

# Prevalence of Enterobius Vermicularis Infections and Associated Risk Factors Among Schoolchildren in Nakhon Si Thammarat, Thailand

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## Research note

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# Abstract

**Objective:** *Enterobius vermicularis* infection is an important public health problem worldwide, especially among schoolchildren in tropical and subtropical countries. The prevalence of *E. vermicularis* infections varies in each region of Thailand, but its status remains unknown among children who live in rural areas of southern region. This study aimed to evaluate the current prevalence of *E. vermicularis* infections and to identify the risk factors for infection among schoolchildren who live in rural communities in Nakhon Si Thammarat, Southern Thailand.

**Results:** The overall prevalence of *E. vermicularis* infections was 5.79% (23 of 397). According to the multivariate analysis, the following were found to be risk factors associated with *E. vermicularis* infections ( $P < 0.05$ ): male sex (AOR = 4.03, 95%CI 1.22-13.29), age group 3-6 years (AOR = 4.85, 95%CI 1.51-15.59), those having mother's education level of primary school (AOR = 11.22, 95%CI 1.75-71.77), those having older sibling(s) (AOR = 6.25, 95%CI 1.83-21.26), those having younger sibling(s) (AOR = 6.24, 95%CI 2.00-19.44), those sometimes washing hands after using toilet (AOR = 5.25, 95%CI 1.24-22.21), those keeping fingernail long (AOR = 29.97, 95%CI 6.16-145.85), and those sucking their finger (AOR = 3.59, 95%CI 1.21-10.66).

## Introduction

Enterobiasis is an intestinal nematode infection caused by *Enterobius vermicularis* or commonly known as pinworms. *E. vermicularis* infection is an important public health problem among schoolchildren, especially in tropical and subtropical countries [1, 2] with an estimate of over 1 billion infections [3]. Most of infections are asymptomatic. Common enterobiasis symptoms include itching, irritation of the perianal region, and vaginal pruritus in females [4, 5]. In severe infection cases, the symptoms include insomnia, weight loss, vomiting, abdominal pain, and appendicitis [2, 6, 7]. *E. vermicularis* has a simple life cycle, where it is transmitted via the finger-oral route, inhalation, or reinfection [1, 6, 8].

In many parts of the world, the prevalence of *E. vermicularis* infections varies between 0.21–54.86% [1–3, 8–17]. In Thailand, the prevalence of *E. vermicularis* infections varies between 0–50.90% [18–30]. Although various studies have been conducted on the distribution and prevalence of *E. vermicularis* infections in Thailand, epidemiological information on *E. vermicularis* infections is lacking for several remote regions, especially in Southern Thailand. Schoolchildren who live in crowded environments with low personal hygiene are the most commonly infected group [10, 22]. Consequently, this study aimed to evaluate the prevalence of *E. vermicularis* infections among schoolchildren in Tha Sala District, Nakhon Si Thammarat, and to find the potential risk factors for infection in the study area. The results are important for monitoring and implementing effective control strategies.

## Methods

### Study design and area

A cross-sectional study was conducted from June to July 2019 and included schoolchildren living in rural area of Taling Chan and Sa Kaeo Subdistricts, Tha Sala District, Nakhon Si Thammarat Province, Southern Thailand. The study area is approximately located 754 km south of Bangkok, the capital city of Thailand. The average temperature is 27.3 °C, with a low of 23.7 °C and a high of 35.2 °C. The annual rainfall is 2,150.0 mm [31]. Taling Chan and Sa Kaeo Subdistricts cover an area of 60.63 and 39.50 km<sup>2</sup> with the geographical location at 8.770288 latitude, 99.885376 longitude and 8.762168 latitude, 99.914407 longitude, respectively (Fig. 1). Both, Taling Chan and Sa Kaeo Subdistricts, are similar in terms of topography, climate, natural resources, land use, culture and economic status.

