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Original Article

Prevalence of Soil Transmitted Helminthes (STH) Infection among Children Aged 2-17 Years in Urban and Rural Areas of Dhaka District in Bangladesh

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Abstract

A multi-staged cross sectional study was conducted among children aged 2 -17 years to assess the level of soil transmitted helminthes (STH) infections and its relation to socio-demographic characteristics among them. Two thousand children were randomly selected from two rural and four different communities of urban areas of Dhaka district since November 2009 to June 2010. Four different communities classified as higher, medium, poorer and slum/ low socio-economic groups from urban areas were selected on the basis of their place of residence with different socio-economic status. Urban study subjects were again sub grouped into upper (higher and medium socio-economic) and lower (poorer and slum/low socio-economic) classes. Stool specimens of the respondents were collected and tested at the Parasitology department of IEDCR, using the Kato-katz faecal technique for identification of helminthes eggs following their morphology (A. lumbricoides, T trichiura, and A. duodenale), and larval stage (S. stercoralis). About 32.15% study population harbored at least one of the four helminthes species. Baseline prevalence of infections and mean parasite loads for Ascaris lumbricoides were 40.61% and 600.80 e/g, for Trichuris trichiura 30.42% and 206.11e/g, and for A. duodenale 6.80% and 78.75 e/g. Three children (0.49%) were positive for Strongyloides stercoralis. Single infection of 78.32 % and double infection of 21.68 % were recorded. Single infection of A. lumbricoides (40.61%) and T trichiura (30.42%) and double infection of A. lumbricoides - T trichiura (18.61 %) were more prevalent. The prevalence of STH infection was 25.47 % and 38.68 % for rural and urban areas respectively (P <.001). Among urban study subjects, the distribution of STH infection was 0.0 % in the higher (living in higher socio-economic areas) (only 3 samples could be collected), 26.75 % in medium (living in medium socio-economic areas), 45.95 % in poorer and 50.54 % in slum/low socio-economic groups. Significantly higher number of STH infection was observed among lower than that in upper socio-economic classes (P <.001). These results suggest that STH infections remain a serious health problem among children in Bangladesh and need appropriate prevention and control measures.

Key words: Prevalence, STH, children, parasite load, urban and rural areas, Kato-katz technique.

Introduction

Soil Transmitted Helminthes infections are a major public health problem with an estimated 2 billion individuals infected worldwide[1-3]. It is more prevalent in the tropical and subtropical parts of the developing world where safe drinking water and sanitation are lacking. Globally more than 1000 millions people are affected and the total burden due to these parasitic worms might exceed 40 million disability-adjusted life years (DALYs) lost annually[4-6]. About 300 million people with heavy helminthes infections suffer from severe morbidity that result in more than 150,000 deaths annually[7,8].

STH infections commonly occur both in rural and the slums of large urban areas. Most prevalent nematodes responsible for STH infections comprise Ascaris lumbricoides (AL), Trichuris trichiura (TT) and Ancylostoma duodenale (AD) (Hookworm). Strongyloides stercoralis is rarely found.

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Infection due to A. lumbricoides and T. trichiura is acquired by ingestion of eggs from contaminated soil while active penetration of the skin by larvae in the soil is responsible for acquiring infection with Ancylostoma duodenale and strongyloides stercoralis. The adult parasite stages inhabit the gastrointestinal tract (Ascaris and hookworm in the small intestine; Trichuris in the colon), reproduce sexually, and produce eggs, which are passed in human feces and deposited in the external environment [6,9-11].

Though STH infections rarely cause death, the insidious effects occurred by their chronic infection adversely affect the hosts' health and nutritional status. Hookworms cause chronic intestinal blood loss that result in iron deficiency anaemia and all STHs cause protein energy malnutrition along with anaemia. Malnutrition and anaemia due to chronic infections by STH can negatively affect physical and mental growth in childhood [8,9,12]. It is stated that nutritional deficiency in children with heavy STH infestation leads to waning immunity and clinically overt illness that can severely affect operational and learning capacities and impair physical growth. The negative impact on physical health and cognitive performance especially of school children are a great public health concern [8,9,13,14].

