

Reducing Soil-Transmitted Helminths Infection in Children: The Best Outcome of The COVID-19 Pandemic

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ABSTRACT

Introduction: Soil-transmitted helminths (STH) infection remains a significant health challenge in developing countries, including Indonesia, with an incidence of around 28.9%. During the COVID-19 pandemic, there have been some changes in society's habits. Therefore, this study aimed to confirm how the pandemic affects the STH infection prevalence in high-risk children.

Methods: This study, designed as a cross-sectional analysis, was conducted across multiple orphanages in Makassar, Indonesia. The sample population was healthy children aged 1–18 years old diagnosed with iron deficiency. Stool samples were collected and analyzed using the Kato-Katz technique to detect STH infection. The data was analysed with SPSS version 26 and presented in diagrams and tabulations.

Results: A total of 545 children 1-18 years old participated in this study, with 144 (26%) suffering from iron deficiency; 89 (61.4%) girls, and 56 boys (38.6%). The soil-transmitted helminth's prevalence in children with iron deficiency was 6.9%, with *A lumbricoides* infection at 2.06% (3/144), *T. trichiura* infection at 2.7% (4/144), and both infections at 2.06% (3/144).

Conclusion: The prevalence of soil-transmitted helminth infections among children in Indonesia significantly decreased during the COVID-19 pandemic.

Keywords: Soil-transmitted helminthes; COVID-19; children



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Introduction

Soil-transmitted helminths (STH) infection is considered a neglected disease, characterized by being overlooked and persistent, often lacking noticeable clinical symptoms¹. More than one billion people globally are affected by one or more species of STH, with these infections being widespread, especially in less developed regions. Within this population, there are specific groups at higher risk of morbidity due to STH infections. This affects over 267 million children in preschool and more than 568 million children in school². STH infection major health problem, not only on a global scale but specifically in Indonesia. STH infection prevalence in Indonesia nationwide is estimated at 28.9%^{3,4}. Efforts to eradicate the disease are ongoing, but progress is slower than anticipated⁴.

There was a close relation between STH infection in children and iron deficiency⁵⁻⁷. Helminthiasis caused by STH can lead to various problems, including anemia from intestinal bleeding and malnutrition, particularly in children. The condition exacerbates nutritional deficiencies in multiple ways and, over time, it affects growth and development, including psychomotor performance and stunting. Among the effects of STH, anemia is probably the most common, compared to other related symptoms⁴. Most of the study on STH infection in Indonesia reported that anemia developed during the disease, with the clinical spectrum ranging from asymptomatic to severe form⁴.

The COVID-19 pandemic has deeply affected many areas of human life, including the psychosocial well-being of children. Just as adults have experienced disruptions, children have also faced challenges due to interruptions in their daily routines and social activities. Prolonged periods of isolation, limited physical activity, and disrupted routines can lead to increased levels of stress, anxiety, and depression among children^{8,9}.

On the other hand, the decision of the World Health Organization (WHO) to issue a general recommendation to halt neglected tropical disease (NTD) programs in April 2020 was indeed a challenging one, and it had significant implications for the control of NTDs, include parasitic infections. There are many achievements in the fight against NTDs were compromised or lost due to the suspension of programs.

Furthermore, Parasitic diseases and other NTDs may have been deprioritized at local, national, and regional levels during this time, further complicating efforts to combat these diseases^{10,11}. The prevalence of soil-transmitted helminth (STH) infections can be influenced by multiple factors. It can be decreased due to social distancing activity, but it is increased the NTD program's interruption. Therefore, this study aimed to confirm how the pandemic affects the helminth infection prevalence in high-risk children.

Methods

This study was conducted from July to September 2021. This study is part of the Iron Deficiency Study in Makassar (IDeM) which subjects are children at several orphanages in Makassar. The study protocol received approval from the Health Research Ethics Review Committee at the Faculty of Medicine, Hasanuddin University (UH21120764). Informed consent was obtained from the parents or guardians of the participants on the day of their inclusion in the study. The child who was diagnosed as positive for intestinal STH was treated following the study.

