

# INVESTIGATION OF *ENTEROBIUS VERMICULARIS* INFECTION AND RELATED RISK FACTORS AMONG CHILDREN FROM A KINDERGARTEN IN SOUTHWEST CHINA

Guoguang Xiao<sup>1,2,3</sup>, Li Li<sup>1</sup>, Lin Liao<sup>4</sup>, Jianjun Deng<sup>1,5</sup> and Min Shu<sup>1,2,3</sup>

<sup>1</sup>Department of Pediatrics, West China Second Hospital, Sichuan University, Chengdu;

<sup>2</sup>Key Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Chengdu, Ministry of Education;

<sup>3</sup>Department of Pediatrics, West China Xiamen Hospital of Sichuan University, Xiamen;

<sup>4</sup>Department of Parasitology, West China School of Basic Medical Sciences and Forensic Medicine, Sichuan University, Chengdu; <sup>5</sup>West China Second UNIV Hospital, SCU, Qingbaijiang Women's and Children's Hospital, Chengdu, PR China

**Abstract.** *Enterobius vermicularis* (pinworm) infection is common among the children population. Studies have not produced consistent results regarding the prevalence and risk factors of pinworm infection among preschool children. A cross-sectional study was undertaken in December 2020 on the prevalence of pinworm infection in a kindergarten located in Qingxi, Sichuan Province, PR China, and to identify risk factors for infection. An adhesive tape method was used to collect perianal pinworm egg specimens and a questionnaire was distributed to the parent/legal guardian of all children ( $n = 97$ ) attending the kindergarten. Eleven percent of the children were positive for pinworm infection. Multivariate logistic regression analysis of replies to the questionnaire revealed girls ( $p$ -value = 0.033), being >54 months of age ( $p$ -value = 0.034) and having older sister(s) ( $p$ -value = 0.026) as risk factors for pinworm infection. In conclusion, this strategy provided a feasible means to rapidly obtain data on pinworm infection prevalence and associated risk factors among kindergarten children, thereby enabling treatment of infected individuals and providing information to curtail transmission among siblings and other children attending the same kindergarten.

**Keywords:** *Enterobius vermicularis*, outpatient, pinworm, preschool children, risk factor

---

Correspondence: Min Shu, Department of Pediatrics, West China Second Hospital, Sichuan University, No. 20, Section 3, Renmin South Road, Chengdu, Sichuan Province, PR China

Tel: +86 181 8060 9276 E-mail: suemin2005@163.com

## INTRODUCTION

*Enterobius vermicularis* (pinworm) is considered one of the most common human intestinal helminths, especially among children (Hsiao *et al*, 2022). Ingestion of *E. vermicularis* infective eggs via anus-to-mouth and contaminated finger routes are the major causes of pinworm infection. Inhaling dust laden with pinworm eggs may also lead to enterobiasis (Chang *et al*, 2009). Pinworm infection is asymptomatic in most patients, but in rare cases, recurrent urinary tract infection and acute appendicitis resulting from the ectopic location of pinworms (Fan *et al*, 2019; Sousa *et al*, 2022; Pogorelić *et al*, 2024).

The study was launched as a result of an outpatient in the Department of Pediatrics, West China Second Hospital, who presented with eosinophilia and subsequently was diagnosed with pinworm infection due to the presence of pinworms in stool and pinworm eggs in perianal specimen. The patient was from

Qingxi, a town in southwest China. The burden of pinworm infection among preschool children has not been well studied (Fan *et al*, 2021) and studies on the risk factors for pinworm infection have yielded different results (Afrakhteh *et al*, 2016; Fan *et al*, 2021). The epidemiological data on pinworm infection in the area was still scarce. To prevent re-infection of pinworm and improve the health condition of other children in this region of the country, we investigated the prevalence of pinworm infection in the kindergarten that the patient attended. We also took the opportunity to identify risk factors for this infection.

