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Soil-Transmitted Helminth Infection In School Children In South-Eastern Nigeria: The Public Health Implication

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Citation

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Abstract

The prevalence of STH infections was assessed among schoolchildren in Onicha, south-eastern Nigeria, using standard parasitological technique. Of the 510 children examined, 86 (16.9%, 95% CI, 9.38-24.34%) had helminth infections. The males were more infected than the females (18.3% vs 15.5%). Individuals aged 4-6 years old had the highest prevalence of STH infection (27.0%, 95% CI, 16. 62-37.38%). The helminths identified were Ascaris lumbricoides (10.8%),hookworm (4.3%), Trichuris trichiura, (1.2%) and Strongyloides stercoralis (0.6%). The prevalence of STH infections increased with increase in the number of persons in the household and the difference was statistically significant (χ 2 = 21.02, df = 3, P<0.05). Stunted growth by 1.6m and 0.04kg weight loss were recorded among the infected children. Treatment of STH infections in school-age children may improve growth but health education can be an effective and safe substitute for repeated deworming and reducing the opportunity for the emergence of drug-resistant helminthes.

INTRODUCTION

Soil-transmitted helminth (STH) infections represent a major public health problem in poor and developing countries and have constituted a universal burden which does not only depend on regional ecological condition but also on local standard of social and economic development of the people [1]. More than one dozen different species of soil-transmitted helminths infect humans, especially in the tropical and subtropical parts of the developing world. However, four nematodes in particular stand out because of their widespread prevalence and distribution that result in hundreds of millions of human infections. These include the large roundworm, Ascaris lumbricoides, the whipworm Trichuris trichiura, and two species of hookworm, Necator americanus and Ancylostoma duodenale [2].

It is estimates that almost 2 billion people are infected with one or more of these soil-ransmitted helminths, accounting for up to 40% of the global morbidity from infectious diseases, exclusive of malaria [3]. The greatest numbers of soil-transmitted helminth infections occur in tropical and subtropical regions of Asia, especially China, India and Southeast Asia, as well as Subsaharan Africa. Of the 1-2 billion soil-transmitted helminth infections worldwide, approximately 300 million infections result in severe morbidity, which are associated with the heaviest worm burdens [2]. The public health importance of STH infections ranked highest in morbidity rate among school aged children who often present much heavy worms infections because of their vulnerability to nutritional deficiency [4]. These infections have been shown to impact negatively on the physical fitness and cognitive performance of the pupils. Intestinal obstruction, anaemia, malnutrition, dysentery syndrome, fever, dehydration, vomiting and colitis are the major complications associated with STH infections [5]. STH infections affect most frequently children in developing countries and are associated with poor growth, reduced physical activity and impaired learning ability[6,7,8,9,10].

It is well established that indiscriminate disposal of human and animal faeces, poor personal hygiene, and inadequate water supply contribute to high levels of STH infections [11]. Soil-transmitted helminths are some of the most common and infective agents of mankind and are responsible for high morbidity and mortality throughout the developing world. This is of great importance in health of many populations in third world countries where illiteracy, poverty, and associated poor environmental sanitation practices have been implicated in the heavy burden of helminthiasis among children [11,12,13]. The relative contribution of environmental climatic and behavioural factors in the transmission of intestinal helminthic infections has been evaluated [14]. However, even more significant are the physical growth retardation, cognitive and educational impairments caused by heavy chronic infection, which have led to calls for school-based periodic anthelminthic drug deworming programs. This study was therefore designed to better assess the distribution and prevalence of STH infections prior to a school-based de-worming campaign. The major objectives were to provide understanding of the ecology, epidemiology and related morbidity of STH infections with the view to providing basis for development of new tools for the control of soil-transmitted helminths, to recognize the impact of helminth infections on the health of infected groups and to create a rational basis for their control.

MATERIALS AND METHODS

STUDY AREA

This study was conducted from December 2005 through March 2006 in Onicha located in the southern senatorial zone of Ebonyi State, south-eastern Nigeria. It lies approximately 6 ° to 15 ° latitudinally and 8 ° to 17 ° East longitudinally. The population is about 1.05 million people. The climate is tropical and the vegetation characteristic is predominantly the rain forest with an average annual rainfall of about 1300mm and average atmospheric temperature of 30 ° C. There are two distinct seasons, the wet and the dry seasons, the former takes place between April and October, while the latter occurs from November to March. The area is traversed by a number of streams and rivers which constitute the major source of water supply to all the communities in the area. Basic amenities are essentially lacking in the area and there are no proper sewage disposal systems in most of the communities. Farming and trading are the major economic activities. Educational status of most of the inhabitants is generally very low and systematic deworming exercise has never been conducted in the area.

