Paediatrica Indonesiana

p-ISSN 0030-9311; e-ISSN 2338-476X; Vol.57, No.6(2017). p. 295-302; doi: http://dx.doi.org/10.14238/pi57.6.2017.295-302

Original Article

Risk factors of soil-transmitted helminth infection among elementary school students

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Abstract

Background Helminth infection remains a health problem, especially in school-aged children. Mass eradication programs with a single dose of anti-helminthic drugs were employed by the local government in some endemic areas in Bali. However, the effectiveness of the programs has not been well evaluated.

Objective To investigate prevalence and possible risk factors of helminth infection, including nutritional status, in elementary school students from endemic areas who participated in mass eradication programs.

Methods This cross-sectional study involved 126 students from Elementary School No. 3 Gegelang, Karangasem, Bali, a location that had recently undergone a mass eradication program. Diagnoses were based on direct smear examination of fecal specimens. Information on suspected risk factors and nutritional status were collected by questionnaire and anthropometric measurement, respectively. Statistical analyses included Chi-square and odds ratio, using *SPSS v21 software*.

Results The prevalence of helminth infection was 31.7% with etiologies of *Trichuris trichuria* (75%), *Ascaris lumbricoides* (17.5%), or both infections (7.5%). Habits of not using footwear [OR=4.88; 95%CI 1.15 to 20.65], not keeping nails trimmed [OR=3.33; 95%CI 1.07 to 10.37], and absence of a proper toilet [OR=4.31; 95%CI 1.93 to 9.64] were found to be significant risk factors for helminth infection. However, we found no significant association between helminth infection and nutritional status, although a considerable number of students had less than normal reference values, in terms of weight, height, and BMI for age.

Conclusion The prevalence of helminth infection continues to be high, with personal hygiene and sanitation as significant risk factors. History of mass eradication programs did not confer an effective protection against helminth infection. **[Paediatr Indones. 2017;57:295-302 ; doi: http://dx.doi.org/10.14238/pi57.6.2017.295-302]**.

Keywords: *helminth infection; soil-transmitted helminth; Trichuris trichuria; Ascaris lumbricoides; school-aged children*

Soil-transmitted helminth (STH) infection is a neglected tropical disease which causes a significant public health burden in developing countries.[1] Among the most common infections, STH affects the poorest and most deprived communities worldwide.[2] The STH is associated with low income, poor personal hygiene and environmental sanitation, limited access to clean water, tropical climate, and low altitude.[3] A 2010 estimate suggested that 438.9 million people were infected with hookworm, 819 million with *Ascaris lumbricoides*, and 464.6 million with *Trichuris trichuria*, with 70% of the cases occurring in Asia.[4] The STH infection, either by single or mixed agents, rarely causes death. However,

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the infection affects nutritional intake, digestion, absorption, and metabolism of the host.[2,5]

The STH predominantly affects school-aged children. Moreover, this population is the most prone to detrimental effects of parasites.[5,6] These effects include nutritional deficiency, anemia, as well as impaired physical growth and mental development.[5] All of these detriments lead to school absenteeism and poor school performance.[1,5] The *World Health Organization* (WHO) advocates anti-helminthic preventive therapy as the main strategy to control such morbidity in countries with high STH endemicity.[7] However, reinfection after successful treatment, especially in the absence of targeted hygiene education and measures to improve sanitation and water supplies, is the major obstacle to mass drug administration programs.[1] Indeed, studies in China have shown that reinfection rates after treatment with albendazole were around 75% and 83%, in 4 and 6 months, respectively.[8,9] In Indonesia, mass drug administration by the local government is a common practice in endemic areas. The program consists of giving a single dose of anti-helminthic to school-aged children every 6 or 12 months. However, effectiveness and reinfection rates of children who received treatment has not been well evaluated.

Nutritional status has a close relationship with infectious disease. Poor nutritional status increases general susceptibility to infection, while infections negatively impact nutritional status.[5,8] This interaction results in a vicious cycle of under-nutrition and infection.[8] Although evidence of increased susceptibility during under-nutrition to STH infection has been inconclusive, it is worth considering nutritional intervention to complement mass drug administration in the future.[8]

Prevalence, risk factors, and nutritional impact of STH infection could vary with localities, therefore, such information is vital to guide policy makers in designing a more focused, preventive approach to control the disease. However, local data regarding this parameter is still lacking, despite the practice of mass drug administration for school-aged children in endemic areas. Therefore, we aimed to estimate prevalence of STH infection, associated risk factors, and nutritional status of students in an area with routine mass drug administration.

