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Soil-transmitted helminths infection in pregnant women with anemia: a systematic review



Dianawaty Amiruddin^{1,2*}, Arifi Jauhary Su'dan², Firdaus Hamid³,
Aldian Irma Amaruddin¹

¹Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia;

²Departement of Parasitology, Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia;

³Departement of Microbiology, Faculty of Medicine, Universitas Hasanuddin, Makassar, Indonesia;

*Corresponding author:

Dianawaty Amiruddin;
Faculty of Medicine, Universitas Hasanuddin,
Makassar, Indonesia;
dianatropis@gmail.com

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ABSTRACT

Background: Soil-transmitted helminths are widespread and grow well in countries with tropical and subtropical climates. It is one of the predispositions to anemia for pregnant women during pregnancy. This condition has long-term adverse effects on mothers and their children, causing the need for serious discussion and treatment.

Methods: This systematic review uses pre-existing research by collecting data from valid sources such as Pubmed, Google Scholar, and NCBI, using the inclusion and exclusion criteria that have been determined.

Results: Based on the vast amount of research that has previously been conducted, it was found that there is a close relationship involving the soil-transmitted helminth infection and various types of worms infecting pregnant women, which causes anemia. Pregnant women need nutrients and increased blood volume during pregnancy. However, the infection interferes with the absorption of micronutrients in the gastrointestinal tract, resulting in impaired nutrient transport between the woman and her unborn child.

Conclusion: Soil-transmitted helminth infection is a predisposing factor for anemia in pregnant women and has long-term adverse effects for both mother and child.

Keywords: Pregnant Women, Anemia, Soil-Transmitted Helminths, Systematic Review .

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INTRODUCTION

Soil-transmitted helminths (STHs) is the intestinal parasite that most often causes infection in humans, namely *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm (*Necator americanus* and *Ancylostoma sp.*). This condition most often occurs in tropical and sub-tropical areas with a warm and humid environment that supports the survival of eggs and larvae of worms.¹ Other risk factors that also play a significant role include socio-economic, personal, and environmental hygiene, as well as demographic position. Symptoms can vary when infected with soil-transmitted helminths, specifically in children and adults. STHs are still a public health problem worldwide, in medium to high population densities, rural, suburban or urban communities.¹

According to the WHO, in 2017, more than 1.5 million people, or 24% of the world's population, were infected with STHs.² Indonesia became the 11th-

ranked country in Southeast Asia with an endemic of this disease.² This infection with STHs is one of the leading health problems faced in this country. Recent data shows the prevalence ranges from 45% to 65% in areas with poor sanitation and the possibility of increasing to 80%.²

STHs are transmitted through soil that the feces of infected people have contaminated. In the adult stages of this disease, the worms live in the intestines, where they produce thousands of eggs every day, as mentioned above, specifically in poor sanitation areas with a high prevalence. People at risk of contracting STHs include preschool or school-aged children, women of childbearing age that are either lactating or pregnant and adults whose occupations have a high risk of contracting the parasite.³

Worms that stick to the intestinal mucosal wall absorb blood and nutrients that are supposed to be used for fetal growth. During pregnancy, women usually experience hormonal changes

that suppress and lower their immune systems, making them easily prone to diseases.⁴ One of the dangerous effects of worm infection they usually suffer from is the occurrence of anemia which increases their pregnancy probability. In addition, 38% of these occurring conditions are caused by helminth infections.⁵

Anemia is when the amount of hemoglobin in the blood decreases. Hemoglobin is a protein in red blood cells that functions as a medium for transferring oxygen to target organs from the lungs to the rest of the body.⁶ The clinical manifestations obtained are very diverse. However, the typical symptom is that someone will feel tired instantly or weak.⁶ The causes are also very varied, and an example of some people with certain conditions with a higher risk factor for experiencing anemia is pregnant women. Approximately 41.8% of them suffer from this condition worldwide, and half of these cases occur due to iron deficiency and parasitic infections.⁷

This research reviewed the latest data and information concerning the STHs parasite and its effect on anemia in pregnant women, taking into account the results of the previous study. This research also includes finding how the clinical symptoms and risk factors of each match the inclusion criteria and its use in the future as material and data for prevention and anticipation against anemia in pregnant women due to STHs infection.