STUDY POPULATION

The study population comprised of 510 primary school pupils aged 4-18 years old. Four largest primary schools in the area were selected for the study. These included; Community Primary School (CPS) Agbabor-Isu, Community Primary School (CPS) Anioma, Union Primary School (UPS) Amanator, and Central Primary School (CPS) Igboeze-Onicha Primary school pupil were considered for this study because: (i) schools are accessible without much difficulties, (ii) the peak of prevalence of STH infection is to be found in this group [15] and (iii) experience shows that there is general good compliance from children and parents [16]. Assessment of the knowledge of schistosomiasis was conducted on the pupils, their teachers and randomly selected adults in the communities by interview, to determine the level of awareness of the disease.

ETHICAL CONSIDERATION

The protocol for this study was approved by the Infectious Diseases Research Division (IDRD), Department of Medical Microbiology/Parasitology, Faculty of Clinical Medicine, Ebonyi State University Abakaliki, Nigeria. The approval was on the agreement that patient anonymity must be maintained, good laboratory practice/quality control ensured, and that every finding would be treated with utmost confidentiality and for the purpose of this research only. All work was performed according to the international guidelines for human experimentation in biomedical research [17]. Approval for the study was obtained from the Chairman, and the Secretary Local Government Education Authority (L. G. E. A.), Onicha Local Government Area, Ebonyi State, Nigeria. Approval was obtained from the Parents Teachers Association (P.T.A.) of each school studied and informed consent was obtained from each of the participating pupils. Seventeen pupils declined participation and were excluded from the study. The participating pupils were given biscuits, sweets, pencils, pens, eraser and pencil sharpeners as incentives. Infected pupils were referred to the Primary Health Care Centre PHCC in the area for immediate treatment.

SAMPLING TECHNIQUE/ LABORATORY ANALYSIS

The pupils were educated on the causes of intestinal helminthic infections among school aged children and they were convinced that every child ought to be free from such infections, thus the necessity of participating in the research work was appreciated by them. Thereafter, wide mouthed corked sterile bottles were given to the pupils for the collection of their stool samples at home and structured questionnaires were distributed among the participating pupils for the collection of demographic information such as age, sex, type of toilet facility used, and number of individuals in the household. The pupils were taught how to collect stool sample and with the aid of their teachers, the questionnaires were correctly filled. The height and weight of the pupils were taken in the morning of the following day as they submitted their stool samples between 7.30 and 8.30am. The stool samples were properly labelled and were carried in a cold box filled with Ice Packs and transported to the laboratory of the department of Medical Microbiology, Faculty of Clinical Medicine, Ebonyi State University Abakaliki, Nigeria, for analysis. The samples that could not be analysed immediately were preserved using 10% formalin until they were examined [18]. Stool analysis was performed using the Kato-Katz technique [18,19].

STATISTICAL ANALYSIS

Differences in proportion were evaluated using the Chi-square test. Statistical significance was achieved if P < 0.05.

RESULTS

Out of the 510 (252 males and 258 females) subjects examined 86 (16.9%, 95% CI, 9.38-24.34%) had helminth infections. The males were more infected than the females (18.3% vs 15.5%) but the difference was not statistically significant (χ^2 = 0.69, df =2, P<0.05) (Table 1). Individuals aged 4-6 years old had the highest prevalence of STH infection (27.0%; 95% CI, 16.62-37.38%); followed by those in 10-12years age group (19.7%; 95% CI, 5.92-33.48%), the lowest prevalence was recorded among those aged 16 years old and above (10.0%; 95% CI, 9.49-29.49%) (Table 1).

Figure 1

Table 1: Sex And Age-Related Prevalence Of Soil-Transmitted Helminth Infections In Onicha, Ebonyi State, Nigeria.

