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▣ BRIEF COMMUNICATION

Enterobius vermicularis Infection among Preschool Children: A 12-Year (2008-2019) Survey in Large Cities and Provinces of the Republic of Korea

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Abstract: A 12-year nationwide survey (2008-2019) was performed to investigate the prevalence of *Enterobius vermicularis* infection among preschool children in Seoul, 4 large cites (Busan, Incheon, Daegu, and Ulsan), and 9 provinces (grouped into 5 localities) in the Republic of Korea (=Korea). The survey was carried out once a year by 16 regional offices of the Korea Association of Health Promotion. The cello-tape perianal swab method (1 smear per child) was applied to detect eggs of *E. vermicularis* and other helminths. According to the results, the egg positive rate of *E. vermicularis* infection in 2008-2009 was 1.8-2.0%, but it decreased gradually to 0.6% in 2019 ($P<0.05$). The prevalence was significantly higher in boys (0.7-5.0%, mean 1.8%) than in girls (0.5-2.8%, mean 1.3%) ($P<0.05$). The 2 most southern localities, Jeju-do (Province) and Jeolla-do (inclusive of Jeollabuk-do and Jeollanam-do) and a mid-western province, Gyeonggi-do, revealed higher prevalences, whereas Seoul and Gangwon-do showed lower prevalences. The results indicate that a low-grade prevalence of *E. vermicularis* infection (less than 4%) has been maintained for the recent 12 years among preschool children in Korea. Continuous monitoring of enterobiasis in the child age group is necessary in Korea.

Key words: *Enterobius vermicularis*, preschool children, prevalence, Korea

Enterobius vermicularis is the most common intestinal nematode worldwide infecting predominantly the children age group (5-14 years) [1,2]. *E. vermicularis* infection occurs by ingesting the eggs of infectious stage through contact with contaminated objects or air transmission [1,3]. Enterobiasis is generally asymptomatic but can cause anal pruritus, discomfort, insomnia, or anxiety especially in young children [4]. Although it is not considered a serious illness, it can sometimes cause serious morbidity such as appendicitis and perianal dermatitis [2]. The infection is diagnosed by microscopic examinations of eggs using the cello-tape perianal swab method [5]. The presence of eggs in perianal swabs does not necessarily mean an actual adult pinworm infection in the intestinal tract [6]. However, the egg positive rate in perianal swabs can be used to estimate the prevalence and endemicity of *E. vermicularis* infection in a community [5,6].

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For treatment and control of *E. vermicularis* infection, it is recommended to take albendazole 400 mg or pyrantel pamoate 10 mg/kg in a single dose at 20-day interval at least 3 times [6]. However, it is quite difficult to manage and control the infection because of frequent and rapid reinfection and incomplete anthelmintic efficacy [2]. For this reason, it is recommended that all members of the family and classmate should be medicated at the same time. It is also important to keep the body clean and improve the environment through washing or disinfection of bedding and underwear [6].

In the Republic of Korea (= Korea), surveys of *E. vermicularis* infection have been continuously conducted, and it has been shown that its prevalence is decreasing gradually over time [1-4,7-26]. However, most of the previous surveys were conducted under limited conditions, i.e., in local regions and targeting specific group during a short period of time [1-4,7-26]. Thus, it is insufficient to understand the nationwide status of pinworm infection. In this study, we performed a 12-year nationwide survey to investigate the status of *E. vermicularis* infection among preschool children in Seoul, 4 large cities, and 9 provinces in Korea.

The survey was conducted once a year using the cello-tape

perianal swab method during 2008-2019 targeting preschool children (aged 1-6) selected by 16 regional branches of the Korea Association of Health Promotion (KAHP). The total number of subjected preschool children during the 12 years was 638,354. The participants were randomly selected from children attending preschools (1-234 preschools each year in each regional branch) under permissions of parents, guardians, and/or director of the preschools which are located in Seoul, 4 large cities (Busan, Daegu, Incheon, and Ulsan), and 9 provinces (grouped into 5, namely, Gyeonggi-do, Gangwon-do, Chungcheongbuk-do, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangbuk-do, and Gyeongsangnam-do). The study protocol was approved by the Ethics Committee for Health Research, the Korea Association of Health Promotion (IRB no. 130750-202009-HR-020). The perianal swab samples were prepared by the parent according to the instructions provided by the survey staff and collected from the parent or the guardian. The samples were transported to the laboratories of 16 branches of the Korea Association of Health Promotion (KAHP) and examined using a light microscope. The egg positive children were prescribed with albendazole 400 mg in a single dose 3 times at 20-day intervals. All statistical analyses were conducted using the Excel program (Microsoft, Redmond, Washington, USA), and P values of < 0.05 were considered statistically significant.

