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Soil-Transmitted Helminthiasis and Schistosomiasis in Children of Poor Families in Leyte, Philippines: Lessons for Disease Prevention and Control

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ABSTRACT

Objective: Neglected tropical diseases (NTDs) continue to be a public health problem in the Philippines. We assessed the association of soil-transmitted helminthiasis (STH) and schistosomiasis with selected health-related and socioeconomic variables in four villages in Leyte, Philippines.

Methods: Stool specimens from 418 adults and 533 of their children from 209 families were examined through the Kato-Katz technique.

Results: STH and schistosomiasis were present in 64.6% and 12.5%, respectively, of study participants. Analysis through the generalized linear mixed model revealed a number of associations between infection in parents and their children. Findings indicate that years of disease prevention and control efforts in these areas have been unable to bring down prevalence in children and their parents. Eliminating NTDs as public health problems will require a systems thinking approach beyond implementation of vertical control programs alone.

KEYWORDS: helminthiasis, neglected diseases, Philippines, poverty, public health, schistosomiasis.

INTRODUCTION

Neglected tropical diseases (NTDs) are considered a proxy for poverty [1]. The World Health Organization (WHO) estimates that NTDs affect more than a billion people worldwide [2]. Soil-transmitted helminthiasis (STH) and schistosomiasis rank first and second, respectively, among NTDs in terms of contribution to years lived with disability [3]. STH refers to a group of parasitic diseases, namely, ascariasis, trichuriasis and the hookworm infections, caused by nematode worms that are transmitted to humans through fecal-contaminated soil [4]. Schistosomiasis is a disease resulting from infection with parasitic trematode worms of the genus *Schistosoma* and is acquired when free-swimming parasitic larvae (cercariae) penetrate the skin of people exposed to infested freshwater [5].

In the Philippines, ascariasis is widespread, with many areas estimated to have prevalence rates of >50% [6]. Schistosomiasis due to *Schistosoma japonicum* is known to be endemic in 28 provinces [7]. Data involving >10 000 individuals in the province of Northern Samar have revealed prevalence rates of 77% and 27% for STH and schistosomiasis, respectively, despite the implementation of mass drug administration (MDA) of anthelmintics in the past 5 years [8]. It has been recognized that elimination of STH and schistosomiasis as public health problems cannot be achieved through MDA alone but will require Water, Sanitation and Hygiene (WASH) interventions that are integrated into disease prevention and control activities [9]. However, in practice, the integration of WASH is rarely realized, as country programs in the Philippines [10] still rely on MDA as the major prevention and control strategy, notwithstanding that good treatment coverage rates are difficult to attain in many settings where the local health system is weak [11].

The Sustainable Development Goals (SDGs) include ending the epidemic of NTDs by 2030 under Goal 3, among 16 other goals that include achieving Universal Health Coverage (UHC) [12]. Effective prevention and control of NTDs can also be considered as a sensitive indicator of progress toward UHC [2, 13].

In the Philippines, the government adopted UHC in 2010 as the national policy to improve the health of Filipinos [14, 15]. Before 2010, the national social health insurance program was estimated to cover 76% of the Philippine population [16]. Efforts to achieve UHC received a boost with the implementation of the sin tax reform law in 2012 that increased taxes on tobacco and alcohol products. Revenues from sin tax were used to increase resource allocation for disease prevention and control programs, as well as support enrollment of more Filipinos into the national social health insurance program [17, 18].

The Philippine government has also scaled-up the conditional cash transfer (CCT) program, which provides cash to poor families subject to compliance with conditionalities, including a requirement for school-age children to take anthelmintics during MDA [19, 20]. An impact evaluation study of the CCT program has concluded that school-age children from enrolled families were more likely to have taken anthelmintics when compared with children in other villages where poor families were not enrolled [20].

In recent years, the Philippines has also been attaining one of the highest growth rates in Asia [21]. Ironically, Southeast Asia is also a region where many poor people continue to suffer the burden of a number of NTDs [22].

We aimed to determine the prevalence of STH and schistosomiasis in a sample of families in four villages in Leyte, Philippines. Consequently, we assessed the association of infection with selected health-related and socioeconomic variables. Lastly, we proposed recommendations to overcome the burden of these diseases.

METHODS

This cross-sectional study was conducted from March to April 2015 in four *barangays* or villages purposively selected in the municipality of Palo in the province of Leyte, Philippines (Fig. 1).

