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Soil-Transmitted Helminth Infection in Elementary School Children: An Integrated Environment and Behavior Case Study in Bandungan Sub-District, Semarang District

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Background: Soil-transmitted helminth (STH) infection was commonly found in children. This study aimed to analyze the factors influence to the prevalence of STH infection in elementary school children. **Methods:** This was a cross-sectional study conducted in Bandungan Sub-District. Study subject consisted of 799 children. The subject was 3rd to 6th-grade children from 24 elementary schools, spread in 10 villages of Bandungan Sub-district. Only 637 out of 799 children returned feces samples. The dependent variable of the study was STH infection, which was examined by the flotation method. Independent variable consisted host characteristics and behavior, and environmental characteristics. **Results:** The prevalence of STH was 3.6%, consisted of ascariasis 1.5%, trichuriasis 1.2%, and hookworm 0.9%. The proportion of ascariasis and trichuriasis were higher in male than female, while hookworm was equally distributed in both sexes. Distribution of STH varied according to the village ($p = 0.000$), most cases were found in Candi Village where 5% of its soil was contaminated with TH eggs. Distribution of ascariasis, trichuriasis, and hookworm infection significantly differed by the school ($p = 0.039$, 0.000 , and 0.044 respectively). There was a significant difference of grade and STH infection ($p = 0.043$), playing on the ground and hookworm infection ($p = 0.016$), lack of water container and trichuriasis ($p = 0.000$), and type of water container and trichuriasis ($p = 0.036$). **Conclusion:** Our study concluded that environment and behavior factors must be addressed to support the accomplishment of STH control program.

Keywords: *Ascaris lumbricoides*, *Trichuris trichiura*, Hookworm, Soil-Transmitted Helminths.

1. INTRODUCTION

Soil-transmitted helminth (STH) is an infection of a group of intestinal worms in human,¹ caused by various species of worm parasite, and transmitted through contaminated soil. Main species of STH are *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm (*Necator americanus* and *Ancylostoma duodenale*).^{2,3} More than 1.5 billion (24%) of the world population, in tropic and sub-tropic areas, were infected by STH. The infection is mostly found in Sub-Saharan, America, China, and Asia. Globally, there were 1,221–1,472 million cases of ascariasis, 750–1,050 million of trichuriasis, and 740–1,300 million of hookworm infection.⁴

The population at risk of STH is children. Around 1 billion of school children live in areas with STH transmission.⁵ More than 613 million of them are already infected.⁶ Tropical climate and humidity, poor personal hygiene and sanitation, low level of

education, barefoot, health and nutrition status are all risk factors for STH infection. In children, playing on the ground and poor awareness of health increases the risk of STH.⁷⁻⁹

To control STH infection, World Health Organization (WHO) recommends mass treatment without an individual diagnosis for all children, especially who live in endemic areas. The treatment is implemented annually in an area with 20% prevalence of STH, and twice a year in an area with 50% prevalence. Treatment is expected to reduce morbidity, uses albendazole 400 mg or mebendazole 500 mg. To facilitating implementation, treatment program is integrated to school children, and in 2009 more than 300 million school children received treatment.¹⁰

STH treatment program has been implemented in Semarang District since 2006. Semarang District delivers mass treatment on school children August annually. However, our preliminary study, which was done two months after treatment, showed 2 out of 107 students at Pringapus Elementary School were infected with

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Table I. Behavior and environmental factors influence to the helminth infection.

