



# Prevalence of *Clonorchis sinensis* Infection among Residents along 5 Major Rivers in the Republic of Korea

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**Abstract:** *Clonorchis sinensis* is currently the most important parasite affecting public health problems in the Republic of Korea. We investigated the prevalence of *C. sinensis* infection among residents living along 5 major rivers in Korea. A total of 42,562 individual stool samples were collected from 37 localities and examined using the formalin-ether sedimentation technique. Helminth eggs were detected in 4,052 (9.5%) residents and 3,586 (8.4%) were infected with *C. sinensis*. The egg positive rate of *C. sinensis* in Nakdong, Seomjin, Geum, Yeongsan, and Han River was 11.7%, 9.9%, 6.5%, 3.1%, and 1.0%, respectively. The overall prevalence of clonorchiasis by sex was 11.2% in males and 6.2% in females. The age-prevalence was the highest in the 50-59 years band. It has been reconfirmed that the endemicity of clonorchiasis is higher in southern areas of Korea, especially along Nakdong and Seomjin Rivers. A combination of continuous control programs with health education initiatives is urgently required in these highly endemic areas of clonorchiasis in Korea.

**Key words:** *Clonorchis sinensis*, clonorchiasis, prevalence, riverside resident, 5 major rivers, Korea

Until the 1970s in the Republic of Korea (Korea), parasitic infections with soil-transmitted intestinal nematodes, such as *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, were highly prevalent [1,2]. Since 1971, nationwide surveys have been conducted every 5-7 years in order to estimate the infection status of intestinal helminth parasites until 2004 [3]. In the first 1971 survey, the overall prevalence was 84.3%, and by 2004, the rate had dramatically decreased to 3.7%. The rapid decrease in the overall prevalence of intestinal parasites over the past several decades has been attributed mainly to nationwide control programs and health education initiatives undertaken by the Korean government along with improvements in the living conditions and quality of life in Korea [4]. Despite the remarkable decrease of soil-transmitted nematode infections, the prevalence of fish-borne trematode infections such as clonorchiasis and metagonimiasis has still remained to be relatively high [5].

The liver fluke, *C. sinensis*, is the most important helminth in Korea these days, and clonorchiasis has been known as the

cause of biliary pathogenesis, i.e., inflammation, dilatation, wall thickening, mucosal hyperplasia, liver cirrhosis, and even cholangiocarcinoma [6-8]. Among human diseases caused by parasites, clonorchiasis is ranked at the first due to its social, economic, and public health impacts in Korea. Clonorchiasis is endemic in most of the major river basins of Korea [9]. In 1981, the egg positive rates of people living in those river basins differed considerably; 40.2% in Nakdong River, 30.8% in Yeongsan River, 17.3% in Seomjin River, 15.7% in Han River, 15.9% in Tamjin River, and 12.0% in Geum River [10]. However, in 2007, the positive rates of *C. sinensis* in Nakdong, Seomjin, Yeongsan, Geum, and Han Rivers were 12.2%, 9.5%, 3.3%, 3.0%, and 1.0%, respectively [11]. Although the infection rates of *C. sinensis* in these major rivers decreased considerably over the past 20 years, clonorchiasis continues to persist and is currently considered as the most important helminthiasis in Korea.

In this study, we investigated the infection status of populations identified to be at risk of clonorchiasis, notably among residents living along 5 major rivers. The surveyed areas consisted of 37 counties, which are located in the vicinity of the Han, Geum, Yeongsan, Seomjin, and Nakdong Rivers, Korea. A total of 42,562 fecal specimens were collected from residents of these regions using a random household sampling method from February to November 2008 (Fig. 1). Stool specimens in

