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Meta Analysis: The Soil Transmitted Helminth Infection and It's Correlation with Anemia in Children

(Hubungan Infeksi Kecacingan Soil Transmitted Helminth dengan Anemia pada Anak-Anak Systematic Review: Meta Analisis)

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Abstrak

Infeksi cacing soil-transmitted helminth (STH) banyak terjadi di wilayah dengan angka anemia tinggi, terutama di negara berpenghasilan rendah dengan gizi buruk. Anak-anak sekolah dasar di daerah ini paling rentan terhadap anemia. Anemia dan infeksi STH dapat menghambat perkembangan fisik, kehadiran sekolah, dan kemampuan belajar anak. Penelitian ini bertujuan menganalisis hubungan antara infeksi STH dan anemia pada anak. Tinjauan sistematik dan meta-analisis dilakukan mengikuti pedoman PRISMA, dengan artikel dipilih berdasarkan kriteria PICO: Populasi = Anak SD, Intervensi = Infeksi STH, Perbandingan = Tidak ada infeksi STH, Hasil = Anemia. Pencarian artikel mencakup publikasi tahun 2002-2024 pada basis data PubMed, Science Direct, Google Scholar, Springer Link, Hindawi, dan PLOS One. Kata kunci yang digunakan meliputi "STH," "Anaemia," "STH AND Children," dan "STH AND Anaemia." Kriteria inklusi adalah studi potong lintang teks lengkap berbahasa Inggris yang membahas dampak STH terhadap anemia pada anak usia sekolah. Analisis data dilakukan dengan RevMan 5.4, dan meta-analisis mencakup 12 artikel dari Afrika dan Asia. Hasil menunjukkan infeksi STH menurunkan kadar hemoglobin secara signifikan, menyebabkan anemia (aOR = 2,23; CI 95% = 1,07-4,65; p = 0,03). Studi ini mengonfirmasi bahwa infeksi STH berkontribusi pada anemia pada anak usia sekolah.

Kata kunci: Soil Transmitted Helminth, Anemia, Anak-Anak Usia Sekolah

Abstract

Soil-transmitted helminth (STH) infections are common in regions with high rates of anemia, particularly in low-income countries where poor nutrition is prevalent. Children attending school in these areas are most vulnerable to anemia. Both anemia and STH infections can negatively affect children's physical development, school attendance, and learning abilities. This study aims to examine the relationship between STH infections and anemia in children. A systematic review and meta-analysis following PRISMA guidelines were conducted. Articles were selected based on eligibility criteria defined using the PICO model: Population = Primary School Children, Intervention = STH infections, Comparison = No STH infections, Outcome = Anemia. The article search covered publications from 2002 to 2024 across databases such as PubMed, Science Direct, Google Scholar, Springer Link, Hindawi, and PLOS One. Keywords used included "STH," "Anaemia," "STH AND Children," and "STH AND Anaemia." Inclusion criteria consisted of full-text, cross-sectional studies published in English that discussed the impact of STH on anemia in school-aged children. The final results were expressed as adjusted odds ratios (aOR) from multivariate analysis. Data were analyzed using RevMan 5.4, and meta-analysis was performed on 12 articles from Africa and Asia. The results indicated that children infected with STH had significantly lower hemoglobin levels, leading to anemia (aOR = 2.23, 95% CI = 1.07 to 4.65, p = 0.03). This study demonstrates that STH infections contribute to anemia in school-aged children.

Keywords: Soil Transmitted Helminth, Anemia, Children

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INTRODUCTION

Soil transmitted helminth (STH) infections caused by *Ascaris lumbricoides, Trichuris trichiura, Necator americanus*, and *Ancylostoma duodenale* are commonly found in developing countries such as those in the Americas, China, East Asia, and Sub-Saharan Africa [1]. STH infections are also prevalent in regions with high anemia cases particularly low income countries where poor nutrition is a significant contributing factor. According to WHO school aged children in low income countries are the most vulnerable group to anemia [2]. Both anemia and STH infections can negatively impact children's physical development, school attendance, and learning abilities [3].