## Study population, sample size, and sampling technique

Schoolchildren from 3 to 9 years of age who agreed to participate and whose parents or legal guardians have given assent were included. The sample size was determined using the finite single population proportion formula [32]:

$$n = \frac{Np(1-p)Z_{1-\alpha/2}^2}{d^2(N-1) + p(1-p)Z_{1-\alpha/2}^2}$$

It was calculated using a prevalence rate (p) of 39.0% as detailed in a previous study [20], with a 95% confidence interval (95%CI) (z = 1.96) and a 5% margin of error (d = 0.05). The population of the students from 3 to 9 years of age in Tha Sala District was 5,412 persons [33]. The calculated sample size was 343 people. The final sample size was 378 including 10% non-response rate students. Participants were randomly selected from all of 11 kindergarten and primary schools of Taling Chan and Sa Kaeo Subdistricts using a voluntary sampling method.

## Parasitological survey and data collection

Letter of information, informed consent form and a self-administered questionnaire were given to parents or legal guardians prior to pinworm screening. Parents and children were informed about the time for experimentation in advance. Collection of samples was performed in the morning before defecating and bathing of children. Children were diagnosed for *E. vermicularis* infections based on the scotch tape technique [6]. Only one sample was taken from each child and microscopic examination was performed by two medical technologists. The child's parents or principal caretakers were asked to complete questionnaire that inquired about the potential risk factors involved. The questionnaire (Additional file 1) was developed and used to access the data including demographic, personal hygiene, and household sanitary conditions data. We collected information on child's gender, child's age, the number of household members, having older/younger sibling(s), parents' education level, parents' occupation, parents' income, handwashing behavior, fingernail trimming, finger sucking, playing with others, bathing behavior, underwear washing, towel or bed-sharing, anthelmintic medication, living conditions, and household cleaning.

# Data analysis

The total data were cleared, entered, and analyzed using STATA Version 10.1 (STATA Corp., Texas, USA). Demographic characteristics of the participants were described by using frequency, percentage, and 95%CI for categorical data; mean and standard deviation (SD) for continuous data. To investigate factors that affected *E. vermicularis* infections, the prevalence rate, 95%CI, and odds ratios (ORs) were estimated using simple and multiple logistic regressions and a generalized estimating equation (GEE). To adjust for possible confounders, all variables with a P-value less than 0.2 in the univariate analysis were selected. A P-value of less than 0.05 was considered statistically significant.

## Results

### Demographic characteristics

From the total of 859 schoolchildren (aged 3–9 years in 2 subdistricts) included in the study, 397 of them and their parents responded the participation making the response rate of 46.2%. In total, 397 children were enrolled in this study, where 205 (51.64%) of the children were girls and 192 (48.36%) were boys. The mean ( $\pm$  SD) age of the children was 6.79 ( $\pm$  1.74) years (Additional file 2: Table S1).

### Personal hygiene behaviors

Two hundred and forty-nine (62.72%) of children sometimes washed their hands after using toilet facilities. Three hundred and eighty-one (95.97%) of children kept their fingernails short and 332 (83.63%) of children did not suck their fingers (Additional file 3: Table S2).

### Household sanitary conditions

Three hundred and eighty-eight (97.73%) of children lived in a single-family detached home. One hundred and fifty-nine (40.05%) of families changed their bedding once every two weeks and three hundred and twenty-five (81.86%) always cleaned their house (Additional file 4: Table S3).

### Prevalence of *E. vermicularis* infections

The overall prevalence of *E. vermicularis* infections through detection using the scotch tape technique was 5.79% (95%CI 3.48–8.10). This prevalence rate of infection was higher in boys (7.29%) than girls (4.39%).

### Factors associated with *E. vermicularis* infections

According to the multivariate analysis, gender, age group, mother's education level, having older sibling(s), having younger sibling(s), washing hands after using toilet facilities, keeping fingernails short, and sucking fingers were found to be risk factors associated with *E. vermicularis* infections ( $P < 0.05$ ). Boys were 4.03 times (AOR = 4.03, 95%CI 1.22–13.29) more likely to be infected than girls. Meanwhile, children

3 to 6 years of age were 4.85 times (AOR = 4.85, 95%CI 1.51–15.59) more likely to be infected than children 7 to 9 years of age. Children who had a mother with graduated from primary school were 11.22 times (AOR = 11.22, 95%CI 1.75–71.77) more at risk to be infected than those who had a mother with higher education. Moreover, children who have older sibling(s) were 6.25 times (AOR = 6.25, 95%CI 1.83–21.26) more likely to be infected than children who did not have. Additionally, children who have younger sibling(s) were 6.24 times (AOR = 6.24, 95%CI 2.00-19.44) more likely to be infected than children who did not have. Furthermore, children who did not frequently wash their hands after using toilet facilities were 5.25 times (AOR = 5.25, 95%CI 1.24–22.21) more likely to be infected than those who did. Children who kept their fingernails long were 29.97 times (AOR = 29.97, 95%CI 6.16-145.85) more likely to be infected than those who kept them short. Additionally, children who sucked their fingers were 3.59 times (AOR = 3.59, 95%CI 1.21–10.66) more likely to be infected than those who did not suck them (Table 1).

