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ORIGINAL ARTICLE

The Impact of Intestinal Parasitic Infections on the Nutritional Status of Rural and Urban School-Aged Children in Nigeria

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ABSTRACT

Objectives

Intestinal parasitic infection and undernutrition are still major public health problems in poor and developing countries. The objective of this study was to assess the relationship between intestinal parasitic infection and nutritional status in 405 primary school children from rural and urban areas of Akwa Ibom State, Nigeria.

Methods

This cross-sectional survey in 2009 obtained anthropometric data, height-for-age (HA), weight-for-height (WH) and weight-for-age (WA) Z-scores from each child and fecal samples were also collected and screened for intestinal parasites using standard parasitological protocols.

Results

The prevalence of infection with any intestinal parasite was 67.4%. A total of six intestinal parasites were detected; hookworm (41.7%) had the highest prevalence. The prevalence of intestinal parasites and undernutrition was significantly higher in rural than in urban children ($P<0.001$). The prevalence of stunting ($HAZ < -2$), underweight ($WAZ < -2$) and wasting ($WHZ < -2$) for rural and urban children were 42.3% vs. 29.7%; underweight 43.2% vs. 29.6% and wasting 10.9% vs. 6.4%, respectively. With respect to nutritional indicators, the infected children had significantly ($P<0.05$) higher z-scores than the uninfected children. Multivariate logistic regression analysis showed that only Hookworm and *Ascaris lumbricoides* were each significantly ($P<0.05$) associated with stunting, wasting, and underweight.

Conclusions and Public Health Implications

Since intestinal parasitic infections are associated with malnutrition, controlling these parasites could increase the physical development and well-being of the affected children.

Key Words

Intestinal parasites • malnutrition • children • rural-urban • Nigeria.

Introduction

In developing countries, intestinal parasitism is a major public health problem that is often neglected. In these less developed countries, poor environmental and personal hygiene, poor nutrition, overcrowding and climatic conditions that favor the development and survival of these parasites are some of the factors contributing to the high level of intestinal parasites transmission[1-3]. School children carry the heaviest burden of the associated morbidity[4], due to their dirty habits of playing or handling of infested soils, eating with soiled hands, unhygienic toilet practices, drinking and eating of contaminated water and food[5].

There are documented reports implicating intestinal parasitic infection with poor nutritional status in children of school age[6-10]. Amoebiasis, Giardiasis, *Acariasis*, Hookworm infection, and *Trichuriasis* are among the most common intestinal parasitic infection worldwide. These infections are associated with decreased child growth, low plasma vitamin A, loss of weight, chronic blood loss, iron deficiency anemia, diarrhea, and stunted growth[4,11,12]. Alteration of the normal gastro-intestinal flora by intestinal parasites has been found to be associated with diarrhea, a major cause of childhood morbidity and mortality in developing countries[13].

There is a plethora of publications on prevalence and intensity of intestinal parasites in Nigeria,[2,3,14]. Surprisingly, there is paucity of information on the impact of these parasites on the nutritional status of their host, especially children. This study therefore aims to fill this gap in knowledge by investigating the association between intestinal parasitic infection and nutritional status of primary school children in rural and urban settings of Akwa Ibom State, Nigeria. The outcome may strengthen the global shift in the control of neglected tropical diseases.

Methods

Study Sites

The study was carried out in two primary schools in Akwa Ibom State, Nigeria. The schools are Methodist Primary School, Mbiabong Ikot Udofia in Ini Local Government Area (LGA), a typical rural setting and Government Primary School, Ikot Ntuen Oku, Uyo in Uyo Local Government Area (an urban setting). The two LGAs are in Akwa Ibom State. The State lies between latitudes 4°33' and 5°33 North and longitudes 7°35' and 8°25 East. It is characterized by humid tropical climate with annual rainfall reaching 23,000mm per annum. Temperature regime is uniform with annual values of 20.4°C to 35.7°C. The State has two distinct seasons, the rainy season from May to October, and the dry season from November to April. Pit latrine is common, while open air defecation is freely practiced.

Subjects

The study was carried out between April and November 2009. The study employed stratified random sampling to select the study subjects. For eligibility to participate in the study, a child had to be attending one of the selected schools. Each enrolled child's date of birth, age, gender, and occupation of parents was obtained from the class teacher's registers and recorded on a standardized field form. In each selected class, at least 40 pupils from each of the 6 educational grades were chosen at random.

Ethical Clearance

Prior to any enrollment of the children, permission was sought and obtained from the head-teacher of the respective schools and parents and/or guardian of the children. The study protocol was approved by the State Ministry of Health.

