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ORIGINAL CONTRIBUTION

The Impact of Perception and Knowledge on the Treatment and Prevention of Intestinal Worms in the Manikganj District of Bangladesh

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Soil transmitted helminths (STHs†) affect more than one billion of the world's population and are very prevalent in regions with high poverty rates and poor sanitation. Efforts to achieve Millennium Development Goals, such as combating diseases and increasing the number of people with access to safe drinking water and proper sanitation facilities, will directly help in eliminating STHs. The Plains regions of Bangladesh has one of the highest prevalence rates of STHs, and the efforts made by the World Health Organization might not be enough to eradicate these diseases in this region before the 2015 goal. This survey was conducted in the Manikganj district of Central Bangladesh to evaluate local awareness about the transmission and prevention of STHs. The results from this survey show that although a large percentage of the respondents were knowledgeable about the spread and impact of intestinal worms, the majority of individuals still do not take the necessary steps to prevent infection. Our findings demonstrate the complexity of controlling and eliminating STHs and show that concluding efforts should incorporate additional measures for vaccine development as well as improved educational efforts that are sensitive to the region's traditions and cultures.

INTRODUCTION

Recent reports estimate that approximately one billion of the world's population is infected with soil transmitted helminths (STHs) [1]. With so many people affected, many programs, including those sponsored by the World Health Organization (WHO), have been established to combat these diseases. Eliminating STH infection is in accordance with accomplishing a number of the Millennium Development Goals (MDGs), such as reducing child mortality, combating diseases, and halving the portion of the world's population without access to safe

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†Abbreviations: STHs, soil transmitted helminths; WHO, World Health Organization; MDGs, Millennium Development Goals; PPC, Partners for Parasite Control; PAC, preschool-age children; SAC, school-age children; LF, lymphatic filariasis; MDAs, mass drug administrations; IUB, Independent University of Bangladesh.

This study was conducted with the approval of the Concordia College Institutional Review Board, approval #05072010. Informed consent was obtained orally from each of the individuals prior to initiation of the survey.

drinking water and basic sanitation by 2015 [2]. Efforts toward achieving these goals are directly related to combating STHs, as their primary mode of transmission has been found to be directly linked to poor sanitation.

Roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworm (*Necator americanus* or *Ancyclostoma duodenale*) are the most prevalent of these STHs and pose great health problems, especially in developing nations where access to safe drinking water and basic sanitation are often absent [3]. Transmission of *A. lumbricoides* and *T. trichiura* usually occurs by ingesting the eggs of the adult worms found in the feces of an infected person. The eggs are often ingested by eating contaminated food or vegetables or from having dirty hands and fingernails [4,5]. Although hookworm also can be transmitted by ingesting the larva, they mainly infect by penetrating the host's skin when humans make contact with soil [6]. The transmission modes of these helminths make it apparent that the populations that are heavily affected are nations with high poverty rates and limited access to safe drinking water and sanitation. Indiscriminate defecating makes the spread of STHs higher in these areas.

Some of the debilitating effects that intestinal worms have on the population include cognitive impairment, intestinal blood loss that can lead to anemia, intestinal obstruction leading to malnutrition, stunted growth, vomiting, abdominal pain, diarrheal symptoms, and, in more extreme cases, death [7]. As a result, STHs not only have implications for public health, but also education and regional economics. The decreased cognitive ability of the individuals is accompanied by an increase in high school dropout rates [8], creating a society in which the citizens are unable to reach their full potential.

Intestinal worms are very prevalent in most Bangladeshi communities and account for one of the 10 most common causes of hospital morbidity [9]. A study by Martin et al. found that by the time these children in northern Bangladesh reached four years of age, 90 percent already had patent *Ascaris* infection [10]. In 2005, the Plains area, which includes Bangladesh, was found to have some of the highest infection rates in the world [11]. The incidence rates for *Ascaris* and *Trichuris* documented for children with moderate to heavy helminth infections was 60.4 percent and 23.2 percent, respectively [12]. The prevalence rate is even greater in the Bangladesh rural communities such as the Jamalpur district, with 74.7 percent, 40.7 percent, and 7.7 percent rates for *Ascaris*, *Trichuris,* and hookworm, respectively [12].

The prevalence of intestinal worms tends to be higher in tropical regions because the climate helps to ensure the viability of the larvae. This is especially important for the transmission of hookworm because the eggs deposited on the soil can only survive and develop to the larvae stage in the right soil conditions. Larvae are dependent on their ability to travel within the soil to reach the host or to prevent desiccation [13]. The optimal conditions — moist, sandy soil in a tropic region where there is enough rainfall and hot climate — for the survival of both the eggs and larvae of intestinal worms make Bangladesh especially vulnerable to STH diseases. Additionally, rural regions in Bangladesh where agricultural practices promote constant contact with moist soil also explain the higher prevalence of helminthes in this region.

The high prevalence rate in the Bangladesh population is expected for a country with a high percentage of its urban and rural dwellers having limited access to proper sanitation [14]. This also makes the dream of achieving MDGs in this country by 2015 less promising. Despite efforts made as part of the Soil Transmitted Helminths National Plan of Action to eliminate worm infection in Bangladesh, they are still endemic in poor communities because of the continuous increase in population and the lack of recognition of the disease burdens by these communities [11,15].

