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Soil-transmitted helminth infections and nutritional status among children: A systematic review

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Abstract

Backgroound: Helminthiasis remains a significant public health problem among children in developing countries, including Indonesia. The prevalence of helminth infections among elementary school children in Indonesia averages 28.12%, with regional prevalence ranging from 2.5% to 62%. Soil-transmitted helminth infections are still widely reported and may contribute to impaired growth, anemia, and other nutritional disorders. Cases of helminthiasis, particularly ascariasis, among children under five in Seluma, Bengkulu, in 2025 were associated with poor sanitation, poverty, and inadequate living conditions.
Purpose: To analyze helminthiasis according to worm species, infection intensity, polyparasitism, and environmental sanitation, as well as its effects on children's nutritional status.
Method: This study used a systematic review design involving scientific articles published in relevant journals. Literature searches were conducted through Google Scholar, PubMed, ScienceDirect, Cochrane, and MDPI using keywords related to helminthiasis, worm species, infection intensity, polyparasitism, environmental sanitation, and children's nutritional status. Articles that met the inclusion criteria were reviewed descriptively to determine how worm species, infection intensity, polyparasitism, and environmental sanitation were associated with the nutritional status of children.
Results: A total of 30 eligible publications addressing worm species, infection intensity, polyparasitism, environmental sanitation, and children's nutritional status were included in the review. The findings showed that helminth infections were associated with poor nutritional outcomes, including underweight, impaired growth, and an increased risk of stunting and anemia.
Conclusion: Helminth infections, particularly those involving *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm, were associated with poorer nutritional outcomes among children. Infection intensity, polyparasitism, poor sanitation, and inadequate hygiene contributed to an increased risk of stunting, wasting, underweight, and anemia.
Recommendations: Improving environmental sanitation, strengthening routine deworming programs, increasing hygiene education, and conducting regular screening for helminth infections and nutritional problems are recommended. Further research should also consider socioeconomic, educational, and behavioral factors.

Keywords: Children; Environmental Sanitation; Nutritional Status; Polyparasitism; Soil-Transmitted Helminths.

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INTRODUCTION

Soil-transmitted helminth (STH) infections remain common in several Asian countries, including Indonesia (Kusumasari, Adi, Satoto, Wahab, & Murhandarwati, 2025). These infections occur particularly often in low-income countries and continue to affect human health (Nembot Fogang, Debrah, Owusu, Agyei, Meyer, Gmanyami, & Debrah, 2025). The World Health Organization (WHO) estimates that approximately 2 billion people worldwide are infected with parasitic worms, particularly in tropical and subtropical regions and areas with poor sanitation (World Health Organization, 2017). More than 4 million schoolchildren in Europe are estimated to have worm infections, while the highest prevalence has been reported in Central and South Asian countries. In Indonesia, the prevalence of worm infections remains high, ranging from 2.5% to 62%. Reported prevalence also varies considerably across regions, from 2.5% to 62%. Indonesia's tropical and humid climate contributes to this high prevalence (Kusumaningsih, Rafli, Sakti, Utama, Sumo, Ryalita, Rifa'ie, Sumarni, & Fitria, 2025).

Poor personal hygiene facilitates the transmission of STH infections and may lead to poor health, nutritional problems, impaired intellectual development, and blood loss. Worm infections may also reduce the productivity of infected individuals and cause substantial economic losses. These infections can cause serious health problems, particularly among elementary school children. Parasites are reported to account for 30% of growth disorders. In Indonesia, the prevalence of worm infections ranges from 20% to 86%, with an average prevalence of intestinal worm infection of 30%. These infections may affect children's nutritional status, growth, and development and may also impair their cognitive abilities (Aulia, Sudaryanto, & Arie, 2024).

