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Short Communication

A Retrospective Study of the Extensive Eradication Program for Brucellosis Outbreaks and Control in Korea, 2002–2009

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SUMMARY: This study concerns the quantitative analysis of brucellosis outbreaks and the related risk factors and control programs for both domestic cattle and human brucellosis infections in Korea between 2002 and 2009. There were a total of 77,082 infections of bovine brucellosis (BB) in domestic cattle with a prevalence rate (PR) of 13.3 per 1,000 cattle; during the same period there were 620 cases of human brucellosis (HB) with a PR of 0.16 per 100,000 persons. Moreover, the correlation coefficient of brucellosis outbreaks between cattle and humans was highly significant ($r = +0.985$). The attack ratio of HB cases was 8.04 per 1,000 BB cases. The distribution of brucellosis outbreaks was concentrated in the southeast region of Korea ($P < 0.01$). Significantly more males were infected than females (86.9% versus 13.1%), and a high incidence of HB was observed in those aged more than 40 years (86.1%). The majority of HB cases occurred primarily among rural inhabitants (92.3%) and among farmers and related workers (47.9%). Finally, all of the measures that were applied in the extensive eradication program for brucellosis outbreaks and control were based principally on an intensive test-and-slaughter policy and contributed significantly to the reduction in the outbreaks of brucellosis in Korea.

Brucellosis is a worldwide zoonotic infection in animals and humans caused by the *Brucella* spp. including *Brucella melitensis*, *Brucella abortus*, *Brucella suis*, and *Brucella canis*; moreover, marine mammal strains are known to be pathogenic agents in humans (1,2). In recent years, brucellosis has become a major zoonosis in Korea with a dramatic increase in incidence in domestic cattle and man (2–4,6–8). Therefore, human brucellosis (HB) was classified as a type 3 notifiable disease by the Communicable Disease Prevention Act in August 2000 (6). In Korea, bovine brucellosis (BB) and *B. abortus* were first detected among dairy cattle imported from the United States in 1955 (2–4); HB was first reported in an official report case in 2002 (2,3,5–10). BB occurred sporadically until 1983, and till 1999, most of the outbreaks have been reported in dairy cattle (2,4). Importantly, the detection rate of BB has been increasing sharply since 2003 because of the brucellosis-negative certification system for cattle trading in the livestock market, which ensured brucellosis detection, and because of the increased brucellosis outbreaks in native cattle that have never been tested (4,7,8). Notwithstanding the extensive eradication programs for brucellosis outbreaks and control (EEPBOC), the implementation of the test-and-slaughter policy nationally, and the stamp-out approach to strictly quarantine infected herds, brucellosis outbreaks have continued to increase among Korean native cattle, including beef cattle that were neglected in the EEPBOC prior to 2004 (2,4,7–9). Accordingly, the screening tests for brucellosis have been reinforced; moreover, the number of HB cases has sharply increased after the first report in 2002 from 16 cases in 2003 to 215 cases in 2006, when it was at its peak. A total of 620 cases were reported between 2002 and 2009 (2–4,10,11).

In the present study, we investigated the epidemiological aspects of EEPBOC among domestic cattle and humans in Korea and compared the risk factors involved with brucellosis during the period between 2002 and 2009. There were 77,082 cases of BB in domestic cattle between 2002 and 2009. For this, we used the raw data from the National Animal Infectious Disease Data Management System provided by the National Veterinary Research and Quarantine Service (NVRQS), Ministry for Food, Agriculture, Forestry and Fisheries (12). Raw data on the HB cases ($n = 620$) were obtained from ''Disease'' by Web and by the Statistical System of Korea Center for Disease Control and Prevention, Ministry of Health and Welfare, 2002–2009 (13).