The Sampling method was based on the guidelines by the WHO for evaluating STH and schistosomiasis at the community level [23, 24]. A minimum sample size of 50 families per village was targeted to obtain a sample of 250 individuals per village (i.e. 50 × 5). Families were randomly selected per village through the use of random numbers generated in Microsoft Excel 2013.

Nurses who spoke the local language were trained as data collectors. Each family in the randomly generated list was visited and included in the survey. Both the father and the mother were interviewed about

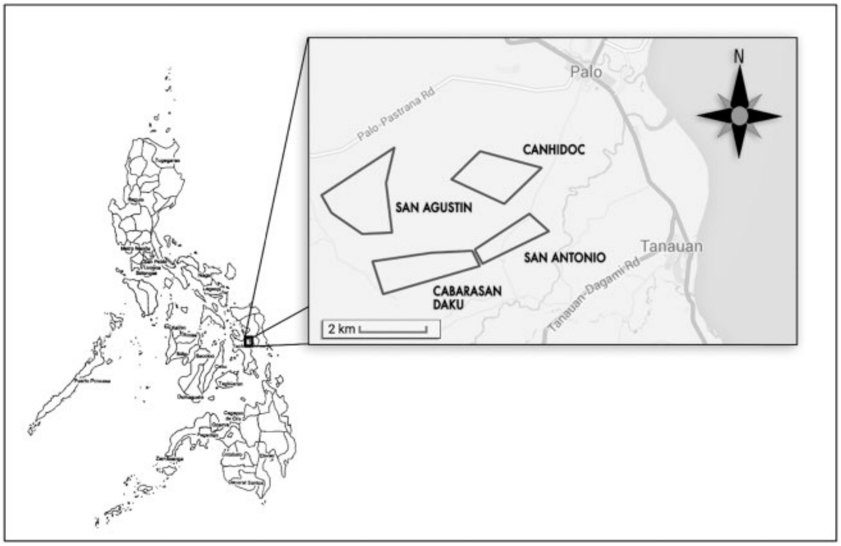

Fig. 1. Map showing the four *barangays*/villages in the municipality of Palo in the island province of Leyte, Philippines, where the study was conducted from March to April 2015 (modified map from https://maps.google.com/).

previous treatment for STH and schistosomiasis as part of MDA. The height and weight of the children were also measured during the visit [25]. The nurses inspected the family's house for a set of characteristics and possessions based on the household questionnaire used in the National Demographic and Health Survey of 2013 [26]. Information from this inspection was used to assess the socioeconomic status following the asset-based approach [27].

Stool collection, processing and analysis

Stool specimens were subsequently collected and delivered to the laboratory for processing and examination using two aliquots through the Kato-Katz technique, or the Kato thick technique for specimens with insufficient amounts [28]. Each slide was examined by licensed microscopists for the presence of helminth ova. Detection of helminth ova in one aliquot was considered sufficient to make a diagnosis. The intensity of infection was categorized following the WHO classification for STH [4] and schistosomiasis [5] (Table 1). Ten percent of all slides examined were randomly selected and re-examined by a professional pathologist as part of quality control measures, as well as to minimize intra- and inter-observer variability.

Data for each individual were double-encoded in Epi Info™ 7 (CDC, Atlanta, Georgia, USA). Data analysis was completed using R version 3.2.0 (The R Foundation for Statistical Computing). Prevalence rates for the presence and intensity of infection were calculated. Nutritional status of the child participants was assessed following the CDC Growth Charts [29]. Principal component analysis was used to obtain a wealth index for each family [27]. The association of infection with selected health-related and socioeconomic variables was determined by calculating *p*-values at 95% level of significance through the generalized linear mixed model [30]. Odds ratios (ORs) for variables with a statistically significant association were calculated using the Wald test.

Ethics review

The study protocol was approved by the Ateneo School of Medicine and Public Health Research Ethics Committee.

RESULTS

This study included 209 families (22.7% of the total number of families in the villages), with 951 participants, 418 (44.0%) and 533 (56.0%) of whom were adults and children, respectively (Table 2).

Table 1. Categories of intensity of infection as defined for STH [4] and schistosomiasis [5] for stool specimens examined through the Kato-Katz technique

Organism	Light-intensity infections	Moderate-intensity infections	Heavy-intensity infections
Soil-transmitted helminths			
Ascaris lumbricoides	1–4999 epg	5000–49 999 epg	≥50 000 epg
Trichuris trichuria	1–999 epg	1000–9999 epg	≥10 000 epg
Hookworms (*Necator americanus* or *Ancyclostoma duodenale*)	1–1999 epg	2000–3999 epg	≥4000 epg
Schistosoma japonicum	1–99 epg	100–399 epg	≥400 epg

epg: eggs per gram.

