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Prevalence of Soil-Transmitted Helminth Infections in Malaysia: A Systematic Review and Meta-Analysis

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Abstract

BACKGROUND: Prevention and control of soil-transmitted helminth (STH) infections in Malaysia remain a challenge, especially among aborigine and rural population. Despite several community-based reports, there are lacking national data on the overall prevalence for STH infection.

AIM: The study aimed to determine the prevalence, endemic species, and distribution and risk zones (RZs) for STH infections in Malaysia through a systematic review and meta-analysis of the data published between 1999 and 2019.

METHODS: This study employed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The databases used in this review include SCOPUS, WEB OF SCIENCE, OVID MEDLINE, and PUBMED. The random-effects model determined the pooled prevalence estimate (PPE) while Cochran's Q-test evaluated the heterogeneity.

RESULTS: A total of 13240 samples were examined during the period under review with 6235 were infected with one or more species of STHs. The overall PPE for STH infections was 51% (95% Confidence interval [CI]: 34, 67). PPEs for sub-groups ranged between 13% (95% CI: 5, 22) and 69% (95% CI: 50, 87). Highest PPEs for STH infections were observed among aborigine children (69% 95% CI: 50, 87). *Trichuris trichiura* was the most prevalent species (46%, 95% CI: 27, 65). Over 46% (17/37) of the studies, especially among aborigine community and their area showed high-HRZ for STH infections.

CONCLUSION: STH infections involving *T. trichiura*, *Ascaris lumbricoides*, hookworms and *Strongyloides stercoralis* are highly prevalent among aborigine community. Primary and secondary prevention such as the use of anthelmintic, health education, and adequate sanitation was essential in the control of these infections in Malaysia to improve individual and community health.

Introduction

Soil-transmitted helminth (STH) infections are classified by the World Health Organization (WHO) as one of the neglected tropical diseases (NTD) targeted for control and elimination [1]. Globally, more than 1.5 billion people or 24% of the world's population are estimated to be infected with STH. The infection is distributed mainly in the tropical and subtropical areas, with the highest prevalence in sub-Saharan Africa, the Americas, China, and East Asia [2]. Even though termed as NTDs, these problems are prevalent, affecting individuals primarily in the period of intense physical and intellectual development. They are the major contributor to the malnutrition-infection cycle that adversely affects physical and cognitive development, thwart educational achievement, thereby hindering economic growth.

In general, STHs refer to the intestinal worm infecting humans that are transmitted through contaminated soil. Traditionally, there are four main species of STH consisting of *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), and the hookworms (*Ancylostoma duodenale* and *Necator americanus*) [3]. However, with the advancement of diagnostic techniques and improved availability of optimal treatment, there is a need to include Strongyloides stercolaris as one of STH for development prevention and control strategies [4]. Oversea studies in Ecuador, Indonesia, and India, revealed that the STH infection is often associated with the marginalised population with poor personal hygiene practice, lack of access to clean water, and sanitation and no previous history of deworming [5], [6], [7]. Thus, it is a significant public health issue in low-income and middle-income countries.

In Malaysia, despite rapid infrastructure development and urbanization efforts, prevention and control of STH remain a challenge, especially among the more impoverished rural population. In 2008, the WHO reported that STH infections in Malaysia were well controlled as a result of the prevention and control programmes [8]. These include the deworming programme in maternal and child clinics, mobile clinics in rural areas, aborigine *(Orang Asli)* settlements, and health programmes at schools. However, several recent studies revealed that the prevalence of STH infections was still high among *Orang Asli* population in the rural areas ranging from 78.1% to 90% [9], [10]. This should set the motion for the reassessment of the existing control measures. Therefore, this study aimed to provide useful epidemiological information, including the prevalence, endemic species, and distribution of STHs in Malaysia. The result will serve as a guide for targeted control as well as ensuring cost-effective control of STH infections in Malaysia.

Methodology

Search strategy

We searched and identified published studies using three automated database searches of Web of Science, PubMed, and Scopus. The systematic review was according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines published by Moher *et al*. [11]. MeSH terms (Medical Subject Headings) and advanced search-builder features were used for the PubMed searches. We have employed the following terms and variations on these keywords: Prevalence, or occurrence, AND STH, or STH or Ascaris, or Trichuris, or hookworm, or Strongyloides, or Ancylostoma, or Necator, AND Malaysia, or Peninsular Malaysia, or West Malaysia.