In this study, the prevalence rate (PR) of BB cases per 1,000 cattle was calculated along with that of HB cases per 100,000 persons; we then calculated the attack ratio (AR, the ratio of HB cases transmitted from BB cases per 1,000 cattle, which was calculated by the number of HB cases divided by the number of BB cases $\times 1{,}000$) (14). Statistically significant differences between the epidemiological aspects were determined using the χ^2 test, estimated with 95% confidence intervals (95% CI), and the correlation coefficient of brucellosis outbreaks

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Table 1. Comparative observation of epidemiological aspects of brucellosis among cattle and humans in Korea, 2002–2009

Item	Bovine brucellosis	Human brucellosis	
	No. (%) of cases	No. (%) of cases	Attack ratio[1)]
Total no. of tested	5,778,620	—	—
Total no. of positive	77,082	620	8.04
Prevalence rate	13.3 per 1,000	0.16 per 100,000	
Season			
Spring	22,999 (29.8)	163 (26.3)	7.09
Summer	20,319 (26.4)	186 (30.0)*	9.15*
Autumn	17,616 (22.8)	159 (25.6)	9.03
Winter	16,148 (21.0)	112 (18.2)	6.94
Total	77,082	620	
Region			
Northeastern	3,817 (5.0)	36 (5.8)	9.43
Northwestern	4,758 (6.0)	53 (8.5)	11.14*
Central	18,276 (23.7)	137 (22.1)	7.50
Southeastern	32,765 (42.5)**	275 (44.4)**	8.39
Southwestern	17,466 (22.7)	119 (19.2)	6.81
Total	77,082	620	

[1)]: The ratio of human brucellosis cases transmitted from bovine brucellosis cases per 1,000 cattle.
Chi-square analysis indicates a significant difference from total value. *$P < 0.05$. **$P < 0.01$.

between cattle and human cases; the levels of significance were set at $P < 0.05$ and $P < 0.01$. Data analysis was carried out using the statistical system software, Microsoft Excel 2007.

Domestic cattle included dairy and native cattle of Korea, which were the principal reservoir for transmission of brucellosis to other animals and humans. Table 1 compares the prevalence of brucellosis in cattle and man between 2002 and 2009. There was a total 77,082 BB cases in domestic cattle with a PR of 13.3 per 1,000 cattle from 2002 to 2009 and a total of 620 HB cases with a PR of 0.16 per 100,000 persons. Moreover, the correlation coefficient of brucellosis outbreaks between cattle and humans was highly significant ($r = +0.985$) ($P < 0.01$) (Fig. 1). In addition, the AR of HB was 8.04.

Since the EEPBOC screening test came into force in 2004, the number of infected cattle in Korea has increased from 5,383 heads in 2004 to 17,690 heads in 2005 and peaked at 26,454 in 2006. However, in recent years, the number of BB cases has decreased from 11,547 in 2007 to 6,571 in 2009 (12). The NVRQS has stated that this reduction is because of improvement in veterinary prevention activity, as a result of enforcement or recommendations of the EEPBOC to livestock farmers, their employees, and others engaged in activities with farmers. During the same period in Korea, outbreaks of HB increased; the number of HB cases in Korea sharply increased from 1 case in 2002 to 215 cases in 2006, when it was at its peak. However, in recent years, the number of HB cases fell from 101 in 2007 to 24 in 2009. A total of 620 cases were reported between 2002 and 2009 (13). Additionally, the AR was higher in summer than in other seasons ($P < 0.05$). This data strongly suggest that the incidence of brucellosis is influenced by climate, farm environmental conditions, epidemic patterns, and the characteristic traits of the disease strain (2,3,6,15). On the other hand, the BB and HB cases were geographically localized in the southeastern region of the Korean peninsula (42.5% of the total BB cases and 44.4% of the total HB cases) as compared to other areas ($P < 0.01$). However, the AR in the northwestern region of Korea (11.14 per 1,000 cattle) was higher than in the other areas ($P < 0.05$).

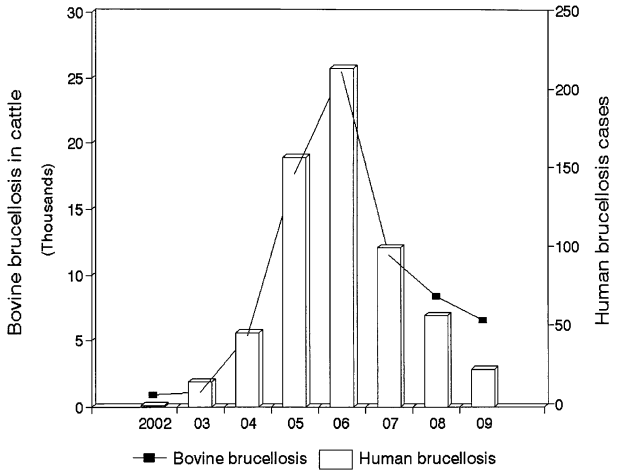

Fig. 1. Brucellosis outbreaks in domestic cattle and humans in Korea, 2002–2009.