Methods

A cross-sectional study was conducted on September 2016 in Elementary School (SD) No. 3 Gegelang, Karangasem Regency, Bali Province. Subjects were collected by total sampling. The 126 participants and their parents provided informed consent. Subjects submitted fecal specimens for examination. This study was approved by the Ethics Committee of Udayana University Medical School, Denpasar, Bali.

Subjects' baseline data were obtained from interviews, questionnaires, and anthropometric measurements. A clean, dry, and leak-proof 60-mL urine pot, pre-labelled with the subject's name and an identification number, was issued to each recruited student. Fecal examination was done by trained analysts using a direct smear (direct wet mount) method, on site, to diagnose STH infection. Body weight (BW) was measured to a 0.1 kg precision, with the child wearing minimal clothing and no shoes. Body height was measured to a 0.1 cm precision, with the child standing up straight.

Nutritional status classification was based on Z-score of body-weight-for-age, height- for-age and BMI-for-age. Height-for-age Z-score was used as an indicator of chronic malnutrition (stunting). Weight-for-age Z-score was used as the general indicator of child general nutritional status (underweight). BMI-for-age Z-score was used as an indicator of the child being too thin for his/her height. Nutritional status was analyzed based on the *WHO 2007* reference chart.[10] Students with Z-scores below −2 standard deviations (SD) of the WHO reference population median values for weight-, height-, and BMI-for-age were considered to be underweight, stunted, or thin, respectively. Z-score cut-off of < -3 SD was considered to be a more severe condition for respective categories.

Finally, demographic information, completed questionnaires, anthropometric data, and test results were analyzed using *SPSS software version 21* (SPSS Inc., Chicago, IL). Chi-square and odds ratio were used to analyze for relationships between STH infection status and suspected risk factors, as well as STH infection status and nutritional status. Logistic regression was used to calculate adjusted odds ratios and corresponding 95% confidence intervals for those variables revealed to be significantly associated by

Chi-square analysis. Results were considered to be statistically significant for P values <0.05.

Results

Subjects were recruited from Elementary School No. 3 Gegelang, Karangasem, Bali. The school location is about 42 kilometers northeast of Denpasar. A total of 126 students completed interviews, weight and height measurements, and provided fecal specimens. There were 67 (53.2%) males and 59 (46.8%) females. Students ranged in age from 6 to 16 years. Subjects' characteristics are shown in **Table 1**.

The mean body weight and height of STH-infected subjects were lower than those of uninfected subjects, although statistically insignificant with P values of 0.85 and 0.37 respectively. Meanwhile mean BMI was higher in STH-infected than uninfected subjects, although it is also statistically insignifant (P=0.64) (**Table 1**). Forty (31.7%) students were infected with at least one type of intestinal parasite. Thirty (75%) infected subjects were positive for Trichuris trichuria infection only; 7 (17.5%) subjects were positive for Ascaris lumbricoides only; and 3 (7.5%) subjects were positive for mixed infection with both species. Infected students were distributed roughly equally in every age group (**Figure 1**) and

Table 1. Characteristics of subjects

Characteristics	STH infected (n=40)	Uninfected (n=86)	All subjects (N=126)
Mean age (SD), years	9.98 (2.22)	10.15 (1.77)	10.1 (1.9)
Gender, n(%)			
Male	26 (38.81)	41 (61.19)	67 (100)
Female	14 (23.73)	45 (76.27)	59 (100)
Mean body weight (SD), kg	25.89 (7.44)	26.15 (7.03)	26.07 (7.13)
Mean body height (SD), m	129.40 (11.16)	131.08 (9.06)	130.55 (9.76)
Mean BMI (SD), kg/m^2	15.19 (2.29)	14.97 (2.53)	15.04 (2.45)
Infection types, n (%)			
T. trichuria only	30 (75)	-	30 (75)
A. lumbricoides only	7 (17.5)	-	7 (17.5)
Mixed	3 (7.5)	-	3 (7.5)

