Helminthic Infestation in Children Aged 6 to 59 Months with Diarrhea in Calabar

Kelechi Uhegbu[1], Vincent M. Uhegbu[2], Komomo Eyong[1], Joanah M. Ikobah[1], Emmanuel E. Ekanem[1]

Departments of [1]Paediatrics and [2]Internal Medicine, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria

Abstract

Background: Helminthic infections and diarrheal diseases have remained public health problem worldwide, especially in developing countries. Children below five years of age are at a higher risk. This study therefore aims to determine the prevalence, and intensity of intestinal helminths in children with and without the diarrheal disease. **Materials and Methods:** This was a cross-sectional analytical study of 130 children aged 6 to 59 months, carried out in the Children Emergency Room and the Diarrhea Treatment and Training Unit of the University of Calabar Teaching Hospital (U. C. T. H), Calabar, Nigeria. Those admitted with and without diarrhoea were consecutively recruited. Data were obtained by administration of questionnaires to parents/caregivers whose children met the inclusion criteria. Clinical examinations including anthropometric parameters (weight and length/height) were carried out on all the children recruited for the study while mid-upper arm circumference was done for children aged 12–59 months. Stool samples were collected from each child into a wide mouth universal, clean, dry, leak-proof, container, with the help of their parents/guardians. Microscopy was carried out on the stool samples collected within 1 h in the microbiology laboratory for the presence of ova, larva, or worm segment using direct microscopy with saline and iodine wet preparation and formol ether concentration. Ova were identified and quantified. The type of worm and intensity were recorded. **Results:** Out of the 130 children, 65 (50%) had diarrhea while the other 65 (50%) were without diarrhoea. The mean age of subjects with diarrhea was 16.86 ± 11.7 months and 17.60 ± 9.9 months for those without diarrhoea. There was no significant difference in sex distribution between the age groups ($P = 0.86$). The overall prevalence of intestinal helminthic infection in the study population was 1.5%. The prevalence of intestinal helminths in those with diarrhea and those without diarrhea was 3.1% and 0.0%, respectively, ($P = 0.496$). Only *Ancylostoma duodenale* (hookworm) was isolated in those with diarrhea and it was of light intensity. There was no significant difference in the method of disposal and source of water, comparing subjects having diarrhea and those not having diarrhea ($P > 0.05$). The proportions of subjects that usually played in the sand, go on footwear outside home, and go on footwear at home, were not significantly different comparing those having diarrhea and those not having diarrhea ($P > 0.05$). **Conclusions:** The prevalence rate of intestinal helminths in children with and without diarrhoea was low. There was general environmental cleanliness and personal hygiene in the study population which were likely responsible for the low helminthic infection thus emphasizing the need for maintenance of good hygiene, access to good water supply and periodic intake of anti-helminthic drugs in view of the public health importance of helminthic infection and diarrhoea.

Keywords: Calabar, children, diarrhea, intestinal helminths

Introduction

Helminthic infections and diarrheal diseases have remained public health problems worldwide, especially in developing countries.[1,2] Despite the replacement of the Millennium Development Goals by the Sustainable Development Goals three aimed at ensuring healthy lives and promoting well-being for all at all ages, helminthic infections and diarrhoeal diseases have remained global burdens.[3,4] It is estimated that two billion people or 24% of the world's population are infected with soil-transmitted helminthic infections.[5-7] According to a 2015 report of the WHO, approximately 0.807–1.221 billion humans have Ascariasis, 604–795 million have Trichuriasis, and 576–740 million have Hookworm infestation worldwide.[6] These infections are widespread in Africa with high prevalence rate in Nigeria.[6,8-10] Over 270 million preschool-age children,

Access this article online

Quick Response Code:

Website: www.njmonline.org

DOI: 10.4103/NJM.NJM_69_21

Address for correspondence: Dr. Kelechi Uhegbu, Department of Paediatrics, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria.
E-mail: kelechi4u2001@yahoo.com

How to cite this article: Uhegbu K, Uhegbu VM, Eyong K, Ikobah JM, Ekanem EE. Helminthic infestation in children aged 6 to 59 months with diarrhea in Calabar. Niger J Med 2021;30:433-45.

Submitted: 23-Apr-2021 **Revised:** 20-May-2021
Accepted: 19-Jun-2021 **Published:** 17-Aug-2021

live in areas where these helminths are intensively transmitted.[6] In Nigeria, the prevalence of intestinal helminthic infection ranges between 15.75%and72% which indicates the magnitude of the disease burden.

Common intestinal helminths include *Ascaris lumbricoides, Strongyloides stecoralis, Enterobius vermicularis, Trichuris trichiura, Ancylostoma duodenale, Necator americanus, Taenia saginata and Taenia solium*.[11]

Intestinal helminths cause chronic infections and can live in the intestine for years without causing symptoms.[12-17] The clinical presentation depends on the intensity of infection and the organs involved. The intensity of the infection which could also be referred to as the worm burden is classified by the WHO as either light moderate or heavy worm burden. This is measured by the number of eggs per gram (EPGs) of faeces and varies for the different helminths.[18-26]

Diagnosis of intestinal helminths requires a high index of suspicion with laboratory evidence using macroscopy and microscopic examination of stool samples. Direct smear with formol ether faecal concentration technique were employed in several studies and have been found to be ideal for use in resource-poor settings.[18,19]

Diarrhea remains among the leading causes of morbidity and mortality in children in developing countries.[20] Globally, 1.7 billion cases of diarrhea are seen annually and it accounts as the fourth leading cause of death among children younger than five years.[20,27] In developing countries, poor sanitation and substandard living conditions create an environment in which diarrheal pathogens exact a terrible toll, especially among children.[14-32]

Considering the duration of the diarrhoea, it could either be acute, persistent, or chronic.[30] Diarrhoea could otherwise present as dysentery.[30] Diarrhea results in dehydration and electrolyte derangement. In severe cases, vascular collapse, shock and metabolic acidosis occur. It also has major effects on nutrition as a result of loss of nutrients from stool, effect of the infection on body metabolism and the erroneous practice of withholding of feeds during diarrhea.[30] Despite the use of oral rehydration therapy, mortality is still high in developing countries.[30]

Intestinal helminthic infections and diarrhoeal disease can occur at any age but children, under five years of age are at a higher risk.[27,33-35] In the past, only heavy worm burdens have been associated with significant morbidity but in recent times lower worm burdens have been seen to be associated with demonstrable clinical effects such as growth retardation, anaemia and a detrimental effect on cognition and educational development in children.[11,36-40] Majority of these effects are also seen in diarrheal disease which share similar epidemiological characteristics.[30] As a result recurrent diarrhoeal disease is also expected in children with intestinal helminthic infection and vice versa.[1,34]

When both infections occur concurrently in children, they are at a much higher risk of a continuous cycle of impairing growth, micronutrient levels, physical fitness, cognitive function and work productivity than when they occur independently.[36]

Most studies[33,41] have documented helminths as a cause of diarrhea but only few studies[34,36,42-43] have shown that both infections could occur concurrently. Helminths and diarrhea also share similarities in their epidemiological characteristics and predisposing factors for which it may be expected that children with diarrheal disease may have a higher prevalence of intestinal helminthiasis not necessarily helminth being a cause of diarrhoea.[36] Diarrheal disease may therefore present an opportunity to deworm children in our environment.

This study is, therefore, necessary to determine the prevalence of intestinal helminthiasis in children with diarrheal disease. A proactive approach in identifying such children at the health facility through routine stool microcopy for helminths and treating with anti helminths following treatment of diarrhea would go a long way in reducing morbidity and mortality including long-term complications.

