SCHOOL-BASED ASSESSMENT OF SOIL-TRANSMITTED HELMINTHIASES AND FOOD-BORNE PARASITOSIS (INTESTINAL FLUKE INFECTION) IN MONKAYO, COMPOSTELA VALLEY

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Abstract. The objectives of the study were: 1) to determine the prevalence and intensity of intestinal helminthiasis, including soil-transmitted helminthiases and heterophyid infections using school-based assessment; 2) to determine the impact of mass treatment using albendazole for soil-transmitted helminthiases in terms of prevalence and intensity of infection, cure rate, and egg reduction rate; 3) to determine the effectiveness of selective treatment using praziquantel for heterophyid infection; 4) to determine reinfection rates of intestinal helminths under study after 6 months; and 5) to attempt to determine intestinal fluke species. The study was conducted in two barangays of Monkayo, Compostela Valley in Southern Mindanao, *ie* San Isidro and Casoon. Grades III and IV pupils were targeted as the indicator group. Parasitologic assessment was done at baseline or Day 0 using Kato-Katz technique. Targeted mass treatment for soil-transmitted helminthiases was done using albendazole 400 mg tablets, while selective treatment for intestinal fluke infection was done with praziquantel 25 mg/kg p.o. three doses in one day. Follow-up parasitologic assessments were done at Days 7 to 14 to document response to treatment and at Day 180 (for Grades IV and V pupils in the next school year) to determine reinfection with soil-transmitted helminths and heterophyid. Data were collated and processed using EpiInfo 6 software, which allowed derivation of descriptive statistics. Of 84 pupils examined at baseline, the overall cumulative prevalence of soil-transmitted helminthiases was 48.6%. Hookworms were the most common soil-transmitted and intestinal helminth in both barangays, with 35.3% of pupils infected. Heterophyid infection was the next most common intestinal helminth, at 32.4%. Multi-parasite infections were common. The cure rate for heterophyid infection was highest, at 92.9%, with excellent cure rates for those with initially light to moderate intensities. The cure rate for hookworm infection was good, at 88.5%. Egg reduction rates for hookworms and heterophyid infections were also excellent, at 95.3 and 82.9%, respectively. At Day 180, the cumulative prevalence of soil-transmitted helminthiases was 41.3%. The hookworm and heterophyid infections were still most common at 27.7 and 29.0%, respectively. Hookworm infection rates were not markedly different between the two barangays. Reinfection by heterophyids was highest among all intestinal helminthiases. The hookworm reinfection rate was 26.3%, with rates similar in the two barangays, and an overall egg reduction of 45.6% compared with baseline. Heterophyid flukes were collected from adult patients with heterophyid eggs on stool examination. Preliminary studies on the flukes indicate the species to be *Haplorchis taichui*.

INTRODUCTION

Soil-transmitted helminthiases remain one of the leading causes of morbidity among school-age children. Long-term effects of chronic infections include malnutrition, poor cognitive function, anemia, and other states of poor health. These infections continue to affect the majority of public elementary schoolchildren in the Philippines, posing a threat to children's productivity and future.

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Intestinal fluke or heterophyid infection until recently was thought to be uncommon but widely distributed in the Philippines. This infection, which is transmitted by ingestion of raw or insufficiently cooked fish, is known to cause gastrointestinal disturbance, mainly peptic ulcer-like symptoms and is known to have destructive effects on the brain, spinal cord, and heart, as parasite eggs are carried to these organs. Recent studies by the proponent's group have shown that contrary to reported findings in the 1980s, it is not uncommon, with prevalence rates ranging from 16 to 36% in villages in Monkayo, Compostela Valley Province (Cross and Basaca-Sevilla, 1984). At present, heterophyid infection is known to exist in 11 out of 21 barangays in Monkayo. In Barangay San Isidro, of 242 individuals examined for this parasitic infection, 87 people (35.9%) were found infected in a survey in

May 2000. The infection was found among individuals of both sexes and all age groups, children included. Heterophyid infection may thus be considered one of the re-emerging food-borne parasitic infections. To date, the exact species of intestinal flukes in the Philippines have not been definitely established.

Schoolchildren may be an excellent indicator group that can provide information on the status of intestinal parasitoses in a community, since they belong to the group that may be at high risk of infection. This group of individuals may help provide estimates of transmission rates and disease burden, which may then help in formulating approaches and strategies for control and prevention. In addition, the school is an ideal venue to conduct control activities, be it chemotherapy through mass treatment or health promotion and education activities. Tackling the two parasitic disease problems, soil-transmitted helminthiases and heterophyid infections, in the school may then provide an opportunity for combined or integrated control, which may have important implications for improved delivery of public health services.

The objectives of the study were: 1) to determine the prevalence and intensity of intestinal helminthiasis, including soil-transmitted helminthiases and heterophyid infections, using school-based assessment; 2) to determine the impact of mass treatment using albendazole for soil-transmitted helminthiases, in terms of: a. prevalence of infection, b. intensity of infection, c. cure rate, d. egg reduction rate; 3) to determine the effectiveness of selective treatment using praziquantel for heterophyid infections; 4) to attempt to determine intestinal fluke species; and 5) to determine reinfection rates of intestinal helminths under study after 6 months.

MATERIALS AND METHODS

Study site

The study was conducted in two barangays of Monkayo, in Compostela Valley Province. Formerly a part of the province of Davao del Norte, the area is known to be endemic for soil-transmitted helminthiases and food-borne intestinal helminthiases, like capillariasis and heterophyidiasis. Agriculture is the main source of livelihood in the area. There is no effective control program directed against soil-transmitted helminthiases and food-borne intestinal helminthiases. In many instances, two or more types of parasitic infections co-exist in individuals (multi-parasitic infections).

Public elementary schools in two villages, Barangays San Isidro and Casoon, were the sites of the school-based survey. The populations of the two schools were 84 and 100, respectively, while the populations of the barangays were 235 and 353 (Table 1).

Day 0 (Baseline assessment)

Stool specimens were collected from third and fourth grade pupils who were considered the indicator group for the whole school. This scheme of sampling is consistent with the World Health Organization Guidelines for the Evaluation of Soil-transmitted Helminthiasis and Schistosomiasis at the Community Level (WHO, 1998).

The Kato-Katz technique was utilized for parasitological assessment using stool samples. This procedure made use of a fixed quantity of fecal material (40 to 50 mg of stool), which enabled not only a qualitative, but also quantitative, assessment of the status of infected individuals. [This technique allowed a much greater chance of diagnosing true positive specimens compared with the routinely used direct fecal smear (DFS), which uses only 2 mg of stool sample. With egg counting, monitoring of the impact of control activities may then be noted not only in terms of clinical cure or cure rate but also of clinical improvement and reduction in egg counts. Egg counts also provide an indirect measure of worm burden with greater egg counts implying a greater number of female worms present]. Soil-transmitted helminth eggs were counted and classified according to a WHO standard classification of intensities of infection (Table 2), while heterophyid eggs were counted and classified according to a proposed classification (Table 3).

