

Footwear as a risk factor of hookworm infection in elementary school students

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ABSTRACT

BACKGROUND

In Indonesia, there is still a high prevalence of hookworm infection, especially in poor areas with poor sanitation. The number of helminthic diseases in Keerom Regency was about 599 cases in 2010. This number is bound to increase due to the low sanitation, hygiene and socio-economic status of the people in the regency. The children are a group at risk for contracting infections, especially intestinal worms, which affect the child's physical growth and intelligence. The objective of this study was to determine the risk factors of hookworm diseases in elementary school students.

METHODS

A cross-sectional study was conducted on 224 elementary school students. Demographic data were obtained by questionnaire, comprising gender, parental socio-economic status, household sanitation, and personal hygiene. Body mass index was calculated by measurement of body weight and height. And hemoglobin concentration was measured using a Quick Check Hb-meter. Stool samples were microscopically examined using the Kato-Katz method. We used chi-square and logistic regression to find predictors of hookworm infections, with level of significance at $p < 0.05$.

RESULTS

The number of hookworm infection was 6.7% and the risk factor of hookworm infection among elementary school students was the habit of using footwear outdoors [OR 5.3; 95% CI 1.7-17.7; $p = 0.004$].

CONCLUSION

The use of footwear outdoors was a predictor of hookworm infections in elementary school children. An effective and efficient intervention program is needed to prevent and eradicate hookworm infection among primary school children.

Key words: Hookworm, sanitation, hygiene, anemia, primary school children

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Penggunaan alas kaki sebagai faktor risiko infeksi cacing tambang pada murid sekolah dasar

ABSTRAK

LATAR BELAKANG

Prevalensi infeksi cacing tambang di Indonesia masih cukup tinggi terutama di daerah miskin yang memiliki sanitasi lingkungan yang buruk. Jumlah kasus kecacingan di Kabupaten Keerom yaitu 599 kasus pada tahun 2010, dan tentunya kasus ini akan bertambah mengingat sanitasi, higiene dan status sosial-ekonomi masyarakat rendah. Anak-anak merupakan kelompok berisiko untuk tertular infeksi cacing yang berdampak pada pertumbuhan fisik dan intelegensia anak. Penelitian ini bertujuan untuk menentukan prevalensi dan faktor risiko infeksi cacing tambang pada murid sekolah dasar (SD)

METODE

Desain penelitian potong lintang (cross sectional) mengikut sertakan 224 murid SD. Pengambilan data demografi menggunakan kuesioner meliputi jenis kelamin, status sosial ekonomi orang tua murid, sanitasi lingkungan rumah, higiene murid pengukuran antropometri untuk mengukur status gizi dan kadar hemoglobin (Hb) menggunakan Quick Chek Hb-meter. Spesimen tinja diperiksa menggunakan metode Kato-Katz. Analisis data menggunakan statistik bivariat (Chi Square) dan regresi logistik untuk menentukan variabel prediktor.

HASIL

Jumlah infeksi cacing tambang sebesar 6,7% (n=224). Hasil analisis regresi logistik menunjukkan faktor prediktor terjadinya infeksi cacing tambang adalah kebiasaan menggunakan alas kaki saat bermain di luar rumah dan sekolah [OR 5,3; (95% KI 1,7-17,7); p=0,004].

KESIMPULAN

Kebiasaan menggunakan alas kaki saat diluar rumah merupakan faktor risiko infeksi cacing tambang pada murid SD di Kabupaten Keerom. Diperlukan suatu intervensi yang efektif dan efisien untuk mencegah dan memberantas infeksi cacing tambang

Kata kunci: Cacing tambang, sanitasi, higiene, anemia, murid Sekolah Dasar

INTRODUCTION

Infection by soil transmitted helminths (STH) is a neglected tropical disease caused by worms of the species *Ascaris lumbricoides*, *Ancylostoma duodenale*, and *Trichuris trichiura*. Soil transmitted helminth infection depends on socio-economic conditions and is frequently found among children in developing countries. A high prevalence of STH infection is found in poor village areas, with poor sanitation and hygiene, where there are no toilets, allowing pollution of the soil with infective worms.^(1,2) Hookworm infection is a soil transmitted

helminthiasis because it needs soil in the growth process of the worm larva to become infective (filariform larva).⁽³⁾ Man is the sole host for hookworm (*A. duodenale* and *N. americanus*), since these worms do not have an intermediate host. The hookworm infection is known as ancylostomiasis (for infection with *A. duodenale*) and as necatoriasis (for infection with *N. americanus*). Hookworm infection is a symptomless chronic infection that can cause microcytic hypochromic anemia.⁽⁴⁾