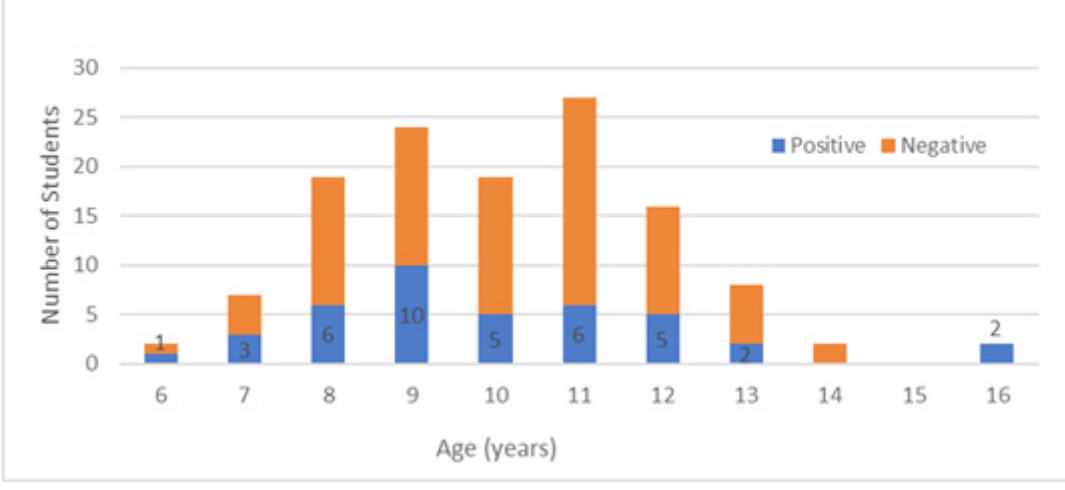

Figure 1. Age distribution of infected students

more boys than girls had STH infection. However, no significant differences were found with regards to age and sex between the infected and uninfected students.

Possible risk factors for STH infection were also analyzed. Chi-square analysis revealed significant relationships between the prevalence of intestinal parasite infection and the following variables: not

Table 2. Suspected risk factors for STH infection

Variables	STH-infected (n=40)	Uninfected (n=86)	P value	Crude odds ratio (95%CI)
Gender				
Female	14 (23.7)	45 (76.3)		1
Male	26 (38.8)	41 (61.2)	0.085	2.03 (0.94 to 4.43)
Hand washing before meals				
Yes	40 (31.7)	86 (68.3)		-
No	0	0		-
Handwashing method				
Water+soap	38 (31.1)	84 (68.9)		1
Water only	2 (50)	2 (50)	0.59	2.21 (0.3 to 16.29)
Handwashing after defecation				
Yes	37 (30.6)	84 (69.4)		1
No	3 (60)	2 (40)	0.33	3.41 (0.55 to 21.23)
Handwashing method after defecation				
Water+soap	34 (29.8)	80 (70.2)		1
Water only	6 (50)	6 (50)	0.19	2.35 (0.71 to 7.82)
Playing with or on soil frequently				
No	23 (32.4)	48 (67.6)		1
Yes	17 (30.9)	38 (69.1)	1	0.93 (0.44 to 1.99)
Eating while playing with soil or objects covered with soil particles (n=55)*				
No	16 (32)	34 (68)		1
Yes	1 (20)	4 (80)	1	0.53 (0.06 to 5.14)
Handwashing after playing with soil or objects with soil particles (n=55)*				
Yes	17 (30.9)	38 (69.1)		1
No	0	0		-
Always using footwear outdoors**				
Yes	34 (29.1)	83 (70.9)		1
No	6 (66.7)	3 (33.3)	0.03	4.88 (1.15 to 20.65)
Playing outdoors without footwear				
Yes	27 (36)	48 (64)		1
No	13 (25.5)	38 (74.5)	0.25	0.61 (0.28 to 1.37)
Cutting nails once per week**				
Yes	32 (28.6)	80 (71.4)		1
No	8 (57.1)	6 (42.9)	0.05	3.33 (1.07 to 10.37)
Nail-biting behavior				
No	33 (32)	70 (68)		1
Yes	7 (30.4)	16 (69.6)	1	0.93 (0.35 to 2.47)
Availability of proper toilet at home**				
Yes	18 (21.2)	67 (78.8)		1
No	22 (53.7)	19 (46.3)	0.0001	4.31 (1.93 to 9.64)
History of anti-helminthic drug consumption within the 2 weeks prior to the study				
Yes	38 (30.9)	85 (69.1)		1
No	2 (66.7)	1 (33.3)	0.24	4.47 (0.39 to 50.85)

