Soil-Transmitted Helminth Infections and Nutritional Status in School-Aged Children in Rural and Urban Areas of Cross River State, Nigeria

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***Abstract: Soil*-transmitted (STHs) and their impact on the nutritional status of school-aged children in rural and urban communities are of great concern to public health. The main objective of this study was to determine the prevalence of STHs infections and nutritional status of school-aged children in rural Biase Local Government Area and urban Calabar South Local government Area of Cross River State. A total of 504 faecal samples were collected from investigated school-aged pupils and screened by Parasitological techniques to determine the presence of adult and developing stages of parasites. Out of 504 faecal samples examined, 42.8% prevalence of helminth infection was recorded among school-aged children in the study area. The varying degree of infections were *Ascaris lumbricoides* 30.3%, Hookworms 28.5%, *Enterobius vermicularis* 25.7%, *Schistosoma mansoni* ova 9.5% and *A. lumbricoides* and Hookworms 5.8%. Chi-square revealed significant difference $X^2 = 60.1, p < 0.001$) in infection among age-group. Children anthropometric measurements were used to determine their nutritional status. A total of 24.4% malnourished children were found to be underweight, 36.5% were stunted and 20.8% showed thinness condition. It was found that body mass index (BMI) of infected pupils decreased as age increases and the calculation of Pearson correlation coefficient revealed a strong association between BMI and infection ($r = 0.897$). In view of these findings, the current school feeding programme sponsored by the federal government of Nigeria should be improved, by providing school-aged pupils with protein rich food to reduce the prevalence of malnutrition in children.**

***Keywords*: Soil-transmitted, helminths, infections, nutritional status, school-aged, children, rural, urban, Cross River, Nigeria.**

I.INTRODUCTION

Soil-transmitted helminths (STHs) are parasitic nematodes or round worms that are transmitted to humans through contact with or ingestion of faecally contaminated soil (Bethony et al., 2006; Hotez et al., 2008). The species of medical importance include *Ascaris lumbricoides*, (round worms), *Trichuris trichiura* (whipworms), *Ancylostoma duodenale* and *Necator americanus* (hookworms) and *Strongyloides stercarolis* (threadworms). They are classified as soil-transmitted helminths because the eggs and larvae passed in faeces need about 3 weeks to mature in the soil before they become infectivee. According to Oguanya et al., [2012), soil-transmitted helminths are intestinal worms that infect humans and are transmitted mainly through contaminated soil. Soil-transmitted helminths are major public health problems in several tropical and subtropical developing countries with poor socio-economic status (WHO, 2010). They thrive and persist in human communities in which poverty, inadequate sanitation, lack of access to health care, and overcrowding are entrenched (WHO, 2002). Additionally, the habits of bare feet on sand and eating unwashed fruits and vegetable also encourage transmission (Monstresor et al., 1998). Climatic and environmental factors such as soil type are closely related with the distribution of STH infections in a country (UNDP, 2011). For this reason, tropical and subtropical regions of the world where climatic and environmental conditions tend to be conclusive for the development of infective stages are major endemic zones. This include countries of South and Central America, south West China, India and South-east Asia as well as sub-Saharan African countries (de Silva et al., 2003; Hotez et al., 2006). The world Health Organization (WHO) estimates that over two billion people are infected with one or more soil-transmitted helminths mainly *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* (Kelechi et al., 2015). Of the two billion people infected by STHs, about 8% were in the three most populous countries in Africa: Nigeria, Ethiopia and Democratic Republic of Congo (Pullan et al., 2014). This figure might be an underestimate of the true global distribution (Albonico et al., 2008; Saboya et al., 2013). Hotez et al., (2008) indicates that 4.5 billion individuals are at risk of intestinal STH infections. The global estimate of cases of infections with *Ascaris lumbricoides* was 807 million, *Trichuris trichiura* was 604 million, hookworms *(Necator americanus, Ancyclostoma duodenale*) was 576 million, and schistosomes was 207 million. These parasites are intensively transmitted, and are in need of treatments. Although the global target is to eliminate morbidity due to STH infections in children by 2020 (Molla and Mamo (2018); Bethony et al., 2006; Hotez et al., 2008) the burden of these helminth parasite infections has been consistently underestimated in the past, but there is now a general consensus that STH infection represents an important public health problem especially for children. Although light helminthic infections are often asymptomatic, there are adverse health and nutritional impacts of severe worm infections on children. More than 568 million school-age children live in areas where these parasites are intensively transmitted, and are in need of treatments. Although the global target is to eliminate morbidity due to STH infections in children by 2020 (Molla and Mamo, 2018), without chemotherapeutic treatment, the infections may also have more serious medical consequences in a minority of cases. Roundworm infections sometimes lead to fatal intestinal obstruction, hookworm severe anaemia and whipworm is associated with chronic dysentery (Uneke, 2010). Although there are several factors that increase morbidity and mortality due to soil-transmitted helminthiasis in the world, lack of personal and environmental sanitation, limited access to clean water, overcrowding and low socioeconomic conditions are the major ones (Tekeste et al., 2013). School-aged children have been shown to be the population at greatest risk of acquiring infections with roundworm, hookworm, and whipworm infections (WHO, 2002). The preponderance of helminthic infection in school-age children makes this subgroup a good target for helminth control programmes in the general population, and schools provide good opportunities for implementation of control programmes (Kelechi et al., 2015). Health adverse effects such as anaemia, growth, stunting, protein calorie malnutrition, fatigue and poor cognitive development tend to occur and persist in populations affected by STH (Hotez et al., 2008). According to the World Health Organization (WHO), intestinal helminthiasis is often associated with reduced physical activity and worsen the already compromised nutritional status of the school-aged children in the rural and urban communities (Kelechi et al., 2015). The prevalence of soil-transmitted helminthiasis differs from region to region. In Nigeria, soil-transmitted helminths infections have continued to increase because of low levels of living standard, poor environmental sanitation and ignorance of simple health promoting behaviours (Udonsi, 1984).

