

Helminthiasis in school-age children from Gresik, East Java, Indonesia

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Summary

This study aims to investigate the soil-transmitted helminth infection among school-age children in Gresik, East Java, Indonesia. An analytical observational study with a cross-sectional design was conducted from July to November 2023 in selected elementary schools in Gresik, East Java, Indonesia. Logistic regression analysis was employed to assess the impact of each risk factor on the likelihood of infection transmission. A total of 183 school-age children were screened for the occurrence of helminth eggs in their feces. Twenty-two feces samples from 183 children were positive for helminth egg, consisting of 14 children infected by *Ascaris lumbricoides* (6.36 %), 3 children infected by *Trichuris trichiura* (1.304 %), 3 children infected by *Oxyuris vermicularis* (1.304 %), and 3 children infected by Hookworm (1.304 %). The highest prevalence was found in 7-year-old children (31.8 %). Children who pulled off shoes while in school were more likely to be infected with an overall OR of 8.392 (95 % CI 1.63 – 43.65). Children who played in the dumpsite were more likely to be infected with an overall OR of 4.521 (95 % CI 0.578 – 31.28). Children who washed before eating were more likely to be infected with an overall OR of 3.579 (95 % CI 0.587 – 21.835). Therefore, to lessen the prevalence of STHs among school-age children in Gresik, we recommend improving hygiene conditions in schools. The government should prioritize enrolling all primary schools in hygiene classes as the school health program.

Keywords: Helminthiasis; *Ascaris*; neglected tropical disease; children

Introduction

Soil-transmitted helminths are the most common infections that can decrease children's productivity. Around 1.5 billion people globally (24 % of the world's population) were infected with helminths. Helminthiasis frequently occurs in regions with poor hygiene and limited access to clean water, sanitation, and hygiene in tropical and subtropical areas. The number of helminthiasis was highest in sub-Saharan Africa, followed by China, South America, and Asia. Helminthiasis is transmitted by helminth eggs, which

can be found in human feces. Then, it can contaminate the soil around human habitat. The current data shows that helminths infected more than 260 million preschool-age children, and the highest group is school-age children, with the number of 654 million (WHO, 2022).

Some helminth groups include *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis*, *Necator americanus*, and *Ancylostoma duodenale*. The three species that cause schistosomiasis in the latter group are *Schistosoma mansoni*, *Schistosoma haematobium*, and *Schistosoma japonicum* (CDC, 2023).

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Helminthiasis can have various impacts on children and pregnant women. Expectant mothers and fetuses are at risk due to iron deficiency anemia, which is brought on by chronic blood loss and iron store depletion caused by hookworms (Degarege *et al.*, 2022). Iron deficiency anemia and intestinal ulceration result from trichuriasis (Pabalan *et al.*, 2018). Additionally, children's learning, memory, and intelligence deficiencies may result from STH and schistosomiasis (Pabalan *et al.*, 2018).

The outcomes of STH infection may be more severe, especially in immunocompromised children or adults. Iron deficiency and other micronutrients are two long-term impacts of helminthiasis that have been associated, specifically in school-age children (Gitore *et al.*, 2020). Previous studies show that helminthiasis is associated with higher stunting rates, impaired cognition, low productivity, and low academic performance (Pabalan *et al.*, 2018). Some risk factors of helminthiasis have been reported, such as insufficient water supply, poor hygiene practices, low socioeconomic status, living near animals, and living in urban areas (Chopra *et al.*, 2022). Soil-transmitted helminths (STHs) include intestinal nematodes such as *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms (*Necator americanus* and *Ancylostoma duodenale*) that infect humans (Weaver *et al.*, 2010; De Silva *et al.*, 2014). Helminthiasis was classified as one of the neglected tropical diseases by the World Health Organization. Asia accounted for the significant burden of infections, with at least 25 % (26.4 %) of the population believed to harbor at least one STH species (Pullan *et al.*, 2014). Numerous detrimental health effects, including diarrhea, malnutrition, and delayed physical and mental development, can be brought on by STHs. The most severe infections have the most noticeable effects on a child's growth, but mild infections can also cause deficiencies in growth if the community's nutritional status is subpar (Stephenson *et al.*, 2000; Okyay *et al.*, 2004).

