

Epidemiology of *Enterobius vermicularis* infection among elementary school children in Hualien, Taiwan from 2007 to 2012

Wang, K.M.¹, Lin, T.Y.¹, Chang, K.C.^{1,2}, Shieh, M.J.¹, Liu, D.G.³ and Peng, S.Y.^{4*}

¹Department of Laboratory Medicine, Buddhist Tzu Chi General Hospital, Hualien, Taiwan

²Department of Laboratory Medicine and Biotechnology, Tzu Chi University, Hualien, Taiwan

³Department of Medical Affairs, Buddhist Tzu Chi General Hospital, Hualien, Taiwan

⁴Department of Biochemistry, School of Medicine, Tzu Chi University, Hualien, Taiwan

*Corresponding author e-mail: pengsy@mail.tcu.edu.tw

Received 6 August 2015; received in revised form 23 August 2016; accepted 24 August 2016

Abstract. *Enterobius vermicularis* is the most common human intestinal parasite, and its control among school children is an important public health issue. The objective of this study was to document the present situation of *E. vermicularis* infection in school children in Hualien. The administrative divisions in Hualien county include 13 districts (3 in a mountainous area, 10 in a rural/urban area). Between 2007 and 2012, a total of 41,191 children in 13 districts in Hualien were examined using consecutive 2-day adhesive cellophane paper perianal swabs. Our results showed *Enterobius* egg-positive infection rates of 5.79% (452/7,089) in 2007, 6.25% (457/7,312) in 2008, 5.37% (385/7,173) in 2009, 4.98% (330/6,804) in 2010, 4.91% (301/6,133) in 2011, and 4.68% (279/5,960) in 2012. Compared to the previously reported national average in Taiwan (range, 1.53–2.23%), the prevalence of *E. vermicularis* in Hualien is relatively high. The infection rates were 7.55–29.10% in mountainous areas and 0.50–12.43% in rural/urban areas. All first and fourth grade students in elementary schools in Hualien were selected as study participants. The average infection rate of the first grade students (6.71%) was higher than that of the fourth grade students (4.23%). These results indicate that enterobiasis remains an important parasitic disease among school children in Hualien, especially those in mountainous areas.

INTRODUCTION

Enterobius vermicularis is one of the most common nematodes found among children in the world (Jardine *et al.*, 2006; Wang *et al.*, 2009; Chu *et al.*, 2012). This nematode has a simple (requires no intermediate host) and short (20–30 days) life cycle. Pinworm eggs can also reach the human intestinal tract through the nose. Retroinfection by the pinworm larvae through the anus have also been reported (Burkhart & Burkhart, 2005; Caldwell *et al.*, 1982). Perianal pruritus is the characteristic symptom of enterobiasis. Moreover, it tends to affect the family members and the people living in the neighborhood (Chen *et al.*, 2003).

Enterobius infection in Taiwan has always been difficult to cure, and prevention effectiveness varies significantly among counties (Wang *et al.*, 2009; Chu *et al.*, 2012; Fan *et al.*, 1998; Lee *et al.*, 2000). *Enterobius* infection characteristics, degree of treatment, case tracking, and health education are all factors that influence prevention and treatment efficacy. Although there is much information available regarding the prevalence of enterobiasis among school children in Taiwan (Wang *et al.*, 2009; Chu *et al.*, 2012; Fan *et al.*, 1998; Lee *et al.*, 2000), little is known about the current status of *Enterobius* infection in school children in Hualien county in eastern Taiwan. The purpose of this study was to

determine the variation in the prevalence of enterobiasis among 7–8 and 10–11-year-old school children in Hualien county, east Taiwan, after the commencement of a pilot control study. This study aimed to analyze the infection rates in elementary school students in Hualien county from 2007 to 2012.

MATERIALS AND METHODS

Study area and population

Hualien county is on the northeast coast of Taiwan along the Pacific ocean and includes 13 townships (10 plains, 3 aboriginal). The eastern Taiwanese city of Hualien, with a humid subtropical climate, mean annual

temperature of 23.3°C, average relative humidity of 78%, and average annual rainfall of 2,157 mm, has favorable environmental conditions that support the spread of parasitic diseases. Hualien Tzu Chi Hospital was entrusted to handle the county's national primary health checks by Hualien county from 2007 to 2012. As primary education for children in Taiwan is mandatory, this number represented the total school-aged population. Therefore, this experiment recruited 107 elementary schools in the 13 townships in Hualien City. A total of 26 primary schools are located in the three mountain townships (Zhuo, Sau, and Wanrong), while 81 primary schools are located in the other 10 townships. The 13 townships of Hualien county are shown in Figure 1.

