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PREVALENCE PATTERNS AND CONTRIBUTING FACTORS OF ENTEROBIUS VERMICULARIS INFECTION IN SCHOOL GOING CHILDREN IN PAKISTAN

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ABSTRACT

Background *Enterobius vermicularis* causes pinworm infection which is extremely common in human beings; especially among children. A cross-sectional study (2023-2024) involving 1213 school children with the age of 3-9 years old in four districts of Khyber Pakhtunkhwa Province, which represents a rural population of students, investigated epidemiology and risk factors of *E. vermicularis* infection.
Methods Simple random sampling method was used in selecting the Two kindergartens and Two primary schools in each of the districts. The adhesive cellophane tape technique was used in the perianal swabbing during the process of detecting pinworm infection. Information regarding demographics and hygienic practices and environment at school was determined on the basis of structured questionnaires. All of the possible risk factors entered into simple logistic regression and factors with a P of less than 0.1 were chosen to enter the multivariate examination that was done through logistic regression.
Result The cumulative infection rate was 5.19%, with maximum 11.51 percent in Tank District, Karak (3.76 percent), Lakki Marwat (3.31

percent) and D. I. Khan (2.7%). The positive rate at the boy level was more than the girls (6.98% vs. 3.30%, P=0.0031). Within boys, Older age was also found to cause an increase in the infection rate (P = 0.186) with the maximum prevalence occurring among 8-year-olds (6.29%). Other than that, the infection rate of the subjects at the primary school was higher compared to that of the subjects in kindergarten (7.17% vs. 2.39%). Among the girls there were no significant differences in the group. In addition, regular disinfection of classrooms and monthly health and educational programs were revealed in connection with the reduced level of infection.

Conclusion The research paper establishes the high infections of *E. vermicularis* by the schoolchildren in KPK Province as a result of rural inhabitants and some of the major risk factors. Hygiene education and sanitation would be significant interventions that should be highly emphasized especially among the male students since this practice would facilitate control of *E. vermicularis* infection.

1. Introduction

The disease of *Enterobius vermicularis* infection is called enterobiasis, which is quite one of the widespread parasitic infections in young kids. The infection occurs around the world in developed countries and approximately 4-28 percent of children worldwide have been infected with the disease (Li et al., 2015).

On the other hand, the infection caused by *E. vermicularis* has not received so much attention as enterobiasis looks like not very serious actually. It is also endemic in congested environments like kindergarten and primary schools since it is easily spread between infected and uninfected children. Infection with *E. vermicularis* is asymptomatic in some individuals, and children tend to have perianal pruritus and restlessness accompanied by loss of appetite, insomnia, and irritability (Kim et al., 2010).

More specifically, prolonged and heavy infection continues to retard mental development of infected children compared to the rest. The cases are also reported, where in rare pairs, the *E. vermicularis* penetrates into fallopian tubes and into kidneys, which develops ectopic enterobiasis and poses atrocious health disorders and even death (Taghipour et al., 2020).

E. vermicularis is a worldwide parasite and one of the most common human helminths in colder and moderate climate areas and developed countries. Transmission of the parasite usually occurs through close-contact between a susceptible person and the infected person or through the eggs by swallowing and breathing them (Wendt et al., 2019).

Reinfection is one of the key causes of acquisition of the infection since *E. vermicularis* has a simple rout of transmission. Nonetheless, full life cycle of the helminth including the egg to adult worm typically require 2 to 4 weeks (Cure-Bolt et al., 2024). Although perianal pruritus is the most frequent symptom of *E. vermicularis* infection, chronic abdominal pain, urinary tract infection, salpingitis, eosinophilic ileocolitis and pelvic abscess also proved to be related to the infection (Choudhury, Kumar, & Pal, 2017).

There are a couple of potential hypotheses that were used to explain the relationship between *E. vermicularis* and appendicitis of which most of them implied ectopic migration of the parasite (Mohtasebi et al., 2023). At times, the unpredictable movement of ova and larvae may cause granuloma in the appendix, kidney, peritoneal cavity, male urogenital system and female genitalia that may produce misdiagnosis. When it comes to appendicitis, dissolution and gathering of egg from the female *E. vermicularis* can trigger the paralysis and inflammation of the appendix (AL-Bairmani & Al-Masoudi, 2023).

The results of the research will add to the present knowledge about the epidemiology of Enterobius vermicularis disclosure in the province and give a scientific foundation to prepare the specific methods of prevention and control of this challenge.