METHODS

Search Strategy

The search for resources was conducted using a validated search engine: PubMed, NCBI, and Google Scholar. The literature sources used in discussing primary material of anemia related to STHs infection in pregnant women used the keywords: anemia, pregnant women, and STHs. With these keywords, 330 study was found, which was then reduced according to the exclusion criteria set by the author, which states that the year of publication must not be more than 10 years unless there was no literature in a similar language and it results in a total of 45 literature. It was then reduced again based on the suitability of the literature title with the topic discussed, resulting in 13 studies to be summarized in this systematic review.

Through a valid search engine, Pubmed, Google scholar, and NCBI, article searches used keywords (AND, OR, NOT) to broaden and specify the tracking so that the journals obtained will be more targeted according to the desired criteria. The keywords for this study are (Soil-transmitted helminth infection) AND (anemia in a pregnant woman) and (Soil-transmitted helminths infection) OR (*Ascaris lumbricoides* infection) OR (*Trichuris trichiura* infection) OR (hookworm infection) AND (anemia in a pregnant woman). Journals used are journals in English and Indonesian only; other than those two languages will not be used.

Eligibility Criteria

We included the following study types: a prospective study, retrospective cohort study, cross-sectional study, retrospective observational study, systematic review, and literature review (full text), and articles

with a period of publication in the last 10 years (2011-2021), Studies that examine pregnant women infected with STHs and exposed to anemia, and also all studies in English and Bahasa.

The included study involved pregnant women living in an area endemic and non-endemic for STHs or who were confirmed to have an STHs infection and the outcome studies that explain the relationship between STHs infection in pregnant women and the occurrence of anemia cases.

Data Collection

The following data were collected from the journals, namely 1) author, 2) year of publication, 3) types of soil-transmitted helminth worms, 4) several samples, 5)

research design, 6) objectives, and 7) research sites.

Quality Assessment

Two authors independently evaluated all identified inclusion studies, and any disagreement between authors was resolved through the involvement of a third author. Newcastle Ottawa Scale (NOS) was used to assess the retrospective/observational study. The evaluation of the NOS instrument was classified into 3 groups which are low quality (0-3), medium quality (4-6), and high quality (7-9).

Study Selection

The review and reporting were conducted according to PRISMA guidelines (Figure 1).

