

# **Anemia and Other Blood Symptoms Related Soil Transmitted Helminthiasis: An Internet Approach of Systematic Literature Study Reported Across Indonesia**

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## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author FES designed the study, performed the initial literature searches, wrote the protocol and wrote the first draft of the manuscript. Author EM managed the analyses of the study and also managed the advanced literature searches. Both authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/IBRR/2020/v11i330133

Editor(s):

(1) Dr. Dharmesh Chandra Sharma, J. A. Groups of Hospital and G. R. Medical College, India.

Reviewers:

(1) Kamal Hashan Bulbul, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India.

(2) Amit Kumar Jaiswal, UP Pt. Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan (DUVASU), India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/62089>

**Received 25 July 2020**

**Accepted 03 October 2020**

**Published 15 October 2020**

**Systematic Review Article**

## **ABSTRACT**

**Background/Aim:** Soil Transmitted Helminthiasis (STH) is still a global major problem, affecting billion vulnerable people of marginalized and unfortunate communities from low to middle level social economic countries. Poor personal hygiene and sanitary practice facilitates its transmission. Children and pregnant women are the most vulnerable group. It causes spectrum of clinical conditions from completely asymptomatic to severe, but anemia and nutritional derangement are the most prominent. Anemia related STH itself was already a huge problem, especially when affected susceptible individuals. In the internet, the data on Indonesia's prevalence of anemia and other blood symptom related STH with its contributing factors are always considered sparse and incomplete. The aim of this systematic literature study was to provide that data by doing the internet literature searching on Indonesia's electronic data regarding this condition.

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**Methods:** A systematic review was done using popular search engine in the internet. All kind of research study, no matter the design (cross sectional, case control or prospective cohort), that fit with inclusion criteria which is anemia or other blood related symptoms (e.g. eosinophilia) related to STH were included.

**Result:** There were 37 studies found on this issues, from 2001 until 2020. Most studies reported anemia that developed during the course of the disease with the clinical spectrum varies from asymptomatic to severe form.

**Keywords:** *Intestinal parasite; epidemiology; neglected tropical disease; iron deficiency; chronic; hemoglobin.*

## 1. INTRODUCTION

Soil transmitted helminthiasis (STH) is a terms that refer to an infection caused by a group of nematoda worms affecting the intestinal of humans that can be transmitted through contaminated soil; where this typical soil facilitates its growth, from egg into mature egg or from egg into hatching egg then released larvae and transform into infection-ready larvae [1,2]. These worms that belongs to the STH are *Ascaris lumbricoides*, the hookworms (*Anclostoma duodenale* and *Necator americanus*), the whipworm (*Trichuris trichiura*), and *Strongyloides stercoralis* [1].

Epidemiologically, STH is the most globally widespread of the neglected tropical diseases, primarily affecting unfortunate and marginalized communities in low- and middle-income countries. In global measurement, it was estimated that 310 million preschool-age children, 762 million school-age children, and 688 million women of reproductive age (including 69 million pregnant women) were at risk of STH infection. More than one billion people are currently infected with STHs [2]. Indonesia also still having this type of helminthiasis as one of its major health problem [3-5]. Eradication is in progress, but its rate is still not as fast as expected.

Helminthiasis due to STH can cause several problems from anemia due to intestinal bleeding and malnutrition, especially in children, as it worsens their nutritional status in multiple ways and in long terms affect their future growth and development status, including psychomotor performance and stunting. Anemia perhaps is the most prevalent effect of STH, compare to other STH related symptoms [6-8].

Internet/electronic data on anemia and other symptom related STH in Indonesia were sparse and perhaps under reported. The aim of this

systematic review on anemia related STH across Indonesia on published data available in the internet is to study the prevalence of anemia related STH and its related factors and to make an overview of the anemia related STH on Indonesia's map.

## 2. METHODOLOGY

Literature searching conducted on the internet using popular search engine Google™, Yahoo™ and Google Scholar™. The phrase used were "Anemia STH Indonesia Pdf", "Soil Transmitted Helminths Anemia Indonesia pdf", "Anemia Kecacingan Usus Indonesia Pdf", "Kecacingan Usus Anemia Indonesia Pdf" and "Anemia among Soil Transmitted Helminths in Indonesia Pdf". We combined the search term in Bahasa Indonesia/Indonesian language and in English in order to get as many as possible electronically available published data on anemia due to STH in Indonesia.