Parameter	Total No. exam.	Total with STH infection	*A. lumb*	Hookw	*S. Sterc*	*T. trich*	Mixed infection
Sex							
Male	252	46(18.3)*	24(9.5)	11(4.4)	3(1.2)	4(1.6)	1(0.4)
Female	258	40(15.5)	31(12.0)	11(4.3)	0(0.0)	2(0.8)	1(0.4)
Total	510	86(16.9)	55(10.8)	22(4.3)	3(0.6)	6(1.2)	2(0.4)
Age							
4-6	74	20(27.0)	12(16.2)	7(9.5)	0(0.0)	0(0.0)	1(1.4)
7-9	186	24(12.9)	17(9.0)	6(3.2)	0(0.0)	5(2.7)	1(0.5)
10-12	132	26(19.7)	15(11.4)	6(4.5)	1(0.8)	0(0.0)	0(0.0)
13-15	108	15(13.9)	11(10.2)	3(2.8)	2(1.9)	1(0.9)	0(0.0)
≥16	10	1(10.0)	1(10.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Total	510	86(16.9)	56(11.0)	22(4.3)	3(0.6)	6(1.2)	2(0.4)

Key: *A. lumb=Ascaris lumbricoides*; Hookw= Hookworm; *S. sterc=Strongyloides stercoralis*; *T. trich= Trichuris trichiura*; ()*= Figure in parenthesis represent percentage

There was no statistical significant difference in the trend (χ^2 = 9.25, df =4, P<0.05). Four helminths were identified which were Ascaris lumbricoides (10.8%),hookworm (4.3%), Trichuris trichiura, (1.2%) and Strongyloides stercoralis (0.6%) (Table 1). Two (0.4%) case of mixed infection were recorded.

The prevalence of the STH infection was highest among those using bush method for defecation (33.8%, 95% CI, 26.09- 41.49%), followed by those using pit latrine method (12.8%, 95% CI, 24.08-31.92%). No case of STH infection was recorded among those who admitted using the water closet method. Statistical analysis showed a significant difference in the trend (χ^2 = 13.01, df = 2, P<0.05) (Table 2). When the number of persons in the house-hold was associated with the STH infection, the prevalence increased with increase in the number of persons in the household, with the highest among those numbering 13 or more persons (27.9%; 95% CI, 19.26-36.50%); followed by those with 9-12 members (22.9%, 95% CI, 16.78-28.97%). The difference in the trend was statistically significant (χ^2 = 21.02, df = 3, P<0.05) (Table 2). The CPS Agbabor-Isu and CPS Igboeze-Onicha recorded the highest (20%; 95% CI, 13.37-26.63%), and the lowest (12.9%; 95% CI, 10.45-21.55%) prevalence of STH infection respectively, but the difference was not statistically significant (χ^2 = 2.75, df = 3, P<0.05) (Table 2).

Figure 2

Table 2: Prevalence Of Soil-Transmitted Helminth Infections In Relation To Type Of Toilet, Number Of Persons In Household And Primary School In Onicha, Ebonyi State, Nigeria.

Parameter	Number examined	Number (%) infected	95% Confidence interval
Type of Toilet			
Bush Method	145	49(33.8)	26.09-41.49
Pit Latrine	290	37(12.8)	24.08-31.92
Water Closet	75	0(0.0)	-
Total	510	86(16.7)	9.38-24.34
Number of persons in household			
≤4	93	0(0.0)	-
5 – 8	125	14(11.2)	5.59-16.81
9 – 12	188	43(22.9)	16.78-28.97
≥ 13	104	29(27.9)	19.26-36.50
Total	510	86(16.9)	9.38-24.34
Primary school			
CPS Agbabor-Isu	140	28(20.0)	13.37-26.63
CPS Anioma	120	22(18.3)	10.95-25.06
UPS Amanator	110	18(16.4)	9.06-22.94
CPS Igboeze-Onicha	140	18(12.9)	10.45-21.50
Total	510	86(16.7)	9.38-24.34

Assessment of mean weight showed little disparity between those infected with STH and those uninfected. The mean height and weight of infected individuals were generally slightly lower than the uninfected. Infected male school children had mean weight of 28.0kg while corresponding mean weight for the uninfected was 29.6kg. Among the females, the mean weight for the infected was 31.4kg, while 33.0kg was recorded among the uninfected (Table 3).

Figure 3

Table 3: Weight And Height-Related Prevalence Of Soil-Transmitted Helminth Infections In Onicha, Ebonyi State, Nigeria.

