Research Article

Prevalence and risk factors associated with *Enterobius vermicularis* infection among 3 to 10-year-old children in the Halpathota Central Grama Niladari Division of Baddegama, Galle District, Sri Lanka

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Abstract

Introduction: Enterobiasis, caused by the nematode *Enterobius vermicularis* (pinworm), remains one of the most common helminth infections worldwide, particularly affecting school aged children. This study investigated the prevalence and risk factors of *E. vermicularis* infection among children aged 3-10 years in the Halpathota Central Grama Niladari Division of Baddegama in Galle District, Sri Lanka.

Methods: Using a descriptive cross-sectional study design, data was collected in August 2024 through interviewer-administered structured questionnaires and perianal scotch tape swabs for parasite detection. Detailed instructions were provided to parents/caregivers on the sampling process. Microscopic examination of swabs was done at the laboratory of the Department of Parasitology, University of Colombo. Data were analysed using SPSS statistical software v27 with calculation of frequencies and proportions for categorical variables, while chi-square and multivariate analyses were done to investigate factors linked to prevalence of enterobiasis. Ethical clearance for the study was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Colombo.

Results: Among 123 successfully analysed samples, the prevalence of enterobiasis was found to be 29.3% (n=36). While all parents/caregivers were aware of enterobiasis, significant risk factors associated with infection included younger age (3-7 years, p=0.027), inadequate hand washing before meals (p<0.001), finger-sucking behaviour (p<0.001), less frequent household cleaning (p=0.003), and lack of prior deworming (p=0.008). Other sociodemographic factors and hygiene practices showed no significant association with infection rates. Multivariate analysis indicated that finger-sucking behaviour (OR=4.71, p=0.003) and infrequent house cleaning (OR=2.94, p=0.043) were significant predictors of infection.

Conclusions: The prevalence of enterobiasis was high with finger-sucking behaviour and infrequent cleaning of the household being significant predictors for infection among these children, underscoring the need for interventions targeting personal hygiene education and environmental sanitation.

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Introduction

Enterobius vermicularis, commonly known as the pinworm, is a parasitic nematode responsible for enterobiasis, one of the most prevalent helminthic infections worldwide. The life cycle of *E. vermicularis* is relatively simple, involving ingestion of infective eggs, larval maturation in the intestines, and nocturnal egg deposition by gravid females around the perianal region.[1] Autoinfection, environmental contamination, and person-to-person spread contribute to its high prevalence.[2]

Despite its general mild clinical manifestations, enterobiasis remains a significant public health concern due to its high transmission rates and potential complications, including sleep disturbances, perianal itching, and secondary bacterial infections.[1] Chronic infection can impact children's quality of life and school performance.[2,3] Although often considered a low-priority parasitic disease, its widespread nature and ease of transmission necessitate continued research and intervention.

Global studies highlight substantial variations in the prevalence of enterobiasis. The World Health Organization estimates that over a billion individuals are affected, with children being the most vulnerable. Despite the economic status of the country, infection affects children in both developed[4,5] and developing nations.[6,7]

Prevalence rates vary depending on environmental and socioeconomic factors. A study in Sri Lanka by Gunawardena et al. (2013)[7] reported a 38% infection rate among primary school children in Ragama, while Suraweera et al. (2015)[8] found a 31.9% prevalence in a poor urban community. Studies on children from China, Thailand, Poland and Pakistan have documented infection rates between 5% and 13%, emphasising the need for localised research to understand regional variations in transmission dynamics.[4,5,9,10]

Several factors contribute to the persistence and spread of pinworm infection. Age is a significant determinant, with the highest infection rates observed among school children.[10,11,12] Gender disparities have been noted, with some studies suggesting a higher prevalence among boys, potentially due to behavioural differences.[7] Socioeconomic factors, including parental education level,[13] household size, and hygiene practices, also play crucial roles.[8,9] Inadequate handwashing,[4] co-sleeping, and crowded living conditions are consistently linked to increased infection rates, highlighting the need for targeted public health interventions.[7]

In Sri Lanka, enterobiasis remains understudied, particularly in the Galle District. While research has documented high prevalence in other parts of the country, there has been limited investigation since 2017. This knowledge gap impedes effective disease management and the implementation of appropriate preventive measures. Understanding the epidemiology of *E. vermicularis* in Galle is essential for developing evidence-based interventions tailored to the local population.

