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Soil-Transmitted Helminth Infections and Anemia in Schoolchildren from Corn Island Archipelago (RAAS, Nicaragua)

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Abstract. The prevalence and intensity of soil-transmitted helminth (STH) infections in schoolchildren from Corn Islands (Nicaragua) were examined to detect mono- or poly-STH infected children, measuring different intensity levels, and to elucidate measurably increased odds of being anemic. A total of 341 stool samples provided by 2- to 15-year-old children were examined using a concentration technique and a Kato–Katz slide. Intensity of infection was expressed as eggs per gram (epg) of feces to classify light, moderate, or heavy intensity infection. A finger-prick blood sample was obtained from each student in the field. Soil-transmitted helminth prevalence was 54.3%, with *Trichuris trichiura* as the most prevalent species (48.9%). The combination *T. trichiura*/*Ascaris lumbricoides* (12.6%) was the most common. When *T. trichiura* or *A. lumbricoides* appeared as a single infection, light or moderate intensity infections were seen, whereas when multiple species were identified, heavy infections were present. Anemia was detected in those with any kind of STH infection (42.7%), with statistically significant differences ($P = 0.004$) when compared with uninfected individuals (28.2%). Polyparasite infection with one parasite species at moderate intensity and the other parasite species at light intensity or absent was found to be a significant factor for the odds of being anemic (odds ratio = 2.07). The present study reveals a high level of STH transmission requiring a deworming control program in Corn Islands and pointing to the need of improving the education and sanitary conditions of the population to avoid environmental contamination and reinfection.

INTRODUCTION

Ascaris lumbricoides, *Trichuris trichiura*, *Necator americanus*, and *Ancylostoma duodenale* are the most common soil-transmitted helminths (STHs) and are found, above all, in developing countries of the Americas, in China and East Asia, and in sub-Saharan Africa.[1–4] Moreover, STH infections are prevalent in those areas where anemia is widespread and they are known to be significant contributors to the overall anemia burden in poverty-stricken countries,[5,6] together with an insufficient daily food intake. The World Health Organization (WHO) estimates that schoolchildren from low-income countries are the group most severely affected by anemia.[7] Anemia and parasitic infections compromise their physical development, school attendance, and learning ability.[7,8] The existence of an inverse relation between intestinal helminthiases and the hemoglobin concentration,[9,10] as well as the risk of anemia correlating with intensity of infection are well known. In this sense, various authors demonstrated that light-intensity polyparasitism can be as adverse to health outcomes as a high-intensity infection with a single helminth.[5,6,11,12]

Nicaragua is the largest country in the Central American isthmus and it is the second poorest country in the Latin American and Caribbean region. Saboyá et al.[13] analyzed the status of STH deworming programs in Nicaragua up to 2011, although with varying outcomes depending on either the Pacific or Atlantic region. Poor sanitary conditions, lack of potable water, and fecal contamination of the environment tend to be the norm, and, thus, are in the background of the propagation of STH infections in the Atlantic region of Nicaragua.

The aim of this study was an island-wide assessment of STHs, to examine both the prevalence and the intensity of STH infections, and to elucidate whether mono- or poly-STH infected schoolchildren from the Corn Island archipelago, with varying intensity levels, have measurably increased odds of being anemic.

MATERIAL AND METHODS

Study area and population. This study was conducted in the Corn Island archipelago, one of the 12 municipalities forming the Región Autónoma del Atlántico Sur (RAAS) (Supplemental Figure 1), located about 70 km of the Caribbean coast of Nicaragua, with a total area of approximately 12.9 km^2, and being formed by two islands, Big (10 km^2) and Little (2.9 km^2) Corn Island. The first (lat. 12°10′N, long. 83°03′W) is located about 80 km east of Bluefields, the main city of the Caribbean coast of Nicaragua. The latter (lat. 12°18′N, long. 82°59′W) is located northeast of the bigger island and located approximately 90 km from Bluefields.