This internet based literature searching held from September 10<sup>th</sup> to September 20<sup>th</sup> 2020. Potential article were carefully sorted based on: (1) type of article (must be research article or original article), (2) its title and (3) content of the abstract and then saved first in the portable storage media for further analysis. Thorough and careful reading was done in order to make sure that the potential article actually revealed the incidence of anemia related STH on their report. Factors, intrinsically or extrinsically, that might contribute to the occurrence of anemia were also screened. A brief note when considered necessary by authors was made on these findings and will be included in the summary table. Publication of research study that met the as early mentioned criteria included in this systematic reviews.

## 3. RESULTS

During 10 days of literature searching, the authors screened hundreds of articles obtained

from popular search engine using phrase previously mentioned. From that article, fast reading conducted on screening of the type of the article (research article or original article is a must), the title and the abstract in order to screen the candidate article to be included in the study. From hundreds of potential article gathered, prospectful articles can be shorten into dozens and the final number of article which was carefully assessed by the authors were 37 articles, all of these article have met the inclusion criteria.

This summary of studies presented in the form of table (Table 1) which consist of the name of the first author, year of publication, design of the study with brief description about the method, number of the subject and the findings. Interesting point related to the study if considered important also included in the table.

### 3.1 Type of STH Infection

From 37 studies, almost all were screened for STH. Species of nematode that belong to STH are *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm (*Ancylostoma duodenale* and *Necator americanus*) and *Strongyloides stercoralis*, with the exception to the study conducted by Aryadnyani et al 14 that only reported cases of trichuriasis (infection caused by *T. trichiura*). From all these studies, not a single study reported cases of strongyloidiasis. Some studies also reported cases on non STH intestinal nematode named *Oxyuris vermicularis/Enterobius vermicularis*, but due to the aim of the study, that report on oxyuriasis/enterobiasis not shown.

### 3.2 Population of the Studies

Most studies included in this systematic review had an almost uniform population which was elementary school based (28 out of 37/75.67%) with the exception of the study conducted by Putra et al [4] in Banda aceh and Bestari and Cambodia [23] in Surakarta which targeted garbage/waste collector worker, study conducted by Nurdianti et al [21] in Purworejo and Pradhana [22] in Gatak Surakarta which targeted pregnant women, study conducted by Elfred et al [27] in Kediri and Cahyani et al [28] in Jember which respectively targeted farmer and coffee plantation worker, study conducted by rahayu [24] in Sukoharjo which targeted female teenager and last but not least was study conducted by

Syahnuddin et al [35] that targeted high school female teenager.

### 3.3 Level of Anemia and Its Relation to the STH

Out of 37 published paper that included in this study, 34 (91.89%) reported the measurement of haemoglobin (Hb) with the exception of three study conducted by Putra et al [4] in Banda Aceh that measured eosinophil, study by Elfred et al [27] in Kediri that tried to determine the role of Basophils, TNF- $\alpha$  and Il-9 in STH infections and the last was the study conducted by Cahyani et al [28] in jJember which tested the leukocytes differential counts among STH infected individuals. Both study conducted by Elfred *et al* and Cahyani *et al* were designated as case control study with the aim of the study were to compare the group of STH infected and non infected [27,28].

### 3.4 Geographic Distribution and Time Range

All studies included in this systematic review conducted within the territory of the republic of Indonesia. Indonesia is a very huge archipelago country consisted Of 13,000+ islands and surrounded by seas. But unfortunately, these studies being reviewed systematically were not able to represent all region of Indonesia. The time range of these studies from the year 2001 conducted by Nurdianti et al. [21] in Purworejo until 2020.