This study aims to address this gap by investigating the prevalence and associated risk factors of enterobiasis in children aged 3-10 years in the Galle District. Through collaboration with local health authorities and academic institutions, this study seeks to provide valuable epidemiological data that can contribute to targeted control strategies and support public health efforts to reduce transmission and improve hygiene practices within the community.

Methods

The study was a descriptive cross-sectional investigation which aimed to examine prevalence of *E vermicularis* infections among children between 3-10 years of age within the Halpathota Central Grama Niladari Division of Baddegama in Galle District, Sri Lanka.

Data collection

Data collection was carried out in August 2024 along with the cooperation of the Public Health Inspector of the Baddegama Medical Officer of Health (MOH) area, MOH staff, and the Grama Niladari of the Halpathota Central Grama Niladari Division to identify and recruit all 136 eligible children from the region.

All participants in the study were recruited following a detailed explanation provided in their preferred language, ensuring comprehension, and obtaining informed written consent. Proxy consent was obtained from the parent/caregiver for their child/children, and assent was obtained from each participating child as well.

Data collection involved two main components: (i) a structured questionnaire administered through interviews to collect information on sociodemographic characteristics, knowledge and practices, clinical symptoms, and environmental factors, and (ii) perianal swabs using the scotch tape technique for detecting the presence of parasite eggs.

Parents were instructed on how to use these scotch tapes and to collect two samples from the perianal area on two consecutive days. Detailed instructions were provided through leaflets, ensuring clarity on the sampling process, with emphasis on the need for sampling early in the morning prior to bathing or washing of the child.

Microscopic examination of perianal swabs

Perianal scotch tape swabs were microscopically examined for the presence of *E. vermicularis* eggs at the laboratory of the Department of Parasitology, Faculty of Medicine, University of Colombo by experienced medical laboratory technologists.

Data analysis

Data analysis, conducted using SPSS statistical software version 27, encompassed the calculation of frequencies and proportions for categorical variables, while chi-square analysis was employed to investigate factors linked to enterobiasis prevalence. Multivariate logistic regression was applied to determine the predictive effect of the various factors investigated on the prevalence of infection. All the variables were initially entered into the analysis and removed stepwise until only the significant variables remained in the analysis (backward conditional method). The predictive risk was determined by the odds ratio (OR) at the 95% confidence interval (CI).

Results

A total of 136 children were recruited for the study. However, valid perianal scotch tape samples obtained on two consecutive days were received from only 123 participants, yielding a response rate of 90.4%. All analyses were consequently conducted using data from these participants (n=123).

General characteristics of the study population
The study involved 123 participants (Table 1), comprising 70 males (56.9%) and 53 females (43.1%). The larger segment of the population (n=70, 56.9%) fell within the 3 - <7 years age group. All participants were identified as Sinhalese (100.0%; Table 1).

The distribution of family size comprised of 57 (46.3%) living in households of 1-4 people and 66 (53.7%) in households with five or more members (categories were based on the average household size being 3.7 persons as per 2019 data of the Department of Census and Statistics of Sri Lanka). A significant majority of the participants had siblings (n=96, 78.1%).

Regarding education levels, 86.2% (n=106) of mothers had been educated up to or less than the Ordinary Level Examination (O/Ls), while 80.5% (n=99) of fathers had a comparable level of education. In terms of income, a predominant number of fathers were employed as casual workers and earned >Rs. 6,000 per month (n=100, 81.3%; Table 1).

Prevalence of infection
Of the 123 samples received, 36 children tested positive for enterobiasis, yielding a prevalence of 29.3%.

Symptoms of infection
Among the participants, 36 (29.3%) complained of perianal itching, while 7 (5.7%) presented with skin irritation (Table 2). Additionally, 12 (9.8%) reported experiencing restlessness during sleep, and 20 (16.3%) had a decreased appetite. Notably, none of the participants experienced weight loss in the past three months (100.0%; Table 2).