Criteria used for selected studies

The articles were evaluated for the inclusion in the meta-analysis based on the following conditions: (i) it was carried out in Malaysia, (ii) it was published in English, (iii) it was a cross-sectional study, (iv) sample size, and number or prevalence of positive cases was clearly stated. The exclusion criteria for this study were study protocol, conference proceedings, review article, non-peer-reviewed article, case study, and animal study. All the studies included in the analysis were assessed for quality independently using the Newcastle-Ottawa Scale (NOS) according to the Cochrane Handbook for Systematic Reviews [12], [13].

Data extra, collation, and synthesis

All the data were first entered through Microsoft Excel version 2019, and the date were extracted relating to the author, year of conduct and publication of the study, sample size, number of positives cases, state and location of research, study design, and species of STHs identified. RevMan 5 software version 5.3.5 was used for meta-analysis. The prevalence for individual studies was determined by multiplying the ratio of cases to the sample size by 100. The 95% Confidence interval (95% CI) was determined with formula 1.96*SQRT(p*(1-p)/n), whereby p is the prevalence and n is the sample size. The random-effects model was used to determine the pooled prevalence estimates (PPEs) and their 95% *CI*, based on the assumption that the true effect sizes might differ within eligible studies [14]. The heterogeneity, which is the measure of variability between studies, was analyzed using the Cochran's Q-test. Meanwhile, the percentage of variation in the prevalence estimate due to heterogeneity was quantified using the formula $I^2 = 100 \times (Q\text{-}df)/Q$, whereby Q is Cochran's heterogeneity statistic, and *df* is the degree of freedom which is the difference between the number of studies and one. The *I*-square values of 0, 25, 50 and 75% were considered as no, low, moderate and high heterogeneities, respectively. The burdens and risk zones (RZs) for STH infections were categorised based on the prevalence of diseases as recommended by the WHO. Regions with PPEs <50% were categorised as low RZs while areas with PPEs ≥50 were categorised as high RZs for STH infections [15].

Results

Literature search and studies selection

First, we screened the studies through a title review to check the relevancy and removed the duplicates. Then, it was followed by a detailed abstract and full text reviewed to determine the outcome of interest and other inclusion requirements.

First, there were 314 studies generated through the search from databases, as presented in Figure 1. Second, 129 duplicate studies were removed, and the title and abstract were reviewed (n = 185). There were 141 studies excluded for the following reasons: Environmental study, study from other countries, review paper, zoonotic study, and treatment study. Third, a full text of each article was thoroughly reviewed (n = 44). There were seven studies excluded for the following reasons: unstated numbers of positive samples and sample sizes, thus unable to calculate the prevalence (n = 3), low quality of NOS (n = 2), and sub-analysis of existence accepted studies (n = 2). Finally, 37 eligible studies were selected and summarized in this review.

Characteristics of the eligible studies

Table 1 shows the characteristics of the studies for meta-analyses. There were 37 eligible