Materials and Methods

Study area

The study was conducted at the Children Emergency Room (CHER) and the Diarrhoea Treatment and Training Unit (D. T. T. U.) of the U. C. T. H, Calabar. The CHER of UCTH is a 20-bed unit where children needing emergency care are admitted. The D. T. T. U. is a subunit of the CHER and its a five-bed unit. The unit was established in 1995 and provides a 24-h service. The D. T. T. U. is a unit that treats children with diarrhea using Oral Rehydration Salt (ORS) or intravenous fluid where indicated. The unit trains mothers on the prevention of diarrhea and the use of ORS Solution. In addition, DTTU offers training for medical students, nurses, house officers, and residents.

The average rate of admission into the CHER is about 1189 patients per year or 175 patients per month while the average rate of admission into the D. T. T. U. is about 265 per year or 35 patients per month (hospital records).

U. C. T. H, is situated in Calabar Municipality, Calabar, Cross River State. Cross River State is situated in the south-south geopolitical zone of Nigeria. Calabar, the state capital (comprising both Calabar Municipality and Calabar South Local Government Area) has a population of approximately 371,022 people.[44] The inhabitants are predominantly Efiks, Ibibios, Ejaghams. Their main occupations are civil service, trading, farming, and tourism.[44] It is the tourism destination of Nigeria and it is clean and green.[44]

Study population

Subjects for this study were consecutive admissions to the D. T. T. U. of the U. C. T. H aged 6 to 59 months with diarrhea who met the inclusion criteria. The control group were consecutive admissions from CHER consisting of children aged 6 to 59 months without diarrhea who met the inclusion criteria.

Study design

The study was a cross-sectional and analytical whose **s**ubjects were consecutive admissions to the D. T. T. U. of the U. C. T. H aged 6 to 59 months with diarrhea who met the inclusion criteria. The control group were consecutive admissions from CHER consisting of children aged 6 to 59 months without diarrhea who met the inclusion criteria.

Sample size determination

The minimum sample size of patients for this study was calculated using the sample size, randomisation and probability theory formula of Jekel JF *et al*.[45]

$$N = \frac{P_1(1P_1)+P_2(1P_2)+(Z\alpha + Z\beta)^2}{(P_1P_2)^2}$$

To adjust for nonrespondents, 10% of the minimum sample size was added to the minimum sample size.

The minimum sample size for each group was 65.

Total sample size was130 subjects.

Sampling technique

Children presenting with or without diarrhea, who met the inclusion criteria were consecutively recruited into the proposed study.

Ethical consideration

Ethical approval was obtained from the Health Research Ethics Committee of the U. C. T. H. A signed or thumb printed informed written consent was obtained from caregivers of eligible patients before recruitment into the study after a detailed explanation of the nature of the study to them. Parents or guardians of children in CHER and DTTU were given a copy of the consent which they read to gain a good understanding of the nature of the study. It was also explained to parents to enable them understand that they were at liberty to withdraw their children or ward from the study without negative consequences.

The questionnaire was interviewer administered to the caregivers with the help of research assistants. The identity of the patient was kept confidential. The results of microscopy were communicated to the guardians and managing paediatricians for early commencement of appropriate therapy.

Selection criteria

Inclusion criteria for subjects: Children who were aged 6 to 59 months with any type of diarrhea who had not taken anti helminths in the previous 3 months.[7,46,47]

Inclusion criteria for controls: Children who were aged 6 to 59 months with conditions other than diarrhea who had not had diarrhea in the previous 3 months. Children who had not taken anti helminths in the previous 3 months.[7,46,47]

Exclusion criteria for subjects and controls: Children who had severe acute malnutrition[48] and clinical features of immunodeficiency such as Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome.[49-51] Children who had any chronic disease likely to affect immune competence such as sickle cell anaemia and chronic renal disease.[50-53] Children whose parents gave consent.

Data collection

Data were collected with the use of interviewer-administered questionnaires.

Assessment of clinical parameters

When consent was obtained from parents or guardians, the child's biodata, information on present illness, past medical history and anthropometric measurements were obtained. The anthropometric measurements taken were weight, length/ height, and mid-upper arm circumference.[54]

Social classification

Participants were stratified into social class based on the Oyedeji[55] classification of social class.

Specimen collection

A teaspoon size of fresh formed faecal specimen or ten millilitres of the fluid fecal specimen, was collected into a wide mouth universal, clean, dry, leakproof, container by the investigator and assistants. The container was free from all traces of antiseptics and disinfectants.[18]

Specimen transport

The fecal specimen was transported to the microbiology laboratory by the investigator, within 1 h of collection. Samples which did not arrive at the laboratory within 1 h were preserved with ten percent v/v formol saline from the laboratory.

Specimen macroscopy

The appearance of the specimen, colour, consistency, presence of blood, mucus and whether the blood was mixed in the faeces or on the surface which indicates rectal or anal bleeding was noted.[18]

The presence or absence of parasitic worms or tapeworm segments were reported.[18]

Specimen microscopy

Direct microscopy was done using saline and iodine wet preparations of the stool specimen to detect the presence of ova or larva and flagellates. The concentration of parasites was done using the formol ether concentration technique. This involved the addition of 3–4 ml of 10% v/v formol water to about a gram of feces in a universal container which was then capped and shaken vigorously to mix. The emulsified feces was sieved to remove fecal debris and the faecal solution mixed with 3 ml diethyl ether. The preparation was centrifuged at 1500 r. p. m. for 5 min.[10] The sediment was transferred to a clean grease-free slide, covered with a coverslip and viewed microscopically. The presence and type of ova or larva of parasites were reported.[10]

Identification of ova and larvae

The number of each species of egg present and by extrapolation the worm burden was evaluated using Stoll's technique of faecal parasites egg count. This was done by mixing 3 g of faeces with 42 ml of formol water (or 0.1 mol/L NaOH if stool was formed) to give a 1:15 dilution of faeces. A wide bore Pasteur pipette was used to collect 150 µl of the suspension onto a clean grease-free microscope slide.[18] The preparation was covered with a long cover glass and examined under the microscope. The slide preparation was systematically examined to look for and count all eggs present. Eggs lying outside the edges of the cover glass were included. The intensity, which was defined as the EPG of faeces was determined by multiplying the number of eggs counted by 100 for the stool sample that was formed and by 5, 4, 3, or 2 for the specimen that was fluid, watery unformed, soft unformed or semiformed, respectively.[18,56-58]

Interpretation of results

The presence of worm segments on macroscopy and ova or larvae of intestinal helminth on microscopy of stool sample indicated that the patient had been infected. The positive result was used to calculate the prevalence, intensity, and type of intestinal helminthic infection in those with diarrhea and those without diarrhoea.[18] Subjects with positive results were treated with mebendazole daily for 3 days.[59]

Data analysis

Statistical analysis was performed using the SPSS version 22.0 software (Statistical Package for Social Sciences) (Chicago, United States of America). Categorical and quantitative variables were compared using Chi-square and Student's *t*-test, respectively. Pearson's correlation was performed to establish the linear relationship between continuous variables. Multivariate logistic regression was used to determine the predictors of the outcome while controlling for anticipated confounders. The level of statistical significance was fixed at $P < 0.05$.

Social classification

Oyedeji[55] classification of social class.

Points	Occupation	Level of Education
1	Senior Public Servants, Professional, Managers, Large scale traders, Businessman contractors	University graduate and equivalent
2	Intermediate grade public servant and Senior School teachers	Secondary School Certificate (A level) with teaching or other professional training
3	Junior School Teachers, Drivers, Artisan	Secondary School certificate (O level) or Grade II teachers Certificate holders or equivalent
4	Petty traders, labourers, messengers and similar grade	Primary school education
5	Unemployed	Can just read and write or illiterate

The sum of father's occupation and education scores plus mother's occupation and education scores divided by 4 gives the social class.

Scores: 1-2-High social class economic class
2.1to 3– Middle Social economic class
3.1-5– Low social-economic class.