According to data from the Bengkulu Provincial Health Office and the Ministry of Health of the Republic of Indonesia, cases of worm infection were still reported in Bengkulu Province in 2024, particularly among school-aged children and toddlers. In 2025, 18 elementary school students in Rejang Lebong Regency tested positive for worm infections (Ministry of Health of the Republic of Indonesia, 2025). Findings from Seluma Regency also indicate that severe worm infestations among toddlers remain closely associated with sanitation conditions and community hygiene practices (Ministry of Health of the Republic of Indonesia, 2024).

According to the epidemiologic triangle theory, worm infections occur through interactions among host, agent, and environmental factors. Host factors include age, personal hygiene, nutritional status, and clean and healthy living behavior. Agent factors include parasitic worms such as *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, while environmental factors include sanitation, clean-water availability, soil conditions, and the community's socioeconomic status. The interaction among these three factors contributes to the transmission of worm infections, particularly among school-aged children (John & Kompithra, 2023).

A previous study in West Jakarta, Indonesia, reported a worm infection prevalence of 5.2%, with *Ascaris lumbricoides* as the most common species and most infections classified as mild. Infections occurred more frequently among female toddlers (62.5%), and children aged 2-5 years were the most commonly affected age group. Most infected toddlers nevertheless had normal weight-for-age, normal height-for-age, and good nutritional status. A previous study in Bengkulu, Indonesia, reported a worm infection prevalence of 36.6% among students, along with malnutrition at 26.4%, stunting at 19.1%, and anemia at 6.4% (Simbolon, Okfrianti, Y., Kermelita, Darwis, Mulyati, Rochmat, & Sahidan, 2026). Research conducted in Italy showed that anemia has multifactorial causes, including infectious agents and parasitic worms, which are often overlooked as contributing factors (Caldrer, Ursini, Santucci, Motta, & Anghebe, 2022).

Another study found that 19,725 of 49,630 examined children were infected with STH, corresponding to a prevalence of 37.16%. The highest prevalence was recorded in the Western Pacific region at 50.41%, followed by Europe at 39.74% and Africa at 37.10%. *Ascaris lumbricoides* was the most commonly identified parasitic worm, with a prevalence of 24.07% (Agrawal, Pattnai, Kshatri, Kanungo, Manda, Palo, & Pati, 2024).

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Research in Malaysia reported 12 parasites, including *Ascaris lumbricoides*, *Cryptosporidium* spp., *Entamoeba histolytica*, *Enterobius vermicularis*, *Giardia lamblia*, hookworm, *Hymenolepis nana*, *Strongyloides stercoralis*, *Taenia* spp., and *Trichuris trichiura*. Ascariasis was the most commonly reported infection, with prevalence ranging from 10.77% in Ethiopia to 57.14% in Malaysia, and it was associated with stunting (OR 2.17, p=0.02). Giardiasis was the second most commonly reported infection, with prevalence ranging from 4.43% in Ethiopia to 66.33% in the Central African Republic, and it was associated with increased risks of stunting (OR 2.34, p=0.03), wasting (OR 2.90, p=0.03), and underweight (OR 1.53, p=0.04). *Trichuris trichiura* infection and hookworm were the third and fourth most commonly reported infections, respectively. Understanding the prevalence and effects of infection according to parasite species is important for implementing appropriate therapeutic interventions and preventive measures (Fauziah, Aviani, Agrianfanny, & Fatimah, 2022).

A previous study in Thailand reported an overall STH infection prevalence of 15.7%. Hookworm was the most common STH species at 10.9%, followed by *Strongyloides stercoralis* at 3.4% and *Trichuris trichiura* at 2.1%. Most older adults infected with hookworm or *T. trichiura* had mild-intensity infections. STH infection was more prevalent among individuals aged over 80 years (23.4%) than among those aged 70-79 years (15.2%) and 60-69 years (14.5%). Men were 1.85 times more likely than women to have an STH infection. Not washing vegetables before consumption increased the risk of STH infection by 3.19 times, while open defecation increased the risk by 2.65 times (Kache, Phasuk Viriyavejakul, & Punsawad, 2020).