The municipality of Corn Island is subdivided into six neighborhoods ("barrios"), five of which (Brig Bay, La Loma, South End, Sally Peache, and North End) are on Big Corn Island, whereas Little Corn Island constitutes the sixth neighborhood. Traditionally, the economy of the islands revolves around coconut production and commercial fishing. However, in recent years, tourism has become the main source of income.

Corn Island archipelago has a tropical rainforest climate, with a dry period from February to April, but the trade winds ensure that, unlike on the Pacific coast of Nicaragua, rain still falls frequently during that period. For the rest of the year, tropical low pressure dominates and rainfall is extremely heavy.

Corn Island has an estimated population of around 6,000 inhabitants, approximately 2,000 of whom are children of different age groups. The survey was carried out in a total of six schools: five schools on Big Corn Island and only one school on Little Corn Island. Students participated voluntarily, random by age group and gender, always with the informed consent correctly completed as the inclusion criterion. The

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sample size, based on a level of confidence of 95% (*Z* value of 1.96), an expected prevalence of 50%, and a marginal error of 5%, was estimated at least on 322 samples. At the end, we managed to obtain 341 samples; thus, our final coverage was nearly 17.5%.

Sampling and laboratory methods. The coprological survey involved 341 children (157 males and 184 females) aged 2–15 years (mean ± SD = 8.53 ± 2.68). A clean, plastic, wide-mouthed, numbered container with a snap-on lid was given to each child. One stool sample per child was collected, if necessary, with the help of the parents/guardian, and personal data (name, gender, and age) were recorded on delivery of the container the following day. Stool samples provided by each child were analyzed by the Kato–Katz technique for the fecal examination of helminth eggs, following WHO recommendations using a template delivering approximately 41.7 mg of feces.[14] These slides were initially examined within 1 hour of preparation to avoid over-clarification of hookworm eggs. The rest of the feces was fixed with 10% formaldehyde and examined at Department of Parasitology of the University of Valencia (Valencia, Spain), using the formol-ether concentration technique.[15,16] The sediments of the concentration technique were used to obtain prevalence data and to avoid false negatives with the Kato–Katz slides.

Soil-transmitted helminth infection intensity levels. Intensity of infection was expressed as eggs per gram (epg) of feces measured by the Kato–Katz slides. The mean number, median, and range of epg of feces were used as quantitative measures of infection status for each sample. The World Health Organization criteria (reference range values for each STH species) were used to classify each infected sample as light, moderate, or heavy intensity infection.[17]

Soil-transmitted helminth infection profile. Given the possible concurrent infection by up to three STHs at one of three potential intensity levels (light, moderate, or heavy) for each species, there were 27 possible categories of polyparasite infections. According to the different risk levels for anemia,[6] the following five infection profiles were considered:

1. Profile 0 or reference profile: no infection or infection with one parasite species at light (L) intensity;
2. Profile I: concurrent infection with two or three parasite species at light (L) intensity;
3. Profile II: infection with one parasite species at moderate (M) intensity and the other parasite species at light (L) intensity or absent;
4. Profile III: concurrent infection with at least two parasite species at moderate (M) intensity and the other parasite species at light (L) intensity or absent;
5. Profile IV: infection with one parasite species at heavy (H) intensity and the other parasite species at light (L) or moderate (M) intensities.

Anemia status. A finger-prick blood sample, the standard technique generally used in field work accepted for accurate hemoglobin (Hb) measurement, was also obtained from the 341 students at the schools. The procedure was carried out using a portable HemoCue photometer according to the manufacturer's instructions. Anemia, following WHO guidelines according to age, was defined as Hb < 11.0 g/dL for children aged 1–5 years, Hb < 11.5 g/dL for children aged 6–11 years, and Hb < 12.0 g/dL for children aged 12–14 years.[7]

Data analysis. Statistical analyses were carried out using Open Source Epidemiologic Statistics for Public Health, version 3.03a. Statistical comparison was made with the χ^2 test, Student's *t*-test, and analysis of variance. A multivariate analysis using logistic regression model estimated the odds ratios (ORs) (95% confidence interval [CI]) of having anemia with children with polyparasite infection Profiles I–IV relative to those with the reference profile. All results were considered significant if the *P* value was < 0.05.

