Association between *Ascaris lumbricoides* infection and undernutrition in children: a systematic review and meta-analysis

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**ABSTRACT**

**Introduction:** Ascariasis is the most common soil-transmitted helminths (STH) infection in children, with prevalence ranging from 6 to 60%, especially in an endemic region in Indonesia such as East Nusa Tenggara, Sumatera, and other remote areas. Ascariasis effects toward undernutrition were still unclear because there were differences between studies. This study aimed to investigate the association between Ascariasis and undernutrition in children.

**Methods:** Six authors reviewed and analyzed eligible studies from PubMed and MEDLINE, Google Scholar, ProQuest, EBSCO-Host, and Springer Link, using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) guidelines with Reference manager was used, and the data analyzed using Revman 5.4. Newcastle-Ottawa Scale adapted for cross-sectional studies was used to examine the publication bias.

**Results:** This review included 15 studies and 12 studies used for meta-analyses. Pooled data indicates that Ascariasis is significantly associated with stunting (OR = 2.22, 95% CI = 1.31;3.77, p = 0.003) and underweight (OR = 1.27, 95% CI = 1.01;1.60, p = 0.04), meanwhile not significantly associated with wasted (OR = 1.11, 95% CI = 0.87;1.40, p = 0.40) of children aged 0-19 years.

**Conclusion:** Ascariasis increases the risk of stunting and underweight among other parameters of undernutrition. Therefore, early screening, diagnosis, and intervention must be taken to prevent stunting and underweight in children.

**Keywords:** ascariasis, stunted, underweight, wasted, children.


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### INTRODUCTION

Ascariasis is the most common soil-transmitted helminth (STH) infection in children worldwide and has more than 1 billion people globally, prevalent in tropical or subtropical countries and any region with poor hygiene. This infection is transmitted by the fecal-oral route.¹⁻³ Twelve percent of global disease was attributed to intestinal helminths. Ascariasis is the most common soil-transmitted helminths (STH) infection in children, with prevalence ranging from 6 to 60%, especially in an endemic region in Indonesia such as East Nusa Tenggara, Sumatera, and other remote areas.⁴⁻⁶ Several studies from different countries, including Ethiopia, Malaysia, and Sri Lanka, found that the risk factor of Ascariasis was similar such as poor sanitation and hygiene, uncooked food, low socioeconomic status, and overcrowded family.⁷⁻⁹ Ascariasis could cause disability throughout childhood and adolescence. Ascariasis causes impairment in the gastrointestinal tract (GIT) by triggering an inflammatory response that may cause anorexia and impair nutrient absorption, such as iron, vitamins, and folate, by damaging the intestinal wall. This nutritional disturbance may lead to anemia and undernutrition that will impact individuals and development, specifically in children.⁹⁻¹° Undernutrition increases children's risk of suffering from other infections and impaired cognitive ability resulting in poor academic performance.¹¹⁻¹² Despite the high prevalence and morbidity of Ascariasis in tropical countries, this infection is included as one of the Neglected Tropical Diseases (NTD) as stated by the Center for Disease Control and Prevention (CDC).¹³ In response to prevent this disease, Indonesia has implemented helminthic infections prevention program that consists of hygiene education, surveillance, and Mass Drug Administration (MDA) using albendazole or mebendazole every year, which is in line with the World Health Organization (WHO) helminthiasis prevention strategy adopted by other countries.⁵,¹⁴,¹⁵