## 4. DISCUSSION

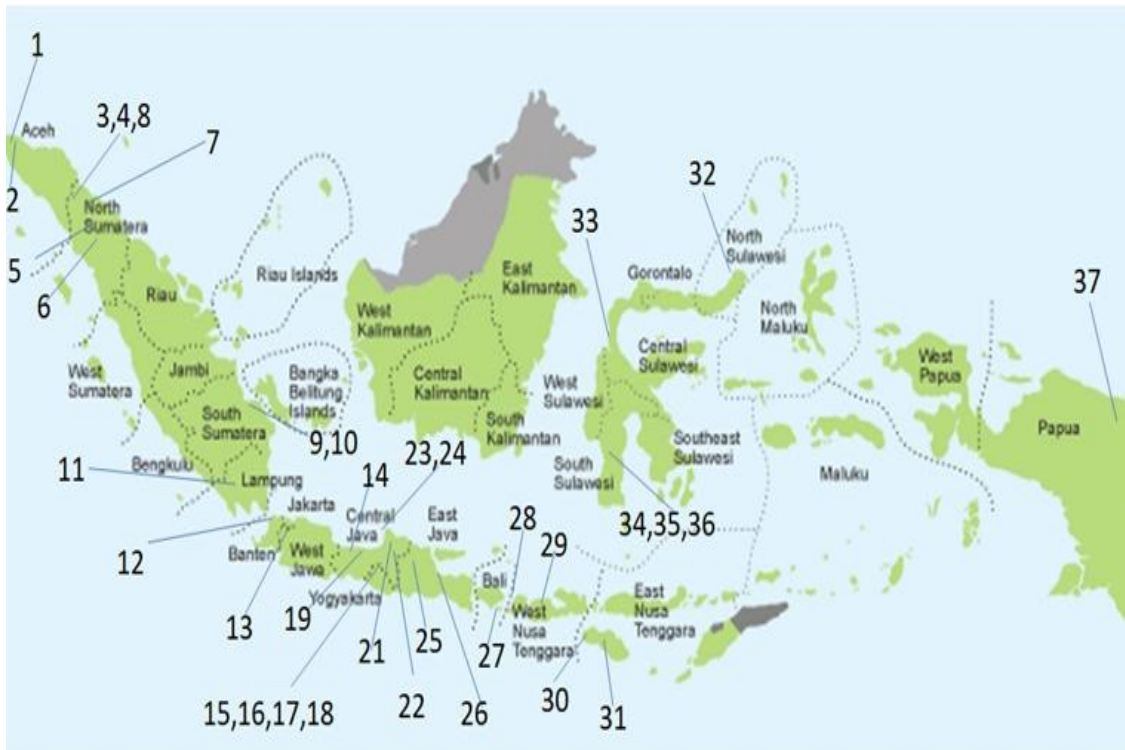
One of the classic problem in country with very wide geographic range like Indonesia is the problem of lack of reporting or unavailability data, just like this study found out, exactly just as Lee & Ryu reported in 2019 [40]. Within the range of 20 years, both authors of this systematic study can only found 37 studies that matched with the aim of the study. Both authors believe that this kind of condition (anemia related STH) are still common, especially in region where personal hygiene practice and environmental sanitary are poor, just as reported elsewhere [41,42]. But to the author's point of view, the problem of unavailability in the internet regarding to this in the same time actually is an opportunity to Indonesian scholar to dig deeper the scope of the problem in their area and then reported it professionally so that the data can become

available in the internet. By providing such data, it will help other scholar to study and perhaps make further exploration related to the issues, e.g other non-medical problem that might predispose this infection to happen. Considering the very wide area of Indonesia, as can be seen in Fig. 1, most of the data came from western part of Indonesia, but the data from eastern area of Indonesia that was available in the internet relatively rare.

Anemia is one of direct effect caused by an ongoing STH. Data from this study showed us that the spectrum of anemia due to STH can be ranging from asymptomatic/unaffected to severe anemia [3-39]. Species of STH that commonly related to anemia is *T. trichiura* and hookworm because both of them directly affected the mucosal surface of the intestine [42]. A comprehensive study conducted by Angraini et al [7] in Karo and Sungkar et al. [32] in Southwest Sumba showed us how treatment with anthelmintic albendazole @ 400mg can reduce the prevalence of STH and anemia, and in turn

improve the quality of life. Many aspects related to STH infection can be explored deeply from the epidemiology, clinical aspect, its treatment and even other public health related issues that might interfere with any other discipline outside Medicine.

Population of study on this systematic review showed us that actually there is nobody immune to STH [43]. But to some extent, there is specific part of the population that become more vulnerable to infection, e.g. children and pregnant women [1,2]. Considering that Indonesia Population data on 2020 as much as 268,583,016 People, it will be very interesting to explore deeper about the possible existence of specific characteristics or differences among particular portion of the society regarding the anemia status among STH infected individuals. By making the data more available in the public area, it might help the effort to fight and eliminate STH and also its blood related consequences. Prevention is still the best way to avoid much greater risk and consequences of STH [44].