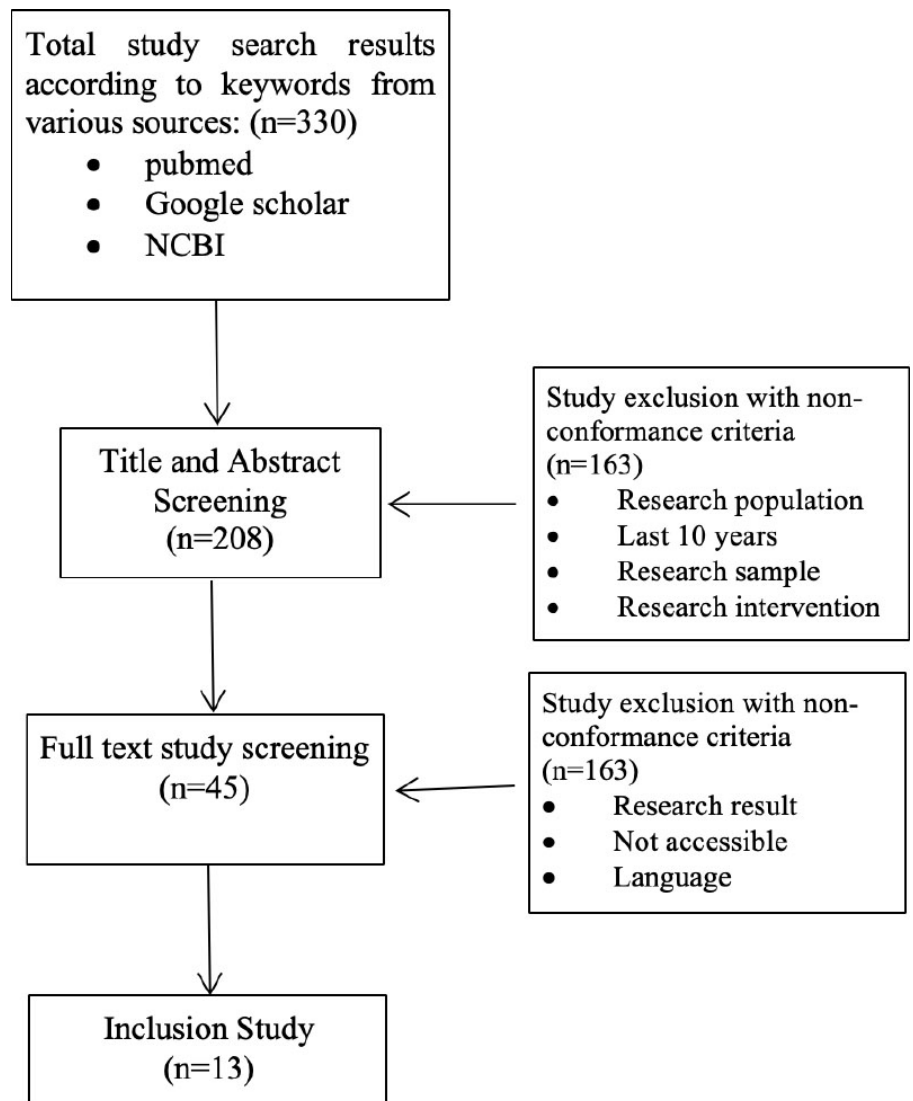


Figure 1. Study Selection (PRISMA flow chart).

RESULTS

This systematic review compares the 13 research (Table 1) with various samples and backgrounds. STHs are widely distributed in tropical and subtropical areas, with no significant symptoms in sufferers. Furthermore, this research investigates how anemia occurs after infection from STHs. This research was carried out by taking stool samples and data from ANC, which mostly had pregnant women as their

patients, and also examining other factors, such as primigravida, multigravida, ethnicity, age, and trimester.

Tay et al. observed the pregnant women and found that 66.4% (249/375) were anemic, and 50% (188/249) with this condition were associated with STHs worm infection.⁸ This research was conducted at ANC; therefore, the correlation between STHs infection and anemia in pregnant women was clear, which was also in line

with Lebso's.⁹ A total of 301/507 were diagnosed with anemia through stool examination by random sampling of 7 health posts (hospitals/public health centers).⁹ It was found that 32% (163/507) were caused by STHs infection, which was dominated by *A. lumbricoides* and hookworms. Both kinds of research suggested that anemia occurred due to STHs infection. Getachew et al., stated that 53.9% or 209 out of 388 pregnant

Table 1. Characteristics of studies included in this study.

Authors	Research Design	Soil-Transmitted Helminths	Number of Samples	Sample Age (n)	Research Sites
Misikir et al. ¹¹	Cross Sectional	Hookworm	300 people	- < 18 years: 12 - 19-24 years: 143 - >24 years old: 145	Dembecha District, western Ethiopia. (Urban and rural areas)
Brummaier et al. ¹⁶	Retrospective Review	- <i>A. lumbricoides</i> - Hookworm - <i>T. trichiura</i> - Variative	12,000 people	- <20 years: 1,213 - 20-29 years old: 3,709 - 30-39 years old: 1,919 - >40 years old: 323	Thailand-Myanmar border. (Rural area)
Kumera et al. ¹²	Cross Sectional	Hookworm	234 people	- 15-24 years old: 73 - 25-34 years: 124 - >35 years old: 37	Debres Markos Hospital, Ghana. (Urban area)
Mengist et al. ¹³	Cross Sectional	- Hookworm - <i>A. lumbricoides</i>	372 people	- <29 years old: 293 - >29 years old: 79	East Wollega, Oromia, Ethiopia. (Rural and urban areas)
Bolka et al. ¹⁸	Cross Sectional	- Hookworm - <i>A. lumbricoides</i> - <i>T. trichiura</i>	504 people	- 18-20 years: 36 - 20-35 years: 304 - > 35 years: 9	Genet District, Southern Ethiopia. (Rural and urban areas)
Kenea et al. ¹⁹	Cross Sectional	Variative	416 people	- 18-24 years: 176 - 25-31 years: 210 - 32-38 years: 28 - 39-45 years: 2	Ilu Abba hospital, West Ethiopia. (Urban and rural areas)
Tay et al. ⁸	Cross Sectional	- Hookworm	375 people	- 15-19 years old: 62 - 20-29 years: 216 - 30-39 years old: 87 - 40-49 years: 10	Dangme district, Northern Ghana. (Urban and rural areas)
Lebso et al. ⁹	Cross Sectional	- <i>A. lumbricoides</i> - Hookworm - <i>T. trichiura</i>	507 people	- 15-24 years: 154 - 25-34 years: 251 - 35-49 years old: 99	Nigeria. (South coast area)
Gyorkos et al. ¹⁴	Cross Sectional	- <i>T. trichiura</i>	935 people	-	Iquitos, Peru. (Coast area)
Getachew et al. ¹⁰	Cross Sectional	Variative	388 people	- 16-20 years old: 69 - 21-25 years: 62 - 26-30:54 - 31-35 years: 17 - 36-40 years: 7	Gilgel gibe dam area, South of Ethiopia. (Rural area)
Obiezue et al. ⁶	Cross Sectional	Variative	282 people	- 18-20 years: 37 - 21-30 years: 177 - 31-40 years old: 62 - 41-45 years: 6	Isaila Mbano, Nigeria. (Urban and rural areas)
McClure et al. ²⁰	Cohort study	Variative	706 people	- 22-44 years: 154 - <20 years: 36	Kenya (Coastal area)
Demeket et al. ²¹	Cohort Study	Hookworm	281 people	26-35 years: 281	Northwest, Ethiopia. (Urban and rural areas)