Mass treatment

Targeted mass treatment with albendazole 400 mg orange-flavored tablets given to all school children,

Table 1
Barangay and school populations San Isidro and Casoon, Monkayo, Compostela Valley, 2001.

Barangay	Barangay population	Elementary school population
San Isidro	235	84
Casoon	353	100
Total	588	184

(Source: RHU Records and DECS, Monkayo, 2001).

Table 2
WHO standard classification of intensities of soil-transmitted infections.

STH	Light	Moderate	Heavy
Ascaris	1 – 4,999 epg	5,000 – 49,999 epg	≥ 50,000 epg
Trichuris	1 – 999 epg	1,000 – 9,999 epg	≥ 10,000 epg
Hookworms	1 – 1,999 epg	2,000 – 3,999 epg	≥ 4,000 epg

Source: WHO Guidelines for the evaluation of STH and schistosomiasis at community level *(WHO/CTD/SIP/198.1)*.

Table 3
Proposed classification of intensities of Heterophyid infections.

	Light	Moderate	Heavy
Heterophyid	1 – 100 epg	101 – 1,000 epg	≥ 1,000 epg

Source: Belizario *et al*, in press

Table 4
Collection of adult flukes.

1. Bowel preparation will consist of administration of 2 to 3 bisacodyl (Dulcolax) 2 mg tabs p.o. after supper on the night prior to treatment. The patient is advised to be on a liquid diet from then on and is expected to move his bowels early on the day of treatment.

2. Treatment shall be in the form of praziquantel 600 mg tabs, 20 mg/kg, three doses in one day. Two hours after the intake of the first dose of praziquantel, magnesium sulfate 30 mg powder mixed with fruit juice will be administered p.o., and thereafter all stools passed out will be collected.

3. Collect the total stool output, wash with NSS and mix until the fecal matter is homogeneously mixed. Pour the fecal solution in a sedimentation flask (plastic container), and let stand for 30 minutes to 1 hour.

4. After sedimentation, decant the supernate. Wash the sediment with NSS, allow the sediment to settle, and decant supernate carefully. Repeat this series of procedures until the supernate becomes clear. Flukes will be in the sediment and will appear like "minute grass seeds". Harvest the suspected adult flukes using a Pasteur pipet and transfer them on to a Petri dish for further examination.

Grades III and IV, with parental consent (informed consent). (Albendazole is one of the four drugs recommended by the WHO for use in mass treatment schemes directed against soil-transmitted helminthiases). Coverage and treatment rates were noted.

Selective treatment of heterophyid infection

Grade III and VI pupils who were found to have heterophyid infection were given praziquantel 25 mg/kg p.o. three doses in one day.

Days 7 to 14 (First follow-up)

Follow-up stool collections and examinations were done on the same indicator group of pupils with stool specimens at Day 0 and 7 to 14 days after treatment, to document response to targeted mass treatment with albendazole and selective treatment with praziquantel. Among pupils who were found to be infected at Day 0, response to treatment for either soil-transmitted helminths or heterophyid flukes was classified according to clinical outcome. Clinical cure meant absence of parasite eggs one to two weeks after

treatment, while clinical improvement meant a decrease in the number of parasite eggs per gram compared with baseline one to two weeks after treatment. Clinical failure meant an increase in the number of parasite eggs per gram compared with baseline one to two weeks after treatment, while lost to follow up meant non-submission of stool specimen one to two weeks after treatment.

Day 180 (Second follow-up)

A second follow-up stool collection and examination was done on the same group of pupils belonging to the indicator group 180 (+/- 14) days after treatment, to determine reinfection rates with soil-transmitted helminths and heterophyids.

Collection and identification of heterophyid species

Total stool collection was attempted on a few heterophyid-infected and consenting adults treated with praziquantel, to enable collection and identification of adult heterophyid species. The procedures for bowel preparation, treatment, purgation, collection of total stool output, washing, sedimentation, and collection of adult flukes followed a proposed protocol (Table 4).

Data handling and analysis

Data were collated, processed and analyzed using EpiInfo 6 software, and descriptive statistics were utilized to describe the results. Data were double encoded and discrepancies were corrected as appropriate.

Quality control

Validation of slide reading was done by a reference microscopist, who re-examined 10% of positive slides and all negative slides, who was blinded to the result of the initial slide reading.

RESULTS

Day 0 (Baseline assessment)

Table 5 shows the targeted number of Grade III and IV pupils for assessment and cumulative prevalence of STH infections in barangays San Isidro and Casoon. Coverage in terms of proportion of targeted pupils examined was excellent at 97.6 and 91.0%, respectively. Overall cumulative prevalence of STH infection was 48.6%. The cumulative prevalence was higher in Casoon, at 57.1%, compared with the level in San Isidro, at 39.0%.

Hookworms were the most common soil-transmitted and intestinal helminth in both village schools. It was seen in 35.3% of pupils examined, with infection rates in the two village schools not markedly different from each other. *Trichuris* was the next most common soil-transmitted helminth, with an infection rate of 16.8%, with Casoon having almost three times as much infection as San Isidro. *Ascaris* was not so common, at 4.0% overall, 7.7% in Casoon and none in San Isidro. Heterophyid flukes were the next most common intestinal helminth. The overall heterophyid infection rate was 32.4%, higher in

Table 5
Targeted pupils, stool examination and cumulative prevalence of STH infections, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Sex	No. of pupils targeted for stool examination	No. of pupils examined (%)	Cumulative prevalence (%)
San Isidro and Casoon			
Male	108	101 (93.5)	52 (51.5)
Female	76	72 (94.7)	32 (44.4)
Total	184	173 (94.0)	84 (48.6)
San Isidro			
Male	52	50 (96.2)	18 (36.0)
Female	32	32 (100.0)	14 (43.8)
Total	84	82 (97.6)	32 (39.0)
Casoon			
Male	56	51 (91.2)	34 (66.7)
Female	44	40 (90.9)	18 (45.0)
Total	100	91 (91.0)	52 (57.1)

Table 6
Infection rates according to parasite species using Kato-Katz method, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Parasite seen	No. of pupils infected	Infection rate (%)
San Isidro and Casoon (n=173)		
Ascaris	7	4.0
Trichuris	29	16.8
Hookworms	61	35.3
Enterobius	7	4.0
Heterophyid	56	32.4
San Isidro (n=82)		
Ascaris	0	0.0
Trichuris	7	8.5
Hookworms	27	32.9
Enterobius	1	1.2
Heterophyid	22	26.8
Casoon (n=91)		
Ascaris	7	7.7
Trichuris	22	24.2
Hookworms	34	37.4
Enterobius	6	6.6
Heterophyid	34	37.4

Casoon, at 37.4%, and lower in San Isidro, at 26.8% (Table 6). Multi-parasite infections were more common than single infections (Table 7).