Results

Sociodemographic characteristics of study population

One hundred and thirty subjects were recruited into the study, equally distributed among those having diarrhea (65, 50%) and those not having diarrhea (65, 50%). The mean age was 17.2 ± 10.8 months, ranging from 6 to 59 months. There was no statistically significant difference in mean age, comparing subjects having diarrhea (16.86 ± 11.7 months) and those that did not have diarrhea (17.60 ± 9.9 months) $t = 0.39$, $P = 0.70$ [Table 1]. Furthermore there was no significant difference in the proportions of the different categories of age groups, tribes, and the number of children in the family, comparing subjects having diarrhea and those not having diarrhea $P > 0.05$ [Table 1].

Ninety-eight subjects (75.4%) were in the upper social class, while the rest were in middle (29, 22.3%) or lower (3, 2.3%) classes. There was no significant difference in social class comparing subjects having diarrhea and those not having diarrhea $P > 0.05$ [Table 1].

All subjects had weight, height and MUAC percentile scores within normal limits of 3rd to 97th percentile. There was no significant difference in the weight percentile score comparing those having diarrhea and those not having diarrhoea $P = 0.16$ [Table 2].

Sixty-eight subjects (68, 52.3%) did not exclusively breastfeed, but there was no significant difference in frequency of nonexclusive breastfeeding, comparing those having diarrhea and those not having diarrhea (58.5% vs. 46.2%, $P = 0.16$) [Table 2].

Table 3 summarised the hygiene and physical protection practices**.** The most common method of fecal disposal was the use of water closet (97, 74.6%). There was no significant difference in the method of disposal comparing subjects having diarrhea and those not having diarrhea $P = 0.214$ [Table 3]. The commonest method of disposal of household wastes was the use of Calabar Urban Development Agency street bins (111, 85.4%), followed by the use of pit (10, 7.7%). There was no significant difference in the method of disposal comparing subjects having diarrhea and those not having diarrhea $P = 0.384$ [Table 3]. Most subjects (124, 95.3%) had their source of water treated, and there was no difference in source comparing subjects having diarrhea and those that were not having diarrhea $P = 0.68$ [Table 3]. There was no significant difference in the categories of mothers who washed their hands before eating and after defecating, comparing subjects having diarrhea and those not having diarrhea $P > 0.05$ [Table 3].

The proportions of subjects that usually played in sand, go on footwear outside the home, and go on footwear at home, were not significantly different comparing those having diarrhea and those not having diarrhea $P > 0.05$ [Table 3].

Two of the subjects with diarrhea had intestinal helminths giving a prevalence of 3.1% [Figure 1]. None (0.0%) of the

Table 1: Sociodemographic characteristics of study population (*n*=130)

Variable	Frequency (%)			χ^2 statistic	*P*
	Those having diarrhea (*n*=65)	Those not having diarrhea (*n*=65)	Total		
Age (months)					
<10	20 (38.5)	20 (38.5)	40 (30.8)	Fisher's exact	0.99
10-19	22 (32.3)	22 (32.3)	44 (33.8)		
20-29	12 (15.4)	12 (15.4)	24 (18.5)		
30-39	7 (7.7)	7 (7.7)	14 (10.8)		
40-49	3 (4.6)	3 (4.6)	6 (4.6)		
50-59	1 (1.5)	1 (1.5)	2 (1.5)		
Sex					
Male	33 (50.8)	32 (49.2)	65 (50.0)	0.03	0.86
Female	32 (49.2)	33 (50.8)	65 (50.0)		
Tribe					
Ibibio/Annang	17 (26.2)	20 (30.8)	37 (28.5)	2.20	0.53
Efik	16 (24.6)	13 (20.0)	29 (22.3)		
Ejagham	10 (15.4)	15 (23.1)	25 (19.2)		
Others	22 (33.8)	17 (26.1)	39 (30.0)		
Number of children in family					
≤3	57 (87.7)	54 (83.1)	111 (85.4)	0.56	0.46
>3	8 (12.3)	11 (16.9)	19 (14.6)		
Father's highest educational level					
None	0	2 (3.1)	2 (1.5)	Fisher's exact	0.32
Primary	2 (3.1)	2 (3.1)	4 (3.1)		
Secondary	18 (27.7)	24 (36.9)	42 (32.3)		
Tertiary	45 (69.2)	37 (56.9)	82 (63.1)		
Mother's highest educational level					
None	0	1 (1.5)	1 (0.8)	Fisher's exact	0.24
Primary	1 (1.5)	0	1 (0.8)		
Secondary	20 (30.8)	27 (41.6)	47 (36.2)		
Tertiary	44 (67.7)	37 (56.9)	81 (62.2)		
Social class					
Upper	51 (78.5)	47 (72.3)	98 (75.4)	Fisher's exact	0.55
Middle	12 (18.5)	17 (26.2)	29 (22.3)		
Lower	2 (3.0)	1 (1.5)	3 (2.3)		

children without diarrhea had helminthic infection [Figure 1] giving an overall prevalence of intestinal helminths among those with and without diarrhea to be 1.5% among the study population. There was no significant difference in the prevalence of intestinal helminthic infection in those with diarrhea compared with those without diarrhea ($P = 0.496$).

Helminthic specie isolated was Hookworm (*A. duodenale)* with light intensity (1–4999) [Table 4].

Prevalence of helminthic infection was not statistically significant among subjects comparing age groups, $P > 0.05$ [Table 5]. There was no significant difference in the prevalence of helminthic infection found comparing age groups, sex, level of education, and social classes [$P > 0.05$, Table 5].

Among subjects with diarrhea, there was no significant difference in the prevalence of helminthic infection comparing all the sociodemographic characteristics [$P > 0.05$, Table 6].

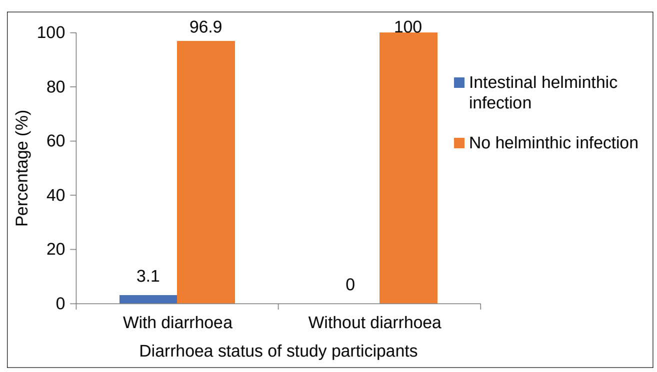

Figure 1: Bar chart showing prevalence of intestinal helminthic infection ($n = 130$)

All subjects with helminthic infection had diarrhoea, with no significant difference in the prevalence of diarrhea comparing each of the sociodemographic characteristics [$P > 0.05$, Table 7].