women experienced this condition, and about 88,5% (n=185) were caused by STHs infection dominated by several types of worms such as *A. lumbricoides*, *T. trichiura*, and hookworm.¹⁰ In addition, the samples were grouped based on socio-demography and economics.

According to the research by Misikir et al., which was conducted in Ethiopia, it was found that hookworm had the highest prevalence compared to other types of worms, which was in line with Kumera et al.^{11,12} Approximately 12% of hookworm infections are the causes and aggravate anemia in pregnant women.^{7,13} About 31% of the total population experience this condition, with hookworms having the highest prevalence, followed by *A. lumbricoides*. These hookworm infections are the causes and aggravate anemia and its effects on mothers and their children. According to Obiezue et al., about 41 or 16.3% of pregnant women are infected with worms that can significantly reduce Hb, and hookworms are numerically the most influential and significant in reducing Hb.⁶ Few of the research mentioned above-collected samples along with several variables such as age, place of residence, marital status, educational history, race, occupation, socioeconomic and demographic, to religion. It is believed that these complex variables can map the distribution of worms and the degree occurring to each individual. The degree of anemia that occurs is generally moderate to severe based on the intensity of the worm eggs present. In addition, according to Gyorkos et al., about 82% of 935 pregnant women were infected with *T. trichiura*, with a worm intensity range of 24 > 1,633 eggs per gram (EPG).¹⁴

DISCUSSION

According to Shrinivas et al., 82% of people suffering from STHs infection have moderate to severe anemia (52/65).¹⁵ STHs infection is associated with slow and massive blood loss and inadequate micronutrients for absorption. In the research by Mengist et al., it was stated that moderate-severe anemia during pregnancy is the leading cause of infant mortality.¹³ At the same time, babies born safely tend to experience Low Birth Weight (LBW), Intra Uterine Growth Restriction

(IUGR), and other secondary infections that interfere with the baby's development. The most common type of anemia after STHs infection is moderate-severe anemia, in which hookworms dominate for the highest infection, followed by *A. lumbricoides*.

This research was conducted on pregnant women that attended ANC, specifically those in their 1st trimester of pregnancy, and cases with a strong relationship between the prevalence of helminth infections and anemia. It was found that the majority of STHs infections were quite large, and around 30% of the total sample with varied types of worms. However, according to other research, hookworms always have the most significant prevalence among other worms. Brummaier et al., stated that cases of STHs infection with anemia occurred in 21.2% (2,702 cases) of the total sample.¹⁶