The Subjects of this study were healthy children aged 1-18 years old who had been screened through several criteria such as, the child had no infection disease, the child with no immunocompromise and did not get blood transfusion nor iron supplementation. Data on age, sex, and nutritional levels were collected using a questionnaire. Height and weight were measured with a standing scale and a stadiometer mounted on a straight wall, while nutritional status was assessed using the WHO Z-score. for children <5 years old and the CDC curve for children >5 years old.

Sampling and laboratory methods

With the assistance of the guardian, one stool sample per child was collected, and their personal data including their name, gender, and age, were recorded when the stool sample was delivered the following day. Stool sample analysis was performed at the Department of Parasitology using the Kato-Katz method. This technique helps in quantifying the eggs, providing the information about the intensity of infection. Ova parasites examined under the microscope using 10 then 40 times of objectives lenses.

The children with iron deficiency were identified based on three key parameters: hemoglobin levels, mean erythrocyte volume (MCV), and serum ferritin levels. These parameters help in assessing the iron status of the children. The subjects were classified into iron depletion (normal hemoglobin, normal MCV, low ferritin), iron deficient erythropoiesis (normal hemoglobin, low MCV, low ferritin), and iron deficiency anemia (low hemoglobin, low MCV, low ferritin). Low ferritin is determined if serum ferritin level <30 ug/dL, low MCV is determined if MCV level <80 pg, and anemia determined if hemoglobin below the normal limit according to aged (children aged 1-6 years; Hb level is < 11.0 g/dL, children aged 6-12 years; Hb level is < 12 g/dL, boys aged 12-18 years; Hb level is <13 g /dL, girls; Hb level < 12 g/dL).

Statistical Analysis

The data were coded and analyzed using SPSS Statistics 26.0 software. Categorical data were assessed using descriptive statistics, such as frequency and percentage, with results displayed in both graphical and tabular form.

Result

Out of the 545 children enrolled in this study, 144 (26%) were found to have iron deficiency. The prevalence of helminthiasis among these iron-deficient children is presented in Table 1.

Table 1. Prevalence of STH infection

	<i>A. Lumbricoides</i>	<i>T. trichiura</i>	<i>A. lumbricoides and T. trichiura</i>	Not Infected
Male	2 (3.6%)	2 (3.6%)	2 (3.6%)	50 (89.3%)
Female	1 (1.1%)	2 (2.3%)	1 (1.1%)	84 (95.5%)
Age	5 (-3.96-13.96)	11.25 (8.53-13.97)	9 (-4.14-22.14)	12.25 (11.57-12.92)

Soil-transmitted helminth prevalence

The STH infection’s prevalence in children with iron deficiency was 6.9% (10/144). Diagram 1 depicts the prevalence of *A. lumbricoides* 2.06% (3/144), *T. trichiura* 2.7% (4/144), and both *A. lumbricoides* and *T. trichiura* 2.06% (3/145). (Figure 1)