Stunting is a good predictor for chronic undernutrition, among other nutritional indicators.¹⁶ The prevalence of stunting is 3.62% worldwide, with Asia and Africa having the highest prevalence rates, 5.0% and 2.9%, respectively. Despite the high prevalence and morbidity of Ascariasis in tropical countries, this infection is included as one of the Neglected Tropical Diseases (NTD) as stated by the Center for Disease Control and Prevention (CDC).¹³ Stunting is a good predictor for
chronic undernutrition, among other nutritional indicators. Stunted, defined as inappropriate height for age, can be caused by pathological processes and other mechanisms such as adverse drug effects. The prevalence of stunting is 3.62% worldwide, with Asia and Africa having the highest prevalence rates, 5.0% and 2.9%, respectively. According to United Nations Children's Fund (UNICEF) global report in 2019, 21.3% (144 million) children under five years suffered from undernutrition, resulting in stunting. Considering that stunting occurs in children under five due to chronic undernutrition, stunted results from any chronic etiology frequently appear in older children. Stunted and stunting were the result of chronic pathological processes; meanwhile, Ascariasis is an acute pathological process that is more likely to affect weight than height. Therefore, an explanation should be made regarding an acute event pathway that could trigger a chronic outcome. Although stunted prevalence has declined from 2000 to 2019 globally, Southeast Asia, including Indonesia, remains the highest among other regions. It is estimated that 1 of 3 children have “height for age” values less than two standard deviations based on the WHO Child Growth Standards median. Besides stunting, another burden of undernutrition is underweight (prevalence of 13%) and wasted (6.9%), which are still prevalent worldwide. The association between Ascariasis and undernutrition between studies remains debatable; therefore, this study aims to conclude various results from existing studies. There were no studies from the last 10 years attributed to this matter. Therefore, this review will also provide an updated discussion.

MATERIAL AND METHODS

Data source and search strategy
Studies were identified by seven authors using the primary medical subject heading “Ascariasis” and “Undernutrition”. PB and MW did the literature search, AP and AH reviewed, and ND assessed the bias. We conducted a literature search using several search engines, including PubMed and Medline, Google Scholar, ProQuest, EBSCO-Host, and Springer Journal (BMC Pediatrics) for both the English and Indonesian languages from the years 2000 to 2020. The studies were searched using the following search strategy (for the PUBMED database): (“Ascariasis” OR “Ascaris lumbricoides” OR “Ascaris lumbricoides infection”) AND (“growth disorder” OR “stunted” OR “growth failure” OR “Nutritional status”) AND (“children”). For other databases we use only the terms without the Boolean logic (“AND” and “OR”) and MESH term. After obtaining the results, we downloaded all the literature from each page using Mendeley’s reference manager.

Selection of studies (Eligibility Criteria)
Our study included cross-sectional, case-control, and cohort/longitudinal studies on children and adolescents with a mono-infection of Ascariasis diagnosed by technique enlisted in the WHO Bench Aids for the diagnosis of intestinal parasites ranging from the year 2000 through 2020. All of the study participants include children and adolescent age group, ranged between 0-19 years old. Measured data were plotted to the WHO height for age curve to differentiate stunted children from the normal population. All studies written in English and Indonesian were included since aside from those languages, only those two languages are well-understood by all authors. The author excluded any case reports, letters, commentaries, editorials, and other reviews found during the literature search. Participants who experienced chronic illness, malignancy, or other diseases that may interfere with the child’s nutritional status were also excluded, and all participants did not receive any anthelmintic drugs.

Data from selected studies were extracted and cross-checked for qualitative synthesis. The following data were extracted: author, year of study, country, number of participants, study design, parasitological examination method, population characteristics including age range and the prevalence of stunted, underweight, and wasted, and the relationship of the former variable with the other three last variables. The data extraction was conducted by two authors independently and followed by a comparison of both data and discussed with other co-authors for the final data extraction result.

Assessment of risk bias/Quality assessment
All six reviewers contributed to the risk of bias assessments, and each study was assessed independently by two reviewers using Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies. NOS comprises seven items, including selection (representativeness of the sample, sample size, non-respondent’s criteria, and ascertainment of the exposure (risk factor)), comparability, and outcome (how the outcome was assessed and the statistical analysis). The scale ranges from zero (minimum) to ten (maximum) stars, and the highest scores represent each study’s greatest quality. All reviewers were mediated by EW and YA to discuss the solution in terms of disagreement further.