Due to the subtropical monsoonal climate and being a least developed country, Bangladesh is endemic for helminthes infection especially for STH. Poor housing conditions, over crowding, scarcity of safe drinking water and lack of proper hygiene and sanitation are common factors that contribute to the increased prevalence of these parasites in this country[15,16,17-23]. People of all age have been observed to experience such infection with the principal helminthes species being A. lumbricoides, T trichiura and A. duodenale. There are a very few studies conducted on STH infection in Bangladesh. Although children of 2-17 years age comprise a large proportion of the population [10,14,16], very few studies on helminthes infection so far were conducted among children in Bangladesh. Data regarding survey on STH among children are also not traceable even after thorough search. However, this group of population is always considered to remain in the risk of acquiring parasitic infection including STH because of their outside playing and eating habit. More over, they lack proper knowledge in hygiene and sanitation [5,10,13,24]. We chose this vulnerable Treatment on a national scale (e.g. via schools group as the study population thinking that the treati and EPI program) would be feasible and very cost-effective. Additionally, the study could contribute to the planning and implementation of effective helminthes prevention and control measures. Thus our study was designed to estimate the level of STH infections amongst 2–17 years aged children in rural and four different communities of urban areas, by assessing the prevalence, parasite intensity, ova count and socio-demographic characteristics, in order to compare the STH distribution among different strata of the community and to suggest recommendations for countrywide control efforts.

Materials and Method

Type of the study: A multi-staged cross sectional study was conducted since November 2009 to June 2010 at the Institute of Epidemiology Disease Control and Research (IEDCR). In order to make a representative picture of the prevalence, this study was designed to cover urban and rural areas.

Study areas: Dhaka district was purposively selected as the study district. Using 'Lottery Draw' technique, Dhamrai upazila (Sub district) and two unions named Roail (Union Number 15) and Nannar (Union Number 16) from Dhamrai upazila were randomly chosen for the rural study areas. Areas such as Banani, Rampura, Khilgaon, malibagh, Mehedibagh,

Adabor, Bhasantek and Basila slums (Mohammadpur) of Dhaka City Corporation with different socio-economic status were randomly chosen for the urban study sites.

Study population: To get the maximum representation of all socioeconomic classes, we grouped the urban study population as higher, middle, poorer and slum/low socio-economic groups depending on their place of residence. In urban areas, communities of diverse socioeconomic classes live in various locations of different socio-economic status with different levels of hygiene and sanitation. The urban study subjects were again categorized into two broad groups like upper and lower socio-economic classes. The upper socio-economic class comprised higher and middle socio-economic groups and the lower comprised poorer and slum/low socio-economic population. However, rural study population was not stratified because more or less similar life style standard for rural people was considered after house to house visit assessment. Inclusion criteria: Children of 2 to 17 years who provided informed consent; parents/legal guardians of children aged 12 years or less were asked for verbal consent. Exclusion criteria: Severely ill children and children or parents/legal guardians who did not give informed consent.

Sample size: Total 2000 children aged 2-17 years were selected as the study population among which 1000 from rural (five hundred from each union) and 1000 from urban study areas (five hundred from upper and five hundred from lower socioeconomic classes).

Sampling technique: Systematic random sampling was done to select the desired sample size. Rural site: The sample interval of 5 was calculated by dividing the number of samples by total number of households (reviewing other similar studies). For randomization, we considered each village of the union as an individual unit and the 'starting house' from selected village was determined by drawing lottery. Data and stool specimen were collected from the 'starting house' and then from every 5 th household onward. One child from each household was considered as the study subject. We used the 'Lottery' method to select one child from the household where more than one child stayed. If one selected house did not have the target population, we considered the next adjacent house for the target subject and so followed the same methodology till the desired samples were collected.

