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TRENDS IN EPIDEMIOLOGICAL ASPECTS OF ENTEROHEMORRHAGIC ESCHERICHIA COLI INFECTIONS IN KOREA AND JAPAN, 2008 TO 2017

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ABSTRACT

Background: Enterohemorrhagic Escherichia coli (EHEC) are an important cause of gastroenteritis in Korea and Japan. We comparative study the epidemiologic aspects of EHEC infections in Korea (Republic of) and Japan by analyzing the current state from 2008 to 2017. **Methods:** We collected national surveillance data of EHEC infections reported in Korea and Japan from 2008 to 2017. The following factors were analyzed: cumulative incidence rate (CIR) of nationwide and habitat, epidemiologic aspects include the cases related gender, male to female morbidity ratio (MFMR), age, seasonality of EHEC infections. **Results:** In total, there were 790 cases of EHEC infections with a CIR of 0.16 per 100,000 populations in Korea from 2008 to 2017 in Korea, while there were a total of 39,371 cases of EHEC with a CIR of 3.13 during the same period in Japan. The CIR in Japan was higher than that in Korea ($p<0.01$). Moreover, both a CIR of EHEC in habitat of two countries were compared, the provinces were much higher than that in capital city. The affects of MFMR, both sexes differently, accounting for 1.05 and 0.82 in Korea and Japan, respectively. The distribution rate of EHEC infection cases by age group of under-9-years old was 50.0% in Korea than that of 32.9% in Japan ($p<0.01$). Additionally, the distribution of EHEC infections throughout the year revealed that outbreaks in spring (16.0% vs. 10.2% of total cases) was much more frequent in Korea than in Japan ($p<0.01$). However, EHEC outbreaks in autumn (21.0% vs. 28.6%) was much more frequent in Japan than in Korea ($p<0.01$). **Conclusion:** EHEC infections is an zoonosis and a serious concern to public health measures of prevention and control.

KEYWORDS: EHEC infections, epidemic aspects, Korea, Japan.

INTRODUCTION

Of all foodborne diseases, enterohemorrhagic Escherichia coli (EHEC) infections were recognized as human pathogens and have been a common cause of bacterial illnesses in worldwide.[1, 2] Since the beginning of August 1982, stool isolations of *Escherichia coli* serotype O157:H7 have been identified at the Center for Disease Control and Prevention (CDC) in the United States from specimens obtained from four patients in two states.[1] Enterohemorrhagic *Escherichia coli* (EHEC) were recognized as a human pathogen for the first time, and since then has been a steady cause of foodborne illness worldwide.[2] Although, the main reservoir of this pathogen appears to be cattle, the dynamics of types, *E. coli* O157, belong to the group of EHEC, which produce potent toxins and cause a particularly severe form of disease, hemorrhagic colitis.[1,2] There have been several cases of human *E.coli* O157 infections in Korea since it was first isolated from a patient with hemolytic uremic syndrome (HUS) in 1998[3], and that of Japan, EHEC cases were reported in 1990.[4] Meat, other foods, and recreational and drinking water contaminated with animal feces are probably the major sources of the *E. coli* O157 infection[3-6] Thereafter, EHEC infections were classified as a group I notifiable disease by the Communicable Disease Control and Prevention Act of the Korea Center for Disease Control and Prevention (KCDC)[3], and as a category III notifiable infectious disease in the National Epidemiological Surveillance of Infectious Diseases (NESID) under the infectious Disease Control Law of Japan [4] More recently, both in Korea and Japan, the number of EHEC infection cases were rapidly increased after the official report since the 2000s; a total of 254 cases in Korea, and those of 20,883 cases in Japan were outbreaks between 2006 and 2010.[3,4] However, there is not so much for information concerning the epidemiological aspects of EHEC infections in Korea[3, 5-8], in comparison to that in other reports.[4, 9-26] Moreover, EHEC infections and outbreaks humans are attributed to the consumption of undercooked meat products including beef, poultry and pork.[1-8, 13-21, 26-28]

In the present descriptive study, comparing the epidemiology and major risk factors of EHEC outbreaks in these two countries provides information for performing risk assessment and establishing food-safety policies.