Table 8 shows the distribution of infected pupils according to intensity of infection at Day 0. The majority of pupils examined had light intensity *Ascaris*, *Trichuris*, hookworms, and heterophyid infections. Tables 8 also shows the same distribution according to elementary school. In both village schools, almost all pupils with *Ascaris*, *Trichuris*, and hookworm infections had light intensity. For heterophyid infection, however, the majority of infected pupils in San Isidro had light infections, while in Casoon, moderate to heavy intensities of infection comprised the majority.

Table 9 shows the overall number of intestinal helminth eggs per gram according to parasite species and the same distribution according to elementary school. Geometric mean egg counts were generally higher in Casoon than in San Isidro.

Treatment coverage

Table 10 shows overall treatment coverage data for soil-transmitted helminths and the same data according to village school, respectively. Treatment coverage according to grade level ranged from 86.9 to 98.9%, with an overall coverage of 96.0%. Treatment

Table 7
Single and multi-parasite infections using Kato-Katz method, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Parasite/s seen	No. of pupils infected (%)		
	San Isidro and Casoon (n=120)	San Isidro (n=51)	Casoon (n=69)
Ascaris only	2 (1.7)	0 (0.0)	2 (2.9)
Ascaris and *Trichuris*	1 (0.8)	0 (0.0)	1 (1.4)
Ascaris and hookworms	3 (2.5)	0 (0.0)	3 (4.4)
Ascaris, Trichuris, Enterobius and heterophyid	1 (0.8)	0 (0.0)	1 (1.4)
Trichuris only	13 (11.0)	4 (7.8)	9 (13.0)
Trichuris and hookworms	3 (2.5)	1 (2.0)	2 (2.9)
Trichuris and heterophyid	7 (5.8)	2 (3.9)	5 (7.3)
Trichuris, hookworms, and heterophyid	3 (2.5)	0 (0.0)	3 (4.4)
Trichuris, hookworms, and *Enterobius*	1 (0.8)	0 (0.0)	1 (1.4)
Hookworms only	36 (30.0)	23 (45.1)	13 (18.8)
Hookworms and *Enterobius*	1 (0.8)	0 (0.0)	1 (1.4)
Hookworms and heterophyid	14 (11.7)	3 (5.9)	11 (16.0)
Enterobius only	4 (3.3)	1 (2.0)	3 (4.4)
Heterophyid only	31 (25.8)	17 (33.3)	14 (20.3)

Table 8
Distribution of infected pupils according to intensity of infection, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Intensity	*Ascaris* (%)	*Trichuris* (%)	Hookworms (%)	Heterophyid (%)
Overall distribution of San Isidro and Casoon (n=173)				
Light	7 (100.0)	28 (96.6)	59 (96.7)	31 (55.3)
Moderate	0 (0.0)	1 (3.4)	2 (3.3)	22 (39.3)
Heavy	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.4)
Total	7 (100.0)	29 (100.0)	61 (100.0)	56 (100.0)
Distribution of San Isrido (n=81)				
Light	0 (0.0)	7 (100.0)	27 (100.0)	16 (72.7)
Moderate	0 (0.0)	0 (0.0)	0 (0.0)	5 (22.7)
Heavy	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.6)
Total	0 (0.0)	7 (100.0)	27 (100.0)	22 (100.0)
Distribution of Casoon (n=91)				
Light	7 (100.0)	21 (95.4)	32 (94.1)	15 (44.1)
Moderate	0 (0.0)	1 (4.6)	2 (5.9)	17 (50.0)
Heavy	0 (0.0)	0 (0.0)	0 (0.0)	2 (5.9)
Total	7 (100.0)	22 (100.0)	34 (100.0)	34 (100.0)

Table 9
Intestinal helminth mean egg counts according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Egg counts (eggs per gram)	*Ascaris*	*Trichuris*	Hookworms	Heterophyid
Overall mean egg counts, San Isidro and Casoon (n=173)				
Range	0-1,920	0-1,416	0-2,736	0-7,589
Arithmetic mean	33.0	25.9	101.5	113.8
Geometric mean	0.3	1.1	4.8	3.6
Standard deviation	211.0	118.6	326.7	608.4
Mean egg count at Isidro (=82)				
Range	N/A	0-408	0-1,704	0-1,008
Arithmatic Mean	N/A	8.5	61.5	41.0
Geometric Mean	N/A	0.4	3.7	2.1
Standard Deviation	N/A	46.8	204.9	146.6
Mean egg count at Casoon (n=91)				
Range	0-1,920	0-1,416	0-2,736	0-7,589
Arithmetic Mean	62.8	41.7	137.7	179.4
Geometric Mean	0.6	2.1	6.0	5.5
Standard Deviation	288.5	156.1	404.3	823.9

Table 10
Distribution of pupils, consent rates, and treatment coverage for STH, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Grade	Number of pupils	No. of pupils with consent		No. of pupils treated	
		No.	%	No.	%
Overall distribution (San Isidro and Casoon)					
I	120	114	95.0	114	95.0
II	101	101	100.0	97	96.0
III	92	91	98.9	91	98.9
IV	93	92	98.9	91	97.8
V	107	106	99.0	93	86.9
VI	75	72	96.0	67	89.3
Total	588	576	98.0	553	96.0
Distribution at San Isidro					
I	46	44	96.0	44	100.0
II	46	46	100.0	42	91.0
III	40	39	98.0	39	100.0
IV	44	44	100.0	43	98.0
V	35	35	100.0	33	94.0
VI	24	22	92.0	21	95.0
Total	235	230	97.9	222	96.5
Distribution at Casoon					
I	74	70	94.6	70	100.0
II	55	55	100.0	55	100.0
III	52	52	100.0	52	100.0
IV	49	48	98.0	48	100.0
V	72	71	98.6	60	84.5
VI	51	50	98.0	46	92.0
Total	353	346	98.0	331	95.7

coverage in San Isidro approximated that of Casoon. Ranges of treatment coverage according to grade level were from 91.0 to 100.0% in San Isidro and 84.5 to 100.0% in Casoon.