Variables	N	<i>A. lumbricoides</i>		p	<i>T. trichiura</i>		p	Hookworm		P	STH		p		
		Yes	No		Yes	No		Yes	No		Yes	No			
Age (years old):															
—6	1	0.0	100.0	0.835	0.0	100.0	0.990	100.0	0.0	0.000	100.0	0.0	0.000		
—7	4	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0
—8	86	1.2	98.8		0.0	100.0		0.0	100.0		0.0	100.0		1.2	98.8
—9	197	1.0	90.0		2.0	98.0		0.0	100.0		0.0	100.0		3.0	97.0
—10	223	2.2	97.8		1.3	98.7		2.2	97.8		5.8	94.2			
—11	107	0.9	99.1		0.9	90.1		0.0	100.0		1.9	98.1			
—12	40	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
—13	11	9.1	90.9		0.0	100.0		0.0	100.0		9.1	90.9			
—> 13	4	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
Sex:															
—Male	333	1.8	98.2	0.503	1.8	98.2	0.146	0.9	99.1	0.980	4.5	95.4	0.194		
—Female	340	1.2	98.8		0.6	99.4		0.9	99.1		2.6	97.4			
Grade:															
—Third	216	1.4	98.6	0.649	0.5	99.5	0.327	0.0	100.0	0.204	1.9	98.1	0.043		
—Fourth	98	2.0	99.8		2.0	98.0		1.7	98.3		5.7	94.3			
—Fifth	98	1.0	99.9		1.0	99.0		1.0	99.0		3.1	96.9			
—Sixth	61	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
Village:															
—Bandangan	79	2.5	97.5	0.000	2.5	97.5	0.128	0.0	100.0	0.000	5.1	94.9	0.000		
—Banyukuning	53	0.0	100.0		5.7	94.3		1.9	98.1		7.5	92.5			
—Candi	52	9.6	93.4		0.0	100.0		7.7	92.3		17.3	72.7			
—Duren	58	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
—Jetis	78	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
—Jimbaran	52	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
—Kenteng	78	0.0	100.0		1.3	98.7		0.0	100.0		1.3	98.7			
—Mliilir	88	1.1	99.1		1.1	99.9		0.0	100.0		2.3	97.7			
—Pakopen	59	0.0	100.0		0.0	100.0		1.7	98.3		1.7	98.3			
—Sidomukti	76	2.6	97.4		1.3	98.7		0.0	100.0		2.9	97.1			
Hand washing before meal:															
—No	59	3.4	96.6	0.206	0.0	100.0	0.378	0.0	100.0	0.446	3.4	96.6	0.939		
—Yes	614	1.3	98.7		1.3	98.7		1.0	99.0		3.6	96.4			
Hand washing after defecation:															
—No	17	0.0	100.0	0.608	0.0	100.0	0.647	0.0	100.0	0.692	0.0	100.0	0.692		
—Yes	656	1.5	98.5		1.2	98.2		0.9	99.1		3.7	96.3			
Playing on ground:															
—Yes	330	2.1	97.9	0.181	1.2	98.8	0.956	1.7	98.3	0.016	3.8	96.2	0.749		
—No	343	0.9	99.1		1.2	98.8		0.0	100.0		3.3	96.7			
Barefoot:															
—Yes	616	1.6	98.4	0.332	1.3	98.7	0.387	1.0	99.0	0.454	3.9	96.1	0.129		
—No	57	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
Regular nail cutting:															
—Yes	149	1.3	98.7	0.870	0.0	100.0	0.129	0.7	90.3	0.746	2.0	98.0	0.247		
—No	524	1.5	98.5		1.5	98.5		1.0	99.0		4.0	96.0			
Nail biting:															
—Yes	85	3.5	96.5	0.096	0.0	100.0	0.279	0.0	100.0	0.350	3.5	96.5	0.984		
—No	588	1.2	98.8		1.4	98.6		1.0	99.0		3.6	96.4			
Long nails:															
—Yes	117	1.7	98.4	0.826	1.7	98.3	0.567	0.0	100.0	0.259	3.4	96.6	0.925		
—No	566	1.4	98.6		1.1	98.9		1.1	98.9		3.6	96.4			
Water sources															
—Boreholes	114	0.9	99.1	0.838	0.0	100.0	0.517	1.8	98.2	0.258	2.6	97.4	0.594		
—Wells	296	1.7	98.3		1.4	98.6		1.4	98.6		4.4	95.6			
—Tap water	236	1.7	98.3		1.7	98.3		0.0	100.0		3.4	96.9			
—No water source	27	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0			
Ring well:															
—No	150	2.0	98.0	0.457	0.7	99.3	0.476	0.7	99.3	0.757	3.5	96.5	0.914		
—Yes	426	1.2	98.8		1.4	98.6		0.9	99.1		3.3	96.7			
Water container:															
—Yes	647	1.5	98.5	0.539	0.8	99.2	0.000	0.9	99.1	0.636	3.2	96.8	0.017		
—No	24	0.0	100.0		12.5	87.5		0.0	100.0		12.5	87.5			
Type of water container:															
—Bath	539	1.5	98.5	0.984	0.7	99.3	0.032	1.1	98.9	0.220	3.3	96.7	0.525		
—Bucket	134	1.5	98.5		3.0	97.0		0.0	100.0		4.5	95.5			

Table I. Continued.