MATERIAL AND METHODS

We investigated the epidemiological aspects of EHEC infections cases between Korea and Japan from 2008 to 2017. The following factors were analyzed: national incidence and the regional habitat (capital city and other provinces or counties), and epidemiologic aspects including gender, age and seasonality of the year outbreaks for reported cases of EHEC infections between 2008 and 2017. The raw data on confirmed EHEC infection cases in Korea (n=790) were obtained from the National Notified Disease Surveillance System of Korea Center for Disease Control and Prevention (KCDC), an agency of the Ministry of Health and Welfare between 2008 and 2017.[3] Data on reported EHEC cases in Japan (n=39,371) were obtained from the National Institute of Infectious Disease (NIID) in Japan from 2008 to 2017.[4]

To better quantify the impact of EHEC infections on health in Korea and Japan, we compiled and analyzed information including cumulative incidence rate (CIR) per 100,000 populations in Korea and Japan estimated by the WHO. The upper and lower limits of the 95% confidence intervals (CIs) were calculated. Statistically significant differences between the epidemiological aspects or risk factors were compared using the Chi-square test or pared *t*-test. All data analyses were performed in Excel 2010 (Microsoft Co. WA, USA).

Results were considered statistically significant for p-value less then <0.05.

RESULTS AND DISCUSSION

Human infection and outbreaks from EHEC O157:H7 have been attributed to the consumption of undercooked beef food products as well as various other foods, as well as to certain ruminants; cattle and sheep are particularly reservoirs, which are infected asymptomatically and shed the organism in feces.[1-4] As shown in Table 1, comparative observations of the CIR of EHEC infection cases between Korea and Japan were measured from 2008 to 2017 and compared. In Korea, we observed 790 EHEC infection cases with CIR of 0.16 per 100,000 populations between 2008 and 2017. During the same period in Japan, 39,371 EHEC cases with CIR of 3.13 per 100,000 populations were observed. In comparison, the CIR in Japan was significantly higher than that observed in Korea ($p<0.01$). Furthermore, the CIR cases in capital city (Seoul) of Korea were 0.12 per 100,000 populations, and that in its provinces were 0.16, during 2008 to 2017. In Japan, the CIR of EHEC cases in the capital city (Tokyo) was 2.75 per 100,000 populations and in its provinces 3.18 per 100,000 populations. For both countries we observed a statistically higher CIR of EHEC in the provinces compared with the capital cities ($p<0.01$).

One may explain these great differences of prevalence rate between two countries based on the differences in their food-related cultural background, even though these two countries are geographically located in close proximity. Moreover, one of the reasons may be differences in their food cultures. Moreover, for example, compared to the Japanese, Koreans like their food spicier or saltier, and also frequently eat fermented food such as a kimchi, suggesting that perhaps the spicy, salty and fermented food may damage pathogenic bacteria.[22-25] An additionally, “kimchi”, a traditional Korean food is a well-known lactic-acid-fermented vegetable product, made of Chinese cabbage, radishes and cucumbers. A typical Korean adult consumes an average of 50-200g of kimchi per day.[24] Moreover, kimchi produces a bacteriocin that inhibits the growth of foodborne pathogens such as *E. coli* O157:H7, *Salmonella typi*, and *Staphylococcus aureus*.[24, 25] The in-situ bacteriocin-production in kimchi would act with antimicrobial ingredients in a synergistic manner to protect the fermented product from delivering pathogens upon consumption.[22-25]