II. MATERIALS AND METHODS

Study Area.

This study was conducted in urban and rural communities of Cross River State, South Eastern Nigeria. A total of 14 primary schools were used in the study, seven (7) from the urban community (Calabar South Local Government Area) and 7 from the rural community in Biase Local Government Area. Cross River State lies within the rainforest zone of Nigeria with marked wet and dry seasons (Fig 1). The people from the rural area are predominantly agrarian with a mixture of fishermen, traders, artisans and civil servants. These communities have no good sources of drinking water and sanitary facilities, depending basically on streams and rivers as sources of water supply. The urban communities are a mixture of civil servants, fishermen, traders, craftsmen with good social amenities

Ethics Statement

Before the study began, ethical clearance letter was obtained from Cross River University of Technology ethics committee. Permission to conduct this investigation was received from the Health Centre in Biase Local Government Area and Ministry of Health, Calabar. Informed ascent was given by guardians and parents, school head teachers of children recruited for this investigation. Infected children were given each a tablet of Albendazole to reduce worm burden.

Study Population and Sample size

The target population was school-aged children between 4-12 years enrolled in primary schools in the study area. With the aid of the serial numbers of children in their class registers, all with even numbers were selected for the study. The sample size of pupils in each selected school was obtained by random sampling. A total of 504 pupils were recruited from the urban and rural communities for this study.

Study Design

The present study i

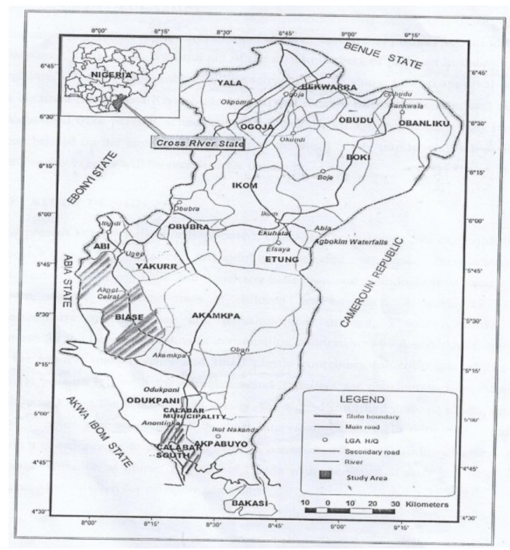

Fig. 1. Map of Cross River showing the study area: Biase and Calabar South Local Government Areas.

s school-based, cross-sectional descriptive experimental research, and the detailed methodology included pre-tested questionnaire administration to parents and teachers, collection and examination of stool samples, height, weight and body mass of children measured. A week prior to questionnaire administration and parasitological surveys, written informed consent sheets were distributed to parent/guardians of participating children through caregivers and teachers. Copies of the pre-test questionnaire and small plastic containers for collection of stool samples were left with the caregivers and Teachers for distribution to selected children. During the school-based survey, the signed informed consent sheets, and stool samples were collected. A short interview was held with each child, using a questionnaire to elicit hygiene behaviour, source of drinking water and general sanitation at home. The head teacher and members of staff helped to organize the children for effective sampling.

Anthropometric Measurement

The body weight and height of children were taken in their individual schools. Height of each pupil was measured to the nearest 0.1 cm, using a height pole attached to a straight vertical wall with bare feet. Their weights were taken barefooted and in light school uniform to the nearest 0.1 kg using a digital electronic balance. Height, weight and age of each child were used to calculate Height-for-age Z-score (HAZ) to assess stunting; body-mass-index for-age Z-score (BAZ) to determine thinness and weight-for-age Z-score (WAZ) to determine underweight, below -2 standard deviation of the reference median, respectively, in the World Health Organization growth chart (WHO, 2007).