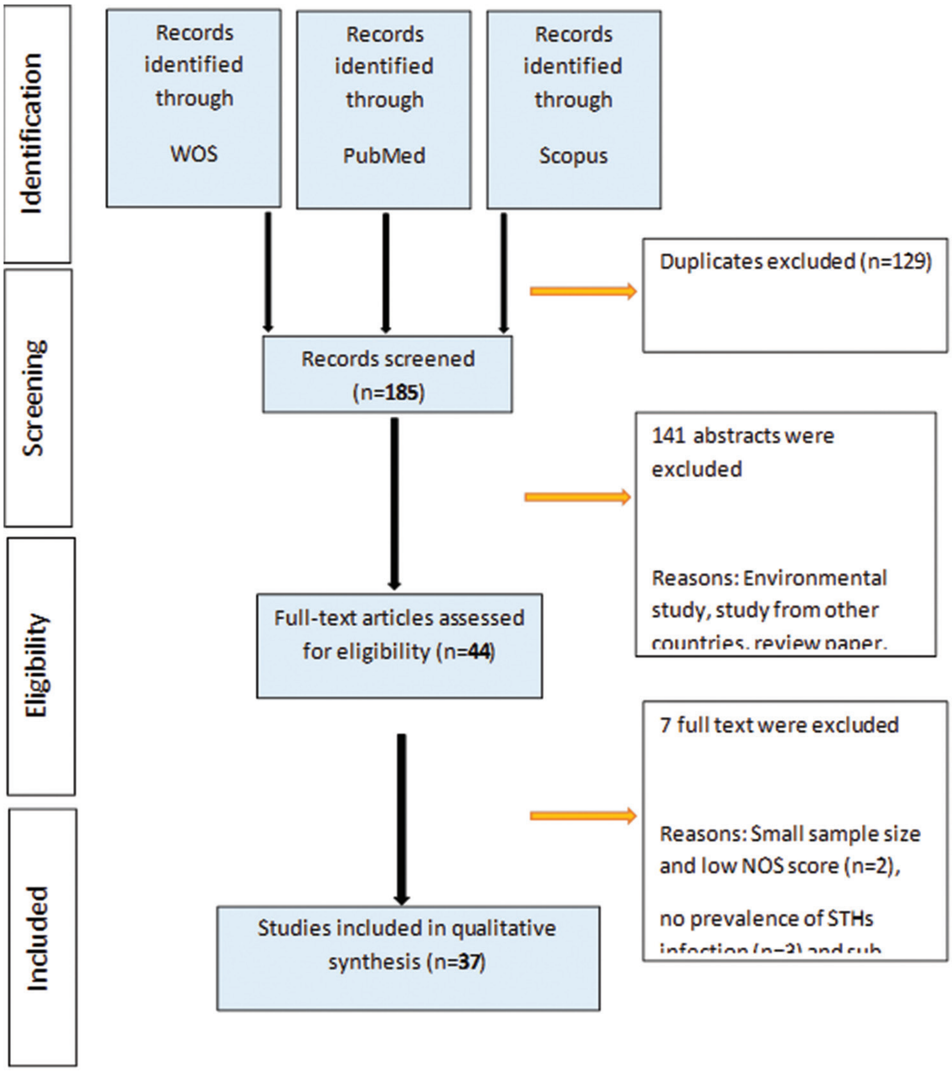

Figure 1: Flow diagram for the selection process of eligible study

studies and thus were included in the analysis. Eleven studies were published between 1999 and 2009 and 26 studies were published between 2010 and 2019. Six studies were reported from West Malaysia and 31 studies were reported from Peninsular Malaysia. There were 25, seven, four and one studies carried out within community, school, hospital, and prison settings, respectively. Out of 25 studies in the community setting, 17 studies were done in the aborigine (*orang asli*) community. There were 20 studies done among children aged fifteen and below, and ten of them were among aborigine children, the community and school settings, respectively. Two, four, and 28 studies had sample sizes of >1000, 500–999, and 100–499, respectively. Only three studies had less than one hundred sample size with the minimum was seventy-seven samples. The lowest prevalence of STH infections among eligible studies was 5.9% reported by Afzan *et al*.[16] Meanwhile, the highest was 100% reported by two studies [17], [18].

PPEs and heterogeneity analysis

The overall and sub-group PPEs for STH infections are presented in Figure 2 and Table 2. A total of 13,240 samples were examined during the period under review with 6,235 samples infected with one or more species of STHs yielding an overall PPE of 51.0% (95% Confidence Intervals [CI]: 34.0–67.0). PPEs for sub-groups (regions, study period, and study settings) ranged between 13% (95% CI: 5–22) and 69% (95% CI: 50–87). The studies among aborigine population have PPE of 62% (95% CI: 46–78), and studies among their children showed the highest PPE recorded that was 69% (95% CI: 50–87), as shown in Figure 3a. A high degree of heterogeneity observed within studies and sub-groups, as shown in Table 2. A study by Al-Mekhlafi *et al*. only examined *Strongyloides stercoralis* among aborigine children [19] and a study by Abd Ghani and Gopal only examined *Ascaris lumbricoides* [20]. The heterogeneity of PPE among aborigine children was still high, although after excluding these two studies, as shown in Figure 3b.

