Original article

Intestinal helminth infections among health examinees: 10-year (2011–2020) nationwide observations in Korea

Hyejoo Shin[1], Sooji Hong[1], Yoon-Hee Lee[1], Young-Sung Kim[1], Yoon-Joong Joo[2], Eun-Hee Lee[2], In-One Kim[2], Jong-Yil Chai[3], Bong-Kwang Jung[1]

[1]MediCheck Research Institute, Korea Association of Health Promotion, Seoul, [2]Korea Association of Health Promotion, Seoul, [3]Department of Tropical Medicine and Parasitology, Seoul National University College of Medicine, Seoul, Korea

Abstract

Background: A nationwide anti-parasite control program (1969–1995) successfully reduced soil-transmitted helminth infections; however, fish-borne trematode infections persisted in some areas. Since the 2012 National Parasite Infection Survey, information on the current status of intestinal helminth infections has not been updated. Analysis of the current trends in intestinal helminth infections is necessary to prevent and manage parasitic diseases in Korea.

Methods: This retrospective study analyzed the prevalence of intestinal parasites in 1,211,799 individuals who visited 16 regional branches of the Korea Association of Health Promotion between 2011 and 2020. Examinations were performed using microscopy and Kato's method. The results were analyzed according to parasite species, year, sex, age, and region of origin.

Results: Intestinal helminth infections remained above 2.0% from 2011 to 2014 but decreased to 1.0% by 2020. *Clonorchis sinensis* had the highest infection rate (1.3%), followed by *Metagonimus yokogawai* (0.3%) and *Trichuris trichiura* (0.2%). Men had a higher infection rate (2.4%) than that of women (1.2%). The infection rate was higher among those in their 50s (2.0%), 60s, and older (1.8%). The highest regional infection rates were observed in Gyeongnam (4.8%), Ulsan (3.1%), Gyeongbuk (2.5%), Busan (1.8%), and Jeonnam (1.6%).

Conclusion: These results provide valuable insights into the decreasing prevalence and epidemiological characteristics of intestinal helminth infections in the Korean population. Therefore, various control measures are needed to prevent intestinal helminth infections, and continuous monitoring is essential until they are eradicated.

Keywords: Intestinal helminths, Examinees, Prevalence, Nationwide, Korea

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Corresponding author
Bong-Kwang Jung
E-mail: mulddang@snu.ac.kr

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Introduction

Until the 1970s, Korea was one of the countries with a high incidence of parasitic infections in humans. In 1966, the Law for the Prevention of Parasitic Diseases was enacted, and the nationwide anti-parasitic control program started in 1969 with the Korean Government and the Korea Association for Parasite Eradication (currently the Korea Association of Health Promotion; KAHP) [1]. The program involved screening all students in Korea and treating all egg-positive cases twice a year until 1995 [2]. In addition to the student program, a deworming campaign was conducted in the community, and national surveys of intestinal parasitic infections have been carried out in Korea every 5–7 years since 1971 to acquire national-level data according to the statistics plan of the National Statistical Office of Korea [2,3]. The nationwide rate of helminth egg-positive cases in Korea was recorded at 84.3% during the first national survey in 1971. The second survey, conducted in 1976, showed a decline to 63.2%, which further dropped in the third survey of 1981 to 41.1%. In the fourth survey, conducted in 1986, the rate of helminth egg-positive cases was the lowest at 12.9%. After the fifth survey (3.8%), conducted in 1992, the rate dropped significantly to 2.4%, 3.7%, and 2.6% in the sixth (1997), seventh (1997), and eighth (2012) surveys, respectively [3].

