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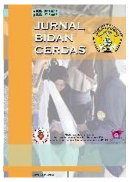

The Prevalence of Trichuriasis in School-age Children in Asia: A Systematic Review

Ivan Elisabeth Purba[1], Vierto Irennius Girsang[2], Amila[2], Toni Wandra[1]
[1]Directorate of Postgraduate, Sari Mutiara Indonesia University, Medan, Indonesia
[2]Faculty of Pharmacy and Health Science, Sari Mutiara Indonesia University, Medan, Indonesia
Corresponding author: poerba.ivanelis@gmail.com

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ABSTRACT

Introduction: *Trichuris trichiura*, hookworms, and *Ascaris lumbricoides* are known as soil-transmitted helminths that commonly infect humans. Transmission is more common in areas with poor personal hygiene and environmental sanitation. **Objectives**: The aim of this study was to determine available information on the prevalence of *T. trichiura* infection in school-age children in Asia. This information can be used for additional studies to evaluate the prevalence and risk factors for *T. trichiura* infection locally that can inform regional control programs and look at laboratory examination techniques to diagnose this parasite disease. **Methods**: Multiple databases (Web of Science, PubMed, ProQuest, Scopus, and Google Scholar) were searched for literature on the trichuriasis prevalence published from 2011 to January 2021. **Results:** A total of 13,836 studies were identified through database searches. The included studies represent 16 countries, with the highest number of study conducted in Yemen. **Conclusions**: The prevalence of trichuriasis in school-age children was found to vary widely by country. The Kato-Katz technique was commonly used to detect *T. trichiura* eggs in school-age children in Asia. Health sector should implement surveillance programs, particularly in countries with high infection prevalence. Educational programs aimed at improving personal hygiene and environmental sanitation to decrease trichuriasis transmission.

INTRODUCTION

Trichuris trichiura (whipworm), *Ancylostoma duodenale* and *Necator americanus* (hookworm), and *Ascaris lumbricoides* are known as soil-transmitted helminths (STHs) that commonly infect humans (Badri et al., 2021; Kapti et al., 2021). Transmission is more common in areas with poor personal hygiene and environmental sanitation (WHO, 2023; Sutisna et al., 2021).

T. trichiura infection (trichuriasis) is caused by ingesting parasite eggs (CDC, 2023). Infection often occurs via ingesting food or water contaminated with infective embryonated eggs (Izurieta et al., 2018; Peradotto et al., 2021). Most individuals with a light *T. trichiura* infection are asymptomatic or subclinical. However, the public health impact of trichuriasis is considerable for cases with a high worm burden. The majority of trichuriasis cases with severe clinical manifestations are in children 5 - 15 years of age (Stephenson et al., 2000). People with heavy infections can experience frequent painful bowel movements that contain a mixture of mucus, water, and blood (CDC, 2023). Severe morbidity, consisting of malnutrition, anemia, and stunting, can occur with chronic infections, with preschool- and school-age children often most severely impacted (Dickison et al., 2000; Badri et al., 2022).

Worldwide, an estimated 604-795 million people are infected with *T. trichiura* (CDC, 2023). In Indonesia, the prevalence of STH infection was reported to range from 2.5% to 62.0% (MHRI, 2017). The current study, the prevalence of *T. trichiura* infection in the Simanindo and Ronggur Nihuta sub-districts of Samosir Island, North Sumatra, was 15.3% and 7.4% in the community (Wandra et al., 2020), and in school-age children was 4.8% and 5.9%, respectively (Wandra et al., unpublished).

Diagnosis of trichuriasis is typically based on fecal sample examination. The Kato-Katz technique is commonly used to detect *T. trichiura* eggs. The control and treatment of trichuriasis are mainly through the administration of antiparasitic medications, such as albendazole (400 mg) and mebendazole (500 mg) (Namwanje et al., 2011). One of Indonesia's current STH control programs, including trichuriasis, is mass drug administration (MDA). Using a three-dose treatment regimen enhances the therapeutic outcome of these drugs against *T. trichiura* (MHRI, 2017). The aim of this study was to determine available information on the prevalence of *T. trichiura* infection in school-age children in Asia. This information can be used for additional studies to evaluate the prevalence and risk factors for *T. trichiura* infection locally, and look at laboratory examination techniques to diagnose this parasite disease.