Urban site: After drawing lottery among the study areas with different socio-economic status separately, Banani was selected as the higher socioeconomic area, Rampura and Khilgaon as the middle, Malibagh and Mehedibagh as poorer, Adabor, Bhasantek and Basila slums (Mohammadpur) were selected as the slum/low socioeconomic areas.

Using 'lottery', one block (para/colony/moholla) was selected as the starting point and a sample interval of 5 was considered. Starting with the first household, every 5th household was selected for data and specimen collection and the similar procedure was followed as before. For the large multi storied buildings, flats were counted from the bottom, the starting flat was selected by lottery and every 5th flat was considered in an ascending order. After finishing the flats of one building we went to the next adjacent building and followed the same formula. The adjacent flat was taken into consideration if the study population was not found in a flat and previous similar technique was followed where more than one child resided. Data and specimens were also collected following the same methodology for Rampura, Khilgaon, Malibagh and Mehedibagh until the desired sample size was reached for each group. For slum areas, we did lottery to select the starting point as right or left side and followed the same method for data and specimen collection as used for rural areas.

Data collection: A pre-tested standard well structured questionnaire was used to collect all socio-demographic, epidemiological and health related information. Informed verbal consent was obtained before interviewing the study subjects (parents/guardians of children aged 12 years age or less) and specimen collection. Confidentiality was strictly maintained. All other ethical issues were taken care of.

Stool collection, processing and laboratory testing: Children and guardians were given brief information on the disease (causes, manifestations, consequences, and diagnosis) prior to stool collection. A stool sample was collected from each respondent in well labeled screw-capped plastic container. Specimens were packed and dispatched in a zip-locked bag and transported to the Parasitological laboratory of IEDCR on the day of collection as early as possible. Received specimens in the laboratory were immediately stored in the refrigerator at 4 °C until being processed. After processing, stool samples were analyzed by the Kato-katz faecal technique for the identification of helminthes eggs following their morphology (A. lumbricoides, T trichiura, and h ookworms), and larva stage (S. stercoralis). A random sample of 5% of the Kato-Katz thick smears was re-examined by a laboratory specialist for quality control. The measurement bias was minimized by reading all slides within 24 h of preparation to avoid the degeneration of hookworm eggs [2,25].

Data Processing and analysis: Analyses were done by computer using the software program ISPSS' (Statistical Package for Social Sciences).

Results

Of 2000 study subjects, 56.65 % were male and 43.35 % were female children (Table-I).

Table-I: Distribution of respondents of study population by Gender

Gender	Frequency	Percentage (%)
Male	1133	56.65
Female	867	43.35
Total	2000	100

Among them 45.95 % were of 2 - 6 years, 44.50 % of 7 - 12 years and 9.55 % of 13 - 17 years old (Table-II).

Table-II: Distribution of respondents of study population by age

Age in Years	Frequency	Percentage (%)
2-6	919	45.95
7— 12	890	44.50
13 - 17	191	9.55

Regarding history of anti-helminthes drug intake, 49.1 % had anti-helminthes drug, 40.2 % did not have and 10.7 % did not know their anti-helminthes drug intake status within last 6 months (Table-III).

Table-III: Number of respondents of study population having history of anti-helminthes drug intake within last 6 months.

Response	Frequency	Percentage
Yes	982	49.1
No	804	40.2
Don't know	214	10.7
Total	2000	100

Out of 2000 study population, we could collect 1922 stool samples of which 972 from urban and 950 from rural areas. Amongst 1922 respondents, 618 (32.15%) harbored at least one of the four helminthes species i.e. A. lumbricoides, Trichuris trichiura, A. duodenale, and Strongyloides stercoralis (Table-IV).

Table-IV: Baseline prevalence of Soil Transmitted Helminthes infection among the study population detected by Kato-katz faecal technique.

Findings	No. of stool samples examined	Result (%)
Positive	618	32.15
Negative	1304	67.85
Total	1922	100

Single infection of 78.32 % and double infection of 21.68 % were recorded in the total number of samples examined (Table-V).

Table-V: Prevalence of single and double or mixed infection.