## MATERIALS AND METHODS

### Study population and design

A cross-sectional investigation was conducted in a kindergarten in Qingxi Town, Sichuan Province, Southwest China in December 2020. This kindergarten is the second largest among the four

kindergartens located in Qingxi, which has a population of approximately 40,000 and covers an area of ~ 54.5 km<sup>2</sup>. This region of the country has a subtropical climate. Children attending this kindergarten came from different parts of Qingxi. The kindergarten consists of three grades; lower, middle and upper grade. The patient attended the upper grade.

A positive case was defined as a child attending kindergarten whose perianal swab was positive for the presence of pinworm eggs. Children who completed the questionnaire but had negative pinworm egg detection were defined as negative controls.

### **Parasitological and questionnaire survey**

An adhesive cellophane-tape perianal swab method was used to detect pinworm eggs (Afrakhteh *et al*, 2016). The sticky side of the transparent cellophane tape was placed around the child's anus at about 08:00 hr, and then the tape was removed and attached to a glass slide. To confirm the result, the same procedure was performed the following morning. The samples were collected by a medical

technical personnel and brought to the laboratory for examination under a light microscope (10x and 40x magnification) by a specialist. If pinworm eggs were found in a sample, the child was defined as positive for pinworm infection.

The validated structured questionnaire consisted of questions on the basic demography of the child and his/her parents, personal hygiene habits and clinical manifestations of the child. This questionnaire was distributed to the child's parent(s)/legal guardian(s) and returned as soon as it had been completed.

### **Chemotherapy and health education**

Upon completion of the investigation, the results were communicated to the child's parent(s)/legal guardian(s). Infected children and their siblings were prescribed albendazole at a single dosage of 200 mg, and arrangements were made for outpatient follow-ups. Other family members of the infected children were also advised to receive treatment with albendazole. Prevention and control measures were also disseminated to the kindergarten staff and the parents/

guardians of the children in the kindergarten.

### Statistical analysis

Statistical analysis of the comparisons of pinworm infection prevalence for different variables was performed using the  $\chi^2$ -test and (if necessary) the Fisher's exact test. Variables with a *p*-value <0.2 by univariate analysis were subjected to a multivariate logistic regression analysis. A *p*-value <0.05 is considered statistically significant. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, version 23.0 (IBM Corp, Armonk, NY).

### Ethical considerations

The study was approved by the Ethical Review Committee, West China Second Hospital, Sichuan University (Approval No. 2020-854). Prior written informed consent was obtained from the parent/legal guardian of each participating child.

## RESULTS

Children (*n* = 97), 47 boys and 50 girls, mean age of 59 ± 11 months

(ranging from 39 to 78 months), attending the kindergarten of interest were enrolled in the study. All children lived in suburban or rural areas from different parts of Qingxi. Twenty-six, 31 and 40 children were in the lower, middle and upper grade, respectively. Eleven (including the original patient) children (11%) tested positive for pinworm infection, attended different grades with no significant difference among their grade levels (*p*-value = 0.428), and the majority of whom did not have close contact with the patient. Pinworm infection is significantly higher among girls (9/50, 18%) than boys (2/47, 4%) (*p*-value = 0.033). The pinworm infection rate is not significantly different between children >54 months of age and those in the lower age group (16% (10/63) *vs* 3% (1/34) (*p*-value = 0.090). All infected children except one (with perianal pruritus) were symptomless. No family member was reported as having a history of pinworm infection.

Four participants returned incomplete questionnaires that were not included in the analysis. Completed questionnaires from

11 positive cases and 82 negative controls were subjected to univariate analysis and variables with  $p$ -values  $<0.2$  were then analyzed using a multivariate logistic regression method (Table 1). These latter variables included gender, age, having older sister(s), having younger brother(s), and sleeping with family members. The multivariate logistic regression analysis revealed that only girls ( $p$ -value = 0.041), age  $>54$  months ( $p$ -value = 0.034), and having older sister(s) ( $p$ -value = 0.026) were risk factors associated with pinworm infection.

