Schistosomiasis and Soil-Transmitted Helminth Infections in School Children in the Lake Mainit Area in Northeastern Mindanao: an Opportunity for Integrated Helminth Control in the School Setting

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ABSTRACT

Objectives. This study aimed to determine the epidemiologic status of schistosomiasis and soil-transmitted helminth (STH) infections in the Lake Mainit area in Northeastern Mindanao.

Methods. School children from the municipalities of Alegria and Mainit in Surigao del Norte, and Jabonga and Kitcharao in Agusan del Norte were targeted as participants. Stools were collected, processed through Kato Katz method, and examined. Data gathered were double-encoded and processed to derive parasitologic parameters that were used to categorize the municipalities based on the World Health Organization guidelines.

Results. The overall prevalence of schistosomiasis was 10.9%, while the prevalence of heavy intensity infections was 0.1%. Alegria and Mainit were classified as moderate-risk communities, while Jabonga and Kitcharao were classified as low-risk communities. The overall cumulative prevalence of STH infections was 43.9%, while prevalence of heavy intensity infection was 12.7%. Jabonga and Kitcharao were classified as Category I communities, while the rest were classified as Category III.

Conclusion. There is a need to consider implementation of a school-based Mass Drug Administration (MDA) for schistosomiasis control in the same manner as in the implementation of MDA for STH control. Multisectoral involvement is necessary for the integration of efforts in addressing the parasitic diseases as public health concerns in the area.

Keywords: Schistosomiasis, soil-transmitted helminth infections, school-based helminth control, integrated helminth control

Introduction

Schistosomiasis caused by *Schistosoma japonicum* remains as a public health concern in certain areas in the Philippines.[1] Results of a nationwide three-phase survey showed an average prevalence of 2.5%.[2] Twenty-eight provinces covering 190 municipalities remain endemic for this parasitic infection, and in 2004 and 2006, the municipalities of Gonzaga, Cagayan and Calatrava, Negros Occidental, respectively, were recognized as newly described endemic areas.[3,4]

The distribution and transmission of *S. japonicum* in endemic areas depend on the presence of the snail intermediate host, *Oncomelania hupensis quadrasi*.[4] The blood fluke can infect several mammalian reservoir hosts allowing for zoonoses, thus schistosomiasis japonicum tends to be the most difficult to control among all schistosome infections.[3,5]

Children age five to 15 years have the highest prevalence of schistosomiasis, although the disease can be observed in all age groups.[6] Occupational exposure and involvement in activities having direct contact with cercaria-contaminated waters are known risk factors for infection.

Acute schistosomiasis may lead to Katayama syndrome characterized by fever, lethargy, myalgia, and other signs and symptoms,[7] while chronic infection may cause hepatomegaly due to the body's immune response against the parasite eggs trapped in small portal venules.[8] Untreated infections are potentially fatal.

Studies have shown that *S. japonicum* has been endemic in the Lake Mainit area that adjoins the provinces of Agusan del Norte and Surigao del Norte. The first cases were reported by Pesigan in Jabonga, Agusan del Norte in 1947.[9] Because the lake has been a source of livelihood for the residents and has a potential for tourism due to its high ecological value,[10] a number of efforts have been done to control transmission of schistosomiasis in the area. However, reports of the Department of Health (DOH) - Provincial Health Teams of Surigao del Norte and Agusan del Norte have shown that schistosomiasis is still prevalent in the municipalities that are in the vicinity of the lake.[11,12]

Soil-transmitted helminth (STH) infections due to *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms are

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also public health concerns in the area. School children who have poor personal hygiene, frequent outdoor exposure, and high risk behavior have the greatest burden of infection, and are themselves significant sources of transmission.[13,14] Complications such as malnutrition, anemia, growth retardation, and delayed motor activity may compromise their productivity, quality of life and future.[14]

An assessment reflecting the epidemiologic status of schistosomiasis and STH infections is vital in order to determine the appropriate intervention for a community.[14] This study aimed to establish baseline epidemiological information on both parasitic infections among school children in four selected municipalities surrounding Lake Mainit. Results of this study will be useful in formulating strategies in the effective control of schistosomiasis and STH infections in these endemic areas.