Table 2 shows a comparative observation of the epidemiological aspects of EHEC cases between Korea and Japan from 2008-2017, which were analyzed by association with the gender and age of each individual, as well as the seasonality when the individual was infected. The first of all, understanding male-female difference in infection rates and the severity of the disease is important for public health control programs. The EHEC cases of men (51.3% of total cases) were slightly higher than that for women (48.7%) in Korea. However, in Japan, the number of men infected (45.1%) was much lower than the number of women (54.9%) as well ($p<0.01$). Additionally, the male-to-female morbidity ratio (MFMR) was estimated to compare incident cases of EHEC infections in Korea and Japan; the former was 1.05 and the latter, 0.82. The MFMR of EHEC cases between the two countries was not similarly. These remarkable differences in gender distribution are believed to reflect cultural differences between Korea and Japan in terms of works, such as food or foodstuff handling. These data strongly indicate that the incidence of EHEC cases in these countries is influenced by their specific culture-related foods intake and climates.[1-4,12,22-26]

When we classified EHEC cases in Korea, the proportionality of the EHEC infections by age group was as follows; for the age groups of under 9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69 and over 70 years, the percentages for Korea were 50.0%, 13.7%, 5.4%, 6.0%, 5.2%, 6.8%, 5.7% and 7.2%, respectively ($p<0.01$), and those for Japan were 32.9%, 14.3%, 14.7%, 11.0%, 6.7%, 6.5%, 6.5% and 7.5%, respectively ($p<0.01$). The distribution of EHEC infection cases by age groups of under-9-years old, the percentage were 50% in Korea and that of 32.9% in Japan, respectively, and a higher rate of EHEC infections were observed in the under 9-years age group more than over 20-year old group, which clearly shows a significantly higher incidence in the children, (p<0.01). These data strongly indicate of communicability of EHEC infections that young children tend to shed the organism longer than adults. Transmission is particularly common among children still in diapers.[3,11-13,18,26-28] For example, in 1996, Japan reported 9,451 cases of EHEC infections of teenagers, 1,808 of which were hospitalized and 12 died; three-quarters of all these cases occurred during six major outbreaks. In outbreaks reported in other areas *E. coli* was isolated from the salad and seafood sauces that were served at school lunches for under teenager.[2] Moreover, On July 7, 2004, a health center in Kanazawa City received a report of EHEC O111 (VT1 and 2) infection. The patient was a high school student who participated in a school excursion to Korea. EHEC was isolated from 103 individuals (98 students, 4 teachers and one family member).[15]

The estimation of the seasonal pattern of outbreaks of EHEC infection patients in Korea, in the order of spring, summer, autumn and winter were 16.0%, 54.2%, 21.0% and 8.9%, respectively, (p<0.01), and 10.2%, 54.0%, 28.6% and 7.2% in Japan, respectively (p<0.01). Additionally, the distribution of EHEC infections throughout the year revealed that outbreaks in spring (16.0% vs. 10.2% of total cases) was much more frequent in Korea than in Japan (p<0.01). However, EHEC outbreaks in autumn (21.0% vs. 28.6%) was much more frequent in Japan than in Korea (p<0.01).

In additions, both in Korea and Japan, EHEC infection cases occurred all year-round; the outbreaks increased drastically in May, peaked in July to August and started to decrease in the end of December, when the cold season begins that although monthly changes in number of cases occurred (Figure 1). These data strongly indicate that the incidence of EHEC infection cases in these two countries influenced by their peculiar food culture and climate conditions.[1-4, 12, 22, 23] The cases occurred predominantly during June in the beginning of summer and the end of November in autumn each year (74.9% of the total cases), during the period of warm climate in Korea that in Japan (82.6%). It is well known that foodborne illnesses including EHEC infections are affected by seasonal or climate conditions because high temperatures and humidity increase the chance of proliferation and toxin production of pathogenic bacteria in incompletely cooked meat; ruminants, particularly beef, mutton and others, can cause EHEC infections.[11-19, 26-27]

Finally, the most effective way of prevent and control EHEC infections is to reduce human exposure to EHEC shedding in domesticated animals, particularly ruminants.[1-3,11] In addition, safety measures should be taken to create a comprehensive strategy against EHEC infections, including required health education and promotion for endemic area for public safety.