## DISCUSSION

The pinworm infection rate in our study (11%) was slightly higher than in another study performed in Chongqing, Southwest China, where the pinworm infection rate among primary school children is 6.7% (Wu *et al*, 2012). Another research performed in Gaozhou, Guangdong Province, South China, reported a much higher overall prevalence of 54.9% among children 2-12 years of age (Li *et al*, 2015). An investigation of Iranian preschool children reported a pinworm infection rate of 7.1% (Afrakhteh

*et al*, 2016). Among preschool children in Majuro City, Republic of the Marshall Islands, with a climate of high temperature and moisture, the pinworm infection rate was reported to be 22.4% (Fan *et al*, 2019), a value similar to the 23.0% among Argentine children (Rivero *et al*, 2017). Thus, pinworm infection rates differ greatly globally, and this infection remains prevalent in some parts of the world, including PR China.

Remarkably, pinworm infection prevalence is quite low in Taiwan, as reported by two studies carried out among preschool children with an infection rate of 0.62 and 0.21% (Chang *et al*, 2009; Chen *et al*, 2018). This indicates that following large-scale mass screening and treatment projects, the prevalence of pinworm infection in Taiwan dropped from a level of 19.9% in 1986 and remained at a very low level in recent years (Chen *et al*, 2018). Hence, large-scale mass screening and treatment projects are efficacious methods for the control of pinworm infection, especially in areas with a high prevalence of this infection.

In our study, all children with pinworm infection were

Table 1  
Uni- and multivariate analyses of possible risk factors for pinworm infection using data from the questionnaire

Factor	Number	Positive pinworm infection, <i>n</i> (%)	OR (95% CI)	<i>p</i> -value <sup>a</sup>
Gender				0.041 <sup>b</sup>
Female	48	9 (19)	5.77 (1.07 - 30.98) <sup>b</sup>	
Male	45	2 (4)	1.00	
Age				0.034 <sup>b</sup>
>54 months	59	10 (17)	11.12 (1.21 - 102.51) <sup>b</sup>	
≤54 months	34	1 (3)	1.00	
Total number of family members				1.000
3	17	2 (12)	1.01 (0.20 - 5.15)	
≥4	76	9 (12)	1.00	
Washing hands before meal				1.000
Yes	82	10 (12)	0.72 (0.08 - 6.24)	
No	11	1 (9)	1.00	
Washing hands after using toilet				0.614
Yes	82	9 (11)	1.80 (0.34 - 9.69)	
No	11	2 (18)	1.00	

Table 1 (cont)

Factor	Number	Positive pinworm infection, <i>n</i> (%)	OR (95% CI)	<i>p</i> -value <sup>a</sup>
Finger sucking				1.000
Yes	29	3 (10)	0.81 (0.20 - 3.30)	
No	64	8 (12)	1.00	
Keeping fingernails long				0.395
Yes	16	3 (19)	1.99 (0.47 - 8.51)	
No	77	8 (10)	1.00	
Type of floor				0.686
Concrete floor	78	10 (13)	2.06 (0.24 - 17.40)	
Mud floor	15	1 (7)	1.00	
Bathing method				1.000
Bathtub	21	2 (9)	0.74 (0.15 - 3.71)	
Shower	72	9 (12)	1.00	
Bathing with the help of family member				0.239
Yes	85	9 (11)	0.36 (0.06 - 2.03)	
No	8	2 (25)	1.00	

Table 1 (cont)