Methods

Study Area

The municipalities of Alegria and Mainit in Surigao del Norte and the municipalities of Jabonga and Kitcharao in Agusan del Norte were the selected sites for this study (Figure 1). The municipalities were chosen due to their proximity to Lake Mainit and their draining tributaries.

Figure 1. Map of the selected municipalities in the Lake Mainit area (Lake Mainit Development Alliance, 2008).

Situated in the east of Lake Mainit, Alegria is a fifth class municipality with 12 barangays and has a total land area of 66.7 sq. km. On the other hand, Mainit, a fourth class municipality with 21 barangays, has a total land area of 892,440.0 sq. km. and is situated in the north of Lake Mainit.

Jabonga, a fourth class municipality with 15 barangays, is situated in the south of Lake Mainit and has a total land area of 293.0 sq. km. Situated in the east of Lake Mainit, Kitcharao is a third class municipality with 11 barangays and has a total land area of 212.4 sq. km.

Study Design and Study Population

A cross-sectional design was utilized for this study. A total of 32 barangays were included. The barangays in Alegria were Alipao, San Juan, Poblacion, Anahaw, Gamuton, San Pedro, and Pongtud while Mabini, Magpayang, Mainit (Poblacion), Mansayao, Matin-ao, Quezon, Roxas, San Francisco, San Isidro, Tagbuyawan, Tapian and Tolingon were the barangays in Mainit. The barangays in Jabonga were A. Beltran, Baleguian, Bunga, Colorado, Cuyago, Magsaysay, Jabonga (Poblacion), and San Pablo while Kitcharao (Poblacion), San Roque, Jaliobong, Canaway, and Bangayan were the barangays in Kitcharao.

Each barangay was represented by a public elementary school except for the barangays of Poblacion, Anahaw and Gamuton in Alegria which were represented by Alegria Central Elementary School. A total of 30 schools were included in the study.

Selection of the target population was based on the World Health Organization (WHO) Guidelines for the Evaluation of Soil-transmitted Helminthiasis and Schistosomiasis at Community Level.[14] A third grade class was randomly selected. When the number of pupils from the selected class was inadequate, another class from the same grade level was selected and combined with the initially selected class.

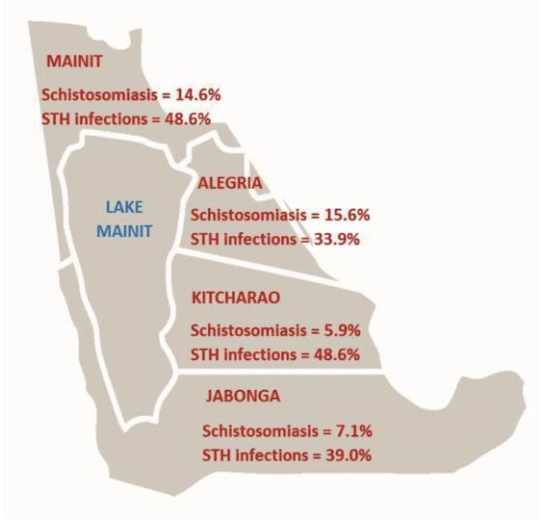

Figure 2. Map showing the distribution of schistosomiasis and STH infections in selected municipalities in the Lake Mainit area Surigao del Norte and Agusan del Norte.

Parasitologic Assessment

Parasitologic assessment was done on March 2007. Stool cups were distributed to the target participants a day prior to the collection. Children were oriented on the proper collection of stools. Stool samples were collected, processed, and examined by a group of trained medical

technologists from the Provincial Health Team of Agusan del Norte and Surigao del Norte. Kato Katz technique was utilized in processing the samples.[15] Two aliquots per formed stool sample were examined to increase the sensitivity of the assessment. Ten percent of the slides and slides with unusually high egg counts from each province were re-examined through an inter-provincial validation scheme to ensure reliability of diagnosis.