According to the results, the egg positive rate of *E. vermicularis* decreased gradually within the period of investigation from 1.8% in 2008 and 2.0% in 2009 to 0.6% in 2019 (Table 1; Fig. 1A) ($P < 0.05$). The egg positive rate was significantly higher in boys (0.7-5.0%, mean 1.8%) than in girls (0.5-2.8%, mean 1.3%) at any time except in 2017 (Fig. 1B) ($P < 0.05$). The mean egg positive rate of *E. vermicularis* according to geo-

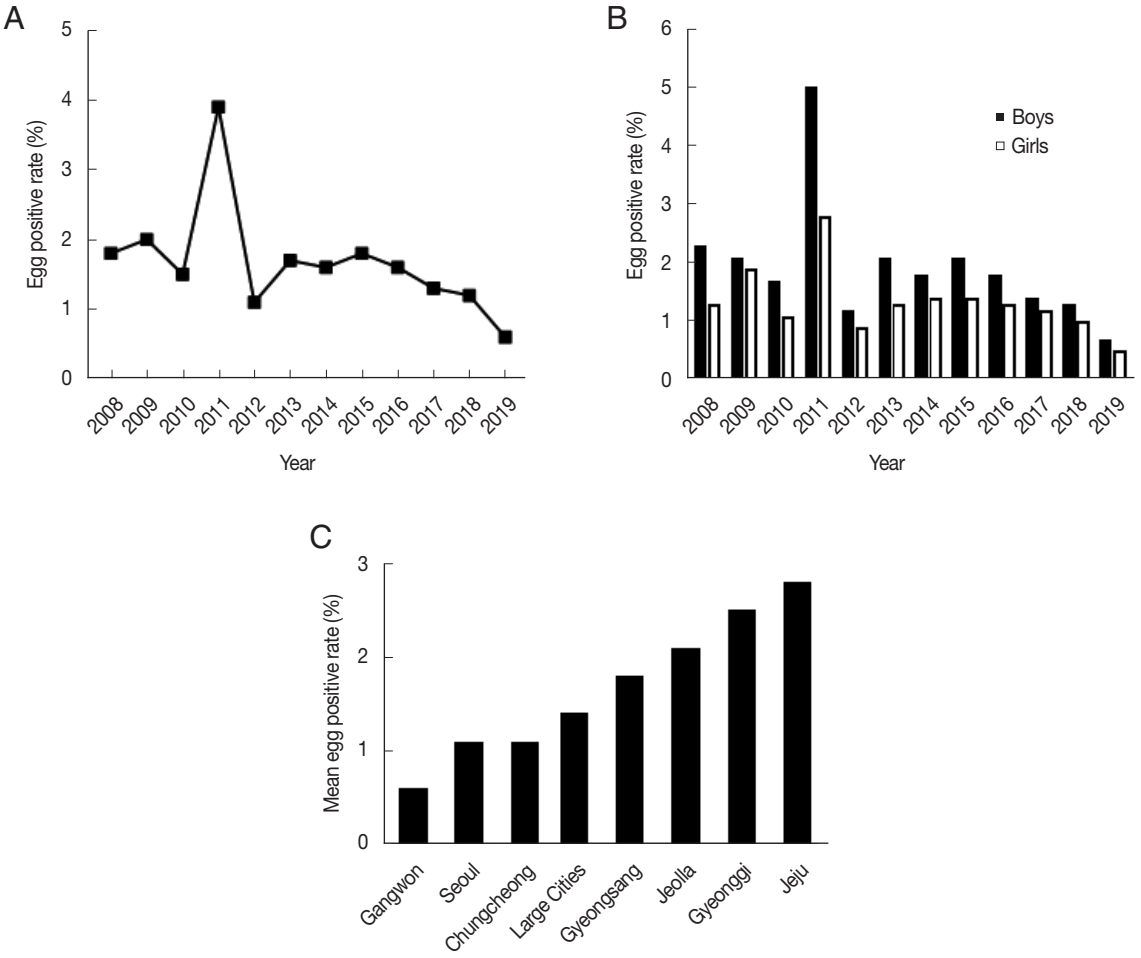

Fig. 1. The egg positive rate of *Enterobius vermicularis* among preschool children in various localities of the Republic of Korea, during 2008-2019 by year (A), sex (B), and geographical regions (C).