Table 11 shows the overall treatment coverage data for heterophyids and the same data according to village school, respectively. Overall treatment coverage was 87.5%. Treatment coverages of the village schools of San Isidro and Casoon were not markedly different at 86.4 and 88.2%, respectively.

Day 7 to 14 follow-up

A total of 155 pupils was seen in both schools. Follow-up rates for San Isidro and Casoon were 92.6% (76/82) and 86.8% (79/91), respectively. Table 12 shows the overall clinical outcomes of infected pupils who were treated for STH infection. For *Ascaris*, hookworms, and heterophyid infections, a majority experienced clinical cure and clinical improvement. Clinical failure was noted for *Trichuris*, hookworms, and heterophyid infections, with *Trichuris* showing the highest percentage of clinical failure.

Table 12 also shows the clinical outcomes in each village school. In San Isidro Elementary School, no *Ascaris* infection was noted at Days 7 to 14, while a majority had clinical cure for hookworms and heterophyid infections. The greatest percentage of clinical improvement and clinical failure were noted for *Trichuris* infection. In Casoon Elementary School, a majority showed clinical cure for *Ascaris*, hookworms, and heterophyid infections, while the greatest percentage of clinical improvement was seen for *Trichuris* infection. Clinical failure was noted for *Trichuris* infection only.

Table 11
Treatment coverage for heterophyids, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, February 2001.

Grade	Number of pupils examined	Number of pupils with heterophydiasis (%)	Number of pupils treated (%)
Overall treatment coverage (San Isidro and Casoon)			
III	87	28 (32.2)	26 (92.8)
IV	86	28 (32.5)	23 (82.1)
Total	173	56 (32.4)	49 (87.5)
Treatment coverage at San Isidro			
III	38	12 (31.6)	11 (91.7)
IV	44	10 (22.7)	8 (80.0)
Total	82	22 (26.8)	19 (86.4)
Treatment coverage at Casoon			
III	49	16 (32.6)	15 (93.8)
IV	42	18 (42.8)	15 (83.3)
Total	91	34 (37.4)	30 (88.2)

Table 12
Clinical outcomes according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, March 2001.

Clinical outcome	*Ascaris* (%)	*Trichuris* (%)	Hookworm (%)	Heterophyid (%)
Overall (San Isidro and Casoon)				
Clinical cure	5 (71.4)	13 (44.8)	46 (75.4)	39 (69.9)
Clinical improvement	1 (14.3)	7 (24.1)	5 (8.2)	1 (1.8)
Clinical failure	0 (0.0)	3 (10.4)	1 (1.6)	2 (3.6)
Lost to follow-up	1 (14.3)	6 (20.7)	9 (14.8)	14 (25.0)
Total	7(100.0)	29(100.0)	61(100.0)	56(100.0)
San Isidro				
Clinical cure	N/A	3 (42.8)	21 (77.8)	15 (68.2)
Clinical improvement	N/A	3 (42.8)	2 (7.4)	0 (0.0)
Clinical failure	N/A	1 (14.4)	1 (3.7)	2 (9.1)
Lost to follow-up	N/A	0 (0.0)	3 (11.1)	5 (22.7)
Total	N/A	7(100.0)	27(100.0)	22(100.0)
Casoon				
Clinical cure	5 (71.4)	10 (45.4)	25 (73.5)	24 (70.6)
Clinical improvement	1 (14.3)	4 (18.2)	3 (8.8)	1 (2.9)
Clinical failure	0 (0.0)	2 (9.1)	0 (0.0)	0 (0.0)
Lost to follow-up	1 (14.3)	6 (27.3)	6 (17.7)	9 (26.5)
Total	7(100.0)	22(100.0)	34(100.0)	34(100.0)

Table 13
Cure rates according to parasite species and intensity of infection, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, Day 0 and Day 7 to 14, March 2001.

Intensity of infection	*Ascaris*		*Trichuris*		Hookworms		Heterophyid	
	No. of pupils infected	No. of pupils cured (%)	No. of pupils infected	No. of pupils cured (%)	No. of pupils infected	No. of pupils cured (%)	No. of pupils infected	No. of pupils cured (%)
Overall cure rates (San Isidro and Casoon)								
Light	6	5 (83.3)	23	13 (56.5)	51	45 (88.2)	21	20 (95.2)
Moderate	0	0 (0.0)	0	0 (0.0)	1	1 (100.0)	18	17 (94.4)
Heavy	0	0 (0.0)	0	0 (0.0)	0	0 (0.0)	3	2 (66.7)
Total	6	5 (83.3)	23	13 (56.5)	52	46 (88.5)	42	39 (92.9)
Cure rates at San Isidro								
Light	0	0 (0.0)	7	3 (42.9)	24	21 (87.5)	11	10 (90.9)
Moderate	0	0 (0.0)	0	0 (0.0)	0	0 (0.0)	5	4 (80.0)
Heavy	0	0 (0.0)	0	0 (0.0)	0	0 (0.0)	1	1 (100.0)
Total	0	0 (0.0)	7	3 (42.9)	24	21 (87.5)	17	15 (88.2)
Cure rates at Casoon								
Light	6	5 (83.3)	16	10 (62.5)	27	24 (88.9)	10	10 (100.0)
Moderate	0	0 (0.0)	0	0 (0.0)	1	1 (100.0)	13	13 (100.0)
Heavy	0	0 (0.0)	0	0 (0.0)	0	0 (0.0)	2	1 (50.0)
Total	6	5 (83.3)	16	10 (62.5)	28	25 (89.3)	25	24 (96.0)

Table 14
Mean intestinal helminth egg counts according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, March 2001.

Egg counts (eggs per gram)	*Ascaris*	*Trichuris*	Hookworms	Heterophyid
Overall mean, San Isidro and Casoon (n=155)				
Range	0-216	0-264	0-240	0-384
Arithmetic Mean	4.0	7.9	3.2	13.5
Geometric Mean	0.2	0.5	0.2	0.6
Standard deviation	22.4	33.6	21.5	54.2
Mean egg counts at San Isidro (n=76)				
Range	0-96	0-216	0-240	0-288
Arithmetic Mean	3.2	7.3	4.1	11.4
Geometric Mean	0.2	0.3	0.2	0.6
Standard deviation	14.8	32.32	28.1	43.0
Mean egg counts at Casoon (n=79)				
Range	0-216	0-264	0-96	0-84
Arithmetic Mean	4.9	8.5	2.4	15.5
Geometric Mean	0.2	0.6	0.2	0.7
Standard deviation	27.8	33.9	12.5	63.3

The overall cure rates by parasite species, for both San Isidro and Casoon Elementary Schools, were generally good (Table 13). Heterophyid infection showed the highest cure rate, at 92.9%, while *Trichuris* infection showed the lowest, at 56.5%. For *Ascaris*, *Trichuris*, and hookworm infections, most, if not, all pupils who were cured had light intensity infections. For pupils with heterophyid infection, a large majority were cured, whether having light, moderate, or heavy intensity infections; however, the cure rate was lowest among those with heavy intensity infections (66.7%).