Type of STH infection	Frequency	Percentage (%)
Single	484	78.32
Double	134	21.68
Total	618	100

Single infection was more prevalent for A. lumbricoides (40.61 %) and T trichiura (30.42%), while A. duodenale (6.80%) and S. stercoralis (.49%) were mostly observed as double or mixed infection. Double infection of A. lumbricoides and T trichiura was 18.61 %, A. lumbricoides and A. duodenale was 2.91 %, and A. lumbricoides and S. stercoralis was .16 % (Table-VI).

Table-VI: Prevalence of specific parasite in relation to single, double or mixed infection.

STHs	No. of stool samples examined	Positive (%)
Ova of Ascaris hunbricoides(AL) (single)	251	40.61
Ova of Trichuris tricheura (TT) (single)	188	30.42
Ova of Anchylostome duodenale (AD) (single)	42	6.80
Larva of Strongyloides stercoralis(SS) (single)	3	0.49
Ova of AL + Ova of TT (double)	115	18.61
Ova of AL + Ova of HW (double)	18	2.91
Ova of AL + Larvae of SS (double)	1	0.16
Total	618	100

Double infection of A. lumbricoides and T. trichiura (18.61%) dominated in the infected subjects and A. lumbricoides was found common in all groups of double infection. Table-VII shows the mean parasite load (ova count) of different STH species. The mean parasite load for AL was 600.80 e/g followed by TT (206.11e/g) and AD (78.75e/g).

Table-VII: Distribution of number of egg per gram (NEPG) (Ova count/parasite load/intensity of infection) among the specific parasitic infections.

Parasite species	Mean Ova count* (Egg/gram)	Standard Deviation
Ascaris lumbricoides(AL)	600.80	1593,037
Trichuris tricheura (TT)	206.11	241.362
Anchylostome duodenale (AD)	78.75	41.538

* Ova count: Number of eggs per gram (NEPG): number of eggs per thin smear - weight of the fecal sample in mg x 1000.

Table-VIII shows the prevalence of STH infection in urban and rural areas, which was 38.68 % in urban and 25.47 % in rural areas respectively (< 0.001).

Table-VIII: Distribution of Soil Transmitted Helminthes prevalence among the study population by urban and rural areas

Areas	Positive		Negative		Total no. of stool examined	P value
Urban	376	(38.68%)	596	(61.32%)	972	<.001
Rural	242	(25.47%)	708	(74.53%)	950	
Total 618 (32.15%) 1304 (67.85%) 1922						

The STH distribution among different urban and rural areas has been shown in Table-IX.

Table-IX: Distribution of STH infection among study population in different urban and rural areas.

	Area	Stool Parasite Positive	Stool Parasite Negative	Total
Urban	Banani	0	3	3
	Khilgaon	52	169	221
	Rampura	74	176	250
	Mlibagh	3	14	17
	Mchedibagh	14	6	20
	Adabor	28	37	65
	Bosila	115	89	204
	Bhashantek	90	102	192
Rural	Nannar	67	412	479
	Roail	175	296	471
	Total	618	1304	1922

Among urban study population, STH distribution was 0.0 % in the higher, 26.75 % in medium, 45.95 % in poorer and 50.54 % in slum/low socio-economic groups (Table-X).

Table-X: Distribution of STH infection among different socioeconomic groups of urban study population.

Socioeconomic groups	Positive	Negative	Total number of stool examined
Higher	00 (00%)	03 (100%)	03
Medium	126 (26.75%)	345 (73.25%)	471
Poorer	17(45.95%)	20 (54.05%)	37
Low (slum)	233 (50.54%)	228 (49.46%)	461
Total	376	596	972

Significantly higher prevalence of STH was found in lower (50.20 %) than that in upper (26.58 %) socio-economic classes (p< 0.001) (Table-XI).

Table-XI: Distribution of STH infection by Upper (higher & medium) and Lower (poorer & slum/low) socioeconomic classes of urban study population.

