

The impact of soil-transmitted helminths infection on growth impairment: systematic review and meta analysis

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Abstract

Human helminthiasis, particularly soil-transmitted helminth (STH) infections, is a prevalent health concern in Indonesia, especially among children, often resulting in growth disorders, notably stunting. To examine the link between STH infections and childhood stunting, we conducted a comprehensive review of literature spanning 2012-2023, encompassing 40 selected articles from databases like Pubmed, Science Direct, and Google Scholar. Our analysis revealed a substantial association between STH infections and increased stunting risk in children, estimating a 44.407% rise in stunting risk due to STH infection. Stunting, a consequence of chronic malnutrition, profoundly affects a child's physical and cognitive development, with long-lasting repercussions on their

future potential and quality of life. This study has significant implications. It underscores the urgent need for robust public health interventions targeting STH infections, especially in high-prevalence areas like Indonesia. Measures such as mass deworming campaigns, improved sanitation and hygiene practices, and health education can significantly alleviate the burden of STH infections and the resulting stunting. Moreover, the research emphasizes the intricate relationship between infectious diseases and malnutrition, highlighting the necessity for a holistic approach to child health. Addressing STH infections necessitates not only medical intervention but also efforts to enhance overall living conditions and nutritional status. Integrating these approaches into a comprehensive public health strategy can yield more effective and sustainable results in the fight against childhood stunting. In conclusion, this study underscores the paramount importance of addressing STH infections in the context of child growth and underscores the urgency of implementing effective public health interventions. This approach can enable children to reach their full physical and cognitive potential, ultimately contributing to the overall well-being and development of societies.

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Introduction

Human helminthiasis, caused by parasitic worms, is a widespread issue.¹ In Indonesia, Soil-Transmitted Helminths (STH) are the most common type. Globally, over 2 billion people have STH infections, with 300 million experiencing severe cases, resulting in 150,000 deaths. *Ascaris lumbricoides* affects about 1.2 billion, *Ancylostoma duodenale* and *Necator americanus* impact 740 million, and *Trichuris trichiura* affects around 795 million people.^{2,3} Indonesia ranks second worldwide in STH infections, primarily affecting preschool-age children. Severely endemic provinces include Banten, DKI Jakarta, South Sulawesi, Bali, Papua, and Nusa Tenggara due to the favorable tropical climate and poor sanitation.⁴⁻⁶ East Java reports an approximately 80.69% prevalence rate, with Surabaya City noting 36% in 2015 according to the Ministry of Health of the Republic of Indonesia.^{7,8}

STH are frequently found in preschool and school-aged children with poor hand hygiene and sanitation practices, making it easier for STH to enter their bodies and disrupt their growth and development processes.^{4,5} Growth and developmental disorders commonly observed in children include stunting.^{9,10} Stunting is a growth and developmental disorder in children caused by factors such as malnutrition, repeated infections, and insufficient psychosocial stimulation.¹¹⁻¹⁴ In Indonesia, the incidence of stunting is alarmingly high, affecting around 7 million toddlers. In East Java province, the stunting incidence is approximately 32%.^{15,16} The consequences of stunting include increased morbidity, mortality, suboptimal cognitive and motor development, decreased reproductive capacity, suboptimal learning ability at school, and reduced work productivity.¹⁷⁻¹⁹

The rate of STH infection in stunted children under 5 years old is estimated at 30.43%, with *Ascaris lumbricoides* and *Trichuris trichiura* being the primary causes of infection. Several factors may contribute to the incidence of STH infections in toddlers, including their medical history, frequency of illnesses in the preceding three months, stunting issues, and their cleanliness and hygiene habits (e.g., handwashing with soap before eating and after using the toilet).^{17–19} In recent years, research on STH infections and stunting has expanded worldwide, with some studies indicating a significant relationship and others suggesting no significant connection between STH infection and stunting in children.^{20–22} Therefore, this study was conducted to investigate the incidence of STH infection and stunting in children, as well as to explore the relationship between these two factors. The research aims to provide up-to-date information with a reasonably high level of accuracy. The researcher conducted a systematic literature review and meta-analysis to examine the relationship between Soil-Transmitted Helminths infection and the incidence of stunting in children. It is hoped that this research will offer insights for the prevention and treatment of STH infections and stunting in accordance with the goals of the government of the Republic of Indonesia in 2024 and the SDGs target in 2030. This study aims to establish the relationship between STH infection and the incidence of stunting in children through a systematic review and meta-analysis approach.

Materials and Methods

Design study

This study employed systematic literature review and meta-analysis methods. Articles were systematically and comprehensively searched across various databases, including PubMed, ScienceDirect, and Google Scholar, covering publications from 2012 to 2023. The article search was conducted over approximately 5 months. The search terms used were as follows: STH infections* and stunting; STH infections* and stunted; STH infections* and growth disorders; helminthiasis* and stunting; helminthiasis* and stunted; helminthiasis* and growth disorders (where * indicates truncation).

