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# PREVALENCE OF HELMINTHS AMONG CHILDREN IN ABI LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA.

Uttah, Chinasa[1]; Uttah, Emmanuel Chukwunenye[2], Ekuti Stephen[2] and Iboh, Cletus[2]

[1]Department of Environmental Resource Management, University of Calabar, Calabar
[2]Department of Animal & Environmental Biology, University of Cross River State, Calabar

**Abstract**

This study was aimed at ascertaining the epidemiology of STHs and diarrhea among primary school children in Abi LGA, Cross River State. Direct wet smear method and Formal-ether concentration technique were used for laboratory examination of the stools. A total of 700 school children from seven council wards were examined for STHs in Abi LGA, Cross River State. Overall prevalence was 23.86%; (24.93% for males, 22.82% for females). Prevalence among age groups was significantly highest in the 9-12 years ($x^2$–test; 4.990, P>0.05). Prevalence between the 1-4 years (21.74%) and the 5-8 years (23.97%), age groups was comparable ($x^2$–test; 4.990, P<0.05). There was significant difference in prevalence rates of communities ($X^2$ – test; 35.865, P>0.05). *Ascaris* had the highest prevalence (13.43%), followed by hookworm (8.57%), while *Strongyloides* (1.57%), and *Trichiuris* had the least prevalence (0.29%). Results from this study shows that STHs and diarrhea are endemic in Abi LGA.

**Keywords:** Helminth, diarrhea, *Ascaris,* hookworm, *Trichiuris*

## 1. Introduction

Diarrheal diseases rank second as the leading cause of under-five mortality globally, only surpassed by pneumonia (UNICEF, 2012). It accounts for eight million hospitalizations and 800,000 deaths among under-fives annually (Fawzy et al., 2011). In Nigeria, diarrhea ranked second among top 10 priority child health problems.

Childhood diarrhea is a preventable and treatable illness. In a bid to reduce the burden of diarrhea disease, the World Health Organization (WHO) recommended some evidence-based cost-effective intervention strategies. The therapeutic components of the strategy are Zinc supplementation, Oral rehydration salt solution, nutritious diets and appropriate antibiotic therapy on professional consultation in children with septicaemic illnesses, persistent diarrhea or dysentery (Chaibi et al., 2010; Dheerai et al., 2012). Most under-fives with diarrhea are treated at home or health facilities. The implementation of the evidence-based diarrhea treatment strategies and guidelines by health care professional at the facility level will go a long way in improving childhood survival. There is need for a baseline study to establish the prevalence of diarrhea among Primary School children in an endemic area and the roles played by STHs. It is also needful to verify some epidemiological factors at play in a typical endemic area in Nigeria.

Diarrhea is particularly devastating for children and remains one of the leading causes of morbidity and mortality among children under five years globally. The incidence of diarrhea disease varies greatly with the season and the child's age. STHs are responsible for parasitic infections in as much as a quarter of the human population worldwide, with more than 1.5 billion people or 24% of the world's population at risk. A total of 89.9 million African school-aged children are infected with any species of soil-

transmitted helminthes and 44% of the infections are concentrated in Nigeria, the Democratic Republic of Congo, South Africa and Tanzania (Brooker *et al.*, 2009).
In Nigeria, a considerable amount of human and animal wastes are discharged into the soil daily leading to the contamination of the soil with STH eggs and larvae (Ahmed *et al*., 2002). From contaminating soil, the STH eggs and larvae infest food, water, vegetables and fruits among others resulting in infection (Neck *et al*., 2007). Transmission to the final host is through ingestion of contaminated vegetables, drinking water, and contaminated soil with human faeces.

The diarrhea problem is a global one. The World Health Organization had released a programme to significantly reduce diarrhea among children by 2020 (Pullan *et al.*, 2014). This target is largely unmet around the world. There is need to assess the prevalence among children of Primary School age regarded as important risk group (Soares-Magalhaes *et al*., 2011), and to understand the contributory role of STHs in the epidemiology. This study intends to re-focus attention on the prevention and management of diarrheal diseases to be central to improving child survival in the country and justify the need to embrace Sustainability Development Goals (SDGs) set by WHO. This will also help to achieve universal access to clean water and basic sanitation, which is the primary preventive measures to reduce the burden of diarrhea in the country. Although a lot of research has been done on STHs in most part of Nigeria to the best of our knowledge, studies on the epidemiology of diarrhea and its relationship with STHs among primary school children in Abi Local Government Area, Cross River State has not been investigated.

