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Intestinal Parasitic Infections and Hemoglobin Levels among Schoolchildren participating in a Deworming Program in Jakarta, Indonesia: A Cross-sectional Study

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Abstract

BACKGROUND: Deworming programs have had positive impacts on the incidence of intestinal parasitic infections (IPIs) and hemoglobin (Hb) levels among schoolchildren.

AIM: This study aimed to evaluate effects of a deworming program on IPIs and Hb levels among schoolchildren in Jakarta, Indonesia.

METHODS: A cross-sectional study was performed in one school in Jakarta, Indonesia. Stool samples from schoolchildren were examined using the direct smear and Kato-Katz methods. The Hb concentrations of the schoolchildren were measured using the Easy Touch GCHb tool kit.

RESULTS: A total of 219 stool samples were obtained, and 18.7% (41/219) were positive for IPIs; specifically 8.2% (18/219) were positive for helminth and 10.5% (23/219) were positive for protozoan infections. The prevalences of *Ascaris lumbricoides* and *Trichuris trichiura* were 6.4% and 1.8%, respectively. The prevalences of *Blastocystis hominis, Giardia lamblia*, *Entamoeba histolytica*, and *Entamoeba coli* were 6.8%, 2.7%, 0.5%, and 0.5%, respectively. The prevalence of anemia (Hb < 11.5 g/dL) among the schoolchildren was 19.6% (43/219). The IPIs were significantly associated with Hb concentrations among the schoolchildren ($p < 0.05$).

CONCLUSION: The results of this study support the use of integrated programs involving deworming, nutrient supplementation, development of good living conditions, use of sanitary facilities, and active participation in the community to reduce IPIs and to improve the nutritional status among schoolchildren.

Introduction

Intestinal parasitic infections (IPIs) are caused by pathogenic helminth and protozoan species. These parasites live in the human intestinal tract and induce intestinal alterations, resulting in serious mortality and morbidity in humans. IPIs are harmful diseases and are endemic worldwide. Estimates for those infected with *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm are 800–1221 million, 604–795 million, and 576–740 million, respectively [1]. There are approximately 50 million people living with *Entamoeba histolytica* infections, and *Giardia lamblia* has infected about 3 million people worldwide [2], [3].

In soil-transmitted helminth (STH) infections, heavy infection with *A. lumbricoides* causes lactose intolerance, Vitamin A malabsorption, intestinal obstruction, and hepatopancreatic ascariasis. *T. trichiura* causes colitis, trichuriasis syndrome, and rectal prolapse, while hookworm causes iron deficiency anemia and protein malnutrition [1], [4], [5]. *G. lamblia* causes diarrhea, malaise, flatulence, greasy stool, and abdominal cramping [6]. The symptoms of *B. hominis* infection are mostly non-specific and include acute and chronic diarrhea, nausea, vomiting, flatulence, abdominal pain, and anorexia [7]. Heavy infections with *E. histolytica* cause fever, abdominal tenderness, vomiting, and bloody diarrhea with 10–20 movements/day [8].

School-aged children represent the group that is the most frequently infected with IPIs compared to other populations [9]. For these reasons, the WHO has recommended the use of deworming programs in primary schools to control the morbidity caused by STH infections. The deworming programs are simple and should be administered to children even without a previous individual diagnosis [10]. In addition, the deworming program using albendazole (single dose, 400 mg) has been shown to decrease the prevalences of *A. lumbricoides*, *T. trichiura*, and hookworm [10], [11]. However, Quihui-Cota and Morales-Figueroa [12] reported that IPIs persisted despite a national deworming campaign in schoolchildren in Northwestern Mexico because albendazole alone was not sufficient to improve the health conditions of the vulnerable population.

Deworming programs, which provide a blanket treatment, are implemented in many countries, including

Indonesia. Jakarta, the capital city of Indonesia, has implemented a deworming program since 1990. This study was conducted in a primary school in Kalibaru subdistrict, North Jakarta, Indonesia, for several reasons. First, because deworming programs have been shown to decrease the morbidity of STH infections [10], the effectiveness of the local program was assessed. Second, although the deworming program is implemented in primary schools, intestinal parasite infections may persistent in areas characterized by poor living conditions and low family income [1], [12]. Finally, IPIs in schoolchildren impact Hb concentrations [13]. Thus, this study aimed to evaluate the effects of the deworming program on IPIs and Hb levels among schoolchildren in Jakarta, Indonesia.