Knowledge and attitude with regard to enterobiasis
All 123 participants in the study expressed familiarity with enterobiasis, reflecting awareness of the condition within the study population (n=123, 100.0%). Most participants reported becoming aware of enterobiasis through health clinics (n=53, 43.1%), while a significant number also learned about it from their community and from general information (n=70, 56.9%).

Most participants in the study lacked knowledge about the spread of enterobiasis, with 105 individuals (85.4%) stating they had not heard how the infection is transmitted. Additionally, a considerable number were unaware of how to prevent the infection, as 107 participants (87.0%) indicated they did not know any preventive measures. However, every parent/caregiver surveyed (n=123, 100.0%) acknowledged the importance of being informed about enterobiasis.

Practices with regard to enterobiasis
Among the 123 participants in the study, a notable number reported washing their hands before meals (n=91, 74.0%), while they all washed hands after using the toilet (n=123, 100.0%). Additionally, most participants keep their fingernails short (n=103, 83.7%) and refrain from finger-sucking (n=76, 61.8%). The majority also socialize with other children (n=102, 82.9%), bathe in the evening (n=97, 78.9%), and share towels with family members (n=64, 52.0%). Most participants changed their bedding weekly (n=98, 79.7%) and cleaned their homes on a daily basis (n=79, 64.2%). All participants had access to toilet facilities (n=123, 100.0%), with 102 participants (82.9%) indicating they lived in <3-bedroomed homes.

All the children shared a bed with other family members (n=123, 100.0%). Among them, 66 (53.7%), shared their sleeping space with fewer than three people.

The majority of children's clothes were washed by hand, with 103 participants (83.7%) using this method. All participants in the study (n=123) reported using soap for washing their clothes. Most of the clothing was laundered at home (n=92, 74.8%). Among the participants, 66 (53.7%) washed their child's clothes separately, while the remaining 57 (46.3%) washed them together with other family members' clothing. Every participant dried their clothes by hanging them outside in sunlight (100.0%). However, only 54 (43.9%) reported ironing their clothes before wearing them.

The majority of households in the study population relied on wells as their primary source of water, with 98 (79.7%) using it for drinking and 93 (75.6%) for other purposes.

A majority of children in the study had undergone deworming treatment before (n=105, 85.4%). Among these 105 children, 23 (21.9%) had been dewormed within the past one month. All houses in the Halpathota Grama Niladari Division were detached (100.0%). In terms of cleanliness, only 44 (35.8%) of the homes were found to be in unsatisfactory condition. These observations were gathered through direct assessment of the houses and their surrounding environment.

Factors associated with prevalence of enterobiasis

Our study identified several key factors that were significantly linked to the prevalence of enterobiasis in this study population. The age of the child being between 3 to <7 years was significantly associated with higher prevalence of infection in this study population ($p=0.027$; Table 1), while certain practices (Table 3) such as inadequate washing of hands before meals ($p<0.001$), finger-sucking behaviour ($p<0.001$), lower frequency of household cleaning ($p=0.003$) and inadequate deworming practices ($p=0.008$) were also associated with greater prevalence of infection among these children.

In contrast, other sociodemographic characteristics such as the gender, family size, level of education of parents were not significantly associated with prevalence of infection in this study population (Table 1).

Similarly, other daily household practices related to the children such as sharing of beds or towels as well as the frequency of changing bed linen or the method of washing and drying of their clothes were not significantly associated with infection ($P>0.05$). Knowledge exhibited by parents/caregivers with regard to spread of infection was not significantly related to infection ($p=0.332$), while knowing how to prevent its transmission was found to be marginally significant ($p=0.051$).