Hookworms infect humans by way of infective (filariform) larvae which penetrate the skin (through the sides of toes and the skin pores

of legs and hands).⁽³⁾ Children and gardeners are at risk of hookworm infection, because children like to play with soil and frequently do not use footwear when outdoors, and gardeners are exposed to filariform larvae if they do not wear boots or gloves when working in the garden.⁽²⁾

Soil transmitted helminth infection occurs in almost all parts of the world. It is estimated that about 2 billion people are infected by these parasitic worms. Generally, this disease is found among poor people with poor environmental sanitation. The World Health Organization (WHO) estimates that 250 million people are infected by ascariasis, 151 million by hookworm, 100 million by strongyloidosis and 45.4 million by trichuriasis.⁽⁵⁾ School-age children are at high risk of becoming infected by this contagious disease.⁽⁶⁾ The factors of poverty, environmental sanitation, and immunity also contribute to infection by these worms through soil. The detrimental effects of these parasitic and contagious worms can be various and harmful, such as impeding physical growth of the children, disturbing their activities, and decreasing their ability to receive lessons at school. The chronicity of these infections can decrease the quality of human resources.⁽⁷⁾

In Indonesia, soil transmitted helminthic infections pose health problems in urban and semi-urban areas with low socio-economic level, poor environmental sanitation, and poor hygiene. Generally, the data on the prevalence of worm infections in Indonesia depend on geography, climate, human behavior, level of education, and personal hygiene. The tropical climate of Indonesia substantially supports the growth of the hookworm, as the high humidity, light intensity, and rainfall influence the process of the eggs maturing to become infective larvae.⁽⁸⁾

Keerom Regency is a region in the Papua Province of Indonesia with a surface area of 9.365 km². Its geographic location is between longitude 140° 15' 00" - 140° 0' 0" E and latitude 2° 37' 00" - 4° 00' 00" S.⁽⁹⁾ It also has a tropical climate

with high rainfall, annual average temperatures of 30.5°C - 35.1°C, 80-89% humidity, consisting for 99.9% of soft soils and 0.42% peaty soils, with soil pH values between 5.0 – 8.3.⁽¹⁰⁾ The geographic condition and physical environment substantially supports the spread of hookworm infection through soil.^(3,11) The number of helminths found in the Regency in 2011 was about 1.2%.⁽⁹⁾ The prevalence of hookworm infection has a high probability of increasing, based on the traditional lifestyle of the local farmer community, poor environmental sanitation, and the existence of people who still defecate in gardens or near their homes. The aim of this study was to estimate the prevalence of hookworm infection among elementary school students and identify the risk factors affecting this infection.

METHODS

Research design

The present study used a cross-sectional analytic observational design and was conducted in the Arso District, Keerom Regency, Papua Province, from September until December 2012.

Research subjects

The research subjects were third- and sixth-grade elementary school students meeting the inclusion and exclusion criteria, and having signed a statement agreeing to join the research (informed consent). The three largest elementary schools in the area were selected for the study, comprising Inpres Elementary School 01 Arso I, Inpres Elementary School 02 Arso I and Inpres Elementary School PIR I. The sample size for this study was calculated by using the single proportion formula at 95% confidence interval (CI) level ($Z(1-\alpha/2) = 1.96$), an expected prevalence of 19.4 % and 5% marginal error.⁽¹²⁾ The calculated total sample size was 241 students. However, the total number of students joining the research, filling the questionnaire and delivering their stool samples for examination, was 224.

Data collection

A structured questionnaire was distributed among the participating pupils for the collection of demographic information, such as age, gender, socio-economic status of their parents, household sanitation, and personal hygiene. The items on parental socio-economic status were educational level, occupation, and income of the parents. On the subject of sanitation, the questions asked were type of toilets, location of toilets, and main water source of household. Personal hygiene questions comprised habitual use of footwear when playing, using soil as medium for playing, the habit of washing hands before eating, and the habit of washing hands after defecating. Body weight (kg) was measured to the nearest 0.1 kg using Omron digital scale and height body (cm) was measured to the nearest 0.1 cm using a microtoise. The children were measured wearing light uniforms, without shoes, belts, caps or any other material that could interfere with their actual height and weight. Subjects were categorized as having wasting and normal anthropometric nutritional indices. Wasting was defined as < -2 Weight for Age Z-score [WAZ score].⁽³⁾

Collection of stool samples and laboratory testing

The pupils were educated on the causes of intestinal helminthic infections among school-age children and they were convinced that every child should be free from such infections, thus the necessity of participating in the research work was appreciated by them. Thereafter, wide mouthed corked sterile containers were given to the pupils for the collection of their stool samples at home. The pupils were taught how to collect the stool samples, with the aid of their teachers. The stool samples received from the children were properly labelled and transported in a cold box to the laboratory of the Papua Health and Biomedical Research and Development Institute, Ministry of Health. The samples that could not be analyzed immediately were preserved using 10% formalin until they

could be examined.⁽¹⁴⁾ Stool analysis was performed using the Kato-Katz technique by malachite green staining to detect hookworm eggs. We used microscopic analysis for identification of hookworm eggs. The results were categorized as positive if the Kato-Katz slide contained hookworm eggs. For the determination of the hemoglobin concentration of the pupils, finger-prick blood samples of the pupils were collected and the hemoglobin concentration measured with a rapid test Quick Check Hb meter, using capillary tubes containing 20 μ L of finger prick blood. Subjects were categorized as having anemia if the hemoglobin concentration was < 11.5 g/dL.