Anthropometric Measurement

Anthropometric measurements were carried out by a nutritionist (DCO) in the research team.

The subjects were weighed barefooted and in light clothing on a bathroom scale accurate to 0.1kg. The scale was standardized before use with 11kg weight. Height was measured to the nearest 1cm, with a paper stadiometer attached to a vertical wall. Subjects stood barefooted with their scapula, buttocks and heels' resting against a wall, the neck was held in a natural non-stretched position, and the heels were touching each other. Nutritional status indicators were classified and standardized into sex-specific Z-scores for height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) in EPI Info (version 3.2) relative to the CDC/WHO 1978 reference curves recommended for international use[15,16]. Children were classified as stunted, wasted, and underweight if their HAZ, WHZ and WAZ was < - 2 SD respectively.

Parasitological Examination

Each enrolled child was asked to provide a fresh fecal sample in cleaned and dried specimen bottles provided. The pupils were adequately instructed on how to get a little portion of their stool into the bottles. Their class teachers ensured compliance. The samples collected on each occasion were all examined in the University of Uyo Medical Center laboratory without preservation. Each fecal sample was examined as a smear stained with Lugol's iodine, as a direct wet smear in physiological normal saline and by formol-ether concentration technique[17-18]. Diagnosis was based on the identification of helminth ova and protozoan cyst in the sample during microscopic analysis. A child was considered to have a polyparasitic infection if they were found to be positive for more than one species.

Data Analysis

Categorical variables are presented as percentages and continuous variables as means and standard deviation (SD). Univariate analysis was carried out using the χ^2 test for proportion. The association between intestinal parasitic infection and nutritional indicators was tested using multivariate logistic regression. All statistical analysis was performed using version 14.0 of the SPSS for windows software package (SPSS Inc., Chicago IL).

Results

A total of 418 children (228 rural and 190 urban) were initially enrolled, the result presented below are the data for 405 children (220 rural and 185 urban) who returned suitable stool specimen after their anthropometric data were collected. There were 100 males and 120 females for rural areas and 105 males and 80 females for urban areas. The subjects were aged between 2.9 and 14 years, with a mean (SD) age of 8.5 (4.7). Table 1 summarizes the prevalence of intestinal parasite in the children. At least one species of intestinal parasite was found in 273 (67.4%) of the children examined. Prevalence of infection was significantly (P<0.001) higher among the rural (80.9%) children than among the urban (51.4%) children. Prevalence of hookworm was higher (55.9% vs. 24.9%) than all other parasites encountered from rural and urban children respectively (P<0.05). The other parasites were *A. lumbricoides* (30.5% vs. 16.8%); *T. trichiura* (4.1% vs. 5.4%); *G. lamblia* (3.2% vs. 2.2%) and *E. histolytica* (0.9% vs. 4.3%). The prevalence of polyparasitism is further shown in Table 1, one species of intestinal parasite were found in (49.1% vs. 32.4%) for rural and urban children respectively. The subjects co-infected with two species of parasites were (23.6% vs. 14.6%), while 8.2% vs. 4.3% were with 3 or more species of parasite in rural vs. urban children.

The age-specific prevalence of infection in rural children is presented in Table 2. Prevalence tends to increase with age, with the highest infection occurring in the age group of 12–14 years, for Hookworm and *Ascaris* infection. In urban children, the age group of 3–8 years had the highest infection rate (Table 3). The overall prevalence of nutritional indicators is presented in Table 4, stunting (42.3% vs. 29.7%); underweight (43.2% vs. 29.6%) wasting (10.9% vs. 6.4%) for rural and urban pupils respectively. Rural children were significantly (P<0.001) more malnourished than urban children. Only Hookworm and *A. lumbricoides* were significantly (P<0.001) associated with low height-for-age (stunting), weight-for-height (wasting) and weight-for-age (underweight). With respect to the nutritional indicators, the infected children had a significantly (P<0.05) higher Z-score than the uninfected children.