Ascaris lumbricoides and other intestinal nematodes, such as *Paragonimus westermani*, *Taenia* spp., and intestinal protozoa have also decreased throughout the country, and lymphatic filariasis has been eradicated in Jeju-do and other endemic southern islands [2]. Despite the remarkable decrease in soil-transmitted nematode infections, fish-borne trematode infections, such as *Clonorchis sinensis* (*C. sinensis*) and *Metagonimus yokogawai* (*M. yokogawai*) have remained relatively high in some endemic areas [4]. For the management of the remaining parasitic diseases, the Division of Vectors and Parasitic Diseases at the Korea Disease Control and Prevention Agency is still investigating the infection status of intestinal parasites among residents of endemic areas, particularly along five major rivers, in cooperation with the KAHP [5]. However, survey data from endemic areas are insufficient to comprehensively understand the infectious status of intestinal parasites across the country.

In this study, we investigated trends in the nationwide infection status of intestinal parasites over the past decade after the final national survey was conducted in 2012 [2,6]. We collected and analyzed vast medical data, including the results of intestinal parasitic infections, from examinees who underwent stool examinations nationwide through the regional branches of the KAHP as a health check-up center.

Materials and methods

Participants

A retrospective study was conducted to determine the results of intestinal parasite examinations of 1,211,799 examinees who visited 16 regional branches of the KAHP between 2011 and 2020. Stool examinations were performed at 16 medical examination centers in different regions, including Seoul (western, eastern, and southern), the main cities (Incheon, Daegu, Busan, and Ulsan), and other provinces, such as Gyeonggi, Gangwon, Chungcheong (north and south), Jeolla (north and south), Gyeongsang (north and south), and Jeju Province.

Stool examination

Intestinal helminth examination was performed by preparing a stool sample using the cellophane thick smear (Kato's method) technique and microscopy by medical technologists of the regional branches of KAHP. Briefly, a small square of cellophane was cut to be slightly larger than a standard glass slide and soaked in glycerin and methylene blue. The slide was labeled, and approximately 50–60 mg of stool was placed at the center of the glass slide and covered with a square piece of prepared cellophane. Cellophane was gently pressed using a rubber stopper to spread the stool specimen evenly around the circumference of the stopper, ensuring that it did not spread beyond the cellophane cover. The slides were incubated at room temperature for 10–20 minutes. During this time, the microscopic field became transparent because of the action of glycerin on the stool samples. The thick layer containing stained helminth eggs concentrated within the plane of the cellophane layer enabled optimal microscopic visualization and identification.

Statistical analysis

Statistical analysis of the results of intestinal helminth infections was performed using the chi-square test to compare qualitative variables; $P < 0.05$ was considered statistically significant by year, sex, age, region (visiting branch), and parasite species based on the results of intestinal helminth examination in the last ten years (2011–2020).

Results

The prevalence of intestinal parasitic infections among the participants was confirmed to be 2.2%, 2.0%, 2.0%, and 2.2% from 2011 to 2014, respectively. However, it decreased to less than 2.0% in 2015 and further decreased to 1.0% by 2020 (Table 1). Over the 10 years of the study, the highest prevalence was observed in 2011 and 2014, with an average infection rate of 2.2%, whereas the lowest was in 2020, with a rate of 1.0% (Table 1). This study showed no significant changes in the prevalence of intestinal helminthiasis between 2011 and 2020 ($P > 0.05$). Among the species of infected parasites, *C. sinensis* had the highest infection rate at 1.3%, followed by *M. yokogawai at* 0.3%, *Trichuris trichiura* at 0.2%, and *Gymnophalloides seoi* at 0.02% (Fig. 1A).

According to the results, the prevalence of intestinal helminth infections was higher in men (2.4%) than in women (1.2%) each year ($P < 0.05$) (Fig. 1B). The infection rate was higher in the age group of the 50s (2.0%), 60s, and older (1.8%) than in the younger age groups of the 40s (1.5%), 30s (0.8%), and 20s (0.7%). Differences in infection rates according to sex and age were statistically significant ($P < 0.05$) (Fig. 1C). By region (local branch), the infection rate was higher in Gyeongnam (4.8%), Ulsan (3.1%), Gyeongbuk (2.5%), Busan (1.8%), and Jeonnam (1.6%). By contrast, the rest of the country had an infection rate of 1% or less. The differences in infection rates by area were also statistically significant ($P < 0.05$) (Table. 1 and Fig. 2). These high infection rate areas are similar to the endemic areas with high freshwater fish-borne fluke infections in Korea.