Socioeconomic groups	Positive	Negative	Total number of stool examined	P value
Upper	126 (26.58%)	348 (73.42%)	474	< 0.001
Lower	250 (50.20%)	248 (49.80%)	498	
Total	376	596	972	

In rural study areas, higher number of positive stools was found in Road (37.15 %) than that in Nannar (13.99 %) union (Table-XI).

Table-XII: Distribution of STH infection in rural study areas.

Name of Union	Positive	Negative	Total number of stool examined	Percentage of positivesamples (%)
Nannar	67	412	479	13.99
Roail	175	296	471	37.15
Total	242	708	950	25.47

Discussion

Our study assessed the prevalence of STH infection and socio-economic characteristics among 2 – 17 years aged children living in different rural and urban areas. A. lumbricoides (40.61%) and T. trichura (30.42%) were found as the most prevalent parasite species while A. duodenale (6.80%) and S. stercoralis (.49%) were less. The findings were in accordance with other national and international studies (e.g. India, Malawi, South-West Cameroon, Kenya, Indonesia, Pakistan, Nepal and other countries in the region) with variation in ra tes of different STH species distribution and study population[5,10,14]. For example, the overall infection rate (32.15%) observed in our study population was higher than that recorded previously among Bangladeshi adult males (20.22 %)[26]. This difference might be due to the higher infection rate among children[10]. Methodological difference could also be attributed as we used the highly sensitive Kato-katz faecal technique[5]. Besides, variation observed in rates among similar study groups in various countries might be explained by uneven parasitic distribution in relation to the different geographical areas[27]. On the other hand, hookworm (AD) infestation rate (6.80%) was found quite lower among children in our study than that previously documented (28.4%) among Bangladeshi tea gardeners[26]. This lower infection rate might be explained by the population studied. Our survey was entirely done on children, who unlikely had exposure to farm or garden work as adults and most of them might have anti-helminthes drugs.

Result regarding single, double or mixed infection rate was found similar and comparable with that of other researchers[5,10,12,14,24,28]. We found highest number of single infection (78.32 %) followed by double infection (21.68 %) with no case of infection with three or four parasite species among study subjects. Single infection was more prevalent for A. lumbricoides (40.61%) and T trichiura (30.42%) while for A. duodenale (6.80%) and S. stercoralis (49%) were less as documented by others. Double infection of A. lumbricoides -T. trichiura (18.61 %) was the most frequent in the study subjects. This observation is in accordance with that of other studies and suggests the faecal - oral transmission of the two parasite species through dirty hands and contaminated food that is mostly observed among children. Conversely, fewer occurrences of A. duodenale and S. stercoralis indicate transmission with agricultural profession and prevalence increases with age. Our observation regarding parasite load was also comparable with that of other researchers as well. The mean parasite load was highest for AL (600.80 e/g) than that for TT (206.1 le/g) and AD (78.75e/g).

We found higher prevalence of STH infection among participants from various communities of urban (38.68%) areas than among rural participants (25.47 %). The prevalence was higher in slum/low (50.54%) and poorer (45.95%) socio-economic groups while the occurrence was less in medium (26.75%) and nil in higher socio-economic cluster (0.00%) in urban study population. In class wise analysis, lower socio-economic class comprised the higher number (50.20%) of STH infected children than that in upper socio-economic class (26.58%) (P<0.001). Other researchers established the similar results where STH infections particularly asеariasis was stated as the prevalent infection in urban environments especially among poverty stricken slum areas (10, 14, 24, 26, 30). In urban areas, communities of diverse socio-economic classes (slum/low, poorer, medium and higher) live with different levels of hygiene and sanitation. People in slum areas lead a very overcrowded and unhygienic life and lack safe drinking water. A variety of junk foods with no or low hygiene are also available in various shops and footpath in urban areas and people like to eat those because of easy availability and cheaper rate. Whereas the life style standard of rural people is more or less similar, less congested, people use tube well for drinking water and they have little habit of outside food intake. Among rural study subjects, we observed increased prevalence of STH infection among children in Roail than that in Nannar union. It might be due to increased number of children in Nannar union had anti-helminthes drug. However, though the prevalence of STH infection of rural study population was less than that of urban areas, the remarkable prevalence was yet observed among children of rural areas due to poor hygiene and sanitation condition, lack of proper knowledge and poverty. Alternatively, zero prevalence observed in higher socio-economic group in urban areas might be due to very small sample size (only three).