According to the World Health Organization (WHO), regular school-based targeted preventive chemotherapy (PC) using albendazole or mebendazole for preschool- and school-aged children is the primary strategy to achieve STH controls (WHO, 2022). The most recent road map for non-communicable diseases (NDDs) released by the WHO aims to eradicate STHs as a public health issue in 96 % of endemic countries by 2030. The definition of elimination as a public health issue is <2 % prevalence of moderate-to-heavy STH infections (Casulli *et al.*, 2021).

Gresik is one of the regions in East Java, Indonesia, that frequently experiences flooding, which can lead to poor hygiene practices. Laboratory examinations are required regularly to diagnose most parasitic diseases, as physical examinations alone are insufficient. This study aims to investigate the occurrence of helminth infection in school-age children in Gresik, East Java, Indonesia.

Material and Methods

Study Design

An analytical cross-sectional study using quantitative and quali-

tative approaches was conducted in Gresik Regency from July to November 2023. The source and study population were randomly selected schoolchildren in six districts in Gresik Regency.

Inclusion and Exclusion Criteria

Children aged between 7 and 12 years old whose parents agreed, signed informed consent or were willing to join as participants were included in this study. Children absent on the day of the school visit or whose parents disapproved of joining this study were dismissed from the study. Children who had immunocompromised disease, received anti-helminthic treatment in the last six months before the sampling period, or had diarrhea in the last three days were excluded.

Sample Size Determination

The minimum sample size was calculated using a cross-sectional formula. The sample size required to estimate the prevalence of STHs was calculated assuming the prevalence of STHs in Gresik Regency was 40 % based on the report from Gresik Health Regency. One hundred eighty-three school-age children were recruited from six districts in Gresik: Sidayu, Duduk Sampeyan, Ujung Pangkah, Cerme, Benjeng, and Balongpanggang.

Stool Collection

Fresh stools were collected into a clean, dry, and labeled tube. The tube was filled with 10 % formalin solution before it was transported. Every study participant was also given information about the procedure of stool collection. Laboratory technicians visited the schools every day for seven days to follow up on stool sample collection. After the collection of stool samples, all were transported to the Bionas Parasitology Laboratory. Direct examinations were conducted by dropping saline and iodine to create a thin, smooth preparation. Then, the smear on the slide was stained with a 2 % eosin solution and covered with a cover glass. When working with deformed and dysenteric specimens, a simple smear was covered with a cover glass without adding any stain or saline (Ubhayawardana *et al.*, 2018). Microscopy examined the samples for the presence of any larvae or helminthic eggs, and the egg size, shape, and other characteristics were closely surveyed.

Data Collection

Each student was interviewed utilizing a structured questionnaire to collect demographic data and risk factors for helminthiasis. Children were asked about their knowledge and hygiene practices. Medical doctors and health analysts conduct interviews in the local language.

Data Analysis

We conducted a cross-sectional study among schoolchildren aged 7 to 12 years old in Gresik Regency to investigate the association between various risk factors and STH infection transmission. Data on risk factors were as follows: playing in the dumpsite, pulling off

Table 1. The number of helminth egg in stool sample from Gresik.

Helminth egg detected	Number of positive sample
<i>Ascaris lumbricoides</i>	13 (7.1%)
Hookworm	3 (1.63%)
<i>Enterobius vermicularis</i>	3 (1.63%)
<i>Trichuris trichiura</i>	3 (1.63%)
Total	22

shoes while at school, washing hands before eating, and washing hands with soap after defecation. All this data was collected through structured questionnaires answered by the study participants. Additionally, information on infection status was obtained through a direct sample examination conducted at the Bionas Parasitology Laboratory. Logistic regression analysis was employed to assess the impact of each risk factor on the likelihood of infection transmission. This statistical method allowed us to calculate odds ratios (OR) and 95 % confidence intervals (CI), measuring the association between each risk factor and infection status.

Ethical Approval and/or Informed Consent

Our study design was approved by the Ethical Committee of Ibnu Sina Gresik Hospital, which has the registered number 071/066/437.76/2023.

Results

Prevalence

From 183 stool samples, 87 were collected from male and 96 from female students. Helminths were found to have a varied prevalence. A single *Ascaris lumbricoides* infection had the highest overall prevalence at 7.1 % (13/183). The total prevalence of mixed infections where *Ascaris lumbricoides* and *Trichuris trichiura* positive samples were observed was 7.65 % included. This was further followed by *Trichuris* (1.63 %; 3/183), *Enterobius vermicularis* (1.63 %; 3/183), and hookworm infection (1.63 %; 3/183). The other 161 samples were reported as negative. (Table 1) *Enterobius vermicularis* infection was only found in three districts, including Benjeng (1/99), Cerme (1/43), and Duduk Sampeyan (1/14). Hookworm infection was only found in two districts, namely Duduk Sampeyan (1/14) and Benjeng (2/99). *Ascaris lumbricoides*

are found in three study sites: Sidayu, Ujung Pangkah, and Benjeng (Table 2). The highest *Ascaris lumbricoides* was found in Sidayu (16.66 %; 1/6), followed by Ujung Pangkah (15 %; 3/20) and Benjeng (8.08 %; 8/99) districts.