Table 2. Total number of families residing in the four barangays/villages included in this study, number of study participants in each village disaggregated into adults, children, age and sex and number of stool specimens examined

	Cabarasan Daku No. (%)	Canhidoc No. (%)	San Agustin No. (%)	San Antonio No. (%)	Total No. (%)
Total number of families[a]	188	178	289	266	921
Number of families included in this study[b]	52 (27.7)	52 (29.2)	52 (18.0)	53 (19.9)	209 (22.7)
Mean number of study participants per family	4.6	4.7	4.3	4.7	4.6
Total number of study participants	240	242	221	248	951
Total number of stool specimens examined[c]	240 (100.0)	240 (99.2)	218 (98.6)	229 (92.3)	927 (97.5)
Number of adult participants	104 (43.3)	104 (43.0)	104 (47.1)	106 (42.7)	418 (44.0)
Mean age[d]	37.6 (35.9, 40.4)	38.5 (36.5, 41.5)	36.1 (34.1, 39.1)	36.9 (35.2, 39.7)	37.3 (36.3, 38.2)
Males	52	52	52	53	209
Females	52	52	52	53	209
Number of child participants[e]	136 (56.7)	138 (57.0)	117 (52.9)	142 (57.3)	533 (56.0)
Mean age[d]	8.8 (8.1, 11.2)	8.7 (8.0, 11.0)	7.5 (6.9, 9.8)	8.8 (8.1, 11.1)	8.5 (8.1, 8.8)
Males	73	75	64	69	281
Females	63	63	53	73	252

[a]Based on the official list of families as of January 2015 provided by the local government unit.
[b]Randomly selected from the official list of families.
[c]By Kato-Katz and Kato thick techniques.
[d]Mean with standard deviation at 95% CI.
[e]2–16 years old.

Table 3. Total number, prevalence and intensity of schistosomiasis, STH and co-infection in stool specimens examined from adults and children in the four barangays/villages

Prevalence and Intensity	Adults No. (%)	Children No. (%)	Total No. (%)
Prevalence[a] of schistosomiasis	56 (13.7)	60 (11.6)	116 (12.5)
Heavy intensity[b]	2 (0.5)	10 (1.9)	12 (1.3)
Moderate intensity	6 (1.5)	8 (1.6)	14 (1.5)
Light intensity	47 (11.6)	42 (8.2)	89 (9.7)
Prevalence of STH	261 (64.0)	338 (65.1)	599 (64.6)
Heavy intensity	16 (4.0)	44 (8.6)	60 (6.5)
Moderate intensity	57 (14.1)	114 (22.2)	171 (18.6)
Light intensity	186 (45.9)	177 (34.4)	363 (39.5)
Prevalence of *Ascaris* infection	110 (27.0)	182 (35.1)	292 (31.5)
Heavy intensity	6 (1.5)	23 (4.5)	29 (3.2)
Moderate intensity	40 (9.9)	86 (16.7)	126 (13.7)
Light intensity	62 (15.3)	72 (14.0)	134 (14.6)
Prevalence of *Trichuris* infection	206 (50.5)	286 (55.1)	492 (53.1)
Heavy intensity	10 (2.5)	22 (4.3)	32 (3.5)
Moderate intensity	31 (7.7)	67 (13.0)	98 (10.7)
Light intensity	163 (40.2)	194 (37.7)	357 (38.8)
Prevalence of hookworm infections	41 (10.0)	14 (2.7)	55 (5.9)
Heavy intensity	0 (0.0)	0 (0.0)	0 (0.0)
Moderate intensity	2 (0.5)	0 (0.0)	2 (0.2)
Light intensity	39 (9.6)	14 (2.7)	53 (5.8)
Prevalence of co-infection with schistosomiasis and any type of STH	43 (10.5)	47 (9.1)	90 (9.7)

[a]Prevalence of infection was based on the total number of stool specimens examined through the Kato-Katz and Kato thick techniques.
[b]Prevalence of intensity of infection was based on the number of stool specimens examined through the Kato-Katz technique only.