**Fig. 1. The Indonesian map of studies available on the internet about anemia due to Soil Transmitted Helminthiasis (STH) across Indonesia, with numbers representing the sequence in table 1 and the blue line indicating the geographic area where the research was conducted**

**Table 1. Anemia and other blood symptom related STH conducted across Indonesia available on the internet as the result of literature searching on popular search engine**

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
1	Aceh Besar, Aceh	Heri et al. [3] (2015)	Cross sectional, school based, Kato Katz methods	736 children of school aged	Prevalence of STH (+) 87/736 (11.82%), consisted of <ul style="list-style-type: none"> <li>hookworm 7/87 (8.04%), all anemia</li> <li>trichuriasis 58/87 (66.66%), 30/58 anemia(51.7%)</li> <li>ascariasis 22/87 (25.28%), 13/22 anemia(59.9%)</li> </ul> <p>(<math>p=0.00</math>)</p>
2	Banda Aceh, Aceh	Putra et al. [4] (2018)	Cross sectional, community based, Kato Katz methods and absolute eosinophil count (blood preparations)	60 waste collectors from Sanitation Department in Banda Aceh	<ol style="list-style-type: none"> <li>Prevalence of STH (+) 14/60 (23.3%) consisted of <ul style="list-style-type: none"> <li>trichuriasis (21.7%)</li> <li>mixed infection 1.6% (ascariasis + trichuriasis)</li> <li>no single infection of <i>A. lumbricoides</i> or hookworm</li> </ul> </li> <li>Prevalence of eosinophilia 21.7% (13/60). There was no significant association between STH infection and blood eosinophil level (<math>p = 1.00</math>).</li> <li>This study does not recommend the use of eosinophilia as a marker for STH infection</li> </ol>
3	Medan Amplas, Medan-North Sumatera	Darlan&Kaban [5] (2016)	Cross sectional, School based	72 school age children	<ol style="list-style-type: none"> <li>Prevalence of STH 29/72 (40.27%) consisted of <ul style="list-style-type: none"> <li><i>A. lumbricoides</i> 19/29 (65.51%)</li> <li><i>T. trichiura</i> 5/29 (17.24%)</li> <li>Mixed (ascariasis+trichuriasis) 5/29 (17.24%)</li> </ul> </li> <li>Anemia among STH (+) 14/29 (48.27%) (<math>p=0.002</math>)</li> </ol>

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
4	Medan tuntungan, Medan-North Sumatera	Rehgita [6] (2017)	Cross sectional School based	50 school aged students	<ol style="list-style-type: none"> <li>No student suffer from STH</li> <li>The prevalence of non STH origin anemia 8/50 (16%)</li> </ol>
5	Tiga Panah, Karo, North Sumatera	Angraini et al [7] (2005)	Cross sectional School based	366 school aged students helminthiasis (+), 113 selected to be treated with a single oral dose of 400mg albendazole.	<ol style="list-style-type: none"> <li>Among 113 subjects, the prevalences of ascariasis, trichuriasis, and mixed infestation were 18.3%, 40.4%, and 41.3%, respectively, while the prevalence of anemia was 33.0% (<math>p&gt;0.05</math>).</li> <li>For each type of infestation, there were significant differences in mean Hb concentration and anemia prevalence before and after treatment (<math>p&lt;0.05</math>).</li> </ol>
6	Silahi sabungan, Dairi, North Sumatera	Girsang et al [8] (2018)	Cross sectional School based	116 school aged students	<ol style="list-style-type: none"> <li>Prevalence of STH (+) 32/116 (27.58%)</li> <li>Mean Hb among STH (+) 9.4 g/dL (low)</li> </ol>
7	Pancur Batu, Deli Serdang-North Sumatera	Julianto et al [9] (2018)	Cross sectional Orphanage based	35 children	<ol style="list-style-type: none"> <li>Prevalence of STH (+) 15/35 (42.85%), consisted of <ul style="list-style-type: none"> <li>trichuriasis 5/15 (30%)</li> <li>ascariasis 7/15 (46.66%)</li> <li>mixed infection (+) 3/15 (20%)</li> </ul> </li> <li>STH (+) based on gender mostly female 8/15 (53.33%)</li> <li>Anemia among STH (+) 7/15 (46.66%)</li> </ol>
8	Medan Amplas & Hamparan perak- Deli Serdang, North Sumatera	Darlan et al [10] (2018)	Cross sectional school based Kato Katz methods	132 school aged children	<ol style="list-style-type: none"> <li>Prevalence of STH (+) 10/132(7.57%) consisted of <ul style="list-style-type: none"> <li>trichuriasis 5/10 (50%)</li> <li>hookworm (+) 1/10 (10%)</li> <li>ascariasis 4/10 (40%)</li> </ul> </li> <li>The Prevalence of anemia among STH (+) 5/10 (50%)</li> </ol>
9	Palembang, South Sumatera	Aji et al [11] (2017)	Cross sectional, school based Kato Katz methods	50 school aged students	<ol style="list-style-type: none"> <li>Prevalence of STH (+) 6/50 (12%)</li> <li>All STH (+) respondents suffer from anemia (<math>p=0.003</math>)</li> </ol>