Variables	N	<i>A. lumbricoides</i>			<i>T. trichiura</i>			Hookworm		P	STH		
		Yes	No	p	Yes	No	p	Yes	No		p		
Latrine:													
—Yes	645	1.6	98.4	0.522	1.1	98.9	0.203	0.9	99.1	0.621	3.6	96.4	0.940
—No	28	0.0	100.0		3.8	96.2		0.0	100.0		3.8	96.2	
Floor:													
—Ceramic	436	1.6	98.4	0.490	1.1	98.9	0.267	1.1	98.9	0.775	3.9	96.1	0.842
—Cement	163	1.2	98.8		0.8	99.2		0.6	99.4		2.5	97.5	
—Soil	51	0.0	100.0		3.9	96.1		0.0	100.0		3.9	96.1	
—Other	21	4.8	95.2		0.0	100.0		0.0	100.0		4.8	95.2	
Yard:													
—Yes	533	1.9	98.1	0.102	1.5	98.5	0.145	1.1	98.9	0.207	4.5	95.5	0.011
—No	140	0.0	100.0		0.0	100.0		0.0	100.0		0.0	100.0	

STH. This study was implemented in Bandungan Sub-District, a peri-urban area of Semarang. This study refers to the previous study that showed peri-urban areas had higher prevalence of ascariasis and trichuriasis compare to urban or rural.⁵ This study aimed to analyze factors influence the prevalence of STH infection in elementary school children.

2. METHOD

This study was a cross-sectional study conducted in Bandungan. The subject was 3rd to 6th-grade children from 24 elementary schools, spread in 10 villages of Bandungan Sub-district. We distributed 1,000 bottle containers to collect feces sample proportionally in each school. Among children who received a bottle, 799 agreed to be interviewed, and 637 out of 799 children handed over feces samples.

The dependent variable of the study was STH infection, which was examined by the flotation method. Independent variable consisted host characteristics (age, sex, school grade, washing hand, playing on the ground, nail hygiene, footwear, food hygiene) and environmental characteristics (village distribution, school distribution, the source of drinking water and its sanitation, latrine, septic tank).

STH infections (ascariasis, trichuriasis, and hookworms infection) were determined by microscopic examination using NaCl flotation method. Age, sex, and school grade were collected from secondary data in the school database. Behavior determinants were obtained through questionnaire and observation list, as well as environmental determinants. Data was analyzed by chi-square test.

3. RESULTS

Six months after treatment, the prevalence of STH was 3.6% (24 cases), consisted of ascariasis 1.5% (10 cases), trichuriasis 1.2% (8 cases), and hookworm 0.9% (6 cases). A high proportion of STH and hookworm infection was found in 6 and 10 years old subjects ($p = 0.000$), while age distribution of ascariasis and trichuriasis spread evenly ($p = 0.835$ and 0.990 respectively). According to distribution by sex, we found no difference in STH infection between sexes. The proportion of STH infection was highest in children of 4th grade, followed by 5th and 3rd grade. There was a significant difference of STH infection between grades ($p = 0.043$). The proportion of STH infection was mostly found in Candi Village, and differ significantly ($p = 0.000$).

Most subjects showed good behavior regarding hand wash, use of footwear, and nails maintenance. The proportion of subject who washed their hands before a meal was higher than those did not, although no significant difference was found ($p = 0.206$). Surprisingly, our study showed all cases (ascariasis, trichuriasis, hookworm, and STH infection) were found in a subject who claimed to wash their hands after defecation, but the difference was not significant. Subjects who like playing on the ground were slightly less than those who did not. Playing on the ground was related to hookworm infection ($p = 0.016$), but not to ascariasis and trichuriasis. On the other hand, not wearing footwear did not differ between the subject with and without infections. However, the proportion of subjects not wearing footwear showed they were more likely to get infected with STH.