Currently, there are no commercially available vaccines against STHs. However, results from a phase 1 clinical trial testing a single vaccine candidate against human hookworm were released in 2008, demonstrating relatively high safety and tolerability at varying doses [16].

Anthelminthic drugs currently available include albendazole, mebendazole, levamisole, and pyrantel pamoate. Keiser and Utzinger conducted a systematic review and meta-analysis of available data concerning treatment with these anthelminthic drugs and concluded that new treatments are needed as the results obtained from single oral dose treatment against *T. trichiura* were found to be unsatisfactory. Treatment of *A. lumbricoides* using albendazole, mebendazole, and pyrantel pomoate resulted in high cure rates, while a single oral dose of albendazole was more effective in treating hookworm infection than mebendazole and pyrantel pamoate [17].

WHO belongs to the Partners for Parasite Control (PPC) program. WHO acts as the lead technical agency of this partnership, whose other members include research institutes, NGOs, and several agencies of the United Nations. The PPC seeks to provide drugs to treat soil transmitted helminths and schistosomiasis to all health services in endemic areas [18]. In 2001, World Health Assembly Resolution 54.19 urged all member states endemic for STH to attain a minimum target of regular administration of chemotherapy to at least 75 percent and up to 100 percent of all school-age children at risk of morbidity by 2010 [18]. In order to regularly report on progress toward the 2010 target, WHO established a databank to collate annual data on the number of preschool-age children (PAC, ages 1-4) and school-age children (SAC, ages 5-14) who had received treatment against STH (usually albendazole or mebendazole) [18]. Average coverage achieved in Bangladesh for reported data in 2006 showed that the 75 percent target was achieved for the PAC population [19]. However, only 12.5 percent of SAC were treated via programs, including lymphatic filariasis (LF), mass drug administrations (MDAs), and others [19].

Actions against STHs are constantly challenged by factors such as availability and affordability of anthelminthic drugs, the efficiency and limited coverage of deworming programs, and the effectiveness of the drugs (low cure rate) [10,20]. Continual re-administration of drugs is necessary due to the non-effective elimination of worm burdens from treatment populations. Recent control programs such as MDAs have proven ineffective in eliminating STHs from the population [21]. Therefore, although single-dose drug costs are relatively under control due to recent heightened awareness and research to drive down costs of treating neglected tropical diseases (the total cost for treatment with albendazole is 0.25-0.50 USD per child using the school system for delivery) [22], it ultimately can be expensive to carry out several long-term deworming programs.

In addition, it is clear that there is a need to organize information to effectively reach all communities that need STH relief. Drugs do not always reach the most worm-burdened societies because there is little knowledge of the infection rates in areas that have not been researched [23]. The Obama administration's establishment of the Global Health Initiative will provide resources to begin research, mapping, and organizing NTD drug administration to reach places that need it most, but weak surveillance systems have made it difficult to estimate disease rates and efficiently deliver drugs [23].

Although recent data shows that about 80 percent of the people in Bangladesh have access to safe drinking water, only 36 percent have access to an improved sanitation facility [24]. The lack of adequate sanitation infrastructure makes efforts to eliminate intestinal worms less effective by promoting re-infection rates. The cost of providing sanitary measures for all of these communities is prohibitive. Also, the short-term nature of the current deworming programs, the possibility of these worms becoming resistant to available anthelminthic drugs, and the high rate of re-infection in these populations calls for support of initiatives to develop vaccines that would ensure disease prevention and eradication. Customized education in these endemic communities about transmission of intestinal worms would help create awareness about the disease burdens and might promote the efficiency of control measures.

Hall et al. studied 1,765 people in Bangladesh and found the prevalence of in-

fection to range from 64 percent to 95 percent. Mean worm burden in these subjects was from 7 to 23 worms [25]. Treatment with mebendazole in a study by Nothrop-Clewes et al. resulted in a decrease in the prevalence of *A. lumbricoides*, *T. trichiura*, and hookworms. They concluded that although administration of anthelminthic drugs increased the number of worms expelled, it did not result in a significant improvement in growth rate of the 1,403 children who participated in this study [26]. The study conducted in a northern district of Bangladesh evaluating the "knowledge and perception of helminth infection in relation to use of health facilities and treatment-seeking behavior" [26] shows that the 131 mothers who participated were aware of the negative effects that worms have on an individual's health, but there were noticeable differences in their description of the causes and prevention of helminths.

In this paper, we have collected and analyzed data from the Manikganj district of Bangladesh to determine how aware the community is about intestinal worms and the consequences of chronic infection. We focused on the attitudes of the local villages toward de-worming programs and future vaccination opportunities, as well as how their knowledge of intestinal worms influences their lifestyle and behaviors toward prevention of worm infection.

MATERIALS AND METHODS

This study was conducted in the division of Dhaka, the Manikganj district of central Bangladesh, in the villages of East Burundi, West Burundi, and Hindu Para Village. To our knowledge, no survey has ever been conducted in this area to evaluate the awareness of the locals about different types of worms, how they are transmitted, and their effects on the health of an individual. This survey (Figure 1) was carried out in May 2010. The survey was translated and conducted in Bengali with the assistance of student interpreters from the Independent University of Bangladesh (IUB) in Dhaka. Two hundred twenty interviews were conducted, each after interviewers obtained oral informed consent. The study sample included randomly selected men and women (both married and unmarried) older than 12. Some of the villagers declined the invitation to participate due to their unavailability. The study sample excluded individuals who were present during the interview of another person. The sample also included only one person per household, and adults were allowed to answer certain, applicable questions for other members of their household. To avoid biases, responses from only the respondents were recorded as some of the questions were testing personal knowledge and others present might try to influence the response of the interviewee. Age, level of education, and occupation were among the data recorded for all respondents.

