



Research Article

Prevalence of pinworm (*Enterobius vermicularis*) infection and associated factors among preschool children at Ban Thai Samakkhi School, Nakhon Ratchasima Province, Thailand

ความชุกและปัจจัยที่มีความสัมพันธ์กับการติดเชื้อพยาธิเข็มหมุด (*Enterobius vermicularis*) ในเด็กก่อนวัยเรียน โรงเรียนบ้านไทยสามัคคี จังหวัดนครราชสีมา ประเทศไทย

สุดาลักษณ์ ธัญญาหาร¹, สราวุธ สายจันมา¹, ราชภัฏ โคกเกษม¹, มาโนช อานทอง¹, พัทธี พิพิธจันทร์¹, พชรพร ชูเดชวัฒนา¹, จุฬารัตน์ เจียมธีระนาถ¹, พนธพันธ์ พลเยี่ยม¹, วิญญู วงศ์ประทุม¹, นิจธร สังขศิริ^{2*}

Sudaluck Thunyaharn¹, Sarawut Saichanma¹, Rajapat Khokkaseam¹, Manoch Arnthong¹, Patchanee Pipittajan¹, Phatchareeporn Choodetwattana¹, Chularat Jiamteeranat¹, Pontapan Polyiam¹, Winyou Wongpratoom¹, Nitchatorn Sungsirin^{2*}

¹ คณะสหเวชศาสตร์ วิทยาลัยนครราชสีมา 290 หมู่ 2 ถ.มิตรภาพ อ.เมือง จ.นครราชสีมา 30000

² ภาควิชาจุลชีววิทยา วิทยาลัยแพทยศาสตร์พระมงกุฎเกล้า 315 ถ.ราชวิถี เขตราชเทวี กรุงเทพมหานคร 10400

¹ Faculty of Allied Health Sciences, Nakhonratchasima College, 290 Moo 2, Mittraphap Road, Mueang District, Nakhon Ratchasima, 30000

² Department of Microbiology, Phramongkutklao College of Medicine, 315, Ratchawithi Road, Ratchathewi, Bangkok, 10400

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Abstract

Enterobius vermicularis (pinworm or thread worm) infection is a common parasitic infestation among preschool children. This cross-sectional study assessed the prevalence of *E. vermicularis* infection and associated factors among preschool children at Ban Thai Samakkhi School, Wang Nam Khiao District, Nakhon Ratchasima Province, Thailand. All eligible preschool children were recruited using purposive sampling, and 69 children were examined in August 2024 using the Scotch tape technique followed by microscopic examination. Demographic and behavioral data were collected through structured questionnaires completed by parents or caregivers. The overall prevalence of *E. vermicularis* infection was 24.64% (17/69), with a significantly higher prevalence among females (50.0%) than males (2.7%; OR = 36.0, 95% CI: 4.4-295.0; $p < 0.001$). Infection was also significantly associated with lack of regular handwashing (OR = 3.9, 95% CI: 1.2-13.1; $p = 0.040$), thumb-sucking behavior (OR = 15.4, 95% CI: 4.2-56.1; $p < 0.001$), and lower parental education level ($p = 0.021$). Age group and sharing utensils were not statistically significant. These findings emphasize the importance of hygiene-focused health education, parental awareness, and regular screening to reduce pinworm transmission in preschool settings, particularly in rural and resource-limited communities.

Keywords: Pinworm, Thread worm, Associated factors, Preschool children, Scotch tape technique

บทคัดย่อ

การติดเชื้อ *Enterobius vermicularis* (พยาธิเข็มหมุดหรือพยาธิเส้นด้าย) เป็นการติดเชื้อปรสิตที่พบได้บ่อยในเด็กก่อนวัยเรียน การศึกษาแบบภาคตัดขวางนี้มีวัตถุประสงค์เพื่อประเมินความชุกของการติดเชื้อ *E. vermicularis* และปัจจัยที่มีความสัมพันธ์ในเด็กก่อนวัยเรียนที่โรงเรียนบ้านไทยสามัคคี อำเภอน้ำขี้เหล็ก จังหวัดนครราชสีมา ประเทศไทย เด็กก่อนวัยเรียนที่เข้าเกณฑ์ทั้งหมดถูกรับเข้าศึกษาโดยใช้การคัดเลือกแบบเจาะจง และมีการตรวจเด็กจำนวน 69 คนในเดือนสิงหาคม พ.ศ. 2567 โดยใช้เทคนิคสกอตซ์เทปตามด้วยการตรวจด้วยกล้องจุลทรรศน์ ข้อมูลด้านประชากรศาสตร์และพฤติกรรมถูกรวบรวมโดยใช้แบบสอบถามที่มีโครงสร้าง ซึ่งกรอกโดยผู้ปกครองหรือผู้ดูแล