Table 1

Multivariate analysis of risk factors associated with *Enterobius vermicularis* infections among study participants

Characteristics	Total Number	Number positive (PR <sup>a</sup> )	COR <sup>b</sup>	AOR <sup>c</sup> (95% CI <sup>d</sup> )	P-value
<b>Gender</b>					
Girl	205	9 (4.4)	1	1	0.022*
Boy	192	14 (7.3)	1.7	4.03 (1.2–13.3)	
<b>Age group</b>					
7 to 9 years	242	10 (4.1)	1	1	0.008*
3 to 6 years	155	13 (8.4)	2.1	4.85 (1.5–15.6)	
<b>Mother's education level</b>					
Diploma, bachelor or higher	56	2 (3.6)	1	1	0.016*
Secondary school	215	13 (6.1)	1.7	4.11 (0.7–22.6)	
Primary school	126	8 (6.4)	1.8	11.22 (1.8–71.8)	
<b>Having older sibling(s)</b>					
No	184	5 (2.7)	1	1	0.003*
Yes	213	18 (8.5)	3.3	6.25 (1.8–21.3)	
<b>Having younger sibling(s)</b>					
No	270	11 (4.1)	1	1	0.002*
Yes	127	12 (9.5)	2.5	6.24 (2.0–19.4)	

\* Significant association

<sup>a</sup> PR: Prevalence rate in each group

<sup>b</sup> COR: Crude odds ratio by univariable analysis

<sup>c</sup> AOR: Adjusted odds ratio by multivariable analysis

<sup>d</sup> CI: 95% Confidence interval

Characteristics	Total Number	Number positive (PR <sup>a</sup> )	COR <sup>b</sup>	AOR <sup>c</sup> (95% CI <sup>d</sup> )	P-value
<b>Washing hands after using toilet facilities</b>					
Always	148	3 (2.0)	1	1	0.024*
Sometimes	249	20 (8.0)	4.2	5.25 (1.2–22.2)	
<b>Keeping fingernails short</b>					
Yes	381	16 (4.2)	1	1	< 0.001*
No	16	7 (43.8)	17.7	29.97 (6.2–145.9)	
<b>Finger sucking</b>					
No	332	12 (3.6)	1	1	0.022*
Yes	65	11 (16.9)	5.4	3.59 (1.2–10.7)	
* Significant association					
<sup>a</sup> PR: Prevalence rate in each group					
<sup>b</sup> COR: Crude odds ratio by univariable analysis					
<sup>c</sup> AOR: Adjusted odds ratio by multivariable analysis					
<sup>d</sup> CI: 95% Confidence interval					

## Discussion

This was the first report that revealed the prevalence of *E. vermicularis* infections among children who live in rural areas of Southern Thailand through detection using the scotch tape technique. In this study, the overall prevalence of *E. vermicularis* infections at 5.79%, which lower than in previous studies conducted in other regions of Thailand. This discrepancy may partly be due to the study setting and source population difference. The prevalence of pinworm infections at percentages ranging from 7.81–38.82% [19–21, 27, 28, 30], 11.30–50.90% [18, 29], and 7.25–45.38% [22–25] in the central, northeast, and northern region of Thailand, respectively.

However, according to these, the prevalence of *E. vermicularis* infections in Thailand tends to be decreased over the past three decades may mainly be due to the sanitary environment and healthcare access has been greatly improved by urbanization.

Our study revealed that boys were more highly infected with *E. vermicularis* than girls, which was also observed in previous studies [9, 12]. Higher infection rates among boys may be due to boys involved in more activities, close contact with other children, and poor personal hygiene than girls. Among the age groups, children 3 to 6 years of age were more at risk to be infected with *E. vermicularis*, which is consistent with previous studies [13, 29, 30]. This could be because they have more group activities together, take naps together during the day on the floor mat, and poor personal hygiene than older children.