Stool Collection and Parasitological Examination

A day prior to collection of stool samples, the aim and objectives of the study was explained to the teachers and selected pupils. Pupils were taught how to collect a small portion of their stool samples at home with the specimen bottles, clean piece of paper and an applicator stick provided. Fresh stool samples collected were prepared by Kato-Katz thick smear technique in the Parasitological laboratory of Cross River University of Technology, Calabar. Diagnosis was based on the identification of helminths ova in the stool sample during microscopic examination. All data collected, both by questionnaire and for laboratory investigation were edited and entered into (SPSS) windows version 20 statistical package. Differences in proportions for categorical variables (e.g. age group, sex of child, stunting, thinness, underweight) were calculated using chi square test of independence.

Statistical Analysis

Differences in helminths infections between age, sex and study area was compared using Chi-square analysis. The differences were accepted to be significant when $p < 0.05$. The association between helminths infections and nutritional status was assessed by Pearson correlation.

Declaration of Interest

Authors declare no conflict of interest.

III.RESULTS

A total of 545 school-aged pupils from urban and rural areas were recruited into the study. Only 504 pupils whose parents or guardians signed consent forms and were able to provide adequate stool samples for microscopic examination were considered. The demographic data analyzed from the 504 (100%) school-aged pupils revealed that a sub total of 258 (51.2%) were males and 246 (48.8%) were females (Table 1).

However, 188 (37.3%) of the school-aged pupils were between the age of 4-6 years, 162 (32.1%) fell within the age bracket of 7-9 years and 154 (30.5%) were between 10-12 years (Table 1).

Table 2 illustrates the prevalence of soil-transmitted helminths infections by age, sex and study area. In table 2, age group 4-6 had the highest prevalence of infection 95 (42.9%), followed by 7-9 age group 79 (35.7%), while 10-12 age group had the lowest prevalence 47 (21.2%). The distribution of these soil transmitted helminths infections by age group across the participated school-aged pupils revealed statistical significant difference (x2 = 60.1, $p < 0.001$) of infections among age groups. In respect of sex, 36 (35.6%) males were more infected with Ascaris lumbricoides than females 31 (25.8%). Females were more infected 8 (6.7%) with Hookworm and Enterobius vermicularis than males 5 (4.9%). There was statistical significant difference ($x^2 = 19.6$, $p < 0.001$) in the infection of both male and female pupils. Prevalence of soil-transmitted helminths infection was highest in the rural area 180 (81.4%) than in the urban 41 (18.5%) school-aged pupils (Table 2). A total 5.8% multiple infections of Ascaris lumbricoides and hookworms was recorded among school-aged pupils in the study area.

Table 3 illustrates the nutritional indices (Z-score) of weight-for-age (underweight) in school-aged pupils in relation to age, sex and study area. It was observed that age group 4-6 years had the highest rate 52 (42.3%) of underweight (Table 3). The lowest prevalence of underweight 24 (19. 5%) was found in age group 10-12 years. There was no statistical significant difference ($x^2 = 6.3$, df = 4, $p > 0.05$) observed among age groups. The data also revealed that the females had the highest prevalence rate of underweight 74 (60.2%) than males (49 (39.8%). It was found that 40 (78.4%) of participated school pupils that were severely underweight were from the rural area, while 11(21.6%) were from the urban. However, there was no statistical significant difference ($x^2 = 3$, df = 1, $p > 0.05$) in the prevalence of underweight within study areas (Table 3).

Height-for-age z-scores were analyzed by age group, sex and study area (Table 4). Data showed that 4-6 years age group had the highest rate of stunting 86 (46.7%). The lowest prevalence of stunting was in age group 10-12 years 20 (10.9%). There was no statistical significant difference ($x^2 = 6.3$, df = 4, $p > 0.05$) in the prevalence of stunting among age groups (Table 4). In respect of sex, it was observed that males had the highest prevalence of stunting 32 (51.6%) pupils who were severely malnourished compared to 30 (48.4%) of females. However, there was no statistical significant difference ($x^2 = 3$, df = 1, $p > 0.05$) in the prevalence of stunting condition between sexes. For the study area, it was found that school aged pupils in the rural area had higher prevalence of stunting 119 (64.7%) than urban 65 (35.3%). There was no statistical significant difference ($x^2 = 5$, df = 1, $p > 0.05$) between study areas in stunting (Table 4).

Table 5 illustrate nutritional indices (Z-scores) of BMI-for-age (thinness) in school-aged pupils in relation to age, sex and study area. The analyzed data revealed that age group 10-12 years had the lowest prevalence 20 (19.1%) of thinness condition compared to the highest prevalence of 43 (40.9%)

of age group 4-6 years. There was no statistical significant difference (x^2 = 2.6, df = 4, p > 0.05) among age groups. However, the rural area had a higher prevalence 78 (74.3%) of thinness condition than the urban area with 27 (25.7%0 thinness condition (Table 5).