Population and sample

Eligibility criteria were established to select studies for inclusion in the systematic literature review or meta-analysis. The population of interest in this study was children. The intervention under investigation was Soil-Transmitted Helminths (STH) infection, and the primary outcome of interest was stunting. Inclusion criteria for research articles were as follows: studies investigating the relationship between Soil-Transmitted Helminths infection and the incidence of stunting in children, research articles published between 2012 and 2023, research articles available in Indonesian and English, and research articles with clearly defined methodologies. Exclusion criteria encompassed incomplete research manuscripts, research results inaccessible for completeness, research lacking both qualitative and quantitative results, and research publications in the form of commentary or opinion pieces.

Operational definition of variables

STH infection refers to intestinal nematode infections affecting humans, where transmission occurs through contact with soil contaminated by eggs or larvae of STH worms. These STH worms include *Ascaris lumbricoides*, *Necator Americanus*, *Ancylostoma duodenale*, *Trichuris trichiura*, and *Strongyloides stercoralis*.

Stunting is a developmental disorder primarily caused by malnutrition, recurrent infections, and insufficient psychosocial stimulation.

Data analysis

Data processing involved the use of MedCalc Software, which calculated heterogeneity and performed Egger's test to determine the model of studies to be combined and to derive the final results of the meta-analysis.

Results

The selected articles encompassed publications from both international and national journals. *Supplementary Material Table 1* and Table 1 provides an overview of the articles that met the inclusion criteria.

Article summary

A total of forty (40) articles were deemed suitable for inclusion in the meta-analysis focusing on the relationship between Soil-Transmitted Helminths infection and the incidence of stunting in children. During the initial search process, a total of 1,157 articles were identified. These articles were subsequently subjected to a screening process, during which 150 articles were assessed for relevance and full-text availability in accordance with the predetermined inclusion and exclusion criteria. Ultimately, 40 articles, which specifically addressed the relationship between STH infection and the incidence of stunting in children, successfully passed the screening phase and satisfied the established inclusion and exclusion criteria. As such, these 40 articles were included in the systematic literature review and meta-analysis (Figure 1).

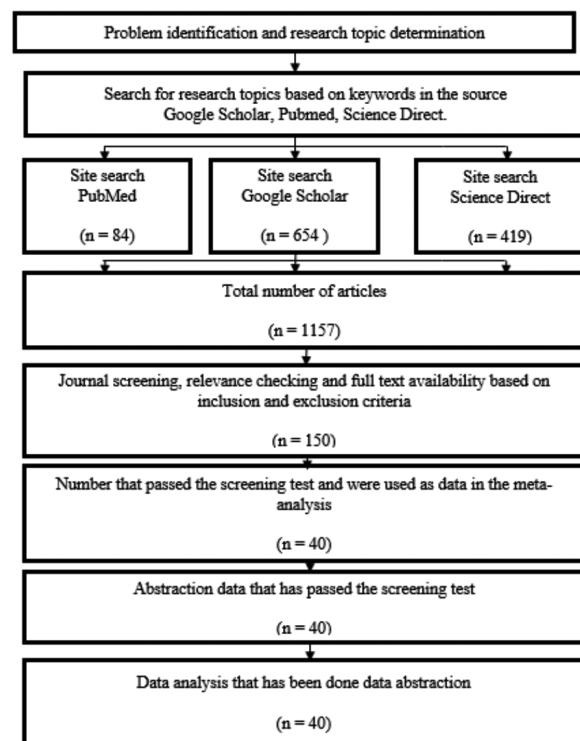


Figure 1. Prisma diagram of the review process.

Meta-analysis article

Forest plot

Table 2 demonstrates a considerable degree of variation between studies, as evident by the p-value in the heterogeneity test being less than 0.05, specifically $p < 0.0001$, and a high I2 value of 98.02%. Therefore, the results in the meta-analysis were analyzed using the total fixed-effects model. The forest plot in Figure 2 illus-

trates that the proportion obtained is 47.642% (95% CI 47.179 - 48.105). Consequently, it can be concluded that STH infection increases the risk of stunting in children by a factor of 47.462.

Funnel plot

To identify the presence of publication bias in this study, funnel plots and Egger’s test were employed. In Figure 3, the funnel plot indicates an asymmetrical distribution of studies, as it is not

Table 1. Meta-analysis of the articles used.