The highest prevalence of helminthiasis was found in Ujung Pangkah (15 %; 3/20), followed by Sidayu (14.2 %; 1/7), Duduk Sampeyan (14.2 %; 2/14), and Benjeng (13.13 %; 6/99). The lowest was in Cerme (6.9 %; 3/43). Our study shows that the prevalence of helminthiasis between the male and female groups was the same (11/22 or 50 % in the male group and 11/22 or 50 % in the female group).

Based on Table 4, those who played in the dumpsite were 6 out of 157 infected, whereas those who did not were 16 out of 16 infected. The Odds Ratio (OR) is 4.521, indicating that those who played in the dumpsite were 4.521 times more likely to be infected than those who did not. The 95 % Confidence Interval (CI) for the odds ratio is 0.578 to 31.281.

Four out of 151 individuals who removed their shoes while in school were infected, while 18 out of 10 who did not were infected. The Odds Ratio (OR) is 8.392, suggesting that those who removed their shoes while in school were 8.392 times more likely to be infected. The odds ratio's 95 % Confidence Interval (CI) is 1.6313 to 43.659. Four out of 149 individuals who washed hands before eating were infected, while 18 out of 12 who did not wash hands were infected. The Odds Ratio (OR) is 9.235, indicating that those who didn't wash their hands before eating were 9.235 times more likely to be infected. The 95 % Confidence Interval (CI) for the odds ratio is 1.859 to 45.876.

Five out of 147 individuals who washed hands with soap after defecation were infected, while 17 out of 14 who did not were infected. The Odds Ratio (OR) is 3.579, indicating that those who didn't wash their hands with soap after defecation were 3.579 times more likely to be infected. The 95 % Confidence Interval (CI) for the odds ratio is 0.587 to 21.835.

Discussion

Our study shows that *Ascaris lumbricoides* was the most common helminth infection found in school-age children in Gresik Regency (7.1 %). This result was in line with other published studies. Ascariasis is a prevalent public health issue among school-age children in developing nations, as reported in Pakistan. A study in Paki-

Table 2. The distribution of helminth infection based on the study site.

No.	Study Site	No. of Sample Examined	No. of Positive Sample
1.	Sidayu	7	1
2.	Duduk Sampeyan	14	2
3.	Ujung Pangkah	20	3
4.	Benjeng	99	13
5.	Cerme	43	3

Table 3. Demographical Characteristics of School Age Children with Positive Helminth Egg in Gresik.

No.	Demographical character	N (Percentage)
1.	Age	
	• 7 years old	7
	• 8 years old	3
	• 9 years old	1
	• 10 years old	5
	• 11 years old	2
	• 12 years old	4
2.	Living	
	• Urban	22
	• City	0
3.	Gender	
	• Male	11
	• Female	11

stan shows the prevalence of *Ascaris* infection was 0.88 % (Ali *et al.*, 2020). *Ascaris lumbricoides* is known as the helminth larvae, which can migrate to the human body, such as to the lungs, leading to some clinical manifestations. Severely infected children can experience volvulus, intestinal obstruction, and intestinal necrosis (Zheng *et al.*, 2012). A cross-sectional study in Nusa Tenggara, Indonesia, also reveals that *Ascaris lumbricoides* was the most common cause of helminth infection in school-age children, with a prevalence of 6.25 % (Bria *et al.*, 2022).

Parasitic disease, especially helminthiasis, has still become a major public health problem in developing countries, including Indonesia. Sociodemographic factors play an important role and are associated with the incidence of helminthiasis. The detail of the demographic factors can be shown in Table 3. As revealed

by another study in Nigeria (Chukwuma *et al.*, 2009), Pakistan (Hussain *et al.*, 2011), and Khamir (Rather & Salati., 2010) showed that poor personal hygiene, low socioeconomic status, insufficient clean water supply, poor sewage system, and low levels of sanitary settings were significantly associated with the helminthiasis. Some stray animals (cats and dogs) closest to humans must also be considered a source of *Ascaris lumbricoides* egg transmission (Olayide *et al.*, 2008). For example, a cross-sectional study in Bali revealed dogs' role as transmitters of Ascariasis. The fecal sample from the dog shows the diversity of helminth eggs, including *Ancylostoma* sp., *Ascaris* sp., and *Trichuris* sp (Agustina *et al.*, 2021). This present study shows that the percentage of some risk factors of STHs among school-age children is still high, where removal of shoes while playing in the yard, playing in the dumpsite, not

Table 4. Knowledge, attitude, and practice about helminthiasis.

