

PREVALENCE OF PINWORM INFECTION AND ASSOCIATED FACTORS AMONG PRESCHOOL CHILDREN IN CU JUT COMMUNE, LAM DONG PROVINCE, VIETNAM, 2026

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Abstract: Objective: To determine the prevalence of pinworm (*Enterobius vermicularis*) infection and associated factors among preschool children in Cu Jut Commune, Lam Dong Province, Vietnam, in 2026.

Methods: A cross-sectional study was conducted among 373 children aged 1-5 years old across Tam Thang and Tuoi Than Tien preschools from April to October 2026. Pinworm infection was diagnosed using the Graham adhesive tape method, while associated factors were collected via structured questionnaires. Multivariable Poisson regression with robust variance and clustered standard errors adjusted for 6 classes was used to estimate adjusted prevalence ratios (aPR).

Results: Among the 373 children tested, 35 were positive for pinworm infection, yielding an overall prevalence of 9.38% (95% CI: 6.63-12.81). No statistically significant differences in infection rates were observed by sex, ethnicity, school type, or class grade. Five factors were independently associated with the infection: caregivers not dewormed in the preceding 6 months (aPR = 3.71; 95% CI: 1.43-9.58); long/dirty fingernails >1 mm (aPR = 3.37; 95% CI: 2.30-4.95); thumb-sucking habit (aPR = 3.13; 95% CI: 1.36-7.18); failure to wash hands with soap (aPR = 2.95; 95% CI: 1.35-6.41); and infrequent washing of bed sheets and mats (aPR = 1.84; 95% CI: 1.11-3.04); all with $p < 0.05$.

Conclusion: The pinworm infection rate was 9.38%. Associated factors primarily involve personal hygiene, children's behaviors, and household environmental sanitation.

Keywords: *Enterobius vermicularis*; pinworm; Graham method; preschool children; associated factors; Cu Jut; Vietnam.

1. INTRODUCTION

Pinworm infection caused by *Enterobius vermicularis* is one of the most common intestinal parasitic infections globally, particularly among preschool-aged children (Centers for Disease Control and Prevention [CDC], 2019). Unlike soil-transmitted helminths, pinworms are capable of direct person-to-person transmission. Eggs can spread via the hands-to-mouth route, autoinfection, reinfection, and contaminated household environments or items such as bed sheets, pillowcases, mattresses, and shared toys (Albasheer et al., 2026; CDC, 2019).

Pinworm infection typically manifests as perianal pruritus, especially at night, which can impair children's sleep and daily activities. In certain cases, worms may migrate ectopically to other organs (Albasheer et al., 2026; CDC, 2019). Because female pinworms deposit eggs primarily around the perianal region, standard stool examinations frequently miss infections. The perianal adhesive tape technique (Graham method) is standardly used to detect pinworm eggs and is well-suited for epidemiological surveys (CDC, 2019; Graham, 1941).

Globally, meta-analyses indicate that the pinworm infection rate among children is approximately 12.9%, with variations across regions and study populations (Fan et al.,

2019; Jeon et al., 2026; Khampoosa & Haruay, 2025; Laoraksawong et al., 2020; Lashaki et al., 2023). In Vietnam, studies have also recorded varying prevalence rates across regions, ranging from 4.8% in urban Hai Phong, 10.6% in Pleiku, 23.8% in Cu Chi, to 12.5%-27.0% in rural districts of Dak Lak (Luu My Phung, 2018; Nguyen Thi Thuy Trang, 2021; Pham Thanh Hien, 2021; Thai Quang Hung & Nguyen Xuan Giao, 2023).

Cu Jut Commune, Lam Dong Province, is a multiethnic locality in the Central Highlands with nearly 50,000 residents. Its economy is mainly based on agriculture and small-scale industry, and living conditions differ markedly between the central area and peripheral villages and hamlets. Although the national deworming programme has been implemented, helminth infections remain a public health concern in the community, while site-specific data on pinworm infection among preschool children are unavailable (Ministry of Health, 2021). In the semi-boarding preschool setting, shared nap times, bedding, toys, and still-developing hygiene practices among children aged 1-5 years may facilitate pinworm transmission.

This study was therefore conducted at Tam Thang and Tuoi Than Tien preschools in Cu Jut Commune, Lam Dong Province, Vietnam, to: (1) determine the prevalence of pinworm infection among children aged 1-5 years using the Graham method; and (2) analyze factors associated with pinworm infection among children in the study setting.

