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# Prevalence and Related Factors of Clonorchiasis among Five Major Riverside Residents in South Korea

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**Purpose:** This study attempted to investigate the prevalence and related factors of Clonorchiasis among five major riverside residents in South Korea. **Methods:** This study is descriptive research, nationwide survey, and the subjects are 23,492 residents selected by convenience sampling. Data collection was conducted between March 1 and June 30, 2011, and stool collection and questionnaire survey were conducted by affiliated public health centers in 38 cities and Gun's. **Results:** The prevalence rates of Clonorchiasis in the five major riversides were as follows: the Guem River 15.2%; the Nakdong River 11.9%; the Seomjin River 10.9%; the Han River 5.7%; and the Yeongsan River 3.9%. The prevalence rates were shown to be significantly high among people who had highly frequent experiences of eating and cooking freshwater raw fish, were diagnosed with liver and/or biliary tract diseases, and drank less than once a month. **Conclusion:** These results suggest that it is necessary to improve awareness of Clonorchiasis and provide intensive public health education for the riverside residents. And the target groups should be set up by reflecting the characteristics of at-risk groups, and it is necessary to prepare customized strategies for prevention and management of Clonorchiasis.

**Key Words:** Clonorchis sinensis, Parasite, Prevalence, Parasite egg count, Health behavior

## INTRODUCTION

As a result of the survey on the incidence of intestinal parasites conducted regularly in the whole country since 1971, the infection rate of intestinal parasites in Korea has a tendency to decrease. Among them, soil-transmitted rotifers and nematodes such as amphibians, hookworm, and Trichuris, which occupied a large proportion in the infestation of the intestinal parasites, showed a drastic decrease and reached a level that no longer needs to be controlled.

In contrast, from the results of the 7$^{th}$ nation wide parasite infestation survey conducted in 2004, Clonorchis sinensis and Metagenesis yokogawai infected by shellfish or fish mediation had a higher positive rate of parasite eggs than other parasitic infections, showing the highest infection rate among the rotifer infections diagnosed by stool test. Especially in the case of Clonorchis sinensis, the results of the 5$^{th}$ and 6$^{th}$ surveys were 2.2% and 1.4% respectively, and in the 7$^{th}$ survey, it has been increasing again to 2.9%[1], which demands active management and research on Clonorchis sinensis.

Clonorchis sinensis that is an endemic disease [2] widely distributed in Korea, Japan, China, Taiwan, eastern Russia and northern Vietnam, etc. mainly subsist in peripheral bile duct, gallbladder or pancreatic duct, etc. and long-lasting can cause complications such as bile duct stones, recurrent pyogenic cholangitis, bile duct abscess, bile duct stenosis and bile duct cancer [3,4].

Clonorchis sinensis differs from other intestinal parasites in that it has a characteristic distribution in local epidemic areas. That is, there are rivers in which first and sec-

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ond intermediate hosts can live, and stools of those human beings and animals infected with Clonorchis sinensis around rivers flow into the living environment where it occurs frequently. Therefore, in the national epidemiological survey of Clonorchis sinensis, it can be concluded that the survey area includes villages with rivers vulnerable to the prevalence of Clonorchis sinensis, and whether the freshwater fish eating uncooked of residents have a major influence on the parasite egg positive rate [1].

As well shown in previous studies with regard to the results reflecting these characteristics, Rim [5] pointed out that the infection rates of residents in the river basins such as Nakdong River, Yeongsan River, Seomjin River, and Geum River are very high. In particular, the rate of Clonorchis sinensis infection in the residents of the five rivers is very high at 11.3%, compared with the national average of 2.9%[6]. The reason is reported to be that most of the river basin population is not aware of the risk of Clonorchis sinensis infection and that the freshwater fish eating raw habits have been incorporated into local culture [5,7,8]. This has an important meaning in terms of public health. As a matter of fact, the incidence of cholangiocarcinoma in areas with high rates of Clonorchis sinensis infection is high [9], as a result of analysis of regional mortality rate difference due to liver cancer, in addition to high mortality rates in Gyeongsangnam-do and Jeollanam-do [10], the mortality rate of liver cancer in the Nakdong River and Yeongsan River basins, where freshwater fish eating raw is high, were found to be significantly higher in statistics [10]. Therefore, there is a need to raise awareness of the effect of Clonorchiasis on public health.

However, the epidemiological characteristics of Clonorchiasis are mutually influencing factors at the individual level, at the collective and community level [11], especially with regard to personal characteristics related to high frequency drinking and smoking with freshwater fish eating raw habits [6,12-14], and it is urgent that countermeasures against still existing duplicate infections and re-infections are needed because people with previous experience of Clonorchis sinensis infection and treatment have adhered to freshwater fish eating raw habits [15].

There is still a culture of enjoying freshwater fish eating raw in some communities of riverside, the residents' lack of knowledge of Clonorchis sinensis, and collective blindness to the treatment of local residents who think they can be treated even if they become infected, all of which eventually increase the infection risk. Thus, to eradicate Clonorchiasis, it is suggested that collective efforts must be made [11], including governments, professionals and the community.

On the subjects of the residents of the riverside centered on the five major river basins raised as the risk area, this study identified the overall infection status and reaffirmed the risk area by analyzing the factors affecting the Clonorchiasis infection. And this study was conducted to provide basic data for systematic implementation of Clonorchiasis prevention and treatment projects.

## METHODS

### 1. Research Design

This study is a descriptive research to identify the actual condition of Clonorchis sinensis infection in the residents of the five rivers and to identify the related factors affecting them.

### 2. Research Subjects

Through convenience sampling, the subjects of this study were selected from among residents of 38 cities and county public health centers near the five major rivers (Geum River, Nakdong River, Seomjin River, Han River, Yeongsan River) with high Clonorchis sinensis positive rate. The criteria for the selection of the subjects were communicable, agreed on the purpose of the study with a written consent, and a total of 23,514 subjects participated in the study. There were 23,514 participants in the primary parasite egg stool examination, but 22 of them answered unfairly and the rest 23,492 of them were included in the final analysis. When the significance level was .05, the effect size was medium (.3), and the power was kept at .95, the G*Power 3.0 program was used to determine the appropriate sample size for the $x^2$ analysis. A sufficient number of specimens were obtained for statistical analysis, and the number of samples required for $x^2$ analysis was confirmed to be 220 people from the result of using the G* Power 3.0 program.