The novelty of this study lies in its comprehensive examination of the effects of helminthiasis on children's nutritional status by simultaneously considering worm species, infection intensity, polyparasitism, and environmental sanitation. Previous studies generally discussed the relationship between worm infections and children's nutritional status, whereas this study seeks to provide a more comprehensive overview through a systematic review. This study also focuses on children in Seluma Regency, Bengkulu, an area characterized by a tropical rural environment that has received limited research attention. The findings are expected to provide a stronger basis for preventing worm infections, improving sanitation, and enhancing children's nutritional status simultaneously. Based on the problems described above, this study aimed to determine whether helminth infections, according to worm species, infection intensity, polyparasitism, and environmental sanitation, affect the nutritional status of children in Seluma Regency using a systematic review approach.

RESEARCH METHOD

This study employed a systematic review design to examine helminth infections among children based on worm species, infection intensity, polyparasitism, and environmental sanitation, as well as their effects on children's nutritional status. The findings were interpreted in relation to the conditions of children in Seluma Regency, Bengkulu, Indonesia.

The literature search was conducted through PubMed, ScienceDirect, the Directory of Open Access Journals (DOAJ), Cochrane, MDPI, and Google Scholar. The search terms included "helminthiasis," "soil-transmitted helminths," "worm species," "infection intensity," "polyparasitism," "environmental sanitation," "nutritional status," and "children." The inclusion criteria were original research articles written in English, published between 2013 and 2025, relevant to the objectives of the review, and presenting complete information on the authors, research objectives, methods, and results. Articles with incomplete structures, irrelevant topics, inaccessible full texts, or findings that did not address the variables examined in this review were excluded.

The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, including identification, screening, eligibility assessment, and final inclusion (Page et al., 2021). All identified articles were manually recorded and screened according to the predetermined inclusion and exclusion criteria. The methodological quality of eligible studies was assessed using the appropriate Joanna Briggs Institute (JBI) critical appraisal instruments.

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The initial literature search identified 500 articles. Following preliminary screening and the removal of articles that did not meet the database and eligibility requirements, 53 articles remained. The titles, abstracts, background relevance, research objectives, methods, and results were then assessed, resulting in 30 potentially eligible articles. After full-text assessment, 20 articles were excluded because they did not meet the established criteria. Therefore, 10 original research articles were included in the final analysis. The selected studies were analyzed descriptively by extracting information on the authors, research objectives, study methods, worm species, infection intensity, polyparasitism, environmental sanitation, nutritional status, and principal findings.