Table 1: Association between sociodemographic factors and prevalence of enterobiasis

Sociodemographic Factor	Number (N=123)	Positives (N=36)	Positive %	X^2	Df	P value
Ethnicity						
Sinhalese	123	36	29.3			
Other	00	00	00			
Gender						
Male	70	24	34.3			
Female	53	12	22.6	1.975	1	0.16
Age						
3 - <7 Years	70	26	37.1			
7 – 10 Years	53	10	18.9	4.866	1	**0.027**
Number of family members						
1 - 4	57	15	26.3			
≥ 5	66	21	31.8	0.447	1	0.504
Siblings present						
Yes	96	30	31.3			
No	27	6	22.2	0.83	1	0.362
Father's education level						
≤ to O/Ls	99	30	30.3			
Up to A/Ls	24	6	25	0.262	1	0.608
Mother's education level						
≤ to O/Ls	106	29	27.4			
Up to A/Ls	17	7	41.2	1.351	1	0.245
Father's income (In Rs.)						
≤ 6,000	23	8	34.8			
> 6,000	100	28	28	0.416	1	0.519

Table 2: Association between symptoms of infection and prevalence of enterobiasis

Symptom	Number (N=123)	Positives (N=36)	Positive %	X^2	Df	P value
Scratching of peri-anal region						
Yes	36	13	36.1			
No	87	23	26.4	1.15	1	0.29
Skin irritation						
Yes	07	01	14.3			
No	116	35	18.4	0.81	1	0.67
Restlessness at night						
Yes	12	02	16.7			
No	111	34	30.6	1.02	1	0.51
Loss of appetite						
Yes	20	03	15	2.35	1	0.18
No	103	33	32			
Loss of weight						
Yes	00	00	00			
No	123	36	29.3			

Table 3: Association between practices and the prevalence of enterobiasis

Practices	Number (N=123)	Positives (N=36)	Positive %	X^2	Df	P value
Washing hands before eating						
Yes	91	18	19.8			
No	32	18	56.3	15.21	1	**<0.001**
Sucking fingers						
Yes	47	22	46.8			
No	76	14	18.4	11.30	1	**<0.001**
Cleaning the house						
Once a week	44	20	45.5			
Everyday	79	16	20.3	8.67	1	**0.003**
Previous deworming status						
Yes	105	26	24.8			
No	18	10	55.6	7.04	1	0.008

Multivariate analysis

The predictive effect of factors, i.e. age of child, washing hands before meals, sucking of fingers, frequency of household cleaning and deworming practices, on prevalence of infection revealed that, after adjusting for the effects of other variables, only sucking of fingers and the frequency of house cleaning were important in reducing the prevalence of enterobiasis (Table 4). Children who sucked their fingers had 4.7 times higher odds of enterobiasis compared to those who did not (OR: 4.71, 95% CI: 1.71 - 13.01, p = 0.003); whilst a household that was cleaned weekly had 2.94 times higher odds of enterobiasis compared to a household that was cleaned daily (OR: 2.94, CI: 1.03 - 8.39, P = 0.043; Table 4). The Hosmer-Lemeshow goodness-of-fit test indicated that the logistic regression model fit the data well (H-L = 7.876, df = 8, p = 0.446).

Table 4: Summary of logistic regression analysis of factors affecting prevalence of enterobiasis

Factor	Regression coefficient	Odds ratio	95% Confidence interval	p value
Constant	-22.802	0.000		0.997
Sucking of Fingers No		1.000		
Yes	1.550	4.711	1.705 – 13.013	**0.003**
Cleaning of House Everyday		1.000		
Weekly	1.079	2.943	1.033 – 8.385	**0.043**

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Discussion

This study found the prevalence of enterobiasis to be 29.3% among children aged 3-10 years in the Halpathota Central Grama Niladari Division of Baddegama in Galle District, Sri Lanka. This prevalence rate is comparable to previous studies conducted in Sri Lanka, including Suraweera et al. (2015)[8], who reported a 31.9% prevalence among children aged 1–12 years from a poor urban community at Hantana. However, it is slightly lower than the 38% infection rate found by Gunawardena et al. (2013)[7] among primary school children in Ragama. The similarity in prevalence rates across different regions of Sri Lanka suggests that enterobiasis

remains a persistent public health challenge throughout the country, despite variations in geography and urbanisation.