Anemia is a global health issue affecting populations in both developed and developing countries. It is the second leading cause of disability worldwide [4]. Globally anemia affects approximately 305 million children aged 5-15 years with a prevalence three to four times higher in non industrialized regions than the industrialized ones. The prevalence of anemia among school aged children is 5% in North America, 22% in Europe, and 30-63% in Asia [5].

Studies conducted in eight countries across Africa and Asia report that 12-58% of school aged children suffer from anemia with a prevalence of 58% in Malawi, Kenya, Ghana, Mozambique, Tanzania, and Mali. Menawhile the prevalence in in Vietnam and Indonesia is approximately 30% [6] [1]. Globally about 1.5 billion people or 24%of world population are infected with soil transmitted helminths. There infections are concentrated in tropical regions affecting over 270 million preschool aged children and more than 600 million school aged children, emphasizing the need for treatment and prevention. [7].

Meta analysis is an epidemiological study method used to statistically combine and unify the results of multiple independent primary studies, enabling a larger sample size and providing the highest level of evidence in the research hierarchy. This study aims to analyze the relationship between STH infections and anemia in children.

METHODS

This study employs a sytematic review and meta analysis approach. Articles were sourced from databases such as Google Scholar, PubMed, Science Direct, Springer Link, and PLOS One covering the years 2012 to 2024. Article selection followed the PRISMA flow diagram using the keywords "STH", "Anemia", "STH AND Children", and "STH AND Anemia.

Inclusion Criteria

The inclusion criteria for this study were full text cross sectional studies published in English focusing on the impact of STH infections on hemoglobin levels. The articles had to provide adjusted oddss ratios (aOR) comparing respondents with STH infections and hemoglobin levels for anemia diagnosis.

Exclusion Criteria

Exclusion criteria included cross sectional studies that used hematological examinations, studies unrelated to STH cases, articles published before 2012, and studies involving subjects other than children with STH infections.

Operational Variable Definition

Articles were screened based on eligibility criteria using the PICO model. Population: School aged children, Intervention: STH infections, Comparison: No STH infections, Outcome: Anemia.

Research Instrument

This study followed the PRISMA guidelines and the quality of the selected articles was assessed using the Critical Appraisal for Cross-Sectional Studies tool from CEBMa.

Data Analysis

Data were analyzed using *Review Manager* (RevMan 5.4). A forest plot and fixed effects model were applied to homogeneous data while a random effects model was used for heterogeneous data.

RESULTS AND DISCUSSION

The article search process was conducted through various journal databases including Google Scholar, PubMed, Science Direct, Springer Link, Hindawi, and PLOS One. The search process and selection of relevant articles are presented in the PRISMA diagram shown in Figure 1.