METHODS

This systematic review based on PRISMA (Systematic Reviews and Meta-Analyses) guidelines (http://www.prisma-statement.org/). Web of Science, PubMed, ProQuest, Scopus, and Google Scholar databases were searched for literature on *T. trichiura* prevalence in Asia. Keywords, used (alone or in combination) were *Trichuris trichiura*, *T. trichiura*, *Trichocephalus trichiuris*, *trichuriasis*, soil-transmitted helminth (STH), Neglected tropical disease (NTD), humans, Asia, intestinal helminthiasis, intestinal diseases, prevalence, and frequency, including the names of the 48 Asian countries.

After screening for titles (including abstract), duplicates and irrelevant records were removed. The full texts of the remaining articles were obtained and evaluated independently by two data analysers (A.V. E. and M.B.). References of full-text articles were assessed to find any potentially applicable articles not identified through the database search. The following a priori inclusion criteria were applied: 1) peer-reviewed articles containing original data, 2) published in English prior to January 31, 2021, 3) cross-sectional study evaluating the prevalence of *T. trichiura* infection in some region of Asia, 4) accessible abstract and full-text article, and 5) numerator and denominator data available to confirm prevalence values.

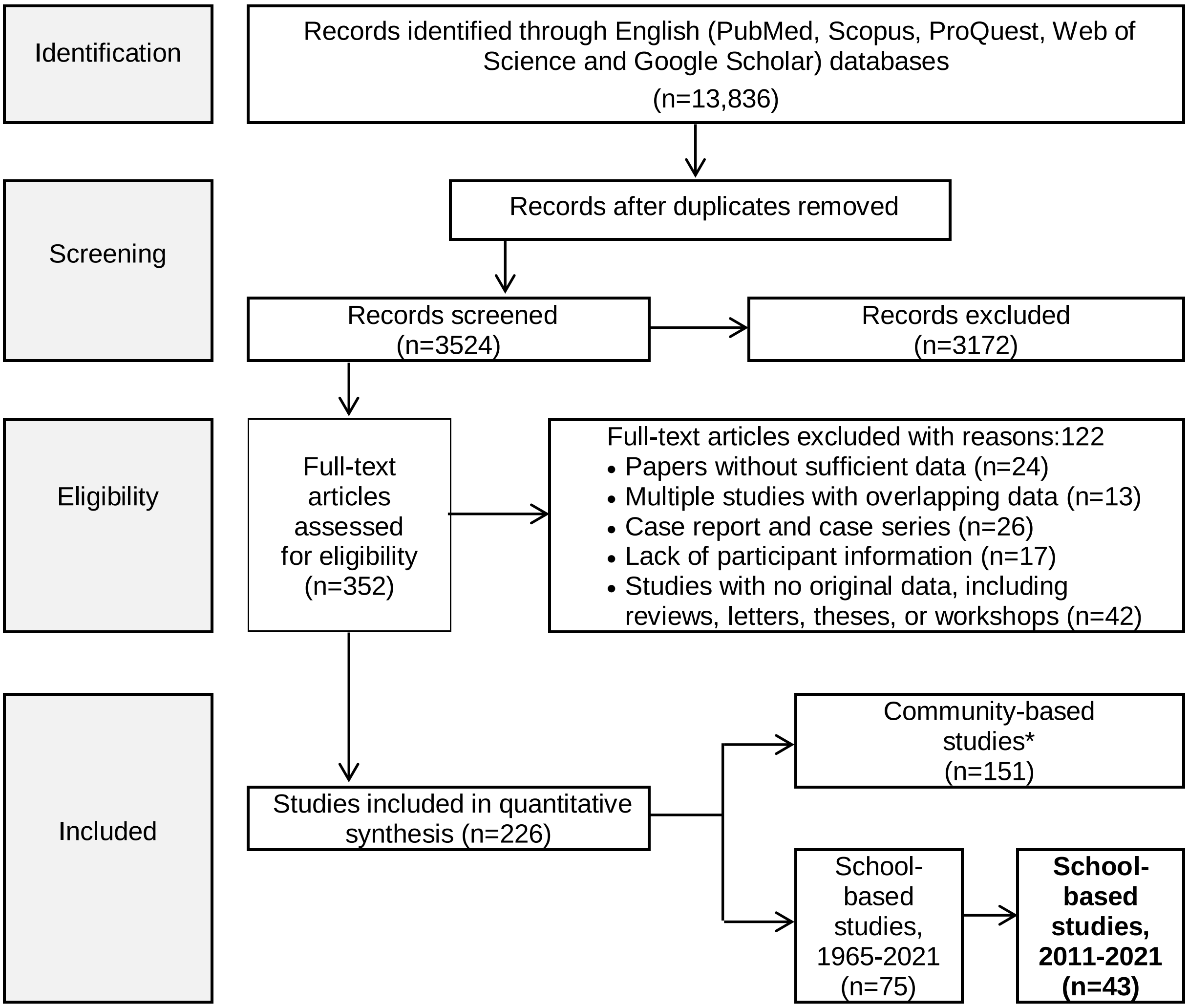
The exclusion criteria were included: 1) peer-reviewed articles did not contain original data, 2) studies were written in other languages, 3) unaccessible abstract and full-text articles, and 4) numerator and denominator data were unavailable to confirm prevalence values. Articles not meeting the above criteria, including letters, editorials, and articles with confusing/undetermined results were excluded. Since studies were conducting using numerous diagnostic methods, the decision was made to not restrict inclusion to a single method. It was also decided to restrict included publications to those written in English based on the language limitations of the research team.