Table 14 also shows the overall mean helminth egg counts at Days 7 to 14, according to parasite species, and the same distribution according to elementary school. Geometric mean egg counts were generally higher in Casoon than in San Isidro.

Table 15 shows the egg reduction rates (ERR) according to parasite species from Day 0 to Days 7 to 14, and the same data according to school, using both arithmetic and geometric mean egg counts. The overall egg reduction rates using geometric mean egg counts were generally high at 95.3 and 82.9%, respectively, hookworm and heterophyid infections (Table 15). Egg reduction rates were generally higher for Casoon than for San Isidro. Egg reduction rates for *Trichuris* were consistently lowest in both elementary schools (Table 15).

Day 180 follow-up

Table 16 shows the targeted numbers of Grade IV and V pupils who were followed up and examined 180 days after treatment, overall and in both schools, respectively. The overall cumulative STH prevalence was 41.3%. Cumulative STH prevalence in San Isidro was 41.5%, not markedly different from the cumulative STH prevalence in Casoon, which was 41.1%.

Hookworms and heterophyids were the most common intestinal helminths found among pupils examined in both schools (27.7 and 29.0%, respectively). The hookworm infection rate was not markedly lower in San Isidro compared to Casoon (27.7 and 27.8%, respectively). The heterophyid infection rate for Casoon was markedly higher than San Isidro (40.0 and 13.8%, respectively). Infection rates according to parasite species are found in Table 17.

Table 18 shows the overall mean helminth egg count according to parasite species at Day 180, and also shows the same distribution according to elementary school. The geometric mean egg counts were generally higher in Casoon than in San Isidro.

The overall infection rates according to parasite species among pupils from both elementary schools followed up from Day 0 to Day 180 are presented in

Table 15
Egg reduction rates from Day 0 to Days 7-14 according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, March 2001.

Parasite	Mean eggs per gram				Egg reduction rate (%)	
	Arithmetic		Geometric			
	Day 0	Day 7 to 14	Day 0	Day 7 to 14	Arithmetic	Geometric
Overall egg reduction rates (San Isidro and Casoon, n=153)						
Ascaris	29.0	4.1	0.3	0.2	85.9	33.3
Trichuris	16.2	7.7	0.9	0.5	52.5	44.4
Hookworms	89.9	3.3	4.3	0.2	96.3	95.3
Heterophyid	117.7	13.3	3.5	0.6	88.7	82.9
Egg reduction rates (San Isidro, n=76)						
Ascaris	0.0	3.2	0.0	0.2	N/A	N/A
Trichuris	9.2	7.3	0.5	0.3	20.7	40.0
Hookworms	59.1	4.1	3.3	0.3	93.1	91.0
Heterophyid	43.3	11.4	2.1	0.6	73.7	71.4
Egg reduction rates (Casoon, n=77)						
Ascaris	57.7	5.0	0.6	0.2	91.3	66.6
Trichuris	23.1	8.1	1.6	0.6	64.9	6.2
Hookworms	120.3	2.5	5.5	0.2	97.9	96.4
Heterophyid	191.1	15.3	5.5	0.6	92.0	89.1

Table 16
Targeted pupils, stool examination, and cumulative prevalence of STH infections, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Sex	No. of pupils targeted for stool examination	No. of pupils examined (%)	Cumulative prevalence (%)
San Isidro and Casoon			
Male	108	88 (81.5)	38 (43.2)
Female	76	67 (88.2)	26 (38.8)
Total	184	155 (84.2)	64 (41.3)
San Isidro			
Male	52	38 (73.1)	15 (39.5)
Female	32	27 (84.4)	12 (44.4)
Total	84	65 (77.4)	27 (41.5)
Casoon			
Male	56	50 (89.3)	23 (46.0)
Female	44	40 (90.9)	14 (35.0)
Total	100	90 (90.0)	37 (41.1)

Table 17
Infection rates according to parasite species using Kato-Katz method, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Parasite seen	No. of pupils infected			Infection rate (%)		
	San Isidro and Casoon (n=155)	San Isidro (n=65)	Casoon (n=90)	San Isidro and Casoon (n=155)	San Isidro (n=65)	Casoon (n=90)
Ascaris	25	7	8	16.1	10.8	8.8
Trichuris	23	4	19	14.8	6.2	21.1
Hookworms	43	18	25	27.7	27.7	27.8
Enterobius	4	0	4	2.6	0.0	4.4
Heterophyid	45	9	36	29.0	13.8	40.0

Table 19. The overall infection rate for *Ascaris* was higher at Day 180 compared with Day 0. *Trichuris,* hookworm and heterophyid infection rates were slightly lower at Day 180 compared with those at Day 0. For Barangay San Isidro, only *Ascaris* infection was higher at Day 180 compared to Day 0, while the levels of *Trichuris*, hookworms, and heterophyid infections in San Isidro were lower. In Barangay Casoon, *Ascaris* infection was only slightly higher, while heterophyid infection was 25% higher at Day 180 compared to Day 0 (Tables 19). *Trichuris* and hookworm infections were, likewise, only slightly lower at Day 180.

Table 20 shows the geometric mean egg counts among pupils from both elementary schools from Day 0 to Day 180. The geometric mean egg counts were lower at Day 180 compared to those at Day 0, except for *Ascaris*. Table 20 also describes the same data for each elementary school, showing a relative increase in geometric mean egg count for heterophyids in Casoon.