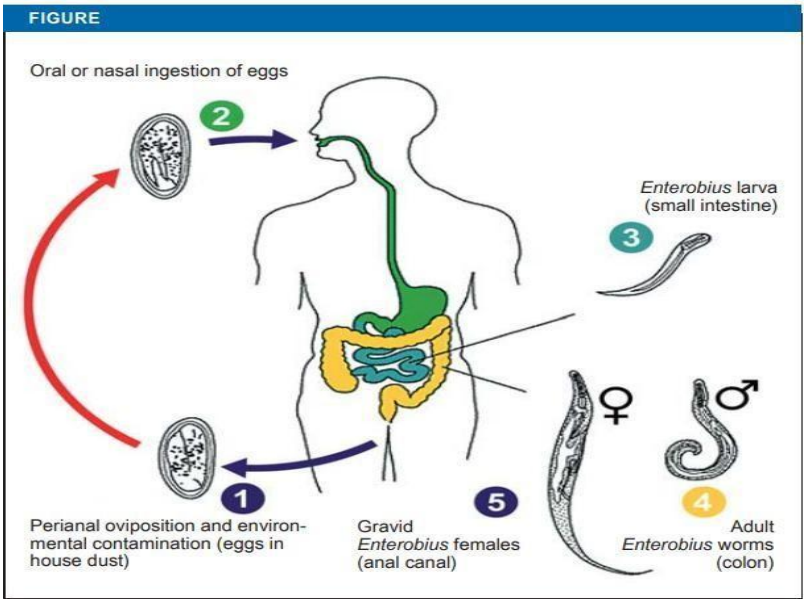
2. Review of Literature

2.1. Life cycle

Pedigree of E. vermicularis is straight forward (Figure), and it occurs in gastrointestinal lumen. It spreads through oral consumption of the infective eggs where the larvae of the package eggs attain its infective status as little as 4-6 h after oviposition (Rahim, Hasbi, Rosyunita, Triani, & Parwata, 2023). Once the eggs slip into the digestive system of the host organism the outer cover softens. The release of larvae of the pinworm takes place after rupture in the small intestine following their admission in pylorus. Once they have been molten twice they are subjected to copulation and then later on they descend to the exit into the large intestine now in large numbers especially in the appendix cecum or in the ascending colon. The males that are copulating get killed shortly; the pregnant females, however, are expected to demonstrate a total life span of 100 days to the anal canal through active migration (Elyasi, Vaezi, & Mohammadian).

It takes 2 to 6 weeks between consumption of the technically infectious pin worm eggs and the maturation of the adults to ovipositioning female pin worms (Cairncross & Feachem, 2018). The oviposition is, in fact, when the host is about to recover i.e. great at night when rest. This involves females that are leaving the anus and anchoring to perianal tissue glue matrix with adhesive matrix. The itching during this process is often painful and therefore the children especially will make an effort to alleviate the itch using their fingers in the area around the anus by scratching. The worm cuticle is dissolved because of the fingers and the fingers nails leading to the eggs being released and spread to the underwear and the surrounding vicinity in large numbers. The infection of hands of the host in maintaining the chain of infection (autoinfection) has a worthy role to play (Fan et al., 2021).

The larvae hatched may also penetrate the anus in a retrograde manner and hence generate a new infection (retrograde infection). In very rare cases, there is some involvement of other organs (< 1% of cases estimated). The eggs must always find appropriate conditions outside gastrointestinal tract and this includes low temperatures, and high oxygen concentration so that the egg can mature. There are no intraluminal propagations (Tsai et al., 2018).



Life cycle of *Enterobius vermicularis* (modified from (Wendt et al., 2019))

2.2. Epidemiology

It has been estimated that the total number of people in the whole world infected by *E. vermicularis* was more than a billion people. Pinworm infection also occurs in moderate climate and industrial nations where it is found across the social levels (Zonta, Cociancic, Oyhenart, & Navone, 2020).

Analysis on the frequency has been performed in a few selected European countries: A Norwegian study indicated that 18 percent of 395 children tested positive after being examined on the presence of Enterobius eggs by means of the scotch tape test, with the highest rate (34 percent) among children aged 6-11 years (only two among 72 children who had come to have positive results were previously known to be already infected). Using the same means of detection, a study carried out in Sweden on children aged 4-10 revealed that the rate of infection was 28.5 percent (49/172) and prevalence in a large number of 954 children at 24.4 percent in Sweden (Chhetri et al., 2023).