Data Handling and Analysis

Data gathered were double-encoded using Microsoft Excel. These were used to derive the cumulative prevalence of STH infections, the infection rates of each parasite species, and the intensities of infections. The intensities of infections reported in eggs per gram (epg) were classified as light, moderate, and heavy based on the WHO guidelines.[14] For the purpose of this study, moderate to heavy intensity STH infection were combined and referred to as heavy intensity.[14]

As recommended by the WHO for helminth control programs, the study areas were categorized based on the prevalence of schistosomiasis[16] and based on the cumulative STH prevalence alone[16] or together with the prevalence of heavy intensity STH infections.[14]

The chi-square test of homogeneity was used to determine whether two or more populations had the same distribution with respect to the variable being analysed. Prevalence odds ratios were also computed to compare the odds of schistosomiasis and STH infections among the municipalities. All of the statistical tests were two-sided with a confidence level of 95%. Statistical analyses were performed using Stata version 11.

Ethical Considerations

This study was part of a research capacity strengthening initiative of the University of the Philippines Manila - National Institutes of Health (UPM-NIH), where a panel of experts on content and methodology from the university reviewed and approved the technical and ethical aspects of the study prior to implementation.

The objectives and procedures of the study were explained to the municipal, barangay, and school authorities of the selected sites and their approval were obtained. In recruiting participants to the project, informed consent from the parents or guardians and assent of the targeted pupils were obtained. Codes were used to represent each participant to ensure confidentiality of information. All participants, regardless of infection status, were treated for STH infection using the guidelines for Mass Drug Administration (MDA) of the DOH. Only those who were found positive for schistosomiasis were given treatment.

Results

A total of 1,539 pupils from schools in the selected municipalities participated in the study. Results of the parasitologic assessment revealed that 10.9% of the pupils were positive for schistosomiasis (Table 1). Alegria (15.6%) and Mainit (14.6%) had infection rates that were significantly higher compared with the overall prevalence of all the other municipalities (p=0.004 and p=0.001, respectively). There was no significant difference observed between the infection rates in the two municipalities with the highest prevalence (p=0.723). The odds of having schistosomiasis in these municipalities were nearly (OR=1.7) twice as high compared with the other two municipalities. In addition, both had rates that were greater than 10%, which classified the municipalities as moderate-risk communities. On the other hand, Kitcharao (7.1%) and Jabonga (5.9%) had infection rates that were significantly lower compared with the overall prevalence of the other municipalities (p=0.002 for both). There was no significant difference observed between the infection rates of the two municipalities with low prevalence (p=0.527). Both of the municipalities were categorized as low-risk communities with rates that were less than 10%. The prevalence rates in all the schools ranged from 0.0% to 27.9%. The overall prevalence of heavy intensity infection was 0.1%, which was reported only in Mainit.

The overall cumulative STH prevalence was 43.9% (Table 1). Mainit (48.6%) and Jabonga (48.6%) had the highest cumulative prevalence, which were significantly higher compared with the overall prevalence of all the other municipalities (p=0.012 and p=0.018, respectively). There was no significant difference observed between the cumulative prevalence of the two municipalities (p=0.997). The odds of having STH infections were relatively higher (OR=1.3) in these municipalities compared with the other two municipalities. Although there was no significant difference observed between Alegria and Kitcharao (p=0.196), only the former (33.9%) had a cumulative prevalence that was significantly lower compared with the overall prevalence of all the other municipalities (p=0.000). Since all of the municipalities had cumulative prevalence rates that were greater than 20% but less than 50%, these were categorized as low-risk communities. The cumulative prevalence in all the schools ranged from 22.6% to 74%.