The research will provide a baseline information on the epidemiology of helminthes and its relationship with diarrhea among primary school children in Abi Local Government Area,
Cross River State. This is quite precursory to establishing blueprint for mitigation of STHs in Abi LGA.

## 2. Materials and methods

### 2.1 Description of the study area

Abi LGA is located between latitudes 5.76° N and 6.02° N of the Equator and longitudes 7.93° E and 8.71° E of the Greenwich Meridian in Cross River State, Nigeria. Ikwo and Afikpo Local Government Areas (LGAs) in Ebonyi State bound Abi in the north and west, respectively. It is bordered in the northeast by Yakurr and Obubra LGAs and in the south by Biase LGA (Chambers *et al*. 2011). Two dominant climatic conditions, the wet and dry seasons are characteristic of the area. These conditions depict a humid climatic condition. The Cross River drains the entire area, and Abi is located in the middle course of the river regime where it exhibits a sluggish and meandering flow pattern with huge sand deposits at the beaches. Dimension of the southward flowing Cross River, which crosses Abi LGA, is ~56 km long and ~0.2 km wide. Some lakes including the Ijum and EkponAzogor Lakes and a few artificial ponds also contribute to the draining of the area. Rainfall being the primary source of recharge for the activities seem to be a dominant factor that dictates the behaviour of many geological structures in the area including the dominant course of the Cross River.

The Usumutong and Ebom are communities in the southeastern region, Itigidi is at the centre, Ekureku in the northern part, Adadama and Igbo Imabana in the northeastern part where fractured materials overlie the aquifer horizon (Ebong*et al.* 2014). Abi Local Government Area produces Yam, Cocoyam, Cassava, Plantain, Okro, Beans, Maize and Pumpkin. Other cash crops available in the area are Rice, oil palm, cocoa, cashew and rubber.

### 2.2 Study design

Ten communities of Abi LGA were selected for this study. One Primary School each was randomly selected from each community. Target population from each community was 100, pooled together to make an overall sample size of 1000 primary school children.

### 2.3 Sample collection

The pupils were supplied with specimen container labelled with serial number, name, age, sex, school and section (primary or nursery); and instructed on how to collect the stool using the container and applicator sticks. The stool specimen were collected the next morning. The stool samples were collected and taken to the laboratory for analysis the same day.

### 2.4 Preparation of reagents and chemicals

***10% Formal-Saline***

A total of 8.5 grams of sodium chloride (Nacl) was weighed and transferred to a clean conical flask, then 900ml of distilled water was added to it, followed by addition of 100ml of formaldehyde to the saline in the flask. Both 10 % formal-saline and 3 % diethyl ether were used in fecal concentration while 10 % formal saline was used in preservation of stool sample.

***0.85 % w/v Normal saline***

Eight and half (8.5) grams of sodium chloride was weighed into a clean conical flask, then 1000 ml distilled water was added to it; the solution was mixed until the salt dissolved. This was used in rinsing out bulb pipette and emulsifying of stool sample.

### *2.5* Concentration technique for stool samples

One gram of fecal material was emulsified in 10 % formal-saline, mixed thoroughly and sieved with cotton wool. Then 1ml of filtrate was transferred into a centrifuge tube after adding 3 ml of diethyl ether, corked with rubber stopper, spun at 2,500 rpm for 3 minutes and the supernatant was decanted, while the sediment was examined microscopically for eggs or larvae with 10x and 40x objectives lenses.

### 2.6 Laboratory Analysis of samples

Microscopic examination was be carried out on each sample as soon as they reached the laboratory using Formal-ether concentration technique. This method has the advantage of removing lipid and colloidal materials to yield clear sediment (Murray *et al*., 2009). In addition, the presence of formalin preserves eggs, larvae and cysts so that the material can be examined hours or even days later. This was used to assess the diarrheic condition of the sample. Particular attention was paid to watery, loose or formed stools including presence of mucus and blood stool. Wet preparation of each sample was done using normal saline and examined immediately. Ridley's modified formal ether concentration technique (Cheesbrough, 1987) was used to improve on the recovery of the ova and larvae of helminth parasites from the samples that would be missed in wet preparation. The sediments was examined by placing one drop each on the centre of the slide covered with cover-slide, while the parasites were identified after NCCLS (2009). The eggs and larvae count was done in formal ether concentration technique by weighing 1 g of faeces; the entire preparation was examined, eggs counted, and results expressed as number of eggs per gram of faeces.