Ethical considerations. Instituto Politécnico de la Salud, as well as Universidad de Valencia Estudio General granted the ethical approval of the study (H1477378643204) in accordance with the Declaration of Helsinki. Informed consent was obtained in person from the parents/guardians of the participating students on the day of inclusion. The Nicaraguan Ministry of Health was informed of the results, and all pupils diagnosed positive for intestinal STH were treated after the study, as no deworming programs had been conducted in that region before.

RESULTS

Soil-transmitted helminth prevalence. Prevalence of infection was obtained with the concentration technique results. Table 1 shows the total prevalence of helminths (54.3%; 185/341), and for each helminth species. Among STHs, *T. trichiura* was the most prevalent (48.9%; 167/341) helminth species in the schoolchildren from Corn Islands, followed by *A. lumbricoides* (19.9%; 68/341) and hookworm infections (10.6%; 36/341). Only six registered *Hymenolepis nana* cases (1.8%; 6/341) were not studied in detail. The analysis of the STH prevalences according to age and gender (Table 1) did not show statistical differences.

Soil-transmitted helminth polyparasitism. Single infection (33.1%; 113/341) was the most common infection, followed by double infections (17.0%; 58/341). The combination *T. trichiura*/*A. lumbricoides* (12.6%; 43/341) was the most common. There was no combination between *A. lumbricoides* and hookworm, and the percentage of the combination hookworm/*T. trichiura* (4.4%; 15/341) was as low as the percentage of infection with all three STHs detected (4.1%; 14/341).

Soil-transmitted helminth infection intensity. The infection intensity was obtained with the Kato–Katz technique and then classified according to the degree of infection.[17]

The median epg of feces was 432 for *T. trichiura* (range 24–11,712), 1,668 for *A. lumbricoides* (range 24–58,408), and 168 for hookworm infection (range 24–1,968), and values were used in the classification of the intensity level (light, moderate, and heavy infections) for the STHs detected (Table 2). Light intensity was the most common level with statistical differences in *T. trichiura* ($P < 0.0000001$) and *A. lumbricoides* ($P = 0.002$) infections.

There were significant differences in intensity between single and multiple infections for *T. trichiura* ($P = 0.011$), but not for *A. lumbricoides* ($P = 0.079$) nor for hookworm ($P = 0.330$). When *T. trichiura* and *A. lumbricoides* appeared in single infections, only light and moderate intensities of infection were found, whereas when those STHs appeared in multiple infections, the median number of epg of feces reached heavy infections (Figure 1). Although hookworm always appeared in light-intensity infection, the median number of epg of feces increased in multiple infections.

TABLE 1

Prevalence (%) of STH species in the 341 schoolchildren who studied in the Corn Island archipelago (Región Autónoma del Atlántico Sur, Nicaragua) by age groups and gender

		STH				*Trichuris trichiura*			*Ascaris lumbricoides*			Hookworm		
	N	*N*	%	CI 95%	*P* value	*n*	%	CI 95%	*n*	%	CI 95%	*n*	%	CI 95%
Age groups (years)														
2–5	55	31	56.3	42.8–69.8	0.610	28	51	37–65	12	22	11–33	7	13	4–22
6–11	246	127	51.6	45.3–57.9	–	115	47	40–53	46	19	14–24	23	9	6–13
12–15	40	23	57.5	42.8–75.1	–	20	50	35–65	8	20	10–34	6	15	6–29
Gender														
Male	157	80	50.9	43–58.8	0.537	71	45	37–53	34	22	15–28	15	10	5–14
Female	184	101	54.8	47.6–62.1	–	92	50	43–57	32	17	12–23	21	11	7–16
Total	341	185	54.3	48.9–59.5	–	167	48.9	43.7–54.3	68	19.9	15.9–24.4	36	10.6	7.6–14.2

CI 95% = 95% confidence interval; *N* = number of schoolchildren studied; *n* = number of schoolchildren parasitized; STH = soil-transmitted helminth.