ความชุกของการติดเชื้อ *E. vermicularis* โดยรวมเท่ากับ ร้อยละ 24.64 (17/69) โดยพบอัตราการติดเชื้อในเพศหญิงสูงกว่าเพศชายอย่างมีนัยสำคัญทางสถิติ (ร้อยละ 50.0 เทียบกับร้อยละ 2.7; OR = 36.0, 95% CI: 4.4-295.0; $p < 0.001$) การติดเชื้อยังมีความสัมพันธ์อย่างมีนัยสำคัญกับการไม่ล้างมือเป็นประจำ (OR = 3.9, 95% CI: 1.2-13.1; $p = 0.040$) พฤติกรรมการดูทีวี (OR = 15.4, 95% CI: 4.2-56.1; $p < 0.001$) และระดับการศึกษาของผู้ปกครองที่ต่ำกว่า ($p = 0.021$) กลุ่มอายุและการใช้ของใช้ร่วมกันไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติ

ผลการศึกษาเน้นย้ำถึงความสำคัญของการให้ความรู้ด้านสุขอนามัย การสร้างความตระหนักรู้แก่ผู้ปกครอง และการตรวจคัดกรองอย่างสม่ำเสมอ เพื่อลดการแพร่กระจายของพยาธิเส้นด้ายในสถานศึกษาระดับก่อนวัยเรียน โดยเฉพาะในพื้นที่ชนบทและพื้นที่ที่มีทรัพยากรจำกัด

คำสำคัญ: พยาธิเข็มหมุด, พยาธิเส้นด้าย, ปัจจัยที่มีความสัมพันธ์, เด็กก่อนวัยเรียน, เทคนิคสกอตซ์เทป

1. Introduction

Enterobiasis is an intestinal parasitic infection caused by the nematode *Enterobius vermicularis*, commonly known as pinworm [1]. It is one of the most prevalent parasitic infections worldwide, particularly affecting young children in preschool and primary school settings, especially in tropical and subtropical regions [2]. Humans are the only natural host for this parasite, making direct human-to-human transmission the primary mode of spread [3].

The life cycle of *E. vermicularis* begins with the ingestion of infective eggs, which hatch in the small intestine. The larvae migrate to the large intestine, where they mature into adult worms [4]. Female worms migrate to the perianal region, typically at night, to deposit eggs, causing intense itching (pruritus ani) [5]. This itching can lead to autoinoculation as children scratch the affected area and inadvertently reintroduce the eggs into their mouth [6]. Besides the gastrointestinal tract, *E. vermicularis* has also been reported in atypical sites such as the vagina, urinary bladder, peritoneum, and even the eye [7-10].

The transmission of pinworm is facilitated by poor hygiene practices, crowded living conditions, and close contact among young children, making preschool environments particularly high-risk areas [11]. Contaminated hands, clothing, toys, utensils, and surfaces serve as important vehicles for the spread of this parasite [12]. Despite its high prevalence in some areas, the burden of pinworm infection varies depending on regional factors, such as hygiene practices, socioeconomic conditions, and public health measures [13].

Recent studies have further shown the global significance of enterobiasis. A systematic review and meta-analysis by Lashaki et al. (2023) analyzed the global prevalence of enterobiasis in young children over the past 20 years, providing a comprehensive overview of infection patterns worldwide. The study emphasized the persistent burden of pinworm infection among children, with notable variations across different regions and time periods [14]. In Iran, a 2023 meta-analysis of 51 studies involving 46,070 children reported an overall prevalence of 6.7%, with a decreasing trend over time, suggesting improvements in public health measures [15]. In China, a meta-analysis covering 66 studies from 2016 to 2021 across 23 provinces revealed a pooled prevalence of 4.5%, with the highest rates in southern regions [16]. A 2021 study in the Republic of Marshall Islands by Fan et al. (2021) reported a prevalence of 19.15% among schoolchildren, indicating the importance of region-specific epidemiological data for understanding the global burden of enterobiasis [17].

