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RESEARCH ARTICLE

Prevalence, physiologic effects, and risk factors of soil-transmitted helminth infections among grade school children

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ABSTRACT

Background: Soil-transmitted helminths (STHs) are widespread and are the most common infectious agents in developing countries such as the Philippines. **Aims and Objectives:** This study was planned (i) to determine the prevalence of intestinal helminth infections, (ii) to identify the predominant helminth parasites and parasite densities, (iii) to measure and compare the effects of helminth infections on the weight of grade school children, and (iv) to identify relevant risk factors for helminth infections. **Materials and Methods:** Stool samples of 61 nursery and grade school children were examined using Kato-Katz method and Formol-ether concentration technique. Anthropometric, demographic, socioeconomic, environmental, and behavioral characteristics of the pupils were obtained using a survey questionnaire and subsequently statistically analyzed. **Results:** The prevalence of STH infections among children was 74% with a high predominance of *Taenia* sp. and high density of *Ascaris lumbricoides*. Of the cases, 39.3% were single infection while 34.4% had mixed infections. Helminth infections, single or mixed, were not associated with sex, but the weight difference between infected and uninfected females is higher compared to males. The prevalence of helminth infections was associated with close contact with livestock or pets in the household. **Conclusion:** There is a high prevalence of intestinal helminths, predominantly of *Taenia* sp., among grade school children. Helminth infections were either single or mixed type, were not associated with sex but with significant effects on the weights of female children, and were associated with close contact with household pets.

KEYWORDS: Soil-transmitted Helminths; Formol-ether; Kato-Katz; Prevalence; Risk Factor; School Children

INTRODUCTION

Helminths are parasitic worms considered as the most common infectious agents in developing countries. The most common helminth infections in humans are those caused by *Ascaris, Trichuris,* and hookworms infecting more than 1.5 billion people worldwide followed by schistosomes and filarial worms infecting 200 million and over 120 million people, respectively.[1,2] Pre-school and school-aged children are prone to soil-transmitted diseases and schistosomiasis.[1] In the Philippines, *A. lumbricoides, Trichuris trichiura,* and hookworms are the major causes of intestinal parasitic infections.[3] Studies done on soil-transmitted helminths (STHs) in the Philippines showed a cumulative prevalence rate of 33.2% in Compostela Valley, 51.6% in Quezon City, 67% in Negros Occidental, 77% in Nueva Ecija, and more than 70% in Western Visayas.[4,5] If not treated, most helminth infections can lead to anemia, malnutrition, fatigue, growth

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retardation, poor cognitive development with increased absenteeism from school, chronic inflammatory disorders, and other life-threatening consequences. These adverse effects of helminth infections contribute in establishing and keeping the vicious cycle of helminth infection, poverty, reduced productivity, and weak socioeconomic development.[1,6]

The huge burden of helminth infections in the health, education and economic system, especially in rural areas, which do not have ready access to medical services and proper diagnostic facilities, poses a very significant issue that needs to be addressed.[6] In this study, the prevalence of intestinal helminth parasites conducted among the preschool and primary pupils in a rural area, where health and medical issues and concerns have not been properly addressed is highly significant. Thus, the baseline data and information about STHs are important in addressing immediate health concerns and in monitoring health programs in the future that can strengthen interventions to reduce helminth infections. Hence, this study determined the prevalence, predominant helminth parasites, and parasite densities among nursery to grade school pupils of the Jaime Hilario Integrated School-La Salle (JHIS-LS) in Bagac, Bataan, Philippines through examination of stool samples using Kato-Katz method and Formol-ether concentration technique. Moreover, the study measured and compared the effects of helminth infections on the mean weights of grade school children, and identified relevant socioeconomic, environmental, and behavioral risk factors for helminth infections.

MATERIALS AND METHODS

Study Location and Population

JHIS-LS, located in Looc, Banawang, Bagac, Bataan, Philippines, is supervised by the Lasallian Institution catering the less fortunate students in the primary and secondary levels of education. Its operation started during the school year 2006-2007 with 40 pupils in Grade 1. After 5 years, the school served 166 students from the areas nearby, and to date, almost 400 students are enrolled. The school is surrounded by the Bay of Bagac in front and a range of hills at the back with a small community of fishermen living in the area where most of the students also reside.