As to environmental factors, most subjects lived in houses equipped with a water source and latrine. Most infection of STH was found in a subject who used well as a water source. Our study showed no difference of infections according to the existence of water source. However, STH infection ($p = 0.017$) and trichuriasis ($p = 0.000$) differed by the existence of water container. Trichuriasis was more often on the subject who stored water in a bucket (3.0%) compared to bath (0.75%).

The proportion of ascariasis, trichuriasis, hookworm, and STH infection was all higher in a subject with the distance between well and septic tank ≤ 10 m. But there was no significant difference found in STH infections between distance ≤ 10 and > 10 m. The similar feature was also shown in the presence of yard. A Higher proportion of ascariasis, trichuriasis, hookworm, and STH infection were found in subject lived in a house with yard compared to without it. The differences were not significant for ascariasis ($p = 0.102$), trichuriasis ($p = 0.145$), and hookworm infection ($p = 0.207$), and only significant in STH infection ($p = 0.011$).

4. DISCUSSION

Our result showed after six months of treatment; reinfection occurred in 3.6% school children. For reasons not well understood, school-aged children tend to harbor the greatest numbers of intestinal worms.¹ In this study, the prevalence of *A. lumbricoid* infection was 1.5%, *T. trichiura* infection 1.2%, and hookworm infection 0.9%. Therefore, the current STH control program with annual mass treatment in elementary school can be continued. In endemic areas where the prevalence of STH infections is above 10%, biannual treatment might be implemented.¹¹

However, it took at least three round of mass treatment to reduce prevalence of ascariasis.¹²

Several studies summarized in a systematic review and meta-analysis concluded reinfection started to occur in three months after treatment. Indeed, 6 months after treatment, the prevalence of ascariasis, trichuriasis, and hookworm reached or exceeded half the initial level.¹¹ Unfortunately, our study did not measure baseline prevalence before treatment. Thus, it became a limitation of this study.

The result showed the prevalence of ascariasis, trichuriasis, hookworm infection, and STH infection, in general, was higher in male than female. This result was by previous studies around the world.^{6,13,14} We found most cases of STH presence in Candi Village. Clustering individuals exists for most diseases caused by infection with a helminth, including ascariasis and trichuriasis.¹

The majority of the children had irregular nail hygiene, used wells as a water source, and lived in rural area with the presence of yard around their houses. Around half of the children liked playing on the ground, with the distance between well and septic tank ≤ 10 m. These factors could contribute to the prevalence of STH observed among schoolchildren living in the study area,⁶ after they received treatment.

Hand washing was not a factor related to STH infection in our study. This study was in accordance with previous studies that revealed neither hand washing before meal nor after defecation had a significant effect on reducing reinfection after mass drug administration for SAC.^{13,15} Playing on the ground, on the contrary, was related to hookworm infection ($p = 0.016$), although not to ascariasis and trichuriasis. Transmission of *A. lumbricoides* and *T. trichiura* are ingestion of infective eggs through hand of food, while transmission of hookworm occurs directly when skin contact with soil.^{2,3}

Our study showed the majority of children used wells as a water source. All of them kept the water in a container (bath or bucket). The presence of water container, if not properly treated, might be contaminated. A previous study revealed children living in households where their water storage vessel had a cover had a reduced prevalence of any STH infection compared with children living in households where the vessel was not properly covered (PR = 0.75; 95%CI 0.58–0.96).¹⁶ The presence of water container should receive attention, especially when the children lived in a house with front or back yard. As revealed in our study,

5% of soil sample were contaminated by eggs, and the presence of yard significantly related to STH infection ($p = 0.011$).

Limitation of our study was regarding to the possible impact of potential confounders since the analysis only used chi-square test.

5. CONCLUSION

Our study showed age, grade, residence village, existence and type of water container, habit of playing on the ground, and the existence of yard are among risk factors of STH infections. Environment and behavior factors must be addressed to support the accomplishment of STH control program.

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