2.3. Risk factors and modes of transmission

Some publications have defined the most serious risk factors of the pinworm infection: children of 411 years old are especially frequently infected, and male patients can be infected more frequently in some cases. Most of the children are involved in kindergarten or primary schooling at this stage of life. Nail-biting and close social contact with toys or writing utensils placed into the mouth, are relevant in this age group to exposure to *E. vermicularis* (Lashaki et al., 2023). Unmonitored anus-finger contact-mouth, scratching in the perianal area, independent and unsupervised practices of personal hygiene and noncompliance in observing handwashing before meals also appear to be closely linked to infection rates that are significantly higher. (Miller, Siller Jr, & Trying, 2023). The form of

home construction and the form of cleaning or sharing bedroom with other children or siblings did not correlate with the increased number of cases in the individual studies. No risk data are available in adults. In respect of the question of whether men who have sex with men (MSM) constitute a special risk group, only isolated older studies have made references to this being the case. Heterosexual partnership is also applicable in transmission (Modlinski, Lancaster, Rabuszko, Llewellyn, & Richardson, 2025). *E. vermicularis* is an exclusively human pathogen, and as a consequence, domestic pets are not considered to act as a natural source of infection.

3. Materials & Methods

3.1. Study population

The study took place in the period of 2023- 2024 with a span of 4 districts in Khyber Pakhtun Khawa Province in Pakistan. The students were randomly sampled to include 2 kindergartens and 2 primary schools in every district selected with a simple random sample. The sample size was calculated using the general formula: The general formula was appropriate and was used as follows: n = Z2 p(1-p)/d2, where n is the sample size, z = 1.96 was obtained using 95 percent of the confidence intervals (CI), p, is the prevalence (2.10 %) as reported previously on the infection rate (Huang et al. 2020) and d is the relative error tolerated (0.01). The sample size required to use in calculation was 790. A nonresponse rate of 10 percent was factored, resulting in a total of 1,213 children depending on the three- to 9-year-old age group: 638 boys and 575 girls.

3.2. Detection of *E. vermicularis* infection

The method adopted to ascertain the condition of *E. vermicularis* infection in the context of the study was an adhesive cellophane tape swab, standardized procedure practiced on 2 consecutive days, with the help of the schoolteachers. The local Centers of Disease Control and Prevention (CDCs) had been set up prior to sampling collection through training efforts of all parents and guardians during the training programs, among other measures, such as showing educational videos and distributing leaflets with information. Perianal swabs were then taken immediately after the children got out of their beds by their parents or guardians before defecating or bathing. Teachers then collected samples and took them to the concerned CDC to be analyzed. Microscopic tests were performed by experienced medical technologists and the *E. vermicularis* infection is defended by single or more eggs in any sample.

3.3. Questionnaire survey

A well-designed questionnaire (Supplementary Table 1) was provided to the parents/guardians including demography data of child and the parents, and hygiene habits to identify the possible risk factors of *E. vermicularis* infection. Besides, the teachers were supposed to complete a clear structured survey (Supplementary Table 2) to record the facts on the school-based environmental risk factors. Instructions were also provided to the parents, guardians, and teachers by the personnel at the local CDCs on how they could fill the questionnaires. Data quality control Data quality control actions taken were stringent screening of all covariates to observe and correct any cases of missing data, out-of-range observations and duplicate values. The children that had any missing data including their age, sex,

school, and personal hygiene practices were not included. EpiData software (version 3.1, EpiData Association, Odense, Denmark) was used to enter our data again and clean in order to maintain high levels of accuracy and consistency.

3.4. Data analysis

Geographically-given distribution of diseases in different regions can be depicted and explained by spatial analysis. The analyses were completed and the prevalence of an E. vermicularis infection investigated according to different demographic and hygienic-related factors in R software (version 4.2.3) with the Chi-squared (chi squared) test. To begin with, each of the potential risk factors was carried out using a simple logistic regression analysis. Secondly, multivariate logistic regression analysis was carried on variables that had a value of P less than 0.1 (Gong, Cui, Jiang, Lu, & Li, 2018). ORs and 95 percent CI analysis were used to determine the associations between factors that posed risks and infections. The tests were carried out to determine statistical significance of $p<0.05$.

4. Results

4.1. Prevalence of *E. vermicularis* infection

Out of 1,213 surveyed persons in four cities, 63 people were found to be infected with E. vermicularis with the overall prevalence rate totaling 5.19 percent (63/1,213). The maximum infection rate was in Tank District (11.51%), Karak (3.76%), Lakki Marwat (3.31) and D. I. Khan (2.7). It is important to note that most of the children who were infected had an egg count of less than 500 (Table 1).

