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Polyparasitism with soil transmitted helminthes and *Schistosoma haematobium* among school-aged children in Igede land, Benue state, Nigeria

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ABSTRACT

Background: Polyparasitism is widespread in rural communities of the developing world, and it is a serious problem for public health. The aim of this study is to investigate the co-infection of intestinal parasites and urinary schistosomiasis among school-aged children in two local government areas of Benue State.

Methods: This study collected 452 stool and urine samples from randomly selected participants and examined them using three techniques - direct wet mount, formol ether concentration, and urine sedimentation. The researchers also utilized questionnaires to assess risk factors associated with the samples. The data was then analyzed using the Chi-square statistical test to identify any significant relationships between the various factors examined.

Results: The study found that 29.0% of the 452 randomly selected participants were infected with at least one parasite. 17.3% of the infected were male, while 11.7% were female. 11.7% had multiple infections, with 13.1% in males and 10.2% in females. 15.0% were infected with single parasites, 9.1% had double infections, and 2.7% had triple infections. *Schistosoma haematobium* was found in 1.8% of participants, with 1.1% in males and 0.7% in females. The most common parasite was *Ascaris lumbricoides* (6.0%), followed by hookworm (5.8%). The hookworm-Ascaris combination was the most common double infection (4.2%). While males were generally more infected, there was no statistically significant difference between males and females. Similarly, the higher infection rate in Obi (16.2%) compared to Oju (12.8%) was not statistically significant. The 11-15 age group had the highest prevalence of multiple infections (14.2%), but this was not statistically significant across age groups.

Conclusion: Aggressive health education and mass drug administration are recommended in the study area.

Kewwords: Polyparasitism, Igede, Oju, Obi, Parasites, Soil Transmitted Helminthes (STH), Schistosomiasis, Nigeria

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1. Introduction

Polyparasitism is common worldwide, though seldom acknowledged but widespread. Its combination and complexity are frightening, but for parasite species interconnected through immunity or transmission, it is likely to confound routine approaches to research (1). In populations and in individuals in the developing countries of the world, this phenomenon is common, with its effects being clinically unclear. In some situations, however, combined infections may exacerbate clinical manifestations (1).

Urinary schistosomiasis caused by *Schistosoma haematobium* constitutes a major public health problem in many tropical and sub-tropical countries and is reportedly endemic in 53 countries in the Middle East and most of the African continent. Helminth infections are rarely fatal but cause long-term chronic morbidity (2, 3). Children are particularly burdened with poverty, parasitic diseases, and political exclusion. The ground on which they walk is seeded with ova and larvae of soil-transmitted helminthes such as *Ascaris lumbricoides*, hookworm, *Strongeloidis stercoralis*, and *Trichuris trichiura*. Children washing clothes, engaging in swimming activities, and other forms of activities around infested water are at risk. Poor hygiene and playing in mud and water make children vulnerable to infection (4).

Polyparasitism, which is widespread in rural communities in the developing world, is a serious problem for public health. It is found to be responsible for most cases of morbidity among school-aged children (5). However, the epidemiology of polyparasitism and its implications for morbidity are poorly understood (6).

Studies in the tropics and sub-Saharan Africa on parasitic infections have been based mostly on their prevalence with little consideration of their co-endemicity (7, 8, 9, 10, 11). Some studies cut across the adult population instead of the most vulnerable population being children (12). This study was conducted to determine the level of polyparasitism and to investigate epidemiological factors that favor its endemicity in school-aged children in two local government areas of Benue State, Nigeria.

2. Materials and Methods

2-1. *Study area*

This study was conducted in Oju and Obi Local Government Areas of Benue State, Nigeria. The state is situated between latitudes 6o30'N and 8o15'N and longitudes 7o30'E and 10o00'E, with a land area of about 34,059 km2 and a population of 2,780,398 by the 1991 Census and 4,253,541 by the 2006 estimate. Oju and Obi have a population of about 195,760 and 114,680, respectively (13). Both neighboring LGAs are an expanse of village settlements and market towns, with a tropical sub-humid climate having two distinct wet and dry seasons. Rainfall averages 7 months annually, with a total ranging between 1,200 mm and 2,000 mm between the months of April and October. Temperatures are relatively high throughout the year, averaging 28–320 °C, with an occasional peak at 370 °C between March and April. The people of both LGAs speak the Igede language and are farmers of rice, yam, cassava, potato, etc (Fig.1).