The study protocol was reviewed and approved in compliance with the existing institutional ethical guidelines. Subsequently, the parents and guardians of the children, 6-8 years old, were given information and consent packets for the collection of stool samples. Sixty-one parents expressed their willingness to participate in the study and were given full explanation, verbal and written, and proper orientation along with survey forms regarding the procedures and benefits of the study. Consent forms were obtained and parents were informed about the results of the study. Pupils found positive for helminth parasites were referred to medical doctors for deworming and to address other health-related concerns.

Survey Questionnaire

Information regarding anthropometric, demographic, socioeconomic, environmental, and behavioral characteristics of the pupils were obtained. Using a questionnaire administered in Filipino, interviews were also conducted with school employees and parents of the pupils to gather additional information on their way of living. Observation of the study site was also done by the researchers during the collection of the stool samples.

Collection of Samples

Stool cups, newspaper, and plastic coverings were distributed for fecal sample collection. Instructions on how the fecal material will be collected were properly given and discussed with the parents and guardians. On submission of the fecal specimen, 10% formalin was added immediately on these samples and subsequently transported to the Zoology and Parasitology Laboratory, Science and Technology Research Center, De La Salle University, Manila, Philippines.

Kato-Katz Method

Approximately 41.7 mg of fecal sample was utilized in this procedure with the unwanted debris filtered using mosquito net replacing the conventional mesh screen. A cardboard template with a hole measuring 6 mm in diameter was used to obtain the 41.7 mg of stool sample for analysis.[7] Cellophane, pre-soaked on glycerol-malachite green solution, was used as the coverslip to examine the samples clearly, incubated for 30 min at room temperature, and subsequently examined under a light microscope. Each sample was prepared in triplicates for a total of 183 slides for microscope viewing.

Formol-ether Concentration Technique

Approximately 1 g of fecal sample was filtered and placed in a falcon tube with 10 ml formalin added into the tube along with 3 ml ether. Additional formalin was introduced to obtain a 15 ml final volume. The solution was agitated and centrifuged at 500 rpm for 2 min. The top 3 layers formed were removed, and the remaining sediment was placed on a clean glass slide and microscopically examined. Each sample was prepared in triplicates for a total of 183 slides for microscope viewing.

Identification of Helminth Eggs

Eggs of the parasites were microscopically viewed noting the quantity, shape, and size using a light microscope (Nikon Eclipse Ci). Identification of parasites was done based on the morphology of the eggs.[8-10]

Data and Statistical Analysis

A reference method is not available for intestinal helminth detection, estimation employed the combined results of Kato-Katz method and Formol-ether concentration technique.[11] The density of each helminth parasite was computed by multiplying 24 to the number of eggs observed in a 41.7 mg stool sample.[11] The prevalence of helminth infection was computed, classified based on helminth parasites and densities, type of infection (single or mixed), and sex and age of study population. Physiologic effects of helminth infections were assessed using the differences in the weight values of the grade school children. Values were reported as frequency count for qualitative variables, and mean ± standard deviation for quantitative variables. Relative risk, odds ratio (OR), and 95% confidence interval (CI) were computed to examine the proportion differences and to correlate identified risk factors in the study on helminth infections. All statistical analyses were carried out at 5% level of significance using Statistical Analysis System (SAS®).

RESULTS

In this study, a helminth infection prevalence rate of 73.77% (45/61) was determined among grade school pupils (Table 1). Intestinal parasites isolated from the fecal samples include eggs of *Taenia* sp., *A. lumbricoides, Fasciola* sp., *T. trichiura, Enterobius vermicularis, Capillaria philippinensis, Ancylostoma duodenale*, *Clonorchis sinensis*, and even tapeworm proglottids (Figure 1). Using Kato-Katz method, 62.30% of the grade school children were found positive for helminth infections (Table 1). In terms of egg per gram (EPG), *A. lumbricoides* and *T. trichiura* were the most commonly identified helminths (Table 2). Kato-Katz method and Formol-ether concentration technique identified *Taenia* sp. as the leading cause of helminth infections. Of these infections, a total of 39.34% (24/61) of the respondents were identified to have single infection while 34.43% (21/61) had mixed infections (Table 3).

