

Age group	No. infected	<i>Ascaris lumbricoides</i>	Hook worms	<i>Schistosoma mansoni</i>	Total
		egg count (Mean Epg)	egg count (Mean Epg)	egg count (Mean Epg)	egg count (Mean Epg)
4-6	22	840(24.4±43.2)	720 (20.57±33.51)	120 (3.43±10.39)	1680 (54.17±73.48)
7-9	58	3624(27.45±49.1)	2544 (19.27±32.68)	672 (5.09±13.60)	6840 (55.27±65.03)
10-12	74	3960 (28.49±46.64)	1944 (3.99±27.55)	624 (4.49±11.761)	6528 (53.01±63.03)
13-15	56	1944(17.0±33.29)	1872 (16.42±27.53)	528 (4.63±13.87)	4344 (41.47±46.08)
16-18	9	530 (22.96±35.88)	408 (17.74±30.87)	120 (5.22±12.44)	1058 (49.04±52.92)
Total	219	10898(24.60±43.66)	7488 (16.90±29.77)	2064 (4.66±12.78)	20450 50.60±60.33

Intensity of Soil Transmitted Nematode and *S. mansoni* Infections by Gender

There was a higher intensity among the males (51.99±60.67) than the females (48.42±59.89) in both gender. *A. lumbricoides* had the highest intensity while *S. mansoni* had the least. There is no significant difference in the intensity of infection between both gender ($p=0.005$) (Table 7).

Intensity of Soil Transmitted Nematode and *S. mansoni* Infections by Age group

The intensity of egg count was highest in age group 7-9 years (55.27±65.03). The lowest intensity was observed in age group 13-15 (41.47±46.08). There was no significant difference in the intensity of infection between the age groups ($p=0.005$) (Table 8).

DISCUSSION

Our study represents a systematic school-based study on co-infection of soil-transmitted nematode infections and intestinal schistosomiasis infections in Nigeria. This study reveals the existence of intestinal schistosomiasis and soil-transmitted nematode co-infections among pupils in the study area. Co-endemicity of infections is an indication of the presence of conditions that favour co-existence of both infections. The high prevalence of STN reported in this study (49.4%) is similar to results obtained by other researchers in Nigeria. Aribodor *et al.*, 2018 recorded a prevalence of 49.6% among pupils in Enugu State, south eastern Nigeria. Salawu and Ughele, 2015 reported a prevalence of 59.2% in Ife East Local Government Area of Osun State. A much higher prevalence of 75.7% was reported by Amaechi *et al.*, 2013 among school children in rural communities of Abia State. However, lower prevalence have been reported by Bolaji *et al.*, 2017 in Ifelodun LGA of Kwara State. The high prevalence of STN reported in this study could be linked to poor environmental conditions, lack of portable water and poor personal hygiene practices among the pupils (Personal communication as observed by the authors).

There was higher prevalence (52.0%) among the males than the females (45.3%) while prevalence was higher in females (11.6%) than males (9.6%) for *S. mansoni*, although the difference was not statistically significant. The higher prevalence among the males in this study is

similar to the reports of Uneke *et al.*, (2007) who reported 18.0% prevalence for males' and 15.5% prevalence for females in South-Eastern Nigeria. On the other hand, the observation that males were more infected than females is not in line with a study carried out in Kwara State (Bolaji *et al.*, 2017). Findings in this study showed that the prevalence of all the soil transmitted nematode and *S. mansoni* infections encountered is not sex dependent. This is consistent with other studies carried out in a similar setting (Hassan *et al.*, 2017). This may be as a result of the fact that both sexes in the study areas have the same level of exposure to infections. The intensity of infection was similar in the males (51.99±60.67) and in the female pupils (48.42±59.89). The similarity in intensity of infection between sexes is mainly associated with the fact that both sexes have the same level of exposure to *S. mansoni*. It was found out that while males had more frequent water contact activity through swimming, the females were equally exposed through domestic chores such as fetching water and washing (Personal observation). However, the higher prevalence reported in male children was an indication that they engaged in special activities such as playing with contaminated soils which could have predisposed them to infection. These activities are carried out in the study area. This is confirmed by studies carried out in parts of Africa (Sangho *et al.*, 2004; Nagi *et al.*, 2014; Alebie *et al.*, 2014; Linsuke *et al.*, 2014). However, the results differ from several studies where male predominance was reported in Yemen (Sady *et al.*, 2013), Ethiopia (Assefa *et al.*, 2013) and Ghana (Anto *et al.*, 2014).