2. MATERIALS AND METHODS

2.1. Study Subjects, Location, and Period

A cross-sectional descriptive study was conducted from April to October 2026 at Tam Thang Preschool (public) and Tuoi Than Tien Preschool (private) in Cu Jut Commune, Lam Dong Province, Vietnam.

Study subjects included children aged 1-5 years enrolled in boarding classes at both schools. Inclusion criteria were children aged 1-5 years studying at the two schools whose parents or legal guardians provided written informed consent. Exclusion criteria were children who received deworming medication within 2 months prior to the survey; absence during sample collection; perianal hygiene performed early in the morning before sample collection; or incomplete questionnaires completed by caregivers.

2.2. Sample Size and Sampling Method

Sample size was calculated for a population proportion incorporating cluster design effect and finite population correction using the formula:

$$n \geq DE \times \frac{Z^2 p(1-p)}{d^2}$$

Where the design effect $DE = 2.0$; $Z = 1.92$; anticipated prevalence $P = 0.125$ based on a 2023 study in Krong Pak, Vietnam; and allowable error $d = 0.05$. The minimum required sample size calculated was 337 children. Accounting for a 5% non-response rate, the required sample size was 354 children.

A purposive cluster sampling method combined with complete enumeration within selected class clusters was utilized. First, two preschools were purposively selected, consisting of one public and one private school. At each school, three grade levels (Nursery, Toddler, and Kindergarten) were chosen, forming 6 class clusters. All eligible children within these clusters were invited to participate.

At Tam Thang Preschool, 239 children were surveyed, including 45 in the Nursery level, 79 in the Toddler level, and 115 in the Kindergarten level. At Tuoi Than Tien Preschool, 134 children were surveyed, comprising 58 in the Nursery level, 42 in the Toddler level, and 34 in the Kindergarten level. A total of 373 children from 6 class clusters across 2 schools were included in the final analysis.

2.3. Diagnosis of Pinworm Infection

Pinworm infection status was diagnosed using the perianal adhesive tape technique (Graham method).

Parents or caregivers were instructed on home sample collection in the morning before the child defecated or washed the perianal area. A clear adhesive tape strip (3×2 cm) was pressed firmly 3-4 times around the perianal folds and then mounted onto a glass slide. Samples were placed in sealed bags and transported during the same morning to the Microbiology-Parasitology Laboratory of the University Hospital for examination.

Slides were examined blindly by laboratory personnel using 10 × and 40 × objectives. A sample was considered positive if pinworm eggs (characterized by oval shape, flattened on one side, smooth shell) or larvae/adult worms were detected.

Test results were utilized to determine the prevalence of pinworm infection in the study population, fulfilling the first study objective.

2.4. Collection of Data on Associated Factors

Data were collected using structured, closed-ended questionnaires via direct interviews with child caregivers.

Information categories included: (i) Child and family characteristics: sex, ethnicity, school, class level, caregiver's education level and occupation; (ii) Child hygiene practices: handwashing with soap, thumb/finger sucking, chewing toys, eating with hands, and presence of long or dirty fingernails (> 1 mm); (iii) Household and deworming history characteristics: type of bed (mattress versus mat), frequency of washing bed sheets/mats (at least weekly versus infrequent), number of siblings under 15 years old in the household, and deworming history of the child and caregiver within the past 6 months.

Exposure variables were cross-referenced with Graham test results to identify factors associated with pinworm infection.

2.5. Data Management and Analysis

Data was entered and managed using EpiData 3.1 and analyzed using Stata 17.

Descriptive statistics were used to present frequencies and percentages. Associations between individual factors and pinworm infection were evaluated using Chi-square or Fisher's exact tests and crude prevalence ratios (cPR) with 95% confidence intervals.

Collinearity among independent variables was assessed using the Variance Inflation Factor (VIF) and tolerance ($1/\text{VIF}$). A threshold of $\text{VIF} < 3.0$ was utilized (Vittinghoff & McCulloch, 2007).

Univariable analysis was performed to calculate infection rates, crude prevalence ratios (cPR), and 95% confidence intervals using Chi-square or Fisher's exact tests where appropriate. Multivariable analysis utilized Poisson regression with robust variance and clustered standard errors adjusted for 6 class clusters to estimate adjusted prevalence ratios (aPR). Statistical significance was defined as $P < 0.05$.

