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Relationship between Intestinal Helminthiasis and the Nutritional Status of School Children in Obio/Akpor Local Government Area, Rivers State.

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Abstract
Background:
Intestinal helminthiasis is associated with malnutrition in children.
Aim:
The objective of this study was to assess the relationship between intestinal helminthiasis and the nutritional status of school children Obio-Akpor LGA, Rivers State,Nigeria.
Subjects and Methods:
It was a descriptive cross-sectional study of 367 children conducted in Obio/Akpor LGA of Rivers, south-south Nigeria between September and November 2016. The physical growth of the pupils was classified as stunting, underweight and thinness using height for age Z- score, weight for age Z-score and BMI for age Z- score below 2 standard deviation of the reference median respectively, in the World Health Organization reference standard. Their stool samples were collected and examined for helminth eggs using Kato- Katz technique analyzed at the department of the Medical Microbiology laboratory, University of Port Harcourt Teaching Hospital. Data was analyzed using Statistical Software for Social Sciences version 17.0 (Chicago IL, USA). p value of 0.05 was regarded as statistically significant.
Results:
Fourteen out of 275 children (WAZ was not calculated for children >10) (5.1%) were underweight, 42/367 were stunted (11.4%) and 38/367 were underweight (10.4%). Twenty of the 367 (5.4%) were affected by helminth.There was no significant relationship between helminth infection and the nutritional status of the children. Three of 161 children resident in urban community compared to 17 of 206 living in a rural community were infested with intestinal helminths. Multivariate analysis showed that children drinking from wells and streams were ten times at risk of being infested with intestinal helminths.
Conclusion:
The prevalence of intestinal helminthiasis in children in Obio-Akpor LGA, Rivers State was low. There was no association between intestinal helminthiasis and nutritional status of the children.
Keywords: *Nutritional status, Children, Helminthic infection.*

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I. Introduction

Intestinal helminthic infestations are major health problems worldwide, especially in the tropical and sub-tropical countries.[1] It is estimated that over a quarter of the world's population is infested with intestinal worms; of whom 1.47 billion have roundworm, 1.30 billion have hookworm and 1.05 billion have whipworm.[2]Children aged 5 – 12 years make up the group with the highest infestation rate and worm burden, which contribute greatly to the contamination of the environment, poor sanitation and hygiene.[3] These parasites have been shown to cause poor appetite, intestinal abnormalities, poor absorption or increased loss of nutrient, whichmay result in protein-energy malnutrition.[4] In addition, *Ascaris lumbricoides* is closely associated with increased risk of childhood asthma, potentiating sensitization to allergens and causing acute pulmonary hypersensitivityresponses (eosonophilic pneumonitis) as the juvenile parasites pass through the host's lungs.[5] Hookworm infestations are noted for their contribution to iron deficiency anaemia which is probably the most significant cause of nutritional stress resulting from intestinal helminthic infestations.[6] Chronic infestations with whipworms can cause persistent blood loss from dysentery leading to anaemia, protein loss and malnutrition.[7]

One of the global health problems faced in developing countries today is malnutrition.[8] Intestinal helminths have been documented as major contributory factors.[9] Malnutrition causes over half of child deaths in many developing countries and affects the physical and mental development of the child.[10] Malnutrition and intestinal helminthiasis often coexist in the same geographical locations with the same individuals experiencing both conditions.[11,12] Growth stunting and anaemia are indicative of chronic malnutrition[13] while infestations whichinclude intestinal helminthic infestations are common factors that can accelerate or exacerbate malnutrition.

Adefioye et al[14] conducted a study among among 304 students aged 1 to 15 years in Osun State; they reported that 17.0% of their subjects were below the third percentile for weight (wasting) and 14.0% were below the third percentile for size (stunting). There was a relationship between the intensity of infection and wasting.

Among school-age children in both Brazil and Mexico,[15, 16] intestinal parasitic infestations have been shown to have a negative impact on various anthropometric indices. Similarly, a study done in Uganda[10] among school children aged 9–15 years revealed that 26.6%, 46% and 10.3% of incidence of stunting, underweight and moderate acute nutrition were attributed to the potential influence of intestinal helminth infestations. A study done by Al-Mekhlafi *et al*[11] in Malaysia revealed that improvement in children's growth after treatment provided indirect evidence of the relationship between intestinal helminthic infestations and malnutrition. This suggests that when helminthias is undermines malnutrition, if properly treated, there is an opportunity to improve the nutritional status of children.