Materials and Methods

Ethical approval

This study obtained ethical approval from the Health Research Ethics Committee of Faculty Medicine (No. 521/UN2.F1/ETIK/VII/2016.), University of Indonesia, Jakarta, Indonesia.

Study design and site

This cross-sectional study was conducted in a primary school, SDN Kalibaru 09, located in Kalibaru Subdistrict, North Jakarta. Jakarta is located in Jakarta Province, and Jakarta is the capital city of Indonesia.

Demographic data

All of the participants, teachers, parents, and schoolchildren were provided with health education by the research team, which included a medical doctor. The health education consisted of the etiology of IPIs, their signs and clinical manifestations, diagnosis, treatment, and prevention of intestinal parasite infections. Furthermore, all of the parents were interviewed by a research team member using a standard questionnaire to obtain their demographic data, including education, occupation, household income, water sources, and the defecation facilities.

Stool examination

In this study, only stool samples collected from the schoolchildren were examined. Stool examinations were conducted using the Kato-Katz method to detect STH eggs and the direct smear method to detect intestinal protozoan cysts. For direct fecal smears, iodine wet mounts were prepared following the WHO procedures [14]. About 2 mg of a stool sample was suspended in Lugol's staining solution and then observed microscopically. The Kato-Katz method was conducted following the WHO procedures as follows. Hydrophilic cellophane strips (40–50 μm thick strips, 25 × 30 cm in size) were cut and immersed in 3% glycerol-malachite green solution for at least 24 h before use. A single thick smear slide was prepared using a 41.7 mg punched plastic template. The total helminth egg count was recorded and then converted to eggs per gram of stool by multiplying the number of eggs per slide by 24.

Hb measurement

Easy Touch GCHb test strips were used to measure Hb following the manufacturer's recommendations for the procedure and interpretation of the results [15]. Briefly, one strip was taken from the vial of hemoglobin (Hb) test strips, and the vial was closed quickly. The test strip was inserted into the test strip slot on the meter. The meter first displayed the code number and then the blood symbol. The lancing device was placed on a finger, and the trigger on the device was pressed. After the lancing device was withdrawn, the first drop of blood was wiped away, and a second one was allowed to form. The drop of blood was placed in the test well of the meter, and a beep sounded when there was a sufficient amount of blood. The meter then counted down from 6, showed the result on the screen, and automatically stored it in its memory. The Hb value was recorded on the provided log sheet.

Statistical analysis

SPSS ver. 20.0 was used to analyze all of the data. Chi-square tests were used to determine whether the prevalence rates of intestinal parasites differed between female or male students and whether intestinal parasites affected Hb levels among schoolchildren [16]. Body weight in kilograms (kg) was measured for all of the schoolchildren using a bodyweight tool. Their height in centimeters (cm) was measured with a body height tool. The body mass index (BMI) was calculated using the BMI formula: Body weight/(body height × body height). Anemia among the schoolchildren was determined following the method described in a previous study [17]. Hb concentrations <11.5 g/dL for those 6–11 years old and 12.0 g/dL for those 12–15 years old were determined as anemia. The study used $p < 0.05$ to indicate statistical significance.

Results

Demographic data of the respondents

A total of 188 respondents (parents) participated in the study, and their data are shown in

Table 1. The respondents' education levels included illiterate, primary school, junior high school, senior high school, and one with higher education, undergraduate. Most of the respondents did not have jobs, working only as homemakers. A total of 179 (94.7%) respondents reported more than 1 US$ per day for household income. They also had latrines in their houses and used various water sources, including wells, pumps, and piped water. Tap water was available in the primary school.