Schistosomiasis was present in 12.5% of stool specimens, most of which were light-intensity infections (9.7% of total stool specimens) (Table 3). Stools from adults and children were positive for schistosomiasis in 13.7% and 11.6% of total specimens, respectively. On the other hand, 64.6% of total stool specimens were positive for any type of STH, most of which were light-intensity infections (39.5% of total stool specimens). Stools from adults were positive for any type of STH in 64.0% of total specimens, while stools from children were positive in 65.1%. Most of the STH diagnosed were due to trichuriasis (53.1% of total stool specimens), followed by ascariasis (31.5%) and hookworm infections (5.9%). Co-infection with schistosomiasis and any type of STH was found in 9.7% of total stool specimens (Fig. 2). The quality control measure revealed a mean sensitivity and specificity of 95.8% and 92.9%, respectively, among the microscopists who examined the slides.

Only 60.0% and 67.8% of study participants reported receiving previous treatment as part of MDA for schistosomiasis and STH, respectively. Only 47.7% of study participants reported receiving previous treatment for both diseases.

Height and weight measurements revealed that 54.9% of child participants had normal body mass index for age. However, 35.5% were underweight.

Among adults and children, 54.5% and 64.4%, respectively, were part of a family enrolled in the CCT program, while 59.3% and 75.2%, respectively, had social health insurance coverage.

Most families have a negative wealth index. Socioeconomic status of the families did not vary significantly across the four villages (Fig. 3).

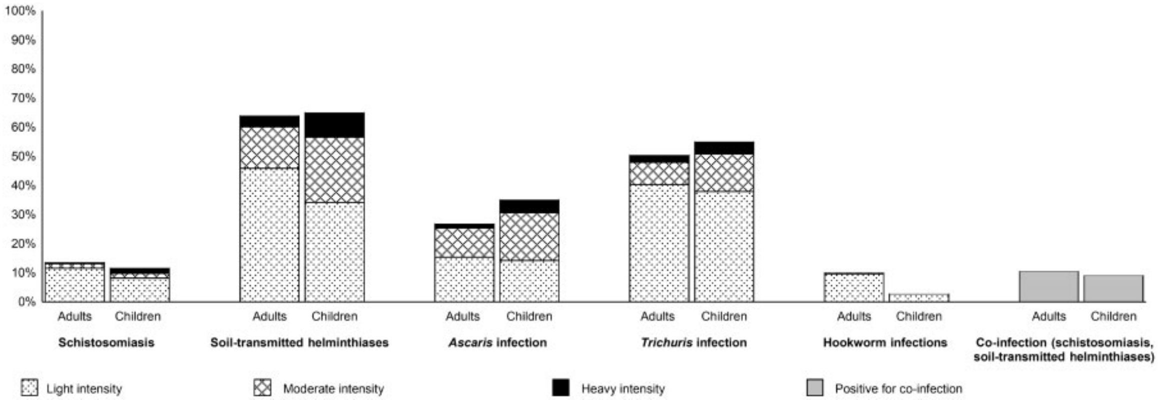

Fig. 2. Bar graph showing the prevalence and intensity of schistosomiasis, STH and co-infection in the stool specimens from adults and children from the four *barangays*/villages included in this study.