In Southeast Asia, studies have shown significant variations in pinworm prevalence. In Laos, Sayasone et al. (2011) identified multiple parasitic infections, including enterobiasis, among rural populations [18]. In Myanmar, Chai et al. (2015) found a high prevalence of *E. vermicularis* among schoolchildren in townships around Yangon [19]. In Malaysia, Anuar et al. (2016) reported notable prevalence among preschool children in an urban area [20].

In Thailand, the prevalence of pinworm infection also varies significantly across regions [21-41]. Studies in the central and northern regions reported prevalences ranging from 14.3% to 22.8% [21-33] and 11.2% to 27.8% [34-36], respectively.

In contrast, the northeastern region has shown lower prevalences ranging from 1.72% to 11.3% [37-40]. In 2010, Kaewpitoon & Kaewpitoon reported a prevalence of 7.73% among preschool children in Warinchamrap District, Ubonratchathani Province [37]. In 2018, Laoraksawong et al. reported a prevalence of and a prevalence of 11.3% among students from 7 elementary schools in Nafhai Sub-district, Mueang District, Chaiyaphum Province [38]. In 2019, Chinjarenpa et al. reported a prevalence of 6.06% among preschool children in Ban Khlong Bong, Wang Nam Khiao District, Nakhon Ratchasima Province [39]. In 2023, Thunyaharn et al. reported a prevalence of 1.72% among preschool children in Ban Mai Municipal Child Development Center, Mueang District, Nakhon Ratchasima Province [40].

This study aimed to determine the prevalence of pinworm infection among preschool children at Ban Thai Samakkhi School in Wang Nam Khiao District, a rural area of Nakhon Ratchasima Province, where hygiene practices, environmental conditions, and socioeconomic factors may influence infection prevalence.

2. Materials and experiment

2.1 Study design, population and ethic approval

A cross-sectional study was conducted to investigate the prevalence of pinworm infection among preschool children at Ban Thai Samakkhi School, Wang Nam Khiao District (Figure 1), Nakhon Ratchasima (14.360452, 101.916649). The study targeted children aged 3 to 6 years. The sample size was calculated using Yamane's formula ($n = N / (1 + N * e^2)$) [42], where n is the sample size, N (77) is the population size (the number of children in Ban Thai Samakkhi School), and e (0.05) is the level of precision. This calculation resulted in a minimum sample size of 65, ensuring adequate representation of the target population.

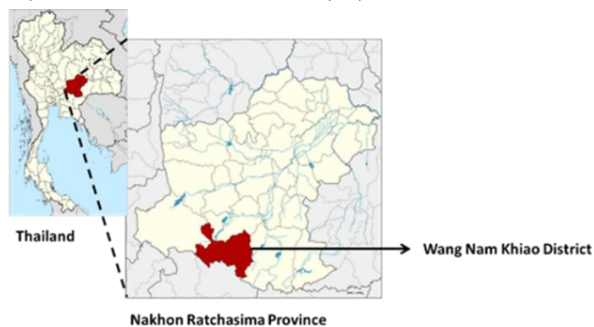


Figure 1 Locality of Wang Nam Khiao District, Nakhon Ratchasima, in northeastern region of Thailand

Ethical approval for the study was obtained from the Institutional Review Board of Faculty of Allied Health Sciences, Nakhonratchasima College (Reference number:

NMCEC-0014/2561). Prior to the study, a meeting was conducted with school authorities and parents. Informed consent was obtained from the parents or legal caregivers of all participating children.

2.2 Sample collection

Eligible participants were recruited using a purposive sampling approach, whereby all preschool children meeting the inclusion criteria at Ban Thai Samakkhi School were invited to participate. All 77 children enrolled at the school were invited to participate in the study. Inclusion criteria encompassed children whose parents or caregivers provided written informed consent. Exclusion criteria included children who had received anthelmintic treatment within the past three months or had underlying health conditions that could interfere with the study procedures. Ultimately, only 69 children met the eligibility criteria and were successfully investigated for pinworm infection. This number met the minimum required sample size based on the sample size calculation for the study.