Table 1: Demographic data of the respondents from Kalibaru 09 PG Primary School in North Jakarta, Indonesia

	n	%
Total respondents	188	
Education		
Illiterate	32	17.0
Primary school	83	44.1
Junior high school	39	20.7
Senior high school	33	17.6
Undergraduate	1	0.6
Job		
Not employed	185	98.4
Employed	3	1.6
Income		
1 US$ per day	10	5.3
> 1 US$ per day	178	94.7
Latrine		
No latrine in house	5	2.7
Latrine in house	183	97.3
Water sources (in household)		
Piped	179	91.2
Well	3	1.6
Pump	6	3.2
Water sources (in the primary school)		
Tap water	188	100.0

Prevalence of IPIs

In this study, 219 stool samples were collected from schoolchildren in Jakarta. Identified intestinal parasites included *A. lumbricoides* eggs, *T. trichiura* eggs, *G. lamblia* cysts, *E. histolytica* cysts, *Entamoeba coli* cysts, and *Blastocystis hominis* cysts. Overall, 41 schoolchildren were infected with one or more intestinal parasite; 37 schoolchildren had a single intestinal parasite infection, and 4 schoolchildren had a double intestinal parasite infection (helminth and protozoan infections). The prevalence of intestinal parasites among the schoolchildren was 18.7% (41/219). The prevalences of *A. lumbricoides* and *T. trichiura* were 6.4% (14/219) and 1.8% (4/219), respectively. The prevalences of *G. lamblia*, *E. histolytica*, *E. coli*, and *B. hominis* were 2.8% (6/219), 0.5% (1/219), 0.5% (1/219), and 6.8% (15/219), respectively (Table 2).

The intestinal parasites with the highest frequencies among the schoolchildren in Jakarta were *B. hominis*, *A. lumbricoides*, and *G. lamblia; E. histolytica*, a pathogenic protozoa, was found in only one child. The distributions of intestinal parasites in each grade are presented in Table 2. *A. lumbricoides* infections were found in Grades 4, 5, and 6, while *T. trichiura* infections were found in Grades 4 and 6. *G. lamblia* infections were found in Grades 4, 5, and 6. *E. histolytica* and *E. coli* infections were found only in Grade 6, while *B. hominis* infections were found in Grades 4 and 6. Thus, these results show that schoolchildren in each grade were infected with intestinal parasites.

Table 2: Intestinal parasites among schoolchildren in Jakarta

Grade	Number of samples	Intestinal parasite Al	Tt	Gl	Eh	Ec	Bh
4	92	5.40% (5/92)	1.10% (1/92)	1.10% (1/92)	0.0% (0/92)	0.0% (0/92)	7.60% (7/92)
5	35	14.30% (5/35)	0.0% (0/35)	2.8% (1/35)	0.0% (0/35)	0.00% (0/35)	0.00% (0/35)
6	92	4.30% (4/92)	3.30% (3/92)	3.30% (3/92)	1.10% (1/92)	1.10% (1/92)	8.70% (8/92)
Total	219	14 (6.4%)	4 (1.8%)	6 (2.7%)	1 (0.5%)	1 (0.5%)	15 (6.9%)

Al: *Ascaris lumbricoides*, Tt: *Trichuris trichiura*, Gl: *Giardia lamblia*, Eh: *Entamoeba histolytica*, Ec: *Entamoeba coli*, Bh: *Blastocystis hominis*

Overall, male schoolchildren were more frequently infected with intestinal parasites than female schoolchildren. Of the 41 schoolchildren with a parasite infection, 73.7% (30/41) were male children, while 27.3% (11/41) were female. The male:female ratios of intestinal parasite infections indicated that male children were frequently infected by intestinal parasites than female children (Table 3).

Table 3: Intestinal parasitic infections among male and female schoolchildren in Jakarta

Intestinal parasites	Male	Female	Ratio
Helminth			M/F
Ascaris lumbricoides	8	6	1.33
Trichuris trichiura	3	1	3.0
Protozoa			
Giardia lamblia	5	1	5.0
Entamoeba histolytica	1	0	-
Entamoeba coli	0	1	-
Blastocystis hominis	13	2	6.5
Total	30	11	2.72