Factor	Number	Positive pinworm infection, <i>n</i> (%)	OR (95% CI)	<i>p</i> -value <sup>a</sup>
Changing clothing more than every three days				0.376
Yes	15	3 (20)	0.46 (0.11 - 1.97)	
No	78	8 (10)	1.00	
Changing bedding more than every fortnight				0.742
Yes	35	5 (14)	1.44 (0.41 - 5.14)	
No	58	6 (10)	1.00	
Sleeping with family members				0.145 <sup>b</sup>
Yes	88	9 (10)	0.17 (0.03 - 1.16)	
No	5	2 (40)	1.00	
Having elder sister(s)				0.026 <sup>b</sup>
Yes	25	6 (24)	5.15 (1.21 - 21.89) <sup>b</sup>	
No	68	5 (7)	1.00	
Having younger sister(s)				1.000
Yes	8	1 (12)	1.07 (0.12 - 9.64)	
No	85	10 (12)	1.00	

Table 1 (cont)

Factor	Number	Positive pinworm infection, <i>n</i> (%)	OR (95% CI)	<i>p</i> -value <sup>a</sup>
Having elder brother(s)				0.277
Yes	25	1 (4)	0.24 (0.03 - 1.99)	
No	68	10 (15)	1.00	
Having younger brother(s)				0.147 <sup>b</sup>
Yes	13	3 (23)	2.70 (0.61 - 11.90)	
No	80	8 (10)	1.00	

<sup>a</sup>*p*-value <0.05 is considered significantly different; <sup>b</sup>*p*-value <0.2, analysed by multivariate logistic regression

CI: confidence interval; OR: odds ratio

asymptomatic, except for one child presenting perianal pruritus. On the other hand, other studies reported children not infected with pinworm having perianal pruritus (26.6-70.2%) (Afrakhteh *et al*, 2016; Amiri *et al*, 2016). Thus the perianal pruritus of the child in our study might not be related to the pinworm infection.

Girls had higher pinworm infection rate than boys, with significant difference in the present study, in accordance with another study (Chen *et al*, 2013). However, other studies have shown no significant differences in pinworm infection prevalence between children genders (Li *et al*, 2015; Afrakhteh *et al*, 2016; Chen *et al*, 2018; Fan *et al*, 2019; Fan *et al*, 2021). The differences in prevalence of pinworm infection between genders might be due to different personal hygiene habits among the study populations.

Our result showing that pinworm infection was more prevalent in children >54 months of age than in the younger age group was similar to the results of other studies (Afrakhteh *et al*, 2016; Fan *et al*, 2019; Friesen *et al*, 2019). The increase in

range of children activities with age would provide more opportunities for older children to come into contact with dirt and with other children leading to a higher risk of contracting pinworm infection (Fan *et al*, 2019). In addition, children with older sister(s) had a higher pinworm infection rate, in agreement with other studies (Chen *et al*, 2018; Fan *et al*, 2019). This may be related to the higher pinworm infection rate among girls, suggesting that pinworm infection may be transmitted among children in a family through school-age siblings, in particular older sister(s) (Chen *et al*, 2018).

Our study indicated other risk factors, such as number of family members, washing hands before meals or after using the toilet, finger sucking, long fingernails, bathing habits, and sleeping with family members were not associated with pinworm infection, in agreement with other studies (Afrakhteh *et al*, 2016; Fan *et al*, 2021). On the other hand, Li *et al* (2015) noted that washing hands before meals reduced the occurrence of pinworm infection among children. Parents tend to over-report hand washing before

meals by their children, which may lead to misleading conclusions (Curtis *et al*, 2009; Cairncross *et al*, 2010). Nonetheless, promoting good hygiene habits should help decrease the pinworm infection rate (Sung *et al*, 2001; Ziegelbauer *et al*, 2012).

For the treatment of pinworm infection, it is recommended that albendazole (400 mg), mebendazole (100 mg) or pyrantel pamoate (11 mg/kg, maximum 1 g) be given in a single dose and repeated after two weeks (Wendt *et al*, 2019; Leung *et al*, 2024). However, other studies reported a dose of 200 mg of albendazole with appropriate follow-up visit could be feasible for treating pinworm infection (Fan *et al*, 2019; Fan *et al*, 2021; Sousa *et al*, 2022). We used albendazole (200 mg) orally to treat children with pinworm infection in the present study and advised them to go to hospital for further treatment.