Conclusion: Analyzing the results we can conclude that the prevalence of STH infections remain high among children and pose an important public health problem in Bangladesh. Our effort is expected to provide an appropriate epidemiological basis for guiding investments in helminthes control and de-worming activities across the country. Proper health and sanitation education, periodic chemotherapy with anti-helminthes, cooperation with school, various organizations and community should be prioritized as the effective helminthes infection prevention and control measures.

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References

1. Artis D. New weapons in the war on worms: Identification of putative mechanisms of immune-mediated expulsion of gastrointestinal nematodes. Int. J. Parasitol, 2006; 36(6): 723-733.

2. Stefanie Knopp, Khalfan A. Mohammed, David Rollinson, J. Russell Stothard, I. Simba Khamis, JUrg Utzinger, AND Hanspeter Marti. Changing Patterns of Soil-Transmitted Helminthiases in Zanzibar in the Context of National Helminth Control Programs. Am. J Trop. Med. Hyg., 2009; 81(6):1071-1078.

3. Brooker S, Archie CAC, Don Bundy AP. Global epidemiology, ecology and control of soil-transmitted helminth infections. Adv. Parasitol, 2006a; 62: 221-261.

4. Stefanie Knopp, Khalfan A. Mohammed, J. Russell Stothard, I. Simba Khamis, David Rollinson, Hanspeter Marti, and JUrg Utzinger. Patterns and Risk Factors of Helminthiases and Anemia in a Rural and a Peri-urban Community in Zanzibar, in the Context of Helminth Control Programs._PLoS Negl Trop Dis, 2010 May; 4(5): e681. Published online 2010 May 11. doe: 10.1371/journal.pntd.0000681.

5. Nkengazong L., F. Njiokoul, S. Wanji, F. Teukeng, P. Enyong and T. Asonganyi. Prevalence of soil transmitted helminths and impact of Albendazole on parasitic indices in Kotto Barombi and Marumba II villages (South-West Cameroon). African Journal of Environmental Science and Technology (Afr. J. Environ. Sci. Technol), 2010; Vol. 4(3):115-121.

6. Peter J. Hotez, M.D., Nilanthi de Silva, Simon Brooker, Jeffrey Bethony. Soil Transmitted Helminth Infections: The Nature, Causes and Burden of the Condition. Disease Control Priorities Project, Working Paper No. 3, 2003; Behesda, Manyland: Fogarty International Center, National Institute. Web site: www.fic.nih.gov/dcpp

7. Montresor A, Cromptom DWT, Gyorkos TW, Savioli L. Helminths control in school age children, a guide for managers and control programmes. WHO, 2002; Geneva.

8. Peter J. Hotez, Donald A. P. Bundy, Kathleen Beegle, Simon Brooker, Lesley Drake, Nilanthi de Silva, Antonio Montresor, Dirk Engels, Matthew Jukes, et al. Helminth Infections: Soil-Transmitted Helminth Infections and Schitosomiasis. Disease Control Priorities in Developing Countries. 2006;-Chapter 24: p 467 – 82.

9. WHO (2011): Intestinal Worms: Soil-transmitted helminthes, Web site: http://www.who.int/intestinal_worm s/en/#navigationg navigation on 01.08.2011.

10. SM. Qadri. Soil Transmitted Helminthic (STH) Infections in Children and it's Impact on Health in India. A Thesis for the Degree of Master of Public Health, KIT (Royal Tropical Institute, Amsterdam, The Netherlands), 2008.

11. Speare R, Falatea FL, Tekaai N, Harmen S, Wayne M, Durrheim D Heukelbach J. Prevalence of soil-transmitted nematodes on Nukufetau, a remote Pacific island in Tuvalu. BMC Infectious Diseases, 2006; Vol. 6: p110.