In light of the above results, the question is whether it is possible that the anthropometric index deficits in the studies cited above are due to possible helminthic infestations or whether there might be other contributing factors.

This study, therefore, aimed at investigating the relationship between intestinal helminthiasis and nutritional status of school children in Obio/Akpor local Government Area of Rivers State. It will also seek to determine the prevalence and intensity of intestinal helminth infestations. The outcome of this study will help to determine whether helminthic infestations should be given priority as a risk factor for malnutrition among children attending primary schools. It will also draw attention to the impact of the helminth infestation as an important aspect of school health, and to the corresponding importance of effective programs designed to improve the health, hygiene and nutrition of school-age children.[17]

II. Subjects And Methods

This was a cross-sectional study. The study was carried out in primary schools located in Obio/ Akpor Local Government Area of Rivers,South-south of Nigeria between September and November 2016. River state is located in the tropical rain forest zone.It is characterized by heavy rainfall from April to October ranging from 2000 to 2500mm with high temperatures all the year round and a relatively constant high humidity.The approval of the Ethics Committee of University of Port Harcourt Teaching Hospital was obtained before the commencement of the study. Notification and permission to carry out the study was obtained from the Rivers State Ministry of Education. Written consent was also obtained from the parents. The study population consisted of children attending private and public primary schools in Obio/Akpor, Rivers state. The body weight and height of the pupils were determined using the weighing scale and height pole respectively. Children with a history of receiving antihelminths in the last 3 months were excluded from the study. Fifteen out of 142 and 4 out of 24 of government approved schools in urban and rural areas of the community were randomly selected. A multi-stage sampling technique was used to select 367 pupils who were studied.

Weight measurement

Children were weighed using Health scale (OceanMedical, England) and read off to the nearest 100g (0.1kg). The Scale was adjusted to zero prior to each measurement and calibrated using a known weight monthly. Pupils were weighed in their schools with minimal clothing (underpants used for physical training).

Height measurement

For measurement of height, the subject had to stand straight on level floor, with buttocks, shoulders and back of the head touching the wall, with the heels flat and together, shoulder relaxed and arms hanging down, the head erect with eyes looking straight forward and the lower border of the orbit in line with the external auditory meatus (Frankfurt plane). The headpiece, a metal bar was lowered gently, pressing down the hair and height was measured.

Anthropometric assessment

The weight for age, height for age and body- mass index for age *Z*-scores of the subjects were determined using the World Health Organization (WHO) International Reference Standards.[18] Underweight, stunting and wasting were defined as *Z*-scores ≤ 2 SD of weight-for-age, height-for-age and BMI-for-age respectively. The pupils were stratified into socio-economic classes (I-V) based on Oyedeji classification.[19] Each pupil was awarded socio-economic index scores based on the occupation and educational attainment of the parents or their substitutes. The mean of four scores (two for the father and two for the mother) approximated to the nearest whole number was the social class assigned to the child. Class I is the highest socio-economic class, followed by class ll, III, IV and V.

Specimen collection and handling

The Stool was collected into a container provided by the investigator which had already been washed and air-dried. Stool samples passed on the collection day was accepted for examination by investigator under the supervision of the laboratory scientists. The stool samples were properly labelled and carried in cold box filled with ice packs and transportedto the Department of Medical Microbiology, University of Port Harcourt Teaching Hospital for analysis within 10hours of the collection. The samples were analyzed by investigators after proper training from certified microbiologist. The samples that could not be analyzed immediately were preserved using 100% formalin for examination at the next day.

Microscopic examination

The cellophane thick faecal smear technique described by Kato and modified by Katz *et al*[20] was used to examine for the parasites. A test kit comprising nylon meshes/ filters, cover-slips of pre-stained cellophane, spatulas, perforated plates and conversion tables for the determination of the number of the eggs per gram of faeces was utilized in the procedure.

III. Data analysis

Data entry was using the Microsoft Excel software and analyzed using version
17.0 of the Statistical Package for Social
Scientific software package (SPSS Inc, Chicago, IL). Anthropometric indices, weight-for-age z scores, height for age Z score and Body-mass-index-for-age Z scores, were calculated using WHO Autho Plus software. The potential influence of place of residence and other socio- demographic variables on the relationship between nutritional status and worm infestations were tested using multivariate logistic regression. A p-value of < 0.05 was considered to be statistically significant.