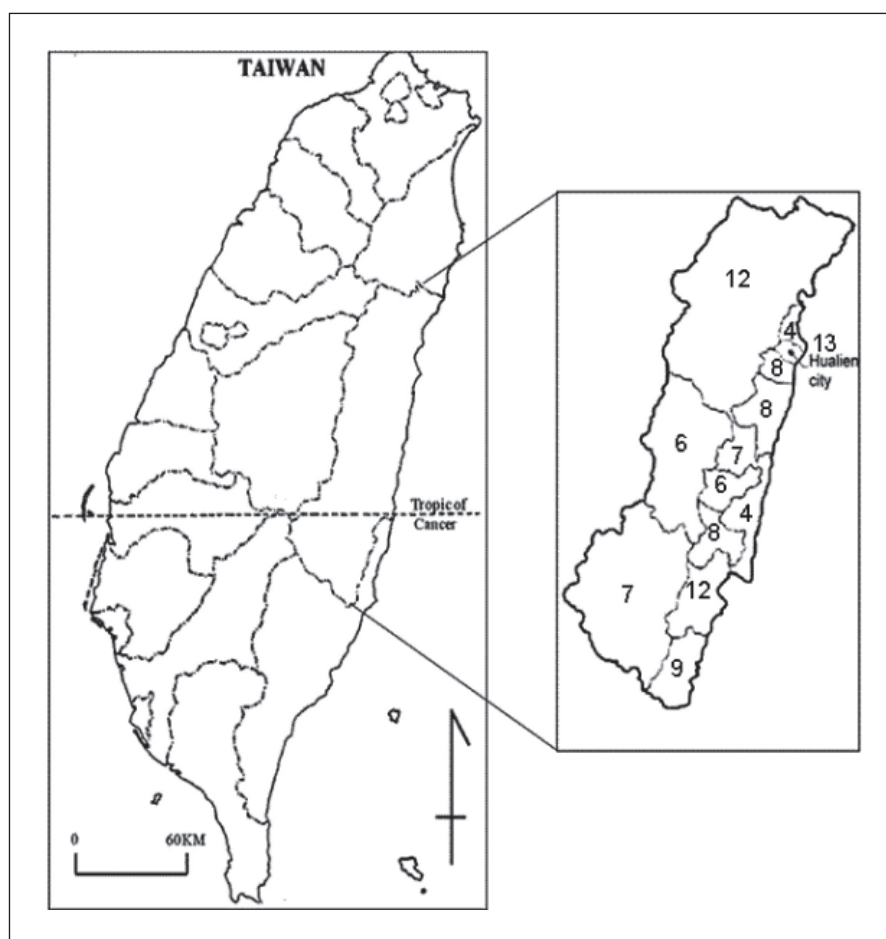


Figure 1. The map indicates the number of primer schools in 13 townships of Hualien country eastern Taiwan.

Sample collection and diagnosis

A total of 41,191 children were included between 2007 and 2012 (7,809 in 2007; 7,312 in 2008; 7,173 in 2009; 6,804 in 2010; 6,133 in 2011; and 5,960 in 2012). In this study, we used special pinworm tape to collect the specimens (consecutive 2-day cellophane tape around anal swabs, Shih-yung Medical Instruments CO., LTD, Taipei, Taiwan) and detection was done by using light microscopy analysis.

Data analysis

Data were entered in a Microsoft Office Excel sheet and analyzed using STATA software. The prevalence of pinworm infections was expressed in percentage; the infection rate in each township for each year was also shown (Table 1 and 2).

RESULTS

There were total 41,191 children to be screened in Hualien county of eastern Taiwan in 2007-2012. Among the total of 7,809 children who were screened for *Enterobiasis* in 2007, 452 were infected (5.79%). In 2008, the rate was 6.25% (457/7,312) (Table 1). In 2009, 2010, 2011, and 2012, the infection rates were 5.37% (385/7,173), 4.98% (339/6,804), 4.91% (301/6,133), and 4.68% (279/5,960), respectively (Table 1). Thus, the infection rate showed a downward trend from 2007 to 2012 (Figure 2).