Table 1: List and characteristics of the 37 eligible studies

No.	Author (Year)	Location/region	Study setting	Sample size	Cases	Prevalence	95% CI
1	Aini *et al*. (2007)	Aborigine villages in Peninsular Malaysia	Community based (Children 2–15 years)	281	281	100	
2	Al-Delaimy *et al*. (2014)	Aborigine villages in Hulu Langat, Selangor	School based	498	490	98.4	97.3–99.5
3	Al-Mekhlafi *et al*. (2019)	Aborigine villages in Peninsular Malaysia	School based	1142	180	15.8	13.7–17.9
4	Al-Mekhlafi *et al*. (2006)	Aborigine villages in Selangor	Community based (Children 2–15 years)	281	281	100	
5	Angal *et al*. (2015)	Kajang prison, Selangor	Institutional based	294	27	8.8	5.9–12.5
6	Anuar *et al*. (2014)	Aborigine villages in Peninsular Malaysia	Community based	500	285	57.0	52.7–61.3
7	Asma *et al*. (2011)	Sungai Buloh Hospital, Selangor	Hospital based (HIV patient)	364	66	18.1	14.2–22.1
8	Basuni *et al*. (2012)	HUSM Kubang Kerian, Kelantan	Hospital based (HIV patient)	225	54	24.0	18.4–29.6
9	Brandon-Mong *et al*. (2017)	Aborigine villages in Kedah and Selangor	Community based	235	192	81.7	76.8–86.4
10	Chin *et al*. (2016)	Aborigine villages in Selangor	Community based	186	140	75.3	69.1–81.5
11	Elyana *et al*. (2016)	Aborigine and Malay rural villages Terengganu	Community based (Children<15 years)	340	192	56.5	51.4–61.6
12	Geik and Sidek (2015)	Aborigine villages in Gua Musang Kelantan	School based	256	161	62.9	57.0–68.8
13	Ghani and Gopal (2013)	Aborigine villages in Kuala Lipis, Pahang	Community based (School aged 4–12)	272	124	45.6	39.7–51.5
14	Hakim *et al*. (2007)	Aborigine villages in Cameron Highland	Community based (School aged 7–12)	91	51	64.6	54.1–75.1
15	Hartini *et al*. (2013)	Aborigine villages in Kelantan	Community based (School aged 7–9)	111	97	87.4	81.2–93.6
16	Al-Mekhlafi *et al*. (2008)	Aborigine villages in Kuala Lipis	Community based (School aged 7–12)	120	118	98.6	97.5–99.7
17	Huat *et al*. (2012)	Malay villages in Kelantan	Community based (School aged 7–9)	79	29	37	26.4–47.6
18	Ismail *et al*. (2019)	HTTA Kuantan Pahang	Hospital based (Paediatric patient)	135	8	5.9	1.9–9.9
19	Jamaiah *et al*. (2005)	Kuala Lumpur	Community base	246	17	6.9	3.7–10.1
20	Lee *et al*. (1999)	Serian Sarawak	School based	264	117	44.3	38.3–50.3
21	Lee *et al*. (2014)	Aborigine villages in Peninsular Malaysia	Community based	269	149	55.4	49.5–61.3
22	Mohd-Shaharuddin *et al*. (2018)	Aborigine villages in Selangor	Community based	411	299	72.7	68.2–77.0
23	Nasr *et al*. (2013)	Aborigine villages in Kuala Lipis	Community based (Children<15 years)	484	378	78.1	74.4–81.8
24	Ngui *et al*. (2015)	Aborigine villages in Peninsular Malaysia	Community based	634	380	59.9	56.1–63.7
25	Ngui *et al*. (2016)	Rural village in Pakan, Sarawak	Community based	329	26	11	7.0–76.2
26	Ngui *et al*. (2011)	Rural Villages in Peninsular Malaysia	Community based	716	524	73.2	70.0–76.2
27	Ngui *et al*. (2012)	Rural Villages in Peninsular Malaysia	Community based (Children<12 years)	550	421	76.5	73.0–80.0
28	Nithyamathi *et al*. (2016)	Schools from in Peninsular Malaysia	School based	1760	107	6.1	5.0–7.2
29	Raj (1999)	Outskirts of the Kota Bahru town, Kelantan	School based	104	72	69.2	60.3–71.8
30	Rajoo *et al*. (2017)	Rural village in Pakan, Sarawak	Community based	341	172	50.4	45.0–55.9
31	Sagin *et al*. (2002)	Bakun valley, Rejang Sarawak	Community based	355	144	41.0	35.9–46.1
32	Sahimin *et al*. (2016)	Migrant workers in Peninsular Malaysia	Community based	388	244	62.9	58.9–68.6
33	Sinniah *et al*. (2012)	Aborigine villages in Perak	Community based	77	39	50.6	39.4–61.8
34	Zueter *et al*. (2014)	HUSM Kelantan	Hospital based (Cancer patient)	192	11	5.7	2.4–9.0
35	Zulkifli *et al*. (2000)	Rural villages in Gua Musang	School based	183	127	69.4	62.7–76.1
36	Zulkifli, *et al*. (1999)	Rural villages in Gua Musang	Community based (preschool children)	268	127	47.4	41.5 53.4
77	Zulkifli *et al*. (1999)	Rural villages in Gua Musang	Community based (preschool children)	259	145	56.6	50.0–56.0