Amongst the STN infections encountered, *A. lumbricoides* was found to be the highest. This could be linked to high level of soil contact activity and low personal hygiene amongst the study population. Generally, ascariasis and trichuriasis co-exist, however, in the present study, such was not the case. This might be linked to the fact that *A. lumbricoides* eggs are more resistant to extreme temperatures than *T. trichiura* eggs. Climatic condition of the study area might have contributed to the nonexistence of Trichuris, since climate is an important determinant of transmission of these infections. Adequate moisture and warm temperature are essential for larval development in the soil. This might be lacking in the study area as at the time of the study. There was higher prevalence in age group 4-6 years (62.9%) and age group 10-12 years (52.5%). The trend then followed from age groups 13-15 years, 7-9 and the least prevalence was seen in age group 16-18 years (34.6%). There was no significant difference in prevalence between the age groups ($p>0.05$). The higher prevalence

among age group 4-6 years old agrees with findings from Tanzania where there was higher prevalence in the younger age group with a steady decline in older age groups (Mugono *et al.*, 2014). This observation could be as a result of little awareness and low personal hygiene observed by pupils of that age group. The relatively low prevalence and mean intensity (41.47±46.08) recorded in the age group 16-18 is similar to studies by other researchers (Adefioye *et al.*, 2011, Obiukwu *et al.*, 2008 and, Ukpai and Ugwu 2003). This could be due to the fact that as adolescents the pupils in this age group are more conscious of their personal hygiene and are less likely to walk bare footed. Variations in the prevalence of STN and *S. mansoni* infection from different areas in the country could be related to several factors such as variation in vegetation and climatic factors, personal hygiene, deworming practices within the population. All the infected children had light intensity of the helminth infections. This observation was consistent with data from previous studies which observed that most of the individuals infected with soil-transmitted nematodes normally excrete a low number of eggs (Odiere *et al.*, 2011, Sang *et al.*, 2014).

Among the schools, LGEA Abinsti and Liberty Foundation, Ukpai had the highest prevalence (57.7% and 51.7%) respectively. The least prevalence was observed in Lobethas, Daudu (41.7%). Similarly, there was lower prevalence in Saint Francis, Ukpai (48.5%), Divine Dove, Abinsti (48.6%) and Community Daudu (48.4%). There was no significant difference ($p > 0.05$) however. The higher prevalence seen in LGEA Abinsti could be due to the fact that it is a public school and pupils could be from parents with lower socio-economic status. The schools with lower prevalence are private schools (i.e schools with a higher fee) and these pupils could come better socio-economic status. Prevalence was highest in primary three (52.9%) while the least prevalence was observed in primary six (46.8%). Statistically, there was no significant difference ($p > 0.05$) in prevalence among the classes. The differences observed among the classes in this study was not significant, this could be due to the fact that class is more age dependent and already, it was shown in this study that there was no significant difference in age group due to the fact that there is equal exposure to parasites in the study location. Of the 443 pupils examined in this study, 46 (10.4%) were positive for *S. mansoni* infection. Community Daudu was observed to have the highest prevalence of *S. mansoni* infection. This could be traced to high level insecurity and insurgencies in the area as compared to other communities. The situation made the community to be abandoned by Government officials. No deworming exercise, poor sanitary condition, no proper waste disposal system. These are all factors that could have contributed to a higher prevalence of *S. mansoni* infection recorded. Co-infection of soil transmitted nematodes and *S. mansoni* was seen 21 (4.7%) of the 443 pupils. Co-infections of soil nematodes and *S. mansoni* have been reported in different parts of Africa (Salawu *et al.*, 2014). This is quite common as a result of similar environmental conditions that favor their transmission as reported in findings by Alemu *et al.*, 2016 and Rupiah *et al.*, 2015.

CONCLUSION

Community mobilization geared at provision of basic amenities such as portable water supply and sustained health education aimed at bringing behavioral change in the study area is advocated. Regular deworming of school children with improved sanitation and integrated control approaches such as engagement of the primary health care will help to eradicate this scourge. Further studies to evaluate the situation in a few month time are advocated.