Fig. 1. Map of Benue State showing the study areas (Obi and Oju).

2-2. Study design

The study was cross-sectional, focusing on school-aged children of both Oju and Obi LGAs, from which four communities were randomly selected from each to constitute the study population. In Oju, *Ibilla, Ainu-Ette, Uwokwu,* and *Ainu* were randomly selected, while in Obi, *Irabi, Ogoro, Adiko,* and *Ochore* were randomly selected. A total of 236 male and 216 female participants form the study sample. Only children between the ages of 3 and 17 constituted the study subjects. All participants were residing in the study areas at the time of data collection. Those who did not give consent did not take part in this study.

2-3. Ethical considerations

Ethical clearance was obtained from the Benue State Ministry of Health ethical board. Permission was obtained from the village heads, head teachers, and parents, as well as from the pupils.

2-4. Sample size determination

The minimum number of samples collected was determined using the standard formular as described by Israel (1992).

$$n= \frac{N}{1+N(e)2}$$

Where "n" is minimum sample size, "N" is population size (total population of the study), "e" is level of significance (0.05), and "1" is constant. The total population size of school-aged children, according to the available data from the Benue State National Population Census (2006), was N (Oju) = 77573, N (Obi) = 45447. The total population size of the study area is 45,447 + 77,573 = 123,019.

$$n=\frac{123,019}{1+123,019(0.05)2} =399$$

The minimum sample size for this study is 399. However, 452 samples were collected for more accuracy.

2-5. Sampling Technique

A random sampling technique was used to collect samples from the study population. Hence, a total of 452 participants were randomly selected from the study population to form the study sample.

2-6. Sampling Duration and Time

The study sampling covered the period between the months of January-March, 2020.

2-7. Questionnaire Survey

A pre-tested questionnaire was self-administered to the study subjects to collect data on risk factors for parasitic infections, such as demography, environmental information, personal hygiene practices, etc.

2-8. Collection and Parasitological Examination of Samples

Each of the participants was given two clean, labeled, wide-mouthed, and screw-capped containers with adequate instructions on how to collect the samples. The samples were retrieved the following morning and transported to the laboratories of the general hospitals situated in both LGAs. Stool samples were examined using direct wet mount and formol-ether sedimentation techniques (14) to view the ova and cyst of intestinal helminthes and protozoas, respectively. Urine samples were examined using the urine sedimentation technique (14) to detect the presence of ova of *S. haematobium*.

Table 1. Prevalence of polypatasitism in relation to sex and locations/community of respondents

Study sites	Male				Female				Total			
	N.E	II	III	(%)	N.E	II	III	(%)	N.E	II	III	(%)
OBI												
Adiko	30	3	0	3 (10..0)	26	2	0	2 (7.7)	56	5	0	5 (8.9)
Ogore	27	1	2	3 (11.1)	24	5	0	5 (20.8)	51	6	2	8 (15.7)
Ochore	32	5	2	7 (21.9)	30	4	1	5 (16.7)	52	9	3	12 (19.4)
Irabi	29	0	0	0 (0.0)	24	4	0	4 (6.7)	53	4	0	4 (7.5)
Total	118	9	4	13 (11.0)	104	11	1	16 (15.4)	212	24	5	29 (13.6)
OJU												
Ibilla	30	2	2	4 (13.3)	27	2	0	2 (7.4)	57	4	2	6 (20.0)
Ainu-Ete	24	2	1	3 (12.5)	30	1	0	1 (3.3)	54	3	1	4 (16.7)
Uwokwu	36	5	2	7 (19.4)	27	0	2	2 (7.4)	63	5	4	9 (25.0)
Ainu	28	4	0	4 (14.3)	28	1	0	1 (3.6)	56	5	0	5 (17.9)
Total	118	13	5	18 (15.3)	112	4	2	6 (5.4)	230	17	7	24 (16.4)
Grand Total	236	22	9	31 (13.1)	216	19	3	22 (10.2)	452	41	12	53 (11.7)

(χ^2=7.008, df=7, P>0.025) Key: N.E=Number Examined, II=Double Infection, III=Tripple Infection.