Table 6 reveals the total nutritional status of investigated school-aged children in relation to underweight, stunting and thinness. Analysis showed that school-aged group 4-6 years had the highest 181 (43.9%) prevalence of underweight, stunting and thinness, while age group 10-12 years had the least prevalence 64 (15.5%). There was significant difference (x^2 = 19.1, df = 4, p < 0.001) in prevalence of underweight, stunting and thinness conditions of school-aged pupils. In respect to sex, female pupils were more infected 221 (53.6%) than males 191 (46.4%). There was significant difference (x^2 = 7.1, df = 2, p < 0.05) in the prevalence of infection between sex. As regards the study area, the rural school-aged pupils were more infected 278 (67.5%) compared to 134 (32.5%) in the urban (Table 6).

Table 7 shows correlation analysis of mean nutritional indices of the infected school-aged pupils in relation to their age. The mean nutritional status of age group 4-6 was 60.3 kg/m2, 7-9 was 55.7 kg/m^2, and 10-12 was 21.3 kg/m2. The results showed that mean nutritional status decrease with increase in age of pupils. As the nutritional indices of pupils improved with increase in age of pupil, the prevalence of infection decreased (r = 0.08970) (Table 7).

Table 8 summarizes nutritional indices (Z-scores) in relation to acute and severe malnourished investigated school-aged pupils. A total of 24.2%, 14.3%, and 14.3% acute malnourished pupils showed underweight, stunting and thinness respectively. Similarly, 12.3%, 10.1%, and 6.5% severe malnourished pupils showed underweight, stunting and thinness

In Table 9, prevalence of 43.4%, 26.7% and 23.3% underweight, stunting and thinness condition was shown respectively in school-aged pupils in rural areas, compared to 29.3%, 21.9% and 18.3 underweight, stunting and thinness conditions respectively, recorded in school-aged pupils in urban area.

Table 10 illustrates the demographic characteristics of school-aged pupils in respect to risk factors and sanitary condition practices. Based on the analysis for source of water, 260 (51.6%); 205 (40.7%) and 39 (7.7%) school-aged pupils used tap water, river or stream and both respectively. There was statistical significant difference (x^2 = 11, df = 4, p < 0.01; x^2 = 28.1, df = 2, p < 0.001; and x^2= 36.3, df = 2, p < 0.001) in the sanitary condition practices of water source among age groups, sexes and study area respectively. In respect of toilet facilities, 152 (30.2%), 230 (45.6%) and 122 (24.2%) used open/bush, water closet and pit toilet respectively. There was statistical significant difference (x^2 = 14.9, df = 4, p < 0.01; x^2 = 82.1, df = 2, p = < 0.001; x^2 = 9.0, df = 2, p < 0.05) in the use of toilet facilities among age groups, sexes and the study area. As regards wearing of footwear when playing, it was discovered that 200 (39.7%), 251 (49.8%) and 53 (10.5%) school-aged pupils wore footwear regularly, not regular and never respectively. There was significant difference (x^2 = 105, df = 4, p < 0.001; x^2 = 9.8, df = 2, p < 0.01; and x^2 = 16.2, df = 2, p < 0.001) in hygiene practice of wearing footwear when playing among age groups, sexes and study area respectively (Table 10).

Table 11 shows the analysis of hygiene practices of investigated school-aged pupils in the study area. Analysis of hygiene practices revealed that 33 (6.5%), 245 (48.6%) and 226 (44.8%) school-aged pupils sucked their fingernails regularly, not regular and never sucked their fingers nails respectively. There was also statistical significant difference (x^2 = 23, df = 4, p <0.001, x^2 = 6.1, df = 2, p < 0.05; and x^2= 6, df = 2, p < 0.05) in hygiene practices of regular sucking finger nails, not regular and never sucked finger nails respectively among age groups, sexes and study area. In the analysis of hand washing hygiene practice after defecation, it was found that 255 (50.6%), 165 (32.7%) and 84 (16.7%) school-aged pupils washed their hands regularly after defecation, not regularly and never respectively. There was significant difference (x^2 = 33.9, df = 4, p < 0.001; x^2= 10.5, df = 2, p < 0.01; and x^2 = 9, df = 2, p < 0.05) in hygiene practice of hand washing after defecation among age group, sexes and study area respectively. From the analysis of playing with bear fingers on soil, 152 (30.2%), 332 (63.9%) and 30 (5.9%) played with bear fingers on soil regularly, not regular and never respectively. There was statistical significant difference (x^2 = 14.8, df = 4, p < 0.01; x^2 = 9.4, df = 2, p < 0'01; and x^2 = 27.4, df = 2, p < 0.001) in playing with bear fingers on soil among age group, sexes and the study area respectively (Table 11).

Table 1: Demographic characteristics of participated school-aged pupils from The urban and rural areas.