Risk factors	Infected	Not infected	Proportion	OR	95% CI
Playing in the dumpsite					
• Yes	6	157	0.89	4.521	0.578 – 31.281
• No	16	16	0.17		
Pulling of shoes while in school					
• Yes	4	151	0.85	8.392	1.6313 – 43.659
• No	18	10	0.15		
Washing of hand before eating					
• Yes	4	149	0.84	9.235	1.859 – 45.876
• No	18	12	0.16		
Washing of hand with soap after defecation					
• Yes	5	147	0.83	3.579	0.587 – 21.835
• No	17	14	0.17		

washing hands before eating, defecation while in school, and not washing of hand with soap after defecation are high-risk factors. According to another report, children are more likely than adults to walk barefoot, increasing their contact with the ground and disregard sanitary facilities even when available (Abera *et al.*, 2013). Our study also showed that unwashed hands with soap after defecation is the risk factor for helminthiasis. This was also confirmed by another study from Iran (Daryani *et al.*, 2012), Uzbekistan (Gungroen *et al.*, 2007), China (Balén *et al.*, 2011), India (Kaliappan *et al.*, 2013; Awasthi *et al.*, 2008), and Nepal (Tandukar *et al.*, 2013). It is estimated that *Trichuris trichiura* infects 465 million people globally, according to recent estimates. Humans infected with *Trichuris trichiura* are known to experience adverse health outcomes, and most of these individuals are children (Dunn *et al.*, 2016; Cruz *et al.*, 2021). *Trichuris trichiura* is the STH helminth parasite linked to stunting and wasting in children who unexpectedly ingest the *Trichuris* egg from water or contaminated food (Else *et al.*, 2020). *Trichuris* infection commonly infects children, leading to malnourishment, anemia, stunting, and other nutritional deficiencies (Stephenson *et al.*, 2000). Although low-intensity infections involving multiple parasite species can cause significant anemia, light single *Trichuris trichiura* infections are considered relatively benign (Ezeamama *et al.*, 2005). This study also found that *Trichuris* infection prevalence was at 1.63 %. It is much lower than that shown in another cross-sectional study in Thailand, which was 2.1 % (Kache *et al.*, 2020).

Helminth infection in school-age children can influence their school performance. Previous studies show that children with hookworm infection perform worse in school. The previous semester's average for children with hookworm infection was 67.26, while the average for children without hookworm infection was 69.76. Two independent sample t-tests confirmed these results to be statistically significant. This results from hookworm's impact on brain cell development and cognitive function (Feleke *et al.*, 2018).

In our study, female and male genders show a proportional percentage, showing the same prevalence. This data contrasts with the other study in Nusa Tenggara, which shows female students were more frequently infected than male students (Bria *et al.*, 2022). Another study shows that soil-transmitted helminths can occur in pregnant women (SHIP), which may contribute to the emotional development of sixth-year-old children (Garrison *et al.*, 2021). Another study shows no significant correlation between sex and helminth infection in Southeast Nigeria (Uneke *et al.*, 2007). However, it is at odds with findings regarding intestinal helminthiasis among students in Ilie, Osun State, Southwest Nigeria (Adefioye *et al.*, 2011), where there is a significant difference in the percentages of male and female pupils infected. The relationship between helminth infection and sex has not yet been determined, though some studies have suggested that it is (Aiwo *et al.*, 2000), while others have suggested otherwise (Uneke *et al.*, 2007). Therefore, more thorough research is still required to understand this matter fully (Narain *et al.*, 2000).

Conclusion

Twenty-two feces from 183 children tested positive for helminth eggs, including 14 children infected by *Ascaris lumbricoides* (6.36 %), 3 children infected by *Trichuris trichiura* (1.304 %), 3 children infected by *Oxyuris vermicularis* (1.304 %), and 3 children infected by Hookworm (1.304 %). The highest prevalence was found in 7-year-old children (31.8 %).

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