Table 1: ***The prevalence of Enterobius vermicularis eggs in children located in four districts***

District	No. of sample sizes	No. positives (%)	No. of *E. vermicularis* eggs*		
			< 100	100~500	≥ 500
Tank	278	32(11.51%)	18 (56.25)	9 (28.12)	5 (15.62)
D. I. Khan	258	7(2.7%)	4(57.14)	2(28.57)	1(14.28)
Lakki Marwat	332	11(3.31%)	6(54.54)	3(27.27)	1(9.09)
Karak	345	13(3.76%)	8(61.53)	3(23.07) 2(15.38)	
Total	1,213	63 (5.19%)	36	17	9

Demographic risk factors

It was found flexible to differ statistically with respect to infection rates between genders, whereby boys recorded a higher prevalence (6.89%) in comparison to girls (3.30%) (P=0.0031, Table 2). The infection rates were higher in older age (P = 0.186, Table 2) with the strongest level recorded in 8-year-olds (6.29, % Fig. 2). Moreover, primary school students had a higher prevalence in comparison with kindergartenstudents (7.17% vs. 2.39%, P=0.037, Table 2). Although the association between infection risk and the educational level of parents seemed to be lower in children whose parents were more highly educated, it did not show statistical significance (7.86% vs. 5.95% vs. 3.08% vs. 1.38%, P >0.05, Table 2). *E. vermicularis* infection had no remarkable correlations with the use of anthelmintic in the last 6 months, parental upbringing and the degree of parent knowledge of *E. vermicularis* infection (P>0.05, Table 2).

There were no remarkable associations found in boy subgroup (P>0.05, Table 3). Gender stratification showed that, in boys the old age population had significantly higher risk of infection than young age (8.08% vs. 3.19%, P=0.010, Table 3), and that school attendance in primary schools had high risk of infection against that attended at kindergarten (7.48% vs. 3.23%, P=0.024, Table 3).

Personal hygienic factors

A total of 1,213 participants were included in the analysis, of whom 63 (5.2%) tested positive for infection. Univariate analysis demonstrated statistically significant associations between infection status and certain hygiene-related practices. Participants who washed beddings once a week had significantly higher odds of infection. compared to those who washed them less frequently (OR = 2.12, 95% CI: 1.25–3.59, p = 0.007). Similarly, washing toys once a month was associated with higher odds of infection (OR = 2.30, 95% CI: 1.37–3.86, p = 0.002). In contrast, washing underwear every 1–2 days was found to be protective, reducing the odds of infection by 58% compared to washing at intervals longer than three days (OR = 0.42, 95% CI: 0.24–0.75, p = 0.005). No statistically significant associations were observed for drinking raw water, sucking pens or fingers, nail trimming frequency, bathing frequency, or handwashing before meals and after toilet use (all p > 0.05). These results suggest that while general hygiene behaviors are important, specific practices related to laundering and cleaning personal items may play a more critical role in infection prevention (Table 4).

Table 2. Univariate Statistical Analysis of Demographic Variables and *Enterobius vermicularis* Prevalence in Rural Schools`

Variables	Total (N=1213)	No. positive (N=63)	Prevalence (%)	OR (95% CI)	P value
Gender					
Boy	638	44	6.89	2.17	**0.0031**
Girl	575	19	3.30		
Age group					
3–6 years	752	34	4.52	0.71	**0.186**
7-9Years	461	29	6.29		
School					
Kindergarten	502	12	2.39	0.32	**0.00017**
Primary School	711	51	7.17		
Taking anthelmintic in past 6 months				1.54	**0.145**
Yes	209	15	7.17		
No	1004	48	4.78		

Brought up by parents Yes No	1109 104	56 7	5.04 6.73	0.74	**0.521**
Parental educational level Primary Middle High higher	445 389 235 144	35 12 14 2	7.86 3.08 5.95 1.38	0.0854 0.0318 0.0444 0.0435	**0.0018**
Do you know *Enterobius vermicularis* Yes No	356 857	41 22	11.51 2.56	4.94	**< 0.00001**
Awareness of how to avoid infection with Enterobius vermicularis by the parents Yes No	456 757	45 18	9.86 2.37	4.49	**< 0.00001**