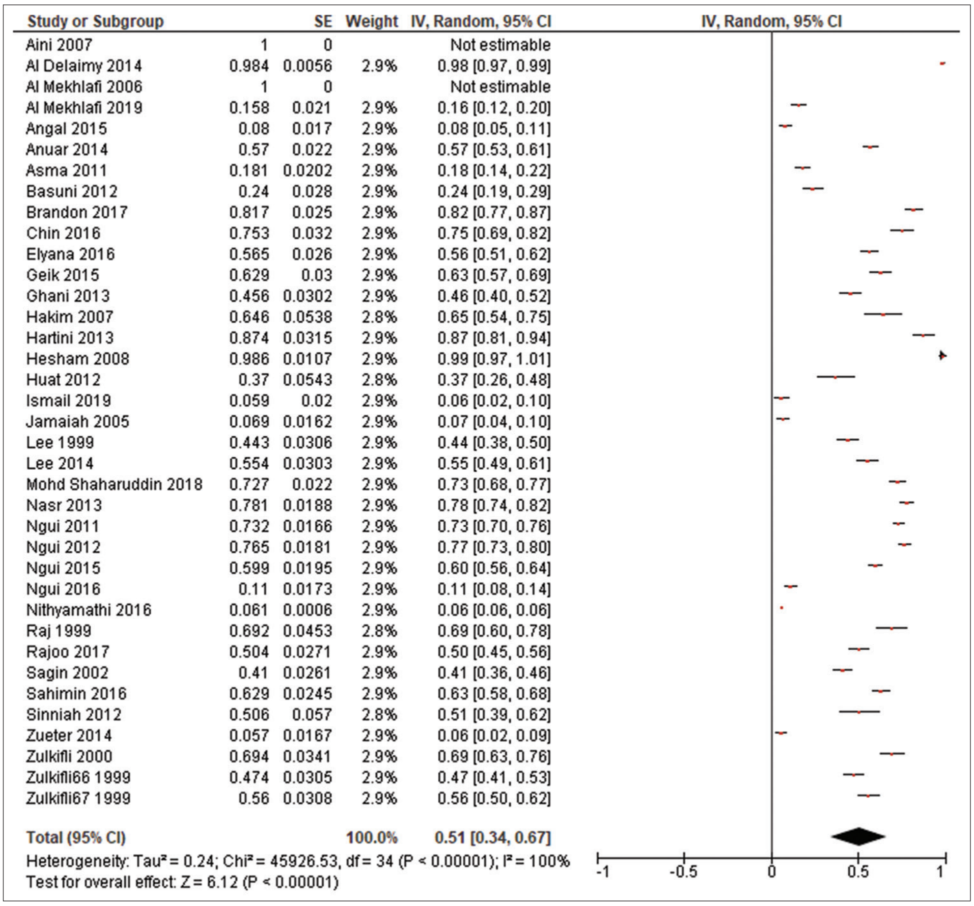

Figure 2: Forest plot of the 37 eligible studies

The prevalence of STHs infection in rural Malay community was relatively similar to the prevalence in the Aborigine community, as shown by the extracted data from studies done by Elyana

Table 2: Pooled prevalence estimates for STH infections in Malaysia according to sub-groups

Variables	No. of studies	Pooled prevalence estimates			95% CI	Heterogeneity	
		Sample size	Positives	Prevalence (%)		I^2 (%)	Q-P
Region							
Peninsular Malaysia*	33	11951	5776	52	35–70	100	<0.00001
East Malaysia	4	1289	459	37	16–57	99	<0.00001
Study period							
1999–2009*	11	2452	1480	55	28–83	100	<0.00001
2010–2019	26	10788	4755	49	30–68	100	<0.00001
Study setting							
Community based*	25	7927	4927	57	45–69	99	<0.00001
Hospital based	4	916	99	13	5–22	94	<0.0001
School based	7	4207	1254	52	7–98	100	<0.00001
Aborigine group*	17	5852	3645	62	46–78	100	<0.00001
Children-aged group <15 years*	20	7478	3506	57	30–83	99	<0.00001
Aborigine-children only <15 years*	10	3536	2161	69	50–87	100	<0.00001

*2 studies with 100% prevalence were not included in PPE.