Moreover, sex does not have any significant association with helminth infection (OR: 1.22; 95% CI: 0.38-3.40; $P > 0.05$). Among the infected children, males have greater odds of having mixed infections than females (OR: 1.05; 95% CI: 0.32-3.41; $P > 0.05$) which suggests that there is no significant relationship between mixed infections and sex. The difference of mean weight between infected and uninfected females (5.48 lbs) is higher compared to males (0.16 lbs), and the mean weight of infected females is also lower compared to males (Table 3). Moreover, there is not much variation in the weights of children between age groupings ($P > 0.05$) (Table 3).

Of the 61 pupils who had fecal specimens examined, only 53 had completed and returned the questionnaire. Among the risk factors, exposure of pupils to street food and administration of antihelminth drugs were found to be associated with low odds for helminth infections (Table 4). This suggests that non-consumption of antihelminth drugs is associated with high odds and risk of being infected with helminths. Among the pupils, 72% have livestock or pets in their household are infected with intestinal helminth parasites. Pupils who have livestock or pets have a higher chance of being infected than those pupils who do not have (Table 4). The risk of a pupil who is in close contact with animals of getting a helminth infection is almost twice the risk of pupils not in contact with animals. Moreover, exposure to untreated water is associated with low odds of being infected with helminths (Table 4). However, there is insufficient evidence to draw this association between helminth infection and consumption of untreated water.

DISCUSSION

The combined results of the Kato-Katz method and the Formol-ether concentration technique were used since in the absence of a reference method for detection of intestinal parasites, combined results from the methods can be utilized.[11] The combined result of the two methods employed suggests that any positive result will be considered as true-positive.[12] In this study, *T. trichiura* and *A. lumbricoides* were the most commonly found helminths among children, a similar finding among pupils in Northeast Ethiopia where *Trichuris* and *Ascaris,* along with *Schistosoma* were mostly detected.[11] In Formol-ether concentration technique, positive for helminth infections were identified in 44.26% of the grade school children. Of these helminth infections, *Taenia* sp. had the highest prevalence, similar among human *Taenia solium* infections in Mbozi District, Mbeya Region, Tanzania.[13] The helminth infection prevalence rate of 73.77% was identified among grade school pupils, which is comparable to the helminth infection prevalence rate of 77% obtained among public school pupils in Nueva Ecija and >70% in Western Visayas.[4,5] However, this was considerably higher than the

Table 1: Comparison between Kato-Katz method and Formol-ether concentration technique in helminth detection

Result	Kato-Katz method (*n*=61)		Formol-ether concentration technique (*n*=61)	
	Positive (%)	Negative (%)	Positive (%)	Negative (%)
Positive (45)	38 (62.30)	7 (11.48)	27 (44.26)	18 (29.51)
Negative (16)	0 (0.00)	16 (26.23)	0 (0.00)	16 (26.23)
Total results	38 (62.30)	23 (37.70)	27 (44.26)	34 (55.74)

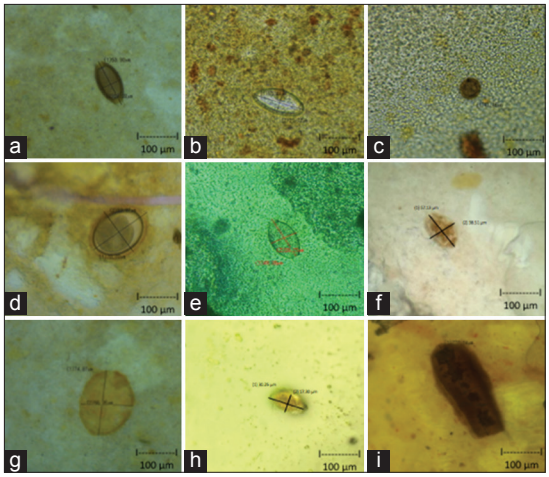

Figure 1: Helminth eggs identified in the fecal samples: (a) *Trichuris trichiura*, (b) *Enterobius vermicularis*, (c) *Taenia* sp., (d) *Ascaris lumbricoides*, (e) *Capillaria philippinensis*, (f) *Ancylostoma duodenale*, (g) *Fasciola* sp., (h) *Clonorchis sinensis*, and (i) a tapeworm proglottid