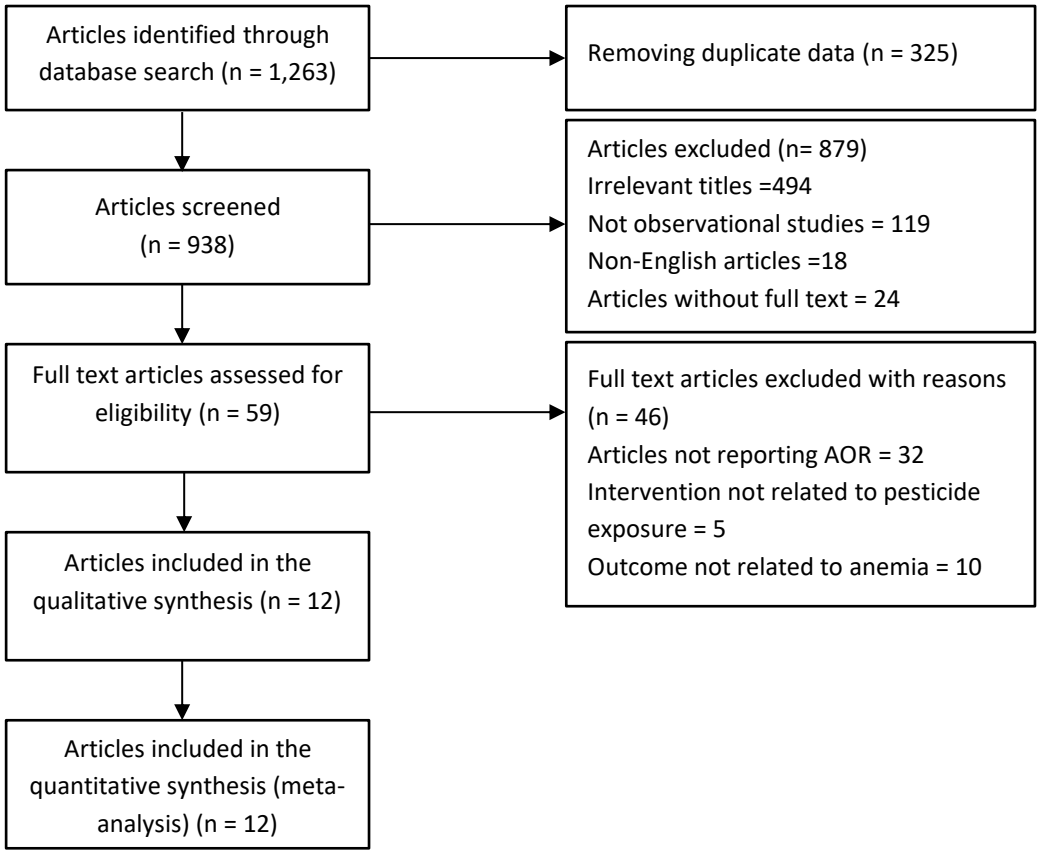


Figure 1. PRISMA Flowchart

Table 1. Quality assessment of studies using the cross-sectional study checklist published by CEBMa

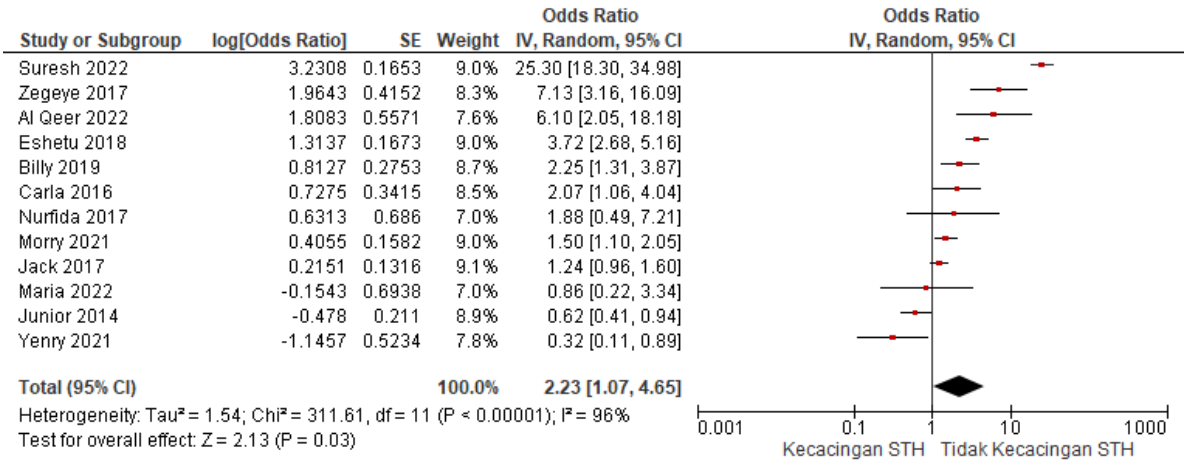
No	Assessment Indicators	Alqeer *et al.* (2022)	Billy *et al.* (2019)	Carla *et al.* (2016)	Eshetu *et al.* (2018)	Jask *et al.* 2012)	Junior *et al.* (2014)	Maria *et al.* (2022)	Morry *et al.* (2021)	Nurfida *et al.* (2012)	Suresh et al. (2022)	Yenry et al. (2021)	Zegeye et al. (2017)
1	Does the study clearly state the research focus/problem?	1	1	1	1	1	1	1	1	1	1	1	1
2	Is the cross-sectional research method appropriate for addressing the research question?	1	1	1	1	1	1	1	1	1	1	1	1
3	Is the subject selection method clearly described?	1	1	1	1	1	1	1	1	1	1	1	1
4	Does the sampling method minimize selection bias?	1	1	0	1	1	1	0	1	1	1	1	1
5	Does the selected sample represent the target population?	1	1	1	1	1	1	1	1	1	1	1	1
6	Was the sample size determined based on pre-study considerations?	1	1	1	1	1	1	1	1	1	1	1	1
7	Was a satisfactory response rate achieved?												
8	Were the instruments used to measure hemoglobin levels in children valid and reliable?	1	1	1	1	1	1	1	1	1	1	1	1
9	Was statistical significance assessed?	1	1	1	1	1	1	1	1	1	1	1	1
10	Were confidence intervals provided for the main results?	1	1	1	1	1	1	1	1	1	1	1	1
11	Were confounding factors accounted for?	1	1	1	1	1	1	1	1	1	1	1	1
12	Are the results applicable to your study?	1	0	1	1	1	1	1	1	1	1	1	1
	Total	12	11	11	12	12	12	11	12	12	12	12	12