2-9. Data analysis

Data were entered into and processed using SPSS (version 16.0) for Windows and Microsoft Excel. Data were analyzed using descriptive statistics to express prevalence and Pearson's Chi-square (χ2) test at the 5% level of significance ($P<0.05$) to determine the nature of the association between polyparasitism and other risk factors.

3. Results

Out of the 452 fecal and urine samples examined, the overall prevalence of infection is 131 (29.0%), of which 73 (17.3%) are male and the remaining 58 (11.7%) are female. Oju recorded a higher prevalence of 24 (16.4%) compared to Obi's 29 (13.6%) (Table 1). A total of nine different parasites were found in the study area, with *A. lumbricoides* recording the highest prevalence (6.0%), followed by hookworm (5.8%), respectively. Multiple infections are 53 (11.8%), out of which 32 (13.1%) are male and the remaining 22 (10.2%) are female. A total of 8 (1.8%) of the participants had a single infection with *Schistosoma haematobium*, out of which 5 (1.1%) are male and the remaining 3 (0.7%) are female. Parasitic combination of hookworm and *Ascaris* was the most commonly observed double parasitic infection (4.2%), while in triple infection, the combination of Hookworm, *E. histolytica*, and *A. lumbricoides* and the combination of *T. trichiura*, *A. lumbricoides*, and Hookworm were the most seen with an equal prevalence of 0.9%. There was no significant difference between the two study areas (df = 23, $P > 0.05$) with respect to parasite combinations (table 2).

Table 2 Distribution of parasites and their combinations in the study Areas

Parasites	Total		Total
	Obi (%)	Oju (%)	
H.W	11(2.4)	15 (3.3)	26 (5.8)
A.I	16(3.5)	11(2.4)	27 (6.0)
G.I	0(0.0)	2(0.4)	2 (0.4)
S.h	7(1.5)	1(0.2)	8 (1.8)
S.m	2(0.4)	2(0.4)	4 (0.9)
S st	2(0.4)	1(0.2)	3 (0.7)
T t	2(0.4)	0(0.0)	2 (0.4)
E.h	3(0.7)	3(0.7)	6 (1.3)
A.l+H.w	14(3.1)	5(1.1)	19 (4.2)
E,h+A.l	3(0.7)	2(0.4)	5 (1.1)
A.l+S.st	0(0.0)	1(0.2)	1 (0.2)
A.l+S.m	0(0.0)	2(0.4)	2 (0.4)
T.spp+H.w	0(0.0)	1(0.2)	1 (0.2)
H.w+G.l	2(0.4)	1(0.2)	3 (0.7)
T.t+A.l	2(0.4)	2(0.4)	4 (0.9)
H.w+E.h	2(0.2)	0(0.0)	2 (0.4)
H.w+S.h	3(0.7)	2(0.4)	5 (1.1)
E.h+A.l+S.h	1(0.2)	0(0.0)	1 (0.2)
H.w+E.h+A.l	1(0.2)	3(0.7)	1 (0.2)
T.t+A.l+H.w	1(0.2)	3(0.7)	4 (0.9)
G.l+A.l+H.w	1(0.2)	0(0.0)	1 (0.2)
T.t+A.l+S.h	1(0.2)	0(0.0)	1 (0.2)
H.w+S.st+Al	0(0.0)	1(0.2)	1 (0.2)
Total	73(16.2)	58(12.8)	131(29.0)

(χ^2 = 27.886, df=23, p>0.05). **key; H.w = Hookworm,** *A. lumbricoides*, G. *G. lamblia*, l. *haematobium*, S.m.=S. *mansoni*, S.st.=*S. stercoralis*, T. t. = *T. trichiura;* E. h. = *E. histolytica*; T. spp. = Taenia species

The age group of 11–15 years had the highest prevalence of multiple infections (14.2%), closely followed by 6–10 years (13.0%). However, males within the age group 6–10 years were more infected (14.2%) with multiple infections compared to females within the same age group (11.6%) (table 3). Polyparasitism was more associated with the use of open defecation (22.2%), followed by the use of a water system (8.3%), although there was no significant difference between the various types of toilets used by the participants in relation to plyparasitism. (χ^2=0.817, df=2, P>0.05) (table 4). Users of streams and deep wells as sources of drinking water had the same prevalence of co-infection of 14.3%, while users of boreholes had a prevalence of 7.8%. The difference between males and females was not statistically significant ($\chi 2$ = 0.78, df = 2, P > 0.05) (table 5). Epidemiological factors that enhance transmission of multiple parasites exit the study area, with those who sometimes keep long finger nails having the highest infection rate (8.8%) (table 6).