### 3. Research Tools

**1) Demographic, behavioral and Clonorchis sinensis infection related factors**

This study used a total of 10 questionnaires including the subjects' demographic factors of gender and age, behavioral factor of drinking frequency, factors related to Clonorchis sinensis infection such as freshwater fish eating raw and eating raw frequency, freshwater fish cooking experience, experience of diagnosis of liver biliary tract disease of the patient and family, positive rate experience

of Clonorchis sinensis, and medication treatment for Clonorchis sinensis

**2) Parasite egg stool examination**

As for parasite egg stool examination, this study used Formalin-Ether Sedimentation Technique, a test technique with the highest detection rate of Clonorchis sinensis eggs. Centers for Disease Control & Prevention conducted the examinations in order to reduce the error range due to the examinations between the research target areas. The procedure of the standardized examination method is, first, 1~5 g of feces was mixed well with 10ml of distilled water, the mixture was gauzed and centrifuged at 1,500 rpm for two minutes, and 10% formalin was added to the clarified solution after centrifuging followed by adding 2~3 mL of ether and shaking vigorously. Next, the mixture was separated again at 1,500~2,000 rpm for 5 minutes to remove the organics and ether supernatants, the precipitates were placed on a slide, and the presence or absence of parasitic eggs was examined by microscopy at 200~400 times.

### 4. Data Collection

The data source used in this study is the raw data of the academic research service project [16] conducted by Centers for Disease Control & Prevention in 2011. Data collection was conducted from March 1 to June 30, 2011, and for accurate and smooth data collection, the first step was to conduct training for practitioners of 38 city-county public health centers on the methods of collecting stools and surveying the questionnaires. A questionnaire survey on Clonorchiasis related factors was conducted for the subjects by a local health care specialist through direct interviews in person. Samples for parasite egg examination were directly delivered from pertinent cities and counties, and diagnostic tests were performed by Centers for Disease Control & Prevention.

Before the questionnaire was distributed in consideration of the ethical aspect, the research purpose and the process of the research were explained in detail, and the participants were informed that they could voluntarily participate in the study without any compulsion. And they were informed that they could be ensured with anonymity and withdrawn at any time during the study, and that the contents of the questionnaire would not be used except for the purposes of this study. After the explanations were completed, the subjects who agreed to participate in the study completed the written consent and explained that the questionnaire was discarded after collecting and statistical analysis in order to protect the personal information of the participants.

### 5. Data Analysis

The collected data were analyzed using SPSS/WIN 20.0 program. Clonorchis sinensis infection was classified as positive and negative by using the results of parasite egg stool examination. The general characteristics of the subjects, Clonorchis sinensis related factors were analyzed by frequency and percentage, and the difference of Clonorchis sinensis positive rate according to related factors was analyzed by $x^2$ test or Fisher's exact test. Data analys is did not include non-respondents by item. Statistical significance was defined as less than .05.

## RESULTS

### 1. Demographic, Behavioral and Clonorchis Sinensis Infection Related Factors of the Subjects

The demographic, behavioral, and Clonorchis sinensis infection related factors of the subjects are shown in Table 1. Among the subjects, 57.0%(13,376 persons) were female and 43.0%(10,409 persons) were male, and by age, 39.0%(9,172 persons) were over 70 years old, 29.3%(6,887 persons) 60~69 years, 19.8%(4,644 persons) 50~59 years old, 11.9%(2,788 persons) under the age of 50 years old. Among the clonorchiasis related factors, 34.7%(7,958 persons) had the eating raw experience of freshwater fish, and the eating raw frequency was 58.7%(4,246 persons) 1~3 times in 6 months, and 13.8% 1~3 times in a month (998 persons). 36.3%(8,298 persons) had experience of cooking freshwater fish, 4.8%(1.096 persons) were diagnosed with liver-biliary disease and 3.5%(800 persons) were diagnosed with family history. Of the subjects, 11.6%(2,609 persons) were positive for Clonorchis sinensis, and 91.2%(2,145 persons) responded that they took Clonorchis sinensis medication. Drinking frequency was 20.5%(4,815 persons) drinking 1~4 times a month, 15.3%(3,681 persons) drinking more than twice a week, and 8.1%(1,904 persons) less than once a month. And 52.1%(12,240 persons) did not drink alcohol.

The residential distribution of the subjects in the 5 major river basins showed that 3,831 persons were in Geum River, 10,095 persons in Nakdong River, 5,810 persons in Seomjin River, 2,462 persons in Yeongsan River, and 1,294 persons in Han River. The experience of freshwater fish eating raw was 40.7% in Nakdong River basin, which was the highest, and then Han River (37.8%), Geumgang (34.5%), Seomjin River (29.5%), and Yeongsan River (21.0%) in that order. The frequency of freshwater fish eating raw is about once a

week, followed by Seomjin River (2.1%), Nakdong River (1.8%), Geumgang (0.8%), Yeongsan River (0.7%) and Han River (0.6%) in that order, 1~3 times a month followed by Nakdong River (15.0%), Han River (13.4%), Seomjin River (13.3%), Geum River (12.0%) and Yeongsan River (10.4%) in that order, which shows the Nakdong River basin was ranked high in all frequencies. Geum River (42.3%) and Yeongsan River (41.6%) were slightly higher than other river basins when they had freshwater fish cooking experience. Seomjin River (6.4%) was the highest with the person's experience of suffering from liver biliary diseases, and Nakdong River (4.0%) was high with the family member's experience of suffering from liver biliary diseases. Seomjin River (16.7%) was the highest with the past experience of Clonorchis sinensis positive followed by Yeongsan River (11.4 %), Nakdong River (10.4%), Geum River (9.3%) and Han River (3.9%) in that order. In the case of taking Clonorchis sinensis remedy, Seomjin River (89.1%) was the lowest and Yeongsan River (95.1%) and Han River (95.1%) were high. The frequency of frequent alcohol drinking more than twice a week was highest in the Nakdong River (18.5%), and Yeongsan River (12.6%) was low. However, In the case of drinking no alcohol, Yeongsan River (59.9%) was the highest.