Questions were asked about how familiar they were with intestinal worms; if they could name one; how they are transmitted; how big a problem worms are in Bangladesh; and whether there were negative or positive effects from the worms. Data also was collected for the following factors that encourage STH transmission: type of sanitation facility available to each household, the type of flooring, main source of drinking water, how often shoes are worn, and examples of routine activities done barefoot. The responses recorded in the questionnaire were assembled and entered in a database. Analysis also was conducted to find a correlation between knowing that worms are spread by going barefoot and the actual act of wearing shoes that could prevent infection. Similar analysis was done to evaluate the effect of education on the practice of preventive measures. Relationships between flooring type, latrine type, and how often shoes are worn were considered. Because the type of floor and latrine could be indications of the economic status of the individuals, data collected may show the effect that the economic status (ability to buy shoes) of an individual can have on his or her ability to take preventive measures against worm infections.

This survey also included questions pertaining to the respondents' major sources

Figure 1. Survey conducted in the Manikganj district of Central Bangladesh to evaluate local awareness about the transmission and prevention of STHs.

Informed Consent

We are conducting a study to learn more about your communities' understanding of intestinal parasite diseases. You are invited to participate in this study by answering questions on a voluntary basis. You may choose not to participate, you may also choose to answer only some of the questions, or to discontinue the survey at any time. If you do not wish to participate in this study, there will not be any negative consequences to you. You will not be denied health care or services of any kind. Although you will not benefit directly from participating in this study, you may make a major contribution to the information known about your communities understanding and treatment of these diseases. In the future, others may benefit because scientists and doctors will learn about how to best assist individuals with these diseases. A research assistant will keep a record of everyone's responses on computer. Your name will not be collected, and all of your answers will be anonymous. Do you agree to participate in this study by answering our questions, which will take about 20 minutes?

SURVEY

1. Sex
   Male
   Female

2. What is your age?

3. What is your occupation?

4. How many children do you have, and what are their ages?

5. What is your education level?
   Graduate education
   Bachelors
   High school-higher secondary (up to 12th)
   High school-lower secondary (up to 10th)
   Grade school (what grade?)
   No formal education

6. Are you familiar with types of soil transmitted helminths (parasites that live in the intestines)?
   Yes
   No

7. Can you name one?

8. How big of a health problem do you consider intestinal worms to be in Bangladesh?
   Very serious
   Serious
   A little serious
   Not serious

9. Are there negative effects of helminth infections?
   Yes
   No

9a. If yes, please list up to 3.

10. Are there positive effects of helminth infections?
    Yes
    No

10a. If yes, please list up to 3.

11. Do you support the idea of deworming programs in Bangladesh?
    Yes
    No
    Yes, but conditionally

11a. If conditionally, what would it require for you to support them?

12. Where is your major source of information about intestine worms and the health risks?
    Doctor
    Newspaper
    Electronic media
    NGOs
    literature
    Other (list)

13. What type of latrine does your household use?
    Any facility shared with other households
    Flush/Pour flush not connected to sewer/septic tank/pit latrine
    Pit latrine without slab/Open pit
    Bucket
    Hanging toilet/Hanging latrine
    No facility/Bush/Field

14. What type of flooring material does your house have?
    Earth/Sand, Palm/Bamboo
    Wood planks
    Cement/Ceramic tiles
    Other

15. What type of roofing material do you have on the main house?
    Thatch/Palm
    leaf/Bamboo
    Tin
    Cement/Ceramic tiles
    Other

16. Where do you go to get their primary drinking water?
    Household well
    Community well
    Bore well
    Hand pump
    Collected rain water
    Artificial tank
    Natural lake
    River
    Piped water
    Bottled/packaged water
    Water tankers

17. How often do you wear shoes?
    All day everyday
    Most of the day everyday
    Very rarely during a day
    Less than every other day

18. Please name any activities when you routinely remove your shoes.

19. If a vaccine against helminths were available, would you go for vaccination (if answering for kids, would you get them vaccinated)?

20. Do you consider access to vaccines a problem?

    20a. If yes, what are the main obstacles?

22. Are you aware of any natural remedies to STHs?

23. What do you think would be the benefit of STHs containment or elimination?

24. Have you experienced any of the following symptoms in the past 6 months?

    Itching or rash where soil may have touched the skin
    Abdominal pain
    Diarrhea
    Weigh loss and/or loss of appetite
    Extreme fatigue and weakness
    Intestinal blood loss resulting in anemia or malnutrition

25. Have you received treatment in the past 1 year for soil transmitted helminths?

    Yes
    No

25a. If yes, where did you receive treatment?
    Hospital
    School
    Community center
    NGO
    other

Table 1. Demographics of respondents including sex, city, age, and education

Demographics		Number
Sex	Male	89(40%)
	Female	131(60%)
City	East Burundi	115(52%)
	West Burundi	83(38%)
	Hindu Village	22(10%)
Age Brackets	12-20	56(25%)
	21-30	66(30%)
	31-40	43(20%)
	41-50	19(8.6%)
	51-60	16(7.3%)
	62 and above	19(8.6%)
Education level	Graduate	4(1.8%)
	Bachelors	6(2.7%)
	Grade 12	12(5.5%)
	Grade 10	33(15%)
	Grade 1-9	95(43%)
	No formal education	70(32%)