Table 2: Anthropometric and breastfeeding characteristics of subjects (*n*=130)

Variable	Frequency (%)			χ^2 statistic	*P*
	Those having diarrhea (*n*=65)	Those not having diarrhea (*n*=65)	Total		
Weight percentile					
≤20	23 (35.4)	5 (7.7)	28 (21.5)	14.75	0.16
41-60	31 (47.7)	44 (67.7)	75 (57.7)		
>80	11 (16.9)	16 (24.6)	27 (20.8)		
Height percentile					
≤20	15 (23.1)	5 (7.7)	20 (15.4)	6.22	0.10
41-60	36 (55.4)	46 (70.8)	82 (63.1)		
>80	14 (21.5)	14 (21.5)	28 (21.5)		
MUAC percentile					
≤20	10 (26.3)	13 (23.6)	23 (24.7)	0.09	0.77
41-50	28 (73.7)	42 (76.4)	70 (75.3)		
Exclusively breastfed?					
Yes	27 (41.5)	35 (53.8)	62 (47.7)	1.97	0.16
No	38 (58.5)	30 (46.2)	68 (52.3)		

MUAC: Mid upper arm circumference

Discussion

The overall prevalence rate in the current study is 1.5%. This rate is at variance with a much higher prevalence rate of 49.7%, reported in a study by Anah *et al*.[61] The findings of Anah *et al*.[61] were obtained from a rural setting bordering Calabar.[37] The present study setting being a metropolitan city, has the benefit of a cleaner and more hygienic environment, with better waste disposal system compared with rural settings.[62-65] There is also good drainage system and potable water supply sponsored by the World Bank which is available to most of the residents in the city of Calabar.[62-65] A hygienic environment has fewer available secondary hosts, therefore breaking the helminthic cycle and limiting transmission to susceptible individuals.[1,66-68] In the study by Anah *et al*.,[61] majority of the children were from the low social class whose parents are peasant farmers and the children walk about barefooted.[61] Lack of footwear in soil-infested farms, coupled with poor access to potable water and poor hygiene in rural settings, increases the risk of helminthic infestation.[61]

In this study, the prevalence rate of intestinal helminths in those with diarrhea and in those without diarrhea was 3.1% and 0.0%, respectively. There was no statistically significant difference in the prevalence of both groups. The absence of statistically significant difference in the prevalence of intestinal helminthic infection, comparing both groups suggests that there may not be an association between intestinal helminthic infection and diarrhea though they have similar predisposing factors. However, with such a low prevalence of infection, no strong conclusion can be made. Most studies[33,34,69] in Nigeria looked at intestinal helminths as a cause of diarrhea not necessarily as co-morbidity despite similarities in their epidemiological characteristics.[33-34]

Transmission of intestinal helminths is enhanced when individuals who are asymptomatically affected continue to shed eggs for years in addition to poor personal hygiene and poor handwashing practices.[11,70] Elimination of these risk factors results in reduction in soil contamination by ova of helminths, thus reducing infectivity.[28,71-73] In this study, the low prevalence (3.1%) of intestinal helminths in those with diarrhoea, is most likely associated with the low transmission rate of intestinal helminths which is attributable to the good personal and environmental hygiene in the locale of study.[28,37] Most of the respondents in this study were from the higher social class and used water closets as a mode of faecal disposal thus limiting the risk of soil contamination by feces. In addition, regular emptying of street bins, sweeping of streets and good drainage system in Calabar, Nigeria may have contributed to a low transmission rate resulting in the low prevalence seen.[62-65]

The prevalence obtained in this study is similar to that of Tinuade *et al*.[34] in Ilesa, Nigeria in terms of the age range used, and also the same hospital setting. Ansari *et al*.[41] in Nepal had similar findings with that seen in the current study. In their study on helminthic infection in children with diarrhea, a prevalence of 1.3% was seen. They conducted their study in an urban setting with good access to water supply which corroborates the reason for low prevalence in the present study. However, findings in the current study differed from findings by Moore *et al*.[36] carried out in a rural region in Brazil, where a high prevalence of intestinal helminths (51%) amongst children with diarrhea was seen. The high prevalence of intestinal helminths in children has been associated with poverty, low maternal education and poor hygiene.[70]

In this study, zero prevalence in those without diarrhea was seen. The study population used in this study was lower when compared with other studies and this may contribute to the zero prevalence seen despite adequate methods used in diagnosing. A relatively higher proportion of respondents were in the high social class with better hygiene when compared with the subjects selected in other studies.[5,74-76] Reduction in soil

Table 3: Hygiene and physical protection practices among study subjects (n=130)

Variable	Frequency (%)			χ^2 statistic	*P*
	Those having diarrhea (n=65)	Those not having diarrhea (n=65)	Total		
Method of faecal disposal					
Pit latrine	3 (4.6)	4 (6.2)	7 (5.4)	Fisher's exact	0.214
VIP	11 (16.9)	8 (12.3)	19 (14.6)		
Bush	6 (9.2)	1 (1.5)	7 (5.4)		
Water closet	45 (69.3)	52 (80.0)	97 (74.6)		
Method of household waste disposal					
Bush	5 (7.7)	2 (3.1)	7 (5.4)	Fisher's exact	0.384
Burning	0 (0.0)	2 (3.1)	2 (1.5)		
Pit	4 (6.2)	6 (9.2)	10 (7.7)		
CUDA	56 (86.1)	55 (84.6)	111 (85.4)		
Source of drinking water					
Treated	63 (96.9)	61 (93.9)	124 (95.3)	Fisher's exact	0.680
Untreated	2 (3.1)	4 (6.1)	6 (4.7)		
Maternal hand washing before eating					
Always	15 (37.5)	27 (30.0)	42 (49.3)	1.818	0.611
Sometimes	17 (42.5)	46 (51.1)	63 (48.5)		
No	8 (20.0)	17 (18.9)	25 (19.2)		
Maternal hand washing after defecating					
Always	19 (47.5)	33 (36.7)	52 (40.0)	1.43	0.489
Sometimes	14 (35.0)	36 (40.0)	50 (38.5)		
No	7 (17.5)	21 (23.3)	28 (21.5)		
Child picks things from ground					
Always	19 (29.2)	25 (38.5)	44 (33.8)	3.12	0.374
Sometimes	30 (46.2)	27 (41.5)	57 (43.8)		
No	16 (24.6)	13 (20.0)	29 (22.4)		
Child playing in the sand (n=117)					
Always	16 (29.1)	27 (43.5)	43 (36.8)	2.65	0.265
Sometimes	22 (40.0)	19 (30.6)	41 (35.0)		
No	17 (30.9)	16 (25.9)	33 (28.2)		
Child going on footwear outside the home (n=117)					
Always	24 (45.3)	22 (35.5)	46 (40.0)	1.14	0.564
Sometimes	24 (45.3)	33 (53.2)	57 (49.6)		
No	5 (9.4)	7 (11.3)	12 (10.4)		

CUDA: Calabar urban development agency, VIP: Ventilated improved pit

Table 4: Helminthic infection type and intensity

Type of helminths	Light infection, n (%)	Moderate infection, n (%)	Heavy infection, n (%)	Total, n (%)	Fisher's exact (*P*)
Hookworm	2 (100)	0	0	2 (100)	0.999
Others*	0	0	0	0	

*Enterobius vermicularis, Ascaris lumbricoides, Trichuris trichiura, Strongyloides stercoralis, Taenia saginata and Taenia solium

contamination as a result of the cleanliness of the study area, may have contributed to the low prevalence seen.[65]

The high prevalence (48.08%) of intestinal helminths seen by Ezeagwuna *et al*.[5] was linked to the prevailing unhygienic environment, poor personal hygiene, and poverty. Thomas *et al*.[74] in Kaduna, had a prevalence of (15.75%) for intestinal helminths and their findings were also linked to lack of adequate toilet facilities. These risk factors were absent amongst most of the respondents in the study population of the present study thus supporting the findings of a low prevalence.

Within Africa, similar disparities are noted as seen in studies by Mokua *et al*.[75] (86%) in Kenya, Abossie and Seid[76](63%) in southern Ethiopia, and Knopp *et al*.[77] (73.7%). These studies[75-77] were all done in rural settings with exposure to risk factors such as poor environmental hygiene which was absent in the present study. To effectively reduce helminthic infection, sanitation must be improved.[78]

This prevalence in this study differed significantly in comparison with studies by Lim *et al*.[79] in rural Malay where an overall prevalence of intestinal helminths of 37% was seen.