RESEARCH RESULTS

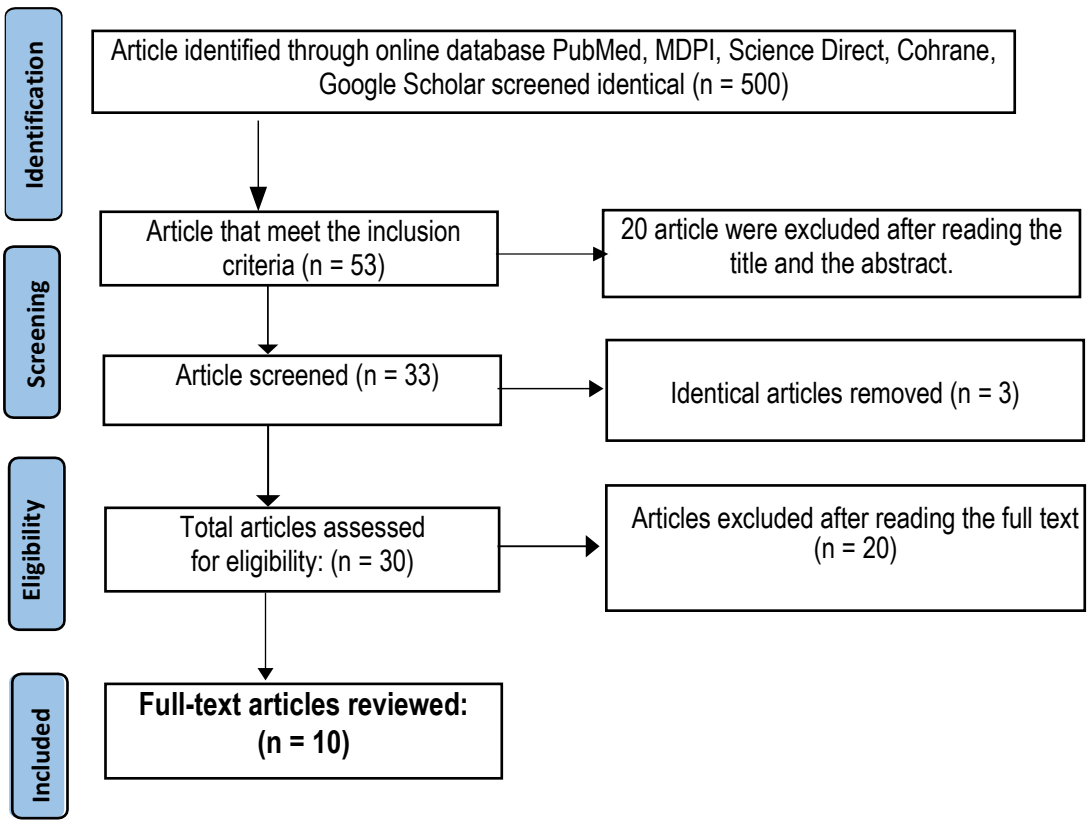


Figure PRISMA Flow Chart

Fiya Diniarti[1]*, Idris Adewale Ahmed[2], Firman Bintara Maju Harianja[1], Susilawaty[3]

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RESEARCH RESULTS

Table Summary of the Included Studies

(Author, Year) (Country)	Purpose	Method	Results
(Degarege et al., 2022). (Ethiopia)	To assess intestinal helminth infections and their association with anemia, nutritional status, and academic performance among children.	Longitudinal follow-up study. Helminth infection was examined using two thick Kato–Katz slides for each child.	Among 1,205 children, 45.4% had a single-species helminth infection, 7.9% had anemia, and 35.8% were malnourished. Infected children had lower mean hemoglobin levels, weight-for-age, height-for-age, and body mass index-for-age z-scores, as well as poorer academic performance. They were also more likely to experience anemia than uninfected children.
(Fauziah et al., 2022) (Indonesia)	To assess the association between intestinal parasitic infections and undernutrition among children under five years of age.	Systematic review.	Twelve intestinal parasites were identified. Ascariasis was the most frequently reported infection, with prevalence ranging from 10.77% in Ethiopia to 57.14% in Malaysia, and was associated with stunting (OR = 2.17; p = 0.02). Giardiasis was associated with stunting (OR = 2.34; p = 0.03), wasting (OR = 2.90; p = 0.03), and underweight (OR = 1.53; p = 0.04). Trichuris trichiura and hookworm were the third and fourth most frequently reported infections. Intestinal parasitic infections may occur early in life and contribute to impaired growth.
(Agrawal et al., 2024) (Western Pacific Region, Europe and Africa)	To summarize the prevalence, geographical variation, and determinants of STH infections among schoolchildren aged 5–18 years.	Systematic review and meta-analysis.	The Western Pacific region was classified as a high-risk zone, while Southeast Asia, Africa, Europe, and the Eastern Mediterranean were classified as moderate-risk zones. The prevalence of STH infections decreased by approximately 12% between 1999 and 2012. Ascaris lumbricoides was the predominant species among school-aged children.
(Agustaria et al., 2019) (Indonesia)	To analyze the association of age, school sanitation, and personal hygiene with helminthiasis among elementary school children in Juhar, Karo Regency.	Observational study with a cross-sectional design.	The prevalence of helminthiasis among elementary school students was 50.0%. Personal hygiene was significantly associated with helminth infection. Children with poor personal hygiene were 6.052 times more likely to have helminthiasis than those with good personal hygiene.
(Mationg et al., 2021) (Philippines)	To evaluate risk factors for STH infection and examine its association with nutritional indicators among schoolchildren aged 9–10 years in Laguna Province.	Randomized controlled trial of the Magic Glasses Philippines health education package.	Among 1,689 schoolchildren, the prevalence of STH infection was 23%. The prevalence of anemia, stunting, underweight, and wasting was 13%, 20.2%, 19%, and 9.5%, respectively. STH infection was significantly associated with stunting ($p < 0.001$) and underweight ($p < 0.003$), but not with wasting ($p = 0.375$) or anemia ($p = 0.462$), after adjustment for confounding variables.