Our study was carried out in the kindergarten attended by the outpatient in West China Second Hospital who presented symptoms of pinworm infection. Not only did the patient received appropriate treatment, but the risk of re-infection was reduced

and transmission of pinworm infection was curtailed among other children in the kindergarten and their siblings. This was achieved through screening for infected children attending the kindergarten and treating those infected as well as their siblings. The subsequent survey to identify potential risk factors can be conducted by public health practitioners. This strategy could be useful for eliminating similar infectious diseases if mass screening and treatment are difficult to carry out, or if the prevalence of the infectious disease is very low. In addition, the cost of this procedure is much less than that of the latter scheme.

However, there are several limitations in our study. Firstly, the study was conducted in only one kindergarten although this kindergarten was the second largest in the area and children came from different parts of Qingxi. Thus, the prevalence of pinworm infection in this kindergarten should reflect the actual situation to some extent. Nevertheless, investigations conducted also in other kindergartens would provide a truer estimation of pinworm

infection in the region. Secondly, the cellophane-tape perianal swab method is convenient but underestimates the pinworm infection rate by 50% if the procedure is conducted only once (Wendt *et al*, 2019). To increase the accuracy of our results, the cellophane-tape method was applied on two consecutive days, but some infected individuals might still be missed. Some specific molecular diagnostic methods for detection of pinworm infection have been developed with a bright future (Zelck *et al*, 2011; Ummano *et al*, 2022). Thirdly, the number of participants is relatively small, and some of the identified negative risk factors could be wrong if a larger cohort of participants were enrolled.

In conclusion, the study demonstrated a feasible approach to determine pinworm infection among kindergarten children and identifying some, but not all, risk factors to provide guidance towards prevention of transmission of the infection among the children and their siblings. Pinworm infection is still an important parasite infectious disease within the children population, and large-scale investigations of pinworm

infection prevalence will be needed to control this infectious disease among preschool and primary school children.

#### ACKNOWLEDGEMENTS

This study was supported by an academic grant from Chengdu Bureau of Science and Technology of Sichuan province, PR China (No. 2015-HM01-00419-SF). We thank Professor Wenzhi Huang, Department of Hospital Infection Control, West China Hospital, Sichuan University for assistance in the statistical analysis.

#### CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest. The funder had no role in the study design, collection, analysis or interpretation of data, writing of the article or the decision to submit the article for publication.

#### REFERENCES

- Afrakhteh N, Marhaba Z, Mahdavi SA, *et al*. Prevalence of *Enterobius vermicularis* amongst kindergartens and preschool children in Mazandaran Province, North of Iran. *J Parasit Dis* 2016; 40(4):