Table 5: Relationship between sociodemographic characteristics and infection status (*n*=130)

Variable	Infected, *n* (%)	Uninfected, *n* (%)	Total, *n* (%)	Fisher's exact (*P*)
Age group				
0-9	0	41 (100)	41 (100)	0.47
10-19	1 (2.3)	43 (97.7)	44 (100)	
20-29	0	25 (100)	25 (100)	
30-39	1 (7.7)	12 (92.3)	13 (100)	
40-49	0	6 (100)	6 (100)	
50-59	0	1 (100)	1 (100)	
Sex				
Male	2 (3.1)	63 (96.9)	65 (100)	0.15
Female	0	65 (100)	65 (100)	
Number of children group				
≤3	2 (1.8)	109 (98.2)	111 (100)	0.56
≥4	0	19 (100)	19 (100)	
Educational level of father				
None	0	2 (100)	2 (100)	0.76
Primary	0	4 (100)	4 (100)	
Secondary	0	42 (100)	42 (100)	
Tertiary	2 (2.4)	80 (97.6)	82 (100)	
Educational level of mother				
None	0	1 (100)	1 (100)	0.75
Primary	0	1 (100)	1 (100)	
Secondary	0	47 (100)	47 (100)	
Tertiary	2 (2.5)	79 (97.5)	81 (100)	
Social class				
Upper	2 (2.0)	96 (98.0)	98 (100)	0.72
Middle	0	29 (100)	29 (100)	
Lower	0	3 (100)	3 (100)	
Source of drinking water				
Treated	2 (1.6)	122 (98.4)	124 (100)	0.91
Untreated	0	6 (100)	6 (100)	
Method of fecal disposal				
Pit latrine	0	7 (100)	7 (100)	0.88
VIP	0	19 (100)	19 (100)	
Bush	0	7 (100)	7 (100)	
Water closet	2 (2.1)	95 (97.9)	97 (100)	
Household waste disposal management				
Bush	0	7 (100)	7 (100)	0.01
Burning	0	2 (100)	2 (100)	
Pit	2 (20.0)	8 (80.0)	10 (100)	
CUDA	0	111 (100)	111 (100)	

CUDA: Calabar urban development agency, VIP: Ventilated improved pit

Relatively higher proportion of mothers in my study were educated when compared with the study by Lim *et al*.[79] This may have contributed to the disparity in the prevalence seen.

Hookworm was the only intestinal helminth seen among those with diarrhea and the intensity was low. The method of diagnosis in this study was by direct microscopy using saline and iodine wet preparations with the concentration of helminths using formol ether faecal concentration techniques. These methods have been found to be useful in the identification of a wide range of helminths. Hookworms have been associated with risk factors such as economic underdevelopment, poverty in the tropics and subtropics, walking bare feet and eating contaminated foods.[5] Surprisingly, the subjects with helminths belonged to the high social group which is in contrast to what is known about helminthic infection. This group is supposed to attain high level of hygiene.[80,81] Most likely these kids may have been left with caregivers with the low level of hygiene. Although most respondents wore shoes outside the home, infection may have been feco-oral which is associated with infection with *A. duodenale* as against *N. americanus* which is transmitted only through penetration of the soles of the feet.[6,7]

The low intensity seen may be attributable to the low transmission rate and low infectivity in the locale of the study.

Table 6: Sociodemographic characteristics and helminthic infection among subjects with diarrhea (*n*=65)

Variable	Infected, *n* (%)	Uninfected, *n* (%)	Total, *n* (%)	Fisher's exact (*P*)
Age group				
0-9	0	16 (100)	16 (100)	0.47
10-19	1 (4.3)	22 (95.7)	23 (100)	
20-29	0	15 (100)	15 (100)	
30-39	1 (12.5)	7 (87.5)	8 (100)	
40-49	0	3 (100)	3 (100)	
Sex				
Male	2 (6.2)	30 (93.8)	32 (100)	0.15
Female	0	33 (100)	33 (100)	
Number of children group				
≤3	2 (3.7)	52 (96.3)	54 (100)	0.52
≥4	0	11 (100)	11 (100)	
Educational level of father				
None	0	2 (100)	2 (100)	0.67
Primary	0	2 (100)	2 (100)	
Secondary	0	24 (100)	24 (100)	
Tertiary	2 (5.4)	35 (94.6)	37 (100)	
Educational level of mother				
None	0	1 (100)	1 (100)	0.46
Primary	0	0	0	
Secondary	0	27 (100)	27 (100)	
Tertiary	2 (5.4)	35 (94.6)	37 (100)	
Social class				
Upper	2 (4.3)	45 (95.7)	47 (100)	0.67
Middle	0	17 (100)	17 (100)	
Lower	0	1 (100)	1 (100)	
Source of drinking water				
Treated	2 (3.2)	61 (96.8)	63 (100)	0.94
Untreated	0	2 (100)	2 (100)	
Method of fecal disposal				
Pit latrine	0	4 (100)	4 (100)	0.64
VIP	0	8 (100)	8 (100)	
Bush	0	1 (100)	1 (100)	
Water closet	2 (3.8)	50 (96.2)	52 (100)	
Household waste disposal management				
Bush	0	2 (100)	2 (100)	0.01
Burning	0	2 (100)	2 (100)	
Pit	2 (33.3)	4 (66.7)	6 (100)	
CUDA	0	55 (100)	55 (100)	
Exclusive breastfeeding				
Yes	1 (2.9)	34 (97.1)	35 (100)	0.50
No	1 (3.3)	29 (96.7)	30 (100)	

CUDA: Calabar urban development agency, VIP: Ventilated improved pit

This is however not surprising as the study population has good personal and environmental hygiene.[63,65] Another explanation for the low intensity may be as a result of infrequent exposure to those infected by the helminths. This is attributable to anti helminthics which have been incorporated into the national program on immunization and its implementation has apparently been effective in Calabar.[60]

Most studies[5,33,34,61,82] in Nigeria, found Ascaris to be more prevalent when compared with other helminths. Anah *et al*.[70] in their study in a rural area bordering Calabar, found Ascaris (64.4%) to be more prevalent. Ogunlesi *et al*.[34] in their study carried out on children below five years, found Ascaris to be more prevalent (23.3%). They attributed their findings to rampant use of antihelminth drugs which favours low transmission rate and low infectivity even though most of their respondents were of low socioeconomic status which favors a higher transmission rate. Other studies[82,83] in the northern part of Nigeria found Ascaris to be more prevalent. Comparison of these other studies with the present study is difficult because of the low prevalence of infection. Tropical countries like Nigeria with warm wet

Table 7: Relationship between sociodemographic characteristics and diarrhea status among subjects with helminthic infection (*n*=2)

Variable	Diarrhea present, *n* (%)	Diarrhea absent, *n* (%)	Total, *n* (%)	Fisher's exact (*P*)
Age (months)				
<10	0	0	0	0.999
10-19	1 (100)	0	1 (100)	
20-29	0	0	0	
30-39	1 (100)	0	1 (100)	
40-49	0	0	0	
50-59	0	0	0	
Sex				
Male	2 (100)	0	2 (100)	0.999
Female	0	0	0	
Number of children group				
≤3	2 (100)	0	2 (100)	0.999
≥4	0	0	0	
Educational level of father				
None	0	0	0	0.999
Primary	0	0	0	
Secondary	0	0	0	
Tertiary	2 (100)	0	2 (100)	
Educational level of mother				
None	0	0	0	0.999
Primary	0	0	0	
Secondary	0	0	0	
Tertiary	2 (100)	0	2 (100)	
Social class				
Upper	2 (100)	0	2 (100)	0.999
Middle	0	0	0	
Lower	0	0	0	
Exclusively breastfed				
Yes	1 (0.0)	0 (100)	1 (100)	0.999
No	1 (0.0)	0 (100)	1 (100)	
Source of drinking water				
Treated	2 (0.0)	0 (100)	2 (100)	0.999
Untreated	0	0	0	
Method of fecal disposal				
Pit latrine	0	0	0	0.999
VIP	0	0	0	
Bush	0	0	0	
Water closet	2 (0.0)	0 (100)	2 (100)	
Method of household waste disposal				
Bush	0	0	0	0.999
Burning	0	0	0	
Pit	2 (0.0)	0	2 (100)	
CUDA	0	0	0	