ACKNOWLEDGEMENTS

We are grateful to all the school authorities who gave approval to conduct the study and to all the teachers and pupils of the individual schools where this study was conducted.

STATEMENT OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- Adefioye, O.A., Efunshile, A.M. and Ojurongbe, O. (2011). Intestinal Helminthiasis among School Children in Ilie, Osun State, Southwest, Nigeria. *Sierra Leone Journal of Biomedical Research*. **3**(1): 36-42.
- Ademowo, A.F., Oyinloye, B.E., Ogunyinka, B.I. and Kappo, A.P. (2015). Impact of human schistosomiasis in sub-Saharan Africa. *Brazilian Journal of Infectious Disease*, **19**(2): 196-205.
- Alebie G., Erko B., Aemero M., and Petros B. (2014). Epidemiological Study on Schistosoma mansoni Infection in Sanja Area, Amhara Region, Ethiopia. *Parasites and Vectors*. **7**(1): 31-36.
- Alemu A., Yalewayker T., Demeketch, D. and Mulugeta, M. (2016). Schistosoma mansoni and Soil-Transmitted Helminths among Preschool-aged Children in Chuahit, Dembia District, Northwest Ethiopia: Prevalence, Intensity of Infection and Associated Risk Factors. *BMC Public Health*. **16**(1): 422.
- Amaechi E.C., Ohaeri C.C and Ukpai O.M. (2013). Prevalence of Helminthiasis among School Children in Some Rural Communities of Abia State, Nigeria. *Animal Research International*, **10**(3): 1817-1825
- Amali, O., Anyam, R.W., Jeje, P.N. and Olusi, T.A. (2013). Soil-transmitted nematodes and hygiene practices in a rural community of Benue State, Nigeria. *Nigerian Journal of Parasitology*, **34**(2): 147-152.
- Anto V., Asoala M and Adjuik, K. (2014). Childhood Activities and Schistosomiasis Infection in the Kassena-Nankana District of Northern Ghana. *Journal of Infectious Diseases and Therapy*. **(2)**: 66-72.
- Aribodor, D.N., Bassey, S.A., Yoonuan, T., Sam-Wobo, S. O., Aribodor, B.O. and Ugwuanyi, I.K. (2018). Analysis of Schistosomiasis and Soil-transmitted helminthes mixed infections among pupils in Enugu State, Nigeria: Implications for control. *Infection, Disease and Health*, <https://doi.org/10.1016/j.idh.2018.12.003>.
- Ash, L.R. and Orihel, T.C. (2007). *Ash and Orihel's Atlas of Human Parasitology*. American Society for Clinical Pathology Press, pp.540.