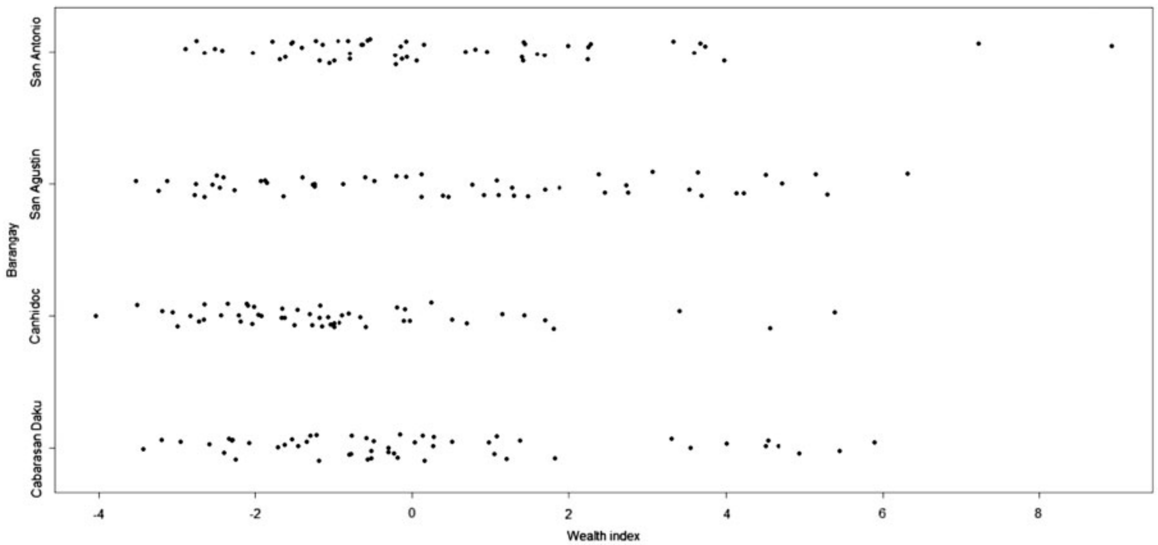

Fig. 3. The distribution of the wealth index of each family in the four *barangays*/villages, indicating that most families have a negative wealth index or a poor socioeconomic status. The socioeconomic status of the families did not vary significantly across the four villages.

Schistosomiasis in an adult was associated with any type of STH in the same adult [OR = 2.45, 95% confidence interval (CI): 1.09–5.51] and, conversely, STH in an adult was associated with schistosomiasis in the same adult (OR = 2.39, 95% CI: 1.09–5.21) (Table 4). On the other hand, schistosomiasis in a child was associated with STH in the same child (OR = 2.11, 95% CI: 1.04–4.27) and, conversely, STH in a child was associated with schistosomiasis in the same child (OR = 4.67, 95% CI: 1.95–11.21) (Table 5).

Schistosomiasis in an adult was associated with schistosomiasis in at least one of his/her children (OR = 13.79, 95% CI: 2.78–68.37) and, likewise, STH in an adult was associated with STH in at least one of his/her children (OR = 4.56, 95% CI: 2.17–9.56). Co-infection in an adult was associated with co-infection in at least one child (OR = 16.93, 95% CI: 1.77–162.26) (Table 4). Schistosomiasis in a child was associated with schistosomiasis in at least one sibling (OR = 5.78, 95% CI: 3.10–10.80) and,

Table 4. Summary of selected variables grouped according to health-related and socioeconomic variables and their association with schistosomiasis, STH and co-infection in the adult participants based on p-values generated from the generalized linear mixed model. The ORs of variables with a statistically significant association ($p < 0.05$) were calculated using the Wald test

Selected Variables	Adult has schistosomiasis		Adult has STH		Adult has co-infection	
	p-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)
Health-related variables						
Adult also has STH	0.030	2.45 (1.09, 5.51)	NA		NA	
At least one child has schistosomiasis	0.001	13.79 (2.78, 68.37)	NA		NA	
Adult had previous treatment for schistosomiasis	NS	NA	NA		NA	
Adult also has schistosomiasis	NA		0.029	2.39 (1.09, 5.21)	NA	
At least one child has STH	NA		6.02×10^{-5}	4.56 (2.17, 9.56)	NA	
Adult had previous treatment for STH	NA		NS	NA	NA	
At least one child has co-infection	NA		NA		0.014	16.93 (1.77, 162.26)
Adult had previous treatment for both diseases	NA		NA		NS	NA
Socioeconomic variables						
Wealth index	0.005	0.77 (0.64, 0.92)	NS	NA	0.018	0.78 (0.63, 0.96)
Family is enrolled in the CCT program	NS	NA	NS	NA	NS	NA
Adult has social health insurance coverage	NS	NA	NS	NA	0.032	2.54 (1.08, 5.94)

NS: not significant; NA: not applicable.

likewise, co-infection in a child was associated with co-infection in at least one sibling (OR = 4.80, 95% CI: 2.45–9.40). However, STH in a child was not associated with STH in a sibling (Table 5).

Schistosomiasis (OR = 0.77, 95% CI: 0.64–0.92) and co-infection (OR = 0.78, 95% CI: 0.63–0.96) in adults, as well as STH in children (OR = 0.81, 95% CI: 0.71–0.92), were inversely associated with a higher wealth index. Finally, co-infection in adults (OR = 2.54, 95% CI: 1.08–5.94) was associated with social health insurance coverage. In children, schistosomiasis (OR = 2.94, 95% CI: 1.43–6.04) and co-infection (OR = 2.77, 95% CI: 1.27–6.07) were associated with being part of a family enrolled in the CCT program.