4. Discussion

Polyparasitism is not a new phenomenon. Concomitant infection with multiple parasites has attracted research interest for a long time. There has, however, been a general renaissance in the epidemiological investigation of polyparasitism, with particular focus on multiple helminth and protozoan species (12). 11.7% prevalence recorded in this study showed a lower prevalence with a wide gap in infection rate compared to the 71.4% recorded in the study of (15). Mekonnen *et al.* recorded 12.4% in a similar study, which is in agreement with the prevalence of polyparasitism in this study (16). The emerging presence of boreholes, which have been made available in parts of the villages, especially in Oju, a project funded by UNICEF, can be pointed out as a significant factor in reducing the massive spread of parasites. This assertion is partly supported by a study that established that unsafe drinking water poses health risks, particularly to children in low- and middle-income countries (17). Double infection with a prevalence of 41 (9.1%) and triple infection with a prevalence of 11 (2.7%), as observed in this study, were low compared to the findings in another study that recorded a prevalence of 54.3% and 17.7% for double and triple infection, respectively (18).

Table 3. Prevalence of polyparasitism in relation to sex and age of respondents

Age	Male				Female				Total			
	N.E	II	III	(%)	N.E	II	III	(%)	N.E	II	III	(%)
3-5	30	3	0	3 (10.0)	31	1	0	1 (3.2)	61	4	0	4 (6.6)
6-10	120	11	6	17 (14.2)	95	8	3	11 (11.6)	215	19	9	28 (13.0)
11-15	58	6	3	9 (15.5)	76	10	0	10 (12.6)	134	16	3	19 (14.2)
16-20	28	2	0	2 (7.1)	14	0	0	0 (0.0)	42	2	0	2 (4.8)
Total	236	22	9	31 (13.1)	216	19	3	22 (10.2)	452	41	11	53 (11.7)

(χ^2=3.709, df=3, P>0.025) Key: N.E=Number Examined, II=Double Infection, III=Triple Infection.

Table 4. Prevalence of polyparasitism in relation to sex and type of Toilet

Type of toilet	Male				Female				Total			
	N.E	II	III	(%)	N.E	II	III	(%)	N.E	II	III	(%)
Water system	66	4	1	5 (7.6)	78	5	2	7 (9.0)	144	9	3	12 (8.3)
Pit	92	6	3	9 (9.7)	88	10	0	10 (11.4)	180	16	3	19 (10.6)
Open defecation	78	12	5	17 (21.8)	50	4	1	5 (10.0)	128	16	6	22 (17.2)
Total	236	22	9	31(13.1)	216	19	3	22 (10.2)	452	41	12	53 (11.7)

(χ^2=0.817, df=2, P>0.05) **Key:** N.E=Number Examined, II=Double Infection, III=Triple Infection

Table 5. Prevalence of polyparasitism in relation to sex and source of drinking water

Source of water	Male				Female				Total			
	N.E	II	III	(%)	N.E	II	III	(%)	N.E	II	III	(%)
Bore hole	87	4	1	5 (5.7)	92	8	1	9 (9.8)	179	12	2	14 (7.8)
Stream	75	9	3	12 (16.0)	65	6	2	8 (12.3)	140	15	5	20 (14.3)
Deep well	74	9	5	14 (18.9)	59	5	0	5 (8.5)	133	14	5	19 (14.3)
Total	236	22	9	31 (13.1)	216	19	3	22 (10.2)	452	41	12	53 (11.7)

(χ^2=0.78, df=2, P>0.05). Key: N.E=Number Examined, II=Double Infection, III=Tripple Infection.