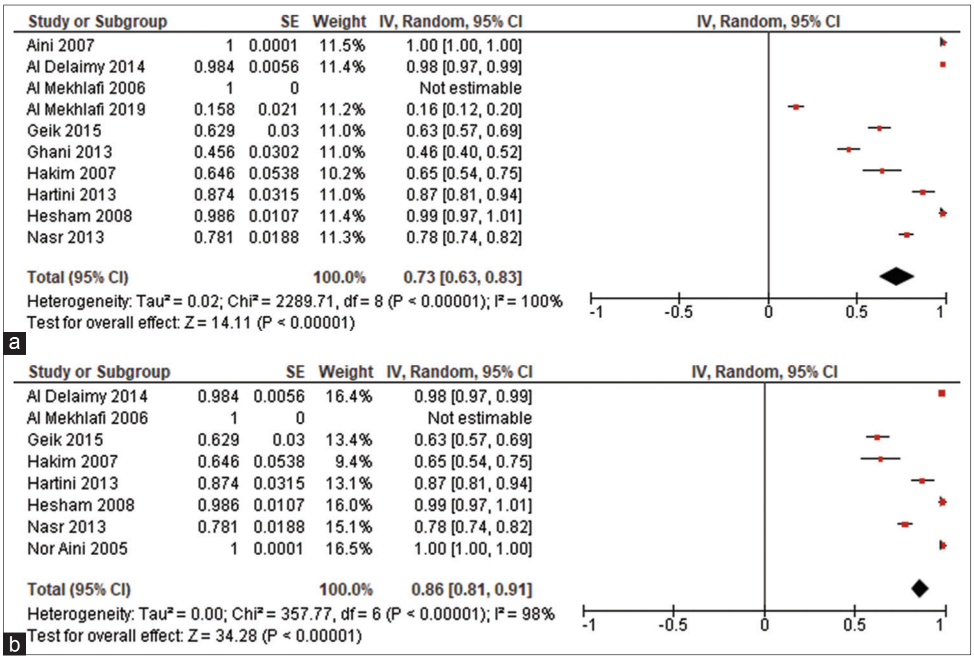

Figure 3: (a) Forest plot of the studies among aborigine children community. (b) Forest plot of the studies among aborigine children community

et al., Huat *et al*., Zulkifli *et al*., and Zulkifli *et al*. [21], [22], [23], [24]. The PPE of STHs infection among rural Malay community was 45.8% (95% CI:22.2–69.4), as shown in Figure 4.

The study on the prevalence of STHs infection among the urban community was limited, as this review only able to include one study by Jamaiah and Rohela [25]. The study revealed a low prevalence with 6.9% (95% CI 3.7–10.1). A survey by Nithyamathi *et al*. showed a zero prevalence of STHs infection among urban school students [26].

In terms of the prevalence of infected species, *T. trichiura* had the highest PPE of 46% (95% CI: 27–65) while, A. lumbricoides, hookworms and *S. stercoralis* recorded PPEs of 33% (95% CI: 26–40), 10% (95% CI: 9–11) and 9% (95% CI: 7–11) respectively (Table 3).

Table 3: The species-specific pooled prevalence estimates for STH infections

Parasites	No. of studies	Pooled prevalence estimates			95% CI	Heterogeneity	
		Sample size	Positives	Prevalence (%)		I^2 (%)	Q-P
Ascaris	33	11283	3336	33	26–40	99	<0.00001
Trichuris	32	11011	4740	46	27–65	100	<0.00001
Hookworms	30	10828	1259	10	9–11	98	<0.00001
Strongyloides	5	2182	298	9	7–11	82	<0.00001