* Only 55 students gave answers to "Playing with soil or on soil frequently"
** Significant result was found

using footwear outdoors, no weekly habit of cutting nails, and lack of an available and proper toilet at home (**Table 2**). Children who did not use footwear outdoors [OR 4.88; 95%CI 1.15 to 20.65] and/or did not routinely cut their nails weekly [OR 3.33; 95%CI 1.07 to 10.37] had a higher chance of STH infection than children who used footwear outdoors and cut their nails weekly. The strongest association with STH infection was the lack of an available and proper toilet at home [OR 4.31; 95%CI 1.93 to 9.54]. Further multivariate analysis revealed that only the last variable was significantly associated with STH infection [adjusted OR = 3.94; 95%CI 1.72 to 8.98].

Assessment of individuals' weight-, height-, and BMI-for-age were compared to the WHO population growth chart (**Table 3**).[10] We found that 39.4% of subjects less than 10 years old were underweight; 25.4% of all subjects were stunted; and 30.2% fell within the range of thin to severely thin. Bivariate analysis of STH infection status and each nutritional parameter revealed no significant associations (**Table 4**).

Table 3. Nutritional parameters of the subjects

Parameters	
Weight-for-age category based on WHO Z-score, n (%)	(N=71)*
Severely underweight (<-3 SD)	9 (12.7)
Underweight (-3 SD to < -2SD)	19 (26.8)
Normal weight for age (≥-2 SD)	43 (60.6)
Height-for-age category based on WHO Z-score, n (%)	(N=126)
Severely stunted (<-3 SD)	6 (4.8)
Stunted (-3 SD to < -2SD)	26 (20.6)
Normal height for age (≥ -2 SD)	94 (74.6)
BMI-for-age category based on WHO Z-score, n (%)	(N=126)
Severe thinness (<-3 SD)	15 (11.9)
Thinness (≥ -3 SD to < -2SD)	23 (18.3)
Normal BMI for age (≥ -2 SD to ≤ +1 SD)	79 (62.7)
Overweight (> +1 SD to ≤ +2 SD)	6 (4.8)
Obese (> +2 SD)	3 (2.4)

*n=71 (WHO weight-for-age reference data not available beyond age 10)

Table 4. Comparison of nutritional parameters in STH-infected and uninfected subjects

Parameter	STH-infected	Uninfected	P value
Weight-for-age*, n (%)	(n=25)	(n=46)	
< -2 SD	8 (11.3)	20 (28.2)	
≥ -2 SD	17 (23.9)	26 (36.6)	0.448
Heigh-for-age, n(%)	(n=40)	(n=86)	
< -2 SD	12 (9.5)	20 (15.9)	
≥ -2 SD	28 (22.2)	66 (52.4)	0.510
BMI-for-age, n(%)	(n=40)	(n=86)	
< -2 SD	11 (8.7)	27 (21.4)	
≥ -2 SD	29 (23)	59 (46.8)	0.835

*n=71 (WHO weight-for-age reference data not available beyond age 10)

Discussion

Children are the most vulnerable population group for parasitic infections, due to their low level of immunity, frequent contact with soil and other potentially contaminated materials, and lack of understanding the importance of hygiene and health standards.[11] In our study, the overall prevalence of STH infection in school-aged children was relatively high at 31.7%. This result was higher than the 25.7% reported by Siregar,[12] but lower than the 38.57% prevalence in Baturiti, Tabanan.[13] However, a study in Telaga village, near Gegelang, reported that 68.41% of SDN 1 Telaga students and 83.87% SDN 2 Telaga students were infected with Ascaris lumbricoides as the predominant agent.[14] Differences in prevalence can be caused by several factors, such as time of research, geographical location, as well as cultural, social, or economic reasons.[11]

Personal hygiene consisting of hand-washing and outdoor play habits are known to be significant factors on the incidence of STH.[15,16] Another risk factor associated with helminth infection is nail hygiene, because the nails can mediate the entry of worm eggs into the human body. The fingernails can hide soil that contains microorganisms or eggs, and are often difficult to clean.[17] However, by interview, most subjects reported good handwashing practice, routine nail trimming, and outdoor footwear usage. Since not cutting nails once per week was significantly associated with helminth infection, we should emphasize the importance of nail hygiene by periodic trimming.