Variable	Male		Female		Total males n%	Total females n%	Grand total
Age group	Urban	Rural	Urban	Rural			
4-6	50 (26.5)	50 (26.5)	44 (23.4)	44 (23.4)	100 (53.2)	88 (46.8)	188 (37.3)
7-9	44 (27.1)	44 (27.1)	37 (22.8)	37 (22.8)	88 (54.3)	74 (45.6)	162 (32,1)
10-12	35 (22.7)	35 (22.7)	42 (27.2)	42 (27.2)	70 (45.5)	84 (54.5)	154 (30.5)
Total	129 (25.5)	129 (25.5)	123 (24.2)	123 (24.2)	258 (51.2)	246 (48.8)	504 (100)

Table 2. Prevalence of soil-transmitted helminths infection by age, sex and study area

Variables	A. lumbricoides	Hook Worm	E. vermicularis	S. mansoni ova	A. lumbricoides & Hook Worm	Total	x^2	P- value
Age/year								
4 – 6	29 (30.5)	32 (33.7)	24 (25.3)	4 (4.2)	6 (6.3)	95 (42.9)		
7 – 9	21 (26.7)	17 (21.5)	29 (36.7)	7 (8.9)	5 (6.3)	79 (35.7)		
10 – 12	67 (30.3)	14 (29.8)	4 (8.5)	10 (21.3)	2 (4.3)	47 (21.2)		
Total		63 (28.5)	57 (25.7)	21(9.5)	13 (5.8)	221 (42.8)	60.1	0.001
Sex								
Male	36 (35.6)	23 (22.8)	25 (24.8)	12 (11.9)	5 (4.9)	101 (45.7)		
Female	31 (25.8)	40 (33.3)	32 (26.7)	9 (7.5)	8 (6.7)	120 (54.3)	19.6	0.001
Study area								
Urban	15 (36.6)	10 (24.4)	13 (31.7)	2 (4.9)	1 (2.4)	41 (18.5)		
Rural	52 (28.9)	53 (29.4)	44 (24.4)	19 (10.5)	12 (6.7	180 (81.4)	16.9	0.01

Table 3: Nutritional indices (Z-scores) of weight-for-age (underweight) of school-aged children in relation to age, sex and study area

Variables	Under-weight (acute malnutrition)	Severely underweight (Severe malnutrition)	Total (% underweight)	X^2	Df	p-value
Age/years:						
4 – 6	31 (43.1)	21 (41.2)	52 (42.3)			
7 – 9	29 (40.3)	18 (35.3)	47 (38.2)			
10 – 12	12 (16.7)	12 (23.5)	24 (19.5)			
Total	72 (14.28)	51 (10.11)	123 (24.4)	10	2	< 0.05
Sex:						
Male	20 (27.8)	29 (56.9)	49 (39.8)			
Female	52 (72.2)	22 (43.1)	74 (60.2)			
Total	72 (14.28)	51 (10.11)	123 (24.4)	3	1	> 0.05
Study area						
Urban	31 (43.1)	11 (21.6)	42 (34.1)			
Rural	41 (56.9)	40 (78.4)	81 (65.9)			
Total	72 (14.28)	1 (10.11)	123 (24.4)	3	1	> 0.05

Table 4: Nutritional indices (Z-scores) of height-for-age (stunting) in School-aged children by age, sex and study area

Variables	Stunted (acute malnutrition)	Severely stunted (severe malnutrition)	Total (stunted)	X^2	Df	p-value
Age/years:						
4 – 6	64 (52.5)	22 (35.5)	86 (46.7)			
7 – 9	45 (36.9)	33 (53.2)	78 (42.4)			
10 – 12	13 (10.7)	07 (11.3)	20 (10.9)			
Total	122 (24.20)	62 (12.3)	184 (36.5)	6. 3	2	> 0.05
Sex:						

Male	70 (57.4)	32 (51.6)	102 (55.4)			
Female	52 (42.6)	30 (48.4)	82 (44.6)			
Total	122 (24.20)	62 (12.3)	184 (36.5)	3	1	> 0.05
Study area:						
Urban	49 (40.2)	16 (25.8)	65 (35.3)			
Rural	73(59.8)	46 (74.2)	119 (64.6)	5	1	> 0.05

Table 5. Nutritional indices (Z-scores) of BMI-for-age (thinness) in school-aged pupils in relation to age, sex and study area.

Variables	Thinness (acute malnutrition)	Severe thinness (severe malnutrition)	Total (thinness)	X^2	df	p-value
Age/years:						
4 – 6	33 (45.8)	10 (30.3)	43 (42.2)			
7 – 9	25 (34.7)	17 (51.5)	42 (41.2)			
10 – 12	14 (19.4)	6 (18.2)	20 (19.6)			
Total	72 (14.2)	33 (6.54)	105 (20.8)	2.6	2	> 0.05
Sex						
Male	27 (37.5)	13 (39.4)	40 (30.1)			
Female	45 (62.5)	20 (60.6)	65 (61.9)			
Total	72 (14.2)	33 (6.54)	105 (20.8)	3	1	> 0.05
Study area:						
Urban	16 (22.2)	11 (33.3)	27 (25.7)			
Rural	56 (77.8)	22 (66.7)	98 (74.3)	3.2	1	> 0.05