Table 2: Density of the identified helminth parasites among infected individuals

Helminth species	EPG
Taenia spp.	74.00
Ascaris lumbricoides	519.00
Trichuris trichiura	356.00
Fasciola hepatica	187.20
Clonorchis sinensis	48.00
Enterobius vermicularis	24.00

EPG: Egg per gram

Table 3: Weight measurements of schoolchildren based on sex, age, and helminth infection

Characteristics	Type of infection	Infected	Non-infected
Sex			
Male=19	Single infection	10	6
	Mixed infection	9	
Female=26	Single infection	14	10
	Mixed infection	12	
Weight, in lbs (mean±SD)			
Sex			
Male	58.17±18.12		58.33±11.69
Female	48.72±10.36		54.20±13.18
Age (years)			
≤7	49.05±13.30		48.00±5.29
>7	58.00±16.63		56.00±13.21

SD: Standard deviation

prevalence rate obtained among schoolchildren in Negros Occidental (67.4%), Quezon City (51.6%), and Compostela Valley (33.2%).[4,5] Variations in socioeconomic and sanitation status, local endemicity, climatic and geographical conditions of the study sites, and the research design are just some of the plausible factors explaining the differences in the prevalence rates of these helminth infections.

Of these helminth infections, the leading cause was due to *Taenia* sp. which was not in agreement with the 2005 nationwide survey done by the Department of Health in the Philippines where *A. lumbricoides* was found to be the most prevalent, followed by *T. trichiura*, and hookworm species such as *Necator americanus* and *A. duodenale*.[3] Despite the incongruence, it is not that surprising because cysticercosis is endemic in developing countries whose economy depends mainly on agriculture such as Philippines.[4] While there are many municipalities and provinces converting their agricultural lands into other uses, Bagac, Bataan, which is very rich in agricultural and aquatic resources, is an exception. Bagac remains to conserve and make use of whatever agricultural land area left to be cultivated.[15]

One possible reason that *Taenia* sp. infection occurred with the highest frequency is that the eggs of *Taenia* sp. have a high resistance to a broad range of temperature and may remain viable in adverse environmental conditions for many months.[16] These are also highly resistant to desiccation as well as to treatment of sewage and can survive for several weeks on pastures.[17] The eggs of *Taenia* sp. are covered by a thick embryophore, which is composed of prismatic keratin blocks held together by a cement-like substance and thus are not easily destroyed.[18] Even though the study has recorded *Taenia* sp. as the most prevalent, it shows that *A. lumbricoides* has the highest EPG. Thus, the species with the highest percentage of infection does not necessarily have the highest EPG.[19] Furthermore, having a high EPG only indicates the density which reflects the intensity of infection on the person and does not mean it is the most prevalent.[20]

Moreover, the study revealed that sex does not have any significant association with helminth infection which agrees with the findings in the STH infection in school children in South-Eastern Nigeria,[21] but contradicts with the intestinal helminthiasis among schoolchildren in Ilie, Osun State, Southwest, Nigeria[22] where the proportions of infected male and female pupils significantly vary. However, it is not yet established if helminth infection is sex-dependent or not,[21] as some studies claimed that it is sex-dependent,[23] while some suggest otherwise.[24] Thus, more systematic studies are still needed to clarify this issue.[21]

Furthermore, a total of 39.34% of the respondents were identified to have single infection while 34.43% had mixed infections. Among the infected children, males have greater odds of having mixed infections than females. However, there is no significant relationship between mixed infections and sex which is not the case among schoolchildren in Honduras regarding the transmission of STH where males

Table 4: Risk factors and proportions of helminth infections among schoolchildren