A Microsoft Excel® spreadsheet was used to extract the following data from included articles: first author name, country where the study was conducted, year of publication, and diagnostic method (s) (parasitological and molecular). The number of children sampled and the number of children positive were obtained.

A Newcastle–Ottawa Quality of Assessment Scale adapted for cross-sectional studies was used to evaluate included studies (Modesti et al., 2016). Scoring was based on three domains: selection (maximum of 5 stars), comparability (maximum of 2 stars), and outcome (maximum of 3 stars).

RESULTS

A total of 13,836 studies were identified through database searches. After removing duplicates and selecting based on inclusion criteria, 352 studies were evaluated at the full-text level. Forty-three studies were included in the systematic review (Fig. 1). Table 1 shows the study's first author, publication year, country, and prevalence of trichuriasis. Table 2 includes the diagnostic method by year, number of countries, and studies.



*Badri et al., 2022

Fig. 1. Flow diagram of systematic review process

The included studies represent 16 countries, with the highest number of studies conducted in Yemen (6 studies), which had the prevalence ranged from 0.5% (6/1218) to 18.0% (36/200), followed by Thailand (5 studies) with the prevalence ranged from 5.3% (4/75) to 50.5 (188/372), and China (5 studies) with the prevalence ranged from 1.9% (7/369) to 94.3% (183/194), respectively (Table 1).

Table 1. The prevalence of trichuriasis in school-age children in 16 countries in Asia, 2011-2021

	First author	Year	Country	Prevalence (%)
1.	Naimullah et al.	2019	Afganistan	1.0 (23/2.263)
2.	Benjamin-Chung et al.	2015	Bangladesh	21.0 (342/1.630)
3.	Benjamin-Chung et al.	2019	Bangladesh	27.7 (775/2.799)
4.	Sohn et al.	2011	Kamboja	0.9 (1/116)
5.	Moore et al.	2012	Kamboja	0.1 (9/16.372)
6.	Bless et al.	2015	Kamboja	14.0 (32/228)
7.	Kuong et al.	2016	Kamboja	0.3 (5/1.760)
8.	Yap et al.	2012	China	81.2 (56/69)
9.	Yap et al.	2013	China	94.3 (183/194)
10.	Xu Li et al.	2015	China	1.9 (7/369)
11.	Lei Xiao et al.	2015	China	39.3 (172/438)
12.	D Yang et al.	2018	China	25.2 (81/321)
13.	Ashok et al.	2011	India	0.5 (1/208)
14.	Ganguly et al.	2017	India	4.6 (295/6.421)
15.	Kumar et al.	2017	India	14.4 (72/500)
16.	Subahar et al.	2020	Indonesia	1.8 (4/219)
17.	Ahmed et al.	2012	Malaysia	84.4 (244/289)
18.	Alaribi et al.	2020	Malaysia	12.8 (19/148)
19.	Vorasan et al.	2015	Myanmar	2.0 (9/457)
20.	Oo et al.	2020	Myanmar	17.1 (171/1.000)
21.	Chai et al.	2020	Myanmar	19.4 (432/2.227)
22.	Oo et al.	2021	Myanmar	17.0 (170/1.000)
23.	Bhattachan et al.	2015	Nepal	4.1 (12/296)
24.	Yadav et al.	2016	Nepal	9.7 (49/507)
25.	Rai et al.	2017	Nepal	0.9 (3/329)
26.	Papier et al.	2014	Filipina	17.9 (124/693)
27.	Mationg et al.	2017	Filipina	38.8 (102/263)
28.	Sagnuankiat et al.	2016	Thailand	50.5 (188/372)
29.	Punsawad et al.	2017	Thailand	8.3 (27/324)
30.	Kaewpitoon et al.	2018	Thailand	5.2 (21/403)
31.	Yanola et al.	2018	Thailand	16.0 (60/375)
32.	Sedionoto et al.	2019	Thailand	5.3 (4/75)
33.	Hung et al.	2016	Vietnam	0.3 (4/1206)
34.	De Gier et al.	2016	Vietnam	53.7 (274/510)
35.	Al-Mekhlafi et al.	2016	Yemen	0.5 (6/1218)
36.	Alwabr et al.	2016	Yemen	18.0 (36/200)
37.	Alsubaie et al.	2016	Yemen	9.3 (24/258)
38.	Alharbi et al.	2019	Yemen	3.1 (24/780)
39.	Alharazi et al.	2020	Yemen	0.8 (3/385)
40.	Mogalli et al.	2020	Yemen	1.8 (7/400)
41.	Ullah et al.	2014	Pakistan	6.8 (15/222)
42.	Galgamuwa et al.	2017	Sri Lanka	1.0 (2/206)
43.	Jameel et al.	2017	Iraq	1.0 (1/103)