Study	Sample size	Proportion (%)	95% CI	Weight (%)	
				Fixed	Random
Wirjanata 2023	622	80.386	77.044 to 83.436	1.39	2.71
Manga 2023	350	38.286	33.169 to 43.603	0.78	2.66
Nasution 2022	46	58.696	43.227 to 73.003	0.10	2.08
Dehury 2022	232	32.759	26.759 to 39.205	0.52	2.61
Olin 2022	230	68.696	62.272 to 74.630	0.51	2.60
Ickowitz 2022	422	50.474	45.596 to 55.345	0.94	2.68
Hlaing 2022	264	32.576	26.957 to 38.591	0.59	2.63
Kassa 2022	405	39.753	34.954 to 44.703	0.90	2.68
Heffernan 2022	80	15.000	7.998 to 24.736	0.18	2.33
Yeshanew 2022	392	51.020	45.953 to 56.073	0.87	2.67
Diptyanusa 2022	138	51.449	42.797 to 60.038	0.31	2.50
Nuraini 2022	60	60.000	46.541 to 72.438	0.14	2.21
Degarege 2022	1205	44.149	41.321 to 47.006	2.68	2.75
Manggabarani 2022	209	47.368	40.440 to 54.373	0.47	2.59
Yogaswara 2022	185	40.000	32.882 to 47.443	0.41	2.56
Munfiah 2021	51	52.941	38.459 to 67.070	0.12	2.13
Lim 2021	343	39.942	34.719 to 45.339	0.77	2.66
Demonteverde 2021	1689	35.406	33.122 to 37.740	3.76	2.76
Shafti 2021	160	35.000	27.639 to 42.928	0.36	2.53
Hasanuddin 2021	20	10.000	1.235 to 31.698	0.047	1.59
Fernandez 2021	100	42.000	32.199 to 52.288	0.22	2.41
Morrissey 2021	380	47.895	42.774 to 53.049	0.85	2.67
Tumwesigire 2021	206	79.126	72.931 to 84.462	0.46	2.59
Salimo 2020	200	27.000	20.980 to 33.715	0.45	2.58
Chelkeba 2020	404	27.970	23.645 to 32.622	0.90	2.68
Hailegebriel 2020	24716	44.999	44.378 to 45.622	55.02	2.78
Augustina 2020	47	57.447	42.178 to 71.742	0.11	2.09
Beyene 2020	622	59.325	55.347 to 63.213	1.39	2.71
Sihombing 2020	2179	41.854	39.772 to 43.958	4.85	2.76
Mbonigaba 2020	4998	66.967	65.643 to 68.271	11.13	2.77
Nathasaria 2020	80	1.250	0.0316 to 6.769	0.18	2.33
Swastika 2019	81	25.926	16.820 to 36.860	0.18	2.33
Angraini 2019	40	47.500	31.512 to 63.872	0.091	2.01
Magga 2019	26	46.154	26.587 to 66.629	0.060	1.76
Moncayo 2018	920	56.957	53.685 to 60.184	2.05	2.74
Campbell 2017	2038	45.535	43.356 to 47.727	4.54	2.76
Teshome 2017	148	59.459	51.088 to 67.444	0.33	2.52
Alexandra 2017	80	21.250	12.894 to 31.829	0.18	2.33
Muhoho 2016	236	59.746	53.187 to 66.057	0.53	2.61
Sembiring 2015	281	35.587	29.990 to 41.492	0.63	2.63
Total (fixed effects)	44885	47.642	47.179 to 48.105	100.00	100.00
Total (random effects)	44885	44.407	40.341 to 48.510	100.00	100.00

balanced on both sides of the central line boundary. This suggests that publication bias affects the relationship between STH infection and the incidence of stunting in children. Furthermore, the publication bias test using Egger's test, as presented in Table 3, reveals that the intercept value is not equal to zero, specifically -0.6427. Based on the results of Egger's test, it is evident that publication bias influences the relationship between STH infection and the incidence of stunting in children.

Discussion

The results of the meta-analysis involving 40 articles examining the relationship between STH infection and the incidence of stunting in children were synthesized in a forest plot. Figure 2 in the forest plot indicates that children with STH infection face a risk increase of approximately 44.407%. In a study conducted by Demonteverde (2021), it was revealed that STH infection had a significant association with the incidence of stunting in children. This research employed a systematic literature review approach, focusing on Filipino schoolchildren. The findings of this study suggest that STH infection can lead to structural changes in the intestines, resulting in reduced villi function and a decreased number of immune cells that protect the intestines. This, in turn, can hinder the absorption of essential nutrients crucial for child growth and development.³⁸

Another study conducted by Hailegebriel (2020) highlighted the impact of STH infection on growth and development disorders in children, including stunting. This systematic review and meta-analysis centered on school-age children or children under 10 years old in Ethiopia. The study emphasized external factors such as poor environmental sanitation, inadequate hand hygiene, unclean drinking water, and insufficient family education as contributors to stunting.⁴⁶