OR odds ratio, CI confidence interval Significant P values are printed in bold

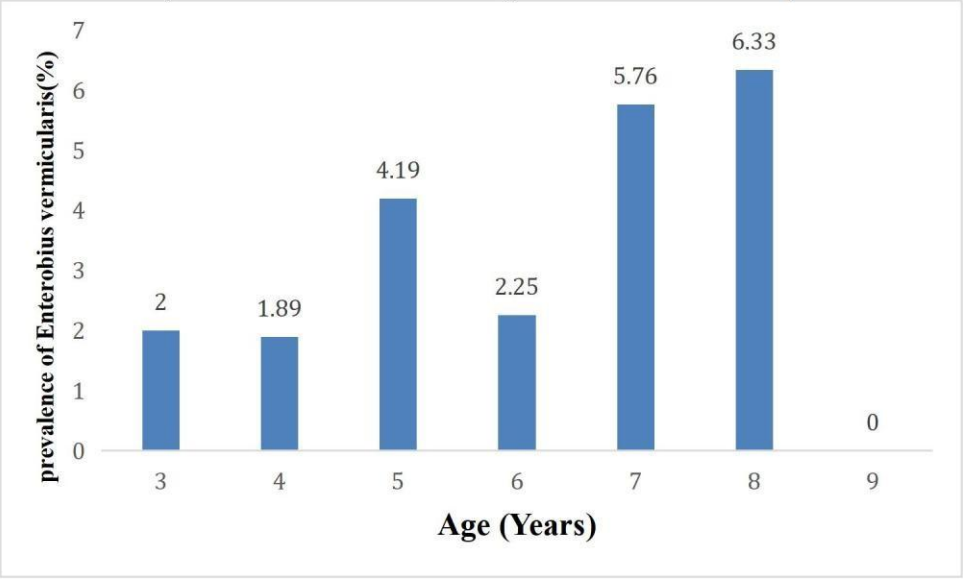


Table.3: ***Heterogeneity in risk factors that may lead to Enterobius vermicularis infection by gender***

Gender	Variables	Total (N=1,213)	No. of negative (N=1,150)	No. of positive (N=63)	Prevalence (%)	χ2	P value*
Boys	**Age Group**					1.35	0.245
	3-6years	345	317	28	8.11		
	7-9 years	293	277	16	5.46		
	School					4.00	0.045
	Kindergarten	306	278	28	9.15		
	Primary School	332	316	16	4.81		
Girls	**Age Group**					2.24	0.134
	3-6years	432	421	11	2.54		
	7-9 years	143	135	8	5.59		
	School					0.35	0.55
	Kindergarten	219	213	6	2.73		
	Primary School	356	343	13	3.65		

Table 4. ***Univariate analysis of personal hygiene factors associated with Enterobius vermicularis infection among rural schoolchildren***

Variable	Reference Category	Compared To	OR	95% CI (Lower–Upper)	P value
Drinking raw water	Yes	No	1.49	0.86 – 2.58	0.195
Sucking pens	Yes	No	1.29	0.77 – 2.15	0.402
Sucking fingers	Yes	No	1.59	0.94 – 2.67	0.106
Keeping fingernails short	Once a week	Longer than a week	0.99	0.59 – 1.65	1.000
Frequency of bathing	Every 1–2 days	Longer than 3 days	0.76	0.45 – 1.27	0.357
Frequency of washing beddings	Once a week	Longer than a week	2.12	1.25 – 3.59	**0.007**
Frequency of washing toys	Once a month	Longer than a month	2.30	1.37 – 3.86	**0.002**
Frequency of washing underwear's	Every 1–2 days	Longer than 3 days	0.42	0.24 – 0.75	**0.005**
Washing hands before meals	Yes	No	0.66	0.39 – 1.12	0.163
Washing hands after using toilet facilities	Yes	No	1.08	0.63 – 1.85	0.887

Environmental factors

This study used environmental factors related to *E. vermicularis* infection to measure the twelve schools in the districts of Tank, D. I. Khan, Lakki Marwat and Karak, which in Bannu district of the participants (n = 261) because, they cannot check the attention issues. The chi-square analysis of environmental and hygiene-related factors revealed varying levels of association with infection prevalence. For the frequency of tableware disinfection, children in classrooms where tableware was disinfected once a meal had a prevalence of 5.42%, compared to 4.29% in those where it was disinfected once a day; however, this difference was not statistically significant ($\chi^2 = 0.219$, $p = 0.640$). Similarly, the frequency of classroom disinfection showed no significant relationship with infection status, with prevalence rates of 4.51% for weekly disinfection and 5.57% for disinfection less frequent than once a week ($\chi^2 = 0.292$, $p = 0.589$). In contrast, the frequency of health education sessions was significantly associated with infection prevalence. Children receiving health education once a month had a prevalence of 3.47%, while those receiving it less frequently showed a much higher prevalence of 9.75% ($\chi^2 = 12.290$, $p = 0.000455$), suggesting a protective effect of regular health education. Analysis of classroom floor type also showed a significant association with infection status ($\chi^2 = 5.593$, $p = 0.018$), with prevalence rates ranging from 2.63% in brick-floored classrooms to 6.97% in classrooms with plastic floors, indicating that flooring material may influence infection risk.