Ethical clearance

Ethical clearance for this research was issued by the Medical and Health Research Ethics Committee, Faculty of Medicine, Gadjah Mada University.

Statistical analysis

The data analysis was by descriptive statistics, and differences between two variables were tested by bivariate statistics (chi square and Fisher's test). Statistical significance was considered to be achieved at $p < 0.05$. Logistic regression was performed to identify the predictor factors of hookworm infections.

RESULTS

The distribution of hookworm infection in elementary school students of Arso District on the basis of gender can be seen in Table 1. The number of hookworm cases was found to be greater in male students (7.8%) than in female students (5.8%).

There was a significant relationship between hookworm infection and the habit of using footwear while playing or being outside the house ($p < 0.05$). There was a risk of hookworm infection in elementary school students who did not use footwear when playing outdoors. The result of the logistic regression

Table 1. Distribution of risk factors of hookworm infection in elementary school students

Risk factor	Hookworm infection		Odds ratio (OR)	Confidence interval (CI)	p value
	Positive n (%)	Negative n (%)			
Gender					
Male	8 (7.8)	95 (92.2)	0.729	0.255-2.084	0.554
Female	7 (5.8)	114 (94.2)			
Anemia					
Anemia (>11.5 g/dL)	3 (10.7)	25 (89.3)	0.543	0.143-2.060	0.410
Normal (<11.5 g/dL)	12 (6.1)	184 (93.9)			
Nutritional status					
Wasting (<- 2 SD)	11 (6.2)	167 (93.8)	1.446	0.438-4.769	0.517
Normal (>-2 SD)	4 (8.7)	42 (91.3)			
Type of toilet					
Toilet without septic tank	4 (5.7)	66 (94.3)	1.269	0.390-4.134	0.781
Toilet with septic tank	11 (7.1)	143 (92.9)			
Location of toilet					
Outside the house	17 (17.7)	79 (82.3)	1.749	0.911-3.358	0.091
Inside the house	35 (27.3)	93 (72.7)			
Main water source					
Untreated water (well water, river water, rain water)	12 (8.4)	131 (91.6)	0.420	0.155-1.534	0.177
Treated water (piped water from PAM / bottled water)	3 (3.7)	78 (96.3)			
Type of house floor					
Noncemented floor (soil, board, bamboo)	5 (5.0)	95 (95.0)	1.667	0.511-5.045	0.362
Cemented/ceramic tile floor	10 (8.1)	114 (91.9)			
Parents' educational level					
Low (elementary school, junior high school, senior high school)	11 (6.4)	160 (93.6)	1.187	0.362-3.896	0.777
High (D3, S1, S2, S3)	4 (7.5)	49 (92.5)			
Parents' job					
Non-employee (farmer, trader)	7 (5.4)	122 (94.6)	1.603	0.560-4.584	0.376
Employee (employee of private firm, civil servant)	8 (8.4)	87 (91.6)			
Parents' income					
Low (<Rp 3,000,000)	13 (6.7)	182 (93.3)	1.037	0.222-4.850	1.000
High (> Rp 3,000,000)	2 (6.9)	27 (93.1)			
Habit of using footwear when playing					
Yes	9 (4.6)	185 (95.4)	0.195	0.064-0.595	0.007*
No	6 (20.0)	24 (80.0)			
Using soil as medium for playing					
Yes	5 (9.8)	46 (90.2)	0.564	0.184-1.734	0.341
No	10 (5.8)	163 (94.2)			
Habit of washing hands before eating					
Using water	2 (4.2)	46 (95.8)	1.834	0.399-8.423	0.744
Using water and soap	13 (7.4)	163 (92.6)			
Habit of washing hands after defecating					
Using only water	4 (8.9)	41 (91.1)	0.671	0.203-2.215	0.509
Using water and soap	11 (6.1)	168 (93.9)			

*chi square test (significant if $p < 0.05$); PAM = water purification plant; D3, S1, S2, S3 = tertiary degrees, equivalent to undergraduate diploma, bachelor, master, PhD

was that the predictor of hookworm infection in this study was the habit of using footwear when playing outdoors [OR 5.3; 95% CI 1.7-17.7; $p=0.004$] (data not shown).