**Table 1.** The Characteristics of Subjects according to Demographic, Behavioral and *C. sinensis* Infection†

| Characteristic | Categories | Total (*N*=23,492) | Guem-gang (n=3,831) | Nakdong-gang (n=10,095) | Seomjin-gang (n=5,810) | Yeongsan-gang (n=2,462) | Han-gang (n=1,294) |
|---|---|---|---|---|---|---|---|
| | | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| Gender | Male | 10,409 (43.0) | 1,409 (36.8) | 4,508 (44.5) | 2,560 (44.1) | 1,052 (42.7) | 584 (45.2) |
| | Female | 13,376 (57.0) | 2,422 (63.2) | 5,587 (55.2) | 3,250 (55.9) | 1,410 (57.3) | 709 (54.8) |
| Age (y) | ≤49 | 2,788 (11.9) | 159 (4.1) | 382 (3.8) | 251 (4.3) | 105 (4.3) | 39 (3.0) |
| | 50~59 | 4,644 (19.8) | 264 (6.9) | 851 (8.4) | 481 (8.3) | 162 (6.5) | 98 (7.9) |
| | 60~69 | 6,887 (29.3) | 709 (18.5) | 2,220 (22.0) | 1,031 (17.7) | 423 (17.2) | 261 (19.8) |
| | ≥70 | 9,172 (39.0) | 2,699 (70.5) | 6,642 (65.8) | 4,047 (69.7) | 1,772 (72.0) | 896 (68.3) |
| Raw freshwater fish consumption | Never | 14,991 (65.3) | 2,475 (65.5) | 5,800 (59.3) | 4,107 (70.5) | 1,925 (79.0) | 739 (62.2) |
| | Yes | 7,958 (34.7) | 1,306 (34.5) | 3,989 (40.7) | 1,703 (29.5) | 511 (21.0) | 449 (37.8) |
| Frequency of raw freshwater fish consumption | 1/wk | 113 (1.5) | 10 (0.8) | 66 (1.8) | 31 (2.1) | 3 (0.7) | 3 (0.6) |
| | 1~3/mo | 998 (13.8) | 141 (12.0) | 564 (15.0) | 195 (13.3) | 45 (10.4) | 55 (13.4) |
| | 1~3/6 mo | 4,246 (58.7) | 701 (59.5) | 2,279 (60.8) | 746 (50.9) | 267 (61.6) | 253 (61.3) |
| | 1/yr | 1,876 (25.9) | 327 (27.7) | 835 (22.3) | 494 (33.7) | 118 (27.3) | 102 (24.7) |
| Cooking of raw freshwater fish | Never | 14,547 (63.7) | 2,160 (57.6) | 6,415 (65.8) | 3,825 (66.2) | 1,418 (58.4) | 751 (63.8) |
| | Yes | 8,298 (36.3) | 1,586 (42.3) | 3,325 (34.1) | 1,949 (33.8) | 1,011 (41.6) | 427 (36.2) |
| Past history of disease of the liver and biliary tract (subject) | Never | 21,632 (95.2) | 3,581 (96.1) | 9,240 (95.2) | 5,386 (93.6) | 2,306 (96.5) | 1,139 (96.9) |
| | Yes | 1,096 (4.8) | 147 (3.9) | 464 (4.8) | 368 (6.4) | 83 (3.5) | 36 (3.1) |
| Past history of disease of the liver and biliary tract (family) | Never | 21,980 (96.5) | 3,656 (97.5) | 9,323 (96.0) | 5,536 (96.1) | 2,315 (97.2) | 1,150 (97.5) |
| | Yes | 800 (3.5) | 93 (2.5) | 388 (4.0) | 223 (3.9) | 66 (2.8) | 30 (2.5) |
| Past history of *C. sinensis* infection | Never | 19,894 (88.4) | 3,358 (90.7) | 8,571 (89.6) | 4,792 (83.3) | 2,072 (88.6) | 1,121 (96.1) |
| | Yes | 2,609 (11.6) | 345 (9.3) | 995 (10.4) | 959 (16.7) | 266 (11.4) | 45 (3.9) |
| Past history of taking medicine because of *C. sinensis* infection | Yes | 2,145 (91.2) | 292 (92.7) | 837 (90.1) | 769 (89.1) | 217 (95.1) | 39 (95.1) |
| | Never | 118 (5.0) | 13 (4.1) | 36 (3.9) | 68 (7.9) | 7 (3.1) | 1 (2.4) |
| | Unaware | 90 (3.8) | 10 (3.2) | 55 (6.0) | 26 (3.0) | 4 (1.8) | 1 (2.4) |
| Alcohol drinking | Never | 12,240 (52.1) | 2,081 (56.1) | 5,145 (53.2) | 3,035 (52.7) | 1,417 (59.9) | 589 (50.3) |
| | ≤1/mo | 1,904 (8.1) | 292 (7.9) | 682 (7.1) | 613 (10.7) | 230 (9.7) | 89 (7.6) |
| | 1~4/mo | 4,815 (20.5) | 846 (22.8) | 2,050 (21.2) | 1,202 (20.9) | 419 (17.8) | 297 (25.3) |
| | ≥2/wk | 3,681 (15.3) | 493 (13.2) | 1,791 (18.5) | 905 (15.7) | 298 (12.6) | 196 (16.8) |

† *C. sinensis* infection=Clonorchis sinensis infection.

## 2. Clonorchis sinensis Positive Rate in the Five Major River Basins

The positive rate of Clonorchis sinensis among all subjects was 11.0%. To explore the Clonorchis sinensis positive rate in the river basins, Geum River (15.2%) was the highest followed by Nakdong River basin (11.9%), Seomjin River basin (10.9%) and Han River basin (5.7%). In contrast, the Yeongsan River basin has the lowest rate of 3.9%(Table 2).

## 3. Clonorchis sinensis Positive Rate according to Administrative Districts

The positive rate of Clonorchis sinensis by province was highest in Chungbuk with 17.9%, followed by Gyeongnam with 13.3%, Gyeongbuk with 9.9% and Jeonnam with 9.2%. In Chungcheongnam-do, 5.0% and Gangwon, 4.5%, respectively. The rate of Clonorchis sinensis positive rate in Jeonnam province was the highest at 22.6%, followed by Chungbuk Okcheon with 22.5%, Gyeongsangnam-do with 19.1%, Jeonnam with Suncheon with 18.8%, Gyeongnam with Sancheong with 17.4%, Hajdong with 16.8 (Table 3), and (Figure1).