Note: 1 = Yes, 0 = No

Table 2. Description of primary studies included in the meta-analysis

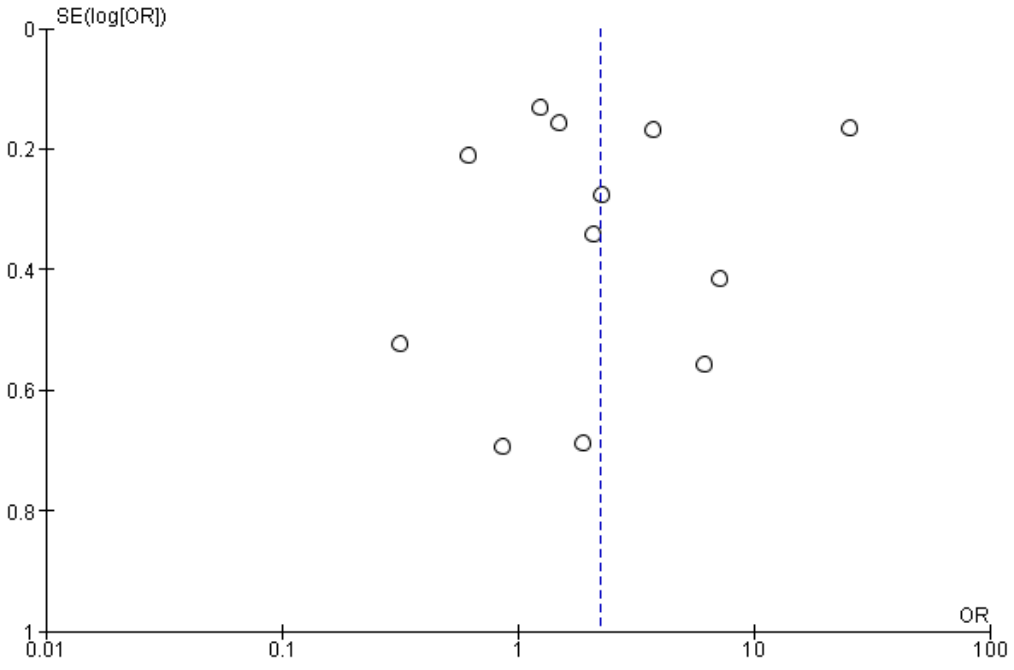
Authors (Year)	**Country**	**Study Design**	**Sample**	**P (*Population*)**	**I (*Intervention*)**	**C (*Comparison*)**	**O (*Outcome*)**	**aOR**
Al Qeer *et al.* (2022) [8]	Ethiopia	*Cross-sectional*	375	375 toddlers in daycare	STH infection	No STH infection	Anemia	6.1 (2.047 – 18.180)
Jack *et al*. (2012) [9]	Ethiopia	*Cross-sectional*	125	125 schoolchildren in Ethiopia	STH infection	No STH infection	Anemia	1.24 (0.958 – 1.570)
Junior *et al.* (2014) [10]	Congo	*Cross-sectional*	616	616 schoolchildren aged 4-13 years	STH infection	No STH infection	Anemia	0.620 (0.410 – 0.920)
Maria *et al.* (2022) [11]	Rwanda	*Cross-sectional*	674	674 students from Nemba	STH infection	No STH infection	Anemia	0.857 (0.220 – 5.540)
Mary *et al*. (2021) [12]	Philippines	*Cross-sectional*	1689	1689 schoolchildren aged 9-10 years	STH infection	No STH infection	Anemia	1.50 (1.10 – 2.00)
Nurfida *et al*. (2012) [13]	Indonesia	*Cross-sectional*	132	132 schoolchildren aged 8-12 years in Medan	STH infection	No STH infection	Anemia	1.88 (0.49 – 7.18)
Suresh et al. (2022) [14]	Nepal	*Cross-sectional*	267	267 schoolchildren aged 6-59 months	STH infection	No STH infection	Anemia	25.30 (18.30 – 33.80)
Yenny et al. (2021) [15]	Indonesia	*Cross-sectional*	393	393 preschool children in NTT, Indonesia	STH infection	No STH infection	Anemia	0.380 (0.114 – 0.887)