Table 5 Environmental factors related to Enterobius vermicularis infection from twelve schools in three districts

Variables	Total (N=925)	No. of negative (N=880)	No. of positive (N=45)	Prevalence (%)	χ2	P value*
Frequency of tableware disinfection						
Once a meal	680	645	35	5.42		
Once a day	243	233	10	4.29	0.219	0.640
Frequency of classroom disinfection						
Once a week	620	592	28	4.51		
Longer than a week	305	288	17	5.57	0.292	0.589
Frequency of health education against children						
Once a month	720	695				
Longer than a month	205	185	25 20	3.47 9.75	12.290	**0.000455**

Type of classroom floor						
Cement	405	379	26	6.41		
Brick	380	370	10	2.63		
Wood	97	91	6	6.18	5.593	**0.018**
Plastic	43	40	3	6.97		

* Result in χ^2 analysis. Significant P values are in bold

Multivariate analysis of factors associated with *E. vermicularis* infection

The multivariate analysis of potential risk factors for infection among the 1,213 schoolchildren showed that gender was a strong and statistically significant association between gender and infection prevalence. Among boys, 52 out of 712 were positive, giving a prevalence of 7.30%, while among girls, only 11 out of 501 were positive, corresponding to a prevalence of 2.19%. The odds of infection in boys were 3.51 times higher than in girls (OR = 3.51, 95% CI: 1.81– 6.79, p = 0.0002), indicating that male students had a markedly greater risk of infection in this study population. Similarly, age group was not a significant factor, with children aged 3–6 years showing a prevalence of 4.12% compared to 6.44% in children aged 7–9 years (OR = 0.63, 95% CI: 0.36–1.09, p = 0.11). School type also showed no significant prevalence of 4.34% compared to 6.16% in primary school students (OR=0.63, 95% CI: association, as kindergarten students had a prevalence of 4.34% compared to 6.16% in primary school students (OR = 0.77, 95% CI: 0.45–1.32, p = 0.34). Overall, none of the examined variables demonstrated a statistically significant relationship with infection prevalence in this population. Overall, none of the examined variables demonstrated a statistically significant relationship with infection prevalence in this population.

Table 6 Multivariate analysis of risk factors associated with Enterobius vermicularis infection among rural schoolchildren

Variables	Total (N=1,213)	No. of negative (N=1,150)	No. of positive (N=63)	Prevalence (%)	OR (95% CI)	P value
Gender					3.51 (1.81–6.79)	**0.0002**
Boy	712	680	52	7.30		
Girl	501	490	11	2.19		
Age group					0.63 (0.36-1.09)	0.11
3–6 years	654	627	27	4.12		
7–9 years	559	523	36	6.44		
School					0.77 (0.45-1.32)	0.34
Kindergarten	645	617	28	4.34		
Primary school	568	533		6.16		
***OR odds ratio, CI confidence interval Significant P values are in bold**						

Discussion

Although there is an observed decline in the occurrence of *E. vermicularis* infection across several countries at a slow pace (Mao et al., 2025), *E. vermicularis* continues to be an important intestinal parasite especially in school-going children. The current investigation has concluded on the overall prevalence of *E. vermicularis* infection of 5.19 among the schoolchildren of Khyber-Pakhtunkhwa Province in 2022-2024 with a distinguished higher frequency of infection in children over 7 years compared to below or 6 years old. The trend on this age distribution is in line with other research studies (Yi, Chengyuan, Yuanchun, & Wei, 2024). The play activity of kids aged 79 years old differs slightly with the younger kids as children of this age do not take naps but instead get involved in outdoor play activities. Thus, these people can be more likely to get the infection with E. *vermicularis* (Kołodziej et al., 2024). Furthermore, the infection prevalence was much higher among the primary school students when compared to that of the kindergarten students, owing to the higher probability of soil restriction contact and close physical contact with other children in that age category (average age of entry into school is 6 years in China). These behavioral aspects have the potential of boosting chances of *E. vermicularis* infection among members of this (Tegen & Damtie, 2021). Hence, there is a recommended need to enhance health education interventions in order to better manage the prevalence rate of *E. vermicularis* infection and adverse health outcomes among primary school-going children by establishing the required health researchers and policymakers.