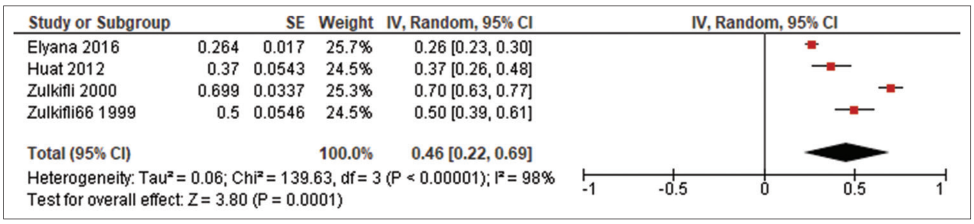

Figure 4: Forest plot of the studies among the rural Malay community

Discussion

STH infections remain among the major public health problems afflicting people in developing countries, especially in tropical and subtropical areas, including Malaysia. Nonetheless, despite their substantial public health importance, they are still largely neglected by the medical and international community [27]. This article will provide useful epidemiological data, the trends of prevalence, the distribution concerning study setting and as input in planning for strategic anthelmintic control of STHs in the community of Malaysia. The analysis is based upon the reporting of STH prevalence data in cross-sectional studies carried out in different location and type of community of Malaysia.

The overall PPE observed in the present study is 51% which is almost the same as Nigeria 54.8% [28]. However, Malaysia had higher prevalence compared to Cameroon and Rwanda with 24.1%, respectively [29], [30]. We were not able to compare the prevalence with local settings and nearby countries as most of the articles were looking based on specific community-based such as rural area and tribes. The limited availability of epidemiological data on STH that represent national sample surveys has greatly restricted our ability to understand the true prevalence. These variations also may be attributable to differences in study locations, study populations as well as diagnostic methods. Other than that, environmental factors and socioeconomic status background also could influence the prevalence of STH [31].

This review showed wide heterogeneity between studies had restricted our ability to perform more in-depth comparisons. Moreover, the majority of the studies included in this article were done in high-risk communities, thereby inflating the country-specific prevalence estimates. High prevalence in aborigine community occurs due to several factors such as the affected people belongs to the poorest and disadvantaged communities who often live in remote, rural areas, urban slums or in conflict zones [27]. They are poorly visible, and most of the time, the outbreaks occur among themselves that would not attract public and media attention [32]. Although STH cause great and permanent despair, they do not kill large numbers of people. Besides, the quantification of their consequence on economic development and education is difficult to assess [27], [32]. Aborigine community in Malaysia synonymous with low socioeconomic status and poor hygiene which are the most risk factor of STH infection. The most important thing is to change of attitude, knowledge and poverty, which are the risk factor of STH infection. The high prevalence was also found in the subgroup analysis of aborigine children only. The aim to reduce the prevalence of STH among this community will not be successful if the mass deworming programme is the only approach that has been done.

In this study, we found out that Trichuris is the highest pooled prevalence of 46% compared to Ascaris and hookworm with 33% and 10% respectively. However, statistic found out in Asia, and South-East Asia showed that Ascaris has the highest pooled prevalence of 15.8% and 20.8% [33]. The Trichuris showed high burden in the aborigine communities is probably an artefact as many studies were from the *Orang Asli* population in Malaysia with a very high prevalence of Trichuris [34]. It also probably due to the type of medication given, which is albendazole, whereby it only works to treat Ascaris and low efficacy to Trichuris [35].

Strengths and limitations

There are several strengths to this review. This systematic review provides valuable insight into the epidemiology of STH infections in Malaysia. This study able to attempts the compilation of available data about the prevalence of STH diseases in Malaysia. To the best of our knowledge, this is the first systematic review and meta-analysis regarding the prevalence of STH in Malaysia from 1999 to 2019.

Despite the valuable data provided by this study, it still has several limitations. Firstly, studies were unevenly distributed across regions, study period and study settings in Malaysia. This review revealed high heterogeneity among studies which may be due to the variations in study designs, methodologies, population samples and methods of diagnosis employed by the various studies. Finally, while every effort has been made to make this review comprehensive and inclusive of all the studies published on STH in Malaysia, some studies will inevitably have been missed due to them are not being published in English language journals. In general, STH studies are difficult to compare and contrast due to a lack of national sample survey.

Conclusion

This analysis showed that the STH is still prevalence despite reaching the status of a developed country. This finding needs to be taken into consideration in planning for future intervention and an exhaustive knowledge of the burden of the disease will help to allocate the resources and designing strategies for the control and monitoring of STH infections in Malaysia.

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Author Contributions

All authors contributed to the design and implementation of the research, analysis of the results, and writing of the manuscript.

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