IV. Results

General characteristics

Three hundred and eighty four pupils were recruited into the study; 374 (98.4%) completed their questionnaires while 367 (95.6 %) of them returned with stool samples. A total of 17 were excluded because of incomplete data while 367 subjects were analyzed. Of these children, 206 (56.1%) were from schools in rural communities while 161 (43.9%) were from schools in the urban community.

The socio-demographic characteristic of the study population is shown in Table I. Out of 367 children studied 138 (37.6%) were males and 229 (62.4%) were females giving male: female ratio of 1: 1.6. The subjects were aged 5 and 12 years with mean age of 8.95±1.96 years. One hundred and eighty four (50.1%) of them were 8-10 years age group, 92 (25.1%) were 11-12 years age group and 91(24.8%) were 5-7 years age group. The weights of the subjects were 12.0-58.0 kg with a mean weight of 25.0±7.13kg. Two hundred and eighty one of their parents (76.6%) were of the lower social class, 73 (19.9%) were of middle class and 13 (3.5%) were of the upper class. Two hundred and six (56.1%) pupils lived with their parents in the rural area while 161 (43.9%) were urban dwellers.

Prevalence of helminths. Figure I show the prevalence of helminth infestation among the school aged children. An overall prevalence of 5.4% was recorded.

Nutritional Status of the School Children. Whereas 14/275 (5.1%) children were underweight, 42/376 (11.4%) was stunted and 38/376 (11.4%) was thin

Nutritional Status and Helminth Infestations among School Children. Table II shows the nutritional status among helminth infested and non-infested children. The prevalence rate of underweight among the infested pupils was 7.7% compared to 5.0% among their non-infested counterparts (p=0.501). The prevalence rate of stunting among the infested pupils was 20.0% compared to 11.5% among their non-infested counterparts (p=1.000). The prevalence rate of thinness among the infested pupils (20.0%) was compared to 10.4% among their non-infested counterparts (p=1.000).

Table III shows that the mean WAZ scores among helminth infested children were -1.00±0.91 compared to -0.18±1.12 among non-infested children (t-test =-2.152, p=0.032). The mean HAZ scores of helminth infested children was -1.00±1.03 compared to -0.03±1.34 in non-infested group (t=-3.188, p=0.002). The mean BMI scores of the helminth infested children was 16.12±2.70 compared to 15.63±2.17 among non-infested children(t=0.959, p=0.338).

Table IV shows the correlation between nutritional status and *Ascaris lumbricodes* infestation.There was positive correlations between underweight and *Ascaris lumbricoides* infestation (r=0.632) and a negative correlation between underweight and *Trichuris trichiuria* (r=-0.544). There was no statistically significant difference in the correlation of underweight and Ascaris infestation (p= 0.368) and Trichuris infestation (p= 0.343). There was a negative correlation between stunting and *Ascaris lumbricoides* (r=-0.549) and *Trichuris trichiuria* (r=-0.426). There was no statistically significant difference in the correlation of stunting and *Ascaris lumbricoides* (p=0.120) and *Trichuris trichiuria* (p=0.167).

Household Characteristics and Intestinal Helminths Infestation among School Children Table V shows the household characteristics and intestinal helminthic infestation among school children. The prevalence of intestinal helminth infestation was 33.0%, 25.0%, 4.9% and 4.1% among children who drank from wells, streams, taps (pipe-borne water) and borehole's (χ^2 = 9.266, p=0.023***).*** The prevalence of helminths was 4.6% among pupils who did not treat their water compared to 6.4% that treated their water (χ^2 =0.525**,** p=0.468). The prevalence of helminthic infestation was 8.9%, 7.1% and 5.0% among children that used pit latrine, open defecation and water cistern respectively (χ^2 = 1.844, p=0.555). The prevalence of helminthic infestation was 7.2% among children who did not wash their hands with soap after using the toilet compared to 5.0% that washed their hands with soap (p=0.554). The prevalence of helminthic infestation was 5.9% among children who did not wear shoes outside the house compared to 4.7% among children that wore shoes (χ^2=0.222, p = 0.638). The prevalence of helminthic infestation was 8.2% among children that wore sander compared to 0.0% that wore shoes (χ^2 = 7.332, p = 0.026).

Predictive Factors for Helminth Infection among School Children. Parameters with probability values less than 0.05 (place of residence, source of water in household, household floor material and footwear used at home) were selected into our logistic regression models accordingly to predict relationships with helminth infections (TableV1). Drinking from the well water and stream was the main predictors of intestinal helminth infestation among these children (β=2.320, 95% CI=2.02 to 51.20, p=0.005).