Table 2. Responses on how intestinal worms spread[a]

How are intestinal worms spread?	Responses
Walking barefoot to toilet/bathroom	57
Contact with feces	29
Garbage	13
Unwashed/dirty food	41
Unclean hands/dirty fingernails	53
Sweets and junk food	50
Air-borne/ person to person	9
Uncovered toilet	4
Polluted water	2
Don't know how	72
Worms don't spread	1

[a]Most respondents described more than one way that worms are spread

of information about STHs, the natural remedies used to treat worms, symptoms that individuals have experienced, if they (or their children) have received treatment for worms, and where they received treatment (clinic, pharmacy, or school). Interviewees also were asked about the benefits of elimination/containment of worms, if they support de-worming programs, if they would make the decision to become vaccinated if a vaccine were available, and if access to other vaccines was a problem in the area.

RESULTS

Respondent Demographics

These results include the responses of all those who agreed to take part in the survey. Table 1 contains the demographics of the respondents, including age brackets, level of education, etc. The survey sample included 89 men and 131 women, ranging in age from 12 to 89. Most of the women were homemakers whose primary responsibilities were to take care of their families and do most of the household chores. Some, however, also took care of domestic animals (cows, chickens, etc). A few of the women were either students or worked in garment factories or spinning mills or were farmers. The men were mostly rice farmers, students, shop owners, construction workers, and rickshaw pullers.

Of the 220 respondents, four had (or were in the process of completing) graduate-level education, six had (or were in the process of completing) bachelors' degrees, 12 had reached grade 12 (high school-higher secondary), 33 reached grade 10 (high school-lower secondary), 95 were between grades one and nine, while 75 had no formal education.

Perception of soil transmitted helminths

When asked if they were familiar with intestinal worms (interpreted as "crimi"[1]), 166 (75 percent) answered yes, while 54 (25 percent) said that they do not know about these worms. Of the 166 who said they were familiar with intestinal worms, only 40 percent could name some of the worms that commonly infect humans. The names given for the worms include the Bengali equivalents: threadworm, hookworm, tapeworm, flatworm, and "malaria" worm. Some also

[1]"Crimi" is a Bengali word used to refer to intestinal worms throughout the survey. The word is understood as such by the locals.

Table 3. Response to questions asked about negative and positive effects of worm infection, support for deworming programs, and vaccination

Question asked	Yes	No	Don't know
Are there negative effects associated with worm infection?	209	6	5
Are there positive effects (benefits) of worm infection?	43	167	10
Do you support deworming program?	206	13	1
If vaccine was available against worms, would you get it? (adult)	203	14	3
If vaccine was available against worms, would you send your kids?	83	1	--
Is access to other vaccines a problem?	23	185	12[a]

[a]These responses were mixed, with some saying that access depended on location and some saying that sometimes access to certain vaccines is a problem.

classified the worms as small, medium, and large. However, more than half (52 percent) of the 54 respondents who said they were not familiar with intestinal worms were able to name some of the worms.

There were mixed responses when the respondents were asked how intestinal worms are spread. Some correctly said that different worms can be transmitted in a variety of ways. Thirty-three percent of the respondents didn't know how they are spread, while one individual said intestinal worms do not spread. The majority (67 percent) who knew how worms spread listed at least one of the following as ways that they are spread: going to bathroom or toilet without shoes, contaminated food and vegetables, contact with feces or garbage, drinking polluted water, unclean hands or nails, and uncovered toilet. However, a large number (23 percent) of those who said they knew how worms are spread thought that intestinal worms are caused by eating sweets and junk food (biscuits or street food). Some also thought that they could be transmitted through contact with an infected person or through the air. Table 2 displays the distribution of the different responses.

When prompted about how big a health problem intestinal worms are in Bangladesh, 44 percent considered it a very serious problem, 31 percent thought it was a serious problem, 19 percent answered that it was a little serious, 3.6 percent didn't think worms were a problem, and 3.2 percent were not sure if worms were a problem.

Most of the respondents acknowledged that intestinal worms negatively affect the health of individuals (Table 3). A few, however, thought worms have no negative effect on one's health, while some didn't know whether there were negative consequences to being infected with worms. Ten percent of those who believed there are negative effects could not list any specific damage to health. Those who were able to list some of the adverse effects of intestinal worms accurately listed at least one of the following symptoms: weakness, weight loss, diarrhea, dizziness, fever, abdominal pain, swelling of stomach, nausea, vomiting, indigestion, loss of appetite, malnutrition, blood loss leading to anemia, blood pollution and destruction of blood proteins, stunted growth and poor development, and inability to focus or work. Some also said that an infected individual could experience itching near the anus, worms could come out of the mouth and/or anus, loss of taste and excess salivation, the person is more susceptible to other diseases such as cholera, and death might follow in extreme cases. There were other responses that associated worms with multiple other disease symptoms such as shrinking of buttocks, cloudy eyes, and a knot in one's stomach that might need surgery. Of interest were several of the misconceptions regarding symptoms of intestinal parasite infections. These included the beliefs that larger worms were more harmful than smaller worms, that the negative effects were limited to children, and that adults have acquired immunity to intestinal worms. Although our data showed that most individuals were aware of the harmful effects of intestinal worms, some of the responses show that they were attribut-