2.3 Data collection

Data collection was carried out over a one-week period in August 2024. Parents or caregivers completed a structured questionnaire designed to gather information on demographic characteristics, personal hygiene practices, and potential factors associated with *E. vermicularis* infection. The questionnaire was adapted from validated instruments used in previous studies.

2.4 Parasitological examination

The Scotch tape technique, as described by Graham (1941), was employed for the detection of *E. vermicularis* eggs [43]. Parents were instructed to collect perianal samples from their children in the early morning before bathing or defecation. The adhesive side of a transparent tape was pressed against the perianal region and then affixed to a clean glass slide. Samples were collected over three consecutive days to enhance detection sensitivity. Slides were transported to the Parasitology Laboratory at Faculty of Allied Health Sciences, Nakhonratchasima College, Nakhon Ratchasima, Thailand, for microscopic examination. Each slide was examined under a light microscope at 10x and 40x magnifications by two independent trained laboratory technicians. A sample was considered positive if *E. vermicularis* eggs were identified on any of the three slides.

2.5 Data analysis

Data were analyzed using IBM SPSS Statistics version 23.0. Descriptive statistics were used to summarize demographic characteristics and prevalence. Associations between potential factors and pinworm infection were assessed using Fisher's exact test or the Fisher-Freeman-Halton exact test. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Demographic data of the study population

A total of 69 preschool children from Ban Thai Samakkhi School were included in the study. The demographic characteristics of the study population are summarized in Table 1. The children were aged 3-6 years, with the majority belonging to the 5-6-year age group (44 children, 63.8%), while 25 children (36.2%) were aged 3-4 years. The gender distribution was relatively balanced, comprising 37 boys (53.6%) and 32 girls (46.4%).

Most parents had completed secondary education (44.9%), followed by higher education (39.2%) and primary education (15.9%). Nearly half reported a monthly income of 10,000-20,000 Thai Baht (44.9%), with 37.7% earning less than 10,000 Thai Baht and 17.4% earning more than 20,000 Thai Baht.

Table 1 Demographic characteristics of the study population (N = 69)

Characteristic	Frequency (n)	Percentage (%)
Age group		
3-4 years	25	36.2
5-6 years	44	63.8
Gender		
Male	37	53.6
Female	32	46.4
Parent's education level		
Primary School	11	15.9
Secondary School	31	44.9
Higher Education	27	39.2
Family income (monthly)		
< 10,000 Thai Baht	26	37.7
10,000 - 20,000 Thai Baht	31	44.9
> 20,000 Thai Baht	12	17.4

> 20,000 Thai Baht

12

17.4

3.2 Prevalence of *E. vermicularis* infection

Of the 69 children examined using the Scotch tape technique, 17 (24.64%) were positive for *E. vermicularis*. Diagnosis was based on the detection of characteristic eggs and, in some cases, adult worms under light microscopy. The eggs displayed the typical D-shaped morphology (Figure 2.1). Adult pinworms were observed in 3 cases (Figure 2.2). Among the positive cases, 1 was male (2.7%) and 16 were female (50.0%). Most infections (14/17) involved eggs only, while 3 cases showed both eggs and adult worms (Table 2).

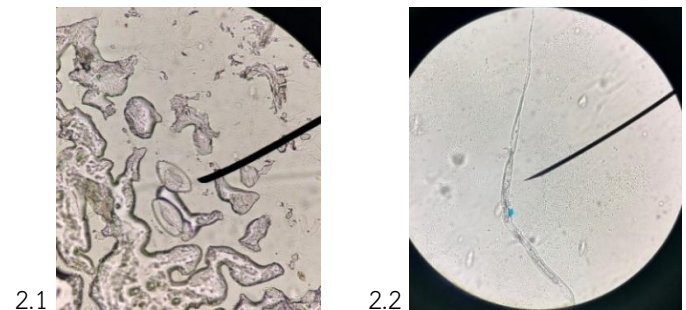


Figure 2 Microscopic view of *E. vermicularis*: Eggs in D-shape (x 40) (2.1); An adult pinworm (x10) (2.2)