Exposure measure
Participants were instructed to collect fresh stool samples in a container, and if needed to be preserved, samples are stored either in iceboxes, sodium acetate-acetic acid–formalin, or 10% formalin. Parents or caregivers have already been instructed how to collect stool samples if the stool was taken from home or children are too young to collect stool samples to minimize sample contamination. Ascariasis was confirmed by the presence of A. lumbricoides eggs or A. lumbricoides helminths identified in stool samples. In this review, infection status is classified into two groups: infected and non-infected. In this review, polyparasitic infections and ascariasis co-infection were not included to minimize nutritional status bias caused by parasitic infections other than A. lumbricoides.

Outcome measure
Height in centimeters (cm) and weight in kilograms (kg) of all participants were measured in all included studies using a measuring tape or stadiometer and weight scales. WHO AnthroPlus software was used for 5-19 years old children to continue the WHO child growth standard chart for 0-5 years old. Stunted is defined as Height-for-Age Z score below –2 from
the standard deviation (HAZ < -2), wasted is defined as Weight-for-Height Z score below -2 from the standard deviation (WHZ < -2), and underweight is defined as Weight-for-Age Z score below –2 from the standard deviation (WAZ < -2).

**Statistical analysis**

Six authors extracted data for systematic review and meta-analysis. Data containing a general population description (age, country, socioeconomic status, or environmental factors), population sample, and comparative data on Ascariasis and undernutrition were used. The effect size was measured by Odds Ratio (OR) using comparison data from study groups diagnosed with stunted, wasted, and underweight, respectively, compared with each control group. Each study was weighted using the Mantel-Haenszel method to obtain a pooled OR with 95% CIs. The data was presented in a categorical binary predictor of ascariasis status and binary outcome of each nutritional status. We used the fixed-effects model to estimate the pooled OR. Comparative data were analyzed using a fixed-effect model by the software Review Manager 5.4 and presented as odds ratio (OR) and forest plot. A funnel plot test was done to assess the potential publication bias in Figure 5.

**RESULTS**

**Study Selection**

PRISMA Guidelines were used for reporting the study selection. The result from the electronic database search identified 1371 records, of which 65 remained after duplicate removal, title, and abstract screening. The full text of each 65 studies was evaluated for eligibility criteria, and 50 were excluded because the studies did not meet the criteria. Therefore, 15 studies were included in the qualitative synthesis, and 12 studies were included in the meta-analysis (Figure 1). Two studies that were excluded from the meta-analysis classify the severity of Ascariasis according to normal-light and moderate-heavy infection. In this review, a light infection should be differentiated from the non-infected group. One other excluded study did not provide data on Ascariasis and stunted that covers all participants.

**Result of literature extraction**

**Study Characteristics**

Most of the study design was cross-sectional (14 studies), while one was a cohort study. The 15 studies included 9,172 participants with a sample size ranging from 183 to 1,851 (Table 1).