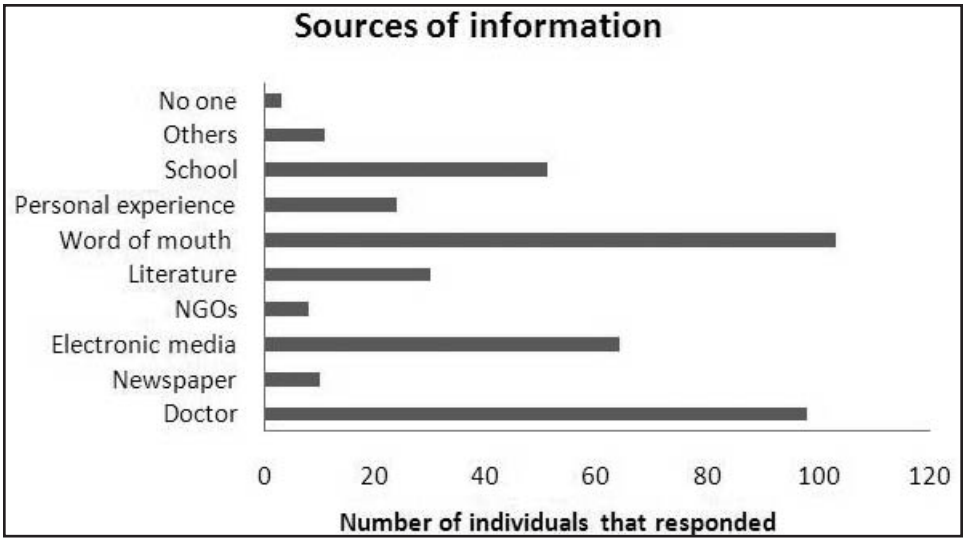

Figure 2. Distribution of the different sources of information

ing the symptoms of other diseases to the presence of worms.

Many individuals seem to harbor misconceptions that were passed on verbally, either from community elders or relatives. One respondent said that "worms make a hole in stomach so food can fall out." Twenty percent of the participants who mentioned that STHs have positive effects said that having some intestinal parasites aid in digestion and that eliminating all the worms would be bad for the health of the individual.

The study participants also were asked about their sources of information on STHs. Most of the information related to the surveyors came from family members or neighbors (word of mouth) and the doctor. The other sources of information are shown in Figure 1, in which a majority said they got their information from more than one source. A small percentage (0.13 percent) said they do not get their information from anyone.

Factors that affect helminth transmission

A high percentage of respondents (83 percent) use the closed pit/slab toilet, 14 percent use the open pit/without slab toilet, 1.8 percent use flush/pour flush, and 0.9 percent use a ceramic pan toilet.

Flooring type in this area was either earth or cement. Seventy-four percent have earth floors, while the rest have cement floors. The data on how many wear shoes and how often they wear them may be biased because some interviewees might be inclined to say that they wear shoes, while they really do not. Evidence of this bias or dishonesty was seen during the interview, as some who said they "wear their shoes all day, every day" were not wearing any shoes during the interview and no shoes were in sight. However, data collected can still be useful in evaluating the relationship between knowledge of how worms are spread and their attitude toward preventing this infection.

Twenty-five percent of the interviewees said they wear their shoes all day every day, 20 percent said they wear them most of the day, 49 percent claimed they rarely wear them during the day, and 6 percent stated that they never wear shoes or wear them less than every other day. Out of the 33 participants who answered for their children, 24 said that the children rarely wear shoes during the day. A separate, visual survey of individuals in the region over a six-day period supported this data from the respondents; approximately 23 percent of both children and adults were wearing shoes during the time of the survey.

Some relationships analyzed revealed that of the 57 respondents who correctly identified walking barefoot as a way that worms spread, close to half (49 percent) rarely or

Table 4. Data showing relationships between wearing shoes and knowing that worms are spread by walking barefoot, and between education level and how often shoes are worn[a]

How often shoes are worn	Stated that worms spread by walking barefoot	Graduate	Bachelors	Grade 12	Grade 10	Grade 1-9	No formal education
All day everyday	12	1	4	5	13	22	10
Most of the day	17	2	2	3	12	21	4
Rarely during the day	25	1	0	3	7	50	46
Never/less than every other day	3	0	0	1	1	2	10

[a]Chi-Squared analysis shows those with higher education level (10+ years) wore shoes most or all of the day. Calculation performed by comparing education level (0-9; 10+ years) vs. frequency of wearing shoes (all/most of the day; rarely/never).

never wear their shoes during the day. Another relationship showed that a large percentage of respondents who have no formal education or those who did not reach grade 10 rarely or never wear their shoes. The highest proportions of people who never wear their shoes have no formal education, as can be seen in Table 4. It is also not surprising that the largest portion of respondents who do not or rarely wear shoes have earth floor (46 percent), while only 9 percent of those who do not or rarely wear shoes have cement floors. While the four individuals who use the flush toilet wear shoes all day or most of the day, a large portion of those who use the closed pit or open pit toilets rarely or never wear shoes (Table 5).