Overall reinfection rates among pupils followed up from both schools six months after treatment according to parasite species are shown in Table 21. Table 21 also shows the same data from the individual schools. The reinfection rate for heterophyids was highest among all intestinal helminthiases. The heterophyid reinfection rate in Casoon was more than

Table 18
Mean helminth egg counts according to parasite species at Day 180, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Egg count (eggs per gram)	*Ascaris*	*Trichuris*	Hookworms	Heterophyid
Overall (San Isidro and Casoon, n=155)				
Range	0-90,288	0-864	0-1,848	0-3,264
Arithmetic mean	627.9	25.5	43.2	82.2
Geometric mean	0.6	1.0	2.4	2.8
Standerd deviation	7,254.0	104.7	171.2	359.8
San Isidro (n=65)				
Range	0-2,304	0-264	0-1,848	0-600
Arithmetic mean	66.1	6.3	60.9	17.0
Geometric mean	0.7	0.3	0.3	0.8
Standerd deviation	354.2	34.3	247.2	77.3
Casoon (n=90)				
Range	0-90,288	0-864	0-576	0-3,264
Arithmetic mean	1,033.6	39.5	30.4	129.3
Geometric mean	0.6	1.6	2.3	5.5
Standerd deviation	9,516.5	132.9	79.8	463.0

Table 19
Infection rates among pupils followed up from Day 0 to Day 180 according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Parasite	No. of pupils followed-up	No. of pupils infected at Day 0 (%)	No. of pupils infected at Day 180 (%)
Overall infection rates (San Isidro and Casoon)			
Ascaris	147	6 (4.1)	14 (9.5)
Trichuris	147	23 (15.6)	20 (13.6)
Hookworms	147	50 (34.0)	42 (28.6)
Heterophyid	147	45 (30.6)	43 (29.2)
Infection rates at San Isidro			
Ascaris	64	0 (0.0)	7 (10.9)
Trichuris	64	6 (9.4)	4 (6.2)
Hookworms	64	19 (29.7)	18 (28.1)
Heterophyid	64	15 (23.4)	9 (14.1)
Infection rates at Casoon			
Ascaris	83	6 (7.2)	7 (8.4)
Trichuris	83	17 (20.5)	16 (19.3)
Hookworms	83	31 (37.4)	24 (28.9)
Heterophyid	83	30 (36.2)	34 (45.9)

Table 20
Arithmetic and geometric mean egg counts among pupils followed up from Day 0 to Day 180 according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Parasite	Arithmetic mean		Geometric mean	
	Day 0	Day 180	Day 0	Day 180
San Isidro and Casoon				
Ascaris	37.6	662.0	0.3	0.7
Trichuris	25.0	25.1	1.0	0.9
Hookworms	111.7	44.9	4.6	2.5
Heterophyid	122.0	83.8	3.3	2.8
San Isidro				
Ascaris	0.0	67.1	0.0	0.7
Trichuris	10.1	6.4	0.5	0.3
Hookworms	68.3	61.9	3.2	2.6
Heterophyid	33.8	17.3	1.6	0.8
Casoon				
Ascaris	66.5	1,120.8	1.6	1.7
Trichuris	36.4	39.6	2.6	2.5
Hookworms	145.2	31.8	7.0	3.5
Heterophyid	190.0	135.0	6.4	6.8

twice that of San Isidro, while the hookworm reinfection rate in Casoon was not markedly different from San Isidro.

Table 22 shows the percent reduction of egg counts among infected pupils followed up according to parasite species from Day 0 to Day 180. A negative overall percentage egg reduction was noted for *Ascaris* infection. For heterophyid infection, while a percentage egg reduction of 50.0% was noted in San Isidro, a negative percentage reduction was noted in Casoon at -6.2%.

Fig 1 shows the heterophyid infection rate according to intensity of infection in both elementary schools at Day 0 and Day 180. The level of heterophyid infection at Day 180 was only slightly lower than the level at Day 0, with the proportion of light intensity infection greater at Day 180 than in Day 0.

Collection and identification of heterophyid species

Six consenting adult patients infected with heterophyid eggs on stool examination were identified for collection and identification of heterophyid species. Using the protocol for collection of adult flukes following treatment (Table 3), adult flukes were collected from the sediment and identified under low power microscopy. Heterophyid flukes were seen to be moving and were preserved in AFA (alcohol-10% formalin with acetic acid solution). Specimens were submitted to the University of the Philippines at Los Baños (UPLB) and the United States Naval Medical Research Unit No. 2 (US NAMRU-2) for species identification. Preliminary findings indicate the species to be *Haplorchis taichui*. A more detailed description of taxonomic findings will be available in a later publication.

DISCUSSION

The prevalence and intensity of intestinal helminth infections, particularly soil-transmitted helminthiasis (STH) and heterophyid infection, were determined through school-based assessment using Kato-Katz technique among elementary schoolchildren from two barangays in Monkayo, Compostela Valley. Third and fourth grade level pupils, considered the indicator group for both schools, were examined and the results showed an overall baseline cumulative prevalence of STH infection at 48.6%, a level not markedly different from 50%, at which mass treatment of high risk groups is recommended (WHO, 1998). The overall prevalence for STH in the two barangays qualifies the two areas for at least targeted mass treatment, which could be done in elementary schools. The cumulative prevalence of STH infection was higher in Casoon, at 57.1%, compared with that of San Isidro, at 39%. This

Table 21
Reinfection rates among pupils six months after treatment according to parasite species, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, August 2001.

Parasite	Baseline			Day 7 to 14			Day 180		
	No. of pupils examined	No. of pupils infected (%)	No. of pupils treated (%)	No. of pupils followed-up (%)	No. of pupils infected (%)	No. of pupils cured (%)	No. of pupils followed-up (%)	No. of pupils reinfected (%)	No. of pupils not infected (%)
Overall reinfection rates (San Isidro and Casoon)									
Ascaris	173	7	7	6	1	5	4	0	4
		(4.0)	(100.0)	(85.7)	(16.7)	(83.3)	(80.0)	(0.0)	(100.0)
Trichuris	173	29	29	23	10	13	10	3	7
		(16.8)	(100.0)	(79.3)	(43.5)	(56.5)	(76.9)	(30.0)	(70.0)
Hookworms	173	61	61	52	6	46	38	10	28
		(35.3)	(100.0)	(85.2)	(11.5)	(88.5)	(82.6)	(26.3)	(73.7)
Heterophyid	173	56	49	42	3	39	31	11	20
		(32.4)	(87.5)	(85.7)	(7.1)	(92.9)	(75.5)	(35.5)	(64.5)
Reinfection rates at San Isidro									
Ascaris	82	0	-	-	-	-	-	-	-
		(0.0)							
Trichuris	82	7	7	7	4	3	2	0	2
		(8.5)	(100.0)	(100.0)	(57.1)	(42.9)	(66.7)	(0.0)	(100.0)
Hookworms	82	27	27	24	3	21	15	4	11
		(32.9)	(100.0)	(88.9)	(12.5)	(87.5)	(71.4)	(26.7)	(73.3)
Heterophyid	82	22	19	17	2	15	11	2	9
		(26.8)	(86.4)	(89.5)	(11.8)	(88.2)	(73.3)	(18.2)	(81.8)
Reinfection rates at Casoon)									
Ascaris	91	7	7	6	1	5	4	0	4
		(7.7)	(100.0)	(85.7)	(16.7)	(83.3)	(80.0)	(0.0)	(100.0)
Trichuris	91	22	22	16	6	10	8	3	5
		(24.2)	(100.0)	(72.7)	(37.5)	(62.5)	(80.0)	(37.5)	(62.5)
Hookworms	91	34	34	28	3	25	23	6	17
		(37.4)	(100.0)	(82.4)	(10.7)	(89.3)	(92.0)	(26.1)	(73.9)
Heterophyid	91	34	30	25	1	24	20	9	11
		(37.4)	(88.2)	(83.3)	(4.0)	(96.0)	(83.3)	(45.0)	(55.0)

finding may help justify Casoon as a priority area for control.