### 2.7 Direct wet smear method

A clean grease-free microscopic slide was used and a drop of normal saline was placed in the middle of the left half and a drop of lugols iodine solution was added in the middle of the right half of the slide. An applicator or wire loop was used to take a small portion of the stool from inside and also the surface of semi-solid stool and also from blood stained mucus portion of liquid stool. The sample was then mixed with the drop of saline and immediately covered with a cover slip. Same was done for the iodine solution. The preparation was then examined under the microscope using x10 and x40 objectives.

### 2.8 Formalin-Ether concentration according to NCCLS (2009).

The following steps were followed:
The faecal specimen were comminuted with sufficient water so that at least 10 to 20 of strained suspension was recovered, which yielded 0.5 to 1.0 ml of centrifuged sediment. The suspension was strained through two layers of gauze or a stainless-steel-wire screen to remove particulate material. The suspension was washed twice by centrifugation in a 5 ml conical centrifuge tube (2 minutes at 2000 rpm), with supernatant poured off.
After the second centrifugation, the faecal sediment was thoroughly mixed with 10ml of 10 % formalin. About 3 ml ether was added to 10 ml formalin suspension and stoppered with a cork, shaken vigorously. The pent-up aerosol of ether was released carefully after shaking by loosening the stopper before the final centrifugation for 2 minutes. An applicator stick was used to rim off the plug of debris and ether that was formed at the top of the tube. The supernatant was poured away leaving only the sediment. Some of the sediments were examined under the microscope.

### 3.0 Data analysis

Prevalence was calculated and expressed as percentage of positive cases and analyzed with respect to ages of pupils examined, sex of the pupils. Data was analyzed using SPSS version 13.0, Chi-Square and ANOVA was used to compare significant differences in prevalence with reference to gender and sex. The odd ratio was used to determine association between infection and both gender and association between infection with risk factors. Significance was determined at P<0.05 (95 % confidence interval).

## 4. Results

### 4.1 Prevalence of STHs in relation to the study communities

The prevalence of STHs among Primary School children in relation to the study communities is presented in Table 1. Ekureku recorded the highest prevalence (41.0%), followed by Usumutong (31.0%) and Imabana (27.0%), while the least prevalence rate of 11.0% was recorded in Anong. Statistical analysis shows significant difference in prevalence rates of communities ($x^2$ – test; 35.865, P>0.05).

### 4.2 The prevalence of STHs in relation to age and sex

The prevalence of STHs in relation to age and sex is presented in Table 2. A total of 700 school children from the 7 communities were examined for helminthiasis in Abi Local Government Area, Cross River State. Of these, 167 were positive indicating an overall prevalence of 23.86%. In all, 86 of those positive were males while 81 were females, representing a prevalence of 24.93% and 22.82% respectively. Prevalence was comparable between the two sexes ($x^2$-test = 3.418; p > 0.05).

Among the males, the age group 1-4 years had a prevalence of 26.45%, age group 5-8 years had 25.22%, while age group 9-12 years had 22.93%. For females, the 1-4 years age group had prevalence of least prevalence 18/06%. The 5-8 years age group had 22.83%, while the 9-12 years age group had 32.88%.

Overall for age groups, prevalence was highest in the oldest age group (9-12 years), which was significantly higher than the other two age groups ($x^2$ – test; 4.990, P>0.05). Prevalence among the 1-4 years age group, 21.74%, was comparable with that of the 5-8 years age group, 23.97%, ($x^2$ – test = 3.016; p> 0.05).

**4.2 Prevalence of the STHs species in relation to age and sex**

The prevalence of STHs species in relation to age and sex is presented in Figure 1. The result showed that *Ascaris* had the highest prevalence (13.43%), followed by hookworm (8.57%). The Threadworm or *Strongyloides* (1.57%), and Whipworm or *Trichiuris* had the least prevalence (0.29%) among the helminth species observed in the study.

For *Ascaris lumbricoides*, prevalence was significantly higher among males than females ($x^2$-test: 4.122; p < 0.05). For hookworm, prevalence was significantly higher among females than among males ($x^2$-test: 5.122; p > 0.05). However, for *Triciuristrichuira* and *Strongyloides stercoralis*, the number of positive cases were too small to make conclusions.

The prevalence of *Ascaris lumbricoides* in relation to age and sex is presented in Figure 2. For the males, prevalence was comparable among the three age groups ($x^2$-test: p < 0.05 for all tests). Among females, prevalence was significantly higher among the two older age groups than among the 1-4 years ($x^2$-test: p < 0.05 for all tests). Overall, prevalence significantly increased with age ($x^2$-test: p < 0.05 for all tests).