3.3 Associated factor analysis

Associated factor analysis (Table 3) identified gender, parental education level, regular handwashing, and thumb-sucking behavior as factors significantly associated with *E. vermicularis* infection. Infection was significantly more frequent among females than males ($p < 0.001$), with females showing markedly higher odds of infection (OR = 36.0; 95% CI: 4.4–295.0). Children who did not practice regular handwashing had a higher prevalence of infection ($p = 0.040$). Thumb-sucking behavior was also strongly associated with infection ($p < 0.001$). Parental education level showed a significant association ($p = 0.021$), with higher infection rates observed among children whose parents had lower educational attainment. Age group ($p = 0.146$) and sharing utensils ($p = 0.052$) were not statistically significant, although higher infection rates were observed among children aged 3–4 years and those who shared utensils.

Table 2 Distribution of positive cases for *E. vermicularis* infection by gender

Gender	N	Positive n (%)	Eggs only (%)	Eggs and adult (%)	Prevalence (%)	OR (95% CI)	p-value
Male	37	1 (2.70)	1 (2.70)	0 (0.00)	2.70	Reference	< 0.001*
Female	32	16 (50.00)	13 (40.63)	3 (9.38)	50.00	36.0 (4.4 - 295.0)	
Total	69	17 (24.64)	14 (20.29)	3 (4.35)	24.64		

* Fisher's exact test (for positive n); OR = odds ratio; CI = confidence interval

Table 3 Associated factor analysis for *E. vermicularis* infection

Associated factor	N	Positive n (%)	Negative n (%)	OR (95% CI)	<i>p</i> -value
Age group					
3-4 years	25	9 (36.0%)	16 (64.0%)	2.5 (0.9–7.0)	0.146 ^a
5-6 years	44	8 (18.2%)	36 (81.8%)	Reference	
Gender					
Male	37	1 (2.7%)	36 (97.3%)	Reference	< 0.001 ^a
Female	32	16 (50.0%)	16 (50.0%)	36.0 (4.4–295.0)	
Parent’s education					
Higher education	27	3 (11.1%)	24 (81.9%)	Reference	0.021 ^b
Secondary school	31	8 (25.8%)	23 (74.2%)	2.7 (0.6–11.2)	
Primary school	11	6 (54.5%)	5 (45.5%)	9.6 (1.7–53.6)	
Regular handwashing					
Yes	54	10 (18.5%)	44 (81.5%)	Reference	0.040 ^a
No	15	7 (46.7%)	8 (53.3%)	3.9 (1.2–13.1)	
Thumb sucking					
No	50	5 (10.0%)	45 (90.0%)	Reference	< 0.001 ^a
Yes	19	12 (63.2%)	7 (36.8%)	15.4 (4.2–56.1)	
Sharing utensils					
No	39	6 (15.4%)	33 (84.6%)	Reference	0.052 ^a
Yes	30	11 (36.7%)	19 (63.3%)	3.2 (1.0–9.8)	

^a Fisher's exact test (2x2 tables); ^b Fisher–Freeman–Halton exact test (>2x2 tables); OR = odds ratio; CI = confidence interval

4. Discussion

This study examined the prevalence of *E. vermicularis* infection and its associated factors among preschool children in a rural area of Nakhon Ratchasima Province, Thailand. The observed prevalence of 24.64% is notably higher than previously reported rates from other areas within the province [39,40] and emphasizes the vulnerability of preschool- aged children living in rural and semi-mountainous settings. Preschool children are often underrepresented in routine surveillance programs, and the

findings indicate the need to prioritize this age group in epidemiological monitoring and control efforts.

Wang Nam Khiao District is characterized by dispersed rural communities, semi- mountainous geography, and limited access to public health resources. Such contextual factors may contribute to delayed health education, reduced preventive interventions, and challenges in implementing routine screening programs. Previous studies conducted in Nakhon Ratchasima Province, particularly in urban and semi-urban areas, have reported substantially lower prevalence

rates, ranging from 1.72% among preschool children in Muang District [40] to 6.06% among school-aged children in Wang Nam Khiao district [39]. The higher prevalence observed in the present study therefore reflects marked intra-provincial heterogeneity and suggests that infection risk may be systematically underestimated in rural communities.