Table 6. Total nutritional status of investigated school-aged pupils in Relation to underweight, stunting and thinness

Variables	Weight-for-age (underweight)	Height-for-age (stunting)	BMI-for-age (thinness)	Total	X2	df	p-value
Age/years							
4 – 6	52 (42.3)	86 (46.7)	43 (40.9)	181 (43.9)			
7 – 9	47 (38.2)	78 (42.4)	42 (40.0)	167 (40.5)			
10 – 12	24 (19.5)	20 (10.1)	20 (19.0)	64 (15.5)			
Total	123 (24.4)	184 (36.5)	105 (20.8)	412 (81.7)	19.1	4	< 0.001
Sex							
Male	49 (39.8)	102 (55.4)	40 (38.1)	191 (46.4)			
Female	74 (60.2)	82 (44.6)	65 (61.9)	221 (53.6)			
Total	123 (24.4)	184 (36.5)	105 (20.8)	4 12 (81.7)	7.1	2	< 0.05
Study Area							
Urban	42 (43.1)	65 (35.3)	27 (25.7)	134 (32.5)			
Rural	81 (65.9)	119 (64.7)	78 (74.3)	278 (67.5)			
Total	123 (24.4)	184 (36.5)	105 (20.8)	412 (81.7)	8.1	2	< 0.05

Table 7. Correlation analysis of mean nutritional status of the infected school-age pupils

Variables	Number examined	Number infected	Mean nutritional status Kg/m2
Age/years			
4-6	188	95 (42.9)	60.3
7-9	162	79 (35.7)	55.7
10-12	154	47 (30.5)	21.3
Total	504	221	137.3

r = 0.897

Table 8: Summary of nutritional indices (Z-scores) in relation to acute and severe malnourished school-aged children

Malnourished school-aged pupils	Nutritional indices		
	Weight-for-age (underweight)	Height-for-age (stunting)	BMI-for-age (thinness)
Number examined	504	504	504
Number below -2SD (acute malnutrition)	122	72	72
% of pupils below -2SD	24.2	14.3	14.3
Number below -3SD (severe malnutrition)	62	51	33
% pupils below -3SD	12.3	10.1	6.5
Mean Z-scores below -2SD	-1.508	-1.708	-1.438
Mean Z-scores below -3SD	-2.921	-2.4	-3.182

Table 9. Summary of Nutritional indices (Z-sores) of investigated School-aged pupils in rural and urban communities.

RURAL n = 258				URBAN n = 246		
	Weight-for-age - (underweight)	Height-for-age (stunting)	BMI-for-age (thinness)	Weight-for age (underweight)	Height-for-age (stunting)	BMI-for-age (thinness)
No below -2SD	112	69	60	72	54	45
% below -2SD	43.4	26.7	23.3	29.3	21.9	18.3
Mean Z-score	-1.475	-1.659	-1.708	-1.286	-1.38	-1.424
SD	1.265	1.612	1.321	1.321	1.136	1.166
No (%) of males below -2SD-	56 (21.7)	38 (14.7)	40 (15.5)	50 (19.4)	34 (13.8)	34 (13.8)
No (%) of females below -2SD	62(24.0)	56 (21.7)	56 (21.7)	34 (13.8)	34 (13.8)	32 (12.4)

Table 10. Demographic characteristics of school-aged pupils in relation to risk factors and sanitary practice

Variables	Age/years			Total	Sex		Total	Study Area	
Source of water	4-6	7-9	10-12		Male	Female		Urban	Rural
Tap water	87 (33.5)	90 (34.6)	83 (31.9)	260 (51.6)	138 (53.1)	122 (46.9)	260 (51.6)	232 (89.2)	28 (10.8)
River/Stream	80 (39.0)	68 (33.2)	57 (27.8)	205 (40.7)	96 (46.8)	109 (53.2)	205 (40.7)	2 (0.97)	203 (99.0)
Both	21 (53.8)	4 (10.3)	14 (35.9)	39 (7.7)	24 (61.5)	15 (38.5)	39 (7.7)	18 (46.2)	21 (53.8)
Total	188 (37.3)	162 (32.1)	154 (30.5)	504 (100)	258 (51.2)	246 (48.8)	504 (100)	252 (50.0)	252 (50.0)
p-value	$X2 = 11.6, df = 4, p < 0.01$				$X2 = 28.1, df = 2, p < 0.001$			$X2 = 36.3, df = 2, p < 0.001$	
Type of Toilet									
Open/Bush	52 (34.2)	48 (31.6)	52 (34.2)	152 (30.2)	93 (61.2)	59 (38.8)	152 (30.2)	7 (4.6)	145 (95.4)
Water Closet	89 (38.7)	70 (30.4)	71 (30.9)	230 (45.6)	105 (45.6)	125 (54.3)	230 (45.6)	176 (76.5)	54 (23.5)
Pit Toilet	47 (38.5)	44 (36.1)	31 (25.4)	122 (24.2)	60 (49.2)	62 (50.8)	122 (24.2)	69 (56.6)	53 (43.4)