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(Author, Year) (Country)	Purpose	Method	Results
(Kusumasari et al., 2025) (Indonesia)	To assess the prevalence, intensity, and distribution of STH infections and their association with nutritional status among children under seven years of age in West Sumba District.	Cross-sectional study.	The prevalence of STH infection was 32.5%. Trichuris trichiura (34.0%) and Ascaris lumbricoides (27.8%) were the predominant species. Significant risk factors included age over two years, low parental education, low family income, playing in soil, absence of septic tanks, and limited toilet facilities. STH infection, particularly A. lumbricoides infection, was associated with stunting.
(Garn et al., 2022) (Nevada, Georgia, and Germany)	To assess the effectiveness of water, sanitation, and hygiene interventions in preventing STH infections.	Cochrane systematic review using extensive search methods, with the final search conducted on October 19, 2021.	Twenty-one studies reported A. lumbricoides, 17 reported T. trichiura, 18 reported hookworm, and one reported S. stercoralis. Sixteen studies assessed infection intensity. Water, sanitation, and hygiene interventions produced a small reduction in STH infections, with an OR of 0.86 in randomized controlled trials and 0.71 in non-randomized studies.
(Bustinduy et al., 2013) (Kenya)	To examine the association among polyparasitism, undernutrition, and anemia among children.	Cross-sectional study based on surveys conducted in 2009–2010.	The most common infections were Schistosoma haematobium (25–62%), hookworm (11–28%), and Plasmodium falciparum malaria (8–24%). More than half of the children had anemia, with high levels of acute and chronic malnutrition. Polyparasitic infection, low socioeconomic status, age, and sex were associated with anemia, wasting, or stunting. The findings support the implementation of integrated parasite-control programs.
(Justine et al., 2024) (Northwestern, Tanzania)	To assess the prevalence, intensity, and risk factors for STH infection among school-aged children aged 6–14 years.	Cross-sectional study.	The overall prevalence of STH infection was 56.2%. Moderate-intensity A. lumbricoides and T. trichiura infections were found in 5.7% and 1.1% of infected children, respectively. Having a mother who worked as a farmer (aOR = 1.2; p = 0.002) and not washing hands with soap and water (aOR = 1.4; p = 0.035) increased the risk of infection. Handwashing after defecation was protective (aOR = 0.6; p = 0.024).
(Kusumaningsih et al., 2025) (Indonesia)	To assess the prevalence and intensity of intestinal helminth and STH infections among school-aged children living in the Deyniile and Kahda internally displaced persons camps.	Observational study using logistic regression analysis.	The overall prevalence of intestinal helminth and STH infections was 72.5% (232/320). Children whose fathers had completed secondary education (AOR = 0.148; p = 0.039) and those living in Kahda (AOR = 0.519; p = 0.033) had a lower risk of infection. Dirty fingernails, eating unwashed fruit, walking barefoot, and household sanitation were not statistically significantly associated with infection.

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DISCUSSION

The findings of this systematic review indicate that *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm were the most frequently identified helminths among children. These infections were commonly associated with stunting, underweight, anemia, and impaired growth. Poor personal hygiene, inadequate sanitation, low socioeconomic status, and limited access to clean water were also frequently identified as important risk factors for STH transmission.