- 1332-6.
- Amiri SA, Rahimi MT, Mahdavi SA, *et al.* Prevalence of *Enterobius vermicularis* infection among preschool children, Babol, North of Iran. *J Parasit Dis* 2016; 40(4): 1558-62.
- Cairncross S, Bartram J, Cumming O, Brocklehurst C. Hygiene, sanitation, and water: what needs to be done? *PLoS Med* 2010; 7(11): e1000365.
- Chang TK, Liao CW, Huang YC, *et al.* Prevalence of *Enterobius vermicularis* infection among preschool children in kindergartens of Taipei City, Taiwan in 2008. *Korean J Parasitol* 2009; 47(2): 185-7.
- Chen KY, Yen CM, Hwang KP, Wang LC. *Enterobius vermicularis* infection and its risk factors among preschool children in Taipei, Taiwan. *J Microbiol Immunol Infect* 2018; 51(4): 559-64.
- Chen YD, Wang JJ, Zhu HH, *et al.* *Enterobius vermicularis* infection status among children in nine provinces/autonomous regions/municipalities of China. *Zhongguo Ji Sheng Chong Xue Yu Ji Sheng Chong Bing Za Zhi* 2013; 31(4): 251-5. [in Chinese]
- Curtis VA, Danquah LO, Aunger RV. Planned, motivated and habitual hygiene behaviour: an eleven country review. *Health Educ Res* 2009; 24(4): 655-73.
- Fan CK, Chuang TW, Huang YC, *et al.* *Enterobius vermicularis* infection: prevalence and risk factors among preschool children in kindergarten in the capital area, Republic of the Marshall Islands. *BMC Infect Dis* 2019; 19(1): 536.
- Fan CK, Sonko P, Lee YL, *et al.* Epidemiologic study of *Enterobius vermicularis* infection among schoolchildren in the Republic of Marshall Islands. *J Trop Med* 2021; 2021: 6273954.
- Friesen J, Bergmann C, Neuber R, *et al.* Detection of *Enterobius vermicularis* in greater Berlin, 2007-2017: seasonality and increased frequency of detection. *Eur J Clin Microbiol Infect Dis* 2019; 38(4): 719-23.
- Hsiao YC, Wang JH, Chu CH, *et al.* Is pinworm infection still a public health concern among children in resource-rich regions? Trends in pinworm infection prevalence and associated factors among children in Hualien County, Taiwan: a retrospective cross-sectional study. *BMC Public Health* 2022; 22(1): 2200.
- Leung AKC, Lam JM, Barankin B, Wong AHC, Leong KF, Hon KL. Pinworm (*Enterobius vermicularis*) infestation:

- an updated review. *Curr Pediatr Rev*. 2024 Jan 28. doi: 10.2174/0115733963283507240115112552. Online ahead of print.
- Li HM, Zhou CH, Li ZS, *et al*. Risk factors for *Enterobius vermicularis* infection in children in Gaozhou, Guangdong, China. *Infect Dis Poverty* 2015; 4: 28.
- Pogorelić Z, Babić V, Bašković M, Ercegović V, Mrklič I. Management and incidence of *Enterobius vermicularis* infestation in appendectomy specimens: a cross-sectional study of 6359 appendectomies. *J Clin Med* 2024; 13(11): 3198.
- Rivero MR, De Angelo C, Nuñez P, *et al*. Environmental and socio-demographic individual, family and neighborhood factors associated with children intestinal parasitoses at Iguazú, in the subtropical northern border of Argentina. *PLoS Negl Trop Dis* 2017; 11(11): e0006098.
- Sousa J, Hawkins R, Shenoy A, *et al*. *Enterobius vermicularis*-associated appendicitis: a 22-year case series and comprehensive review of the literature. *J Pediatr Surg* 2022; 57(8): 1494-8.
- Sung JF, Lin RS, Huang KC, Wang SY, Lu YJ. Pinworm control and risk factors of pinworm infection among primary-school children in Taiwan. *Am J Trop Med Hyg* 2001; 65(5): 558-62.
- Ummarino A, Caputo M, Tucci FA, *et al*. A PCR-based method for the diagnosis of *Enterobius vermicularis* in stool samples, specifically designed for clinical application. *Front Microbiol* 2022; 13: 1028988.
- Wendt S, Trawinski H, Schubert S, Rodloff AC, Mössner J, Lübbert C. The diagnosis and treatment of pinworm infection. *Dtsch Arztebl Int* 2019; 116(13): 213-9.
- Wu CG, Xie J, Luo XJ, *et al*. Influence factors of *Enterobius vermicularis* infection among pupils in Chongqing City. *Zhongguo Ji Sheng Chong Xue Yu Ji Sheng Chong Bing Za Zhi* 2012; 30(5): 382-6. [in Chinese]
- Zelck UE, Bialek R, Weiss M. Molecular phylogenetic analysis of *Enterobius vermicularis* and development of an 18S ribosomal DNA-targeted diagnostic PCR. *J Clin Microbiol* 2011; 49(4): 1602-4.
- Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J, Utzinger J. Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. *PLoS Med* 2012; 9(1): e1001162.