Findings from this study also showed similarity with those of Omudu *et al.*, who recorded a 9.1% prevalence of double infections and a 0.7% prevalence of triple infections (12). Males were found to be more polyparasitized with a prevalence of 13.1% than females, who recorded a prevalence of a prevalence of 10.2%,, probably because the males were more engaged with playing on the fields seeded with helminth eggs. Generally, male children are known for football activities on play grounds, in school fields, and at home. This activity might have predisposed them more to parasitic infections than the female children. Males are generally more susceptible to infectious diseases than females (19).

Table 6. Attitude of respondents and its epidemiological relationship with polyparasitism and mono parasitism.

Epidemiological factors	Attitude	Parasitism (%)		χ^2	df	Significant level (e=0.05)
		Multiple	Single			
Open defecation	Always	16(3.5)	28(6.2)	2.842	2	P>0.05
	Sometimes	35(7.3)	42(9.3)			
	Never	2(0.4)	8(1.8)			
Washing of hands after visiting the toilet	Always	15(3.3)	17(3.8)	2.066	2	P>0.05
	Sometimes	32(7.2)	56(12.4)			
	Never	6(1.3)	5(1.1)			
Washing of hands before eating	Always	16(3.5)	22(4.9)	0.725	2	P>0.05
	Sometimes	37(8.2)	55(12.2)			
	Never	0(0.0)	1(0.2)			
Washing of fruits before eating	Always	10(2.2)	23(5.1)	8.244	2	P<0.05
	Sometimes	37(8.2)	35(7.7)			
	Never	6(1.3)	20(4.4)			
Walking barefooted	Always	16(3.5)	24(5.3)	0.157	2	P>0.05
	Sometimes	35(7.7)	52(11.5)			
	Never	2(0.4)	2(0.4)			
Boiling of water before drinking	Always	4(0.9)	0(0.0)	6.809	2	P<0.05
	Sometimes	14(3.1)	17(3.8)			
	Never	35(7.7)	61(13.5)			
Geophagy	Always	2(0.4)	0(0.0)	3.102	2	P>0.05
	Sometimes	22(4.9)	36(8.0)			
	Never	29(6.4)	42(9.3)			
Keeping long finger nails	Always	2(0.4)	2(0.4)	8.057	2	P<0.05
	Sometimes	40(8.8)	41(9.1)			
	Never	11(2.4)	35(7.7)			

The result of this study strongly agrees with this assertion. With respect to the source of drinking water, a good number of respondents use water from the stream, well, or borehole. Although those who drink borehole water have cases of multiple parasitic infections, those who use other sources, such as a deep well or stream, have cases of multiple infections with a higher prevalence, especially among those who use deep wells. The reason for this can be attributed to the fact that these water sources are not protected and are subject to contamination by ova and cysts of parasitic agents (19). The source of drinking water, which was observed to have no significant influence on the rate of parasitic infection in this study, agrees with another study by Omudu *et al*. (12), but does not concur with some others (17, 18, 20), who showed that the source of drinking water was a significant risk factor for polyparasitic infections among school-aged children. The main reasons for the high prevalence of multiple parasitisms have always been blamed on deplorable sanitary, social, and environmental conditions and a lack of basic amenities in both urban and rural communities.

A major reason that exacerbates soil transmission is the practice of open-air defecation and unhygienic pit toilets, which are common in both communities. The absence of good household toilet facilities as well as potable sources of drinking water is epidemiologically significant as the environment continues to be seeded with parasite eggs (12). This study supports the assertion, as those who practice open defecation are more parasitized than those who use the water system.

Most of the multiple infections observed in this study were attributed to the nature of activity, such as farming, which predisposed children to parasitic infections, probably as a result of the continuous use of organic fertilizers in their farms. Polyparasitism with helminthes is capable of retarding growth and impeding learning speed and performance in school. Poor sanitary, social, and economic conditions and other basic social amenities, as well as inadequate knowledge of the causes and modes of transmission as well as their signs and symptoms, are significant epidemiological factors that facilitate the spread of parasitic diseases. Both government and non-government agencies should join forces in providing platforms for enlightenment campaigns and deworming programs against the spread of parasites. The provision of portable sources of water, especially in rural communities, is highly recommended.

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