## 4. Clonorchis Sinensis Positive Rate Difference by Related Factors

Table 4 shows the difference in the positive rate of Clonorchis sinensis according to related factors. Overall, the positive rate of male (15.0%) was higher than that of female (8.0%) ($x^2$=283.96, $p$<.001), while in the distribution by age was the positive rate of 50~59 years (14.3 persons) and that of 60~69 years (11.4%) were significantly higher than other age groups ($x^2$=79.07, $p$<.001). In addition, it is shown that there was a significant difference in experience of freshwater fish eating raw ($x^2$=200.14, $p$<.001) and freshwater fish cooking experience ($x^2$=46.52, $p$<.001), the person's experience of liver biliary disease diagnosis ($x^2$=6.03, $p$=.014), whether or not the remedy was taken among those who experienced Clonorchis sinensis positive ($x^2$=6.58, $p$=.037), and the number of drinking alcohol ($x^2$=264.30, $p$<.001) among the patients with Clonorchis sinensis. In other words, the positive rate of Clonorchis sinensis was found to be significantly high in case of freshwater fish eating raw experience, in case of a high frequency of eating raw rate, in case of experience of cooking freshwater fish, in case of experience of a diagnosis of liver biliary disease, in case of being not taken Clonorchis sinensis remedy, and in case of drinking alcohol less than once a month. On the other hand, it is found that there was no significant difference in Clonorchis sinensis positive rate according to eating raw frequency, family history of liver biliary disease diagnosis, and experience with Clonorchis sinensis positive.

In the five major rivers, freshwater fish were significantly different except Han River basin, but there was no difference according to the frequency of freshwater fish eating raw. In the case of freshwater fish cooking experience, there was a significant difference in all except Han River, and the case of freshwater fish cooking experience showed high positive rate. As for whether taking Clonorchis sinensis remedy or not, the river basins in which the positive rate was significantly high with the case of taking the remedy were the Seomjin river basin ($x^2$=15.18, $p$=.001) and the Han river basin ($x^2$=6.10, $p$=.047). According to the frequency of drinking, all of the basins of Geum River ($x^2$=115.23, $p$<.001), Nakdong River ($x^2$=92.03, $p$<.001), Seomjin River ($x^2$=49.00, $p$<.001), Yeongsan River ($x^2$=28.47, $p$<.001), and Han River ($x^2$=20.91, $p$<.001) showed a difference in Clonorchis sinensis positive rate, and the positive rate was significantly higher when drinking 1~4 times or less than once a month, rather than drinking frequently.

**Table 2.** Positive Rates of *C. sinensis* Categorized by Five Major Rivers

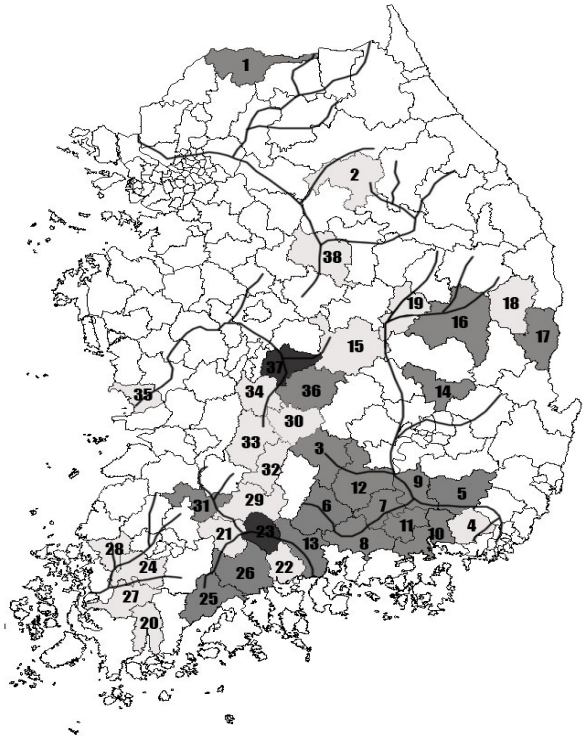
| River | No. of examined | No. of positive cases | Positive rates |
|---|---|---|---|
| | n | n | % |
| Guem-gang | 3,831 | 582 | 15.2 |
| Nakdong-gang | 10,095 | 1,204 | 11.9 |
| Seomjin-gang | 5,810 | 634 | 10.9 |
| Yeongsan-gang | 2,462 | 97 | 3.9 |
| Han-gang | 1,294 | 74 | 5.7 |
| Total | 23,492 | 2,591 | 11.0 |

**Table 3.** Positive Rates of *C. sinensis* Categorized by Region

| Province | Si · Gun | No. of examined | No. of positive cases | Positive rates by si·gun | Positive rates by province |
|---|---|---|---|---|---|
| | | n | n | % | % |
| Gangwon | Cheorwon-gun | 224 | 29 | 12.9 | 4.5 |
| | Hoengseong-gun | 539 | 5 | 0.9 | |
| Gyeongnam | Geochang-gun | 567 | 57 | 10.1 | 13.3 |
| | Gimhae-si | 229 | 18 | 7.9 | |
| | Miryang-si | 776 | 148 | 19.1 | |
| | Sancheong-gun | 737 | 128 | 17.4 | |
| | Uiryeong-gun | 568 | 70 | 12.3 | |
| | Jinju-si | 1,144 | 157 | 13.7 | |
| | Changnyeong-gun | 699 | 75 | 10.7 | |
| | Changwon-si | 486 | 57 | 11.7 | |
| | Haman-gun | 694 | 72 | 10.4 | |
| | Hapcheon-gun | 533 | 59 | 11.1 | |
| | Hadong-gun | 457 | 77 | 16.8 | |
| Gyeongbuk | Gunwi-gun | 499 | 75 | 15.0 | 9.9 |
| | Sangju-si | 553 | 42 | 7.6 | |
| | Andong-si | 498 | 55 | 11.0 | |
| | Yeongdeok-gun | 998 | 125 | 12.5 | |
| | Yeongyang-gun | 449 | 25 | 5.6 | |
| | Yecheon-gun | 665 | 41 | 6.2 | |
| Cheonnam | Gangjin-gun | 505 | 23 | 4.6 | 9.2 |
| | Gokseong-gun | 859 | 64 | 7.5 | |
| | Gwangyang-si | 338 | 24 | 7.1 | |
| | Gurye-gun | 486 | 110 | 22.6 | |
| | Naju-si | 851 | 27 | 3.2 | |
| | Boseong-gun | 822 | 84 | 10.2 | |
| | Suncheon-si | 821 | 154 | 18.8 | |
| | Yeongam-gun | 543 | 26 | 4.8 | |
| | Hampyeong-gun | 563 | 21 | 3.7 | |
| Cheonbuk | Namwon-si | 536 | 27 | 5.0 | 6.8 |
| | Muju-gun | 565 | 54 | 9.6 | |
| | Sunchang-gun | 465 | 57 | 12.3 | |
| | Jangsu-gun | 499 | 10 | 2.0 | |
| | Jinan-gun | 527 | 27 | 5.1 | |
| Chungnam | Geumsan-gun | 546 | 41 | 7.5 | 5.0 |
| | Seocheon-gun | 320 | 2 | 0.6 | |
| Chungbuk | Yeongdong-gun | 636 | 88 | 13.8 | 17.9 |
| | Okcheon-gun | 1,764 | 397 | 22.5 | |
| | Chungju-si | 531 | 40 | 7.5 | |
| Total | | 23,492 | 2,591 | | 11.0 |