2.6. Ethical Considerations

The study protocol was approved by Tay Nguyen University under Decision No. 1013/QĐ-ĐHTN, dated March 27, 2026. Written informed consent was obtained from parents or legal guardians. Participant information was coded and kept confidential.

Children with positive test results were privately notified and provided with free 400 mg albendazole treatment according to Ministry of Health guidelines (2021).

3. RESULTS

3.1. Overall Pinworm Infection Prevalence and Demographic Characteristics

Among 373 preschool children tested using the Graham method, 35 tested positive, yielding an overall pinworm infection prevalence of 9.38% (95% CI: 6.63%-12.81%). Table 1 presents the distribution of infection rates by demographic characteristics.

Table 1. Demographic characteristics and pinworm infection prevalence among preschool children ($N = 373$)

Demographic Characteristics	Sample Size (n)	Positive Cases (×)	Prevalence (%)	cPR (95% CI)	<i>P</i> -value
Sex					0.574
- Female (Reference)	166	14	8.43	1.00	
- Male	207	21	10.14	1.20 (0.63 - 2.29)	
Ethnicity					0.374
- Kinh (Reference)	176	14	7.95	1.00	
- Ethnic minority	197	21	10.66	1.34 (0.70 - 2.55)	
School Type					0.369
- Tam Thang (Public) (Ref)	239	20	8.37	1.00	
- Tuoi Than Tien (Private)	134	15	11.19	1.34 (0.71 - 2.52)	

Note: cPR: crude Prevalence Ratio; CI: Confidence Interval.

3.2. Association Between Exposure Factors and Pinworm Infection

Univariable analysis results for 7 exposure variables (after checking collinearity) are displayed in Table 2. All 7 factors showed statistically significant associations with pinworm infection in children ($p < 0.05$).

Table 2. Univariable association between exposure factors and pinworm infection (*N*=373)

Exposure Factor	Sample Size (n)	Positive (+)	Prevalence (%)	cPR (95% CI)	<i>P</i> -value
Child Personal Hygiene Behaviors					
1. Use soap when washing hands					< 0.001
- Yes (Reference)	354	27	7.63	1.00	
- No	19	8	42.11	5.52 (2.91 - 10.47)	
2. Thumb/finger-sucking habit					< 0.001
- No (Reference)	262	9	3.44	1.00	
- Yes	111	26	23.42	6.82 (3.30 - 14.08)	
3. Fingernail status (observed)					< 0.001
- Short, clean (≤ 1 mm) (Ref)	322	18	5.59	1.00	
- Long, dirty (>1 mm)	51	17	33.33	5.96 (3.29 - 10.79)	
Household Environment & Health					
4. Child's bed type (Mattress vs. Mat)	215 vs. 158	26 vs. 9	12.09 vs. 5.70	2.12 (1.02 - 4.40)	0.043
5. Bed sheet/mat hygiene (Infrequent vs. Yes)	105 vs. 268	21 vs. 14	20.00 vs. 5.22	3.83 (2.02 - 7.24)	< 0.001
6. Siblings <15 y (>2 children vs. ≤ 2)	24 vs. 349	8 vs. 27	33.33 vs. 7.74	4.31 (2.20 - 8.44)	< 0.001
7. Caregiver deworming (>6 months vs. ≤ 6)	188 vs. 185	31 vs. 4	16.49 vs. 2.16	7.63 (2.75 - 21.18)	< 0.001

Note: cPR: crude Prevalence Ratio; CI: Confidence Interval.

3.3. Multivariable Analysis

VIF values for the seven exposure variables ranged from 1.019 to 1.079, with a mean VIF of 1.050, indicating no substantial multicollinearity. Table 3 presents the multivariable robust Poisson regression model with clustered standard errors across 6 class clusters, identifying 5 independent risk factors maintaining statistical significance ($p < 0.05$).

Table 3. Association between exposure factors and pinworm infection in multivariable Poisson regression

Risk Factor in Model	cPR (Univariable)	aPR (Multivariable)	95% CI (aPR)	<i>p</i> (Robust SE)	<i>P</i> (Clustered SE)
Caregiver > 6 months not dewormed	7.63	3.71	1.43 - 9.58	0.013	0.007
Long, dirty fingernails (>1 mm)	5.96	3.37	2.30 - 4.95	< 0.001	< 0.001
Thumb/finger-sucking (Yes vs. No)	6.82	3.13	1.36 - 7.18	0.004	0.007
Not washing hands with soap (No vs. Yes)	5.52	2.95	1.35 - 6.41	0.001	0.006
Infrequent bed sheet/mat washing	3.83	1.84	1.11 - 3.04	0.036	0.018
Sleeping on mattress (Mattress vs. Mat)	2.12	1.82	0.70 - 4.76	0.068	0.222
Large family (> 2 siblings < 15 y)	4.31	1.11	0.61 - 1.99	0.745	0.738

Note: aPR: adjusted Prevalence Ratio; *p* (Clustered SE): *p*-value calculated using clustered standard errors adjusted for 6 class clusters.