Additionally, a study by Campbell (2017) identified the influence of STH infection on impaired growth and development in children, specifically leading to stunting. The research explored the connection between STH infections, hemoglobin levels, and child development indices in Manufahi District, Timor-Leste. The findings revealed that children with STH infection were twice as likely to experience stunting compared to their unaffected peers.⁵⁵

Mbonigaba's study (2020) showed a significant association between STH infection and the incidence of stunting in children. Using Kato Katz microscopy (KK) and real-time PCR (qPCR)

techniques to analyze 4998 children in Western Rwanda, the study indicated that around 88% of Rwandan children were affected by Soil-Transmitted Helminths infection, along with other conditions like stunting.⁵⁰

Similarly, Sihombing's study (2020) found that STH infection influenced impaired nutritional status and cognitive ability in children. This research explored the relationship between STH infection, nutritional status, and cognitive ability in children in Indonesia, revealing that children with STH infection were more vulnerable to stunting compared to those without.⁴⁹

While this study offers valuable insights, it is important to acknowledge several limitations. The quality of the meta-analysis and systematic review depends on the quality of the source articles. Variability in data quality and reporting standards across the selected articles may introduce bias and uncertainty into the results. The study focused on articles published from 2012 to 2023, which may not fully capture the historical and geographical variations in STH infection and stunting prevalence. These factors can change over time and may vary in different regions. Additionally, the study may be subject to language bias, as it relied on articles available in

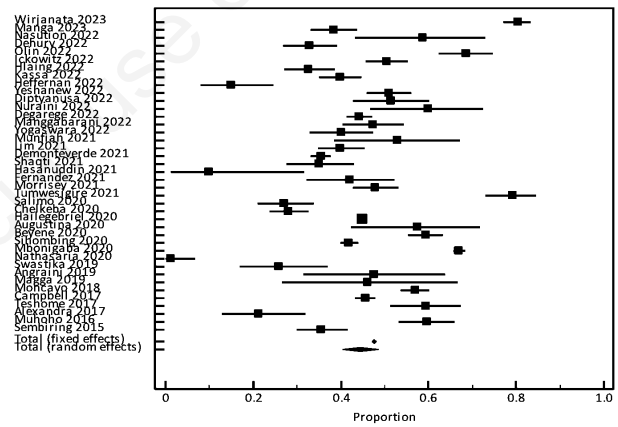


Figure 2. Forest plot of the relationship between Soil Transmitted Helminths (STH) infection and the incidence of stunting in children.

Table 2. Test of heterogeneity of the association of STH infection with the incidence of stunting in children.

Q	1965.4566
DF	39
Significance level	p<0.0001
I ² (inconsistency)	98.02%
95% CI for I ²	97.71 to 98.28

Table 3. Publication bias test of the association of STH infection with the incidence of stunting in children.

Egger's test	
Intercept	-0.6427
95% CI	-3.6784 to 2.3931
Significance level	P = 0.6707

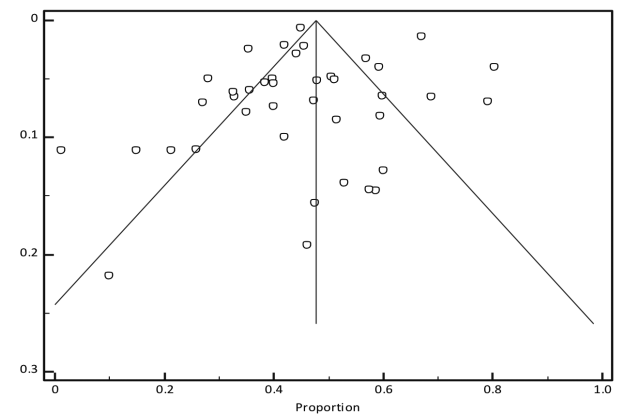


Figure 3. Funnel plot of the association of Soil-Transmitted Helminths (STH) infection with the incidence of stunting in children.

Indonesian and English, potentially overlooking relevant research published in other languages. Addressing these limitations in future research will enhance our understanding of the relationship between Soil-Transmitted Helminths (STH) infections and stunting, providing more accurate insights for policy development and intervention strategies.

Conclusions

High STH infection rates in Indonesian children result from the tropical climate, poor sanitation, unhygienic water, and inadequate education. STH infections, notably, lead to stunting, impairing child growth and development. This meta-analysis establishes that STH-infected children are at higher risk of stunting. This study contributes to the understanding of parasitic infections and growth impairment in pediatrics, parasitology, and public health. Practically, health professionals and policymakers must prioritize public health initiatives. Deworming programs, sanitation improvements, and health education are vital for countering STH infections and their adverse effects on children. On a governmental level, this research supports policies to reduce childhood STH infections. It offers a blueprint for regions with similar challenges, aiding in resource allocation to combat helminthiasis, thus enhancing community health and well-being.

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Online supplementary material:

Table 1. Articles included in the meta-analysis.

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