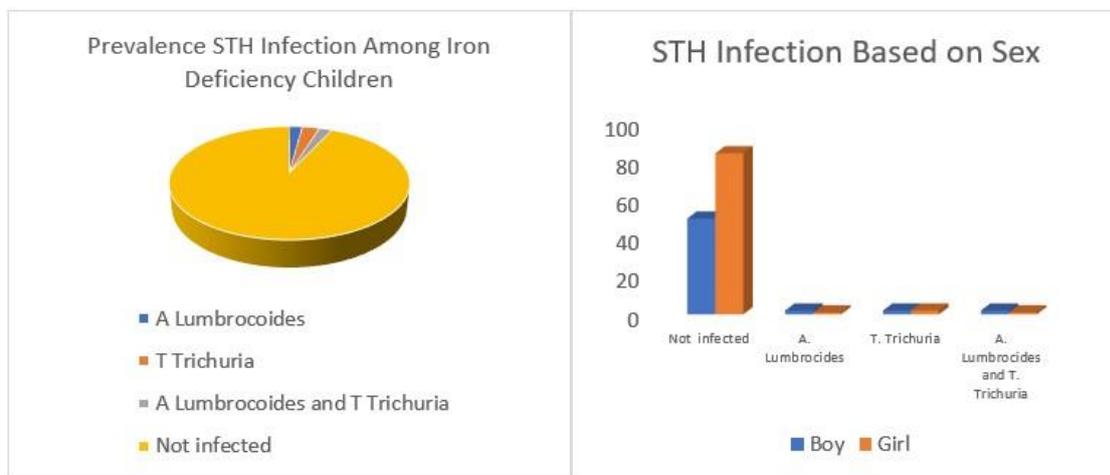


Figure 1. Prevalence STH Infection

Soil-transmitted and Nutritional States

Children infected with *A. lumbricoides* were all well-nourished, whereas children infected with *T. trichiura* consisted of three well-nourished children and one overweight child. Children with both infections consist of two well-nourished children and one overweight child. (Figure 2)

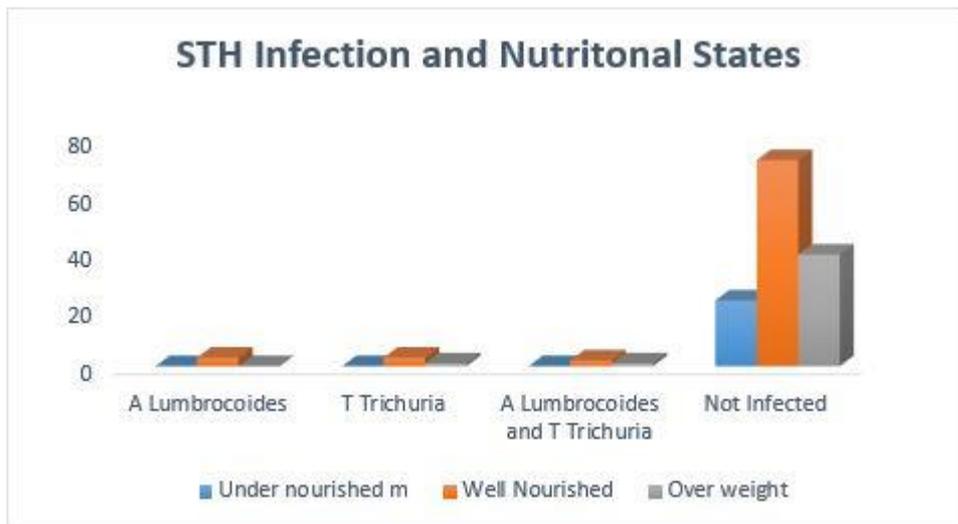


Figure 2. STH Infection and Nutritional States

STH infections and Hemoglobin Level

Hemoglobin concentration in children with STH infection was 12.60 g/dL, while the mean Hb concentration in children without STH infection was 12.95 gr/dl. Hemoglobin level in children with *A. lumbricoides* infection was 12.20 gr/dl, in children with *T. trichiura* was infection 13.10 g/dl, and the children with infection both infection was 11.80 g/dl.

STH infections and Ferritin Level

Children with STH infection had a mean ferritin level of 22.92 ng/ml, compared to 16.42 ng/ml in those without STH infection. Specifically, ferritin levels were 25.69 ng/ml in children with *A. lumbricoides* infection, 20.79 ng/ml (range 2.81-40.19 ng/ml) in those with *T. trichiura* infection, and 24.58 ng/ml in children with both infections." (Figure 3)