CUDA: Calabar urban development agency, VIP: Ventilated improved pit

climate, provide environmental conditions that favour year-round transmission of Ascaris in addition to its association with poverty and poor environmental hygiene.[84] Good environmental hygiene in Calabar may have accounted for its absence in findings in this study. Hookworm was also found in addition, in some of these studies.[5,34,61] Ezeagwuna *et al*.[5] in their study, found hookworm to be the prevalent helminth seen. Most of the respondents in the study by Ezeagwuna *et al*.[5] worked barefeet to the farm. The presence of Hookworm in this study corroborates findings in other studies. However, its transmission in subjects found with helminths may have been feco-oral considering that most of the study population wore shoes outside the home which differed from other studies[5,34,61] whose subjects walked barefoot.[6,7,85] Penetration through the feet is known to be the most common mode of transmission for Hookworm.[6,7] In studies[70,86] outside Africa, Ascaris was prevalent which was similar to studies[5,33,34,61,74] in Nigeria but differed from findings in the present study. Within Africa, Ascaris and Trichuris were more prevalent.[75,77] Regular deworming exercise with the use of broad-spectrum anti-helminths, tends to reduce Ascaris more than Hookworm infection. The drug of choice for Hookworm is biphenium hydroxyl naphthoate and it's toxic in children thus not readily used.[61] These reasons may have accounted for the absence of Ascaris in this study when compared with other studies.

The difference in age and mean age between the comparative groups was not statistically significant. The participants with diarrhea who had intestinal helminths were within the age range 10–19 months and 30–39 months. Studies have shown that decreasing age in children is associated with a higher prevalence of helminthic infection especially when exposed to its risk factors such as low socioeconomic status, poor hygiene and walking barefeet in infected soil with particular regard to hookworm infection.[63,80,81,87-88] In the current study, most of the parents of children selected were from the high socio-economic class with reduced exposure to risk factors for intestinal helminths.

Only males were found with helminthic infection. The adventurous nature of males may explain this.[5]

Surprisingly the subjects with helminthic infection belonged to the high social class. This social class is expected to attain high level of hygiene. It is also true that this group are not always around with their kids and caretakers are often employed which may not apply hygienic measures as the parents. Very often these caretakers are not routinely screened for helminthic infection and other common illnesses.[80,81,87] Despite this fact, most of the parents in this study were from the high social class which may have contributed to the low prevalence of Hookworm seen.

There was no statistically significant difference when comparing sociodemographic factors of those having helminthic infection with and without diarrhoea. This was as a result of the zero prevalence of helminthic infection seen in those without diarrhoea.

In conclusion, the prevalence of intestinal helminthic infection amongst the children with and without diarrhea in this study is low which is likely due to the relatively good environmental hygiene and availability of pipe-borne water in Calabar. In addition, there was no significant difference in the prevalence of helminths infection between children with and without diarrhoea. However, it will not be out of place to assume that helminths found in this study occurred as a co-morbidity with diarrhoeal disease thus emphasizing the need for routine stool microscopy.

Conclusions

The prevalence rate of intestinal helminths in children with diarrhea was 3.1% which depicts a low prevalence. Zero prevalence rate of intestinal helminths in children without diarrhoea was seen. The intestinal helminth isolated was hookworm and it was of low intensity. There is no statistically significant difference in the prevalence of intestinal helminthic infections in children with diarrhea and those without the diarrheal disease. There was general environmental cleanliness and personal hygiene in the study population. Cleanliness in Calabar and good water supply are likely responsible for the low helminthic infection rate which emphasizes the need for maintenance of good hygiene, access to good water supply and periodic intake of anti-helminthic drugs in view of the public health importance of helminthic infection and diarrhoea.

Recommendations

1. It is recommended that at the individual, family and state levels, the continuous emphasis on personal and environmental hygiene should be made for continuous reduction in the prevalence of intestinal helminth
2. Further studies could be carried out in a larger population in the rural settings bordering the state capital
3. The WHO recommendation for regular deworming in children should be upheld
4. Stool microscopy should be done routinely on children to exclude helminthic infection in view of its long term deleterious effect.

Acknowledgment

We acknowledge Prof Asindi A.A., Prof Antiabong O.E., Prof Meremikwu M.M., Prof Anah M., Prof Udo J. J., Prof Odey, Consultants and colleagues, in the Department of Paediatrics, University of Calabar Teaching Hospital, who made useful suggestions at various stages of the study. We appreciate Dr Ogban, Elemi, nurses and our research assisstants.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organisation.In:WHO expert committee on control of schistosomiasis (eds).Prevention and control of schistosomiasis and soil transmitted helminths. 2nd ed. Geneva. WHO technical report series; 2002;68-70.
2. World Health Organisation/ United Nations Children Fund. Ending preventable child deaths from pneumonia and diarrhoea by 2025: The integrated global action plan for pneumonia and diarrhoea (GAPPD). WHO/UNICEF; Geneva 2013;1-61.
3. World Health Organisation.World Health Statistics. World Health Organ; Geneva 2017;1-10.
4. World Health Organisation.Sustainable development goals. World Health Orga; Geneva 2015;1-4.
5. Ezeagwuna D, Okwelogu I, Ekejindu I, Ogbuagu C. The prevalence and socioeconomic factors of intestinal helminth infection among school pupils in Ozubulu Anambra State Nigeria.Internet J Epidemiol 2009;9:1-10.
6. World Health Organisation. Soil transmitted helminth infection. World Health Organ Geneva 2015;366-70.
7. World Health Organisation.Intestinal worms. World Health Organ Geneva 2014:1-2.
8. Muniz P. The major human helminthiasis and their prevalence in Africa. African J Clin Investig 2008;118:1311-21.
9. Pullan L, Smith L, Jasrararia R, Brooker J. Global numbers of infection and diseaseburden of soil transmitted infections in 2010. Parasit Vectors 2014;7:1-10.
10. Tefera E, Belay T, Mekonness KS, Zeynudin A, Belachew T. Prevalence and intensity of soil transmitted helminths among school children of Mendera Elementary School, Jimma, Southwest Ethiopia. Pan African Med J 2017;27:88-96.