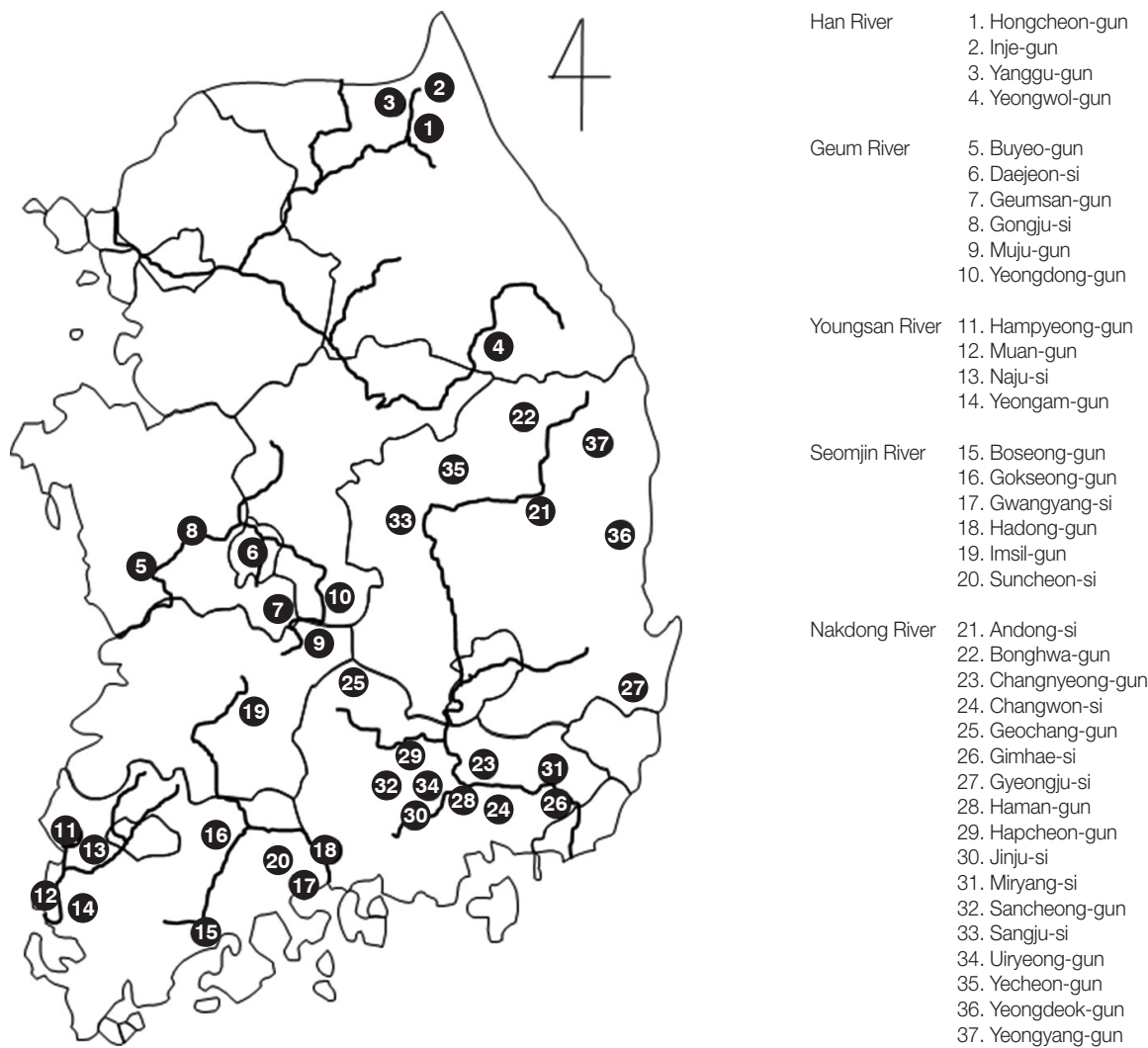
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**Fig. 1.** Surveyed areas along 5 major rivers, the Republic of Korea.

**Table 1.** Positive rates of parasite eggs by fecal examination in residents along 5 major rivers

Parasite species	No. positive cases (%)
Overall intestinal parasites	4,052 (9.5)
<b>Helminths</b>	
<i>Clonorchis sinensis</i>	3,586 (8.4)
<i>Metagonimus</i> spp.	411 (1.0)
<i>Trichuris trichiura</i>	63 (0.1)
<i>Echinostoma</i> spp.	12 (0.03)
Hookworm	5 (0.01)
<i>Ascaris lumbricoides</i>	4 (0.01)
<i>Gymnophalloides seoi</i>	4 (0.01)
<i>Strongyloides stercoralis</i>	4 (0.01)
<i>Trichostrongylus orientalis</i>	1 (0.002)
<i>Diphyllobothrium</i> sp.	1 (0.002)
<b>Co-infection</b>	
<i>C. sinensis</i> + <i>Metagonimus</i> spp.	78 (0.18)
<i>C. sinensis</i> + <i>Echinostoma</i> spp.	7 (0.02)
<i>C. sinensis</i> + <i>T. trichiura</i>	5 (0.01)

plastic containers (1/person) collected in individual survey areas were transferred to the laboratory of National Institute of Health, and then examined by means of the formalin-ether sedimentation technique. Microscopic examinations were performed twice by well-trained technicians. The egg positive rate was estimated by arithmetic means. The egg positive individuals were treated with either praziquantel or other appropriate anti-parasitic drugs at the end of the study.