## DISCUSSION

This study was conducted to investigate the current status of Clonorchis sinensis infection, which has the highest infection rate among intestinal parasites in Korea on the subjects of residents who live in the basins of five major rivers of Korea. The residents of the basins of five major rivers of Korea, Geum River, Nakdong River, Seomjin River, Yeongsan River and Han River, are located in a region where they can easily access freshwater fish. This study performed Clonorchis sinensis egg test of a stool specimen, and conducted the survey to investigate the characteristics of subjects affecting Clonorchis sinensis infection at the same time.




| No. | Si · Gun | Positive rates (%) |
|---|---|---|
| 1 | Cheorwon-gun | 12.9 |
| 2 | Hoengseong-gun | 0.9 |
| 3 | Geochang-gun | 10.2 |
| 4 | Gimhae-si | 7.8 |
| 5 | Miryang-si | 19.1 |
| 6 | Sancheong-gun | 17.3 |
| 7 | Uiryeong-gun | 12.3 |
| 8 | Jinju-si | 13.8 |
| 9 | Changnyeong-gun | 10.7 |
| 10 | Changwon-si | 11.7 |
| 11 | Haman-gun | 10.4 |
| 12 | Hapcheon-gun | 11.1 |
| 13 | Hadong-gun | 16.8 |
| 14 | Gunwi-gun | 15 |
| 15 | Sangju-si | 7.6 |
| 16 | Andong-si | 11 |
| 17 | Yeongdeok-gun | 12.5 |
| 18 | Yeongyang-gun | 5.6 |
| 19 | Yecheon-gun | 6.2 |
| 20 | Gangjin-gun | 4.6 |
| 21 | Gokseong-gun | 7.5 |
| 22 | Gwangyang-si | 7.1 |
| 23 | Gurye-gun | 22.6 |
| 24 | Naju-si | 3.2 |
| 25 | Boseong-gun | 10.2 |
| 26 | Suncheon-si | 18.8 |
| 27 | Yeongam-gun | 4.8 |
| 28 | Hampyeong-gun | 3.7 |
| 29 | Namwon-si | 5 |
| 30 | Muju-gun | 9.6 |
| 31 | Sunchang-gun | 12.2 |
| 32 | Jangsu-gun | 2 |
| 33 | Jinan-gun | 5.1 |
| 34 | Geumsan-gun | 7.5 |
| 35 | Seocheon-gun | 0.6 |
| 36 | Yeongdong-gun | 13.8 |
| 37 | Okcheon-gun | 22.5 |
| 38 | Chungju-si | 7.5 |

positive rates below 10%
positive rates 10~20%
positive rates above 20%

**Figure 1.** The map of positive rates of *C. sinensis* by Region.

As a result, the Clonorchis sinensis positive rate of the five river basin residents was much higher than the national average, and various characteristics were associated with this positive rate. Thus, this study is to discuss the major results of this study.

A total of 23,492 subjects participated in the study, of which 2,591 were positive and Clonorchis sinensis positive rate was 11.0%. The rate of Clonorchis sinensis infection in the whole country was reported to be 2.6% in 1980 and 2.9% in 2004[1], but the survey of the whole country was not properly conducted. There is significance of this study in that this study investigated all five major rivers that are susceptible to Clonorchis sinensis. To explore domestic studies that examined some limited regions, by using formalin ether sedimentation technique of stool parasite eggs that is the same method employed by this study, Lee et al. [17] surveyed 509 residents in the Nakdong River basin in 1994 (27.7%), and Park et al. [18] surveyed 848 and 699 people in the Sumjin River basin in 1999 and in 2005 (19.0%, 11.3% respectively). Compared with the results of Lee et al.'s and Park et al.'s, the positive rate in this study shows a tendency to decrease. However, since 1989 in China, the rate of Clonorchis sinensis positive rate gradually increased to 46.5% in 2011[19], showing a very high positive rate as compared with that of Korea. Despite the high economic growth, Korea and China have a dietary culture to enjoy freshwater fish, so Clonorchis sinensis infection is still regarded as a health problem which calls for

a national strategy. Efforts are urgently needed to raise awareness of the risk of freshwater fish eating raw for all citizens and to reduce Clonorchis sinensis infection, particularly by providing intensive education programs for residents in river basins.

Geum River showed the highest positive rate for all river basins, followed by Nakdong River, Seomjin River, Han River and Yeongsan River in that order. The Clonorchis sinensis positive rate in the Geum River basin was relatively high at 15.2%, and in cities and counties of the Geum river basin there were 22.5% in Okcheon, 9.6% in Muju and 0.6% in Seocheon, showing a big difference depending on the regions. Especially, Okcheon-gun showed a high positive rate. In a study of June et al. [6], which surveyed the residents of Okcheon, Seocheon and Iksan in the Geum River basin in 2008, it was found that the positive rate was slight-

**Table 4.** Differences in *C. sinensis* Positive Rates according to Five Major Rivers, Demographic, Behavioral & Other Characteristics (*N*=23,492)