The overall prevalence of heavy intensity STH infections was 12.7% (Table 1). Jabonga (22.1%) and Kitcharao (11.5%) had prevalence of heavy intensity infections that were significantly higher compared with the overall prevalence of all the other municipalities (p<0.0001 and p=0.484, respectively). Although the prevalence of heavy intensity infections was significantly higher in Jabonga than in Kitcharao (p=0.000), the two municipalities were categorized under Category I

Table 1. *Schistosoma* infection rates, cumulative STH prevalence, *Ascaris* infection rates,*Trichuris* infection rates, and prevalence of heavy intensity infections among pupils in selected municipalities in the Lake Mainit area Surigao del Norte and Agusan del Norte (March 2007)

Municipality	No. of pupils examined	*Schistosoma japonicum*	STH infections		*Ascaris lumbricoides*		*Trichuris trichiura*	
		Infection rate	Cumulative prevalence	Heavy intensity infections	Infection rate	Heavy intensity infections	Infection rate	Heavy intensity infections
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Alegria	289	45 (15.6)	98 (33.9)	12 (4.2)	43 (14.9)	10 (3.5)	74 (25.6)	2 (0.7)
Mainit	492	72 (14.6)	239 (48.6)	48 (9.8)	90 (18.3)	28 (5.7)	205 (41.7)	31 (6.3)
Jabonga	453	32 (7.1)	220 (48.6)	100 (22.1)	185 (40.8)	91 (20.1)	145 (32.0)	27 (6.0)
Kitcharao	305	18 (5.9)	119 (39.0)	35 (11.5)	65 (21.3)	23 (7.5)	93 (30.5)	16 (5.2)
TOTAL	**1539**	**167 (10.9)**	**676 (43.9)**	**195 (12.7)**	**383 (24.9)**	**152 (9.9)**	**517 (33.6)**	**76 (4.9)**

Table 2. Co-infection rates within STH and between STH and *S. japonicum* in selected municipalities in the Lake Mainit area Surigao del Norte and Agusan del Norte (March 2007)

	Alegria No. (%)	Mainit No. (%)	Jabonga No. (%)	Kitcharao No. (%)	Overall No. (%)
No. of pupils examined	**289**	**492**	**453**	**305**	**1539**
A. lumbricoides* + *T. trichiura	19 (6.6)	56 (11.4)	110 (24.3)	41 (13.4)	226 (14.7)
***T. trichiura* + hookworm**	2 (0.7)	3 (0.6)	12 (2.6)	3 (1.0)	20 (1.3)
***A. lumbricoides* + hookworm**	0 (0.0)	2 (0.4)	14 (3.1)	2 (0.7)	18 (1.2)
***A. lumbricoides* + *T. trichiura* + hookworm**	0 (0.0)	2 (0.4)	12 (2.6)	2 (0.7)	16 (1.0)
At least 1 STH + *S. japonicum*	19 (6.6)	46 (9.3)	19 (4.2)	10 (3.3)	94 (6.1)

communities. Mainit (9.8%) and Alegria (4.2%) had prevalence of heavy intensity infections that were significantly lower compared with the overall prevalence of all the other municipalities (p=0.019 and p<0.0001, respectively). Although the prevalence of heavy intensity infections was significantly higher in Mainit than in Alegria (p=0.000), the two municipalities were categorized under Category III communities. The prevalence of heavy intensity STH infections in all the schools ranged from 2.2% to 29.1%.

Ascariasis was observed in 24.9% of pupils examined (Table 1). Jabonga had the highest infection rate at 40.8%, while Alegria had the lowest at 14.9%. Almost 10% of the pupils from all the municipalities had heavy intensity ascariasis. The prevalence of heavy intensity ascariasis was highest in Jabonga at 20.1% and lowest in Alegria at 3.5%.

Trichuriasis was observed in 33.6% of pupils examined (Table 1). Mainit had the highest infection rate at 41.7%, while Alegria had the lowest at 25.6%. Almost 5% of the pupils from all the municipalities had heavy intensity trichuriasis. The prevalence of heavy intensity trichuriasis was highest in Mainit at 6.3% and lowest in Alegria at 0.7%.

Hookworm infections were observed only in 1.6% of pupils examined. Jabonga had the highest infection rate at 3.1%, followed by Kitcharao with rate at 1.6%. Alegria and Mainit had prevalence rates at 0.7% and 0.6%, respectively. Cases of hookworm infections in all the municipalities were identified as light intensity.