4. DISCUSSION

4.1. Pinworm Infection Prevalence and Demographic Characteristics

The study among 373 children aged 1-5 years across two preschools in Cu Jut Commune recorded 35 positive cases of *Enterobius vermicularis*, corresponding to an infection prevalence of 9.38% (95% CI: 6.63%-12.81%). This finding is lower than the global pooled average of 12.9% among children reported in meta-analyses (Lashaki et al., 2023), yet falls within the range reported across various Asian regions. In southern Thailand, prevalence was reported around 5.79% among schoolchildren (Laoraksawong et al., 2020), while comprehensive reviews in Thailand indicate varying prevalence across locations and periods (Khampoosa & Haruay, 2025). The 9.38% prevalence in this study is also lower

than the 22.4% reported in the Marshall Islands (Fan et al., 2019) and higher than very low rates reported in parts of South Korea and Taiwan (Jeon et al., 2026).

Compared to studies in Vietnam, the 9.38% rate is close to 10.6% in Pleiku city (Nguyen Thi Thuy Trang, 2021) and 12.5% in Krong Pak district, Dak Lak (Thai Quang Hung & Nguyen Xuan Giao, 2023), while lower than figures recorded in Cu Chi, Ho Chi Minh City (Luu My Phung et al., 2018). Differences across studies relate to study locations, populations, living conditions, hygiene behaviors, survey timing, and diagnostic methods. Consequently, direct comparisons of prevalence across sites should be interpreted with caution.

The Graham method utilized in this study is appropriate for detecting pinworm infections since eggs are predominantly deposited around the perianal region and may be missed by routine stool exams (CDC, 2019; Graham, 1941). However, single-sample collection means the 9.38% rate may under-capture all infections within the population. Laoraksawong et al. (2020) also demonstrated that detection rates vary depending on protocols and survey conditions. Therefore, findings should be understood as the prevalence detected at survey timing using a single-pass Graham method.

Demographic analysis revealed no statistically significant differences in infection prevalence between boys and girls (10.14% vs. 8.43%; $p=0.574$), ethnic minority and Kinh children (10.66% vs. 7.95%; $p=0.374$), or public and private schools (11.19% vs. 8.37%; $p=0.369$). This aligns with prior studies noting no distinct variations in pinworm infection across basic demographic traits (Fan et al., 2019).

The absence of statistically significant differences between groups does not imply demographic characteristics play no role. Children in both schools shared similar boarding preschool environments involving learning, dining, napping, and play activities, which may minimize observable group differences. However, this is an epidemiological interpretation and cannot be definitively established from a cross-sectional design.

4.2. Factors Associated with Child Personal Hygiene Behaviors

Following multivariable adjustment and clustering correction, three child hygiene and behavioral factors remained statistically significant: long/dirty fingernails > 1 mm

(aPR=3.37; 95% CI: 2.30-4.95; $p<0.001$), thumb-sucking habit (aPR=3.13; 95% CI: 1.36-7.18; $p=0.007$), and not washing hands with soap (aPR=2.95; 95% CI: 1.35-6.41; $p=0.006$).

Children with long, dirty fingernails had approximately 3.37 times higher infection prevalence than those with short, clean nails. Mechanistically, *E. vermicularis* exhibits direct transmission; eggs spread from perianal areas via hands, particularly when children touch their mouths or shared items (CDC, 2019; Graham, 1941). Thus, fingernail hygiene has a strong biological basis linking to egg exposure. This finding concurs with Laoraksawong et al. (2020), where long fingernails were associated with pinworm infection in children.

Thumb-sucking was likewise associated with higher infection prevalence (aPR=3.13). This behavior facilitates hand-to-mouth transfer of infectious agents, reflecting pinworm transmission characteristics (CDC, 2019). This is consistent with Laoraksawong et al. (2020).