In the period between 2007 and 2012, we screened 26 schools in the three aboriginal districts (Siolin, Zhuoxi, and Wanrung) and found infection rates of 17.78% (117/658), 17.82% (118/662), 13.36% (85/636), 13.97% (81/580), 15.43% (85/551), and 14.08% (79/561), and the total average infection rate was 15.49% (565/3,648). Children from 81 schools of the other 10 ground districts were screened from 2007 to 2012. The infection rates in 2007, 2008, 2009, 2010, 2011, and 2012 were 4.68% (335/7,151), 5.10% (339/6,650), 4.59% (300/6,537), 4.15% (258/6,224), 3.87% (216/5,582), and 3.70% (200/5,399), respectively, and the overall average rate was 4.39% (1,648/37,543) (Table 2). The chi-square test with biometric (χ^2 test) analysis showed a very significant difference ($P < 0.001$) for the infection rates of the school students between aboriginal and ground districts during the period from 2007 to 2012 (Table 2). The infection rate of the aboriginal district school children was >3 times higher than that of the ground district children. We also compared the average infection rate between boys and girls but saw no significant difference among them in Hualien county from 2007 to 2012.

DISCUSSION

Molecular diagnosis of a parasite is the most rapid and sensitive method of diagnosing a parasitic infection. However, development of molecular diagnostics is expensive. In

Table 1. Prevalence of enterobiasis among Children in Hualien country eastern Taiwan (2007-2012)

Year/age	7-8			10-11			Total		
	No. exam	positive		No. exam	positive		No. exam	positive	
		No.	%		No.	%		No.	%
2007	3701	266	7.19	4108	186	4.53	7809	452	5.79
2008	3390	244	7.20	3922	213	5.43	7312	457	6.25
2009	3215	232	7.22	3958	153	3.87	7173	385	5.37
2010	3036	198	6.52	3768	141	3.74	6804	339	4.98
2011	2823	168	5.95	3310	133	4.02	6133	301	4.91
2012	2756	162	5.88	3204	117	3.65	5960	279	4.68
Total	18921	1270	6.71	22270	943	4.23	41191	2213	5.37

Table 2. Prevalence of Enterobiasis among Children in 13 townships of Hualien country, Eastern Taiwan (2007-2012)

Township	2007			2008			2009			2010			2011			2012			Total		
	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.	positive %	Exam No.
Yuli	609	28	4.60	520	23	4.42	531	21	3.95	502	16	3.19	466	20	4.29	417	18	4.32	3045	126	4.14
Guangfu	256	23	8.98	208	7	3.37	220	15	6.82	226	10	4.42	165	4	2.42	201	1	0.50	1276	60	4.70
Jian	1353	70	5.17	1221	80	6.55	1215	81	6.67	1114	42	3.77	1031	33	3.20	1006	45	4.47	6940	351	5.06
Hualien	3422	106	3.10	3155	126	3.99	3100	95	3.06	3048	75	2.46	2686	67	2.49	2646	76	2.87	18057	545	3.02
Fuli	202	7	3.47	242	11	4.55	223	16	7.17	210	13	6.19	196	4	2.04	166	8	4.82	1239	59	4.76
Sincheng	395	38	9.62	407	40	9.83	372	21	5.65	364	34	9.34	362	45	12.43	312	22	7.05	2212	200	9.04
Rueisuei	259	22	8.49	270	15	5.56	277	11	3.97	225	27	12.00	212	13	6.13	213	10	4.69	1456	98	6.73
Shoufeng	353	20	5.67	334	26	7.78	305	31	10.16	274	25	9.12	252	22	8.73	211	10	4.74	1729	134	7.75
Fenglin	224	17	7.59	222	7	3.15	217	7	3.23	190	8	4.21	161	5	3.11	175	9	5.14	1189	53	4.46
Fengbin	78	4	5.13	71	4	5.63	77	2	2.60	71	8	11.27	51	3	5.88	52	1	1.92	400	22	5.50
Ground townships	7151	335	4.68	6650	339	5.10	6537	300	4.59	6224	258	4.15	5582	216	3.87	5399	200	3.70	37543	1648	4.39
Siulin*	397	58	14.61	371	77	20.75	384	49	12.76	353	44	12.46	328	55	16.77	326	45	13.80	2159	328	15.19
Zhuoxi*	127	20	15.75	130	17	13.08	106	8	7.55	110	11	10.00	120	14	11.67	117	13	11.11	710	83	11.69
Wanrung*	134	39	29.10	161	24	14.91	146	28	19.18	117	26	22.22	103	16	15.53	118	21	17.80	779	154	19.77
Aboriginal townships	658	117	17.78	662	118	17.82	636	85	13.36	580	81	13.97	551	85	15.43	561	79	14.08	3648	565	15.49
Total	7809	452	5.79	7312	457	6.25	7173	385	5.37	6804	339	4.98	6133	301	4.91	5960	279	4.68	41191	2213	5.37