Table 1. Yearly prevalence of *Enterobius vermicularis* infection among preschool children in various localities of the Republic of Korea (2008-2019)

Survey area	No. egg positive / No. examined (%)					
	2008	2009	2010	2011	2012	2013
Seoul	55/2,545 (2.2)	23/3,128 (0.7)	8/222 (3.6)	7/273 (2.6)	43/2,676 (1.6)	26/1,527 (1.7)
Large cities[a]	342/25,200 (1.4)	402/17,610 (2.3)	140/13,223 (1.1)	28/427 (6.6)	56/7,977 (0.7)	56/2,937 (1.9)
Gyeonggi	-	-	-	1/110 (0.9)	38/2,574 (1.5)	203/4,453 (4.6)
Gangwon	41/1,890 (2.2)	27/6,635 (0.4)	213/20,866 (1.0)	2/100 (2.0)	101/20,136 (0.5)	77/16,339 (0.5)
Chungcheong	169/15,209 (1.1)	211/16,617 (1.3)	45/4,174 (1.1)	6/201 (3.0)	33/4,246 (0.8)	37/3,061 (1.2)
Jeolla	120/4,571 (2.6)	453/26,107 (1.7)	178/6,674 (2.7)	15/209 (7.2)	140/5,339 (2.6)	22/813 (2.7)
Gyeongsang	430/16,949 (2.5)	292/14,368 (2.0)	46/2,339 (2.0)	5/200 (2.5)	116/7,934 (1.5)	205/15,032 (1.4)
Jeju	339/15,043 (2.3)	859/29,145 (2.9)	91/2,213 (4.1)	0/106 (0)	22/483 (4.6)	383/14,504 (2.6)
Total	1,496/81,407 (1.8)	2,267/113,610 (2.0)	721/49,711 (1.5)	64/1,626 (3.9)	549/51,365 (1.1)	1,009/58,666 (1.7)
Survey area	No. egg positive / No. examined (%)					
	2014	2015	2016	2017	2018	2019
Seoul	30/1,713 (1.8)	30/2,135 (1.4)	37/2,381 (1.6)	28/2,887 (1.0)	13/1,880 (0.7)	39/10,765 (0.4)
Large cities[a]	9/1,275 (0.7)	8/846 (0.9)	7/1,224 (0.6)	3/279 (1.1)	13/957 (1.4)	19/3,980 (0.5)
Gyeonggi	120/3,318 (3.6)	71/2,667 (2.7)	56/2,216 (2.5)	13/2,446 (0.5)	12/1,470 (0.8)	9/1,311 (0.7)
Gangwon	87/17,785 (0.5)	83/18,356 (0.5)	152/18,024 (0.8)	101/16,769 (0.6)	84/16,043 (0.5)	37/15,035 (0.2)
Chungcheong	56/3,793 (1.5)	9/2,211 (0.4)	1/1,214 (0.1)	41/2,153 (1.9)	1/556 (0.2)	3/1,093 (0.3)
Jeolla	23/1,518 (1.5)	4/428 (0.9)	16/836 (1.9)	79/2,213 (3.6)	38/1,394 (2.7)	38/2,537 (1.5)
Gyeongsang	236/15,903 (1.5)	297/16,720 (1.8)	245/12,119 (2.0)	204/10,397 (2.0)	136/7,922 (1.7)	21/2,188 (1.0)
Jeju	388/12,482 (3.1)	477/11,774 (4.1)	272/12,247 (2.2)	79/4,895 (1.6)	105/4,644 (2.3)	95/4,970 (1.9)
Total	949/57,787 (1.6)	979/55,137 (1.8)	786/50,261 (1.6)	548/42,039 (1.3)	402/34,866 (1.2)	261/41,879 (0.6)

[a]Large cities included Busan, Daegu, Incheon, and Ulsan.

graphical regions during the 12 years was highest in Jeju-do, followed by Gyeonggi-do and Jeolla-do (including Jeollabuk-do and Jeollanam-do) and lowest in Gangwon-do, Seoul, and Chungcheong-do (Fig. 1C).

