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Original Article

Enterobius vermicularis infection and its risk factors among pre-school children in Taipei, Taiwan

Kuang-Yao Chen [a,f], Chuan-Min Yen [b,f], Kao-Pin Hwang [c], Lian-Chen Wang [a,d,e,*]

[a] *Department of Parasitology, College of Medicine, Chang Gung University, Taoyuan 333, Taiwan*
[b] *Department of Parasitology, Faculty of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung 807, Taiwan*
[c] *Department of Infectious Diseases, China Medical University Children's Hospital, Taichung 404, Taiwan*
[d] *Molecular Infectious Disease Research Center, Chang Gung Memorial Hospital, Taoyuan, Taiwan*
[e] *Graduate Institute of Biomedical Sciences, College of Medicine, Chang Gung University, Taoyuan 333, Taiwan*

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Abstract *Background:* The prevalence of pinworm infection is extremely low in Taipei, Taiwan. This population study was designed to determine the current status and the associated risk factors of this infection among pre-school children.
Methods: Perianal swab specimens were obtained from the parents or guardians using a two-consecutive-day adhesive cellophane perianal swab kit. Information of family background, personal hygiene, and household sanitary conditions were collected by asking the parents or guardians to complete a questionnaire.
Results: Of 44,163 children, 0.21% was found to infect with pinworm. The positive rate was highest in Datong (0.59%) and Nangang (0.58%) Districts and lowest in Neihu District (0.02%). There was no significant difference in the rates by gender (boys 0.24% and girls 0.19%) or school (kindergartens 0.25% and nurseries 0.17%). Significantly higher positive rates were found in children having parent with lower educational level and elder brother(s)/sister(s). Children taking bath by themselves and those sleeping in bed with matting had significantly higher positive rates. Five significant independent predictors of pinworm infection were determined by multivariate analysis: having elder brother(s), having elder sister(s), infrequent washing hands after using toilet facilities, bathing without the help of family members, and sleeping on bed with matting.

* Corresponding author. Department of Parasitology, College of Medicine, Chang Gung University, Taoyuan 333, Taiwan. Fax: +886 3 2218385.
E-mail address: wanglc@mail.cgu.edu.tw (L.-C. Wang).
[f] These authors contributed equally to this work.

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Conclusion: The prevalence of pinworm infection in the pre-school children of Taipei is extremely low and decreasing. Good hand washing habit should be an important preventive measure. Transmission of this infection in pre-school children may occur in the family through their school-age siblings.

Introduction

Enterobius verimcularis, the pinworm, has a simple life cycle. Contamination of eggs to the environment not only enables the transmission of infection through the finger-oral route but also by inhalation. In addition, retro-infection of the larvae through the anus is not uncommon. Among the common intestinal helminths, the prevalence of enterobiasis is generally underestimated since pinworm eggs are not usually detected by stool examination. This infection is more common in the temperate than in the tropic.[1] Recent studies indicate that positive rates over 20% were not uncommon in many parts of the world.[2–28]

In Taiwan, the control of pinworm infection among school children should be considered to a success. The prevalence was reduced from 19.9% in 1986 to 2.5% in 2001 after a 15-year population-based control.[29] Mass examination, treatment, and follow-up should be continued until the eradication of the infection. However, this large-scale control project was put to an end in 2001 and the control works then become tasks undertaking by the health-related agencies in each county/city government. In order to determine the status of pinworm infection among school children after this change in the control works, we examined 118,190 school children from 25 counties/cities in 2007 and found 2.4% (0.6–6.6%) were infected with pinworm, indicating the prevalence remains at a low level after the control works transferred to the local governments.[30]

Large-scale mass screening and treatment projects for pinworm infection among pre-school children in Taipei have been carried out since 1990. The positive rate significantly reduced from 4.3% in 1990 to 0.40% in 2007.[31] The positive rates in children of kindergartens and nurseries have also been reported to be 0.62%[32] and 0.5%,[14] respectively. This study was designed not only to determine the current status of pinworm infection among pre-school children in Taipei but also the associated risk factors with this infection.