Hb concentrations among schoolchildren

Table 4 shows the results for the Hb levels among the schoolchildren. Four schoolchildren infected with *A. lumbricoides* had Hb concentrations (<11.5 g/dL or 12.0 g/dL) that indicated anemia, while only one child infected with *B. hominis* was anemic (< 11.5 g/dL Hb). Regarding infections with the other parasites, no schoolchildren infected with *T. trichiura*, *G. lamblia*, *E. histolytica*, or *E. coli* were found to be anemic. Among the non-infected schoolchildren, the prevalence of anemia was 16.9% (37/219), and the overall prevalence of anemia among the schoolchildren was 19.6%. The 41 intestinal parasite-infected schoolchildren had normal BMI values and no clinical symptoms of intestinal parasites (Table 5). The results of the Chi-square tests indicated that sex was not significantly associated with intestinal parasites among the schoolchildren in Jakarta ($p > 0.05$). However, the species of intestinal parasite was

Table 4: Hb concentrations among schoolchildren

Schoolchildren	n	Hb <12.0 g/dL	Hb >12.0 g/dL
No infection	178	37	141
Infections			
Ascaris lumbricoides	14	4	10
Trichuris trichiura	4	0	4
Giardia lamblia	6	0	6
Entamoeba histolytica	1	0	1
Entamoeba coli	1	0	1
Blastocystis hominis	15	2	13
Total	219	43 (19.6%)	176 (80.4%)

Hb: Hemoglobin

Table 5: Hemoglobin, body mass index, and clinical symptoms of the parasite-positive schoolchildren in Jakarta

Intestinal parasite	Number positive	Hb	BMI	Clinical symptoms
Ascaris lumbricoides	14	11.0–14.4	11.6–24.4	Asymptomatic
Trichuris trichiura	4	12.2–15.6	15.8–24.4	Asymptomatic
Giardia lamblia	6	13.5–15.5	15.4–30.0	Asymptomatic
Entamoeba histolytica	1	13.6	15.4	Asymptomatic
Entamoeba coli	1	14.2	19.2	Asymptomatic
Blastocystis hominis	15	10.5–17.4	13.4–22.2	Asymptomatic

significantly associated with Hb concentrations among infected children ($p < 0.05$) (Table 6).

Table 6: Results of Chi-square tests

Crosstabs	Number of samples	Chi-square tests			
		Pearson Chi-square	Asymp. sig.	Likelihood ratio	Asymp. sig.
Intestinal parasites >< Sex	41	2.942	0.23	3.31	0.191
Type of infection >< Hb	41	33.89	0.204	48.18	0.017

Anemia; Hb concentration <11.5 g/dL for 6–11 years old and 12.0 g/dL for 12–15 years old. Non-anemia; Hb concentration >12.0 g/dL [17].

Discussion

This study was conducted in a primary school in an urban area in Jakarta, Indonesia. Since 2019, the primary school has implemented a deworming program in accordance with the WHO recommendations [10]. After 1 year of the program, this study examined IPIs, including STH and intestinal protozoan infections, among the schoolchildren. *A. lumbricoides* and *T. trichiura* infections were found among schoolchildren who did not exhibit any clinical symptoms. Our findings are line with the previous studies that reported that *A. lumbricoides* and *T. trichiura* were the most common STH infections among schoolchildren [18], [19], [20]. The prevalences of *A. lumbricoides* (6.4%) and *T. trichiura* (1.8%) were lower among the schoolchildren in Jakarta than in India, where the prevalences of *A. lumbricoides* and *T. trichiura* were found to be 8.1% and 3.7%, respectively [21].

Deworming programs do have an impact on STH infections. Many factors are associated with *A. lumbricoides* and *T. trichiura* infections [22]. Dahal *et al*. [20] reported that the age and type of toilet used by schoolchildren were significantly associated with STH infections. Other risk factors that contribute to STH infections are hand washing [19], never undergoing deworming, and lack of a facility for defecation [21]. The present study found that 97.3% of the schoolchildren used a latrine in their homes. In addition, a school deworming program is being implemented in Jakarta. Thus, the deworming program and the presence of latrines in the home resulted in the low prevalences of *A. lumbricoides* and *T. trichiura* among the schoolchildren in Jakarta. A deworming program that uses albendazole (single dose 400 mg) administered once a year can decrease infections with *A. lumbricoides*, *T. trichiura*, and other parasites, but the STHs still persist because albendazole alone is not sufficient to improve the health conditions of vulnerable populations [12]. Another study showed that reinfections with STH occurred among children after treatment with anthelmintic drugs [23].