Anemia prevalence. The present study showed that 36.1% (123/341) of the schoolchildren presented with anemia (Table 3). The occurrence of anemia was associated neither with age group nor with gender. Although the prevalence of anemia in young children aged 2–5 years (40%) was higher compared with that of schoolchildren aged 6–11 years (34.1%), the difference was not statistically significant. With regard to gender, anemia was more frequent in girls than in boys (37.5% versus 33.8%), but without statistical difference.

Relationship between STH infections and anemia. The mean value of the Hb concentration was 11.8 g/dL (range: 7.5–14.2) for uninfected schoolchildren, whereas the mean Hb concentration value was 11.4 g/dL (8–15.1) for those with any kind of STH infection. Anemia (42.7%) was detected with statistical differences (P = 0.007) in those with any type of infection compared with those uninfected (28.2%) (Table 4). There were no differences in the anemia prevalence in relation to the type of mono- or poly-STH infection.

Table 5 contains the characteristics of the study populations (% infection, mean Hb values, and % anemic) by five different parasite infection profiles, taking into account the level of infection intensity (light, moderate, and heavy). Of the 27 possible categories of polyparasite infection, a total of 21 categories were found in the present study. It is noteworthy that polyparasite infection Profile II (infection with one parasite species at moderate intensity and the other parasite species at light intensity or absent) was found to be a significant factor for the odds of being anemic (OR = 2.07; 95% CI = 1.06–4.02; P = 0.040).

DISCUSSION

The STH prevalence obtained in schoolchildren from Corn Islands was 54.3%, above the 20% baseline considered by WHO to promote mass deworming control programs.[18] Also, the prevalence of anemia among those schoolchildren constitutes another public health problem (36.1%). Moreover, anemia among schoolchildren in the study area does not seem to be only the result of dietary deficiency, as the percentage of anemia increases when an STH infection is involved, reaching 42.7%, with statistical differences when compared with those without infection.

In Nicaragua, about 1.8 million children require periodic deworming.[19] However, there are only very few previous studies dealing with prevalence and intensities of STH infections in Nicaragua. Rosewell et al.[20] compiled data from four departments revealing an STH infection rate of 46%, with heterogeneous prevalence and intensities, and *T. trichiura* being the most common infective species (34.7%). Muñoz-Antoli et al.[21] found 52.9% STH infection, with *T. trichiura* reaching 43.2% in Department of Rio San Juan and, recently, Muñoz-Antoli et al.[22] found a total helminth prevalence of 76.7%, with a dominance of *T. trichiura* (72.4%) light intensity infections, in Laguna de Perlas (RAAS). Concerning Corn Islands, there is, however, only one previous survey dating back 25 years,[23] revealing a prevalence of 41% of roundworms

TABLE 2

STH infection intensity levels in schoolchildren who studied in the Corn Island archipelago (Región Autónoma del Atlántico Sur, Nicaragua)

	Trichuris trichiura, *N* = 167			*Ascaris lumbricoides*, *N* = 68			Hookworm, *N* = 36		
Intensity levels	*n*	%	Median	*n*	%	Median	*N*	%	Median
Light	126	75.4	228	42	61.8	828	36	100	168
Moderate	39	23.4	2,280	23	33.8	12,672	0	0	0
Heavy	2	1.2	11,184	3	4.4	56,376	0	0	0

N = number of schoolchildren parasitized; *n* = number of schoolchildren parasitized with the intensity levels; STH = soil-transmitted helminth.