p-value	X2 = 14.9, df = 4, p = 0.01				X2 = 82.1,df = 2, p < 0.001			X2 = 9.0, df = p < 0.05	
Wearing of shoes when playing									
Regular	68 (34.0)	59 (29.5)	73 (36.5)	200 (39.7)	83 (31.5)	117 (58.5)	200 (39.7)	142 (71.0)	58 (29.0)
Not regular	110 (43.8)	81 (32.3)	60 (38.9)	251 (49.8)	139 (55.4)	112 (44.6)	251 (49.8)	99 (39.4)	152 (60.6)
	10 (18.9)	22 (41.5)	21 (39.6)	53 (10.5)	36 (67.9)	17 (32.1)	53 (10.5)	11 (20.3)	42 (79.2)
p-value	X2 = 12.0, df = 4, p < 0.05				X2 = 9.8, df = 2, p < 0.05			X2 = 16.2, df = 0.001	

Table 11. Demographic characteristics of school-aged pupils in relation to risk factors and hygiene practices

Variables	Age/years			Total	Sex		Total	Study area	
Sucking of finger nails	4-6	7-9	10-12		Male	Female		Urban	Rural
Regular	21 (63.3)	10 (30.3)	2 (6.1)	33 (6.3)	11 (33.3)	22 (66.7)	33 (6.5)	15 (45.5)	18 (54.5)
Not regular	119 (48.6)	76 (31.0)	50 (20.4)	245 (48.6)	124 (50.6)	121 (49.4)	245 (48.6)	91 (37.1)	154 (62.9)
Never	48 (21.2)	76 (33.6)	102 (45.1)	226 (44.8)	123 (54.4)	103 (45.6)			
p-value,	X2 = 23, df = 4, p < 0.001				X2 = 6.1, df = 2, p < 0.05			X2 = 6, df = 2, p < 0.05	
Hand washing after defecation									
Regular	80 (31.4)	75 (29.4)	11 (39.2)	255 (50.6)	125 (49.0)	130 (50.9)	255 (50.6)	161 (63.1)	94 (36.9)
Not regular	76 (46.1)	40 (24.2)	49 (29.7)	165 (32.7)	85 (51.5)	80 (48.5)	165 (32.7)	84 (50.9)	81 (49.1)
Never	32 (38.1)	47 (55.9)		84 (16.7)	48 (57.7)	36 (42.9)	84 (16.7)	7 (8.3)	77 (91.6)
p-value	X2 = 39.9, df = 4, p < 0.001				X2 = 10.5, df = 2, p < 0.01			X2 = 9, df = 2, p < 0.05	
Playing with bear fingers on soil									
Regular	61 (40.1)	42 (27.6)	49 (32.2)	152 (30.2)	85 (55.9)	67 (44.1)	152 (30.2)	52 (34.2)	100 (65.8)
Not regular	117 (36.3)	104 (32.3)	101 (31.4)	322 (63.9)	167 (51.9)	155 (48.1)	322 (63.9)	187 (58.0)	135 (41.9)
Never	10 (33.3)	16 (53,3)	4 (13.3)	30 (5.9)	6 (30.0)	24 (80.0)	30 (5.9)	13 (43.3)	17 (56.7)
p-value	X2 = 14.8, df = 4, p < 0.01				X2 = 9.4, df = 2, p < 0.01			X2 = 27.4, df = 2, p < 0.001	