11. Hotez P, Brindley P, Bethony J, King C, Pearce E, Jacobson J. Helminths infection:the great neglected tropical diseases. J Clin Invest 2008;118:1311-21.
12. Cox F, Et A. History of human parasitology. Clin MicrobiolRev 2002;15:595-612.
13. Hotez P, Kamath A. Neglected tropical diseases in Sub-Saharan Africa: review of their prevalence, distribution, and disease burden. PLoS Negl Trop Dis 2009;3:412-22.
14. Dumba R, Kaddu J, Mangen F. Intestinal helminths in Luweero district, Uganda. Afr Heal Sci 2008;8:90-6.
15. Lone AB, Ahmad F, Tak H.Impact of soil transmitted helminth infections on haematobiochemical profile in children. Acta Parasitol Global 2015;6:79-82.
16. World Health Organisation. Soil transmitted helminth infection. Media Centre Geneva 2014;366:1-4.
17. World Health Organization. Helminth control in school age children, a guide for managers of control programmes. In: WHO(ed). 2nd ed. Geneva. WHO.2012:24-35.
18. Cheesbrough M. Identification of helminth eggs and larvae found in feaces. In: Guy M, Williams J, Moody A, eds. District Laboratory Practice in Tropical Countries. 2nd ed. New York: Cambridge University Press; 2005:209-29.
19. Oguoma V, Ekwunife C. The need for a better method: Comparison of direct smear and formol-ether concentration techniques in diagnosing intestinal parasites. Int J Trop Med 2006;3:1-7.
20. World Health Organisation.Diarrhoeal disease. World Heal Organ. Geneva 2017;37-40.
21. Nwaneri D, Omuemu V. Intestinal helminthiasis and nutritional status of children living in orphanages in Benin City,Nigeria. Niger J Clin Pract 2013;16-28.
22. Cepon-Robins TJ, Liebert AM, Gildner ET, Urlacher SS, Colehow MA, Snodgrass JJ, *et al*. Soil transmitted Helminth prevalence and infection intensity among geographically and economically distinct Shuar communities in the Ecuadorian Amazon. J Parasitol 2014;100:598-607.
23. Oguoma V, Ekwunife C. The need for a better method: Comparison of direct smear and formol-ether concentration techniques in diagnosing intestinal parasites. Int J Trop Med 2006;3:2-9.
24. Polman K, Becker L, Alirol E, Bhatta K, Bottieau E, Bratschi W. Diagnosis of neglected tropical diseases with persistent digestive disorders. BMC Infect Dis 2015;15:338-51.
25. Sayasone S, Utzinger J, Akkharong K, Oddermatt P. Multiparasitism and intensity of helminth infections in relation to symptoms and nutritional status among children: A cross sectional study in Southern Lao People's Democratic Republic. Acta Tropica 2014;9:15-25.
26. Somers K, Morse S. Lange Microbiology and Infectious Diseases Flash Cards.In: Somers K, Morse S (eds) (2nd ed.)Lange Medical Books. 2nd ed. New York: Lange Medical Books/ McGraw-Hill; 2010:184-6.
27. Feigin V. Mortality and causes of death collaborators. Global, regional, and national life expectancy, all-cause and cause-specific mortality for 249 causes of death, 1980-2015: A systematic analysis for the global burden of disease study 2015. Lancet 2016;388:1459-544.
28. Clasen T, Boisson S, Routray P. The effect of improved rural sanitation on diarrhoea and helminth infection: design of a cluster-randomized trial in Orissa, India. Emerg Themes Epidemiol 2012;9:7-14.
29. Ejemot-Nwadiaro R, Ehiri J, Meremikwu M, Critchley J. Handwashing for Preventing Diarrhoea(review).Cochrane Database of Systematic Review 2015; 9:1465-1858.
30. Akinbami F. Diarrhoeal disease in childhood. In: Nkanginieme, KEO, Azubuike J. (eds)Paediatrics and Child Health in the Tropics.1st ed. Portharcourt: African Educational Series; 2007: 855-74.
31. Mbae C, Nokes D, Molinge E, Nyambure J, Waruru A, Kariuki S. Intestinal parasitic infections in children presenting with diarrhoea in outpatent and inpatient settings in an informal settlement of Nairobi,Kenya. BMC Infect Dis 2013;13:243.
32. Tomczyk S, Deribe K, Brooker JS, Clarke H, Rafique K, Knopp S. Association between footwear use and neglected tropical diseases: A systematic review and meta analysis. PloS Negl Trop Dis 2014;8:1371-81.
33. Akingbade O, Akinjimi A, Ezechukwu U, Okerentugba P, Okonko I. Prevalence of intestinal parasites among children with diarrhoea in Abeokuta, Ogun state, Nigeria. Researcher 2013;5:66-70.
34. Ogunlesi T, Okeniyi J, Oseni S, Oyelami O, Njokanma F, Dedeke O. Parasitic aetiology of childhood diarrhoea. Indian J Pediatr 2006;73:1081-4.
35. Bado A, Susuman S, Nebie E. Trends and risk factors for childhood diarrhoea in Sub-Saharan (1990-2013): Assessing the neighbourhood inequalities. Global Health Action2016;9:1-13.
36. Moore S, Lima A, Conaway M, Schorling J, Soares A, Guerrant R. Early childhood diarrhoea and helminthiasis associate with long term linear growth faltering. Niger J Clin Pract 2001;30:1457-64.
37. Saka MJ, Aremu AS, Saka AO. Soil Transmitted Helminthiasis: Prevalence Rate and Risk Factors Among Schoolchildren in Ilorin, Nigeria. J App Sc Env Sanit 2014;9:139-45.
38. Hashmey R, Genta RM, Clinton A. Parasites and Diarrhoea II: Helminths and Diarrhoea. J Travel Med 1997; 4:72-5.
39. Hotez P, Ottesen E, Fenwick A, Molyneux D. The neglected tropical diseases: The ancient afflictions of stigma and poverty and the prospects for their control and elimination. Adv Exp Med 2006;582:23-33.
40. Mukutmoni M, Khanum H. Soil transmitted helminth infestation in diarrhoeal and non-diarrhoeal children in Mirpur slum area of Dhaka city. Bangladesh J Zool 2016;44:219-28.
41. Ansari S, Sherchand B, Parajuli K. Pattern of acute parasitic diarrhoea in children under five years of age in Kathmandu, Nepal. Open J Med Microbiol 2012;2:95-100.
42. Pullan L, Brooker J. The global limits and population at risk of soil transmitted helminth infections. BioMed Cent 2012;85:1-23.
43. Sobani S, Shakoor S, Malik F, Malik E, Beg M. Gastrointestinal helminthiasis presenting with acute diarrhoea and constipation: Report of two cases with a second pathology. Trop Biomed 2010;27:348-50.
44. National population commission. Nigeria Demographic and Health Survey. Abuja: National population commission; 2013.
45. Jekel J, Katz D, Elmore J. Sample Size,randomisation and Probability Theory. In:Schmitt W, (ed.)Epidemiology,biostatistics and Preventive Medicine. 2nd ed. New York.US, WB, Saunders; 2001:160-99.
46. Kirwan P, Asaolu OS, Molloy FS, Abiona CT, Jackson AL, Holland CV. Pattern of soil transmitted helminth infection and impact of four monthly albendazole treatment in preschool children from semi-urban community in Nigeria: A double blind placebo controlled randomised trial. BMC Infect Dis 2009;9:20-30.
47. Wiria E, Hamid F, Wammes LJ, Kaissar MM, May L, Prasetyani MA, *et al*. The effect of three monthly albendazole treatment on malaria parasiteamia and allergy: A household-based cluter-randomized, double-blind, placebo-controlled trial. PLoS One 2013;8:1371-80.
48. Garba CMG, Mbofung CMF. Relationship between malnutrition and parasitic infection among school children in the Adamawa region of Cameroon. Pak J Nutr 2010;9:1094-9.
49. Turner D, Faulkner H, Kamgno J, Cormont F, Snick V, Else J. Th2 cytokines are associated with reduced worm burdens in a human intestinal helminth infection. J Infect Dis 2003;188:1768-75.
50. Assefa S, Erko B, Medhin G, Assefa Z, Shimelis T. Intestinal parasitic infections in relation to HIV/AIDS status, diarrhoea and CD4 T-cell count. BioMed Cent Infect Dis 2009;2:155-65.
51. Vince J. Helminthiasis. In: Stanfield P, Brueton M, Chan M, Parkin M, Waterston T(eds).Diseases of Children in the Tropics and Subtropics.4th ed. London: Horder and Arnold; 2008:633-49.
52. Maizels R, Pearce, EJ, Artis D, Yazdanbakhsh M, Wynn A. Regulation of pathogenesis and immunity in helminth infections. J Exp Med 2009;206:2059-66.
53. Garside P, Kennedy M, Wakelin D, Lawrence C. Immunopathology of intestinal helminth infection. Parasit Immunol 2000;22:605-12.
54. Cape Town Metropole Paediatric working group. Anthropometric Guidelines Paediatrics. 2nd ed. Cape Town: Cape Town Metropole interest group; 2009:1-10.
55. Oyedeji G. Socio-economic and cultural background of hospitalized children in Ilesa. Nig J Paediatr 1985;12:111-7.
56. Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli F. Controlling soil transmitted helminthiasis in pre-school-age children through preventive chemotherapy. Plos Negl Trop Dis 2008;2:1-17.
57. Levecke B, Behnke MS, Ajjampur SR, Albonico M, Ame S,Charlier J, Geiger MS, *et al*. A comparison of the sensitivity and faecal egg counts