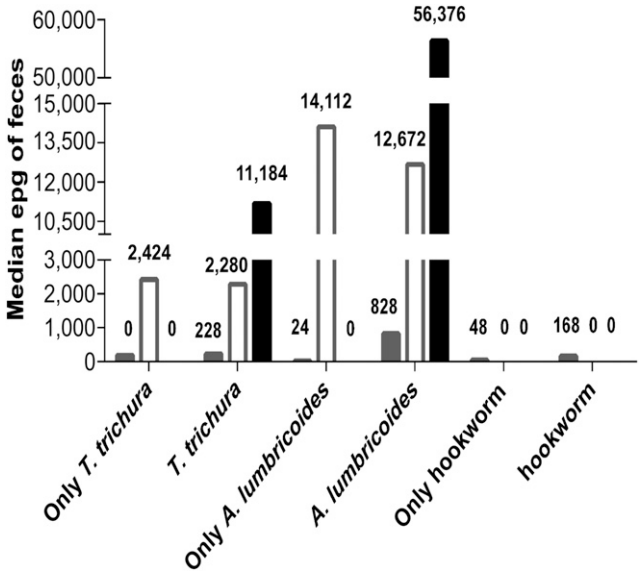

FIGURE 1. Type of soil-transmitted helminth intensity of infection (light [grey filled square], moderate [white filled square], and heavy [black filled square]) in single and multiple infections. Columns indicate median of eggs per gram (epg) of feces.

TABLE 3

Prevalence (%) of anemia in the 341 schoolchildren who studied in the Corn Island archipelago (Región Autónoma del Atlántico Sur, Nicaragua) by age groups and gender

		Hb		Anemia		
	N	Mean (g/dL)	Range	*n*	%	*P* value
Age groups (years)						
2–5	55	11.3	10.8–11.5	22	40.0	0.686
6–11	246	11.6	11.4–11.8	84	34.1	–
12–15	40	12.05	11.1–12.3	15	37.5	–
Gender						
Male	157	11.6	11.3–11.8	53	33.8	0.545
Female	184	11.7	11.3–11.7	69	37.5	–
Total	341	11.6	11.4–11.7	123	36.1	–

Hb = hemoglobin value; *N* = number of schoolchildren studied; *n* = number of anemic schoolchildren.

(33% *T. trichiura*, 16% *A. lumbricoides*, and 7% hookworms), although no concentration techniques, nor Kato–Katz technique, were used in the examinations.

Moreover, anemia is considered a moderate public health problem in Nicaragua in children less than 6 years of age.[7,24] The etiology of anemia is multifactorial and can result not only from nutritional deficiencies but also from parasitic infections.[25] In several parts of the world, children infected by STHs were found to have lower mean values of hemoglobin than uninfected children.[9,12,26–28] Nonetheless, in Nicaragua, there is only one previous study concerning schoolchildren from Carazo department who were analyzed to correlate helminth infections, malnutrition, and child development,[29] and there is no previous work on anemia and STH infections in schoolchildren in that country. *Trichuris trichiura*, causing the loss of 0.005 mL/day/worm of blood,[9] is associated with decreased hemoglobin values[11] as a significant predictor for anemia and iron-deficiency anemia among Panamanian,[30] Kenyan,[31] and Malaysian[12] children; and in the present work, *T. trichiura* was found to be the most common STH species (48.3%). Similarly, significant relationships between *A. lumbricoides* infections and anemia were encountered in previous studies in Nigerian[32] and Zanzibari[33] children, which demonstrated that an *A. lumbricoides* infection was also associated with lower hemoglobin values.[12] In our work, when a single STH infection of low intensity is observed, no association with anemia is expected, probably because of a regular infection of single STH of light intensity. The most common level of single *T. trichiura* infection (82.1%) was of light intensity. However, moderate or heavy intensities of *T. trichiura* are usually associated with a higher risk of anemia.[6,10,12,27,30,34,35] However, polyparasitism is also present in Corn Islands, and when those STHs appear in multiple infections, the median number of epg of feces reaches even heavy infection intensity, and thus aggravates the anemic situation. Therefore, anemia seems to be directly related to the intensity of STH infection as Profile II, with at least one parasite species at moderate intensity, was found to be a significant factor for the odds of being anemic. Reducing the STH burden is very likely to lead to a decline in anemia.[36,37]