The highest prevalence of trichuriasis was reported from China (94.3%; 183/194) in 2013, followed by Malaysia (84.4%; 244/289) in 2012. The lowest prevalence was recorded in Vietnam (0.3%; 4/1206).

There were 43 studies that applied laboratory diagnostic techniques. The Kato-Katz (10 studies) was the most frequently used technique in 2011 – 2021. There were 2 studies in 2017-2019 that applied molecular techniques to identification of *T.*

trichiura infection. All of the molecular analyses in the included studies were conducted using the Polymerase Chain Reaction (PCR) (Table 2).

Table 2. Laboratory examination techniques for fecal samples to detect trichuriasis in school-age children in Asia, 2011-2021

Laboratory examination techniques for fecal sample	Year	No. of country*	No. of study	
			n	%
Kato-Katz	2011-2021	10	19	44,2
Formalin-ether concentration	2016-2020	3	6	14,0
Direct smear	2012-2017	5	5	11,6
Direct smear, Formalin-ether concentration	2011-2020	3	4	9,2
Direct smear, Kato-Katz	2019-2021	3	3	7,0
Formalin-ether concentration, Kato-Katz	2015-2017	3	3	7,0
Kato-Katz, PCR	2017-2019	2	2	4,7
Kato-Katz, Mini-FLOTAC	2015	1	1	2,3
Total	--	--	43	--

*Each of the 16 countries in Asia uses one or more different laboratory examination techniques

DISCUSSION

Based on this systematic review, the highest prevalence of trichuriasis was reported in China (2013) and Malaysia (2012), which may be associated with heavy rainfall, high temperatures, and high humidity in these countries. These factors have increased the survivability of *T. trichiura* eggs and larvae in the environment (Afsah-Hejri et al., 2013). However, to confirm the results (pooled prevalence), a meta-analysis is needed due to the potential for bias or heterogeneity among studies.

A study by Silver et al. (2018) looking at the geographic distribution of STHs found the overall prevalence of *Trichuris* was 14% (95%CI: 9–19%) in countries located in South and Southeast Asia. Another study found that infection was most prevalent in the South-east Asian region (18.6%, 95%CI: 11.8–26.5%), which is known to have large numbers of cases of NTDs, including STHs (Hotez et al., 2015).

STH infections, including due to *T. trichiura*, are also common in tropical and sub-tropical regions (Molla & Mamo, 2018). The study also found that the highest prevalence of trichuriasis was in tribal communities (38.3%, 95%CI: 18.5% - 63.3%) (Silver et al., 2018).

In Indonesia, it is estimated that around 13 million children (< 6 years) and 37 million children (aged 6 to 12 years) live in endemic areas due to STH infections (Tan et al., 2014; Sutisna et al., 2021). In children, STH infections, especially *T. trichiura*, remain public health problems (Kapti et al., 2021).