Methods

Study population

This study was conducted from September 2010 to November 2012. The participants were 45,014 pre-school children enrolled in 751 kindergartens and nurseries of Taipei. In addition to the pre-school children, teachers and workers in the kitchen of the schools were also examined for pinworm infection.

Parasitological survey

An informed consent was obtained from the parents or guardians of each participant. Through the assistance of the teachers, a two-consecutive-day adhesive cellophane perianal swab kit was distributed to each child. The parents or guardians were instructed to take perianal swabs for their children immediately after getting up in the morning of the next two days. The specimens were examined microscopically for pinworm eggs or worms by parasitologists and experienced medical technologists.

Questionnaire survey

The parents or guardians were asked to complete a questionnaire concerning with the family background, personal hygiene, and household sanitary conditions. In addition to the demographic data, educational levels and occupations of the parents were obtained. To determine the personal hygiene, washing hand behaviors, finger sucking, fingernail cutting habits, and bathing habits was collected. Household sanitary including household cleaning and living conditions was assessed.

Chemotherapy and follow-up

Infected children and their families were administered with a single dose of mebendazole (100 mg/tablet). Follow-up examination was conducted 2–4 weeks after chemotherapy.

Statistical analysis

Data were managed and analyzed using the statistical software SPSS 12.0 (SPSS, Inc., Chicago, IL). Rates were compared by the Chi-square test. Factors associated with pinworm infection were analyzed by stepwise logistic regression. A p value < 0.05 was considered to be statistically significant.

Results

A total of 44,163 (98.11%) specimens were collected from the 45,014 participants. Of the children examined, 94 (0.21%) were found to infect with pinworm. Table 1 shows the prevalences in the 12 districts of Taipei. Datong (0.59%) and Nangang (0.58%) Districts had the highest positive rates whereas Neihu District had the lowest rate of 0.02% ($p < 0.001$). Although the rate was slightly higher in boys

Table 1 Prevalence of *Enterobius vermicularis* infection among pre-school children in the 12 districts of Taipei.

District[a]	No. exam.	No. pos.	% pos.
Datong	2023	12	0.59
Nangang	2913	17	0.58
Wenshan	4901	22	0.45
Beitou	4402	12	0.27
Wanhua	2932	7	0.24
Zhongshan	3453	5	0.14
Daan	5911	7	0.12
Zhongzhen	1918	2	0.10
Xinyi	2927	3	0.10
Shilin	5043	4	0.08
Songshan	3246	2	0.06
Neihu	4494	1	0.02
Total	44,163	94	0.21

[a] Chi-square test: $p < 0.001$.

(0.24%) than in girls (0.19%) and in kindergartens (0.25%) than in nurseries (0.17%), no significant difference was found by gender or school ($p > 0.05$) (Table 2).

Statistical analyses of the family background indicate that significantly higher positive rates were found in children having lower educational level of the parent (father: 0.31% vs. 0.18%, mother: 0.34% vs. 0.18%). Children with elder brother(s) (0.33% vs. 0.19%) or sister(s) (0.34% vs. 0.18%) had significantly higher rates ($p < 0.05$). However, there were no significant differences in the rate by occupation of the parents or having younger brother(s) or sister(s) ($p > 0.05$) (Table 3).