If the increasing odds of having anemia with increasing severity in the polyparasite infection profile is assumed, the association between multiple light-intensity infection and anemia remains significant.[5] In that sense, concurrent multiple light-intensity infection, another common situation among the schoolchildren from Corn Islands, is not clinically benign and should not be ignored. In that sense, anthelminthic treatment could be extremely effective in the improvement of the hemoglobin levels of the population.[26]

A possible limitation of this study is the examination of a single Kato–Katz smear, which is usually accepted in field studies.[6] For that reason, we used the concentration technique results for the presence of STH infection, to avoid false-negatives. All samples that were positive for the concentration technique were also positive in the Kato–Katz smears. However, results could be improved by using molecular diagnostic techniques.

Our results confirm the high level of STH transmission and its repercussions on the anemic status of schoolchildren, requiring a deworming control program in Corn Island archipelago according to the WHO criteria, focusing on STH morbidity, and using anthelminthic drugs. We, therefore, recommend improving the education and sanitary conditions of the population to avoid environmental contamination and reinfection after the deworming programs. The impact of studies of this type could indirectly improve child development.

TABLE 4

Distribution of anemia according to the type of STH infection in schoolchildren who studied in the Corn Island archipelago (Región Autónoma del Atlántico Sur, Nicaragua)

		Hb		Anemia		
	N	Mean (g/dL)	Range	*n*	%	*P* value
No infection	156	11.8	7.5–14.2	44	28.2	0.007
Any kind of STH infection	185	11.4	8–15.1	79	42.7	–
One infection only	–	–	–	–	–	0.884
Trichuris trichiura only	95	11.7	8–15.1	36	37.9	–
Ascaris lumbricoides only	11	11.7	9–12.6	4	36.3	–
Hookworms only	7	12.1	9.7–12.8	2	28.5	–
Poly- STH infection	–	–	–	–	–	0.289
Two infections						
Trichuris trichiura/*A. lumbricoides*	43	11.1	8.9–14.8	24	55.8	–
Hookworm/*T. trichiura*	15	11.7	10.3–14.3	5	33.3	–
Hookworm/*A. lumbricoides*	0	0	0	0	0	–
Three infections						
Hookworm/*T. trichiura*/*A. lumbricoides*	14	11.3	8.6–13.9	8	57.1	–

Hb = hemoglobin value; *N* = number of schoolchildren; *n* = number of anemic schoolchildren; *P* value = comparison no infection *vs* any STH infection; among one infection only; among poly-STH infection; STH = soil-transmitted helminth.

TABLE 5
Characteristics of the schoolchildren according to profile–subprofile classification and infection categories with determinant odds of anemia