Studies by Ahmed et al.7 and Aiemjoy et al.19 show that children who belong to families with low household incomes have a higher prevalence of Ascariasis. The primary water resource was mentioned in four studies8,19,22,28, the result of these studies was varied; Most of the studies show that most participants already have protected primary water resources, but surprisingly these studies show higher cases of Ascariasis. A study from Zulkifli et al.28 shows that 56.9% of the participants use unprotected water (river and rainwater). Sanitation facilities include either covered, uncovered latrines, or no sanitation facilities available. Aiemjoy et al19 and Yoseph et al8 reports
<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
<th>Study Design, Country</th>
<th>Parasitological Examination</th>
<th>Participants (N)</th>
<th>Age (years)</th>
<th>Ascariasis-Stunted* (%)</th>
<th>p-value</th>
<th>Ascariasis-Underweight** (%)</th>
<th>p-value</th>
<th>Ascariasis-Wasted*** (%)</th>
<th>p-value</th>
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<td>Kato-Katz Technique</td>
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<td>6-13</td>
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<td>Cross-sectional, Ethiopia</td>
<td>Diethyl-ether concentration methods</td>
<td>201</td>
<td>0-5</td>
<td>13</td>
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<td>Kato-Katz Technique</td>
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<td>Cross-sectional, Sri Lanka</td>
<td>Direct wet mount with iodine or normal saline</td>
<td>489</td>
<td>1-12</td>
<td>39.5</td>
<td>0.797</td>
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<td>0.409</td>
<td>35.7</td>
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<td>Direct saline method</td>
<td>532</td>
<td>7-14</td>
<td>67.3</td>
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<td>6</td>
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<td>Malaysia</td>
<td>Kato-Katz Technique</td>
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<td>Cohort, Kenya</td>
<td>Ritchie Method</td>
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<td>8</td>
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<td>Iodine (microscopic)</td>
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<td>Stoll's dilution egg-count technique</td>
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<td>Kato-Katz</td>
<td>1192</td>
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<td>Cross-sectional, China</td>
<td>Kato-Katz</td>
<td>1031</td>
<td>9-12</td>
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<td>0.007</td>
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<td>13</td>
<td>Silva et al. (2008)</td>
<td>Cross-sectional study, Brazil</td>
<td>Kato-Katz</td>
<td>1851</td>
<td>7-14</td>
<td>10.6</td>
<td>&lt;0.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>14</td>
<td>Yoseph et al. (2020)</td>
<td>Cross-sectional, Ethiopia</td>
<td>Direct Wet Mount and Kato-Katz</td>
<td>622</td>
<td>0.5-5</td>
<td>92.5</td>
<td>&lt;0.001</td>
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<td>N/A</td>
<td>N/A</td>
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<td>15</td>
<td>Zulkifi et al. (2000)</td>
<td>Kuala Betis- Malaysia</td>
<td>Modified Stool's technique</td>
<td>183</td>
<td>7-10</td>
<td>41.7</td>
<td>&gt;0.05</td>
<td>58</td>
<td>N/A</td>
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</table>
that uncovered latrines and the absence of sanitation facilities have a significant positive association with a parasitic intestinal infection. Studies conducted by Getachew et al.\(^{10}\) and Shang et al.\(^{26}\) reported a significant association between parental education and Ascariasis; however, these studies do not mention its correlation with undernutrition in children. Hesham et al.\(^{21}\) reported that parental education does not correlate with undernutrition; however, the study stated that uneducated mothers have a higher prevalence of stunted children than educated mothers.\(^{20,21,26}\)

The impact of family size as a predisposition to Ascariasis was included in three studies. Three studies suggest that the larger (>5 people) the family size, the higher the risk for Ascariasis and stunted.\(^{8,9,20}\) Ahmed et al.\(^{7}\) also reported their participants’ demographic on large family size (>7 people) but did not further discuss its relation toward Ascariasis and stunting.

As one of the variables discussed in this review, the primary water resource was mentioned in four studies.\(^{8,19,22,28}\) The result among these studies was varied; however, most of the studies\(^{6,15,19}\) shows that most of the participants already have protected primary water resources, except a study from Zulkifli et al.\(^{28}\) in which 56.9% of the participant use unprotected water (river and rainwater). These studies show a surprising result in children with protected water resources having higher cases of Ascariasis.\(^{8,19}\) In contrast with this result, Zulkifli et al.\(^{28}\) reported that the group with unprotected primary water source contributed to a higher case of Ascariasis and found that unprotected water resource is associated with STH infections.\(^{29}\) reported that group with unprotected primary water source contribute to a higher case of Ascariasis and found that unprotected water resource is associated with STH infections.

Sanitation facilities as a population characteristic variable were discussed in three studies.\(^{8,19,22}\) Sanitation facilities include either covered, uncovered latrines, or no sanitation facilities available. Aiemjoy et al.\(^{19}\) report that uncovered latrine was the most used facility among sanitation facilities, followed by open defecation. report that uncovered latrine was the most used facility among sanitation facilities, followed by open defecation.

**Meta-Analysis Result**

The following figures present the forest plot as meta-analysis outcomes that evaluated the association between Ascariasis and undernutrition.