The prevalence of hookworm in relation to age and sex is shown in Figure 3. For the males, prevalence decreased with increasing age, although this was not statistically significant ($x^2$-test: p < 0.05 for all tests). The reverse was the case among females as the prevalence increased with age. However, prevalence was comparable among the 1-4 years and 5-8 years age groups ($x^2$-test: p < 0.05), while prevalence among the 9-12 years age group was significantly higher than both the 5-8 years and 1-4 years age groups respectively ($x^2$-test =: 4.668, p < 0.05 for both tests). Overall, the prevalence of hookworm infection was highest among the 9-12 age group and statistically different from the lower age groups ($x^2$-test: 4.442 & 4.672; p > 0.05 for both tests).

The prevalence of *T. trichiura* in relation to age and sex is presented in Figure 4, while the prevalence of *S. stercoralis* in relation to age and sex is presented in Figure 5. Prevalence in both cases were very low to make conclusions.

Table 1. Prevalence of STHs among Primary School children in relation to communities in Abi L.G.A, Cross River State.

| Council Wards | No. Examined | No. positive | Prevalence (%) |
|---|---|---|---|
| Itigidi | 100 | 21 | 21.00 |
| Usumutong | 100 | 31 | 31.00 |
| Ediba | 100 | 17 | 17.00 |
| Anong | 100 | 11 | 11.00 |
| Imabana | 100 | 27 | 27.00 |
| Ekureku | 100 | 41 | 41.00 |
| Adadama | 100 | 19 | 19.00 |
| Total | 700 | 167 | 23.86 |

Table 2. Prevalence of helminth infections among Primary school children in relation to age and sex

| AGE | MALE | | FEMALE | | TOTAL | TOTAL |
|---|---|---|---|---|---|---|
| | No. Examined | No. Positive (%) | Number examined | No. Positive (%) | No. examined | No. Positive (%) |
| 1-4 | 121 | 32 (26.45) | 155 | 28 (18.06) | 276 | 60 (21.74) |
| 5-8 | 115 | 29 (25.22) | 127 | 29 (22.83) | 242 | 58 (23.97) |
| 9-12 | 109 | 25 (22.93) | 73 | 24 (32.88) | 182 | 49 (26.92) |
| TOTAL | 345 | 86 (24.93) | 355 | 81 (22.82) | 700 | 167 (23.86) |