In conclusion, EHEC is a new emerging zoonosis, a serious concern to the public health measures of the prevention and control for the high risk of EHEC infections might be caused by consumption of raw or undercooked meat products from the reservoir of ruminants, which is a habit of an epicure. This study provides a quantitative analysis of the epidemiological aspects and risk factors of EHEC infection between Korea and Japan to shed insight on how to more effectively plan future strategies. It is our hope that this information will be a useful reference in future studies of EHEC infection for the public health service.

Table 1: Comparative observation of cumulative incidence rate (CIR) of EHEC infection cases between Korea and Japan, 2008-2017.

Item	Korea		Japan	
	No. of cases (%)	CIR /100,000	No. of cases (%)	CIR /100,000
Nationwide				
Total cases	790	0.16	39,371	3.13**
Habitat				
Capital city	125	0.12	3,561	2.75**
Provinces	665	0.16	35,810	3.18**

Remarks: PR/100,000: Prevalence rate per 100,000 populations.
Statistical significant level was set at *p<0.05 and **p<0.01.

Table 2: Comparative observation of epidemiologic aspects of EHEC cases between Korea and Japan, 2008-2017.

Item	Korea		Japan	
	No. of cases (%)	95% CI	No. of cases (%)	95% CI
Gender				
Male	405 (51.3)**	47.8-54.8	17,752 (45.1)	44.6-45.6
Female	385 (48.7)	45.1-52.2	21,619 (54.9)**	54.1-55.4
Total	790		39,371	
MFMR=M/F	1.05		0.82	
Age				
<9	395 (50.0)**	46.5-53.4	12,956 (32.9)	32.4-33.4
10-19	108 (13.7)	11.3-15.4	5,615 (14.3)	14.0-14.6
20-29	43 (5.4)	3.8-7.0	5,771 (14.7)**	14.4-14.7
30-39	47 (6.0)	4.3-7.7	4,330 (11.0)**	10.7-11.3
40-49	41 (5.2)	3.7-6.7	2,649 (6.7)	6.4-6.8
50-59	54 (6.8)	5.1-8.6	2,546 (6.5)	6.3-6.7
60-69	45 (5.7)	4.1-7.3	2,543 (6.5)	6.3-6.7
>70	57 (7.2)	5.4-9.0	2,957 (7.5)	7.2-7.8
Total	790		39,371	
Seasonality				
Spring	126 (16.0)**	13.9-18.1	4,001 (10.2)	9.9-10.5
Summer	428 (54.2)	50.7-57.7	21,244 (54.0)	53.5-54.5
Autumn	166 (21.0)	18.2-23.8	11,277 (28.6)**	28.2-29.1
Winter	70 (8.9)	6.9-10.9	2,849 (7.2)	6.9-7.5
Total	790		39,371	

Remarks: MFMR: male-to-female morbidity ratio.
Statistical significant level was set at *p<0.05 and **p<0.01.
95% CI: Confidence interval of 95% of the rate.

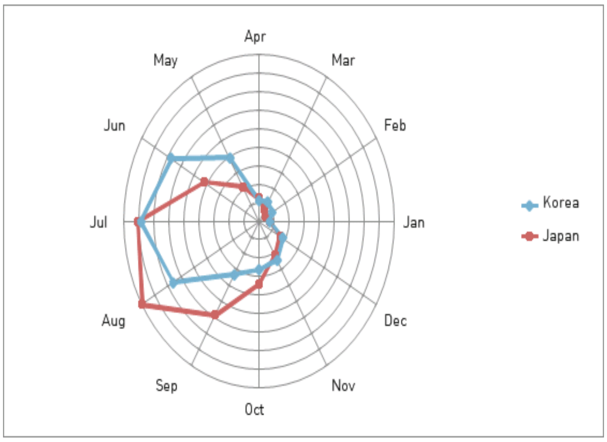

Fig 1: Epidemiologic Pattern and distribution of EHEC infection cases by monthly in Korea and Japan for the last decade from 2008 to 2017.

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