More than 10 species of helminth eggs were detected in 4,052 (9.5%) stool samples (Table 1). Eggs of *C. sinensis* were found in 3,586 (8.4%) fecal specimens of residents. The prevalence of clonorchiasis was highest in residents of Nakdong River (11.7%), followed by Seomjin River (9.9%), Geum River (6.5%), Yeongsan River (3.1%), and Han River (1.0%). Especially, Gyeongju-si (city) had the highest rate of 25.9%, fol-

**Table 2.** Prevalence of overall intestinal parasites and *C. sinensis* according to localities and river basins

River basins	Locality	No. of examination	No. of positive (%)	No. of cumulative positive (%)	<i>C. sinensis</i> (%)
Han river	Hongcheon-gun	1,016	22 (2.2)	22 (2.2)	16 (1.6)
	Inje-gun	1,265	15 (1.2)	15 (1.2)	8 (0.6)
	Yanggu-gun	1,025	9 (0.9)	9 (0.9)	4 (0.4)
	Yeongwol-gun	1,349	35 (2.6)	37 (2.7)	19 (1.4)
	Subtotal	4,655	81 (1.7)	83 (1.8)	47 (1.0)
Geum river	Buyeo-gun	1,433	47 (3.3)	47 (3.3)	40 (2.8)
	Daejeon-si	1,075	42 (3.9)	42 (3.9)	40 (3.7)
	Geumsan-gun	1,209	61 (5.0)	62 (5.1)	53 (4.4)
	Gongju-si	1,016	48 (4.7)	48 (4.7)	47 (4.6)
	Muju-gun	1,708	204 (11.9)	208 (12.2)	190 (11.1)
	Yeongdong-gun	287	74 (25.8)	78 (27.2)	68 (23.7)
	Subtotal	6,728	476 (7.1)	485 (7.2)	438 (6.5)
Yeongsan river	Hampyeong-gun	1,144	47 (4.1)	52 (4.5)	29 (2.5)
	Muan-gun	1,267	83 (6.6)	83 (6.6)	32 (2.5)
	Naju-si	1,271	54 (4.2)	54 (4.2)	45 (3.5)
	Yeongam-gun	1,041	48 (4.6)	48 (4.6)	40 (3.8)
	Subtotal	4,723	232 (4.9)	237 (5.0)	146 (3.1)
Seomjin river	Boseong-gun	1,200	141 (11.8)	148 (12.3)	123 (10.3)
	Gokseong-gun	1,650	169 (10.2)	178 (10.8)	137 (8.3)
	Gwangyang-si	1,394	148 (10.6)	149 (10.7)	86 (6.2)
	Hadong-gun	1,065	281 (26.4)	306 (28.7)	233 (21.9)
	Imsil-gun	1,074	66 (6.1)	68 (6.3)	57 (5.3)
	Suncheon-si	1,162	136 (11.7)	144 (12.4)	112 (9.6)
	Subtotal	7,545	941 (12.5)	993 (13.2)	748 (9.9)
Nakdong river	Andong-si	1,932	258 (13.4)	261 (13.5)	242 (12.5)
	Bonghwa-gun	936	20 (2.1)	20 (2.1)	16 (1.7)
	Changnyeong-gun	1,044	147 (14.1)	149 (14.3)	141 (13.5)
	Changwon-si	851	58 (6.8)	58 (6.8)	56 (6.6)
	Geochang-gun	1,256	63 (5.0)	64 (5.1)	61 (4.9)
	Gimhae-si	184	6 (3.3)	6 (3.3)	6 (3.3)
	Gyeongju-si	710	185 (26.1)	185 (26.1)	184 (25.9)
	Haman-gun	1,142	121 (10.6)	122 (10.7)	111 (9.7)
	Hapcheon-gun	1,142	184 (16.1)	189 (16.5)	180 (15.8)
	Jinju-si	1,020	137 (13.4)	140 (13.7)	134 (13.1)
	Miryang-si	1,603	291 (18.2)	294 (18.3)	268 (16.7)
	Sancheong-gun	1,365	226 (16.6)	228 (16.7)	222 (16.3)
	Sangju-si	1,067	91 (8.5)	92 (8.6)	86 (8.1)
	Uiryeong-gun	955	115 (12.0)	115 (12.0)	112 (11.7)
	Yecheon-gun	1,314	152 (11.6)	152 (11.6)	151 (11.5)
	Yeongdeok-gun	1,253	154 (12.3)	162 (12.9)	125 (10.0)
Yeongyang-gun	1,137	114 (10.0)	114 (10.0)	112 (9.9)	
Subtotal	18,911	2,322 (12.3)	2,351 (12.4)	2,207 (11.7)	
Total		42,562	4,052 (9.5)	4,149 (9.7)	3,586 (8.4)

**Table 3.** Positive rate of *C. sinensis* according to gender and river basins

River basins	No. of positive / No. examined (%)		
	Male	Female	Total
Han river	32/2,518 (1.3)	15/2,137 (0.7)	47/4,655 (1.0)
Geum river	307/3,076 (10.0)	131/3,628 (3.6)	438/6,728 (6.5)
Yeongsan river	84/1,915 (4.4)	62/2,808 (2.2)	146/4,723 (3.1)
Seomjin river	422/3,221 (13.1)	326/4,324 (7.5)	748/7,545 (9.9)
Nakdong river	1,306/8,555 (15.3)	901/10,327 (8.7)	2,207/18,911 (11.7)
Total	2,151/19,285 (11.2)	1,435/23,224 (6.2)	3,586/42,562 (8.4)

lowed by Hadong-gun of 21.9%, which were located in the mid- or downstream of Nakdong and Seomjin Rivers, respec-

tively. Egg positive rates by surveyed areas are shown in Table 2.