A group of intestinal hookworms penetrate the oral cavity and human skin and travel into the gastrointestinal system through the blood vessel. They arrive in the jejunum or small intestine and then grow and attach themselves to the intestinal wall resulting in severe blood loss from the host.¹⁷ However, despite their long lifespan, most worms are usually eliminated within 1 to 2 years, and when in their dormant phase, they are aggressively undetectable. Anatomically, hookworm is 8 to 11 mm long for females and 10 to 13 mm for males; during the eggs, it has a thin shell but is quite remarkable because they can adapt to the host's internal environment or outside.¹⁷

This research was conducted in tropical and subtropical areas through available data on pregnant women attending ANC. The worms also examined varied, whereby hookworm and *A. lumbricoides* were the two worms with the highest prevalence. The second trimester of infection was the most common time with the highest prevalence of 46.3%, followed by the 1st and 2nd trimesters having 39.6% and 14.1%, respectively. Lateness and non-compliance with ANC were also predisposing factors for severe anemia due to STHs infection. The intensity of the severity of infection and anemia experienced by pregnant women is related to the stool examination results from ANC

and high egg content.

It was found that each worm has a relatively high probability of causing post-infectious anemia. Examples include hookworm, *T. trichiura*, and *A. lumbricoides*. Furthermore, the intensity of the infection is most likely to determine the degree of anemia that will be experienced. This study is also in line with Gyorkos et al., which was carried out on pregnant women by paying attention to the type of worm, namely *T. trichiura*. The infection was believed to be 'severe,' 'moderate,' and 'mild' as seen from the intensity of the eggs (EPG or eggs per gram), which were examined on stool samples.¹⁴

In the study by Lebso et al., 23.2% of pregnant women with STHs infection experienced moderate-to-severe anemia.⁹ The economic status factor was not ruled out, considering how a sample of 504 people followed the diet and dietary patterns. The diagnosis was made through stool collection to determine infection from STHs and blood sampling to diagnose anemia. It was found that about 66.6% of anemia cases were moderate to severe cases, and about 33.3% were mild. This is in line with previous research on the type of anemia that occurs after infection from STHs. Furthermore, it was stated that women in their 2nd and 3rd trimesters have a 3 times greater chance of developing anemia.

The research by Obiezue et al., found that STHs worm infection or helminthiasis by this species could reduce hemoglobin levels significantly compared to pregnant women who were not infected.⁶ Through hematological assessment, it was found that hookworms had the most significant effect compared to other worms, with a reduction of about 0.389 post-infection Hb levels, while *A. lumbricoides* and *T. trichiura* were 0.104 and 0.056, respectively.

In another research conducted by Tay et al., with a total of 375 samples, about 66.4% were infected with worms of various types.⁸ They emphasized that anemia during pregnancy is detrimental to the mother, the unborn baby, and those who have already been born. Furthermore, the previous study also showed that an individual pregnant woman with anemia in the 1st trimester was 10 times more

likely to have LBW than those who were not anemic, while the 2nd-trimester anemia had 16 times greater risk.⁸

Further and in-depth research is needed concerning the relationship between STHs infection and the incidence of anemia in pregnant women. This is because there is limited literature that specifically discusses the relationship between these two conditions and the causes of anemia in mothers and children.

This study is not without limitations. The study's design is a systematic review and does not reach the meta-analysis level. Therefore, a quantitative analysis could not be made to analyze the exact effect of STH infection further. Furthermore, the result from the qualitative research may not be able to provide subgroup analysis to potentially further identify the specific factors which could influence the incidence of STH infections in a pregnant woman as well as the risk of developing anemia in this population.

CONCLUSION

Most research observed the association between STHs infection and anemia in pregnancy and the prevalence of anemia in pregnant women in varying trimesters. However, the most severe anemias were found in the 2nd and 3rd trimesters, and hookworm was one of the risk factors for moderate to severe anemia. The presence of anemia during pregnancy will significantly impact the fetus after birth, LBW, secondary infections, and IUGR, which are several factors that will disrupt the baby's development after birth and long-term growth.

ETHICAL CONSIDERATION

This study is exempt from ethical approval in our institution.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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AUTHOR CONTRIBUTION

Dianawaty Amiruddin and Arifi Jauhary Su'dan were responsible for the literature search, data analysis, statistical analysis, manuscript preparation, editing, and review. Firdaus Hamid and Aldian Irma Amaruddin were accountable for concepts, design, the definition of intellectual content, clinical studies, data acquisition, and manuscript preparation. All authors read and approved the final manuscript.

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