Notably, our prevalence findings from Sri Lanka (29.27%) are substantially higher than those reported in several other countries, including Taiwan (2.4%),[11] North-Eastern Poland (10.1%),[5] and Busan, Korea (10.7%).[13] The low prevalence of enterobiasis (2.4%, n=2,825/118,190) observed in Taiwan is due to their long-term nationwide control programme (1986–2001) with regular screening and treatment of school-children. The good hygienic practices and strong public health infrastructure have been able to successfully maintain a low level of infection even after termination of the programme.[11] In Korea, although the overall prevalence of infection among children attending 21 kindergartens across 11 districts of Busan, Korea was relatively low (10.7%, n=179/1,674), higher rates of infection (range: 0–32.4%) were detected in certain kindergartens located in densely populated communities, with thumb-sucking, infrequent finger-nail trimming and low parental knowledge of correct treatment being significantly associated with infection.[13] Similarly in Poland, a survey conducted among 296 children aged 2–18 years from kindergartens, schools and orphanages, found an overall prevalence of 10.1%. However, the prevalence of infection among orphans was significantly higher (32.8%) when compared to children living in families (3.9%).[5] These marked differences highlight the potential influence of regional factors, including population density, socioeconomic conditions, and public health infrastructure on enterobiasis transmission dynamics.

Age significantly influenced infection rates (p=0.027), with younger children with three <7 years showing higher prevalence (37.1%) than older children (7-10 years, 18.9%). This pattern, consistent with studies from Thailand and Pakistan, likely reflects developmental factors including immature hygiene habits among younger children.[9,10]

Finger sucking behaviour emerged as a critical predictor of infection showing a 4.71-fold greater risk among those who sucked their fingers (p=0.003; Table 4). Similarly, household cleaning frequency was another significant predictor of infection with the risk being 2.94 times greater (p=0.043) in weekly cleaned homes compared to daily cleaned homes. Peri-anal itching is a characteristic clinical feature in enterobiasis and infective eggs that contaminate fingers can be easily ingested by sucking of fingers. In addition, eggs of *E. vermicularis* can get dislodged during scratching and become airborne, subsequently to be deposited on various household surfaces. Transmission of infection can occur either through ingestion of infective eggs or through inhalation of airborne eggs. As such, daily cleaning of the house is essential to control and prevent spread of infection.

Hand hygiene was also shown to be associated with infection. Children who did not regularly wash hands before eating meals showed significantly higher infection rates (56.3% vs. 19.8%, p<0.001), supporting the classic autoinfection (self-inoculation) pathway of enterobiasis. Previous deworming demonstrated protective effects (p=0.008), with non-dewormed children showing substantially higher rates of infection (55.6% vs. 24.8%). Anthelmintics are effective in killing adult worms but not the eggs. Hence, deworming should be repeated after two weeks in order to eliminate any newly hatched worms. Furthermore, all persons living in the household must be de-wormed simultaneously to prevent re-infection.

Several traditionally associated factors showed no significant relationship in our study, including gender, family size, sibling presence, parental education, and economic indicators. This differs from international studies and may be due to the relatively uniform socioeconomic

background of our population. Alternatively, it could indicate that behavioural factors have a greater impact than sociodemographic characteristics in this community.

Though all participants were aware of enterobiasis, specific knowledge about transmission (14.6%) and prevention (13%) was limited. The borderline significant association (p=0.051) between knowledge on prevention and lower infection rates suggests potential benefits from focused educational interventions.

Our findings demonstrate significant associations with modifiable factors such as finger sucking behaviour, household cleaning, hand hygiene and deworming habits, suggesting targeted intervention points. School based hygiene education emphasising the importance of good hand hygiene and discouraging finger sucking could effectively reduce transmission, while community programs addressing household cleaning practices could complement these efforts.

Conclusion

Targeting of key behavioural factors while expanding deworming efforts could significantly reduce the prevalence of enterobiasis in this community. Future studies should cover a wider area in Sri Lanka, use longitudinal designs to track reinfection patterns, and explore implementation strategies that could effectively prevent and control infection in the community.

Declaration

Conflict of interest: There are no conflicts of interest.
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Author contributions:
PVEHG, KMKCG, GG & PKSG: Data acquisition, Analysis and Writing of project report
KKR: Microscopic analysis of samples, Writing of draft manuscript
MHG: Microscopic analysis of samples, Supervision of laboratory work
SG: Conceptualisation, Critically reviewing and finalising of manuscript
All authors critically reviewed and approved the final manuscript.

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