The most common co-infection was with *A. lumbricoides* and *T. trichiura*, which was seen in 14.7% of all the pupils examined (Table 2). Jabonga (24.3%) had the highest co-infection, while Alegria (6.6%) had the lowest. Only 1% of the participants were co-infected with the three STH (Table 2). Co-infection with *S. japonicum* and at least one STH was observed in 6.1% of all the pupils examined (Table 1). The highest co-infection rate was observed in Alegria at 6.6%, while the lowest was seen in Kitcharao at 3.3%.

Discussion

This study determined the status of schistosomiasis and STH infections in school children in the Lake Mainit area. However, the findings cannot be generalized to the population in the region. The limitation can be attributed to the selection of school children from a certain grade level in selected schools, resulting in possible sampling bias. In spite of this, the study had followed the standards recommended by the WHO and the results may still serve as guide to implementers of control programs in conceptualizing an appropriate strategy for the study area.

Parasitologic assessment revealed that 10.9% of the school children in the Lake Mainit area had schistosomiasis, showing the need to target WHO set parameters. The WHO aims to eliminate the parasitic infection in low-transmission endemic countries, while intensifying control in high-transmission endemic countries.[17] The findings also indicate that there are still certain places in the Philippines with high prevalence of

schistosomiasis,[18] although the national average prevalence was only 2.5%.[2] This situation may imply limitations in the implementation of the schistosomiasis control program in certain areas of the country with local residents remaining at risk of infection.

As recommended by the WHO, communities that are endemic for schistosomiasis were categorized based on the prevalence of the infection.[14,16] Alegria and Mainit were categorized as moderate-risk communities, where treatment of all school children and adults at high risk once every two years is recommended.[16] Jabonga and Kitcharao, on the other hand, were categorized as low-risk communities, where treatment of school children twice during their stay in elementary school is recommended.[16] Praziquantel is the drug of choice aimed at controlling morbidity as a result of infection.[4] The distribution pattern indicates that morbidity due to and transmission of schistosomiasis may be higher in the first two municipalities than in the latter two. Factors such as the distribution of the snail intermediate host in the environment[18] and the distribution of the blood fluke in reservoir hosts such as domesticated animals[6] may explain the pattern, though their direct influence were not directly explored in this study. Inadequate sanitation, open defecation, and lack of access to safe water may also have an influence in the distribution of schistosomiasis in school children.

Irrespective of the infections status of the municipalities, schistosomiasis should be given the appropriate attention in terms of morbidity control through preventive chemotherapy. This will be beneficial in maintaining a low morbidity rate, which is indicated by the low prevalence of heavy intensity infection in the municipalities at 0.1%, and eventually, in achieving the targeted prevalence of heavy intensity infections at 0%. Transmission control, through snail control, improvement in environmental sanitation, promotion of the use of sanitary toilets, provision of safe water and water sources, and building foot bridges as waterway crossing in contaminated bodies of water, should complement morbidity control.[6]

STH infections were also found to be prevalent in the lake area, which is a common finding in schistosomiasis endemic areas.[19,20] The overall cumulative prevalence was 43.9%, which was already less than the targeted rate of less than 50% in the Integrated Helminth Control Program (IHCP) of the DOH.[13] Although this may imply success of the biannual school-based MDA, the rate was still markedly higher than the targeted rate of less than 20% set by the WHO.[16] In addition, the prevalence of heavy intensity infection was still high at 12.7%, which may imply that many are still suffering from morbidity due to STH infections.[14] The WHO set parameter targets to reduce the prevalence of heavy intensity infections to zero. Sustained regular MDA may result to significant decreases in infection rates and morbidity;[21] but the success lies in achieving high MDA coverage. While the WHO targets a coverage rate of at least 75%,[22] the DOH targets at least 85% .[4,12]

Referring to the WHO classification of communities based on cumulative STH prevalence and prevalence of heavy intensity infection, Jabonga and Kitcharao were classified as Category I communities,[14] while Alegria and Mainit were classified as Category III communities.[14] These may suggest that many had experienced superinfection, referring to the condition of acquiring an infection on top of an existing infection, and re-infection in the first two municipalities than in the latter two municipalities due to poor sanitary and environmental condition.[23] For Category I communities, treatment of the whole population once a year is recommended, except for school and preschool children, and women of child-bearing age that shall be treated twice or thrice a year.[14] Only case management is recommended for Category III communities.[14] Regardless of the category, improvement in sanitation in the municipalities should be promoted through information, education, and communication strategies aimed at changing health-related behaviors of the people.[24] Referring to the revised WHO guideline, which is based on the cumulative STH prevalence alone, all of the municipalities were classified as low-risk communities, where treatment of all school children and other high risk groups once each year is recommended.[16]