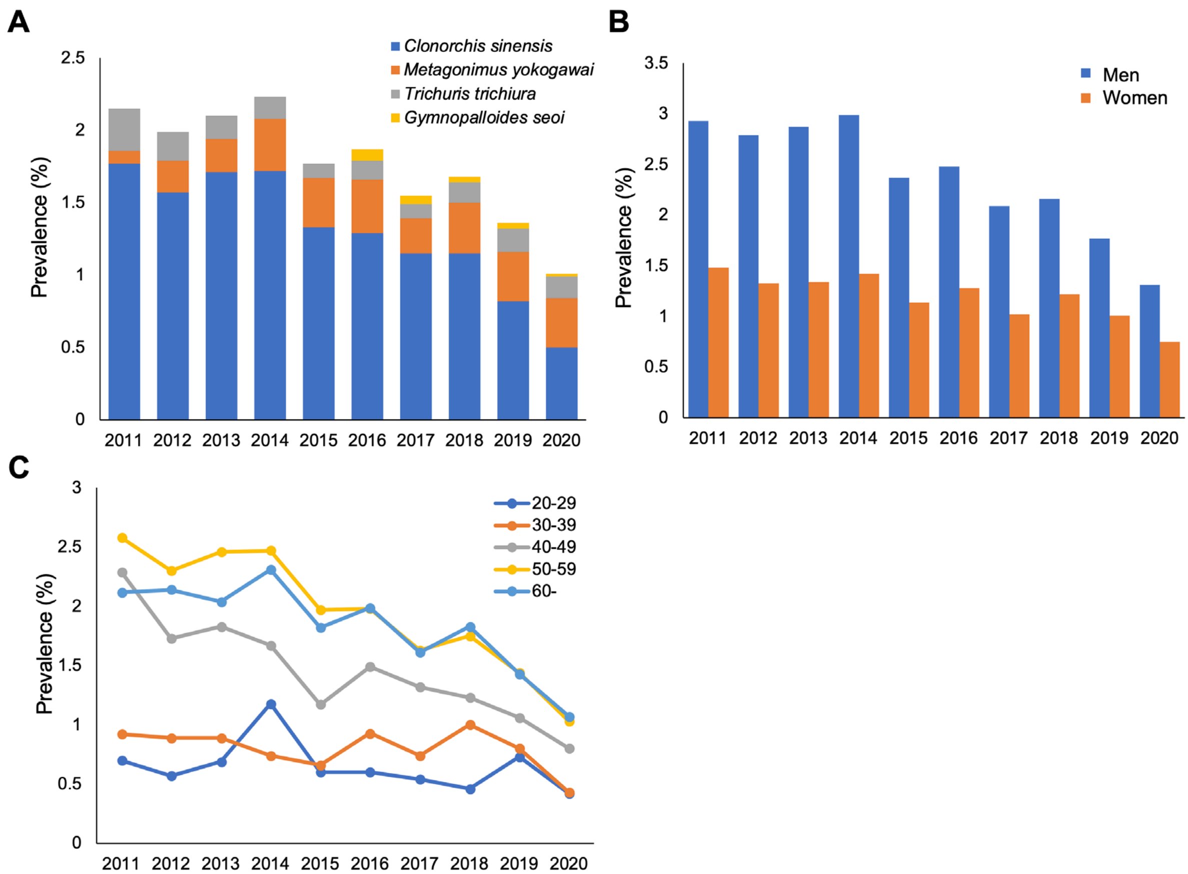

Fig. 1. Characteristics of intestinal helminth infections among examinees in Korea over a 10-year period. (A) Overall prevalence of parasite infections by species of intestinal helminth. (B, C) Prevalence by sex and age. Significant differences were observed in prevalence by species and age ($P < 0.05$) and in the differential prevalence between men and women throughout all periods ($P < 0.05$).