Three main factors that are often involved in *E. vermicularis* infections among children are family background, living conditions, and personal hygiene. In the present study, children with mothers who had a primary level of education had a higher risk of infection. This finding was similar to those reported previously [1, 13] and it may be explained by mothers who had low education levels; thus, they did not have accurate knowledge of pinworm infection are a principal caretaker of children. Meanwhile, some previous reports have suggested that parents' knowledge about enterobiasis might be one of the most important risk factors for enterobiasis in children [11, 14]. In addition, children who had younger/older siblings were more highly infected with *E. vermicularis* than those who had not and these findings were similar to those reported previously [1, 12, 17]. These results suggested that new infection or reinfection may occur in the family among children who are in constant close contact over long periods of time. Further, it seems that their resident including parents or caretakers should be investigated and treated.

Previous reports suggested that inadequate personal hygiene can increase the risk of enterobiasis in children [1, 11, 13–15]. In our study, children who did not frequently wash their hands after using toilet facilities were more at risk to be infected with pinworms. This finding was similar to those reported previously [1, 14], indicating that direct infection by hand from anus to mouth might occur, and additionally it also causes of distribution into the surrounding environment. Moreover, children who sucked their fingers were more at risk to be infected with *E. vermicularis*, which was consistent with other studies [11, 15]. Interestingly, we found that children who kept their fingernails long were more at risk to be infected with pinworms, which is consistent with a previous study [11]. It could be due to pinworm eggs that may thus be transferred from contaminated hands to mouth. Finally, in our study, these findings indicate that finger-oral route remains the most important avenue for *E. vermicularis* transmission.

## Conclusion

This study demonstrated that the high prevalence of *E. vermicularis* infections in schoolchildren with siblings was a significant independent predictor, and transmission of this infection may occur in the family through their school-age siblings. In addition, children who have bad personal hygiene had a high prevalence of *E. vermicularis* infections. Therefore, good handwashing habits, keeping fingernails short, and avoid sucking finger should be an important preventive measure against the infection. Moreover, health literacy or health education, especially for parents or principal caretakers of children, should be implemented to reduce *E. vermicularis* infections. Additionally, these results should encourage

policymakers and public health personnel to improve programs for pinworm control and health promotion.

## Limitations

The limitation in our study was using a single-day scotch tape technique for parasite examination, which is not valid enough to measure the true prevalence of pinworm infection. The prevalence demonstrated in this study was underestimated. Another important limitation is the causes and risk factors associated *E. vermicularis* infection might not be strongly demonstrated from the cross-sectional design of the study.

## Abbreviations

CI: confidence interval; SD: standard deviation; THB: Thai baht; OR: odds ratio; COR: crude odds ratio; AOR: adjusted odds ratio.

## Declarations

## Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Committee on Human Rights Related to Research Involving Human Subjects, Walailak University (Protocol No. WUEC-19-095-01). All research was performed in accordance with the Declaration of Helsinki. The aim and all process of the study were fully described to the children and parents or legal guardians, and participation was voluntary. Written informed consent was obtained from a parent or guardian on behalf of any participants under the age of 16 before data and sample collection. Confidentiality and anonymity of the information has remained.

## Consent for publication

Not applicable.

## Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplementary information files. The raw data are available from the corresponding author on reasonable request.

## Competing interests

We declare that we do not have any competing interests.

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# Authors' contributions

PJ and PL conceived and designed the study. SK, PPO, PJ, and PP performed the experiments. PL and PJ performed the statistical analysis, interpreted the data, and wrote the first draft. All authors have approved the final version of the manuscript and its conclusions.

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## Figures



**Figure 1**

Map of Taling Chan and Sa Kaeo Subdistricts, Tha Sala District, Nakhon Si Thammarat (NST) Province, southern Thailand. (Map from Wikipedia: [https://de.wikipedia.org/wiki/Datei:Thailand\\_Nakhon\\_Si\\_Thammarat\\_locator\\_map.svg](https://de.wikipedia.org/wiki/Datei:Thailand_Nakhon_Si_Thammarat_locator_map.svg) and [https://de.wikipedia.org/wiki/Amphoe\\_Tha\\_Sala](https://de.wikipedia.org/wiki/Amphoe_Tha_Sala))

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