The role played by gender in the prevalence of *E. vermicularis* infection is well-recorded. Past research has shown that genders were no different on any statistically significant difference related to the rates of infections (Taghipour et al., 2020). The female students also had an increased infection rate compared to the male students in our study which was also in concurrence with a similar study done both in Thailand and Republic of Marshall Islands (Oñez & Hinay Jr, 2024).

Also, our study resulted in the realization that the correlations between age and level of schools only prevailed in the female group implying that gender is likely to be a modifier of effect upon prevalence of the *E. vermicularis* infection among school aged children. The possible reason then why such observation is made is the fact that girls unlike boys have higher chances of being willing to participate in such group exercises, including the use of the restroom and engagement in outdoor games. This hypothetical point has to be further investigated and proved. However, our results showed that gender-specific health education and hygiene promotion programs are necessary, which is more specifically targeted with giving girls power of knowledge to understand personal hygiene and the necessity of proper cleanliness. Moreover, this could be in forms of offering proper sanitation units in schools, which may be very crucial in reducing the susceptibility of girls to infection by *E. vermicularis*.

Conclusion

This paper gives a clear report of the distribution of *E. vermicularis* infection and the risk factors associated with it among schoolchildren in Khyber Pakhtunkhwa Province. The results indicate a high likelihood that *E. vermicularis* infection was found in Male students with the older age and School attended as risk factors among Boys only, and not Girls. Specifically, boys of older age in primary school have more risk of being attacked by *E. vermicularis*, which means that the gender factor should also be further explored as part of prevention measures, including better school hygienic conditions and gender-related health education.

Limitations

This research is limited in some ways. It is cross-sectional in nature thus limiting causal relationship between risk factors and Enterobius vermicularis infection. There may have been some bias caused by some self-reporting involving hygiene and health history. The generalizability of the study is narrowed down to the chosen field of rural environment of the Khyber Pakhtunkhwa province. Prevalence may have been underestimated using only one method of diagnosis (cellophane tape technique). The variables that were not considerably addressed include potential seasonal variation and certain environmental or socio economic factors which were not characterized due to data being collected only across a single season. Also, the investigation might have provided more accurate estimates and performed a more thorough subgroup analysis with an increased sample size.

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References

AL-Bairmani, A. S. N., & Al-Masoudi, H. K. (2023). Assessment of the serum level of IL-1B, IL-2, and IL-10 in children infected with Enterobius vermicularis in Babylon province. *Medical Journal of Babylon, 20*(1), 59-63.

Cairncross, S., & Feachem, R. (2018). *Environmental health engineering in the tropics: Water, sanitation and disease control*: Routledge.

Chhetri, S., Al Mamari, A. H., Al Awfi, M. M., Al Khaldi, N. H. N., Abed, N. M., Pandak, N., . . . Al Lawati, S. (2023). Enterobius vermicularis related acute appendicitis: A case report and review of the literature. *Infectious Disease Reports, 15*(4), 417-424.

Choudhury, S., Kumar, B., & Pal, D. K. (2017). Enterobius vermicularis infestation of urinary tract leading to recurrent urinary tract infection. *Tropical parasitology, 7*(2), 119-121.

Cure-Bolt, N., Perez, F., Broadfield, L. A., Levecke, B., Hu, P., Oleynick, J., . . . Stuyver, L. (2024). Artificial intelligence-based digital pathology for the detection and quantification of soil-transmitted helminths eggs. *PLOS Neglected Tropical Diseases, 18*(9), e0012492.

Elyasi, H., Vaezi, H., & Mohammadian, H. Prevalence of Enterobiasis and its relationship with clinical symptoms in children aged 2 to 12 in Sabzevar (Northeast of Iran). *Journal of Zoonosis*, 1-11.

Fan, C.-K., Sonko, P., Lee, Y.-L., Yin, A.-
W., Chuang, T.-W., Kios, R., . . . Wu, M.-S. (2021). Epidemiologic study of Enterobius vermicularis infection among schoolchildren in the Republic of Marshall Islands. *Journal of Tropical Medicine, 2021*(1), 6273954.