Tab I: Socio-demographic characteristics of the study population

Variables (N=367)	Frequency	Percentage (%)
Age category		
5-7 years	91	24.8
8-10 years	184	50.1
11-12 years	92	25.1
Mean age +SD (years)	8.95±1.96	
Mean weight +SD (Kg)		
Gender	25.0±7.13	
Male	138	37.6
Female	229	62.4
Social class		
Upper (I-II)	13	3.5
Middle(III)	73	19.9
Lower(IV-V)	281	76.6
Place of residence		
Rural	206	56.1
Urban	161	43.9

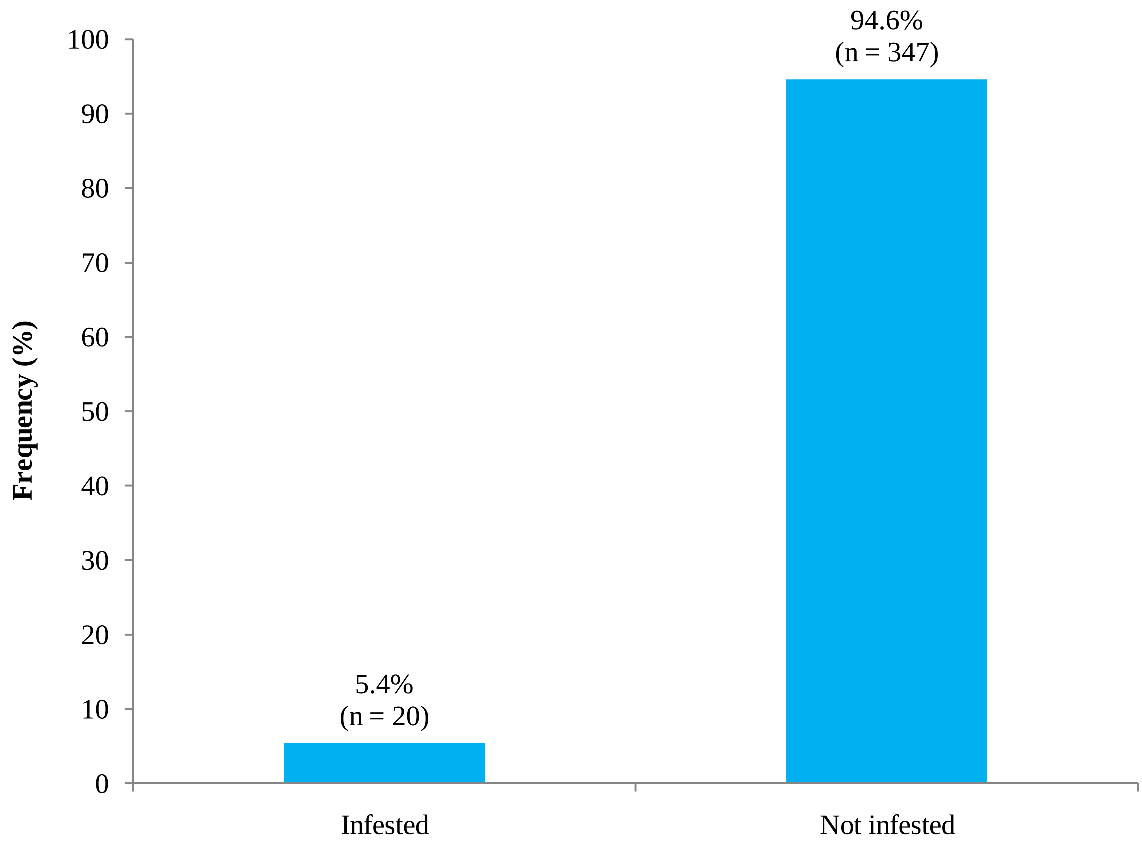

Fig 1: Prevalence of worm infestation among school children infested

Table II: Nutritional status among helminth infested and non-infested children

Variables	Intestinal helminth infestation: Infested n (%)	Intestinal helminth infestation: Not infested n (%)	Total n (%)
Weight-for-age-status			
Underweight	1 (5.0)	13 (3.7)	14 (3.8)
Normal weight	19 (95.0)	334 (96.3)	353 (96.2)
	Fisher's exact p-value = 0.550		
Height-for-age status			
Stunted	2 (20.0)	40 (11.5)	42 (11.4)
Not stunted	18 (80.0)	307 (88.5)	325 (88.6)
	Fisher's exact p-value = 1.000		
BMI-for-age classification			
Thinness	2 (20.0)	36 (10.4)	38 (10.4)
No thinness	18 (80.0)	311 (89.6)	329 (89.6)
	Fisher's exact p-value = 1.000		