*Most inhabitants of these three districts are aboriginals.

addition, the specific molecular diagnostic techniques for *Enterobius* infection were less developed and used (Piperaki *et al.*, 2011; Jaeger & Iñiguez 2014). For detecting pinworms, the microscopic examination from feces is not the best method because pinworm eggs appear less frequently in the feces and female pinworms climb out of the children's anuses and lay eggs around the anus at night. Therefore, NIH swab, cellophane swab, or scotch tape swab method is needed to help detect *Enterobius* eggs from children's anuses (Garcia 2001). In this survey, we used the cellophane tape method to investigate pinworm infection in children in Hualien county of eastern Taiwan.

Using the cellophane tape method for detecting *E. vermicularis* is very convenient. However, the infection rate would be underestimated if detection was done on a single day. We used Scotch tape for 2 consecutive days to increase the accuracy of the test. In this study, we detected *Enterobius* infection rate in primary school students of Hualien county from 2007 to 2012. The infection rate did not differ significantly throughout the study period (6.25% in 2008 vs. 4.68% in 2012). The infection rate found in this study was 1% lower than the average infection rate of the period from 2001 to 2004 (8.14%) (Liu *et al.*, 2007). This result showed that the infection rate in Hualien is improving; however, it is much higher than those in other cities and countries in Taiwan during the period from 2001 to 2005 (1.53–2.23%) (Liu *et al.*, 2007). This finding indicates that *Enterobius* infection in Hualien is a serious problem. The program of intestinal parasite prevention in Taiwan has been on-going since nearly 50 years (Liu *et al.*, 2007). The infection rates of *Ascaris lumbricoides*, hookworm, and *Trichuris trichiura* have reduced considerably; however, the infection rate of *E. vermicularis* has remained at 2–5% (Lee *et al.*, 2000; Liu *et al.*, 2007; Wang *et al.*, 2010). *Enterobius* infection rates in Taiwan as well as that in children from other regions have been reported in some papers: Miaoli county (2.39% in 2005) (Wang *et al.*, 2009), Taichung island (2.95% in 2006) (Wang *et al.*, 2009), and Taipei (0.62% in 2008 (Chang *et al.*, 2009) and 0.5% in 2009 (Chu *et al.*, 2012).

The above reports indicate that *Enterobius* infection is still present in Taiwan, but the infection rate has reduced from 2001 to 2004 (Chen 2003; Chang *et al.*, 2009). Based on the result of this study, we can conclude that the infection rate in Hualien is higher than that in other countries. As the Central Mountain Range separates eastern and western Taiwan, it is not surprising to see the differences in the infection rate.

In Europe and other countries, *Enterobius* infection is quite common, with a prevalence of up to 20% in children (Wanger & Eby 1983); in some families, it is even as high as 50% (Pezzani *et al.*, 2004). Another study indicated that the pinworm infection rate was 41.6% in the Thailand mountainous regions (Chaisalee *et al.*, 2004), 31.1% in the urban areas of Korea, 18.5% among 3–10-year-old children in the western and southern coasts of the islands of Korea, and as high as 59.3% in preschoolers and school children in the other parts of Korea (Park *et al.*, 2005). In Taiwan, pinworm screening and treatment is included in the routine annual physical examinations for preschoolers and school children.

Further analysis revealed higher rates in the mountain townships (13.36–17.82%) than in the plain townships (3.70–5.10%). This shows that health education and public health environment in mountain townships of Hualien should be improved. Our data show that 7–8-year-old school children have a high rate of pinworm infection, similar to that shown in the results of other studies in Taiwan (Liu *et al.*, 2007). This may be because younger children have poor personal hygiene. Most cities and counties in Taiwan will focus on decreasing the *Enterobius* infection rate in school children, and the annual screening for *Enterobius* will continue.

Recent data showed that the average infection rate of students in Hualien was always 5–6%. This may be related to diet, health habits, treatment, health education, case tracking, and parental education (Liu *et al.*, 2007). We recommend that *Enterobius* prevention programs be implemented in the public health policy in all regions, health education advocacy be strengthened, and

personal hygiene habits be improved. Hualien mountain towns should offer more comprehensive and intensive inspection and treatment strategies to achieve effective pinworm infection control.

Acknowledgments. We thank the Department of Health, Hualien Country Government and Department of Laboratory Medicine, Buddhist Tzu Chi General Hospital for supporting this investigation and all the primary schools as well.