The included studies also examined environmental sanitation conditions among children. The findings consistently indicate that *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm are the most frequently identified helminths, while these infections are commonly associated with stunting, underweight, anemia, and impaired growth. Poor personal hygiene, inadequate sanitation, low socioeconomic status, and limited access to clean water were also frequently identified as risk factors for STH transmission.

The helminth infections identified in this study were predominantly caused by *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm, all of which are closely associated with children's nutritional status. *A. lumbricoides* infection may interfere with nutrient absorption because the worms consume nutrients within the intestine, thereby increasing the risk of malnutrition and weight loss. *T. trichiura* infection is associated with appetite disturbances, chronic diarrhea, and blood loss, which may impair children's growth. Hookworm infection contributes to iron-deficiency anemia through chronic blood loss and may consequently increase the risk of wasting and stunting. According to the epidemiological triangle theory, helminth infections occur through interactions among agent, host, and environmental factors. From the host perspective, children with poor nutritional status are more susceptible to recurrent infections because of reduced immunity, while poor sanitation and soil contamination increase the risk of STH transmission from the environmental perspective (John & Kompithra, 2023; Hardjanti, Rachmawati, Desiyanti, Rahman, Wahyudi, & Farellina, 2017).

The findings showed that the prevalence of STH infection among 1,689 schoolchildren was 23%. The prevalence of anemia, stunting, underweight, and wasting was 13%, 20.2%, 19%, and 9.5%, respectively. Age, socioeconomic status, rural or urban school location, and knowledge of STH were identified as significant risk factors for STH infection. After controlling for confounding variables, STH infection was significantly associated with stunting and underweight but was not significantly associated with wasting or anemia. These findings suggest that helminth infections may affect children's long-term nutritional status by disrupting nutrient absorption and reducing food intake (Mationg, Williams, Tallo, Olveda, Aung, Alday, & Gray, 2021).

These findings are consistent with research in Indonesia showing that infections with *A. lumbricoides*, *T. trichiura*, and hookworm are associated with anemia, stunting, underweight, and wasting among schoolchildren (Fauziah et al., 2022; Kusumasari et al., 2025). Previous research in Northwestern Tanzania also showed that moderate-to-heavy STH infections and polyparasitism were associated with poorer nutritional status among children, particularly in weight-for-age and height-for-age indices. These findings indicate that helminth infections are not merely infectious diseases but are also closely linked to growth impairment and poor nutritional status among children (Justine, Bhuko, Rubagumya, Basinda, Ruganuza, Zinga, & De Malsche, 2024; Bustinduy, Parraga, Thomas, Mungai, Mutuku, Muchiri, & King, 2013).

The findings indicate that *Ascaris lumbricoides* is the predominant STH species among school-aged children. Its high prevalence may be influenced by children's frequent direct contact with soil, limited handwashing before eating, and the consumption of unhygienic food and beverages. *Ascaris lumbricoides* eggs can survive in moist soil for extended periods, thereby increasing the risk of transmission, particularly in areas with poor sanitation. School-aged children are especially vulnerable because they engage more frequently in outdoor play and interact more intensively with their surrounding environment

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than other age groups. The predominance of *Ascaris lumbricoides* also suggests that fecal–oral transmission remains the primary route of STH infection, which is closely related to inadequate sanitation, limited access to clean water, and poor clean and healthy living practices. Chronic infections may lead to various health consequences, including malnutrition, anemia, impaired growth, reduced immunity, and disturbances in children's cognitive development and learning abilities. Therefore, sustained control measures are required through routine deworming, health education, regular handwashing with soap, improved environmental sanitation, and adequate access to clean water to interrupt transmission and improve the health of school-aged children (Agrawal et al., 2024).

The intensity of helminth infection is closely associated with a decline in children's nutritional status. As the intensity of infection with *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm increases, disturbances in nutrient absorption, protein loss, and chronic blood loss become more severe, potentially resulting in underweight, wasting, stunting, and anemia. Mild infections generally cause minimal symptoms, whereas moderate-to-heavy infections may significantly interfere with children's growth and development (Kusumasari et al., 2025; Napitupulu, 2022).