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
10	Palembang, South Sumatera	Armo [12] (2019)	Cross sectional, School based Kato Katz methods	84 school aged children	1. Prevalence of STH (+) 34/84 ( 40.5%) 2. Prevalence of anemia among STH (+) 4/34 (11.8%)
11	Kelumbayan, Tanggamus, Lampung	Riswanda et al [13] (2019)	Cross sectional, School based	50 school aged children	1. Prevalence of STH (+) 29/50 (58%) 2. Prevalence of STH (+) with anemia 17/29 (58.62%) ( $p=0.093$ )
12	Kilalah, East Serang, Banten	Aryadnyani et al [14] (2020)	Cross sectional school based kato Katz methods	42 school aged students trichuriasis (+)	Prevalence of anemia among trichuriasis (+) 6/42 (14.28%) ( $p=0.00$ )
13	Jatinangor, West Jawa	Eidwina et al [15] (2016)	Cross sectional school based	74 school aged students	1. Prevalence of STH (+) ascariasis only 16/74 (21.62%) 2. Prevalence of anemia among ascariasis (+) 3/16 (18.75%)
14	Barengan Teras Boyolali, Central Jawa	Salsabila et al [16] (2015)	Cross sectional, school based, formol ether concentration technique	74 school aged children	1. Prevalence of STH (+) 35/74 (47.29%) 2. Prevalence of anemia among STH (+) 11/35 (31.42%) ( $p=0.43$ )
15	Kokap-Kulon Progo, Yogyakarta	Fatimah et al [17] (2012)	Cross sectional, 1 <sup>st</sup> grade, 25 elementary school, Kato Katz methods	241 school aged children	1. Prevalence of STH 71/241 (29.46%) consisted of <ul style="list-style-type: none"> <li>• ascariasis: 16/71 (22.53%) light infection, 7/71 (9.85%) medium infection</li> <li>• trichuriasis 36/71 (50.70%) light infection, 8/71 (11.26%) medium infection</li> <li>• hookworm 4/71 (5.63%)</li> </ul> 2. Prevalence of anemia among hookworm (+) 1/4 (25%)
16	Banguntapan, Bantul, Yogyakarta	Sumekar et al [18] (2019)	Cross sectional, 3 elementary school, flotation method	115 school age children	1. Prevalence of STH (+) 1/115 (0.86%) 2. No clear statement wether individuals with STH (+) suffer from anemia

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
17	Sleman, Yogyakarta	Pratiwi et al [19] (2019)	Cross sectional, elementary school based, Kato Katz methods	81 school age children	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 9/81 (11.11%)</li> <li>2. Prevalence of anemia among STH (+) 5/9 (55.55%) (<math>p=0.152</math>, Ratio Prevalent=1.818)</li> </ol>
18	Moyudan-Sleman, Yogyakarta	Sofiana et al [20] 2019	cross sectional, elementary school based	311 school aged children	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 5/311 (1.6%), non STH (+) 3/311 (0.96%)</li> <li>2. Prevalence of anemia among helminthiasis (+) 2/8 (40%) (<math>p=0.214</math>, Ratio Prevalent=2.367)</li> </ol>
19	Purworejo, Central Jawa	Nurdiati et al [21] (2001)	cohort study population based	442 pregnant women from early pregnancy until 5-7 weeks post delivery	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) at 1st/2nd/3rd semester consisted of: <ul style="list-style-type: none"> <li>• hookworm: 23.8%/23.3%/19.3%</li> <li>• trichuriasis: 49.3%/49.7%/40.4%</li> <li>• ascariasis: 18.8%/21.2%/20.7%</li> </ul> </li> <li>2. Anemia at 1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup>: 20.2%/37.1%/30.0%</li> </ol>
20	Gatak, Surakarta, Central Jawa	Pradhana [22] (2014)	Cross sectional, Primary health care based	30 pregnant women	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 14/30 (46.66%)</li> <li>2. All STH (+) were also suffer from anemia</li> </ol>
21	Surakarta, Central Jawa	Bestari & Cambodia [23] (2016)	Cross sectional, specific population	30 garbage worker	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 3/30 (10%) consisted of <ul style="list-style-type: none"> <li>• Ascariasis 1/3 (33.33%)</li> <li>• Hookworm 2/3 (66.67%)</li> </ul> </li> <li>2. All STH (+) were also suffer from anemia</li> </ol>
22	Sukoharjo, Central Jawa	Rahayu [24] (2018)	Case control, specific population	46 female Teenager; 26 anemia and 20 non anemia	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 7/46 (15.21%)</li> <li>2. Prevalence of anemia among STH (+) 2/7 (28.57%) (<math>p=0.04</math>)</li> </ol>