When asked to list some of the activities in which they routinely remove their shoes, those who responded to rarely or never wearing shoes said that they wear shoes only during select hours — after evening showers before going to bed, while going to the toilet or dirty areas, while praying, traveling, or during winter — but apart from those times, they perform most activities without shoes. Some of these activities include household chores such as sweeping, cooking, spreading rice,[2] and looking after domestic animals. Some of the women and most of the men do farming work without shoes; they believe that they will spoil the shoes if they wear them while working in the fields. Others said that they never wear shoes because their feet "itch and burn when they wear shoes" or that their "doctor recommended walking barefoot because it helps some of their health conditions, such as vision problems and diabetes." Some also strongly believed that they do not need to wear shoes because they are too old and thus immune to helminth infections. Some of those who wear shoes most of the day said that they take their shoes off for leisure or when playing a sport. Lastly, a good portion of the respondents who answered for their children said the children wear shoes only to school and take them off when they return home to perform all other activities, such as playing outside.

Estimate of disease burden and approach to treatment

General symptoms associated with helminth infection include weakness/fatigue, weight loss/appetite loss, abdominal

[2]Spreading rice is an activity that is mostly done without shoes. The rice, after being harvested from the fields, is brought home to be sun dried. While the rice is still in the husk, the women spread them barefoot in front of their homes daily until they are well dried.

Table 5. Data showing the impact of economic status on lifestyle (how often shoes are worn)

How often shoes worn	Floor Type		Toilet Type			
	Cement	Earth	Flush/ pour flush	Closed pit/slab	Open pit/no slab	Ceramic pan
All day everyday	22	33	3	50	2	0
Most of the day	15	29	1	31	11	1
Rarely during the day	16	91	0	91	15	1
Never/less than every other day	4	10	0	11	3	0

pain, diarrhea, itching (in hands and legs — body parts that may be in contact with contaminated soil), and intestinal blood loss resulting in anemia. When the respondents were asked if they experienced any of these symptoms in the past six months, 67 percent reported that they had. Eighty-one percent of those had experienced two or more of these symptoms. Table 6 shows the breakdown of the symptoms experienced by the interviewees and their family members. Weakness and weight loss were the most frequently reported symptoms, but these can also be caused by a variety of factors. However, itching was very predominant and when listed with other symptoms is a strong indicator of hookworm infection. Also, more than half of the respondents had a combination of these symptoms. Responses given for other family members, including children, follow the same distribution with a third answering yes to itching and two-thirds answering yes to weakness and weight loss.

Most of the interviewees agreed that helminths were harmful to one's health; therefore, not surprisingly, most of them supported de-worming programs in the area. Ninety-four percent of the individuals said they support de-worming programs. Of the remaining 6 percent (a total of 13 individuals) who did not support de-worming programs, 93 percent (12 individuals) were women. Ninety-two percent of individuals said they would choose to be vaccinated if a vaccine against helminths was available, and a majority of those who responded said they would also have their children vaccinated. Access to other vaccines does not seem to be a problem in this region, as 84 percent said they had access to other vaccines but 10 percent said that access was a problem. The remaining 6 percent had mixed responses, based mainly on the availability of the vaccine (distance to location), who was distributing it (government or NGOs), and how expensive the vaccines were.

When asked about traditional remedies for treating worms, 69 percent were able to name at least one natural remedy used. It was not always specified if the responders had used one or not, but they were knowledgeable about alternative medicines. Some of the natural remedies against intestinal worms listed include: pineapple stalk mixed with limestone, limewater, neem leaves, jute leaves, korola, jargari syrup, chirota, kolponath, and sugar syrup. Most of the leaves are bitter, and some of the respondents who couldn't name a leaf referred to bitter things in general as being effective in relieving the symptoms of intestinal worm infections, as well as clearing worm infections.

While a larger portion of the respondents who have young children said that their children received treatment either through the de-worming programs in the school or from the doctor or pharmacist, 71 percent of the adults had not taken any anthelminthic drug. It is not surprising that 63 percent of those who had not received any

Table 6. Self-reported symptoms of interviewees and their family members

Symptoms	Personal experiences	Other family members' experiences
Abdominal pain	79	40
Itching	51	22
Diarrhea	37	17
Weakness/fatigue	118	41
Weight/appetite loss	99	40
Intestinal blood loss	8	6
None	72	14

treatment in the past year for STHs had symptoms of infection. Of those who received anthelminthic drugs for either themselves or their family members, 56 percent acquired the medicine from either a doctor, a government clinic, or a social worker, 25 percent purchased it from either a pharmacy (without prescription) or at the market. Sixteen percent said their children got it from school, while four people (3 percent) said a local doctor, a practitioner in herbal medicine, distributed it.

The respondents also recognized that there are benefits to elimination. Some of the benefits listed include improved overall health and relief from the major symptoms such as abdominal pain, lack of appetite, blood loss, etc. It also was mentioned that elimination of intestinal worms would protect an individual from other diseases, help them look better and grow stronger, assist in school-related activities, and would save money that would have been used to buy more drugs or to see the doctor.

DISCUSSION

The main purpose of this research was to evaluate the knowledge and perceptions of the people of the impoverished district on Manikganj Bangladesh with regard to STHs. Data collected through this survey shows that most people in this region of Bangladesh are aware of some of the effects of helminth infections on the health of an individual and that their knowledge appears to be evenly distributed amongst both men and women. This means that knowledge of intestinal worms was not affected by the sex of the respondent. In addition, although most of the individuals who said they did not support de-worming were women (males answered support for:against at a ratio of 88:1, while females answered 119:12), these results were not statistically significant ($p > 0.05$) and thus do not suggest education about the importance of de-worming were influenced by the sex of the respondent.