Recommended strategies of the DOH in controlling STH infections include mass targeted deworming of school children twice a year and promotion of WASH strategies, which refers to improvement in safe water supply, sanitation, and hygiene.[13] Approaches that can change the behavior of people through health education, community participation, advocacy, and social mobilization are also integrated.[13]

The prevalence of hookworm infections was low at 1.6% only. This finding may be attributed to the limitation of Kato Katz method in the diagnosis of hookworm infection. Glycerine, which was used as a clearing agent, contributed to the rapid clearance of hookworm eggs within 40-60 minutes after processing.[15] The time interval between Kato-Katz processing and microscopic examination is critical in detecting hookworm eggs.

Co-infection with *Ascaris* and *Trichuris* were the most prevalent multiple helminth infection observed among 14.7% of school children. This can be attributed to their common mode of transmission.[25,26,27] Co-infection with STH and *Schistosoma*, which is associated with anemia, was also observed at 6.4%.[19,28] Polyparasitism is an important public health concern since individuals simultaneously infected with different parasites are predisposed to an increase risk of morbidity.[21,23] The

occurrence of this condition suggests the need to consider the delivery of antihelminthic drugs in combination during MDA. This is possible since the safety and effectiveness of praziquantel and albendazole combination had already been studied and validated.[29,30,31]

One concern in the case detection of schistosomiasis and STH infections is the limitation of local microscopists in detecting helminth infections.[32,33,34] Another is the limitations of the Kato Katz technique as a processing method for laboratory diagnosis.[1,15] As an implication, infected individuals remain untreated, leading them to experience the sequelae of and complications due to parasitic infections. Another consequence is the underestimation of the estimated burden and prevalence of the parasitic infections, since only a portion of the real picture of the epidemiologic distribution is reported. Capacity strengthening for the local microscopists is therefore needed. A quality assurance scheme also ensures the accuracy in the diagnosis.[35]

Since infection with *S. japonicum* and STH are both associated with poor sanitation and lack of access to safe water,[13] and both can be addressed simultaneously with preventive chemotherapy,[24] there is an opportunity to integrate existing control programs. The guiding principles and framework of the IHCP can be adopted in developing a local model of an integrated schistosomiasis and STH infection control. Snail control shall be included to address schistosomiasis.[4] Preventive chemotherapy will serve as the key morbidity control strategy of the program, with an aim of covering at least 85% of the target population during MDA. Promotion of sustainable sanitation to attain and maintain zero open defecation can be a complementary strategy to ensure that the transmissions of the parasites are under control. Health promotion and education will be useful in modifying health-related and health-seeking behavior of the people in the community, and in mobilizing the people to partake in the effort to control the parasitic infections. Capacity building will be necessary for the local government units (LGU) in leading the program. Collaborations of LGU leaders with stakeholders from national government agencies such as the DOH and the DepEd, non-government organizations, and research and academe can be established for technical, human, and financial assistance for the planning, implementation, monitoring, and evaluation of the program. The local school system can be the venue for implementation and evaluation of the program since this is where the target population is most accessible. This considers DepEd involvement in schistosomiasis control alongside with STH control, and in an opportunity for morbidity control by regular preventive chemotherapy in classrooms, avoiding the situation of bringing infected children in the local health centers when they are already suffering from morbidity. Teachers will assist in drug administration and will be advocates for health awareness and improved environmental sanitation. This set-up may provide a better ground for the improvement of health status and academic performance of school children.

Results of this study prove that an integration of the efforts to control schistosomiasis and STH infections is necessary in order to address both public health concerns in the Lake Mainit area. Commitment of stakeholders and community participation are vital for an effective implementation of the program.

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