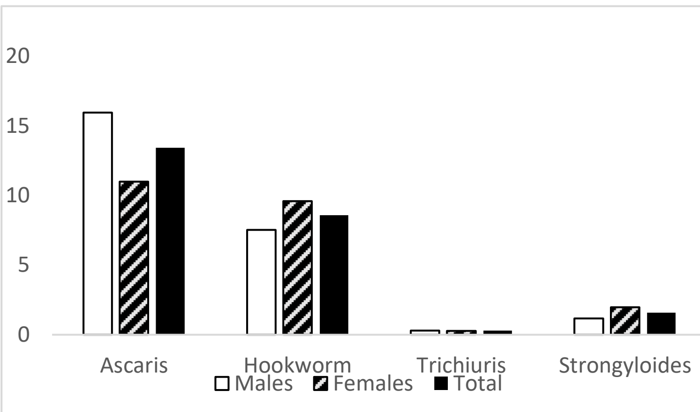


Figure 1. Relative prevalence of STHs species in relation to sex

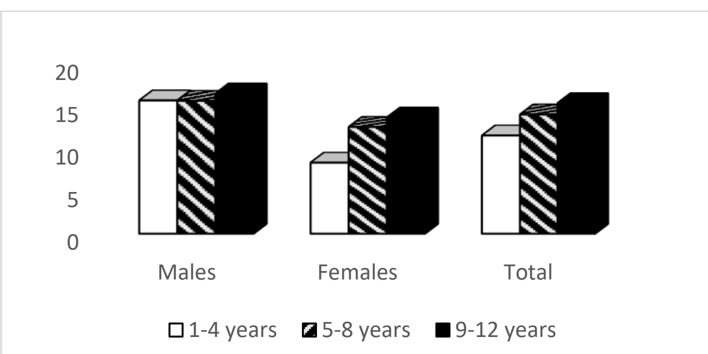


Figure 2. Prevalence of *Ascaris lumbricoides* in relation to age and sex

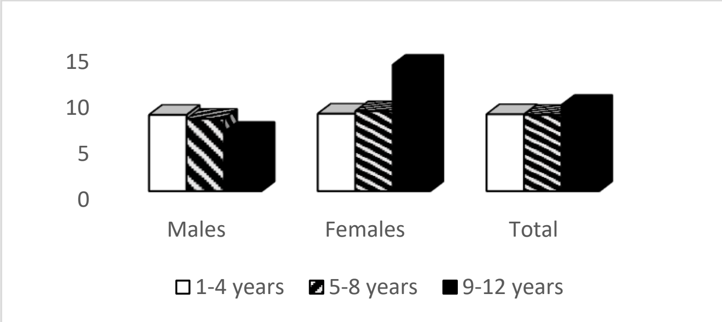


Figure 3. Prevalence of hookworm in relation to age and sex

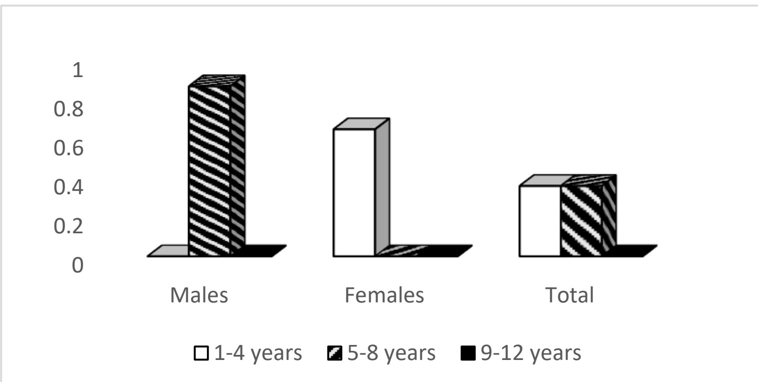


Figure 4. Prevalence of *Trichiuristrichiura* in relation to age and sex

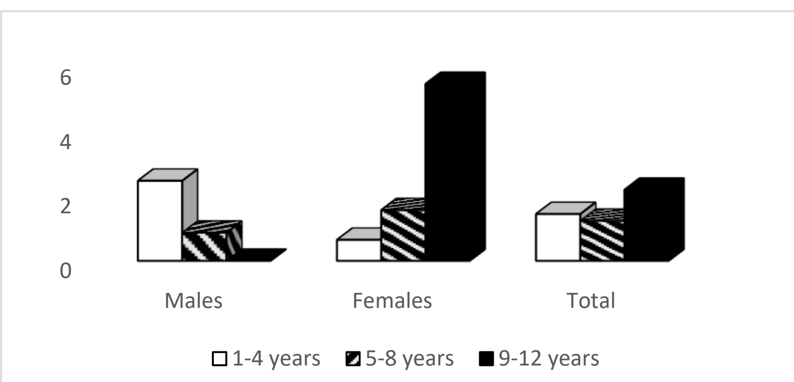


Figure 5. Prevalence of *Strongyloides stercoralis* in relation to age and sex

## 5. Discussion

The present study showed a total of 167 indicating 23.86% were positive from seven council wards for helminthiasis among school children in Abi Local Government Area, Cross River State. The present study was similar to a previous study in Nigeria by Ozumba UC and Ozumba N (2002) on Patterns of helminths infection in the human gut at the University of Nigeria Teaching Hospital, Enugu, Nigeria but does not agreed with Rabiu Adamu (2015) who had 76.1% among primary school pupils in Tamburawa, Dawakin-Kudu Local Government on the prevalence of intestinal helminthes and protozoan parasites. This implies helminths infection is highly endemic among the primary schools' pupils in Abi Council ward which could leads to high mortality among the pupils if not treated. This could also be due to lack of good hygiene, poverty and lack of awareness on soil transmitted helminths and its route of transmission as most of the primary schools visited were situated in rural areas.

In this study, infection rate was higher in males (24.93%) than females (22.82%). This result is contrary to Rabiu Adamu, 2015 and Michael *et. al*., 2017 that recorded the highest prevalence of helminthes among the females compared to the males. Previous study had also reported that there was no statistical significant difference between the prevalence of intestinal infestation across gender (Kirwan *et al*., 2009). Both genders could be equally exposed to factors such as poor hand washing and absence of modern toilet facilities at home among other factors associated with helminths infestation. Statistically, the prevalence of helminths among males and females was significant.