Table III: Mean nutritional indices in infested and non-infested school children

Variables	Intestinal helminth infestation: Infested Mean ± SD	Intestinal helminth infestation: Not infested Mean ± SD	t-test	p-value
WAZ	-1.00±0.91	-0.18±1.12	-2.152	0.032*
HAZ	-1.00±1.03	-0.03±1.34	-3.188	0.002*
BMIAZ	16.12±2.70	15.63±2.17	0.959	0.338

*Statistically significant

SD – Standard deviation

WAZ- Weight for age Z score
HAZ- Height for age Z score
BMIAZ- Body mass index for age Z scores

Table IV: Correlation between nutritional status and type of egg infestation

Independent variables	*Ascaris lumbricodes* number of eggs		*Trichuris trichiuria* number of eggs	
	Correlation coefficient (*r*)	p-value	Correlation coefficient (*r*)	p-value
WAZ	0.632	0.368	-0.544	0.343
HAZ	-0.549	0.120	-0.426	0.167
BMIAZ	-0.085	0.842	0.216	0.501

Table V: Household characteristics and intestinal helminth infestation among school children

Variables	Intestinal helminth infestation				
	Infested n (%)	Not infested n (%)	Total n (%)	Chi-square/fisher's exact test	p-value
Source of water in household					
Tap	14 (4.9)	269 (95.1)	283 (100.0)	*9.266***	*0.023**
Borehole	3 (4.1)	71 (95.9)	74 (100.0)		
Well	2 (33.3)	4 (66.7)	6 (100.0)		
River	1 (25.0)	3 (75.0)	4 (100.0)		
Treatment of water in household					
Yes	11 (6.4)	162 (93.6)	173 (100.0)	*0.525*	*0.469*
No	9 (4.6)	185 (95.4)	194 (100.0)		
Type of toilet in household					
Water cistern	15 (5.0)	285 (95.0)	300 (100.0)	*1.844***	*0.555*
Pit latrine	4 (8.9)	41 (91.1)	45 (100.0)		
Public toilet	0 (0.0)	8 (100.0)	8 (100.0)		
No toilet (open air defecation)	1 (7.1)	13 (92.9)	14 (100.0)		
Use of soap for hand washing after toilet					
Yes	15 (5.0)	283 (95.0)	298 (100.0)	**	*0.554*
No	5 (7.2)	64 (92.8)	69 (100.0)		

*Statistically significant ** Fisher's exac

Table V: Household characteristics and intestinal helminth infestation among school Children continued

Variables	Intestinal helminth infestation				
	Infested n (%)	Not infested n (%)	Total n (%)	Chi-square / fisher's exact test	p-value
Home floor material					
Tiles	6 (3.3)	178 (96.7)	184 (100.0)	*8.179 ***	*0.030**
Earth	1 (12.5)	7 (87.5)	8 (100.0)		
Cement	8 (5.6)	134 (94.4)	142 (100.0)		
Rug	5 (15.2)	28 (84.8)	33 (100.0)		
Going outside without shoes					
Yes	6 (4.7)	122 (95.3)	128 (100.0)	*0.222*	*0.638*
No	14 (5.9)	225 (94.1)	239 (100.0)		
Footwear used at home					
Shoe	0 (0.0)	44 (100.0)	44 (100.0)	*7.332*	*0.026**
Sandal	17 (8.2)	191 (91.8)	208 (100.0)		
Neither	3 (2.6)	112 (97.4)	115 (100.0)		

*Statistically significant

Table: VI Logistic regression analysis for predictors of intestinal helminth infestation in school children

Independent variables	Coefficient (B)	Odds ratio	95% Confidence Interval		P-value
			Lower	Upper	
Place of residence					
Rural	1.215	3.370	0.91	12.54	0.070
Urban [R]		1			
Source of water in household					
Well/Stream	2.320	10.176	2.02	51.20	0.005*
Tap/Borehole [R]		1			