Geographical variation in *E. vermicularis* prevalence has been well documented across Thailand. Studies from the Central and Northern regions have reported prevalence rates comparable to or slightly lower than those observed in this study [21-36], whereas reports from the Northeastern region have generally indicated lower prevalence, including among children [37-40]. The comparatively high prevalence identified in this rural northeastern setting suggests that local environmental conditions, settlement patterns, and access to health services, rather than regional trends alone, may play a critical role in shaping transmission dynamics.

This study demonstrates that *E. vermicularis* infection in a rural preschool population is influenced by a combination of gender, parental education level, and hygiene-related behaviors, indicating the interplay between individual, household, and behavioral factors in shaping infection risk.

Although age group was not statistically associated with infection, a higher prevalence was observed among children aged 3-4 years compared with those aged 5-6 years. This trend may reflect developmental differences, including immature hygiene practices, increased hand-to-mouth behaviors, and greater dependence on caregivers, which can increase exposure risk in rural preschool environments [21,31,38,41].

Gender emerged as a strong and statistically significant associated factor, with female children exhibiting markedly higher odds of infection than males. While previous studies have reported inconsistent associations between gender and *E. vermicularis* infection [21,29,31,33,41], the present findings suggest that gender-related behavioral patterns, caregiving practices, or hygiene assistance may influence transmission dynamics in this setting. Such differences may be more pronounced in preschool environments, where close contact and shared activities are common.

Parental education level was also significantly associated with infection, with higher prevalence observed among children whose parents had lower educational attainment. This finding supports existing evidence that parental education may indirectly affect infection risk through health literacy, supervision of hygiene practices, and awareness of preventive measures [22,31,32,41]. In rural contexts such as

Wang Nam Khiao District, limited access to health information and structured health promotion activities may further amplify the impact of lower parental education on children's hygiene behaviors and subsequent infection risk.

Hygiene-related behaviors showed the strongest and most consistent associations with infection. Lack of regular handwashing and thumb-sucking behavior were both significantly associated with increased odds of *E. vermicularis* infection, emphasizing the central role of direct contact and hand-to-mouth transmission in preschool-aged children. Although sharing utensils did not reach statistical significance, a higher prevalence was observed among children who reported this behavior, suggesting a potential contributory role that warrants further investigation. These behaviors are modifiable, emphasizing the importance of targeted interventions such as school-based hygiene education, caregiver-focused awareness programs, and routine supervision of hand hygiene to reduce transmission.

Several limitations should be acknowledged. The cross-sectional design and purposive sampling from a single preschool limit causal inference and generalizability. Although the cellophane tape swab is a widely accepted diagnostic method for enterobiasis [14,43], its sensitivity may be reduced in cases of light infection or intermittent egg shedding. Additionally, caregiver-reported behavioral data may be subject to recall bias, and other socioeconomic or environmental determinants relevant to rural transmission could not be comprehensively assessed.

Given the identified risk factors and the rural setting, school-based screening, periodic deworming, and hygiene-focused health education - particularly targeting parents and caregivers - are strongly recommended. Interventions promoting regular handwashing and discouraging thumb-sucking behavior may be especially effective in reducing transmission in preschool settings. Future multi-site and longitudinal studies incorporating repeated sampling and complementary diagnostic approaches are needed to confirm these findings and evaluate the impact of context-specific intervention strategies.

5. Conclusion

This study demonstrates a relatively high prevalence of *E. vermicularis* infection among preschool children at Ban Thai Samakkhi School, Wang Nam Khiao District, Nakhon Ratchasima Province, Thailand. Female gender, lower parental education level, poor handwashing practices, and thumb-sucking behavior were significantly associated with

infection, indicating the importance of both household and hygiene-related factors. Although sharing utensils and age group were not statistically significant, higher infection rates were observed among younger children and those who shared utensils. These findings emphasize the need for targeted hygiene- focused health education for parents, caregivers, and preschool children, as well as regular screening and timely treatment to reduce transmission in rural and resource-limited settings.

6. Declaration of conflicting interests

The authors declared that they have no conflicts of interest in the research, authorship, and this article's publication.

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