Parameter	Uninfected Mean Weight (kg)	Infected Mean Weight (kg)	Uninfected Mean height (m)	Infected Mean height (m)
Sex				
Male	29.6	28.0	1.26	1.24
Female	33.0	31.4	1.31	1.29
Age				
4-6	20.4	19.2	0.86	0.84
7-9	30.8	28.5	1.22	1.17
10-12	33.2	31.6	1.30	1.24
13-15	41.3	39.7	1.45	1.42
≥16	49.2	47.0	1.52	1.50

There was also a little disparity between the infected and uninfected school children with respect to height. Infected males had a slightly lower mean height than the uninfected (1.24m vs 1.26m). The mean height for infected females was 1.29m while a mean height of 1.31m was recorded among the uninfected females (Table 3).

DISCUSSION

In this study a prevalence of 16.9% of STH infection was obtained among primary school children. This is comparable to the STH infection prevalence rate of 15.6% obtained among schoolchildren in Thailand [20], but was considerably lower than the prevalence rates obtained in a number of other studies including Myanmar (69%) [21], Kenya (63%) [22], Ecuador (65%) [23], Kelatan (56%) [24], Guinea (53%) [25] and western Nigeria (64%) [26]. These variable results in prevalence are a reflection of the Local endemicity and sanitary standard, environmental conditions, timing and seasonal differences in the design of the survey work and personal hygiene [27]. The lower prevalence obtained in the present study could be attributed to the timing and the geographical differences in the area. For instance, a similar work conducted in another part of Ebonyi State, Nigeria, between the months of April-June (rainy season and when the soil is usually more humid/wet) recorded 76% prevalence of STH infection [28], but this current work was conducted between the months of December – March (dry season, when the soil is usually dry). It is well established that wet or damp soil favours the eggs of helminths and rainy season enables them to thrive more than the dry season [29,30]. Similar works done in Zaria and Jos, Nigeria [30,31], revealed that rainy season favours the proliferation of STH infections. More so, it agreed with the report from Vietman [32], which indicated that helminthic environmental and human behavioural factors influence the transmission process.

Four STH parasites (Ascaris lumbricoides, Hookworm, Trichuris trichuria,and Strongyloides sterculalis) were identified in this study. This was in conformity with a number of previous studies [1,4,6,8,11]. There is a high level of contamination of objects that frequently change hands by these helminths and this a reflection of poor local level of environmental sanitation and personal hygiene [2]. This is typical of most tropical and subtropical regions of the world where up to 15% of host population harbor approximately 70% of the worm population and serve as major source of environmental contamination [3]. A. lumbricoides infection occurred with the highest frequency. The possible reason for this is not far fetched. It is well established that the infective stages of A. lumbricoides, the embryonated eggs have enormous capacity for withstanding the environmental extremes of urban environments [2]. Furthermore, Ascaris eggs are coated with a mucopolysaccharide that renders them adhesive to a wide variety of environmental surfaces; this feature accounts for their adhesiveness to everything from door handles, dust, fruits and vegetables, paper money and coins[33,34].

Male children were more infected than female children but the difference was not significant (P<0.05). This observation was in consonance with some previous works [1,27,31] but contrary to others [28,35]. It is not apparently clear if the prevalence of STH infection among children is gender dependent, more systematic research works are required to elucidate this. The prevalence of STH infection was highest among the youngest age category (4-6years old). This could be because of high level of soil contact activity and low personal hygiene in this age group. This finding is supported by a previous report from India [36].

The measurements of height and weight were conducted in order to verify WHO emphasis of malnutrition and stunted growth associated with STH infection among schoolchildren. In Brazil a 2.4% stunned growth and 0.6% weight loss were observed among infected children [37]. Thus the results from this survey showed stunted growth by 1.6m (5.4%) and 0.04kg (3.2%) weight loss among the infected children. Our observation showed that infected males were shorter and weighed less than infected females.

Thus from this study it was obvious that girls demonstrated a better development in terms of growth and weight compared with boys and it is worthy to note that helminthiasis is one of the leading causes of stunted growth and malnutrition among the children which needed urgent attention.