Enterobiasis is the most common human parasitic disease worldwide, including developed and developing countries [5,6,27-29]. In Korea, the survey of the prevalence of *E. vermicularis* has been continuously performed in most cases targeting preschool and primary school children in various regions [1-4,7-26] (Table 2). According to the reports, the prevalence of *E. vermicularis* has been decreasing over time in Korea. The prevalence in 2019 was 0.6%, considerably lower than other countries. Even in developed countries, the prevalence of *E. vermicularis* infection was quite high [27-29]. For example, in Berlin, Germany, the prevalence of *E. vermicularis* was 17.4% from 2007 to 2017 [27]. In the Sivas region of Turkey, the prevalence of *E. vermicularis* was 17.0% (365/3,569) co-infected with other parasites [28]. In northeastern Poland, the prevalence of *E. vermicularis* was 10.1% between 2013 and 2015 [29].

In our study, the prevalence of *E. vermicularis* infection tended to decrease over the surveyed period from 2008 to 2019. One of the reasons for the decrease seems to be the continued hygiene education and preventive chemotherapy. In fact, Kim and Yu [3] reported that it was sharply reduced in the experimental group trained for preventive education about *E. vermicularis* infection than in the control group after 3 months of treatment. In addition, the prevalence of *E. vermicularis* was relatively lower in orphanage children than in preschool and primary school children, because the orphanage children were regularly educated about personal healthcare and infectious diseases and received medication with anthelmintics [26]. According to Kim et al. [23], parent's knowledge about enterobiasis was correlated with *E. vermicularis* infection of their children. For this reason, it was recommended that children and their parents be consistently provided with health education for their knowledge and prevention of enterobiasis [3,23]. The second reason infers from the decrease in the number of students in each class and preschool followed by the decrease in the frequency of contact and transmission rate. Actually, the average number of children per class of preschools reported by the Korean Educational Statistics Service was 26.3 in 2000, 21.0 in 2010, and 17.0 in 2019 [30]. Therefore, it is considered that the possibility of *E. vermicularis* infection would be increased proportionally to the number of students in a class.

Table 2. Summary of previous surveys on the prevalence of *Enterobius vermicularis* infection among children or general people in Korea