Failure to wash hands with soap yielded an aPR=2.95 (95% CI: 1.35-6.41), fitting the transmission profile where hand hygiene limits egg dissemination from hands to mouths and contact surfaces (CDC, 2019; Albasheer et al., 2026). However, handwashing data relied on caregiver interviews, leaving potential for information or social desirability bias.

These three factors exhibit strong biological links to pinworm transmission. Due to the cross-sectional design, results represent associations at the time of study rather than causal proof.

4.3. Factors Associated with Caregivers and Household Environment

In the multivariable model, caregivers not dewormed for > 6 months showed the highest aPR among studied factors (aPR=3.71; 95% CI: 1.43-9.58; $p=0.007$). Children whose caregivers fell into this group had higher infection rates compared to those whose caregivers were dewormed within 6 months.

This aligns with direct pinworm transmission traits and the household environment's role in egg exposure. Caregivers frequently interact with children during daily care, hygiene, and feeding routines. Consequently, caregiver deworming status may reflect household

anti-parasitic compliance. Prior literature emphasizes family member management during pinworm control (Albasheer et al., 2026; CDC, 2019).

However, caregiver infection status was not tested; thus, untreated caregivers cannot be definitively labeled as direct sources or confirmed reservoirs. The observed association likely reflects broader household hygiene and care practices.

Infrequent washing of bed sheets/mats remained significantly associated with infection after adjustment (aPR=1.84; 95% CI: 1.11-3.04; $p=0.018$). This accords with egg dispersal onto bedroom furnishings. CDC (2019) and Albasheer et al. (2026) highlight household environmental and article hygiene in controlling pinworm spread.

Compared to direct child behaviors, the association magnitude for infrequent bed sheet washing was lower (aPR=1.84), suggesting household environmental cleaning should accompany child personal hygiene. However, bedroom dust or bedding egg contamination was not directly assessed.

Sleeping on mattresses and having > 2 siblings < 15 years old showed univariable associations but lost significance in multivariable analysis. These shifts highlight potential confounding or mediating effects within models, though cross-sectional data and relatively low event counts preclude definitive causal dissection.

4.4. Implications for Pinworm Control

Findings indicate pinworm infections persist among preschool children locally, with associated factors spanning modifiable domains including fingernail hygiene, thumb-sucking, handwashing with soap, bed linen washing, and caregiver deworming status.

This corresponds to *E. vermicularis* transmission mechanisms where combining personal hygiene, environmental cleanliness, and household management aids control (Albasheer et al., 2026; CDC, 2019). Consequently, preschool interventions should integrate handwashing education, nail management, reduction of hand-to-mouth behaviors, and routine article sanitation.

Regarding deworming, findings show an association with caregiver deworming status, but without caregiver screening or intervention design, this does not establish specific

deworming schedule efficacy or confirm universal household deworming impacts. Deworming schedules should follow current professional guidelines (Ministry of Health, 2021).

4.5. Limitations

Several limitations exist. First, cross-sectional design precludes causal inference due to lack of temporal sequence. Second, single-pass Graham sampling may miss infections. Third, behavioral and deworming histories relied on caregiver recall, introducing recall or reporting bias. Fourth, 35 positive cases across 7 exposure variables yielded an events-per-variable (EPV) of approximately 5. While robust clustering standard errors accommodated data structure, low event counts remain a constraint (Vittinghoff & McCulloch, 2007). Finally, purposively selected schools limit generalizability to all local preschoolers.

5. CONCLUSION

The prevalence of pinworm infection among children aged 1-5 years in the studied preschools of Cu Jut Commune, Vietnam was 9.38% (35/373; 95% CI: 6.63%-12.81%). No, statistically significant differences in infection rates emerged across sex, ethnicity, school type, or class grade ($p > 0.05$).

Following multivariable analysis and class cluster adjustment, 5 factors showed significant statistical association with infection: caregivers not dewormed in the past 6 months (aPR=3.71; 95% CI: 1.43-9.58; $p=0.007$); children's long/dirty fingernails > 1 mm (aPR=3.37; 95% CI: 2.30-4.95; $p<0.001$); thumb-sucking habit (aPR=3.13; 95% CI: 1.36-7.18; $p=0.007$); not washing hands with soap (aPR=2.95; 95% CI: 1.35-6.41; $p=0.006$); and infrequent bed sheet/mat washing (aPR=1.84; 95% CI: 1.11-3.04; $p=0.018$).

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