Significant heterogeneity was observed among the studies for stunted (\(I^2 = 92\%, p<0.00001\)), therefore, a fixed-effects model was used to analyze the outcome. A forest plot of OR and 95% for stunted is presented in figure 2. The heterogeneity is low for wasted and underweight (0%, \(p=0.78\), and \(p=0.45\), respectively), and the forest plot of OR and 95% CI for wasted and underweight are presented in Figures 3 and 4. The results of the pooled analysis revealed that uncovered latrines and the absence of sanitation facilities have a significant positive association with a parasitic intestinal infection. Studies conducted by Getachew et al.\(^{10}\) and Shang et al.\(^{26}\) reported a significant association between parental education and Ascariasis; however, these studies do not mention its correlation with undernutrition in children. Hesham et al.\(^{21}\) reported that parental education does not correlate with undernutrition; however, the study stated that uneducated mothers have a higher prevalence of stunted children than educated mothers.\(^{20,21,26}\)

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**DISCUSSION**

A total of 15 studies show that Ascariasis significantly correlates to undernutrition, whereas seven studies show vice versa. From those eight studies, six studies reported Ascariasis to correspond to
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Contributing to Ascariasis. Low household income is associated with Ascariasis because families with low household income tend to be reluctant to build proper sanitation facilities and practice inappropriate defecation behavior, such as open defecation, promoting STH infection such as Ascariasis. Parental education contributes as a protective factor against undernutrition and poor sanitation, thus contributing towards a lower incidence of Ascariasis. Overcrowding in the family increases the chance of helminth transmission. Unprotected water sources also lead to higher cases of Ascariasis and other STH infections.

Incidence of Ascariasis could be explained by the fact that the absence of proper and clean sanitation facilities can directly contaminate water and soil, which becomes one of the most critical risk factors for STH infection.

The prevalence of undernutrition globally remains high, especially in rural areas and developing countries, with half of all mortalities among children under five years old due to undernutrition. This phenomenon can lead to a greater risk for children suffering from acquired infections, delayed recovery, and impaired cognitive ability, resulting in poor academic performance. WHO determines three major undernutrition indicators, stunted, wasted, and underweight, whereas stunted contributes to undernutrition's best indicator because of its ability to depict the chronic nutritional state. Other undernutrition burdens are wasted and underweight, which prevalence's less common compared to stunted. Wasted, underweight, and stunted share common causal factors, such as infection, poor living conditions, and insufficient energy intake for zinc, calcium, vitamin A, and folate micronutrients. Other findings also suggest that these conditions can occur simultaneously, despite the concurrence remaining poorly understood.

Our meta-analysis shows children with Ascariasis are two times more likely to suffer from stunted (Figure 2). This outcome may result from many pooled participants' data. The underlying pathology that causes stunted in children with Ascariasis is still not fully understood. However, this phenomenon is caused by recurrent stunted only, and two reported Ascariasis related to underweight only and wasted only. Ascariasis may be associated with undernutrition by several mechanisms: 1) ascariasis as a primary underlying cause of undernutrition 2) ascariasis as exacerbating and precipitating factor of undernutrition.

Ascariasis may cause gut inflammation, lactose intolerance, malabsorption of vitamins and other micronutrients, and appetite loss that could impair weight gain. Several clinical studies demonstrated that adult worms of A. lumbricoides could lead to abdominal distension and pain due to large bowel obstruction. Ascariasis may worsen undernutrition alongside inadequate nutrition intake, hindering children's growth. Regarding stunted as a chronic outcome of infections, besides the parasitic infection itself, other factors could contribute to the development of stunted, such as sociodemographic backgrounds, primary water resources, sanitation facilities, parental education, and family size, as explained below.

Studies also included other factors contributing to Ascariasis. Low household income is associated with Ascariasis because families with low household income tend to be reluctant to build proper sanitation facilities and practice inappropriate defecation behavior, such as open defecation, promoting STH infection such as Ascariasis. Parental education contributes as a protective factor against undernutrition and poor sanitation, thus contributing towards a lower incidence of Ascariasis. Overcrowding in the family increases the chance of helminth transmission. Unprotected water sources also lead to higher cases of Ascariasis and other STH infections. Incidence of Ascariasis could be explained by the fact that the absence of proper and clean sanitation facilities can directly contaminate water and soil, which becomes one of the most critical risk factors for STH infection.