No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
23	Semarang, Central jawa	Ali et al, [25] (2012)	Cross sectional, elementary School based	32 school age children Mean age 10.94	<ol style="list-style-type: none"> <li>The prevalence of STH 10/32 (31.25%) consist of <ul style="list-style-type: none"> <li>ascariasis 9/10(90%)</li> <li>trichuriasis 1/10 (10%)</li> </ul> </li> <li>Anemia based on STH species (<math>p=0.017</math>) : <ul style="list-style-type: none"> <li>ascariasis 6/9 (66.66%) very low (8-10g/dL) and 3/9 (33.33%) low (10.1-12g/dL)</li> <li>trichuriasis 1/1(100%) very low</li> </ul> </li> </ol>
24	Bandar Harjo, Semarang, Central Jawa	Pradipta <i>et al</i> ,[26] (2019)	Cross sectional elementary school based	51 school age children, 4 <sup>th</sup> and 5 <sup>th</sup> grade	<ol style="list-style-type: none"> <li>The prevalence of STH 2/51 (3.92%)</li> <li>Anemia among STH 1/2 (50%) (<math>p=1.00</math>)</li> </ol>
25	Kediri, East Jawa	Elfred et al, [27] (2016)	Case control Specific population	20 STH (+) infected farmer vs 20 non-infected farmer; to determine the role of basophils, TNF- $\alpha$ and IL-9 on STH infections	<p>Statistically, there is:</p> <ol style="list-style-type: none"> <li>no difference on mean basofil count (infected vs non infected) (<math>p=0,418</math>)</li> <li>difference on mean TNF-<math>\alpha</math> count (infected vs non-infected) (<math>p=0,019</math>)</li> <li>no difference on mean IL-9 count (infected vs non-infected) (<math>p=0,725</math>)</li> </ol>
26	Jember, East Jawa	Cahyani et al,[28] (2020)	Cross sectional, specific population coffee plantation worker	101 adults, checking the Leukocytes differential counts	<ol style="list-style-type: none"> <li>The prevalence of STH (+) 27/101 (26.73%) consisted of <ul style="list-style-type: none"> <li>hookworm 25/27 (92.59%)</li> <li>mixed 2/27 (7.4%)</li> </ul> </li> <li>The leukocytes differential counts, (abnormal n=17: <ul style="list-style-type: none"> <li>eosinophilia 5/17 (29.41%)</li> <li>neutrophilia (segmental) 9/17 (52.94%)</li> <li>eosinophia+neutrophilia 2/17 (11.76%)</li> <li>lymphocytosis 1/17 (5.88%)</li> </ul> </li> </ol>