In 2023, the prevalence of STH infections in school-age children (6 -11 years) in the Simanindo sub-district of Samosir Island was lower (4.8%, 9/187), and all infections were due to *T. trichiura* (Wandra et al., unpublished). This finding may be due to the impact of the MDA program in elementary schools on Samosir Island (MHRI, 2012; 2017). The national MDA program for elementary school children in Indonesia includes the administration of a single dose of albendazole (400 mg) two times a year if the local prevalence is > 50% and one time a year if the local prevalence is 20-50% (MHRI, 2017).

In contrast, the prevalence of STH infections in the community-based study in Samosir Island, North Sumatra, Indonesia (2015) was 46.8% (147/314). Infections were caused by *T. trichiura* (32.7%, 48/147), *A. lumbricoides* + *T. trichiura* (6.8%, 10/147), and *T. trichiura* + hookworms (1.4%, 2/147) (Wandra et al., 2020).

Simanindo sub-district of Samosir Island is predominately rural with a small tourist industry (Wandra et al., 2020). Therefore, in this destination needs to have data on the transmissions of this parasite to domestic and foreign tourists.

Infection with *T. trichiura* often only presents with minor clinical manifestations; however, this chronic infection has several hidden sequelae, including nutritional deficiencies (Modesti et al., 2016) and anemia (WHO, 2001).

Laboratory diagnostic techniques can impact *T. trichiura* apparent prevalence values. The Kato-Katz technique is widely used to identify *T. trichiura* eggs in fecal samples since it is low-cost and relatively simple to apply (Knopp et al., 2009; Tarafder et al., 2010) (Table 2, Fig.2). In contrast, the FLOTAC method has a higher sensitivity with a low parasite burden but is more complicated and expensive (Speich et al., 2010). Compared to molecular methods (PCR), microscopic examination is known to have lower sensitivity (Knopp et al., 2009; Badri et al., 2020; 2022).

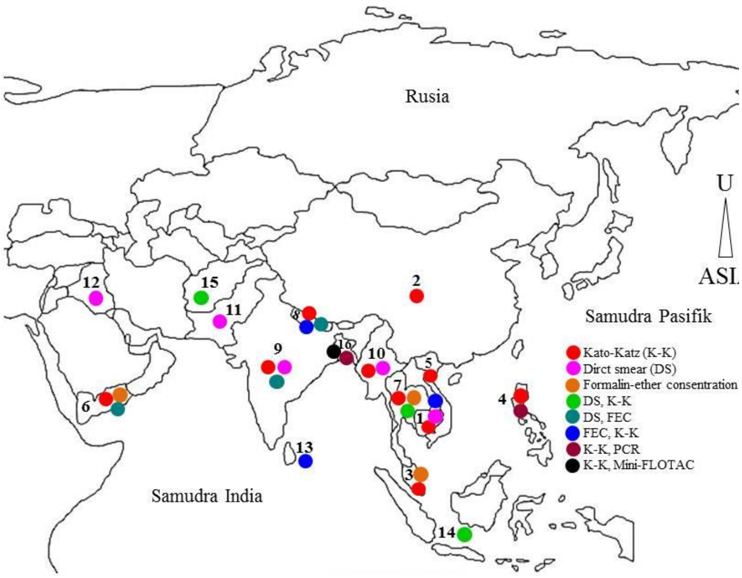


Fig. 2. Map of Asia. Countries included in the systematic review: Cambodia (1), China (2), Malaysia (3), Philippines (4), Vietnam (5), Yemen (6), Thailand (7), Nepal (8), India (9), Myanmar (10), Pakistan (11), Iraq (12), Sri Lanka (13), Indonesia (14), Afghanistan (15), and Bangladesh (16). Colored circles indicate laboratory examination techniques used in each country in school-age children in Asia

This systematic review did have some limitations since the diagnostic tests used in the various studies are low sensitivity. Moreover, some studies were likely published in languages other than English that were not included in this review.

CONCLUSIONS

The prevalence of trichuriasis in school-age children was found to vary widely by country in Asia. The Kato-Katz technique was commonly used to detect *T. trichiura* eggs in school-age children in Asia. Health sector should implement surveillance programs, particularly in countries with high infection prevalence. Educational programs aimed at improving personal hygiene and environmental sanitation to decrease trichuriasis transmission. Further study in school-age children in Asia using meta-analysis is needed.

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