Table 1. Prevalence of Intestinal Parasites among Children in Rural and Urban Communities

Parasite	**Rural children No (%) infected n = 220**	**Urban children No (%) infected n = 185**	**All children No (%) n = 405**
Any	178 (80.9)	95 (51.4)	273 (67.4)
Hookworm	123 (55.9)	46 (24.9)	169 (41.7)
A. lumbricoides	67 (30.5)	31 (16.8)	98 (24.2)
T. trichiura	9 (4.1)	10 (5.4)	19 (4.7)
G. lamblia	7 (3.2)	4 (2.2)	11 (2.7)
E. histolytica	2 (0.9)	8 (2.3)	10 (2.4)
No. of intestinal parasite per child			
1	108 (49.1)	60 (32.4)	168 (41.5)
2.	52 (23.6)	27 (14.6)	79 (19.5)
>= 3	18 (8.2)	8 (4.3)	26 (6.4)

Table 2. The Age-Specific Prevalence of Intestinal Parasite among 220 Rural children

	Age (years)			
	3 – 5	**6 – 8**	**9 – 11**	**12 - 14**
No. of children investigated	32	84	66	38
No. infected with:				
Hookworm	15 (46.9)	47 (56.0)	36 (54.5)	25 (65.8)
A. lumbricoides	5 (15.6)	26 (30.9)	21 (31.8)	15 (39.5)
T. trihiura	0 (0)	7 (8.3)	2 (3.0)	0 (0)
G. lamblia	1 (3.1)	4 (4.8)	1 (1.5)	1 (2.6)
E. histolytica	1 (3.1)	0 (0)	1 (1.5)	0 (0)

Table 3. The Age-Specific Prevalence of Intestinal Parasite among 185 Urban Children

	Age (years)			
	3 – 5	**6 – 8**	**9 – 11**	**12 - 14**
No. of children investigated	57	51	45	32
No. infected with:				
Hookworm	16 (28.0)	14 (27.5)	9 (20.0)	7 (61.9)
A. lumbricoides	15 (26.3)	9 (17.6)	4 (8.9)	3 (9.4)
T. trihiura	5 (8.8)	3 (5.9)	1 (2.2)	1 (3.1)
G. lamblia	0 (0)	0 (0)	4 (8.9)	0 (0)
E. histolytica	3 (5.3)	1 (2.0)	0 (0)	0 (0)

Table 4. Summary of Nutritional Indices (Z-scores) of Rural and Urban Children

	RURAL			URBAN		
	Height-for-age (stunting)	Weight-for-age (underweight)	Weight-for-height (wasting)	Height-for-age (stunting)	Weight-for-age (underweight)	Weight-for-height (wasting)
No. examined	220	220	220	185	185	185
No. below –2SD	93	95	24	55	55	12
% below –2SD	42.3	43.2	10.9	29.7	29.7	6.5
Mean z-score	-1.602	-1.717	-1.511	-1.942	-1.834	-1.501
SD	1.70	1.11	1.41	1.53	1.44	1.23
SEX						
No. (%) of boys						
Below –2SD	40 (40.0)	48 (48.0)	14 (14.0)	33 (31.4)	36 (34.3)	7 (6.7)
No. (%) of girls						
Below –2SD	53 (44.2)	47 (39.2)	10 (8.3)	22 (27.5)	18 (22.5)	5 (6.3)

Discussion

Generally intestinal parasitic infection abounds in developing countries[18], with school children carrying the heaviest burden of the associated morbidity[20, 21].

The prevalence of 67.4% recorded in this study is consistent with 70%, 70.8%, 62.0% obtained in Kwara, Ogun and Plateau States of Nigeria respectively[22-24]. Such high prevalence has been attributed to poor environmental and personal hygiene, shortages of clean potable water and indiscriminate defecation[13]. School children from the rural areas (80.9%) were significantly more infected than children from the urban areas (51.4%). This finding corroborates the report of Hurtado et al.[25] that a high prevalence of intestinal parasites is consistent with what is found throughout indigenous population in the rural tropical areas. The prevalence obtained for intestinal parasites in the rural areas of the present study is consistent with 82.6% obtained by Ukpai and Ugwu[26] in Southern Nigeria. In rural areas, ignorance, unhealthy socio-cultural and religious practices, lack of basic public amenities, poor sanitation, poverty and inadequate access to health care are major predisposing factors to intestinal parasitic infections[27]. This study observed the above factors in the rural community where the school is located. The school used in the present study lack adequate toilet facility. There is complete absence of potable water, student obtain their water from nearby stream that might have been contaminated with fecal matter. Evidently, students defecate indiscriminately in the bushes around the school premises as observed with fecal littering, which were likely to contain ova and/or cyst of parasites. The 51.4% prevalence obtained in urban children in this study, though lower than the rural prevalence, is relatively high. The result is similar to the 54.7% and 50.6% recorded by Egwunyenga and Ataikiru[2] and Igbinaso et al.[28] in Delta and Anambra States of Nigeria respectively. It is possible that the home communities of the urban children are more aware of parasitic infections and have slightly better sanitation and improved personal hygiene than rural communities. Furthermore access to health care is within the reach of the urban children. Despite all these factors, the relatively high prevalence connotes continuous infection, re-infection and transmission of intestinal parasites.