REFERENCES

- Burkhart, C.N. & Burkhart, CG. (2005). "Assessment of frequency, transmission, and genitourinary complications of enterobiasis (pinworms)". *International Journal of Dermatology* **44**: 837-840.
- Caldwell, J.P. (1982). "Pinworms (*Enterobius Vermicularis*)". *Canadian Family Physician* **28**: 306-309.
- Chaisalee, T., Tukaew, A., Wiwanitkit, V., Suyaphun, A., Thiamtip, S. & Suwansaksri, J. (2004). Very High Prevalence of Enterobiasis among the Hilltribal Children in Rural District "Mae Suk," Thailand. *Medscape General Medicine* **6**: 5.
- Chang, T.K., Liao, C.W., Huang, Y.C., Chang, C.C., Chou, C.M., Tsay, H.C., Huang, A., Guu, S.F., Kao, T.C. & Fan, C.K. (2009). Prevalence of *Enterobius vermicularis* Infection among preschool children in kindergartens of Taipei City, Taiwan in 2008. *Korean Journal of Parasitology*. 2009; **47**: 185-187.
- Chen, E.R. (2003). Cross-sectional study of enterobiasis control in school children in Taiwan. Technology Development Program. Centers for Disease control, *DOH, Executive Yuan, Taipei, Taiwan*.
- Chu, T.B., Liao, C.W., Nara, T., Huang, Y.C., Chou, C.M., Liu, Y.H. & Fan, C.K. (2012). *Enterobius vermicularis* infection is well controlled among preschool children in nurseries of Taipei City, Taiwan. *Revista da Sociedade Brasileira de Medicina Tropical* **45**: 646-648.
- Fan, P.C. (1998). Review of enterobiasis in Taiwan and offshore islands. *Journal of Microbiology, Immunology and Infection* **31**: 203-210.
- Garcia, L. (2001). Diagnostic Medical Parasitology. 4th ed. Washington DC: *American Society for Microbiology*.
- Jaeger, L.H. & Iñiguez, A.M. (2014). Molecular paleoparasitological hybridization approach as effective tool for diagnosing human intestinal parasites from scarce archaeological remains. *PLoS One*. **9**: 1-5.
- Jardine, M., Kokai, G.K. & Dalzell, A.M. (2006). *Enterobius vermicularis* and colitis in children. *Journal of Paediatric Gastroenterology and Nutrition* **43**: 610-612.
- Lee, J.D., Wang, J.J., Chung, L.Y., Chang, E.E., Lai, L.C., Chen, E.R. & Yen, C.M. (2000). A survey on the intestinal parasites of the school children in Kaohsiung country. *Kaohsiung Journal of Medical Sciences* **16**: 452-458.
- Liu, C.I., Chen, Y.X., Huang, Z.M. & Chen, C.H. (2007). Current Status of intestinal parasites Prevention: on the prevention and treatment of Enterobiasis. *Taiwan Epidemiology Bulletin* **23**: 645-661.
- Park, J.H., Han, E.T., Kim, W.H., Shin, E.H., Guk, S.M., Kim, J.L. & Chai, J.Y. (2005). A survey of *Enterobius vermicularis* infection among children on western and southern coastal islands of the Republic of Korea. *Korean Journal of Parasitology* **43**: 129-134.
- Pezzani, B.C., Minvielle, M.C., de Luca, M.M., Cordoba, M.A., Apezteguia, M.C. & Basualdo, J.A. (2004). *Enterobius vermicularis* infection among population of General Mansilla, Argentina. *World Journal of Gastroenterology* **10**: 2535-2535.
- Piperaki, E.T., Spanakos, G., Patsantara, G., Vassalou, E., Vakalis, N. & Tsakris, A. (2011). Characterization of *Enterobius vermicularis* in a human population, employing a molecular-based method from adhesive tape samples. *Molecular and Cellular Probes* **25**: 121-125.

- Wagner, E.D. & Eby, W.C. (1983). Pinworm Prevalence in California Elementary School Children, and Diagnostic Methods. *American Society of Tropical Medicine and Hygiene* **32**: 998-1001.
- Wang, C.C., Lee, Y.F., Chang, C.C., Lee, N.S., Chen, P.Y., Huang, F.L. & Liou, N.W. (2009). Current status of *Enterobius vermicularis* infection in primary school children in Miaoli County and Taichung County, Taiwan. *Journal of Microbiology, Immunology and Infection* **42**: 420-426.
- Wang, L.C., Hwang, K.P. & Chen, E.R. (2010). *Enterobius vermicularis* infection in school children: a large-scale survey 6 years after a population-based control. *Epidemiology & Infection* **138**: 28-36.