The overall prevalence of clonorchiasis by sex was 11.2% in

**Table 4.** Prevalence of *C. sinensis* eggs according to age groups and river basins

River basins	No. of positive / No. of examined (%)								
	Total	1-19	20-29	30-39	40-49	50-59	60-69	70-79	80-
Han river	47/4,655 (1.0)	1/242 (0.4)	7/719 (1.0)	3/327 (0.9)	11/652 (1.7)	17/965 (1.8)	4/917 (0.4)	4/706 (0.6)	0/115 (0.0)
Geum river	438/6,728 (6.5)	2/302 (0.7)	5/163 (3.1)	7/342 (2.0)	48/738 (6.5)	127/1,330 (9.5)	122/1,746 (7.0)	107/1,638 (6.5)	15/390 (3.8)
Yeongsan river	146/4,723 (3.1)	0/56 (0.0)	0/56 (0.0)	3/103 (2.9)	18/378 (4.8)	37/893 (4.1)	48/1,531 (3.1)	35/1,428 (2.5)	4/261 (1.5)
Seomjin river	748/7,545 (9.9)	6/225 (2.7)	11/116 (9.5)	29/276 (10.5)	77/642 (12.0)	152/1,097 (13.9)	203/2,073 (9.8)	187/2,265 (8.3)	34/626 (5.4)
Nakdong river	2,207/18,911 (11.7)	3/377 (0.8)	6/235 (2.6)	49/558 (8.8)	224/1,815 (12.3)	534/3,773 (14.2)	666/5,523 (12.1)	517/4,880 (10.6)	69/938 (7.4)
Total	3,586/42,562 (8.4)	12/1,202 (1.0)	29/1,289 (2.2)	91/1,606 (5.7)	378/4,225 (8.9)	867/8,058 (10.8)	1,043/11,790 (8.8)	850/10,917 (7.8)	122/2,330 (5.2)

males and 6.2% in females (Table 3). The egg positive rate by age group was highest in the 50-59 age band, followed by the forties (8.9%), sixties (8.8%), seventies (7.8%), thirties (5.7%), over 80 (5.2%), twenties (2.2%), and below 19 (1.0%) (Table 4).

The present study provided the prevalence of *C. sinensis* infection among residents living along 5 major rivers of Korea and confirmed the high endemicity of *C. sinensis* infection in southern localities. Although the prevalence of clonorchiasis along the major rivers appears to decline over the past decade, we identified that Nakdong and Seomjin Rivers are still highly endemic regions in common with previous studies; a national survey undertaken in 1981 reported that the egg positive rates of people living along these major river basins were 40.2% in Nakdong River, 30.8% in Yeongsan River, 17.3% in Seomjin River, 15.7% in Han River, 15.9% in Tamjin River, and 12.0% in Geum River [10]. Also, in 2006, the egg positive rates of *C. sinensis* observed in the river basins of Nakdong, Seomjin, Yeongsan, and Geum were 17.1%, 11.2%, 5.5%, and 4.6%, respectively [9]. In addition, our results showed that the positive rates of overall intestinal parasites and *C. sinensis* in residents along 5 major rivers was 9.5% and 8.4%, respectively. The 9.5% prevalence of overall intestinal parasites is 2-fold higher than the national intestinal helminth prevalence of 3.7% in 2004 [3].

The infection status of *C. sinensis* according to age groups appears to be a typical pattern for *C. sinensis* infection, reaching a peak at the age groups of 40-49 and 50-59 years. These results suggest that the eating habit of raw fishes containing *C. sinensis* metacercariae is a deeply rooted traditional custom

among residents living in rural and riverside areas. As well, the higher prevalence in males than in females may be caused by frequent alcohol consumption and raw freshwater fish intake with increasing activities such as fishing that are mostly carried out by men.

While not conceptually new, our results provided the basic data and important information regarding the prevalence of clonorchiasis in high risk regions in Korea and are valuable for providing control strategies and medication of clonorchiasis patients in these areas.

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## CONFLICT OF INTEREST

We have no conflict of interest related to this work.

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