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The prevalence of undernutrition globally remains high, especially in rural areas and developing countries, with half of all mortalities among children under five years old due to undernutrition. This phenomenon can lead to a greater risk for children suffering from acquired infections, delayed recovery, and impaired cognitive ability, resulting in poor academic performance. WHO determines three major undernutrition indicators, stunted, wasted, and underweight, whereas stunted contributes to undernutrition's best indicator because of its ability to depict the chronic nutritional state. Other undernutrition burdens are wasted and underweight, which prevalence's less common compared to stunted. Wasted, underweight, and stunted share common causal factors, such as infection, poor living conditions, and insufficient energy intake for zinc, calcium, vitamin A, and folate micronutrients. Other findings also suggest that these conditions can occur simultaneously, despite the concurrence remaining poorly understood.

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Ascariasis may cause gut inflammation, lactose intolerance, malabsorption of vitamins and other micronutrients, and appetite loss that could impair weight gain. Several clinical studies demonstrated that adult worms of A. lumbricoides could lead to abdominal distension and pain due to large bowel obstruction. Ascariasis may worsen undernutrition alongside inadequate nutrition intake, hindering children's growth. Regarding stunted as a chronic outcome of infections, besides the parasitic infection itself, other factors could contribute to the development of stunted, such as sociodemographic backgrounds, primary water resources, sanitation facilities, parental education, and family size, as explained below.

Studies also included other factors contributing to Ascariasis. Low household income is associated with Ascariasis because families with low household income tend to be reluctant to build proper sanitation facilities and practice inappropriate defecation behavior, such as open defecation, promoting STH infection such as Ascariasis. Parental education contributes as a protective factor against undernutrition and poor sanitation, thus contributing towards a lower incidence of Ascariasis. Overcrowding in the family increases the chance of helminth transmission. Unprotected water sources also lead to higher cases of Ascariasis and other STH infections. Incidence of Ascariasis could be explained by the fact that the absence of proper and clean sanitation facilities can directly contaminate water and soil, which becomes one of the most critical risk factors for STH infection.

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infections, supported by the population characteristics such as household income, primary water resources, sanitation facilities, parents’ education, and family size. These characteristics could be a risk factor for reinfection and prolonged illness course, leading to chronic undernutrition that manifests as growth restriction. Although the results indicate that Ascariasis increases the risk of stunting, some studies state that chronic nutritional deficits that cause stunting are more affected by socioeconomic and cultural factors, impaired food supply, and its intake, rather than the metabolic effects and impairment of the gastrointestinal function of Ascariasis. Ascariasis might not cause stunting if children were provided with adequate food intake, which may explain why some individual studies show that Ascariasis does not cause stunting. Meanwhile, other studies represent a group of subjects already at risk of stunting due to poor socioeconomic status and impaired sanitation, which increases the risk of other infections and inadequate food intake. Therefore, the manifestation of stunting in children results from multifactorial settings.

The household income as a population characteristic towards Ascariasis showed mixed results. In a study by Yoseph et al., there were no significant associations with Ascariasis after adjusting for other variables, such as sanitation facilities and protected water sources. At the same time, Aimjoy et al. showed that there was an association. The ascariasis infection may be caused by other factors, such as the lack of sanitation facilities and unprotected water sources. Despite these, the associations between household income and stunting are still unclear in the studies.