Playing on the ground is also a risk factor for STH infection, since soil contaminated with feces can be a source of intestinal helminth infections.[18] Samad reported a relationship between soil contamination by *Ascaris lumbricoides* eggs and infection in elementary school children in the Tembung subdistrict of Medan.[19] Also, Sumanto found that the habit of playing on the ground increased the odds of STH infection (OR 5.2).[20] In our study, no significant association was observed between the habit of playing with/on soil environment and STH infection. But we did find a significant difference between groups with regards to footwear usage. Similarly, Maryanti (2006) found that not using footwear was associated with STH infection (OR 8.8), but Sumanto (2010) found no significant results.[20,21]

Improper sanitation is the dominant risk factor for STH infection.[22] We noted that 55% of infected subjects had no proper toilet at home (*vs.* 22% of uninfected subjects), and it was the only significant factor in the multivariate analysis. A previous study found that children who defecated in toilets had a lower prevalence of STH infection compared to children who defecated outdoors, due to soil/environmental pollution by feces containing worm eggs.[21] In our study, more than half of infected subjects did not have toilet at home. This factor was the most significant one related to STH infection. People who lack a proper toilet habitually defecate on the open ground or in the river. As such, recurrent infection can occur as helminth eggs are deposited in the soil, where they develop before becoming infectious and continue their life cycle.[23]

This study was borne out of a suspicion that the mass eradication program was ineffective, since almost all of the children had received drugs in recent weeks before the study. While the *WHO* recommends mass eradication by albendazole (400 mg) or mebendazole (500 mg) as effective, inexpensive, and easy to administer by non-medical personnel (e.g., teachers), a high prevalence of STH infection persists, particularly for *T. trichuria*. Similarly, a Honduras study reported this problem.[24] Possible reasons for this finding are that the helminths were drug-resistant or that patients received an inadequate dose of anti-helminthic drugs. The predominance of *T. trichuria* as the infectious helminth in our study may related to the fact that a single dose of albendazole used in the mass drug administration program is not adequate for eradication. In fact, the efficacy of short course cure rates with albendazole for *T. trichuria* was only 28%, which is fairly low compared to 88% for Ascaris.[25,26] Even the WHO recently recommended using 400 mg albendazole for 3-7 days for *T. trichuria* treatment.[27,28] However, this hypothesis needs further study specifically designed for a larger number of subjects.

In terms of nutritional status, a considerable proportion of our subjects were within less than normal WHO reference values for growth and nutrition. This trend is common for the Indonesian population, albeit, the values were slightly lower than average compared to those reported in the 2013 Indonesian Health Survey (*Riskesdas*).[29] The proportion of children suffering chronic undernutrition (as measured by stunting) was 25.4% in our study. However, the proportion of general undernutrition (as measured by thinness) was 30.2% in our subjects. Both fall roughly within corresponding data from the average population, with exception to weight-for-age, since no published data was available. As mentioned, we aimed to discern potential associations between STH infection and subjects' nutritional status (stunting, underweight, and thinness), but we observed no such associations. Therefore, STH infection was not associated with increased odds of stunting, thinness, or underweight in this study.

Our study had several limitations. Due to the cross-sectional design, we could not determine causal relationships between observed risk factors and STH infection. The direct smear method also may not detect mild infections.[30] Moreover, since only a single stool specimen was collected from each student, there might be significant underestimation of the prevalence of STH because of the temporal variation in egg excretion over hours and days.[31] Consequently, the underestimation may not truly reflect a lack of association between STH infection and nutritional status.

In conclusion, we find a high prevalence of intestinal parasite infection in a school within an area following a mass eradication program. Furthermore, absence of a toilet, no routine nail trimming, and no outdoor footwear usage are found to be associated with STH infection. However, there is no association between STH infection and nutritional status. As a

recommendation, regular STH monitoring, sanitary improvement, and de-worming programs are necessary to reduce the load of infection and effectively minimize eggs being deposited into the environment. These steps may subsequently decrease the rate of recurrent infections. Future study involving a larger sample size and more schools is warranted.

Acknowledgements

We would like to thank the 2016 Pelayanan Kesehatan dan Penelitian Committee who helped to organize the place, time, and opportunity to conduct this study. In addition, we thank Agus Rendy for critical suggestions on the study design and the manuscript, as well as Komang Widianingsih for technical assistance.

Conflict of Interest

None declared.

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