Year	Area	Target	Prevalence (%)	Reference
1976	North of Seoul	Primary school children (aged 8-9)	73/107 (68.2)	Chai et al. [7]
1983	Daegu, Gyeongsangbuk-do	Residents (all age)	118/1,697 (7.0)	Joo [8]
1983	Yeongyang-gun, Gyeongsangbuk-do	Preschool children and primary school children	1,428/2,227 (64.1)	Ho and Park [9]
1985	Cheongyang-gun, Chungchongnam-do; Wando-gun, Jeollanam-do; Incheon	Primary school children (grade 1-6)	316/860 (36.7)	Im et al. [10]
1986-1988	Dobong-gu, Seoul; Uijeongbu and Yangju, Gyeonggi-do	Primary school children (grade 1-6)	345/2,156 (16.0)	Ryang [11]
1987	Jongno-gu and Nanjido Seoul; Okku-gun, Jeollabuk-do	Primary school children (aged 6-11)	217/1,336 (16.2)	Choi et al. [12]
1991	Wonju, Gangwon-do	Preschool and primary school children (aged 4-12)	251/1,262 (19.9)	Kim et al. [13]
1994-1995	Chunchon, Gangwon-do	Primary school children	138/789 (17.5)	Yang et al. [14]
1997	Chorwon-gun, Gangwon-do	Handicapped people (aged 1-59)	34/165 (20.6)	Lee et al. [15]
1998	Tangjin-gun, Chungcheongnam-do	Preschool and primary school children (grade 1-5)	28/189 (14.8)	Lee et al. [16]
1999	Chunchon, Gangwon-do	Preschool children	434/4,711 (9.2)	Yoon et al. [17]
1999	Seongbuk-gu, Seoul	Preschool children (aged 2-7)	113/1,191 (9.5)	Song et al. [2]
2000	Hamyang-gun, Gyeongsangnam-do	Primary school children (grade 1-6)	88/654 (13.4)	Kim et al. [18]
2000	Gyeonggi-do, Incheon, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangnam-do, Busan, Jeju-do	Preschool and primary children school (aged 3-10)	307/1,661 (18.5)	Park et al. [19]
2001	Goseong-gun and Wonju, Gangwon-do	Primary school children (grade 1-6)	39/398 (9.8)	Lee et al. [20]
2002	Geoje Island, Gyeongsangnam-do	Preschool and primary school children (grade 1-6)	74/754 (9.8)	Kim et al. [21]
2004-2005	Cheongju, Chungcheongbuk-do	Preschool children (aged 3-7)	119/1,512 (7.9)	Kang et al. [1]
2008	Chuncheon and Inje-gun, Gangwon-do and Paju, Gyeonggi-do	Preschool children (aged 1-7)	285/7,048 (4.0)	Hong et al. [4]
2008-2009	Muan-gun, Jeollanam-do	Preschool children (aged 1-7)	102/2,347 (4.3)	Hong et al. [22]
2010[a]	Busan, Gyeongsangnam-do	Preschool children (aged 1-7)	179/1,674 (10.7)	Kim et al. [23]
2011[a]	Gimhae, Gyeongsangnam-do	Preschool children (under aged 7)	729/6,921 (10.5)	Lee et al. [24]
2011[a]	Southeast area of Korea	Preschool children	205/3,422 (6.0)	Kim et al. [25]
2012-2013	Industrial city, urban, and suburban areas	Primary school children (aged 7-9)	163/3,840 (4.2)	Kim and Yu [3]
2014	Busan and Ulsan, Gyeongsangnam-do	Orphanage children (aged 4-13)	1/117 (0.85)	Kim et al. [26]

[a]Reported year.

In our study, the egg positive rate in 2011 was exceptionally high compared to other years (Fig. 1A). Two factors were suggested to be the reasons. One was the high prevalence in large cities (6.6%) and Jeolla-do (including Jeollabuk-do and Jeollanam-do) (7.2%) compared to lower prevalences in other areas (0-3.0%). The other was the much smaller number of examinees in 2011 (1,626 children) compared with other years (34,866-113,610 children each year). We consider that there may have an outbreak of *E. vermicularis* infection at that time in a few preschools subjected in this study. However, thereafter, sudden rising of the prevalence was not seen throughout the survey period.

In previous papers, the prevalence of *E. vermicularis* infection was higher in girls than in boys by 1980s, but the pattern of pinworm infection changed since the 1990s in Korea [15,17, 19-21,23-25]. Our study showed a significantly higher prevalence among boys than in girls, except in 2017 ($P<0.05$) (Fig. 1). The precise reason why boys are more highly infected with *E. vermicularis* than girls is unknown. However, it is considered that inadequate personal hygiene, particularly among boys, could be a risk factor for *E. vermicularis* infection [19].

Our study has a few strong points and a few weak points. One of the strong points is the large subjected population, from around 35,000 to 114,000 subjects each year except in 2011, totaling 638,354 children during the total 12 years. Another strong point is that our study covered nationwide locali-

ties, including Seoul, 4 large cities, and 9 provinces, thus, it was fairly good to see the national trend of *E. vermicularis* prevalence among preschool children. One of the weak points is that our study was not based on strictly randomized selection of participants in each branch of the Korea Association of Health Promotion. Another weak point is that the cello-tape perianal swabs were prepared by the parents of children, not by experienced technologists.

In conclusion, the prevalence of *E. vermicularis* seems to be decreasing in Korea when compared with previous results, but a low-grade infection is still maintained. Therefore, monitoring and control programs of enterobiasis should be implemented consistently in preschools in Korea. In addition, it is necessary to provide health education on enterobiasis against children as well as their parents.

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CONFLICT OF INTEREST

We have no conflict of interest related to this study.

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