Although some of the respondents said they were not familiar with intestinal worms and how they are spread, knowledge about the different types of worms and how they are spread was not limited among those who said they were aware of these worms. A good number thought that worms were spread from eating sweet foods. This seems to be a common misconception about worms in Bangladesh [27]. It is difficult to determine whether the misconception concerning the spread of intestinal worms is due to the lifestyle of these people or if it is the lifestyle that affects attitude toward this infection. In a society such as this, where most information comes from family members and elders, individuals are susceptible to having information passed down to them that might be serving more than one purpose. For instance, a parent or grandparent might try to convince the children that sweets are bad for their health by telling them that they cause intestinal worms. Elders also might note that the children often have abdominal upsets after eating sweets. This experience can lead individuals to wrongly conclude that intestinal worms are caused by eating "sweet and junk food." Such a misconception can be corrected by emphasizing the causes of intestinal worms and how they are spread by using existing education programs within the region. Every member of the society

should be targeted for these educational programs since most obtain their information from family members, elders, and neighbors. This will ensure that the right information is getting to everyone. Doctors also are instrumental in spreading knowledge about worms, so the importance of educating their patients should be reiterated. The school and media are also, to some extent, sources of information. Parties that want to educate should target their population using these mediums.

Most of the respondents were aware that worm infections have adverse effects on the health of an individual. However, recognizing the negative effects of intestinal worms did not equate to taking measures to prevent infection. Data from this survey show that close to half of those who know helminths are spread by walking barefoot still rarely or never wear shoes. This might be due to the ideas that some are too old and thus immune to helminth infection or the economic status of the family. Estimates about the economic status of an individual can be made by looking at their floor and toilet type. A larger number of the respondents who have earth floor and use closed/open pit latrines rarely or never wear shoes. This might suggest that those who do not wear shoes cannot afford shoes or do not want to destroy the ones they have by farming with their shoes on.

The education level of the respondents positively correlated with knowledge about intestinal worms and also with taking measures to prevent them. A higher number of those with higher education wore shoes all or most of the time, while a larger percentage of respondents with no formal education or with just grade 1-9 education never or rarely wore their shoes (see Table 4, $p < 0.005$). The information suggests that education helps encourage some of the practice to prevent worm infections and that carrying out education programs for intestinal worms might help reduce the prevalence of worm infection in these areas.

Nevertheless, a high percentage of respondents appeared knowledgeable about helminth modes of infection but still do not take care to prevent transmission. This could be attributed to some economic limitations — inability to buy shoes, lack of proper sanitation facilities, and inability to maintain personal hygiene (buy soaps, use clean utensils, and take care of hands and nails). There is also difficulty in modifying the lifestyles of the individuals in the society in order to reduce their susceptibility to intestinal worm infection. Such lifestyles include the inability of the members of the community to control indiscriminate defecating and/or promote the maintenance of proper hygiene. This is why helminth education alone cannot solve the problem in Bangladesh.

The estimate of disease burdens showed that many of the respondents had multiple symptoms associated with worm infection. Although no other study has been done in this area that would confirm that these villages are endemic, studies conducted in other regions of Bangladesh, including northern Bangladesh [10] and a suburb of Dhaka [25], described those regions as having a high prevalence rate. Also, the nationwide survey conducted in 2005 confirmed that Bangladesh is in the region with the highest incidence of worms in the world [11]. What is surprising is that most of the people who show symptoms of infection rarely receive treatment. Although most parents supported de-worming programs for their children and said they would get vaccinated if a vaccine were available, the vast majority of parents do not seek treatment for themselves. The reason for this disparity may be their lack of awareness about the symptoms of worm infection or the knowledge about the debilitating effect worm infection can have on an individual. It also might be because they rely on natural remedies to take care of the symptoms. Nevertheless, this knowledge might not be enough to cause action if they are unable to afford the anthelminthic drugs. Individuals in these communities have to bear the cost of purchasing the anthelminthic drugs in pharmacies for treating intestinal worms (anthelminthic drugs are provided free in the schools for children ages 6 and younger only). This cost tends to be expensive, especially when they have to buy them continu-

ously due to the nature of these infections. As a disease that has a high re-infection rate in poorer communities and has some associated low cure rates, the community members might not be motivated enough to seek proper treatment. However, if the anthelminthic drugs, or, better yet, vaccines, are developed and made available at the clinics for low to no cost at all, most people would be more inclined and motivated to seek treatment. In addition, explaining the effect that intestinal worms have on the growth and cognitive development of children may compel more to actively seek out treatment.

Any program geared toward control of STHs in Bangladesh will need to incorporate solutions that involve not only educating the community, but also a program that encourages support for cultural changes in lifestyle (e.g., cultural support for a shift to wearing shoes outdoors on a regular basis, despite this habit not fitting the cultural norm). We are not aware of any such programs that exist. This survey has shown that while knowledge of these intestinal worms may promote some preventive behaviors, in many cases, those who are aware still do not take the necessary precautions. They are limited by their customs, traditions relating to lifestyle, or by their economic status. Poverty in these communities has to be tackled in order to empower them to live hygienic lives (improved sanitation) and be able to purchase shoes to curb disease transmission. People also need to have the means to purchase anthelminthic drugs. Also, in a community where there are traditions that might impair preventive practices, there is the need to pursue alternative treatment practices such as vaccination. This will help reduce the disease burdens in these societies and will stop the spread and re-infection of children who are at the greatest risk and will benefit most from such immunity.