Parasite infection profile	Corn Island archipelago					
	N = 341					
	n	%	Hb mean (g/dL)	*n*	% Anemic	OR (95% CI) *P* value
Profile 0	–	–	–	–	–	–1
Subprofile 0:	–	–	–	–	–	–
0 or 1 L infection (*N* = 251)	–	–	–	–	–	–
0 infections	156	45.8	11.8	44	28.2	–
Trichuris trichiura	78	82.1	11.7	30	38.4	–
Ascaris lumbricoides	10	90.9	11.7	3	30	–
Hookworm	7	100	12.1	2	28.5	–
Profile I	–	–	–	–	–	1.93
Subprofile 1:	–	–	–	–	–	(0.92–4.02)
2 L infections (*N* = 32)	–	–	–	–	–	0.106
Trichuris trichiura and *A. lumbricoides*	22	5.2	11.2	12	54.5	–
Trichuris trichiura and hookworm	10	66.6	11.6	3	30	–
Ascaris lumbricoides and hookworm	0	0	0	0	0	–
Subprofile 2:	–	–	–	–	–	–
3 L infections (*N* = 2)	–	–	–	–	–	–
Trichuris trichiura, *A. lumbricoides*, and hookworm	2	14.3	10.9	1	50	–
Profile II	–	–	–	–	–	2.07
Subprofile 3:	–	–	–	–	–	(1.06–4.02)
1 M infection (*N* = 18)	–	–	–	–	–	0.040
Trichuris trichiura	17	18.3	11.8	6	35.3	–
Ascaris lumbricoides	1	9.1	10.4*	1	100	
Hookworm	0	0	0	0	0	–
Subprofile 4:	–	–	–	–	–	–
1 M and 1 L infections (*N* = 18)	–	–	–	–	–	–
Trichuris trichiura (M) and *A. lumbricoides* (L)	3	6.9	12.8	1	33.3	–
Trichuris trichiura (M) and hookworm (L)	5	33.3	11.8	2	40	–
Ascaris lumbricoides (M) and hookworm (L)	0	0	0	0	0	–
Ascaris lumbricoides (M) and *T. trichiura* (L)	10	23.3	11.3	6	60	–
Hookworm (M) and *T. trichiura* (L)	0	0	0	0	0	–
Hookworm (M) and *A. lumbricoides* (L)	0	0	0	0	0	–
Subprofile 5:	–	–	–	–	–	–
1M and 2 L infections (*N* = 7)	–	–	–	–	–	–
Trichuris trichiura (M), *A. lumbricoides* (L), and hookworm (L)	4	28.5	10.7	3	75	–
Ascaris lumbricoides (M), *T. trichiura* (L), and hookworm (L)	3	21.4	11.3	2	66.6	–
Hookworm (M), *T. trichiura* (L), and *A. lumbricoides* (L)	0	0	0	0	0	–
Profile III	–	–	–	–	–	2.17
Subprofile 6:	–	–	–	–	–	(0.47–9.84)
2 M infections (*N* = 5)	–	–	–	–	–	0.471
Trichuris trichiura (M) and *A. lumbricoides* (M)	5	11.6	11.1	2	40	–
Trichuris trichiura (M) and hookworm (M)	0	0	0	0	0	–
Ascaris lumbricoides (M) and hookworm (M)	0	0	0	0	0	–
Subprofile 7:	–	–	–	–	–	–
2 M and 1 L infections (*N* = 3)	–	–	–	–	–	–
Trichuris trichiura (M), *A. lumbricoides* (M), and hookworm (L)	3	21.4	10.7	2	66.6	–
Trichuris trichiura (M), hookworm (M), and *A. lumbricoides* (L)	0	0	0	0	0	–
Ascaris lumbricoides (M), hookworm (M), and *T. trichiura* (L)	0	0	0	0	0	–
Subprofile 8:	–	–	–	–	–	–
3 M infections (*N* = 0)	–	–	–	–	–	–

(continued)

TABLE 5
Continued

Parasite infection profile	Corn Island archipelago					
	N = 341					
	n	%	Hb mean (g/dL)	*n*	% Anemic	OR (95% CI) *P* value
Trichuris trichiura (M), *A. lumbricoides* (M), and hookworm (M)	0	0	0	0	0	–
Profile IV	–	–	–	–	–	3.24
Subprofile 9:	–	–	–	–	–	(0.47–27.78)
Any H infections (*N* = 5)	–	–	–	–	–	0.384
Trichuris trichiura (H) and *A. lumbricoides* (L)	1	2.3	9.6*	1	100	–
Ascaris lumbricoides (H) and *T. trichiura* (L)	1	2.3	10.5*	1	100	–
Ascaris lumbricoides (H) and *T. trichiura* (M)	1	2.3	10.4*	1	100	–
Ascaris lumbricoides (H), *T. trichiura* (M), and hookworm (L)	1	7.1	12.7*	0	0	–
Trichuris trichiura (H), *A. lumbricoides* (M), and hookworm (L)	1	7.14	12.9*	0	0	–

H = heavy infection; Hb = hemoglobin value; L = light infection; M = moderate infection; *N* = total number of schoolchildren; *n* = number of schoolchildren in the group; OR (95% CI) = odds ratio (95% confidence interval).
* Absolute value.

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