Figure 2. Forest plot of STH infection and anemia incidence in children



Based on the Forest plot in Figure 2, it shows that STH infection can lower hemoglobin levels, increasing the risk of anemia in children by 2.23 times compared to school-aged children who are not infected with STH, and this result is statistically significant (aOR = 2.23, 95% CI = 1.07 to 4.65; p = 0.03). The heterogeneity in this study shows I^2 = 96%, indicating that the data distribution is heterogeneous (random effect model).

Figure 3. Funnel Plot of STH Infection and Anemia Incidence in Children



Based on Figure 3, the funnel plot shows an asymmetric distribution of studies with estimates both above and below the average, indicating publication bias.

Helminth infections in individuals can be influenced by various factors such as personal hygiene practices, water sources, defecation habits, and environmental sanitation [16].

Soil Transmitted Helminth (STH) infections can reduce hemoglobin levels, leading to anemia. *Ascaris lumbricoides*, for example, can disrupt nutrient absorption required for red blood cell production, thus lowering hemoglobin levels [17]. Hookworms (*Necator americanus* and *Ancylostoma duodenale*), when they attach to the intestinal mucosa, can cause irritation and inflammation, potentially leading to bleeding. If the worm load exceeds 51, it can cause severe infection and worsen anemia, with hemoglobin levels dropping below half of the normal range [18]. These findings are consistent with Pratiwi's (2019) research, which showed that individuals infected with helminths are 1.818 times more likely to develop anemia and experience lower hemoglobin levels compared to those without such infections. The study identified *Ascaris lumbricoides* and hookworms as the main parasites causing reduced hemoglobin due to mucosal irritation and subsequent bleeding [19].

The limitations of this study may arise from the meta-analysis results on the relationship between helminth infections and anemia in children, which used a cross-sectional study design. These limitations include publication bias, article search bias due to the use of only six databases, and language bias because only English-language articles were included.

CONCLUSION

Soil Transmitted Helminth (STH) infections can reduce hemoglobin levels, leading to anemia in children.

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CONFLICT OF INTEREST

I hereby declare that there is no conflict of interest in the writing of this paper.

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