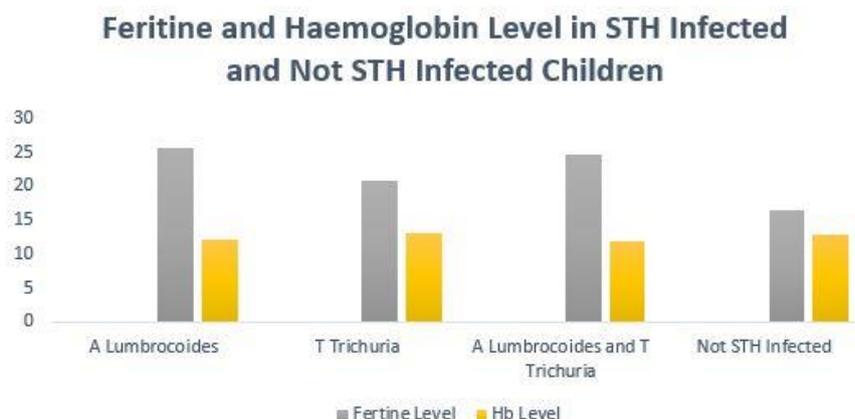


Figure 3. Hemoglobin and Ferritin Level in STH Children

STH infections and Level of Iron Deficiency

Among children with *A. lumbricoides* infection, 1 child (1.5%) had iron depletion, 1 child (1.9%) had iron-deficient erythropoiesis, and 1 child (3.8%) had iron deficiency anemia. Among Children with *T. trichiura* infection, 1 child (1.5%) had iron depletion, 3 children (5.7%) had iron-deficient erythropoiesis, and there were no cases of iron deficiency anemia. Among Children with both *A. lumbricoides* and *T. trichiura* infection, there were no cases of iron depletion, 1 child (1.9%) had iron-deficient erythropoiesis, and 2 children (7.7%) had iron deficiency anemia.

Discussion

Helminth infections, including ascariasis and trichuriasis, remain significant public health concerns in Indonesia (more than 90 million cases of each)¹². A systematic study by Siagian and Maryanti on the condition of anemia-related STH conducted in Indonesia from 2001 to 2020 found that anemia was quite high among STH infection sample⁴. Meanwhile, our study found the helminth infection prevalence among children diagnosed with iron deficiency during covid 19's pandemic among iron deficiency's children was 6.9%. The prevalence was lower compared to national data from Indonesia, which estimates that 28.9% of children are affected by helminth infections³. In Indonesia, the prevalence of helminth infections varies across provinces and is influenced by factors such as demographics, culture, parental education, and socio-economic conditions. Previous studies have reported prevalence rates in different regions: Palembang 22%¹³, Semarang 33%¹⁴, Medan 40.2%¹⁵ East Nusa Tenggara 58.8%¹⁰. The most recent report from Makassar indicates a prevalence of 24%.¹⁶ Based on our study, it appears that the prevalence of this infection was significantly lower during the COVID-19 pandemic.

The children are particularly susceptible to infections due to limited self-protection capabilities, which include both inadequate immune responses and insufficient hygiene awareness¹⁷. Low education levels, poor quality of drinking water and sanitation, and overcrowded living conditions are well-established risk factors for helminth infections in children^{18,19}. Personal hygiene consisting of hand-washing and outdoor play habits are known to be significant factors in the incidence of STH. Another risk factor for helminth infection is poor nail hygiene, as worm eggs can enter the human body through it. The finger nails can hide soil that contains microorganisms or eggs, and it is difficult to clean^{20,21}.

During the pandemic, there have been several changes in living behavior in a society. The physical distancing limits the movement of people. The community has also begun to implementing the health protocol by diligently washing hands using a soap or antiseptic alcohol. Besides, children are doing school

activities at home. These conditions could be the reason for the decrease in helminthiasis prevalence in children. Both *Ascaris lumbricoides* (*A. lumbricoides*) and *Trichuris trichiura* (*T. trichiura*) are transmitted through the fecal-oral route. This means that the transmission of these helminths typically occurs when individuals inadvertently ingest infective eggs, either through contaminated food, water, utensils, or improperly washed hands^{14,21}. Water, sanitation, and hygiene (WASH) is a predominant factor in reducing the risk of infection. WASH is an important intervention for infection prevention. The decrease in helminth prevalence in this study may be due to changes in hand-washing behavior that were implemented during the pandemic era, despite the study participants was a high-risk group, in which the children lived in orphanages with low socioeconomic conditions.