In conclusion, health education programs in these villages, stronger de-worming programs both in schools and out, poverty alleviation programs, and alternative treatments are recommended for fighting soil transmitted helminths in Bangladesh.

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REFERENCES

1. de Silva NR, Brooker S, Hotez P, et al. Soil transmitted helminths: updating the global picture. Trends Parasitol. 2003;19:547-51.
2. Jensen L, editor. The Millennium Development Goals Report 2010. New York: United Nations Department of Economic and Social Affairs; 2010 June.
3. Stoll NR. This Wormy World. J. Parasitol. 1947;33:1-18.
4. Cooper ES, Bundy DA. Trichuriasis. In: Pawlowski ZS, editor. Intestinal helminthic infections: ballieres clinical tropical medicine and communicable disease. London: Balliere Tindall; 1987. p. 629-43.
5. Crompton DW, Nesheim MC, Pawlowski Z. Ascaris and its prevention and control. London: Taylor and Francis; 1989.
6. Bethony S, Brooker S, Hotez PJ. Human hookworm infection in the 21st century. Advances in Parasitol. 2004;58:197-288.
7. Brooker S. Estimating the global distribution and disease burden of intestinal nematode infections: Adding up the numbers – A review. Int J Parasitol. 2010;40:1137-44.
8. Berkman DS, Lescano AG, Gilman RH, Lopez SL, Black MM. Effects of stunting, diarrhoeal disease, and parasitic infection during infancy on cognition in late childhood: a follow-up study. The Lancet. 2002;359(9306):564-71.
9. World Health Organization Regional Office of South-East Asia [Internet]. Country Health System Profile: Bangladesh. c2010 [updated 2007 Aug 6; cited July 20]. Available from http://www.searo.who.int/en/Section313/Section1515_6121.htm
10. Martin J, Keymer A, Isherwood RJ, et al. The prevalence and intensity of Ascaris lumbricoides infections in Moslem children from northern Bangladesh. Trans R Soc Trop Med Hyg. 1983;77(5):702-6.
11. Schools & Health [Internet]. Country Programmes – Bangladesh. c2007 [updated 2009 July 6; cited 2010 July 17]. Available from: http://www.schoolsandhealth.org
12. Schools & Health [Internet]. School Health Database – Bangladesh. c2009 [updated 2009 June 26; cited 2010 July 17]. Available from: http://www.schoolsandhealth.org

13. Hotez P. Hookworm and Poverty. Ann NY Acad Sci. 2008;1136:38-44.
14. WHO Bangladesh [Internet]. Country Health Profile: Dhaka; c2008 [cited 2010 July 17]. Available from: http://www.whoban.org
15. Chan M-S. The global burden of intestinal nematodes infections – fifty years on. Parasitol Today. 1997;13:438-43.
16. Bethony JM, Simon G, Diemert DJ, et al. Randomized, placebo-controlled, double-blind trial of the Na-ASP-2 hookworm vaccine in unexposed adults. Vaccine. 2008;26(19):2408-17.
17. Keiser J, Utzinger J. Efficacy of Current Drugs Against Soil-Transmitted Helminth Infections: Systematic Review and Meta-analysis. JAMA. 2008;299(16):1937-48.
18. World Health Organization. Partners for Parasite Control; c2010 [cited 2010 Oct 26]. Available from: http://www.who.int/wormcontrol/about_us/en/
19. WHO. Progress report on number of children treated with anthelminthic drugs: an update the 2010 global target. Weekly Epidemiological Record. 2008;83:237-52.
20. WHO. Soil transmitted helminthiasis. Weekly Epidemiological Record. 2010;85:141-8.
21. Smits HL. Prospects for the control of neglected tropical diseases by mass drug administration. Expert Review of Anti-infective Therapy. 2009;7(1):37-56.
22. WHO [Internet]. The new worm control strategy; c2010 [updated 2010; cited 2010 Oct 24]. http://www.who.int/wormcontrol/statistics/control_strategy/en/index.html
23. Brooker S, Hotez PJ, Bundy DAP. The Global Atlas of Helminth Infection: Mapping the Way Forward in Neglected Tropical Disease Control. PLoS Negl Trop Dis. 2010;4(7):779.
24. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation [Internet]. Bangladesh: improved sanitation coverage estimates (1980-2008); c2003-2010 [updated 2010 March; cited 2010 July 20]. Available from: http://www.wssinfo.org/fileadmin/user_upload/resources/1273062654-BGD_san.pdf
25. Hall A, Anwar KS, Tomkins A, et al. The distribution of Ascaris lumbricodes in human hosts: a study of 1765 people in Bangladesh. Trans R So Trop Med Hyg. 1999;93:503-10.
26. Northrop-Clewes CA, Rousham EK, Mascie-Taylor CGN, et al. Anthelminthic treatment of rural Bangladeshi children: effect on host physiology, growth, and biochemical status. Am J Clin Nutr. 2001;73:53-60.
27. Rousham EK. Perception and treatment of intestinal worms in the rural Bangladesh: Local difference in knowledge and behavior. Soc Sci Med.1994; 39:1063–8.