It is important to note that our inability to conduct the survey during both rainy and dry season in order to compare prevalence results from each season was a major draw back. This is advocated in future studies. We conclude that treatment of helminth infections in school-age children may improve growth in areas where malnutrition and helminth infections are prevalent. The Ministry of Health should integrate deworming into the existing health infrastructure so that every time a child is reached for any health service, the child is also de-wormed. However, instructing children and corrects personal habits which are conducive to infection and practice good personal hygiene can be an effective and safe substitute for repeated deworming, reducing the opportunity for the emergence of drug-resistant helminthes, which should prolong the time antihelminthic drugs such as benzimidazoles may be used for treatment of STH infections.

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References

1. Ukpai OM, Ugwu CO. The prevalence of gastro-intestinal tract parasites in primary school children in Ikwuano Local Government Area of Abia State, Nigeria. Nig J Parasitol 2003;240: 129-36.
2. Hotez PJ, da Silva N, Brooker S, Bethony J. Soil Transmitted Helminth Infections: The Nature, Causes and Burden of the condition. Working Paper No. 3, Disease Control Priority Project. Behesda, Manyland: Fogarty International Centre, National Institute. 2003.
3. Bundy DAP. Epidemiology and transmission of intestinal helminthes, in: Farthing, M.J.G., Keusch, G.T & Wakelin, D (Eds.), Enteric Infection 2, Intestinal Helminths, Chapman & Hall Medical, 1995: 5-24.
4. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, Hotez PJ. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet 2006; 367(9521):1521-32
5. Cooper, E. (1991). Intestinal parasitoses and the modern description of diseases of poverty. Trans Rl Soc Trop Med Hyg 85; 168-70.
6. Stephenson LS, Latham MC, Kinoti SN, Kurz KM, Brigham H. Improvement in physical fitness of Kenyan schoolboys infected with hookworm, Trichuris trichiura and Ascaris lumbricoides follow-ing a single dose of Albendazole. Trans R Soc TropMed Hyg1990; 84:277-82.
7. Nokes C, Grantham-Mc Gregor SM, Sawyer AW, Cooper ES, Bundy DAP. Parasitic helminth infection and cognitive function in school children. Proc R Soc Lond 1992; 247: 77-81.
8. Adams EJ, Stephenson LS, Latham MC, Kinoti SN. Physical activity and growth of Kenyan school chil-dren with hookworm, Trichuris trichiura and Ascaris lumbricoides infections are improved after treat-ment with Albendazole. J Nutr 1994; 124: 1199-206.
9. Koroma MM, Williams AM, De La Haye RR, Hodges M. Effects of Albendazole on growth of pri-mary school children and the prevalence and inten-sity of soil-transmitted helminths in Sierra Leone. J Trop Ped 1996; 42: 371-372.
10. Stoltzfus RJ, Albonico M, Chwaya HM, Savioli L, Tielsch J, Schulze K, Yip R 1996. Hemoquant de-termination of hookworm-related blood loss and its role in iron deficiency in African children. Am J Trop Med Hyg 55: 399-404.
11. Bundy DAP.Epidemiology and transmission of intestinal helminths. In: Enteric Infection 2, Intestinal Helminths, Farthing MJG, Keusch GT, Wakelin D eds.Chapman & Hall Medical,19955-24.
12. Wagbatsoma UA, Aisien MB. Helminthiasis in selected children seen at the University of Benin City Nigeria. Nig J Parasitol 2000; 113: 87-95.
13. Oyerinde JPO. Essentials of Tropical Medical Parasitology. University of Lagos Press Akoka, Lagos Nigeria, 1999; 211-34.
14. Crompton DWT. How much human helminthiasis is there in the world? J Parasitol 1999; 85: 397- 403.
15. Bundy DAP, Hall A, Medley GF, Savioli L. Evaluating measures to control intestinal parasitic infections. Wld Health Stat Quart 1992; 45: 168-79.
16. Montresor A, Crompton DWT, Hall A, Bundy DAP, Savioli L. Guidelines for the Evaluation of Soil-transmitted Helminthiasis and Schistosomiasis at Community Level. A Guide for Managers of Control Programmes, World Health Organization, Geneva, 1998; 1-45.
17. World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. World Medical Association, 2000. Available at http://www.wma.net/e/policy/b3.htm. Accessed June 15, 2005.
18. Cheesbrough M. District Laboratory Practice in Tropical Countries. Part 1. London: Cambridge University Press, 1998.
19. World Health Organisation. Manual of Basic Techniques for a Health Laboratory, 2nd edn. Geneva: World Health Organisation, 2003.
20. Anantaphruti MT, Waikagul J, Maipanich W,