12. Patrick Kirwan, Samuel 0 Asaolu, Sile F Molloy, Titilayo C Abiona, Andrew L Jackson, Celia V Holland. Patterns of Soil -Transmitted Helminth Infection and Impact of Four Monthly Albendazole Treatments in Preschool Children from Semi-urban Communities in Nigeria: A double-blind Placebo- controlled Randomized Trial. BMC Infectious Diseases, 2009; 9: 20.

13. Bundy D, Shaeffer S, Jukes M, Beegle K, Gillespie A, Drake L, Lee seung-hee F, Hoffman AM, Jones J, Mitchell A, Wright C, Barcelona D, Camara B, Golmar C, Saviolo L, Takeuchi T, Sembene M School based Health and Nutrional Programs. In: Jamison D, Claeson M, Breman J, Meacham A., editors. Disease Control Priorities for Developing Countries. Oxford: Oxford Univ. Press, Chap. 61, 2005.

14. WHO Expert Committee. Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis. WHO technical Report Series 912, World Health organization, 2002, Geneva, WHO Library Cataloguing – In - Publication data.

15. D.W.T. Crompton A. Montresor M.C. Nesheim L. Savioli. Controlling disease due to helminthes infections. Published by World Health Organization, Geneva, 2003.

16. Bangladesh Bureau of Statistics, 2010.

17. Masum MAE, Literature Review on Different Aspects of Intestinal Worms. (Personal Communique). October-2002.

18. Rosenfield PL, Gollady F and Davidson R.K. The economics of Parasitic Diseases: Research Priorities, Soc. Sci. Med, 1984; 19 (10): 1117-1126.

19. Muttalib M A., Islam N and Islam S. Prevalence of intestinal Parasite in rural Children of Bangladesh. Bangladesh Medical Journal, 1976; 5(1): 9-27.

20. Hassain SKR. Incidence of Helminthiasis in Residence of Dhaka; A Preliminary communication. Bangladesh Medical Journal, 1980; 13(2): 14-17.

21. Rao VG, Yadav R, Bhondeley MK, Das S, Agrawal MC and Tiwary RS. Worm Infestation and Anaemia: A Public Health Problem Among Tribal Pre-School Children of Madhya Pradesh. J Commun. Dis., 2002; 34(2):100-105.

22. Rabbani G.H.,Intestinal Helminth Infection and Malnutrition: The Role of Individual Versus Mass Chemotherapy. Bangladesh J of Child Health, 1985, Vol. 9 (1):45-52.

23. Hopkins D R. Homing in on Helminths. Am. JTrop. MedandHyg, 1992; 46(6): 626- 634.

24. Ali SS Barbhuiya MAK, Rahman AKM, Chowdhury SA. Incidence of Hookworm among the Workers in Tea Garden. Bangladesh Med Res Counc Bull, 1985; 11 (2): 69-74.

25. Tanowitz HB, Weiss LM, Witmer M. Diagnosis and treatment of Intestinal helminths. Gastroentrol, 1993: 1(4): 265-273.

26. Khatun M, Naher A. Prevalence of soil transmitted helminthes infections among Bangladeshi males seeking job abroad. Mymensingh Med J, 2006; Jul' 15(2):159-62.

27. Ratard RC, Kouemeni LE, Ekani Bessala MM. Ascariasis and trichuriasis in Cameroon. Transactions of the Royal Soc. Trop. Med. Hyg, 1991; 85: 84-88.

28. J.V. Mbuh, N.H. Ntonifor and.J. Ojong. The epidemiology of soil-transmitted helminth and protozoan infections in south-west Cameroon, Journal of Helminthology, DOI: 10.1017/S0022149XI000091X (About DOI) Published online: 2011.

29. Phiri K, Whitty CJ, Graham SM, Ssembatya-I-Llle G. Urban/rural differences in prevalence and risk factors for intestinal helminth infection in southern Mali. Ann Trop Med Parasitol, 2000; Vol. 94: 381-7.