Gong, X., Cui, J., Jiang, Z., Lu, L., & Li, X. (2018). Risk factors for pedicled flap

a multivariate logistic regression analysis. *ANZ Journal of Surgery, 88*(3), E127-E131.
Kim, D.-H., Son, H.-M., Kim, J. Y., Cho, M. K., Park, M. K., Kang, S. Y., . . . Yu, H. S. (2010). Parents' knowledge about enterobiasis might be one of the most important risk factors for enterobiasis in children. *The Korean journal of parasitology, 48*(2), 121.
Kołodziej, P., Wujec, M., Doligalska, M., Makuch-Kocka, A., Khylyuk, D., Bogucki, J., . . . Tomczuk, K. (2024). Synthesis and anthelmintic activity of novel thiosemicarbazide and 1, 2, 4-triazole derivatives: in vitro, in vivo, and in silico study. *Journal of Advanced Research, 60*, 57-73.
Lashaki, E. K., Mizani, A., Hosseini, S. A., Habibi, B., Taherkhani, K., Javadi, A., . . . Dodangeh, S. (2023). Global prevalence of enterobiasis in young children over the past 20 years: a systematic review and vermicularis (threadworms): a systematic review. *Frontline Gastroenterology*.
Mohtasebi, S., Shokripour, M., Vahid, P., Mikaeili, F., Afshar, M. J. A., Alimi, R., . . . Teimouri, A. (2023).
Parasitological and histopathological features of appendectomy specimens in Fars Province, southern Iran: a retrospective study. *Annals of Medicine and Surgery, 85*(5), 1601-1606.
Oñez, Z., & Hinay Jr, A. (2024). Prevalence, Spatial distribution, and Risk Factors of Enterobius vermicularis among Children in Kidapawan City, Philippines. Rahim, A. R., Hasbi, N., Rosyunita, R.,
Triani, E., & Parwata, W. S. S. (2023). Prevalence of Enterobiasis Infection Among School-Aged Children in the Kebon Kongok Landfill Area, West Lombok. *Jurnal Penelitian Pendidikan IPA, 9*(SpecialIssue), 455-459.
Taghipour, A., Olfatifar, M., Javanmard, E., Norouzi, M., Mirjalali, H., & Zali, M. meta-analysis. *Osong Public Health and Research Perspectives, 14*(6), 441.
Li, H.-M., Zhou, C.-H., Li, Z.-S., Deng, Z.-H., Ruan, C.-W., Zhang, Q.-M., . . . Chen, Y.-D. (2015). Risk factors for Enterobius vermicularis infection in children in Gaozhou, Guangdong, China. *Infectious diseases of poverty, 4*(1), 28.
Mao, F., Xu, X., Tang, F., Ni, B., Zhang, Q., Zhang, J., . . . Cao, J. (2025). Unveiling the disparities between private and public preschools in the risk for pinworm infections in China: a multicentre cross-sectional study. *BMC Public Health, 25*(1), 1-12.
Miller, A. C., Siller Jr, A., & Tyring, S. K. (2023). Parasitic diseases. *Rook's Textbook of Dermatology*, 1-60.
Modlinski, A., Lancaster, S., Rabuszko, L., Llewellyn, C. D., & Richardson, D. (2025). The characteristics of men who have sex with men with Enterobius

R. (2020). The neglected role of Enterobius vermicularis in appendicitis: A systematic review and meta-analysis. *PloS one, 15*(4), e0232143.
Tegen, D., & Damtie, D. (2021). Prevalence and risk factors associated with intestinal parasitic infection among primary school children in Dera district, northwest Ethiopia. *Canadian Journal of Infectious Diseases and Medical Microbiology, 2021*(1), 5517564.
Tsai, C. Y., Junod, R., Jacot-Guillarmod, M., Beniere, C., Ziadi, S., & Bongiovanni, M. (2018). Vaginal E nterobius vermicularis diagnosed on liquid-based cytology during Papanicolaou test cervical cancer screening: A report of two cases and a review of the literature. *Diagnostic cytopathology, 46*(2), 179-186.
Wendt, S., Trawinski, H., Schubert, S., Rodloff, A. C., Mössner, J., & Lübbert, C. (2019). The diagnosis and treatment of

pinworm infection. *Deutsches Ärzteblatt International, 116*(13), 213.
., Chengyuan, L., Yuanchun, M., & Wei, L. (2024). Health education interventions for pinworm in children based on PRISMA: A systematic review. *Journal of Tropical Diseases and Parasitology, 22*(1), 47.
a, M. L., Cociancic, P., Oyhenart, E. E., & Navone, G. T. (2020). Intestinal parasitosis, undernutrition and socio-environmental factors in schoolchildren from Clorinda Formosa, Argentina. *Revista de Salud Pública, 21*, 224-231