of the McMaster egg counting and Kato Katz thick smear methods for soil transmitted helminths. Plos Neglect Trop Dis 2011;10:1371-81.
58. Idris MA, Al-Jabri AM. usefulness of Kato-Katz and trichrome staining as diagnostic methods for parasitic infections in clinical laboratories. J Sci Res Med Sci 2001;3:65-8.
59. Truscott J, Turner H, Anderson R. What impact will the achievement of the current WHO targets for anti helminthic treatment coverage in children have on the intensity of soil transmitted helminth infections? Parasit Vectors 2015;8:551-61.
60. Ekenjoku A, Oringaje C, Meremikwu M. Comparative efficacy of levamisole, mebendazole and pyrantel pamoate against common intestinal nematodes among children in Calabar, South-South Nigeria. Niger J Paed 2013;40:217-21.
61. Anah M, Ikpeme O, Etuk I, Eyong K, Ibanga I, Asuquo B. Worm Infestation And Anaemia Among Pre-school Children Of Peasant Farmers In Calabar, Nigeria. Niger J Clin Pract 2008;11:220-4.
62. Maurice A, Ugumanin B, Ude U. Managing Sustainable Development in Our Modern Cities: Issues and Challenges of Implementing Calabar Urban Renewal Programmes, 1999-2011. Asian Soc Sci 2013;9:1911-2025.
63. Anijaobi-Idem F, Ukata B, Bisong N. Environmental awareness and school sanitation in Calabar metropolis of Cross River State, Nigeria. JEdu Pract 2015;6:2222-8.
64. Ishaku H, Majid R, Ajayi A, Haruna A. Water supply dilema in Nigerian rural communities: Looking for an answer. JWater Res Protect 2011;3:598-606.
65. Achu A, Nyong I, Ndiyo N. Public waste management and tourism development in Calabar, Cross river state, Nigeria. Multi-Discip J Res Dev Perspect 2015;4:185-94.
66. Taiwo TO, Sam-Wobo OS, Idowu OA, Adewale OT, Taiwo MA. Comparative assessment of intestinal helminths prevalence in Water, Sanitation and Hygeine (WASH) intervention and non-intervention in Abeokuta, Nigeria. Asian Pacific J Trop Biomed 2017;10:1016-36.
67. Schimidin T, Hurlimann E, Silue DK, Yapi BR, Clarrisse H, Kouadio AB, *et al*. Effects of Hygeine and defaecation behavior on helminths and intestinal protozoa infection in Taabo, Cote D'ivoire. Plos One 2013;8:1371-81.
68. Ricardo J, Soares M, Adrian G, Archie C. Geographical analysis of the role of water supply and sanitation in the risk of helminth infections of children in West Africa. PNAS 2011;108:2084-9.
69. Davies MS, Worrell MC, Wiegand ER, Odero KO, Suchdev PS, Ruth LJ, *et al*. Soil transmitted helminths in preschool aged and school aged children in an urban slum: a cross sectional study of prevalence, distribution and associated exposures. Am J TropMed Hyg 2014;9:1002-10.
70. Belizario YV, Tuliao HA. Soil transmitted helminth and diarrhoeal disease. In: Tana J Goma M, Perez M, Metin R, Sahagun V, Mendossa E (eds) 2nd ed. Phillipines: Department of Health;2010:1-10.
71. Ilechukwu GC, Ilechukwu CGA, Ozumba AN, Ojinnaka NC, Ibe BC, Onwasigwe CN. Some behavioral risk factors for intestinal helminthiasis in nursery and primary school children in Enugu, South Eastern Nigeria. Niger J Clin Pract 2010;13:1119-029.
72. Chukwuma M, Ekejindu I, Agbakoba N, Ezeagwuna D, Anaghalu I, Nwosu D. The prevalence and risk factors of geohelminth infections among primary school children in Ebenebe town, Anambra state, Nigeria. Middle East J Sci Res 2009;4:211-15.
73. Roy E, Hazan KZ, Haque R, Fazlul Haque AKM, Siddique AK, Sack BR. Patterns and risk factors for helminthiasis in rural children aged under two years in Bangladesh. SA JChild Health 2011;5:78-83.
74. Gimba U, Dawam N. Epidemiological status of intestinal parasitic ifection rates in children attending Gwagwalada township clinic, FCT-Abuja, Nigeria. Am J Res Com 2015;3:97-110.
75. Mokua D, Shivairo R, Muleke C, Mukabane D, Oswe M, Kumba J. Soil transmitted helminthes prevalence among pre-school age children in Elburgon municipality, Kenya. J Biol Agric Health 2014;4:2204-3208.
76. Ashenafi A, Mohammed S. Assessment of the prevalence of intestinal parasitosis and associated risk factors among primary school children in Chencha town, Southern Ethiopia. BMC Pub Health 2014;14:166-175.
77. Knopp S, Mohammed A, Stothard R. Patterns and risk factors of helminthiasis and anemia in a rural and a peri-urban community in Zanzibar, in the context of helminth control programs. PLoS Negl Trop Dis 2010;10:1371.
78. Fletcher M, Stark D, Ellis J. Prevalence of gastrointestinal pathogens in Sub-Saharan Africa: systematic review and meta-analysis. J Public Heal Africa 2011;2:30-44.
79. Lim B, Amal K, Noor I, Pim C, Hamid J, Wan A. Prevalence and risk factors of intestinal helminth infection among rural Malay children. J Glob Infect Dis 2012;4:10-14.
80. Ogbaini- Emovon EA, Eigbedion AO, Ojide CK, Kalu EI. Prevalence and Impact of socio-economic/ environmental factors on soil transmitted helminth infection in children attending clinic in a tertiary hospital in Benin city, Nigeria. Int J Basic Appl Innov Res 2014; 9:365-370.
81. Nyantekyi AL, Legesse M, Bellay M, Tadesse K, Manaye K, Macias C. Intestinal parasitic infections among under-five children and maternal awareness about the infections in Shesha Kekele, Wondo Genet, Southern Ethiopia. Ethiop J Health Dev 2010;24:185-190.
82. Thomas H, Jatau E, Inabo H, Garba D. Prevalence of intestinal helminths among primary school children in Chikun and Kaduna south local goverment areas of Kaduna state, Nigeria. J Med Res 2014;2:6-11.
83. Nasr N A, Al-Mekhlafi HM, Ahmed A, Roslan MA, Bulgiba A. Towards an effective control programme of soil-transmitted helminth infections among Orang Asli in rural Malaysia. Part 2: Knowledge, Attitude, and Practices. Parasit Vectors 2013;6:28-38.
84. Murat H. Nematode Infection.eMedicineMedscape.http//www.eMedicine.com/med/Topic 1; 2011:1-5. accessed December,2017
85. Ghaffar A. Intestinal helminths. In: Murray PR(ed) Medical Microbiology. 6th ed. South Carolina: Richard Hunt: University of South Carolina; 2010:83-93.
86. Adeniran AA, Mogaji OH, Aladejida AA, OLayiwola IO, Oluwole SA, Abe EM, *et al*. Schistosomiasis, intestinal helminthiasis and nutritional status among preschool aged children in sub-urban communities of Abeokuta, Southwest Nigeria. Bio Med Central 2017;10:637-47.
87. Opara KN, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ. The Impact of Intestinal Parasitic Infections on the Nutritional Status of Rural and Urban School-Aged Children in Nigeria. Int J MCH AIDS 2012;1:73-82.
88. Dana D, Mekonnez Z, Emana D, Ayana M, Getachew M, Workneh N, *et al*. Prevalence and intensity of soil transmitted helminth infection among preschool aged children in 12 kindergattens in Jimma town, Southwest Ethiopia. Trans R Soc Trop Med Hyg 2014;10:1093-98.