| Characteristics | Categories | Total (*N*=23,492) | | | Guem-gang (*N*=3,831) | | | Nakdong-gang (*N*=10,095) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Negative (n=20,901) | Positive (n=2,591) | $x^2$ (*p*) | Negative (n=3,249) | Positive (n=582) | $x^2$† (*p*) | Negative (n=8,891) | Positive (n=1,204) | $x^2$ (*p*) |
| | | n (%) | n (%) | | n (%) | n (%) | | n (%) | n (%) | |
| Gender | Male | 8,597 (85.0) | 1,516 (15.0) | 283.96 | 1,050 (74.5) | 359 (25.5) | 183.06 | 3,809 (84.5) | 699 (15.5) | 99.33 |
| | Female | 12,304 (92.0) | 1,075 (8.0) | (<.001) | 2,199 (90.8) | 223 (9.2) | (<.001) | 5,082 (91.0) | 505 (9.0) | (<.001) |
| Age (year) | ≤49 | 2,500 (89.7) | 288 (10.3) | 79.07 | 359 (84.9) | 64 (15.1) | 21.50 | 1,090 (88.7) | 139 (11.3) | 29.57 |
| | 50~59 | 3,981 (85.7) | 663 (14.3) | (<.001) | 564 (79.5) | 145 (20.5) | (<.001) | 1,892 (85.2) | 328 (14.8) | (<.001) |
| | 60~69 | 6,103 (88.6) | 784 (11.4) | | 940 (84.9) | 167 (15.1) | | 2,616 (87.7) | 367 (12.3) | |
| | ≥70 | 8,316 (90.7) | 856 (9.3) | | 1,386 (87.1) | 206 (12.9) | | 3,292 (89.9) | 370 (10.1) | |
| Raw freshwater fish consumption | Never | 13,653 (91.1) | 1,338 (8.9) | 200.14 | 2,208 (89.2) | 266 (10.8) | 108.13 | 5,174 (89.5) | 609 (10.5) | 28.33 |
| | Yes | 6,758 (84.9) | 1,200 (15.1) | (<.001) | 999 (76.5) | 307 (23.5) | (<.001) | 3,427 (85.9) | 562 (14.1) | (<.001) |
| Frequency of raw freshwater fish consumption | 1/wk | 94 (83.2) | 19 (16.8) | 1.74 | 5 (50.0) | 5 (50.0) | 8.77 | 54 (81.8) | 12 (18.2) | 1.15 |
| | 1~3/mo | 839 (84.1) | 159 (15.9) | (.629) | 106 (75.2) | 35 (24.8) | (.032) | 488 (86.5) | 72 (13.5) | (.763) |
| | 1~3/6mo | 3,597 (84.7) | 649 (15.3) | | 525 (74.9) | 176 (25.1) | | 1,951 (85.6) | 328 (14.4) | |
| | 1/yr | 1,607 (85.7) | 269 (14.3) | | 265 (81.0) | 62 (19.0) | | 717 (85.9) | 118 (14.1) | |
| Cooking of raw freshwater fish | Never | 13,094 (90.0) | 1,453 (10.0) | 46.52 | 1,863 (86.3) | 296 (13.7) | 8.11 | 5,706 (89.2) | 691 (10.8) | 24.33 |
| | Yes | 7,225 (87.1) | 1,073 (12.9) | (<.001) | 1,315 (72.9) | 271 (17.1) | (.004) | 2,852 (85.8) | 473 (14.2) | (<.001) |
| Past history of disease of the liver and biliary tract (subject) | Never | 19,266 (89.1) | 2,366 (10.9) | 6.03 | 3,043 (85.0) | 537 (15.0) | 0.44 | 8,130 (88.2) | 1,092 (11.8) | 5.00 |
| | Yes | 950 (86.7) | 146 (13.3) | (.014) | 122 (83.0) | 25 (17.0) | (.505) | 393 (84.7) | 71 (15.3) | (.025) |
| Past history of disease of the liver and biliary tract (family) | Never | 19,550 (89.0) | 2,410 (11.0) | 1.04 | 3,105 (85.0) | 550 (15.0) | 0.08 | 8,197 (88.1) | 1,109 (11.9) | 0.01 |
| | Yes | 703 (87.9) | 97 (12.1) | (.307) | 80 (86.0) | 13 (14.0) | (.776) | 341 (87.9) | 47 (12.1) | (.907) |
| Past history of *C. sinensis* infection | Never | 17,687 (88.9) | 2,207 (11.1) | 1.45 | 2,857 (85.1) | 500 (14.9) | 0.43 | 7,532 (88.0) | 1,023 (12.0) | 0.40 |
| | Yes | 2,340 (89.7) | 269 (10.3) | (.229) | 289 (83.8) | 56 (16.2) | (.508) | 882 (88.7) | 112 (11.3) | (.524) |
| Past history of taking medicine because of *C. sinensis* infection | Yes | 1,934 (90.2) | 211 (9.8) | 6.58 | 245 (84.2) | 46 (15.8) | 3.58 | 745 (89.3) | 89 (10.7) | 0.61 |
| | Never | 101 (85.6) | 17 (14.4) | (.037) | 7 (63.6) | 4 (36.4) | (.167) | 29 (85.3) | 5 (14.7) | (.735) |
| | Unaware | 75 (83.3) | 15 (16.7) | | 9 (90.0) | 1 (10.0) | | 44 (88.0) | 6 (12.0) | |
| Alcohol drinking frequency | Never | 11,182 (91.4) | 1,058 (8.6) | 264.30 | 1,875 (90.1) | 206 (9.9) | 115.23 | 4,599 (89.8) | 520 (10.2) | 92.03 |
| | ≤1/mo | 1,558 (81.8) | 346 (18.2) | (<.001) | 219 (75.0) | 73 (25.0) | (<.001) | 542 (79.5) | 140 (20.5) | (<.001) |
| | 1~4/mo | 4,077 (84.7) | 738 (15.3) | | 647 (76.5) | 199 (23.5) | | 1,734 (84.6) | 316 (15.4) | |
| | ≥2/wk | 3,316 (90.1) | 365 (9.9) | | 408 (82.8) | 82 (17.2) | | 1,608 (89.9) | 181 (10.1) | |

† Calculated by $x^2$ or Fisher's exact test.

**Table 4.** Differences in *C. sinensis* Positive Rates according to Five Major Rivers, Demographic, Behavioral & Other Characteristics (Continued) (*N*=23,492)