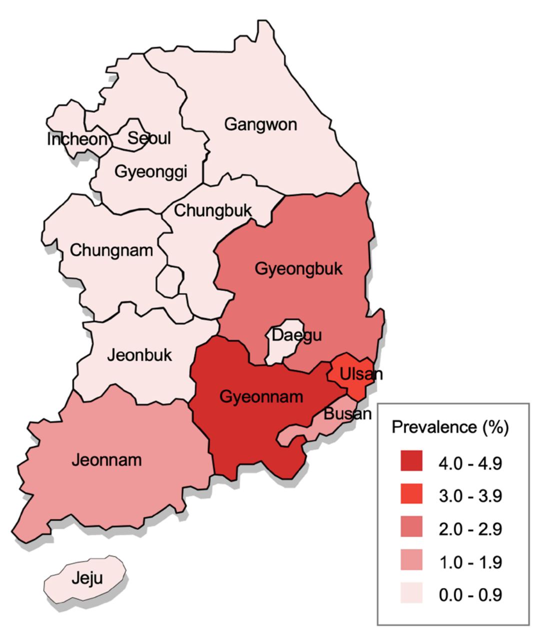

Fig. 2. Geographic variation in the overall prevalence of intestinal helminth infections among examinees from 2011 to 2020 in Korea. Gyeongnam (4.8%), Ulsan (3.1%), and Gyeongbuk (2.5%) exhibited a high mean prevalence.

Table 1. The overall prevalence of intestinal helminth infections among examinees at 16 branches of the Korea Association of Health Promotion over the 10 years from 2011 to 2020