Univariate analyses of personal hygienic factors indicate that there were no significant associations between pinworm infection and washing hand habits, finger sucking, long fingernails, and bathing habits ($p > 0.05$) (Table 4). However, children taking bath by themselves had a significantly higher positive rate (0.42% vs. 0.20%) ($p < 0.001$). Among the household sanitary conditions, a significant higher rate was found in the children sleeping in bed with matting (0.69% vs. 0.20%) ($p < 0.001$). There was no significant association between pinworm infection and style of residence, type of floor, cleaning house or bedding, or sharing bedroom/bed ($p > 0.05$) (Table 5). Multivariate analysis showed that having elder brother(s) (odds ratio (OR) = 2.358), having elder sister(s) (OR = 2.450), infrequent washing hands after using toilet facilities (OR = 2.324), bathing without the help of family members (OR = 1.949), and sleeping on bed with matting (OR = 2.659) were significant independent predictors of pinworm infection among the pre-school children ($p < 0.05$) (Table 6).

Table 3 Univariate analysis of family background associated with *Enterobius vermicularis* infection among pre-school children in Taipei.

Factor	No. exam.	No. pos.	% pos.	*p*
Education of father				
Secondary or below	10,455	32	0.31	0.0169
University or above	30,662	54	0.18	
Education of mother				
Secondary or below	10,758	37	0.34	0.0020
University or above	30,284	53	0.18	
Occupation of father				
Laborer or farmer	5768	12	0.21	1.0000
Others	3,4781	70	0.20	
Occupation of mother				
Laborer or farmer	1493	2	0.13	0.6870
Others	3,9468	86	0.22	
Having elder brother(s)				
Yes	9141	30	0.33	0.0151
No	32,122	60	0.19	
Having elder sister(s)				
Yes	9676	33	0.34	0.0045
No	31,587	57	0.18	
Having younger brother(s)				
Yes	6810	12	0.18	0.5035
No	34,453	78	0.23	
Having younger sister(s)				
Yes	6722	10	0.15	0.2344
No	34,541	80	0.23	

In addition to the pre-school children, 204 teachers and 521 workers in the kitchen from 357 schools were also examined for pinworm infection. However, only negative results were obtained in these adult participants.

Of the 94 infected children, 328 children and their families were treated with mebendazole. In addition to negative results in the infected children after chemotherapy, no positives were also found among the treated families.

Discussion

In the present study, we have determine only 0.21% of 44,163 pre-school children were infected with pinworm. This infection rate was lower than that reported in 2007 (0.40%).[31] Moreover, the positive rates of 0.25% in kindergartens and 0.17% in nurseries were also lower than

Table 2 School- and sex-specific prevalence of *Enterobius vermicularis* infection among pre-school children in Taipei.

School	Boy		Girl		Total	
	No. exam.	No.(%) pos.	No. exam.	No.(%) pos.	No. exam.	No.(%) pos.
Kindergartens	11,978	32 (0.27)	10,798	25 (0.23)	22,776	57 (0.25)
Nurseries	11,389	23 (0.20)	9998	14 (0.14)	21,387	37 (0.17)
Total	23,367	55 (0.24)	20,796	39 (0.19)	44,163	94 (0.21)

Chi-square test: Boy vs. girls $p = 0.3244$, kindergartens vs. nurseries $p = 0.0974$.

Table 4 Univariate analysis of personal hygienic factors associated with *Enterobius vermicularis* infection among pre-school children in Taipei.

Factor	No. exam.	No. pos.	% pos.	*p*
Washing hands before eating				
Infrequent	6022	18	0.30	0.1887
Frequent	35,803	73	0.20	
Washing hands after using toilet facilities				
Infrequent	3698	13	0.35	0.0924
Frequent	38,065	77	0.20	
Finger sucking				
Yes	19,790	46	0.23	0.4929
No	21,875	43	0.20	
Keeping fingernails short				
No	33,305	77	0.23	0.3302
Yes	7314	12	0.16	
Way of bathing				
Showering	30,741	69	0.22	0.5902
Bathing in a tub	11,020	21	0.19	
Taking a bath after getting up				
Yes	413	1	0.24	1.0000
No	41,093	90	0.22	
Taking a bath everyday				
No	1184	4	0.34	0.5561
Yes	40,728	87	0.21	
Bathing with the help of family members				
No	3369	14	0.42	0.0179
Yes	37,399	75	0.20	