IV. DISCUSSION

In this study the overall prevalence of stunting was observed in 36.5% of the school-aged pupils and 12.3% of severely stunted study population. This prevalence is similar to the report of Omitola et al., (2016) who recorded an overall stunting prevalence of 35.1% and 13% of severely stunted study population. Also the study conducted in India with school going adolescents, reported an overall prevalence of 44% stunting and observed 14% of severe stunting in the study participants (Dey et al., (2011). In this present study, male school-aged pupils were more stunted (55.4%) than females (44.6%). According to Anand et al., (1999), growth deficit tend to accumulate with age and particularly in boys, therefore overall prevalence of stunting among school age children in Haryana was 39% with a higher proportion in males (41%) than females (37%). As important as daily intake of protein source is to children growth and development, sustaining the feeding habit in extreme rural or poor setting where parents are either unemployed, peasant farmers or low income earners is a challenge (Omitola et al., 2016). This study recorded an overall 24.4%, 36.5%, and 20.8%, of underweight, stunting and thinness conditions respectively, of school-aged pupils in the study areas. The underweight result reported in this study is higher when compared to 5.3% underweight reported by Wanga et al., (2012) in Uganda. However, the 24.4% underweight condition reported in this study is slightly less compared with 52.6%, 51.7% and 60% recorded by Omitola et al., (2016), Oseiet et al., (2010) and Medhi et al., (2006) respectively. The difference between these studies and the present study could be due to differences in the dietary diversity of children or economic status in the general population (Zerdo et al., (2017). It was also observed that school-aged pupils in the rural area were more underweight (65.9%) than their urban counterpart (34.1%). This study indicated that 20.8% school-aged pupils revealed thinness condition while 6.5% showed severe thinness. This prevalence is higher than 9.3% and 13.7% previously reported for preschool age children in a peri-urban settlement of Ogun State and school children in urban and peri-urban area of Ouagadougou in Burkina Faso respectively (Debone, 2011). The prevalence of soil-transmitted helminthiasis in the study population was 43.8%. This infection rate agrees with the report of Elkannah et al., (2017) and Mordi et al., (2011) who recorded high prevalence of intestinal helminthes infection in school children of Zing communities in Taraba State and school children in Aniocha South Local Government Area, Delta state respectively. The higher prevalence rate of soil-transmitted helminthes in the study population could also be attributable to the risk factors associated with no availability of water supply and toilet facilities in schools as earlier reported (Kelechi et al., 2015). From this study, the infection rate appears to be decreasing with age since age group 4-6 years had the highest (42.9%) prevalence as compared to 21.2% infection rate of age group 10-12 years. This finding corroborates that of Elkanah et al., (2017) who recorded highest prevalence rate of infection among 5-7 age groups. This trend may be due to the fact that as children advance in age, they are able to take care of themselves by reducing the rate of playing with soil and also take care of their drinking water (Abera et al., 2013). This study showed variation in prevalence rate of soil-transmitted helminthes infection between urban (18.5%) and rural (81.4%) in the study areas and attributed it to improper hygiene, poverty, poor sanitary conditions and agricultural habits. It could further be argued that the home communities of urban children are more conscious of parasitic infections and have little advantage of better sanitation and improve personal hygiene than rural communities.

Ascaris lumbricoides and hookworms were the most common soil-transmitted helminthic infection identified in this study. The occurrence of 5.8% multiple infections identified in this study is in line with several earlier reported stidies: (Opara et al., (2012), Kelechi et al., 2015; Nematian et al., 2004; Sanchez et al., 2013). This observation is not unconnected with poor sanitary and hygiene practices shown in the study area. The multiple infections observed in this study is in accordance with the studies of Zerdo et al., (2017) and Opara et al., (2012) who reported similar infections in Ethiopia and Nigeria respectively. The overall relationship between the infected and the mean nutritional indices of school-age children in this current study was strongly correlated (r = 0.897). This agrees with the work of Elkannah et al., (2017) who observed similar trend among school children in Zing Local Government Area, Taraba State, Nigeria.

Ascertaining the potential association of soil-transmitted helminths and risk factors, the study revealed that 84.2% of school-aged children who drank from river or stream and 67.4% who commonly defecate in the bush were mostly infected with soil-transmitted helminths. This finding is in agreement with the study of Adefioye et al., (2011). The use of pit toilets and nearby bush reflects the poor socio-economic status of the study population and soil-transmitted helminthes thrive and flourish in such communities where pupils in the school had no access to clean water supply and good toilet facility (WHO, 2010). It was also observed from the study subject that 81.6% of children infected with soil-transmitted helminthes through the risk factors were actually from the rural area. The predisposition of rural children with high infection rate may be due to the fact that majority of these children were from poor farmers and low socio-economic group, where little or no attention is given to proper hygiene practices.

The significant difference observed between soil-transmitted helminthes and the associated risk factors is consistent with the study carried out by Tilahun et al., (2015) in Durbite Town, North Western Ethiopia. Furthermore, habits of not wearing shoes and not washing hand regularly after defecating and before eating were associated with increased odds of STH infection (Alemu et al., (2011).

However, the analysis of risk factors in this study was based on prevalence and not burden of infection. Lack of information on the burden of infection with helminthes among our study participants is a limitation for further research work.

Likewise malaria and other gastrointestinal parasites were not determined and their role on children's nutritional status cannot be ruled out. It was also observed that this study did not entail an exhaustive investigation of underlying causes of malnutrition, example food security, dietary intake and expenditure and others. We therefore suggest that future research should take these into consideration.

In conclusion, soil-transmitted helminthes infections and malnutrition remains a public health concern and threat to school-aged children in Biase and Calabar South Local Government Areas. The study showed high prevalence of soil-transmitted helminthes infection among the study population, an indication of poor state of hygiene and high level of carriers especially within the rural communities. The adverse effect of soil-transmitted helminthes infection cannot be over looked in impaired growth, a strong positive relationship between helminthes and malnutrition among the study population calls for a greater concern. The current school feeding programme sponsored by the federal government of Nigeria need to be improved, by providing school-aged pupils with varieties of food types including protein rich food so as to reduce the prevalence of malnutrition condition in them.

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COMPETING INTEREST

This study was not sponsored by organizations or individuals, and therefore the authors have declared no competing interest.

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