WHO has suspended several Healthcare programs to control Neglected Tropical Diseases (NTD) programs during the pandemic, including the helminth infection prevention program¹¹. Indonesia's Mass Drug Administration (MDA) program, which includes biannual albendazole treatment for schoolchildren, has effectively lowered the prevalence of STH infections. While education is recognized as fundamental in changing behavior and promoting better hygiene practices, achieving effective education in poor and remote areas can be challenging. Factors such as limited access to educational resources, low literacy rates, and cultural barriers may hinder the implementation of educational programs¹². The Health Service has a worm eradication program in Makassar that administers anti-helminth drugs twice a year. During the pandemic, however, this program was temporarily postponed in order to focus on the COVID-19 improvement program. Despite the fact that this infection control program was not as effective as usual, this study showed a much lower helminthiasis' prevalence. It could be related to the community's increased emphasis on hand hygiene.

The observed age-related differences in helminth showed a significant difference in helminth prevalence. *Ascaris* infections were found to be more common in children under 5 years, and *Trichuris* infection was found in the children under 10 years. This finding was similar to Osazuwa's study, which discovered that the prevalence of ascariasis decreased gradually as children's ages increased. The widespread parasitemia across nearly all age groups indicates a widespread lack of awareness and/or intentional disregard for basic hygiene rules among children^{7,22}.

Iron deficiency is globally recognized as one of the leading causes of anemia. Several factors such as insufficient dietary iron intake, physiologic demands of pregnancy, rapid growth, and parasitic infections contribute to iron deficiency, leading to inadequate iron reserves in the body and, subsequently, anemia^{5,18}. *T. trichiura* and *A. lumbricoides* are the most caused helminth infections in a children and both of them lead to be iron deficiency^{7,18,23,24}. This study found no significant differences in hemoglobin and ferritin levels between the children with and without helminth infections, nor among those infected with *A. lumbricoides*, *T. trichiura*, or both types of helminthiasis, suggests that the helminth infections may not

be having a substantial impact on these particular hematological parameters in the studied population. This finding was consistent with previous studies, which discovered that children with positive STH infections had a positive relationship with low serum iron levels and iron deficiency anemia^{5,6,14,15}. Meanwhile, some other studies explained that soil-transmitted helminths are associated with anemia^{5,7,10,25}. *Trichuris* directly invades the large intestine, it can attach to the mucosa and cause damage. This damage may lead to blood loss, contributing to anemia. It can also suck micronutrients, including iron, from the intestine. People with trichiuriasis infection usually have anorexia, which can result in reduced food intake. Another helminth, *Ascaris lumbricoides*, can impair the absorption of essential nutrients, from the gastrointestinal tract. It also competes with the host for nutrients, and further compromises the absorption of micronutrients like iron, further causes iron deficiency anemia¹⁵. Therefore, it is possible that helminth infection was not the cause of iron deficiency in the sample study.

This study did not identify a significant association between helminth infection and nutritional status. Almost every subject studied received adequate nutrition. A study in Molla, Ethiopia, reported a similar result among school-age children. The presence of STH infection in children did not appear to be associated with undernutrition²⁵. However, several previous studies found that helminth infection contributes to malnutrition^{10,14,24}. Helminth infection affects the small intestine mucous and causes villous atrophy to varying degrees, as well as crypt hypertrophy and inflammatory infiltrate. These changes damage enterocytes and disrupt bile acid metabolism, leading to inadequate absorption of essential macro- and micronutrients, including, iron, zinc, vitamin, and folic acid¹⁵. The differences in this study explain how helminth infection in children may contribute to nutrition based on the severity and duration of the infection.

The limitation of this study is the small sample size, as we only analyzed children with iron deficiency, targeting a high-risk population. Due to the limited data, the results are not fully detailed but are instead presented in diagram and table formats.

Conclusion

This study concludes that the soil-transmitted helminth infection prevalence of children in Indonesia was significantly decreased during the COVID-19 pandemic. This could be caused by the change of behavior in personal hygiene. This study suggested that primary schools and parents should focus more on maintaining these good habits to prevent the spreading and development of soil helminth infection.

Conflicts of Interest

There is no conflict of interest.

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