- Assefa A., Dejenie T. and Tomass Z. (2013). Infection Prevalence of *Schistosoma mansoni* and Associated Risk Factors Among School Children in Suburbs of Mekelle city, Tigray, Northern Ethiopia. *Momona Ethiopian Journal of Science*. **5**(1): 174-188.
- Bolaji, O.S., Akinleye A., Agunbiade, B.T., Adeyemo A.O., Bakare O.E and Adeyeba O.A. (2017). Survey of Intestinal Schistosomiasis and Soil Transmitted Helminthiasis among Pupils in Ifelodun, Kwara State Nigeria. *Bio.Innovation*, **6**(1): 78-90.
- Eme, T.O., Obioma, C.U., Tumininu, O.A. and Eniola, O.C. (2016). A Review of the Health Problems of the Internally Displaced Persons in Africa. *Nigerian Post Graduate Medical Journal*, **23**(4): 161-171.
- Hassan, A.O., Ossai, A.C., Aladenika, S.T., Ogundeyi, S.B., Ojo, J.F., Fadeju, O.J. and Adebimpe, W.O. (2017). Soil-Transmitted Helminthes Among Primary School Children in Owo Metropolis. *International Journal of Infectious Tropical Disease*, **4**(1):28-38.
- Hotez, P.J., Asojo, O.A. and Adesina, A.M. (2012). Nigeria: 'Ground zero' for the high prevalence neglected tropical diseases. *PLoS Neglected Tropical Diseases*, **31**; **6**(7):1600.
- Linsuke, S., Nundu, S. and Mupoyi, S. (2014). High prevalence of *Schistosoma mansoni* in Six Health Areas of - Kasansa Health Zone, Democratic Republic of the Congo: Short Report. *PLoS Neglected Tropical Diseases*. **8**(12): 33-39.
- Nagi S., Chadeka, E.A. and Sunahara T. (2014). Risk Factors and Spatial Distribution of *Schistosoma mansoni* Infection among Primary School children in Mbita District, Western Kenya. *PLoS Neglected Tropical Diseases*. **8**(7): 45-50.
- Nzeakor, S.O., Nwaimo, N.C., Kafaru, O.J. and Onoja, H. (2013). Nematode parasitaemia in school aged children in Sapele, Delta State, Nigeria. *Nigerian Journal of Parasitology*, **34**(2): 129-133.
- Obiukwu, M.O., Umeanaeto, P.U., Eneanya, C.I., and Nwaorgu, G.O. (2008). Prevalence of Gastro-Intestinal Helminths in School Children in Mbaukwu, Anambra State, Nigeria. *Nigerian Journal of Parasitology*. **29**(1): 15-19.
- Odiere, M.R., Opisa, S., Odhiambo, G., Jura, W.G., Ayisi, J.M., Karanja, D.M. and Mwinzi, P.N. (2011). Geographical Distribution of Schistosomiasis and Soil-Transmitted Helminths among School Children in Informal Settlements in Kisumu City, Western Kenya. *Parasitology*, **12**(15): 69-77.
- Sady, H., Al-Mekhlafi, H.M., Mahdy, M.A.K., Lim, Y.A. L., Mahmud, R. and Surin, J. (2013). Prevalence and Associated Factors of Schistosomiasis among Children in Yemen: Implications for an Effective Control Programme. *PLoS Neglected Tropical Diseases*. **7**(8): 77-82.
- Salawu, S.A., Asaolu, S.O. and Sowemimo, O.A. (2014). Co-infections with *Schistosoma haematobium* and Soil-transmitted Helminthes Among School-aged children in Saki, Oyo State, Nigeria. *Journal of Public Health and Epidemiology* **6**(12): 417-423.
- Salawu, S.A. and Ughele, V.A. (2015). Prevalence of Soil-Transmitted Helminths Among School-Age Children in Ife East Local Government Area, Osun State, Nigeria. *FUTA Journal of Research in Sciences*, **1**: 139-151.
- Samwobo, S.O., Akintola, O., Atungwu, J., Ekpo, U.F., Adeleke, M.A and Mafiana, C.F. (2013). Prevalence and Effect of Schistosome and Soil-Transmitted Helminth Infection on Labour Input in Rice- Growing Communities of Ogun State, Nigeria. *Epidemiology Biostatistics and Public Health*. **10**(2): 9-13.
- Sang, H.C., Muchiri, G., Ombok M., Odiere, M.R., Mwinzi, P.N. (2014). *Schistosoma Haematobium* Hotspots in South Nyanza, Western Kenya: Prevalence, Distribution and Co-Endemicity With *Schistosoma Mansoni* and Soil-Transmitted Helminths. *Parasite and Vectors*. **7**:125.
- Sangho, H., Dabo A., Sangho, O., Diawara, A., and Doumbo, O. (2004). Prevalence and Perception of Schistosomiasis in Irrigated Rice Field Area in Mali. *Le Mali Medical* **20**: 315-20.
- Ukpai, O.M. and Ugwu, C.D. (2003). The Prevalence of Gastrointestinal Tract Parasites in Primary School Children in Ikwuano Local Government Area of Abia State, Nigeria. *Nigerian Journal of Parasitology*. **23**: 11-18.
- Uneke, C.J., Nnachi, M.I. and Arua, U. (2009). Assessment of Polyparasitism with Intestinal Parasite Infections and Urinary Schistomiasis Among School Children in a Semi-Urban Area of South-Eastern Nigeria. *International Journal of Health*, **9**: 1.
- WHO. (2001). Schistosomiasis and Soil-transmitted helminth infections, Geneva: World Health Organisation. p 1-2. Resolution WHA54.19.2001.