Infection rates for specific parasites at baseline showed that hookworm and heterophyid were the most common intestinal helminths with infection rates of 35.3 and 32.4%, respectively, showing that for both parasitoses, about one of every three pupils examined in the two elementary schools was infected.

Hookworm infection rates in each barangay at baseline were not markedly different from each other, with levels in Casoon (37.4%) only slightly higher than San Isidro (32.9%). Nonetheless, these levels for hookworm infection could pertain to the deleterious effects posed to those infected, as it could result in chronic anemia with subsequent increased morbidity.

Heterophyid infection at baseline was seen in about one of every three pupils examined in Casoon (37.4%) and in about one of every four pupils examined in San Isidro (26.8%). In the previous survey by Belizario *et al*, in 2000, the level of heterophyid infection in those belonging to the elementary school-age group, <15 years of age (27.4%), was not much different from the overall heterophyid infection rate in the village of San Isidro

Table 22
Percent reduction of egg counts among infected pupils followed up according to parasite species from Day 0 to Day 180, San Isidro and Casoon Elementary Schools, Monkayo, Compostella Valley.

Parasite	Arithmetic mean egg counts		Geometric mean egg counts		Percent reduction of egg counts (%)	
	Day 0	Day 180	Day 0	Day 180	Arithmetic	Geometric
San Isidro and Casoon (n=147)						
Ascaris	37.6	662.0	0.3	0.7	-1,660.6	-133.3
Trichuris	25.0	25.1	1.0	0.9	-0.4	10.0
Hookworms	111.7	44.9	4.6	2.5	59.8	45.6
Heterophyid	122.0	83.8	3.3	2.8	31.3	15.2
San Isidro (n=64)						
Ascaris	0.0	67.1	0.0	0.7	N/A	N/A
Trichuris	10.1	6.4	0.5	0.3	36.6	40.0
Hookworms	68.3	61.9	3.2	2.6	9.4	18.8
Heterophyid	33.8	17.3	1.6	0.8	48.8	50.0
Casoon (n=83)						
Ascaris	66.5	1,120.8	1.6	1.7	-1,585.4	-6.2
Trichuris	36.4	39.6	2.6	2.5	-8.8	3.8
Hookworms	145.2	31.8	7.0	3.5	78.1	50.0
Heterophyid	190.0	135.0	6.4	6.8	29.0	-6.2

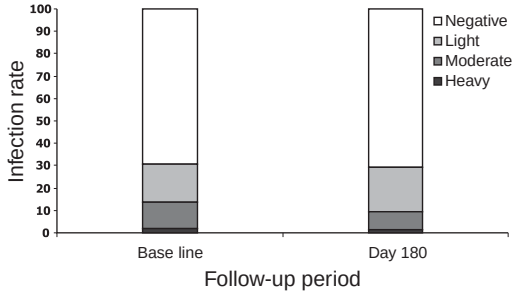

Fig 1- Heterophyid infection rate according to intensity of infection at Day 0 and Day 180, San Isidro and Casoon Elementary Schools, Monkayo, Compostela Valley, 2001.

at baseline or Day 0 (26.8%). In San Isidro, where selective treatment was done about one year before the baseline survey, the similar levels of infection in the same age group over two time periods described here may indicate the need for more effective control strategies against heterophyidiasis in the future, more than just selective treatment given the year before. On the other hand, the level of heterophyid infection in Casoon in the same age group was noted to be about 40% higher than San Isidro in the same period (37.4 *versus* 26.8%, respectively, at baseline). Casoon, where only passive case detection was undertaken in the past, may benefit from the same more effective control strategies if these become available.

Most of the pupils with hookworms at baseline had light intensity infections, which indicates generally lower morbidity and potential for transmission. For pupils with heterophyid infection, 44.7% or close to one out of two pupils had moderate to heavy intensities of infection, which could indicate heavier burden of infection, greater morbidity, as well as a higher potential for transmission. Greater morbidity in turn could lead to more complications such as heart, brain, or spinal cord involvement. The extent of such morbidity in these communities may need to be described in the future.

Cure rates after targeted mass treatment for STH infection and selective treatment for heterophyid infection were generally good to very good according to WHO parameters (WHO, 1996a,b). The cure rate for hookworm infection was 88.5%, and for heterophyid infection 92.9%. In terms of egg counts, there were marked reductions among those who were not cured. For those with hookworms and heterophyid infections, the egg reduction rates were 95.3 and 82.9%, respectively. The cure and egg reduction rates for heterophyid infection were, in fact, as favorable as

the 97.1% cure rate and 98.4% egg reduction rate obtained in the previous survey (Belizario *et al*, in press). With these favorable outcomes of treatment for both parasitoses, it may be suggested that morbidity related to these may have drastically decreased prior to reinfection.

A follow-up survey done six months after treatment showed an overall cumulative prevalence of STH infection at 41.3%, a level lower than, but not markedly different from, the baseline prevalence of 48.6%. Cumulative prevalence levels six months after in San Isidro and Casoon were not markedly different from each other (41.5 and 41.1%, respectively). Compared with the cumulative prevalence at baseline, the follow-up levels in San Isidro were not markedly different (39.0 and 41.5%, respectively), while the follow-up cumulative prevalence in Casoon was 28% lower than that of baseline (57.1 and 41.1%, respectively). The phenomenon of reinfection may explain why the two levels taken six months apart approximate each other. For Casoon, although the follow-up level was already lower than baseline, subsequent levels may approximate baseline and even surpass it, as was seen in San Isidro, if and when intervention strategies are not sustained.

Hookworm and heterophyid were again the most common parasites found in both barangays combined six months after (27.7 and 29.0%, respectively). While levels for hookworm in San Isidro and Casoon were almost equal at this time (27.7 and 27.8% in San Isidro and Casoon, respectively), heterophyid infection in San Isidro was markedly lower at 13.8% than that of Casoon at 40.0%, almost three times greater than San Isidro. In addition, it is important to note that while there was a decrease in heterophyid infection rate of about 50% in San Isidro, there was a slight increase in Casoon even with a good cure rate established post-treatment (at Days 7 to 14). Furthermore, the mean egg counts after six months also showed much higher counts of the parasites found in Casoon compared to those in San Isidro. Comparing mean egg counts of pupils seen from baseline up to six months after, percentage reduction of egg counts for the two barangays combined were 45.6 and 15.2%, for hookworms and heterophyid, respectively (the percentage reduction of egg counts was 18.8 and 50.0%, for hookworms and heterophyid, respectively, in San Isidro, while 50.0 and -6.2%, respectively, for hookworms and heterophyid in Casoon). Also, geometric mean egg counts for hookworms and heterophyid were 8 and 7 times higher, respectively, in Casoon (hookworm mean epg = 2.3, heterophyid mean epg = 5.5) compared to San Isidro (hookworm mean epg = 0.3, heterophyid mean epg = 0.8).