The highest prevalence rate (21.74%) of helminths infection were those in the age group of 1-4 years, followed by those in the 5-8 years age group (23.97%) while the least (26.92%) was from age group of 9-12 years respectively. This could be because of high level of soil contact activity and low personal hygiene in this age group. The result was contrary with report from Zaria (Nock et al., 2007). In his study, the age group 12-14 years were mostly affected (10.9%) while the age group 9 -11 years were the least affected (9.2%), Statistical analysis show that there is a significant difference between helminth infection among school children in relation to sex and age group. ($X^2$ – test; 4.990, P>0.05). The prevalence rate of 36.86% is also in agreement with earlier report that infectious disease was much with age of the pupils (Asaolu*et al*., 1992; Sakti*et al*., 1999; Budy, 1990). The result revealed a decrease in infection rate among the older children. This could be attributed to the increased public health awareness of the danger of intestinal helminthiasis as the children grow older.

The result of helminths infection showed that out of 700 samples analyzed 13.43% had Ascaris, 8.57% had Hookworm, 1.57% had Strongyloides (Threadworm) while 0.29% had Trichuris (whipworm). 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 parasite.

The occurrence of poly parasitism in this study is in line with what is obtained elsewhere in the tropics and subtropics (Enekwechi and Azubike, 2004). This high prevalence could be due to the standard of living of the subjects and the geographical condition of the study area. This study found that intestinal helminthes remain a problem in Abi Local Government Area.

In conclusion, our findings revealed STH infections have become a considerable health problem and are endemic in the study area. Thus, public health interventions such as provision of safe water supply, health education, and de-worming programs should be regularly implemented in communities in Abi LGA.

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**References**

Abdullahi, I.O and Adullhazeez, A.J. (2000). Prevalence of intestinal Parasite in some human patients in Zaria. *The Journal of Parasitiology*, **21**: 125-130

Adamu H, Endeshaw T, Teka T, Kifle A, Petrose B.(2005). The prevalence of Intestinal parasites in paediatricdiarrhoeal and non-diarrhoeal patients in Addis Ababa hospitals. *Ethiopia Journal of Health Development*, **20**:39–46.

Adugna S, Kebede Y, Moges F, Tiruneh M.( 2007). Efficacy of mebendazole and albendazole for *Ascaris lumbricoides* and hookworm infections in an area with long time exposure for antihelminthes, Northwest Ethiopia. *Ethiopia Medical Journal*, **45**:301–306.

Bellido-Blasco, J.B. and Arnedo-Pena, A. (2019). Epidemiology of Infectious Diarrhea. *Encyclopedia of Environmental Health***2011** : 659–671.

Bethony, Jeffren; Brooker, Simon; Albonico, Marco; Geiger, Stefan M., Loukas, Alex; Hotez,

Belizario VY, Totanes FI, de Leon WU, Lumampao YF, Ciro RN. (2011). Soil-transmitted helminth and other intestinal parasitic infections among school children in indigenous people communities in Davao del Norte, Philippines. *Acta Trop*. **120**(Suppl. 1):S12–8.

Belizario V, Ng J, Amarillo M, Trinos J, Reyes M, Fudalan O. (2016). High burden of soil-transmittedhelminthiases in preschool-age children in Masbate: a decade of implementation of the integrated helminth control program in the Philippines. *Southeast Asian J Trop Med Public Health*. **47**:667–79.

Belizario VY, Liwanag HJ, Naig JR, Chua PL, Madamba MI, Dahildahil RO. (2015). Parasitological and nutritional status of school-age and preschool-age children in four villages in Southern Leyte, Philippines: lessons for monitoring the outcome of Community-Led Total Sanitation. *Acta Trop*. **141**:16–24.

Bhagwan JN, Still D, Buckley C, Foxon K. (2008). Challenges with up-scaling dry sanitation technologies. *Water Sci Technol*. **58**:21–27.

Brooker S, Alexander N, Geiger S, Moyeed RA, Stander J, Fleming F, *et al*. (2006). Contrasting patterns in the small-scale heterogeneity of human helminth infections in urban and rural environments in Brazil. Int J Parasitol. **36**:1143–51.

Brabin L, Brabin BJ. (1992). Parasitic infections in women and their consequences. *AdvParasitol.* **31**:1–81.

Brooker S, Clements AC, Bundy DA. (2006). Global epidemiology, ecology and control of soil-transmitted helminth infections. *AdvParasitol*. **62**:221–61.