The deworming program has impacted protozoan infections among schoolchildren in Jakarta. In this study, protozoan infections were examined after 1 year of implementing the deworming program, and the results indicated that the protozoan infections consisted of *G. intestinalis*, *E. histolytica*, *E. coli*, and *B. hominis*. In Tamil Nadu, India, *E. histolytica* (23.2%) and *G. lamblia* (5.2%) were the most common protozoan infections among female schoolchildren [24]. In Nepal, the protozoan infections found among schoolchildren were *E. histolytica* and *G. lamblia* [25]. The prevalence of *G. lamblia* is higher in urban areas than in rural areas. In Tripoli, Lebanon, the prevalence of *Blastocystis* spp. (63%) was higher than those of *Dientamoeba fragilis* (60.6%), *G. duodenalis* (28.5%), and *Cryptosporidium* spp. (10.4%) [26]. Similarly, the present study found that *B. hominis* (6.8%) and *G. lamblia* (2.7%) were the most common protozoan infections among schoolchildren in Jakarta.

Protozoan infections are transmitted through the fecal–oral route. The ingestion of contaminated water or food and person-to-person transmission are the most frequent routes [27]. Several studies have determined that the risk factors of protozoan infections among schoolchildren include contact with family members who are suffering from gastrointestinal disorders [26], suboptimal water quality [28], drinking untreated water [29], drinking water from tanks, and washing hands with only water [30], [31]. In the present study, it was found that schoolchildren who were infected with one or more intestinal protozoa used only the untreated tap water provided in their school for washing their mouths and hands. Moreover, they used untreated water sources from wells, pumps, and piped sources.

A previous study showed that male schoolchildren had higher rates of IPIs than female children. Hailegebriel [31] reported that the prevalences of IPIs were 33.5% and 32% among male and female students, respectively, in Bahir Dar, Ethiopia, while in Jawi town, Northwest Ethiopia, the prevalences of intestinal parasites among male and female students were 51.85% and 45.3%, respectively [32]. Similarly, the present study showed that 73.7% (30/41) of the students infected with intestinal parasites were male and that 27.3% were female. Possible explanations for this difference are that male students more frequently play in contaminated soil and water than female students and that male students have a lower level of awareness of the transmission of intestinal parasites than female students [32].

Overall, the prevalence of Hb concentrations <12.0 g/dL (anemia) among the schoolchildren in Jakarta was 19.6%. In Ethiopia, the prevalence of anemia among schoolchildren was reported to be 23% [33], in Northwest Ethiopia, 33.9% [34], and in Eastern Nepal, 31.6–45.5% [35]. Many factors are associated with anemia in children. For example, Birhanu *et al*. [34] reported that a mother who is illiterate (AOR = 7.5 95% CI = 2.6–16.3), low income (AOR = 4.8 95% CI = 1.3–10.9), stunted growth (AOR = 7.1 95% CI = 2.9–11.9), being underweight (AOR = 5.2 95% CI = 2.1–13.3), intestinal parasite infections (AOR= 5.2 95% CI= 2.1–12.6), and malaria infection (AOR = 8.2 95% CI = 1.8–14.5) was significantly associated with anemia among schoolchildren in Northwest Ethiopia. In the present study, multivariate logistic regression was no performed, but we expect that the IPIs alone are not responsible for the low Hb concentrations among the schoolchildren and that the low education level of the mothers and low family income may contribute the low Hb levels (anemia), in accordance with the previous studies [34].

Conclusion

The most frequently found infections in schoolchildren in Jakarta who have participated in the deworming program were *B. hominis* and *G. lamblia*, whereas *A. lumbricoides* was the most frequently found STH infection. The infections with helminths and protozoa among the schoolchildren were attributed to their washing their mouths and hands with only untreated water from taps, wells, pumps, and piped sources. The low prevalences of *A. lumbricoides* and *T. trichiura* were likely due to the deworming program, which uses a single dose of albendazole. IPIs were associated with the prevalence of low Hb concentrations (anemia) among the schoolchildren.

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