Overall reinfection rates in the two barangays combined were 26.3 and 35.5% for hookworms and heterophyid, respectively. Reinfection rates for hookworms were almost equal in each of the two barangays (26.7 and 26.1% for San Isidro and Casoon, respectively). However, the reinfection rate for heterophyids was 18.2% in San Isidro, and 45.0% in Casoon. These findings suggest higher chances of reinfection in Casoon, despite a greater degree of difference between baseline and follow-up infection rates, meaning increased potential for transmission of disease that may lead to much heavier burden of infection and greater morbidity, pointing towards the need to prioritize that area. These findings in Casoon, therefore, make this barangay an ideal target for strengthening of health education aside from treatment. Health education inputs like proper disposal of human waste along with provision of toilet facilities and its proper utilization plus thorough cooking of fish should be highlighted.

Reinfection seen in these two barangays implies the need to repeat the treatment for hookworms and other soil-transmitted helminths at least after six months. For schoolchildren, targeted mass treatment for hookworms with a frequency of at least twice a year may be indicated. This strategy could result in lowered levels of infection in terms of prevalence and intensity, decreased morbidity, and lesser potential for transmission, which are actually the aims of control programs for soil-transmitted helminths (WHO, 1999). With effective control, the quality of life of school-children becomes better. However, the current survey involved only third and fourth grade pupils, while the status in other age groups was not obtained. With consideration of the levels of hookworm infection in older age groups (Belizario *et al*, 2000; 2004, in press), which may not be very different from, and may even be higher than, the levels in the age group included in the current study, universal mass treatment to cover other age groups in the community could possibly be carried out to combat the effects of hookworm infection. Furthermore, strengthening of health education focused on hookworm prevention and control, particularly emphasizing the need to subject one's self to treatment, and highlighting the benefits of personal protection, personal hygiene, and the importance of proper waste disposal, could be well indicated to prevent reinfection.

For heterophyidiasis, selective treatment has shown benefits in terms of decreasing egg counts, suggesting lower levels of infection; however, the

probability of reinfection was generally high at six months' post-treatment. The prospect of employing mass treatment for heterophyid infection in these areas, therefore, remains a research issue, with consideration that there are a greater proportion of individuals were affected among the older age groups (Belizario *et al*, 2002; Belizario *et al*, in press). The use of elementary school age children as the window of heterophyid status in the whole community could be of use in terms of monitoring success and impact of a possible mass treatment strategy.

In targeting individuals in the community at large for control of parasitoses brought about by hookworms and heterophyids, utilization of children in the elementary schools, as a window on the status of these parasitoses in the community, may be a logical and feasible scheme. In this sense, the role of schools is seen to be expanding, as this could still be the most accessible venue to monitor the status of infection and the delivery of treatment, not only for STH (WHO, 1999) but also for food-borne fluke infection. Therefore, the schools, with the teachers and the local school officials, still have vital roles in the control program for these continuing and emerging parasitoses. Specifically, community members and local officials may contribute an important part to the control program by helping to ensure the success of the control strategy, *eg*, by helping to increase coverage of treatment, to disseminate health education and advocacy messages. Prospects to integrate control of heterophyid infection with control of soil-transmitted helminthiases through schools may therefore be promising, given a situation where STH and heterophyid infections co-exist and where multi-parasite infections are evident.

Finally, this study has shown the usefulness of schools in assessing the infection status of the community and in deliveries mass treatment. Results and learning experiences from this study lead towards prospects of school-based integrated helminth control using mass treatment, for soil-transmitted helminthiases and possibly even food-borne parasitoses, with schools serving as venue for monitoring and surveillance, to assist in evaluation, as well as delivery of control measures like treatment and health education, altogether directed against existing and emerging infections. The participation of local, provincial, and regional counterparts in health and education may be important determinants of success, especially through their roles in advocacy, health education, and implementation of innovative control programs addressing parasitoses of public health importance.

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to the following for their help: the Local Government Unit (LGU) of Monkayo, Compostela Valley; barangay officials, Rural Health Unit (RHU) staff under the leadership of Dr Olivia Kapoor, Department of Education (DepEd) officials of Monkayo and schoolteachers of San Isidro and Casoon; Center for Health Development for Southern Mindanao; barangay health workers (BHWs) of San Isidro and Casoon; Mr Mark Philip Bugayong and Mr Antonio de Guzman, Jr of College of Public Health, University of the Philippines Manila. Thanks to Dean Salcedo Eduardo of the UPLB College of Veterinary Medicine and Dr Michael Bangs of US NAMRU-2. Special thanks to the Committee on Research Implementation and Development (CRID) for providing financial support in making this important study possible.

REFERENCES

Belizario VY Jr, Bersabe MJ, de Leon WU, *et al*. Intestinal heterophyidiasis: an emerging food-borne parasitic zoonosis in southern Philippines, *Southeast Asian J Trop Med Public Health* 2002;32 (suppl 2):36-42.

Belizario VY Jr, de Leon WU, Esparar DG, Galang JM, Fantane J, Verdadero C. Compostela Valley: a new endemic focus for Capillariasis philippinensis. *Southeast Asian J Trop Med Public Health* 2000;31:478-81.

WHO Study Group. Control of food-borne trematode infections. Report of a WHO Study Group. *WHO Tech Rep Ser* 1995;849:1-157.

Cross JH, Basaca-Sevilla V. Biomedical surveys in the Philippines. *NAMRU-2 SP-47*, 1984.

WHO. Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level. *WHO/CTD/SIP/98.1*. 1998.

WHO. Monitoring helminth control programmes. *WFO/CDS/CPC/SIP/99.3*. 1999.

WHO. Report of the WHO informal consultation on the use of chemotherapy for the control of morbidity due to soil-transmitted nematodes in humans. *WHO/CTD/SIP/96.2*. 1996a.

WHO. Strengthening interventions to reduce helminth infections. WHO Series on School Health, Document One. World Health Organization, *WHO/SCHOOL/96.1 WHO/HPR/HEP/96.10*. 1996b.