Chandra A, McNamara EK, Dargusch P, Caspe MA, Dalabajan D. (2017). Gendered vulnerabilities of smallholder farmers to climate change in conflict-prone areas: a case study from Mindanao, Philippines. *J Rural Stud*. **50**:45–59.

Crompton D. W. T. and Nesheim, M. C.( 2002). “Nutritional impact of intestinal helminthiasis during the human life cycle,” *Annual Review of Nutrition*. **22:** 35–59.

Crompton, D.W.(1999).How much human helminthiasis is there in the world? *Journal of Parasitology***85:** 397-403

Dana D, Mekonnen Z, Emana D, Ayana M, Getachew M, Workneh N, ( 2015). Prevalence and intensity of soil-transmitted helminth infections among pre- school age children in 12 kindergartens in Jimma Town, southwest Ethiopia. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **109**:225–227.

De Silva, N.R., Booker, S., Hotez, P.J., Montresor, A., Engles, D. and Savioli, L. (2012). Soil-transmitted helminth infection: updating the Global Picture. *Trends Parasitology*. **19**: 547-551.

Del Rosso, Joy Miller and Tonia Marek (1996). Class Action: Improving School Performance in the Developing World

Health and Nutrition. The World Bank, Direction in Development, **22**: 45-66.

Dold, C. and Holland, C.V. (2011). "Ascaris and ascariasis". Microbes and Infection Institute Pasteur, **13**(7):632-637.

Doris, A.O., Giusti, T. S and Holland, C.V. (2002). "Ascariasis". *Journal of Microbes and Infection Institute Pasteur*, **43**(6):632-664.

Fenwick, A.(2012). The global burden of neglected tropical diseases. *Public Health*, **126** (3): 233-6.

Fischer-Walker C, Jamie Perin, Martin J Aryee, *et al*. (2012). Diarrhea incidence in low- and middle-income countries in 1990 and 2010: a systematic review. *BMC Public Health*. **12**:220.

Food and Agriculture Organization (2000). The elimination of food insecurity in the Horn of Africa. Rome: Food and Agriculture Organization of the United Nations.

Hagel, I. and Giusti, T. (2010). "*Ascaris lumbricoides*: an overview of therapeutic targets" infectious disorder drug targets, **10** (5):349-67.

Hailu, T., Wondemagegn, M., and Bayeh A. (2019). Prevalence and determinant factors of hookworm infection among school age children in Jawe district, NorthWest Ethiopia. Afr Health Sci 19(3):2439-2445. doi:10.4314/ahs.v19i3.18.

Hayes, K.S.(2010). Explotation of the intestinal microflora by parasitic nematode *Trichuris muris*. *Science*, **328**, 1391.

Hotez, P.J. and Kamath A.(2009a). Neglected tropical disease in sub-saharan Africa: review of their prevalence distribution and disease burden. *Neglected Tropical Diseases* **3**, 31.

Hotez, P.J. and Molyneux, D.H.(2010). Tropical anaemia: one of Africa great killers and human Development: Scientific Approaches *Annals of the New YorkAcademy of Sciences*, **1136**, 38-44.

Jamison, Dean. (2006). Helminth infections: soil-transmitted Helminth. Infection and Schistosomiasis. Disease Control Priorities in developing countries (2nd ed.). New York: Oxford University Press. P. Chapter. ISBN 9780821361801

Karshima, S.N. (2018). Prevalence and distribution of soil-transmitted helminth infections in Nigerian children: a systematic review and meta-analysis. *Infect Dis Poverty*. **7**(1):69. doi: 10.1186/s40249-018-0451-2.

Leonardo L, Rivera P, Saniel O, Villacorte E, Lebanan MA, Crisostomo B, et al. (2012). A national baseline prevalence survey of schistosomiasis in the Philippines using stratified two-step systematic cluster sampling design. *J Trop Med*. **2012**, 936128.

Leonardo LR, Rivera P, Saniel O, Villacorte E, Crisostomo B, Hernandez L, *et al*. (2008). Prevalence survey of schistosomiasis in Mindanao and the Visayas, The Philippines. *Parasitol Int*. **57**:246–251

Moser W, Ali SM, Ame SM, Speich B, Puchkov M, Huwyler J, *et al*. (2016). Efficacy and safety ofoxantelpamoate in school-aged children infected with Trichuristrichiura on Pemba Island, Tanzania: a parallel, randomised, controlled, dose-ranging study. *Lancet Infect Dis*. **16**:53–60.