No.	Branch	No. positive / No. examined (%)									
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Western Seoul	63/6,815 (1.0)	41/5,596 (0.7)	43/8,849 (0.5)	34/10,968 (0.3)	48/7,892 (0.6)	41/6,440 (0.6)	18/4,674 (0.4)	15/4,462 (0.3)	6/4,396 (0.1)	7/3,941 (0.2)
2	Eastern Seoul	48/5,641 (0.9)	47/3,937 (1.2)	39/5,745 (0.7)	19/5,512 (0.3)	17/6,736 (0.3)	16/3,546 (0.5)	14/5,508 (0.3)	21/6,113 (0.3)	11/6,929 (0.2)	1/1,956 (0.1)
3	Southern Seoul	-	17/2,633 (0.7)	23/6,115 (0.4)	16/7,493 (0.2)	13/6,381 (0.2)	6/4,587 (0.1)	6/4,197 (0.1)	8/3,976 (0.2)	6/4,937 (0.1)	4/4,693 (0.1)
4	Busan	463/16,345 (2.8)	272/17,247 (1.6)	761/38,407 (2.0)	830/37,733 (2.2)	735/41,225 (1.8)	994/49,467 (2.0)	865/49,047 (1.8)	741/41,817 (1.8)	545/44,264 (1.2)	440/43,745 (1.0)
5	Daegu	43/3,917 (1.1)	18/4,928 (0.4)	71/8,440 (0.8)	35/7,926 (0.4)	18/9,499 (0.2)	31/8,728 (0.4)	63/12,227 (0.5)	39/9,378 (0.4)	39/6,809 (0.6)	33/9,379 (0.4)
6	Incheon	14/3,229 (0.4)	5/2,092 (0.2)	15/3,854 (0.4)	7/3,257 (0.2)	0/2,566 (0.0)	8/2,355 (0.3)	29/3,086 (0.9)	30/2,522 (1.2)	22/2,098 (1.1)	22/3,259 (0.7)
7	Ulsan	128/2,888 (4.4)	304/7,275 (4.2)	544/12,940 (4.2)	660/14,400 (4.6)	523/15,207 (3.4)	269/10,923 (2.5)	203/11,339 (1.8)	190/7,251 (2.6)	107/7,280 (1.5)	51/3,477 (1.5)
8	Gyeonggi	41/3,210 (1.3)	25/2,859 (0.9)	65/6,319 (1.0)	76/7,527 (1.0)	35/7,540 (0.5)	28/5,716 (0.5)	17/7,106 (0.2)	20/5,257 (0.4)	11/3,673 (0.3)	7/3,270 (0.2)
9	Gangwon	0/436 (0.0)	0/434 (0.0)	0/1,106 (0.0)	0/770 (0.0)	0/718 (0.0)	0/270 (0.0)	3/469 (0.6)	2/1,195 (0.2)	0/2,023 (0.0)	0/1,729 (0.0)
10	Chungbuk	6/1,201 (0.5)	6/1,308 (0.5)	0/1,787 (0.0)	0/1,707 (0.0)	0/2,072 (0.0)	0/1,832 (0.0)	17/2,859 (0.6)	8/3,350 (0.2)	11/3,032 (0.4)	9/1,831 (0.5)
11	Chungnam	28/2,601 (1.1)	37/3,676 (1.0)	75/6,334 (1.2)	42/4,993 (0.8)	18/4,536 (0.4)	40/4,109 (1.0)	16/4,605 (0.4)	13/4,735 (0.3)	20/5,446 (0.4)	24/11,331 (0.2)
12	Jeonbuk	34/4,404 (0.8)	26/4,730 (0.6)	43/7,506 (0.6)	43/7,924 (0.5)	29/6,643 (0.4)	3/3,805 (0.1)	12/3,766 (0.3)	15/3,606 (0.4)	35/5,129 (0.7)	24/4,599 (0.5)
13	Jeonnam	62/3,876 (1.6)	86/3,009 (2.9)	99/5,996 (1.7)	143/6,742 (2.1)	77/5,897 (1.3)	89/5,294 (1.7)	78/5,762 (1.4)	97/5,563 (1.7)	84/6,964 (1.2)	90/7,503 (1.2)
14	Gyeongbuk	63/1,205 (5.2)	69/1,445 (4.8)	321/11,111 (2.9)	241/9,571 (2.5)	136/8,743 (1.6)	130/6,428 (2.0)	113/7,315 (1.5)	121/6,508 (1.9)	103/6,770 (1.5)	37/5,252 (0.7)
15	Gyeongnam	373/7,226 (5.2)	464/8,080 (5.7)	758/14,123 (5.4)	945/15,890 (6.0)	811/16,635 (4.9)	750/14,909 (5.0)	676/15,056 (4.5)	711/14,721 (4.8)	782/20,119 (3.9)	538/20,819 (2.6)
16	Jeju	0/450 (0.0)	1/1,435 (0.1)	0/1,537 (0.0)	0/1,615 (0.0)	0/1,659 (0.0)	0/1,896 (0.0)	0/2,156 (0.0)	0/1,173 (0.0)	0/826 (0.0)	0/944 (0.0)
	Total	1,366/63,444 (2.2)	1,418/70,684 (2.0)	2,857/140,169 (2.0)	3,091/144,028 (2.2)	2,460/143,949 (1.7)	2,405/130,305 (1.9)	2,130/139,172 (1.5)	2,031/121,627 (1.7)	1,782/130,695 (1.4)	1287/127,728 (1.0)

Discussion

The prevalence of intestinal helminth infections among 1,211,799 examinees across the country has gradually decreased over the past 10 years. The average prevalence of overall intestinal helminth infections was 2.2% in 2011, which decreased yearly to 1.0% by 2020. During this period, the highest average infection rate was observed in Gyeongnam (4.8%), followed by Ulsan (3.1%) and Gyeongbuk (2.5%). By contrast, Gangwon had the lowest infection rate (0.1%). This difference can be attributed to various regional factors, including the distribution of infectious agents and the residents' dietary habits.