Although most of the studies already have protected primary water sources, the incidence of Ascariasis remains high. This phenomenon could be caused by numerous contributing factors that lead synergistically to Ascariasis and not solely to primary water resources, such as sanitation, household income, education level, family size, and other factors which are not discussed in this review, such as shoe-wearing practice and raw-food eating behavior. As presumed, the participant group practicing open defecation has the highest ascariasis cases of Ascariasis. The result is also supported by Yoseph et al. who found that the absence of sanitation facilities has a significant positive association with intestinal parasitic infection. This phenomenon could be explained by the fact that the absence of proper and clean sanitation facilities promotes defecation practices such in the rivers, bushes, and latrine pits dug several meters underground, which can directly contaminate water and soil, which these are one of the most critical risk factors for STH infection. Parental education also plays a significant role in Ascariasis, which contributes as a protective factor against undernutrition and poor sanitation. The association between large family size and Ascariasis might be explained by overcrowding in the family increases the chance of helmint transmission. Studies included in this review found that underweight and frequently wasted present in children with Ascariasis, even though their association’s significance may vary. There are several ways that Ascariasis could cause acute undernutrition, such as wasted and underweight. Several clinical studies demonstrated that adult worms of A. lumbricoides could lead to abdominal distension and pain due to large bowel obstruction, that causes lactose intolerance, malabsorption of vitamins and other micronutrients, and appetite loss that could impair weight gain. Considering that wasted and underweight constituted an acute outcome of undernutrition, socioeconomic and demographic determinants are unlikely to affect the occurrence of these conditions. In addition, our meta-analysis shows only underweight have a significant association with Ascaris infections, that are possibly due to limited studies included in our quantitative synthesis.

This issue should be addressed correctly because of its negative long-term effects such as slowed growth, cognitive impairment, and decreased productivity on the next generation. Ascariasis has caused 22.1 million of DALY’s (Disability Adjusted Life Years). As human capital, they play a significant role in country development, therefore, such unaddressed issues may cause slowed development or even a decline.

Ascariasis prevention program has been done in the last several decades by Indonesia government, but Ascariasis is still prevalent (2.5-62%) in Indonesia, especially in poor and remote areas. Several challenges faced by the government were the lack of sanitary education, availability of clean water and waste management, and unsustained intervention in the prevalent region. The inter-program and intersectoral coordination by private or public institutions must also be improved. The Indonesian government should take this matter seriously by conducting programs oriented toward treating and prevention of Ascariasis. According to Indonesia’s national program, Nawa Cita, preventing Ascariasis by improving these factors could help the development in rural and remote regions and increase citizen productivity. Indonesia Sehat Program is part of Nawa Cita to improve health quality and decrease infectious diseases such as Ascariasis in Indonesia.

In this study, we gathered multiple methods to diagnose the A. lumbricoides infection as stated by WHO bench aid, which may not underestimate the infection prevalence. Another strength of this study is that we only focused on mono-infection to investigate the effect of A. lumbricoides on stunted growth in children because A. lumbricoides is the most common cause of intestinal helmint infection in children worldwide. The novelty of our study is the authors evaluate the correlation between Ascariasis and its impact on stunted, wasted, and stunted among the untreated population.

There is some potential limitation to this study. We limit our studies to English and Indonesian language. Therefore, the result can differ from other studies obtained outside this study range of language. We only included published studies; gray literature was not checked and included. Another limitation of this study was that we did not limit the age of the pediatric population, and there were various sample sizes, which resulted in high heterogeneity. Most of the studies included were cross-sectional; therefore, the anthropometric data was only measured once to determine
stunted. Meanwhile, anthropometric data must be taken in serial measurement. Another potential bias that may interfere with these results was the anthropometric measurement tool’s brand and calibrations, which vary among studies.

For future studies, we recommend limiting the pediatric population’s age to reduce the heterogeneity. We suggest the present study investigate the correlation between other intestinal helminths, such as T. trichiura or A. duodenale on stunted children. We also suggest further study about the association between A. lumbricoides infection severity on stunted in children because we lack data for the A. lumbricoides infection severity.

CONCLUSION
Ascariasis increases the risk for stunted, underweight, and wasted in children; however, only stunted, and underweight was statistically significant. Ascariasis is thought to be an acute infection that leads to acute consequences; however, it may also have a chronic and long-term effect on a child’s growth. Considering that Ascariasis remains a neglected tropical disease (NTD) that causing stunted is a great burden of disease in many developing countries, early screening, diagnosis, and intervention need to be taken seriously.

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