those reported previously (kindergartens 0.62% and nurseries 0.5%).[14,32] These findings indicate that repeated mass screening and treatment is feasible for the eradication of enterobiasis. Although no significant differences were found between the positive rate by gender and school, the rates in boys and kindergartens were slightly higher. These findings are similar to those reported previously.[14,32] However, significant grade- and gender-specific prevalences of the infection have been reported among school children in Taiwan.[30] The gender difference in the children may be due to the fact that girls have better personal hygienic measures against pinworms than boys. The level of personal hygiene may become similar in the elder children.

Pinworm infection among pre-school children in South Taiwan has a tendency of family aggregation.[33] Moreover, bed/bedroom sharing with family members and floor covered with carpet or cement have been found to be important risk factors.[34] In the present study, we determined that children having elder brother(s)/sister(s) had significantly higher positive rate. These findings suggest that transmission of the infection may occur in the family through their school-age siblings. Although education and occupation of parents are important indicators of socio-economic status of the children, we found that only children having parents with lower education level had significantly higher positive rates. These findings are not consistent with those reported previously that knowledge of parents about enterobiasis might be one of the most important risk factors for enterobiasis in children.[2] However, occupation of parents has also been reported to be a risk factor for the infection.[4,6,8,9,22,24]

Table 5 Univariate analysis of household sanitary conditions associated with *Enterobius vermicularis* infection among pre-school children in Taipei.

Factor	No. exam.	No. pos.	% pos.	*p*
Style of residence				
Ground floor, single-family detached or townhouse	4228	13	0.31	0.2233
Apartment	35,994	73	0.20	
Type of floor				
Wood, plastic, or stone	39,527	88	0.22	0.3997
Concrete or carpet	1337	1	0.07	
Cleaning house everyday				
Yes	14,103	32	0.23	0.8609
No	26,762	57	0.21	
Type of bed				
Matting	1305	9	0.69	0.0007
Wood or spring mattress	37,593	76	0.20	
Changing bedding less than two weeks				
No	19,409	50	0.26	0.1125
Yes	22,185	40	0.18	
Sharing bedroom with family members				
Yes	35,839	82	0.23	0.6045
No	3528	6	0.17	
Sharing bed with family members				
Yes	32,985	78	0.24	0.1207
No	7950	11	0.14	

Table 6 Multivariate analysis of factors associated with *Enterobius vermicularis* infection among pre-school children in Taipei.

Factor	Odds ratio	*p*
Having elder brother(s) (yes vs. no)	2.358	0.001
Having elder sister(s) (yes vs. no)	2.450	0.001
Washing hands after using toilet facilities (infrequent vs. frequent)	2.324	0.015
Bathing with the help of family members (no vs. yes)	1.949	0.046
Type of bed (matting vs. wood or spring mattress)	2.659	0.024

Behavior and environmental factors have been to be important in the transmission of pinworm. A case-control study on school-age children in Central Taiwan revealed playing on the floor, nail biting, failure to wash hands before meals and living in nonapartment dwellings as significant factors.[35] Positive rates in urban regions have been reported to be significantly lower than the suburban and rural counterparts.[18,20–22] Recently, pinworm eggs have been recovered from armor, fingers, bedclothes, briefs, and stationery of infected pre-school children in Korea.[16] Moreover, pinworm eggs have also identified on the hands of school children in a rural South African region.[27] These findings indicate that finger-oral route remains the most important avenue for enterobiasis transmission. Although univariate analysis did not show a significant association between enterobiasis and washing hand habits ($p > 0.05$), infrequent washing hands after using toilet facilities is a significant independent predictor. Therefore, good hand washing habit should be an important preventive measure against the infection. Since pinworm infection is more prevalent in the school age and pre-school children with elder siblings are significant independent predictors, transmission of this infection may occur in the family through their school-age siblings.

Conflicts of interest statement

None.

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