DISCUSSION

The WHO considers STH eliminated as a public health problem when the prevalence of moderate-heavy intensity infections among school-age children is <1% and has also set a target of at least 75% MDA coverage of the population at risk [4]. The prevalence of moderate and heavy intensity infections (22.2%, 8.6%) and MDA coverage rate for STH (67.8%) in the villages are clearly far from this target despite the establishment of a prevention and

Table 5. Summary of selected variables grouped according to health-related and socioeconomic variables and their association with schistosomiasis, STH and co-infection in the child participants based on p-values generated from the generalized linear mixed model. The ORs of variables with a statistically significant association ($p < 0.05$) were calculated using the Wald test

Selected Variables	Child has schistosomiasis		Child has STH		Child has co-infection	
	p-value	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value	OR (95% CI)
Health-related variables						
Child also has STH	0.038	2.11 (1.04, 4.27)	NA		NA	
At least one sibling has schistosomiasis	3.69×10^{-8}	5.78 (3.10, 10.80)	NA		NA	
Child had previous treatment for schistosomiasis	NS	NA	NA		NA	
Child also has schistosomiasis	NA		0.0006	4.67 (1.95, 11.21)	NA	
At least one sibling has STH	NA		NS	NA	NA	
Child had previous treatment for STH	NA		NS	NA	NA	
At least one sibling has co-infection	NA		NA		4.64×10^{-6}	4.80 (2.45, 9.40)
Child had previous treatment for both diseases	NA		NA		NS	NA
Child is underweight	NS	NA	NS	NA	NS	NA
Socioeconomic variables						
Wealth index	NS	NA	0.0009	0.81 (0.71, 0.92)	NS	NA
Family is enrolled in the CCT program	0.003	2.94 (1.43, 6.04)	NS	NA	0.011	2.77 (1.27, 6.07)
Child has social health insurance coverage	NS	NA	NS	NA	NS	NA

NS: not significant; NA: not applicable.

control program in the municipality. These villages remain as high-risk areas with prevalence of any type of STH >50% and therefore require intensified prevention and control measures. Moreover, expanding the STH prevention and control program to include not only preschool-age and school-age children but also the adult population especially in moderate-high risk areas should be considered, as this strategy has been demonstrated to be cost-efficient [31]. Thus, the global target to eliminate STH as a public health problem by 2030 may be too ambitious a target [32] if high prevalence rates for STH are still being observed in villages like those included in this study.

The WHO considers schistosomiasis eliminated as a public health problem when the prevalence of heavy-intensity infections in the population at risk is <1% and likewise classifies a community with 10% to <50% prevalence rate in school-age children as a moderate-risk community [5]. Following this definition, the prevalence rate (11.6%) observed in this study classifies the villages as moderate risk; however, the goal of elimination may be considered within reach (with heavy intensity at 1.3%). On the other hand, when populations, whether adults or children, remain infected no matter what level of intensity, they serve as a hidden reservoir that continue to drive reinfection [33].

Results also indicate a high likelihood of STH and schistosomiasis occurring in the same individuals, a finding which is consistent with the tendency for these infections to share similar risk factors [34]. Consequently, the WHO has long campaigned for the integration of STH and schistosomiasis programs to maximize impact as integrated community-wide MDA targeting both diseases have also been shown to be a cost-effective strategy [31]. In the Philippines, the integration of prevention and control programs for STH and schistosomiasis has to be established to maximize efficiency and impact.

Results likewise indicate the presence of families with co-infections. This finding is not surprising, as families in these rural settings are usually exposed to the same risk factors [35]. These families are often the poorest families as validated by the association of infection status with a lower wealth index. The association of infection in children with membership of the family in the CCT program is an interesting finding. The possibility of confounding is difficult to rule out, as those families enrolled in the CCT program are usually the poorest families who are also most at risk for STH or schistosomiasis. Nevertheless, this result may suggest that the children from these families continue to suffer the burden of helminth infections despite the inclusion of deworming as a conditionality for families enrolled in the CCT program. Therefore, parameters for an accurate evaluation of the impact of the CCT program may include parasitological assessment of the children in enrolled families. The association of co-infection in adults with social health insurance coverage is another interesting finding that puts to test the progress made toward the goal of UHC. As this is a cross-sectional study, we are unable to establish clear temporality between social health insurance coverage and infection status. Further studies, specifically qualitative studies, are recommended to explore this interplay between social health insurance coverage or membership in the CCT program and the persistence of STH or schistosomiasis.

CONCLUSION

To end the epidemic of NTDs by 2030 as stated in the SDGs, prevention and control efforts must focus on settings that likely suffer the highest burden of NTDs. These efforts need to include increasing MDA coverage and integration of WASH interventions. In the Philippines, there is an excellent opportunity to take advantage of the increased resources for health services provided. Eliminating STH and schistosomiasis as public health problems will require a health systems approach that goes beyond the implementation of vertical disease control programs alone.

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