DISCUSSION

Examination for hookworm eggs was done by means of the Kato-Katz method, which is a widely used diagnostic stool providing estimates of population prevalence and infection intensity. The accuracy of the Kato-Katz method to detect hookworm eggs was reported by Knopp et al.⁽¹⁵⁾ to be higher than that of the FLOTAC technique. Another study on the accuracy of the Kato-Katz technique for hookworm eggs was done by Funk et al.,⁽¹⁶⁾ who showed that the prevalence of hookworm infection in elementary school students was 6.7%. Similar results were obtained in an Indian study, which found the prevalence hookworm infections to be about 6.3%.⁽¹⁷⁾ In the present study, male children were more infected than females. This is presumably caused by the different playing habits of male and female children, such as walking on the ground without footwear, using soil as medium for playing, playing with balls, jump ropes, and marbles. The children also have the habit of taking off the footwear (shoes) when going home.^(1,2,7) This is in agreement with the results of a study conducted by Unike et al.⁽¹³⁾ in Nigeria, where male children were more infected than females, although the difference in infection rate was not significant. However, contrasting results were obtained in a Malaysian study showing that hookworms were more frequent in female children.⁽¹⁸⁾

There was no significant relationship of hookworm infection effects with nutritional status and anemia. The finding for anemia is similar to that obtained in the Satak Malaysian study, showing no significant association between anemia and hookworm infection.⁽²⁾ In addition, the finding for nutritional status in our study is similar to the results obtained in Pahang, Malaysia, showing no association of nutritional

status with soil-transmitted helminth infection.⁽¹⁹⁾ There is the possibility of finding symptoms of malnutrition in round worm infection of children, while anemia is probably found in children infected by malaria and hookworm.^(11,20) That there is no significant relationship between hookworm infection and anemia may be because generally the number of infected children is smaller, and there are other causative factors of anemia in children, such as nutritional intake. The finding on anemia in our study is also in agreement with that obtained in Turkey of no association between anemia and parasitic worm infections.⁽²¹⁾

Environmental sanitation has an important role in worm infections that are transmitted through the soil, especially hookworm infection,⁽²²⁾ where poor sanitation increases the risk of this infection. The bivariate statistical test results of risk factors in environmental sanitation found no significant relationship with hookworm infection. This is presumably because of the small number of hookworm infection cases in this study, whereas a large number of cases are needed to find relationships at population level. Another study showed that water source and the habit of handwashing with soap were significantly associated with hookworm infection.⁽⁷⁾

The present study found no significant relationship between socio-economic status of the parents and hookworm infection. High educational level of parents does not guarantee that their children are free from hookworm infection. Although parents with high educational level, income, and job status are different from the lower classes of the community, generally all community members have gardening as a side job. Therefore members of the higher class also have direct contact with the soil and their children can be exposed to hookworm infection, because after school they help their parents in the garden.^(1,13,14)

The risk factor of personal hygiene plays an important role in hookworm infection transmission. The bivariate analysis results show

a significant relationship for the risk factor of hygiene, i.e. the habit of using footwear outdoors. The latter habit is very important to avoid exposure to soil polluted by infective (filariform) larvae. The behavior of children of using sandy soil as playing medium has a high risk of this worm infection.^(7,23) This is in contrast with the results of a study conducted by Nasr et al.⁽²⁴⁾ and Kattula et al.,⁽¹⁷⁾ where use of footwear and shoes outdoors was not associated with hookworm infection.

There are several limitations of this study as potential sources of bias. One source may have been the administration of the socio-economic survey forms. The children answered questions about their personal, household, and health behavior characteristics on their own, while the same information was collected about children by asking their parents. Since only a single stool sample per child was collected in this study, using the Kato-Katz preparation to determine infection status, there is presumably a significant underestimation of the infection. This is because a single sample may miss infection in an individual as a result of the temporal variation in egg excretion over hours and days.⁽²⁵⁾ The cross-sectional study did not describe the effects of socio-economic factors on the children's nutritional and parasitic status. A longitudinal cohort study would be necessary to provide information about a community's social, educational, economic and behavioral characteristics.⁽²¹⁾

Our study shows that hookworm infections still pose a significant health challenge to children in the poor rural areas of Papua. Intestinal parasitic infections have detrimental effects on survival, appetite, growth and physical fitness of children. We hope that this study may motivate the government to the deworming of soil transmitted helminths in school-age children and provide educational information for preventing soil transmitted helminth and other intestinal parasite infections. When supporting school health programs, hopefully parents may become involved in deworming and dietary

activities which may increase their care about the importance of health information and education.⁽²¹⁾

CONCLUSION

The prevalence of hookworm infection among elementary school students was 6.7%. The habit of using footwear was a risk factor in transmission of hookworm infection to these elementary school students.

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