These findings are consistent with previous studies showing that moderate-to-heavy STH infection intensity is significantly associated with stunting, wasting, and anemia among school-aged children. Children with a higher infection intensity have a greater risk of malnutrition than those with mild infections. These findings demonstrate that increasing infection intensity may worsen children's nutritional status, highlighting the need for integrated control through routine deworming, nutritional improvement, and enhanced environmental sanitation and personal hygiene (Kusumasari et al., 2025; Sulistyani, 2026).

The occurrence of polyparasitism, defined as simultaneous infection with more than one helminth species, was associated with poorer nutritional status among children, as reflected in increased risks of stunting, wasting, underweight, and anemia. Combined infections involving *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm may aggravate nutritional disorders through reduced nutrient intake and absorption, damage to the intestinal mucosa, and simultaneous chronic blood loss (Bustinduy et al., 2013; Garn, Wilkers, Meehan, Pfadenhauer, Burns, Imtiaz, & Freeman, 2022; Caldrer et al., 2022).

These findings are consistent with previous research reporting that STH polyparasitism is associated with a greater risk of stunting and anemia than single-species infection. Other studies have also shown that children infected with more than one helminth species have poorer nutritional outcomes, particularly in height-for-age z-score (HAZ) and weight-for-age z-score (WAZ) indicators. These findings confirm that polyparasitism aggravates the clinical and nutritional consequences of helminth infection, thereby requiring an integrated control strategy involving mass deworming, sanitation improvement, and nutritional interventions to interrupt recurrent infection cycles (Bustinduy et al., 2013). The findings of this study also indicate that environmental sanitation conditions play an important role in the occurrence of helminth infections and their consequences for children's nutritional status. Poor sanitation increases exposure to *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm through soil and water contaminated with human feces, which may subsequently contribute to stunting, wasting, underweight, and anemia (Degarege, Erko, Negash, & Animut, 2022).

These findings are consistent with previous studies showing that inadequate access to sanitation significantly increases the risk of STH infection and contributes to stunting and anemia among children. Other studies also indicate that improved sanitation and the use of proper latrines are associated with reductions in helminthiasis prevalence and improvements in children's nutritional status. These findings confirm that environmental sanitation is essential for interrupting helminth transmission and sustainably improving children's nutritional status (Justine et al., 2024; Garn et al., 2022; Mationg et al., 2021).

The findings showed that the proportion of helminthiasis among elementary school students in the study area reached 50.0%, indicating that helminth infections remain an important health

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problem among school-aged children. Personal hygiene was associated with helminthiasis, with children who had poor personal hygiene being 6.052 times more likely to experience helminth infection than those with good personal hygiene. These findings indicate that hygiene practices, including handwashing, maintaining clean fingernails, and wearing footwear, play an important role in preventing helminth infections. School-aged children are more susceptible to infection because their activities frequently involve contact with soil and environments contaminated with helminth eggs. Therefore, health education, improved environmental sanitation, and routine administration of anthelmintic medication are required to reduce the occurrence of helminthiasis among elementary school children (Agustaria, Fazidah, & Nurmaini, 2019).

CONCLUSION

STH infections among children are associated with worm species, infection intensity, polyparasitism, and environmental sanitation. *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm were the most frequently identified species and were linked to stunting, wasting, underweight, and other nutritional problems. Poor sanitation, limited access to clean water, open defecation, and inadequate personal hygiene further increased the risk of infection and worsened children's nutritional status.

RECOMMENDATIONS

The local government should improve access to clean water and proper sanitation, strengthen routine deworming programs, and expand health education on personal hygiene and food safety. Regular screening for helminth infections and nutritional problems should also be conducted, while future research should consider socioeconomic conditions, parental education, and children's sanitation-related behaviors.

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