Nguyen PH, Nguyen KC, Nguyen TD, Le MB, Bern C, Flores R, *et al.* (2006). Intestinal helminth infections among reproductive age women in Vietnam: prevalence, co-infection and risk factors. *Southeast Asian J Trop Med Public Health*. **37**:865–74.

Owada, K., Colleen, L.L., Leonardo, L., Archie, CAC.,Yakob, L., Nielsen, M., Carabin, H. & Soares-Magalhães, R.J. (2018). Spatial distribution and populations at risk of *A. lumbricoides* and *T. trichiura* co-infections and infection intensity classes: an ecological study. *Parasites & Vectors***11**(535): DOI https://doi.org/10.1186/s13071-018-3107-y

Peter J.(2006). Soil-transmitted helminth infections: ascariasis, trichuriasis and hookworm. *The Lancet*, **367** (9521):1521-1532.

Peter, A.K. and Umar, U. (2018). Combating diarrhoea in Nigeria: the way forward. *Journal of Microbiology & Experimentation* **6**(4): 191-197. DOI: 10.15406/jmen.2018.06.00213

Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. (2014). Global numbers of infection and disease burden of soil-transmitted helminth infections in 2010. *Parasite Vectors***7**:37.

Pullan R, Brooker S. (2008). The health impact of polyparasitism in humans: are we under-estimating the burden of parasitic diseases? *Parasitology*. **135**:783–94.

Soares-Magalhaes RJ, Clements AC. (2011). Mapping the risk of anaemia in preschool-age children: the contribution of malnutrition, malaria, and helminth infections in West Africa. *PLoS Med*.,8:e1000438.

Soares Magalhaes RJ, Biritwum NK, Gyapong JO, Brooker S, Zhang Y, Blair L, *et al*. (2011). Mapping helminth co-infection and co-intensity: geostatistical prediction in Ghana. *PLoSNegl Trop Dis*. **5**:e1200.

Soares-Magalhaes RJ, Salamat MS, Leonardo L, Gray DJ, Carabin H, Halton K, et al. (2015). Mapping the risk of soil-transmitted helminthic infections in the Philippines. *PLoSNegl Trop Dis*. **9**, e0003915.

Shumbej T., Tariku, B., Zeleke, M., Tamirat, T. and Endalew, Z. (2015). Soil-Transmitted Helminths and Associated Factors among Pre-School Children in Butajira Town, South-Central Ethiopia: A Community-Based Cross-Sectional Study. *PLoS One***10**(8):e0136342. doi: 10.1371/journal.pone.0136342.

Sakti, Hastaning (1999). “Evidence for an Association Between Hookworm Infection and Cognitive Function in Indonesian School Children”. *Tropical Medicine and International Health*. **4** (5): 322-334.

Tadesse G. (2005). The prevalence of intestinal helminthic infections and associated risk factors among school children in Babile town, eastern Ethiopia. *Ethiopia Journal Health Development*, **19**:140–147.

UNICEF (2011). Collaboration, Information of Implementable Effective Sustainable Nation building exercise update. Weekly Epidemiologial Record, **81**(8): 71-80

Vanderkooi, M. (2000). Village Medical Manual (5thed.). Pasadena: William Carey libaray. ISBN 0878087788.

WHO (2012). “Research priorities for helminth infection” *World Health Organization Technical Report Series*. **972** (972): 1-174.

WHO (2013). “Research priorities for helminth infection” World Health Organization Technical Report Series. 572 (972): 1-144.

WHO, (1987). Prevention and Control of Intestinal Helminth Infections. Report of World Health Organization Expert Committee. Technical Report series 749, WHO Geneva. P.12.

World Health Organization (2012).. Eliminating STH as a public health problem in children. Geneva: World Health Organization.

Yakob L, Williams GM, Gray DJ, Halton K, Solon JA, Clements AC. (2013). Slaving and release
in co-infection control. *Parasit Vectors*. **6**:157.

Zeleke, A.J., Adane, D., Abebe, G.B., Gilleard J.S., 3, TegegneEshetu, T. (2021). Prevalence, Infection Intensity and Associated Factors of Soil-Transmitted Helminthiasis Among School-Aged Children from Selected Districts in Northwest Ethiopia. *Res Rep Trop Med* .**12**:15-23. doi: 10.2147/RRTM.S289895

Ziegelbauer, K., Speich, B., Mausezahl, D., Bos, R., Keiser, J. and Utzinger, J. (2012). "Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-anaylsis

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