Nuamtanong S, Pubampen S. Soil-transmitted helminthiases and health behaviors among schoolchildren and community members in a west-central border area of Thailand Southeast Asian J Trop Med Public Health. 2004; 35:260-6.
21. Montresor A, Zin TT, Padmasiri E, Allen H, Savioli L. Soil-transmitted helminthiasis in Myanmar and approximate costs for countrywide control. Trop Med Int Health 2004;9:1012-5.
22. Handzel T, Karanja DM, Addiss DG, Hightower AW, Rosen DH, Colley DG, Andove J, Slutsker L, Secor WE. Am J Trop Med Hyg. Geographic distribution of schistosomiasis and soil-transmitted helminths in Western Kenya: implications for anthelminthic mass treatment 2003; 69:318-23.
23. Andrade C, Alava T, De Palacio IA, Del Poggio P, Jamoletti C, Gulletta M, Montresor A. Prevalence and intensity of soil-transmitted helminthiasis in the city of Portoviejo (Ecuador). Mem Inst Oswaldo Cruz. 2001; 96:1075-9.
24. Zulkifli A, Khairul AA, Atiya AS, Abdullah B, Yano A. Med J Malaysia. The prevalence and intensity of soil-transmitted helminthiasis among pre-school children in Orang Asli resettlement villages in Kelantan 1999; 54:453-8.
25. Glickman LT, Camara AO, Glickman NW, McCabe GP. Nematode intestinal parasites of children in rural Guinea, Africa: prevalence and relationship to geophagia. Int J Epidemiol.1999;28:169-74.
26. Adeyeba OA, Akinlabi AMJ. Intestinal Parasitic infections, among school children in a rural Community, Southwest Nigeria. Nig J Parasitol 2002; 23:11-18.
27. Albonico M, Crompton DW, Savioli L. Control strategies for human intestinal nematode infections Adv Parasitol 1999; 42:277-341.
28. Odikamnoro OO, Ikeh IM.. Prevalence of common intestinal nematode infection among primary School children in Kpirikpiri community of Abakaliki, Nigeria. Nig J Parasitol, 2004; 24: 71-9.
29. WHO Expert Committee. Prevention and control of schistosomiasis and soil-transmitted helminthiasis World Health Organ Tech Rep Ser 2002;912:i-vi, 1-57.
30. Nock JH, Duniya D, Galadima, M. Geohelminth eggs in the soil and stool of pupils of some primary schools in Samru, Zaira Nigeria. Nig J Parasitol 2003; 24: 115-22 .
31. Dakul DA, Onwuliri COE, Uneke CJ, Nwabigwe EU. Assessment of intestinal helminth infections in Utan Plateau State. J Health Vis Sci 2004; 6(2): 70-74.
32. Vander-Hoek W, De NV, Konradsen F, Cam PD, Hoa NT, Toan NO, Congle D. Current status of soil transmitted helminths in Vietnam. Am J Trop Med Hyg 2003; 70(2), 334-36.
33. Crompton, DWT. Biology of Ascaris lumbricoides, in: Crompton, D.W.T., Neshem, M.C & Pawlowski, Z.S. (Eds), Ascariasis and is prevention and control. London: Taylor & Francis, 1989; 9-44.
34. Kagei, N. Techniques for the measurement of environmental pollution by infective stages of soil-transmitted helminthes, in : Yokogawa, M. (Ed.), Collected Papers on the Control of Soil Transmitted Helminthiases, Vol. 2, Asian Parasite Control Organization, 1983; 27-46.
35. Flores A, Esteban JG, Angles R, Mas-Coma S. Soil-transmitted helminth infections at very high altitude in Bolivia Trans R Soc Trop Med Hyg 2001; 95:272-7.
36. Naish S, McCarthy J, Williams GM. Prevalence, intensity and risk factors for soil-transmitted helminth infection in a South Indian fishing village. Acta Trop 2004; 91:177-87.
37. Muniz PT, Ferreira MU, Ferreira CS, Conde WL, Monteiro CA. Intestinal parasitic infections in young children in Sao Paulo, Brazil, Prevalence Temporal trends and associations with Physical growth. Am.J.Crop.Med. Parasitology 2002; 965: 503-12.

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