A recent study showed that the overall characteristics of parasitic infections were similar to those caused by liver and intestinal flukes transmitted from freshwater fish [4,5]. The study also found that the prevalence of these infections was higher in older age groups, among men than among women, and in areas with major rivers in the southern part of the country, which are known to be endemic for freshwater fish-borne parasites, such as Gyeongbuk and Gyeongnam [4]. The high proportions of *C. sinensis* and *M. yokogawai* infections among all helminth species are believed to be responsible for this. Studies have shown that the prevalence of clonorchiasis follows a typical pattern, with peaks in the age groups of 40 to 49 and 50 to 59 years [4]. The higher prevalence of liver fluke infection in men than in women may be attributed to the more frequent consumption of raw freshwater fish and engagement in fishing activities, which are more common among men [4,5]. This study confirmed that the southern regions, known as the main endemic areas for liver flukes, had the highest infection rates [4,5].

Accurate diagnostic tools are crucial for identifying parasite-infected individuals, assessing the prevalence of endemic diseases, and monitoring anthelmintic drug efficacy and responses to interventions, including development [7]. Kato's method and the Kato–Katz method are commonly used to diagnose intestinal helminth infections in fecal samples. Kato's method, known as the thick-smear technique by Kato and Miura, was introduced for examining fecal samples to obtain qualitative information about the presence of helminth infections. The Kato–Katz method with a standardized amount of fecal material, was modified and adapted from Kato's method for quantitative and qualitative assessment of the prevalence of endemic diseases in survey fields [8-10]. The World Health Organization adopted the Kato–Katz method as the gold standard for the diagnosis and quantification of intestinal helminths infections in epidemiological studies and control programs. Garcia et al. [11] observed that the Kato–Katz method was more sensitive than Kato's method for diagnosing helminths. Martin and Beaver [12] concluded that the Kato thick-smear technique is reliable and practical for the quantitative analysis of hookworm, *T. trichiura*, and *Schistosoma* infections. However, the Kato–Katz method has certain limitations, especially when the prevalence of soil-transmitted helminth infections is less than 20% or when infection intensities are low, as in Korea [9]. The ether concentration method, a useful alternative to the Kato–Katz method, can detect soil-transmitted helminth eggs in fixed stool samples [7]. Using a single stool sample, the formalin-ether concentration method is almost as effective as the Kato–Katz method, which uses two to three stool samples to diagnose soil-transmitted helminth infections [9].

The prevalence of intestinal helminth infections can vary depending on the examination method used. In the current study, we used Kato's method for stool examination in health examination centers, and we considered that this method has certain limitations. As the intensity of infection in Korea is low, the prevalence rate obtained using Kato's method is expected to be slightly lower than the actual rate of intestinal helminth infections. Therefore, the results must be interpreted with consideration of the limitations of the methods used.

In 2012, a national survey of intestinal parasites was conducted in Korea [6]. The results showed that infections caused by soil-transmitted parasites, such as roundworms and hookworms, decreased significantly. However, foodborne parasites, such as liver and intestinal flukes, which are transmitted through freshwater fish, continue to maintain high levels of infection in endemic areas [6]. The Vector Analysis Division of the Korea Centers for Disease Control and Prevention has continuously conducted parasite control projects among residents of areas endemic for liver and intestinal fluke infections. However, there is insufficient data to understand the recent nationwide infection status of intestinal helminths.

In this study, we conducted a retrospective analysis of a comprehensive survey on the prevalence of intestinal parasites among examinees of KAHP regional branches from 2011 to 2020. These results provide valuable information regarding the prevalence of intestinal helminth infections in the Korean population. Additionally, this study offers insights into the epidemiological characteristics of parasites and their impact on human health. This information will aid future research and assist in the development of effective prevention and control strategies.

Ethics statement

The study was approved by the Institutional Review Board of the Korea Association of Health Promotion (No. 2022-HR-009).

Conflict of interest

No potential conflicts of interest relevant to this article were reported.

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