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
27	Nusa Penida, Bali	Wahyuni & Kurniawati [29] (2018)	Cross sectional, Elementary school based	44 school age students	<ol style="list-style-type: none"> <li>The prevalence of STH (+) 0/44 (0%)</li> <li>The prevalence of anemia 31/44 (70.45%)</li> </ol>
28	West Lombok, Nusa Tenggara Barat	Wibowo et al,[30] (2019)	Cross sectional, School aged children 7 <sup>th</sup> , 8 <sup>th</sup> grade	50 school aged children, specific population- pottery craftman	<ol style="list-style-type: none"> <li>The prevalence of STH (+) 14/50 (28%) consisted of <ul style="list-style-type: none"> <li>trichuriasis 10/14 (71.42%)</li> <li>ascariasis 2/14 (14.28%)</li> <li>hookworm 1 (7.14%)</li> <li>mixed infection 1 (7.14%)</li> </ul> </li> <li>The prevalence of anemia among STH (+) 4/14 (28.57%)</li> </ol>
29	Seriwe, East Lombok, Nusa Tenggara Barat	Nurmayani et al,[31] (2019)	Cross sectional, specific community based	49 children	<ol style="list-style-type: none"> <li>The prevalence of STH (+) 18/49 (36.73%)</li> <li>Mean Hb of STH (+) 9.9 g/dL</li> </ol>
30	Southwest Sumba, Nusa Tenggara Timur	Sungkar et al,[32] (2018)	Before and after treatment with Albendazole 400mg, specific community based		<p>The prevalence of STH,</p> <p>Before treatment</p> <ul style="list-style-type: none"> <li>ascariasis 65%</li> <li>trichuriasis 55.8%</li> <li>hookworm 15.4%</li> <li>anemia among STH 71.2%</li> </ul> <p>After treatment (6 month after therapy)</p> <ul style="list-style-type: none"> <li>ascariasis 8.3%</li> <li>trichuriasis 12.3%</li> <li>hookworm 0%</li> <li>anemia among STH 25%</li> </ul>
31	Northwest Sumba, Nusa Tenggara Timur	Paun et al,[33] (2019)	Cross sectional, specific community based	school aged children	<ol style="list-style-type: none"> <li>The prevalence of STH (+) 14/80 (17.5%)</li> <li>The prevalence of anemia among STH (+) 5/14 (35.71%)</li> </ol>

No	Location	Author (year of publication)	Design and laboratory technique	Total no. investigated	Findings
32	Manado, North Sulawesi	Basalamah,[34] (2013)	Cross sectional, specific community based	80 school aged children	<ol style="list-style-type: none"> <li>1. The prevalence of STH (+) 14/80 (17.5%)</li> <li>2. The prevalence of anemia among STH (+) 5/14 (35.71%)</li> </ol>
33	Palu, Central Sulawesi	Syahnuddin et al,[35] (2017)	Case control (anemic vs non anemic), specific population	72 High School age female teenager;	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 8/72 (11.11%) consisted of <ul style="list-style-type: none"> <li>• hookworm 4/8 (50%)</li> <li>• trichuriasis 3/8 (37.5%)</li> <li>• mixed infection 1/8 (12.5%)</li> </ul> </li> <li>2. Anemia among STH (+) 4/4 (50%) (<math>p=0.645</math>)</li> </ol>
34	Makassar, South Sulawesi	Ibrahim [36] (2012)	Cross sectional , specific population,	182 school aged children 3 <sup>rd</sup> -5 <sup>th</sup> grade in slum area	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 166/182 (91.20%)</li> <li>2. Prevalence of anemia among STH (+) 90/166 (54.21%) (<math>p=0.305</math>)</li> </ol>
35	Gowa, Makassar, South Sulawesi	Ibrahim [37] (2013)	Cross sectional, Elementary school based	65 school aged children	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 19/65 (29.23%)</li> <li>2. Prevalence of anemia among STH (+) 10/19 (52.63%) (<math>p=0.234</math>)</li> </ol>
36	Talo, Makassar, South Sulawesi	Sulastri et al. [38] (2020)	Cross sectional, Elementary school based	121 school aged children	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 29/121 (23.96%)</li> <li>2. Prevalence of anemia among STH (+) 2/29 (6.89%)</li> </ol>
37	Arso, Keerom, Papua	Sandy et al. [39] (2015)	Cross sectional, elementary school based	224 school aged children	<ol style="list-style-type: none"> <li>1. Prevalence of STH (+) 67/224 (29.9%) consisted of <ul style="list-style-type: none"> <li>•ascariasis 45/67 (67.16%)</li> <li>•hookworm 6/67 (8.95%)</li> <li>•trichuriasis 4/67 (5.97%)</li> <li>•mixed infection 12/67 (17.91%)</li> </ul> </li> <li>2. Prevalence of anemia among STH (+) 7/67 (10.44%)</li> </ol>

## 5. CONCLUSION

This short systematic study has revealed the condition of anemia related STH from studies conducted in Indonesia from the year 2001 to 2020. STH and its consequences still a major health problem in Indonesia. Prevention of transmission and proper management of STH needed to be conducted in order to avoid worse consequences of STH and its related complication.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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