| Characteristics | Categories | Seomjin-gang (*N*=5,810) | | | Yeongsan-gang (*N*=2,462) | | | Han-gang (*N*=1,294) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Negative (n=5,176) | Positive (n=634) | $x^2$ (*p*) | Negative (n=2,365) | Positive (n=97) | $x^{2\dagger}$ (*p*) | Negative (n=1,220) | Positive (n=74) | $x^2$ (*p*) |
| | | n (%) | n (%) | | n (%) | n (%) | | n (%) | n (%) | |
| Gender | Male | 2,213 (86.5) | 346 (13.5) | 32.01 | 994 (94.5) | 58 (5.5) | 12.01 | 531 (90.8) | 54 (9.2) | 24.42 |
| | Female | 2,964 (91.1) | 288 (8.9) | (<.001) | 1,371 (97.2) | 39 (2.8) | (<.001) | 689 (97.2) | 20 (2.8) | (<.001) |
| Age (year) | ≤49 | 664 (90.7) | 68 (9.3) | 17.61 | 254 (95.1) | 13 (4.9) | 20.18 | 133 (97.1) | 4 (2.9) | 5.76 |
| | 50~59 | 895 (86.8) | 136 (13.2) | (.001) | 391 (92.4) | 32 (7.6) | (<.001) | 239 (91.6) | 22 (8.4) | (.124) |
| | 60~69 | 1,495 (87.6) | 212 (12.4) | | 750 (97.3) | 21 (2.7) | | 302 (94.7) | 17 (5.3) | |
| | ≥70 | 2,122 (90.7) | 218 (9.3) | | 970 (96.9) | 31 (3.1) | | 546 (94.6) | 31 (5.4) | |
| Raw freshwater fish consumption | Never | 3,712 (91.2) | 358 (8.8) | 62.64 | 1,859 (96.6) | 66 (3.4) | 6.36 | 700 (94.7) | 39 (5.3) | 1.00 |
| | Yes | 1,432 (84.1) | 271 (15.9) | (<.001) | 481 (94.1) | 30 (5.9) | (.012) | 419 (93.3) | 30 (6.7) | (.316) |
| Frequency of raw freshwater fish consumption | 1/wk | 30 (96.8) | 1 (3.2) | 4.58 | 3 (100.0) | 0 (0.0) | 5.56 | 2 (66.7) | 1 (33.3) | 6.81 |
| | 1~3/mo | 158 (81.9) | 35 (18.1) | (.205) | 39 (86.7) | 6 (13.3) | (.135) | 48 (87.3) | 7 (12.7) | (.078) |
| | 1~3/6mo | 631 (84.6) | 115 (15.4) | | 253 (94.8) | 14 (5.2) | | 237 (93.7) | 16 (6.3) | |
| | 1/yr | 415 (84.0) | 79 (16.0) | | 113 (95.8) | 5 (4.2) | | 97 (95.1) | 5 (4.9) | |
| Cooking of raw freshwater fish | Never | 3,443 (90.1) | 379 (9.9) | 11.64 | 1,374 (96.9) | 44 (3.1) | 6.47 | 708 (94.3) | 43 (5.7) | 0.06 |
| | Yes | 1,698 (87.1) | 251 (12.9) | (.001) | 959 (94.9) | 52 (5.1) | (.011) | 401 (93.9) | 26 (6.1) | (.799) |
| Past history of disease of the liver and biliary tract (subject) | Never | 4,807 (89.3) | 578 (10.7) | 0.59 | 2,215 (96.1) | 91 (3.9) | 0.89 | 1,071 (94.0) | 68 (6.0) | 0.64 |
| | Yes | 322 (88.0) | 44 (12.0) | (.443) | 78 (94.0) | 5 (6.0) | (.344) | 35 (97.2) | 1 (2.8) | (.422) |
| Past history of disease of the liver and biliary tract (family) | Never | 4,939 (89.2) | 595 (10.8) | 1.12 | 2,227 (96.2) | 88 (3.8) | 7.75 | 1,082 (94.1) | 68 (5.9) | 0.35 |
| | Yes | 194 (87.0) | 29 (13.0) | (.289) | 59 (89.4) | 7 (10.6) | (.005) | 29 (96.7) | 1 (3.3) | (.552) |
| Past history of *C. sinensis* infection | Never | 4,256 (88.9) | 533 (11.1) | 2.22 | 1,982 (95.7) | 90 (4.3) | 4.92 | 1,060 (94.6) | 61 (5.4) | 4.97 |
| | Yes | 868 (90.5) | 91 (9.5) | (.136) | 262 (98.5) | 4 (1.5) | (.026) | 39 (86.7) | 6 (13.3) | (.026) |
| Past history of taking medicine because of *C. sinensis* infection | Yes | 698 (91.2) | 67 (8.8) | 15.18 | 212 (98.1) | 4 (1.8) | 0.18 | 34 (87.2) | 5 (12.8) | 6.10 |
| | Never | 59 (89.4) | 7 (10.6) | (.001) | 6 (100.0) | 0 (0.0) | (.910) | 0 (0.0) | 1 (100.0) | (.047) |
| | Unaware | 17 (68.0) | 8 (32.0) | | 4 (100.0) | 0 (0.0) | | 1 (100.0) | 0 (0.0) | |
| Alcohol drinking frequency | Never | 2,768 (91.2) | 267 (8.8) | 49.00 | 1,379 (97.3) | 38 (2.7) | 28.47 | 561 (95.2) | 28 (4.8) | 20.91 |
| | ≤1/mo | 512 (83.8) | 99 (16.2) | (<.001) | 209 (90.9) | 21 (9.1) | (<.001) | 76 (85.4) | 13 (14.6) | (<.001) |
| | 1~4/mo | 1,028 (85.6) | 173 (14.4) | | 394 (93.6) | 27 (6.4) | | 274 (92.3) | 23 (7.7) | |
| | ≥2/wk | 820 (90.6) | 85 (9.4) | | 288 (96.6) | 10 (3.4) | | 192 (98.0) | 4 (2.0) | |

† Calculated by $x^2$ or Fisher's exact test.

ly decreased by 24.6% in Okcheon and 2.7% in Seocheon. However, in the case of Muju-gun, it is necessary to note that the positive rate in 2007 was found to be 3.5% in a study of Park [8] but the survey conducted four years later showed that the positive rate was doubled to 9.6%. In the case of Okcheon-gun, June et al. [6] and this study show a high positive rate of more than 20% and so therefore for the regions where Clonorchis sinensis positive rate was significantly higher than the national average and/or was shown to have changes of positive rates comparing the results of previous studies, a strategic approach is needed to identify the causes and take measures customized to reflect regional characteristics.

In this study, the positive rate of Clonorchis sinensis in the Nakdong River was 11.9%, and the positive rate of cities and counties in the Nakdong River basin was 11.0% in

Andong City and 10.4% in Haman County. In a study of Hwang et al. [20], the positive rate of Clonorchis sinensis in Andong city was 24.5% and in a study of Ju et al. [21], the positive rate of Clonorchis sinensis in Haman County was 34.4%, demonstrating that the positive rate of the Nakdong river basin was decreased in contrast to that of the Geum river basin.

The positive rate of Clonorchis sinensis in the Sumjin River basin was 10.9% in this study. Park et al. [18] reported that the Clonorchis sinensis positive rate in the Sumjin River basin was 19.0% in 1999 and 11.3% in 2005. Thus, the positive rate of the Seomjin River basin gradually decreased after 2005, and the positive rate of Clonorchis sinensis in Gokseong county embracing the Seomjin River was also gradually decreased.

In the present study, the positive rate of the Han River basin is 5.7%, and the positive rate of the Han River basin was 7.9% in a study of Kim et al. [22], showing that the positive rate of the Han River basin is lowered. The positive rate of the Yeongsan River basin is also lowered and in this study, the positive rate is 3.9%, and Jung et al.'s [23] study showed 4.8% higher than that of this study.