The occurrence of poly parasitism in this study is in line with what is obtained elsewhere in the tropics and subtropics[4, 26, 29-30]. The commonest was the co-infection of hookworm and *A. lumbricoides*. No individual had up to four parasites. Hookworm was the most prevalent. The poor fecal disposal system coupled with the fact that most of the children play barefooted might have exposed them to infective stage of the hookworm larvae. The use of excreta as manure commonly practiced by vegetable farmers might also be acting as a veritable source of infection since children and their mothers often go to the farm to tender the vegetables[20]. Ukoli[31] described warmth, shade, moisture, optimum temperature of 230C to 300C and loose humus soil as suitable environmental conditions for the survival of hookworm egg and larvae. Since these conditions are almost similar to the climatic conditions of the study area, it is possible that the longevity of hookworm eggs and larvae in soil and on vegetation might have been enhancing transmission. Other workers elsewhere have reported a high prevalence of hookworm infection in their studies[3,30,32,33]. Hookworm and Ascaris infection increased with age among the rural children, while children aged 3–5 years in the urban area had the highest prevalence for the two parasites. No single age group had the highest prevalence for all the intestinal parasites detected.

This present study recorded a high degree of malnutrition among the children investigated for intestinal parasitic infections. These findings agree with the publication of other investigators[6,8,9,33,34]. The high rate (>=30%) of stunting and underweight recorded in this study might be due to high prevalence of hookworm, *Ascaris* and *Trichuris*. It has been documented by Crompton and Neisheim[34] that growth and development during childhood could be diminished by ascariasis, trichiuriasis and hookworm infection. Multivariate analysis showed a significant association between hookworm, *Ascaris* and anthropometric parameters suggesting that these helminths affect the nutritional status of the studied children. While this present study did not obtain a significant association between nutritional indicators and protozoan parasites *(G. lamblia, E. histolytica)*, similar studies in Tehran and Brazil by Nematian et al.[9] and Carvalho Costa et al.[8] respectively, recorded a significant association between *G. lamblia* and nutritional status. According to Assis et al.[35] the social, economic and physical environment in which an individual lives are major determinant of the degree of association between intestinal parasites and nutritional status. These factors might be responsible for the difference observed in this study when compared with others elsewhere. Although causes of malnutrition are multifactorial intestinal parasitic infections have been associated with impaired growth[9,36,37] and stunting[12] in diverse population. There are several mechanisms by which intestinal parasitism may cause or aggravate malnutrition including impaired nutrient absorption resulting from infection and reduced appetite[34]. Adult helminth worms residing in the small intestine are in an excellent position to interfere with their host nutrition and can induce damage to the intestinal mucosa that may reduce a person's ability to extract and absorb nutrient from food[38]. Intestinal parasitic infections can cause vomiting, diarrhea, anorexia, abdominal pain and nausea that may result in reduced food intake, thereby further reducing nutrient availability[36,39]. The most significant cause of nutritional stress resulting from helminth infection is hookworm associated iron-deficiency anemia. It is documented that light hookworm infections of 20 – 50 adults worms can result in significant iron losses[37]. Even mild to moderate intensity helminth infection during childhood have been associated with undernutrition and reduced physical fitness[39,40]. All these factors singly or collectively might have contributed to the high degree of malnutrition observed in this study.

Conclusions and Public Health Implications

A weakness of the present study is that no attempt was made to determine biochemical indicators of malnutrition and the intensities of the infection, as a consequence, the actual cause(s) of wasting recorded in the study could not be ascertained. Intestinal parasitism is one of the neglected tropical diseases that remain a common public health problem in most developing countries. With the current global economic meltdown, dietary inadequacies and other forms of nutritional stresses, the harboring of heavy intestinal parasites by children could have adverse health implications. Hence, there is the need for policy makers to intensify health education program in schools. School-based education may be an effective way of reaching the larger population, parents and families of the student and other members of the community. In view of the high prevalence of intestinal parasites recorded in this study, mass chemotherapy will be of immense benefit on child growth, development and cognitive abilities.

Intestinal parasitic infections affect childhood development and morbidity in many developing countries. Reducing the prevalence of parasitic infections in school children, may be of tremendous benefit on child growth, development and educational outcome.

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