Risk factor	Infected	Not infected	Proportion	Odds	RR	95% CI	OR	95% CI
Street food consumption								
Yes	30	14	0.68	2.14	0.87	0.58-1.31	0.61	0.11-3.24
No	7	2	0.78	3.50				
Administration of antihelminth drug								
Yes	29	15	0.66	1.93	0.74	0.55-1.02	0.24	0.03-2.28
No	8	1	0.89	8.00				
Close contact with livestock or pets								
Yes	31	12	0.72	2.58	1.20	0.69-2.07	1.72	0.41-7.18
No	6	4	0.60	1.50				
Untreated water supply								
Yes	17	9	0.65	1.89	0.88	0.46-1.68	0.66	0.20-2.11
No	20	7	0.74	2.86				

RR: Relative risk, CI: Confidence interval, OR: Odds ratio

had twice the odds of being infected with *A. lumbricoides* and having mixed infections.[25] However, it is still not yet well-established if this finding is due to differential exposure or physiologic factors.[25]

The weight, sex, and age distribution of these pupils were recorded since these may influence the intestinal helminth parasite infections. It was observed that the difference of mean weight between infected and uninfected females is higher compared to males, and the weight of infected females is also lower compared to males. However, this contradicts with STH infection in schoolchildren in South-Eastern Nigeria in which males weighed less than females.[21]

The high infection rate (73.77%) of schoolchildren in JHIS-LS with intestinal helminth parasites can be attributed to many risk factors such as poor hygiene and sanitation, unspecific antihelminth drug, unsafe or untreated drinking water, proximity to animals which serve as hosts to parasites, and consumption of contaminated food. Street food vending has been a public health concern because of the spread of certain diseases and lack of basic food safety knowledge for the vendor.[26] Some sources of this contamination include the raw materials and personal hygiene of the vendor. A survey on the presence of *T. solium* egg in a soldier camp in Mexico City revealed that 86.7% of families positive for *T. solium* ate in street food stores.[27] There is a high risk for pupils and their families eating street food to obtain *Taenia* spp. However, in this study, exposure to street food is found to be associated with low odds among pupils for helminth infection.

Furthermore, administration of antihelminth drugs is associated with low odds among pupils for helminth infection. This study suggests non-consumption of antihelminth drugs is associated with high odds and risk of helminth infection. Antihelminth drugs are still the principal means by which helminth infections can be controlled.[28] Antihelminth drug resistance poses a problem inhibiting the drug to function and remove the helminth species infecting a host. Even though 71.8% of them had taken antihelminth drugs at some point in their lives, the majority is still infected since most of the available drugs target only specific types of helminths. Thus, having a single dose of medication cannot eliminate the helminth parasites. Finally, among the pupils who have livestock or pets, they have a slightly higher chance of being infected than those pupils who do not have. It is considered a risk factor since animals can freely roam on contaminated areas and bring it close to the household. The risk of a pupil who is in close contact with animals of getting a helminth infection is almost twice the risk of pupils not in contact with animals. The exposure of pupils to animals in their household is associated with the high odds of being infected with helminths, as there is a significant relationship between the medium to high soil-transmitted infection with the presence of pets in a household.[29] Animal feces can also contribute to the fecal-oral exposure of the pupils.[30] Moreover, exposure to untreated water is said to be associated with low odds of the pupils being infected with helminths. However, there is insufficient evidence to conclude that the association between helminth infection and consumption of untreated water is statistically significant. This supports high helminth infection rate in Nepal, but there was no significant association between consumption of untreated water and helminth infection.[31] Hence, the lifestyle of an individual greatly influences the probability of acquiring intestinal helminth infections, and the transmission of these intestinal helminth parasites can be prevented by altering the identified risk factors.

CONCLUSION

The overall prevalence rate of STH infections among grade school children is 73.77%. Of these, 39.34% were found to have single infection predominantly of *Taenia* sp. while 34.43% had mixed infections predominantly of *Taenia* sp. and *A. lumbricoides*. Despite the high prevalence of

Taenia sp., *A. lumbricoides* has the highest density. In this study, sex has no significant association with either single or mixed helminth infections, but the difference in the mean weights between infected and uninfected female pupils was higher compared with males. Moreover, the significant risk factor identified for the high prevalence of helminth infection is close contact with livestock or pets in the household. Other factors that could have contributed to the high prevalence of helminth parasites include street food consumption, non-administration of antihelminth drug, and untreated water supply.

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