Household floor material					
Earth/Rug	0.981	2.668	0.89	8.02	0.081
Tiles/Cement [R]		1			
Footwear used at home					
Non-sandal use	1.284	3.612	0.96	13.57	0.057
Sandal use [R]		1			

*Statistically significant R – Reference category

V. Discussion

The overall prevalence of intestinal helminths in this study was 5.4%. This is comparable to a previous study in Jos, Nigeria[21] but was lower than that of a similar study in the same local government.[22] This variable rate in prevalence of intestinal helminths could be due to different methods employed in the analysis of the stool samples. Odu *et al*[22] used formol - ether concentration technique for stool analysis while Kato-Katz was used in this study. Formol - ether concentration technique is believed to have a sensitivity that is 15 to 50 times greater than the direct method.[23] This low prevalence could also be due to the fact that the various health campaigns have led to increased public awareness of intestinal infestations and some parents now routinely administer anthelmintic drugs to their children in Rivers State.

The prevalence of underweight in this study was 5.1 % which is less than the national average of 18% according to the 2013 National Demographic and Health Survey (NDHS).[24] It was comparatively lower than the rate reported in a study done in Ile-Ife, Osun State.[25] The reason could be that the study involved a wider age group ages (1 – 19 years) compared to 5 – 12 years in this present study. This low prevalence of underweight reported in this study may be attributed to the good feeding practices among the pupils and the routine de-worming programme that has been running in the State since 2012. A previous study [16] had shown improvement in children's growth after deworming.

The 11.4% prevalence of stunting recorded in this study is similar to what was reported in Jos.[26] It is much lower than studies done in Ethiopia [27] and Malaysia.[8] This difference is likely due to different nutritional intake, socioeconomic and cultural differences. The difference may also be due to the methodology used in the studies. The study in Ethiopia used the National Centre for Health Statistics/WHO reference values while the current study and the study in Malaysia used WHO AnthroPlus based on Z- scores.

The overall prevalence of thinness in this study was 10.4%. This is similarto an Ugandan study,[28] but less than 22.2% reported in semi-urbanprimary school children in Sagamu, Nigeria[29] and 13.7%previously reported for school children in urban and peri-urban areas of Ouagadougou – Burkina Faso.[30] The prevalence reported among the school children in Burkina Faso was associated with global economic and food crisis that hit Burkina Faso and this was responsible for reduced access to food particularly among the vulnerable school children.[30] Thinness was not significantly affected by gender in this study, a finding that is similar to that of another study.[31]

A strong reduction in the mean of the Z-scores for weight-for-age was observed in children infested with intestinal helminths, This finding is similar to study done in Ethiopia [32] where the probability of being underweight was significantly higher in children who were infested with intestinal helminths. This shows that the presence of worms undermines the health of these children as a result of the nutrient malabsorption that may subsequently lead to weight loss.[33] Furthermore, the mean of the Z-scores for height- for- age was lower in the infested pupils compared to their non-infested pupils. This was similar to a study done in Egypt [34] where stunting was noticed among helminth infested pupils compared to the non-infested pupils. Stunting is an indicator of chronic malnutrition, which has its origin in infancy. It, however, results from poor nutrition and is aggravated by infectious diseases like intestinal helminths.[35]

It may not be possible to give a cause-effect interpretation of this association since there was no significant correlation between helminthic infestation and nutritional status in the school children (p>0.05). It is recognized that studying the association between intestinal helminthiasis and nutritional status in endemic population is not an easy task as it is difficult to control for other environmental or socio-economic factors or seasonal changes in food supply.[4, 6] According to Assiset al,[36] the socio-economic and physical environment in which an individual lives are a major determinant of the degree of association between intestinal helminths and nutritional status. It is worth mentioning that there was no significant association between the prevalence of intestinal helminth infestations and low and high socio-economic classes (p>0.05).

The findings from multivariate analysis demonstrated that children who drank from wells and streams had ten times risk of being infested with intestinal helminths. This agrees with another study[37] in Port Harcourt but at variance with a study done in Turkey.[38] This may be due to contaminated soil particles that are washed into open wells and streams. When water is drawn from these wells and streams and used by households without boiling or treatment, the household gets infected by ingestion of the helminth eggs.[39]

Limitation of the study

In the present study, the dietary intake and energy expenditure as possible confounding factors were not considered in the relationship between intestinal helminthic infestations and nutritional status. The Weight-for-age Z scores (WAZ) was not calculated for children >10 as it is not recommended for the assessment of growth beyond childhood (>10 years).

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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