To summarize the positive rates of individual cities, while there are 19.1% in Milyang city, 17.4% in Sancheong County, 16.8% in Hadong County in Gyeongnam Province, 15.0% in Gunwi County in Gyeongbuk Province, 22.6% in Gurye County 18.8% in Suncheon City in Jeonnam Province, 22.5% in Okcheon county in Chungbuk Province, etc., showing very high positive rates, there are 7.9% in Gimhae city in Gyeongnam province, 7.6% in Sangju city, 5.6% in Yeongyang county, 6.2% in Yecheon county in Gyeongbuk Province, 4.6% in Gangjin County, 7.5% in Gokseong County, 7.1% in Gwangyang City, 3.2% in Naju City, 4.8% in Yeongam County, 3.7% in Hampyeong County in Jeonnam Province, 5.0% in Namwon County, 5.1% in Jinan County in Jeonbuk Province, and 7.5% in Chungju city in Chungbuk Province, showing relatively low positive rates.

In particular, there was a very low positive rate in Hoengseong-gun (0.9%), Jeonbuk-gun (2.0%) and Chungcheong-Seocheon (0.6%) in the areas of Gangwon-do province. In Yecheon county and Sangju city in Gyeongbuk province it was decreased to 6.2% and 7.6% respectively from 28% in 1995[17], showing a magnificent result. Gokseong county also showed a steady decline from 19.0% in 1999 to 11.3%[18] in 2005 to 7.5% in 2011. Identifying local policies or strategies that significantly reduce the positive rate and spreading them to other regions are also considered a necessary method for the prevention of Clonorchis sinensis infection.

From the results of this study, the factors that showed difference in Clonorchis sinensis positive rate are sex, age, freshwater fish eating raw experience, freshwater fish cooking experience, diagnosis of liver and biliary disease, medication of Clonorchis sinensis drug, and frequency of drinking, etc. In terms of gender, the positive rate in males was higher than that of females, and in terms of distribution among all age groups, the positive rate was higher in 50s and 60s. In the previous studies [19,24,25], males showed higher positive rate than females, showing the same results as this study. By age group, the results of previous studies which showed high positive rates in 40s and in 50s were considered to be similar to those of the 50s and 60s of this study. It is necessary to study whether this is mainly due to the dietary culture that freshwater fish eating raw in the drinking situation of men in their 40s and 60s. In addition, there was significant difference in the experience of freshwater fish eating raw, freshwater fish cooking experience, the person's experience of liver and biliary disease diagnosis, the medication of treatment drug for Clonorchis sinensis, and drinking frequency. In a study by Stauffer et al. [26], Clonorchis sinensis infection rate was higher in patients with biliary obstruction, and in a study by Lee et al. [27], 27.5% of patients with biliary pancreatitis had a Clonorchis sinensis positive rate, showing there is a close relationship between Clonorchis sinensis positive rate and liver and biliary diseases. The medication of treatment drug for Clonorchis sinensis was associated with a higher positive rate when the patients did not take or recognize the medication, and it is probably due to the low concern about the severity and sequelae of Clonorchiasis. It can be seen in the same context as emphasized in the study of Kim et al. [28], reporting that the administration of one-time therapies has no effect on reducing the positive rate of Clonorchis sinensis, and that continuous education that pays more attention to the risk and treatment of Clonorchis sinensis can prevent Clonorchis sinensis infection.

The positive rate of Clonorchis sinensis according to the experience of Clonorchis sinensis positive did not show significant difference. The subjects with Clonorchis sinensis positive were found to be 11.1% of the subjects with no experience of Clonorchis sinensis, and among the subjects with the experience of positive Clonorchis sinensis, 10.3% were found to be positive, showing that both experienced and non-experienced subjects had little awareness of Clonorchis sinensis infection. It is believed that even if the patients were positive for Clonorchis sinensis in the past, it is thought to be treated after taking the drug, so they do not live for prevention and are re-infected because of exposure to Clonorchis sinensis infection risk. The person's presen-

ce or absence of liver-biliary disease affects Clonorchis sinensis positive rate. In other words, in the Nakdong River basin ($x^2$=5.00, $p$=.025) and the total subjects ($x^2$=6.03, $p$=.014), the Clonorchis sinensis positive rate was significantly higher in cases of the subjects with liver-biliary disease than those with no liver-biliary disease.

These results indicate that Clonorchis sinensis has not yet been eradicated, and freshwater fish eating raw and cooking are still in progress. It is recognized that It is necessary to provide more thorough education on the persistent prevention of eating raw and freshwater fish cooking for the river basin population and it suggests that the need of careful guidance and management of medication should be required for those residents with the diagnosis of positive Clonorchiasis.

## CONCLUSION

In Korea, there are still dietary habits of freshwater fish eating raw with high rates of Clonorchis sinensis infection in some regions of river basins. Therefore, this study is significantly meaningful in that it conducted a nationwide large-scale survey focusing on the five major river basins, which are high risk areas of Clonorchis sinensis infection. The positive rate of Clonorchis sinensis in this study is 11.0 %, which is much higher than that of the 7th nation wide parasite infection survey conducted in 2004.

These results provide an opportunity to confirm that riverside residents are vulnerable to Clonorchis sinensis infection. In addition, the results of this study present Clonorchis sinensis positive rates based on five major rivers and administrative districts, thus this study provides a basis for setting measures at the regional community level by recognizing the necessity of prevention and management of Clonorchis sinensis in each region.

First, Clonorchis sinensis management project is recommended as a national health policy and is to be managed regularly and periodically. Considering that Clonorchis sinensis infection can cause liver and biliary disease and as Clonorchiasis is a serious disease, Clonorchis sinensis management project should be included in the national disease management programs and it is necessary to make continuous and periodic efforts to reduce Clonorchis sinensis. It is believed that Clonorchiasis will be eradicated in the future if fundamental measures and regular monitoring in a national dimension are carried out every year, especially for residents with high positive rate characteristics.

Second, this study proposes to make a campaign to change the lifestyle of the riverside residents and to develop educational programs for them. It is necessary to change the perception of eating habit of freshwater fish eating raw for drinking. Particularly in areas with high positive rates, it is necessary to take special care and secure measures to change the perception.

Finally, this study attempted to identify related factors affecting Clonorchis sinensis infection, but there are limitations in studying the related factors of recurrent cases among those with positive experience. Future research should continue to explore in depth the factors that influence the rate of recurrence of Clonorchis sinensis-positive patients.

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