Table 2. Epidemiological aspects of human brucellosis by gender, age, inhabitant, and attack ratio of cases in Korea, 2002–2009

Item	Human brucellosis cases		
	No. (%) of cases	95% CI	Attack ratio
Gender			
Male	539 (86.9)**	86.5–91.3	7.00**
Female	81 (13.1)	10.5–15.8	1.04
Total	620		
Age (yr)			
<39	86 (13.9)	11.2–16.6	1.12
>40	534 (86.1)**	83.4–88.8	6.92**
Total	620		
Inhabitant			
Urban	48 (7.7)	5.6–9.8	0.62
Rural	572 (92.3)**	91.2–93.4	7.42**
Total	620		
Occupation			
Farmers & others	297 (47.9)**	44.0–51.8	3.85*
White-collar	15 (2.4)	1.6–3.2	0.19
Blue-collar	14 (2.3)	0.8–2.8	0.18
Mistress	11 (1.8)	0.8–2.9	0.15
Other jobs	283 (45.6)	41.9–49.7	3.67
Total	620		

Footnotes are in Table 1.

As shown in Table 2, the epidemiological aspects of HB cases that occurred in Korea between 2002 and 2009 were analyzed by association with gender, age, inhabitant, occupation, and AR of the individual. A significantly higher number of men were infected (86.9%) than women (13.1%) ($P < 0.01$); this is believed to be owing to the different responsibilities that men and women have in their jobs and the various activities that are characteristic to the livestock field (3,16). The percentage distribution of HB among those aged less than 39 years and among those aged more than 40 years was 13.9% and 86.1%, respectively. There was a significantly high incidence ($P < 0.01$) of HB among those aged more than 40 years. Thus, the higher incidence of HB in the elderly group of farmers may be a result of the increased risk of infection because of the indoor or outdoor activities required for livestock work in rural areas, which are prone to BB outbreaks. In Korea, there is a tendency for most young people to move to cities for work, whereas, the elderly people work as farmers and livestock workers on their own land (2–4).

The distribution of HB cases was significantly higher in rural areas (92.3%) than in urban areas (7.7%) ($P < 0.01$). In addition, the distribution of cases classified by occupation was as follows: farming and related work (47.9%), white-collar work (2.4%), blue-collar work (2.3%), mistress (1.8%), and others (45.6%). These data indicate that the higher incidence of HB in farmers may be caused by their working in rural areas.

Table 2 shows the AR of HB cases by gender, age, inhabitant, and occupational group. Significantly more men (7.0 per 1,000 BB cases) than women (1.04) were infected ($P < 0.01$); moreover, this was true for those aged more than 40 years (6.92, $P < 0.01$) and for rural inhabitants (7.42, $P < 0.01$). Farmers and related workers were more likely to be infected by brucellosis (3.85, $P < 0.05$).

In the majority of endemic countries with BB outbreaks, domestic animals are the chief source of HB infection. BB is a contagious disease that causes economical loss to owners of domestic animals because of the loss of breeding cattle and milk yield (6–8,13,17,18).

In Korea, the period from 1955 to 2009 can be divided into 3 separate phases on the basis of the epidemiological pattern of brucellosis in domestic animals. The first phase ''the neglectful period of BB'' covers the outbreaks between 1955 and 1983. At that time, BB outbreaks occurred sporadically (only a few cases) until 1983. The second phase ''the endemic period of brucellosis outbreaks'' spans from 1984 to 2002. The number of infected cattle was over 100 in 1984, and the prevalence of BB has increased continuously (4,12). The third phase ''the explosive outbreak of BB'' began in 2003. The detection rate of BB has increased sharply since 2003. Meanwhile, the prevalence of HB cases, since they were first reported in 2002, showed a corresponding increase as the increase in the number of BB outbreaks in cattle (2,4,13). A total of 620 cases of HB were reported in Korea during the period from 2002 to 2009. HB outbreaks in Korea were primarily concerned with the livestock industry and infection by unprotected contact was the major route of brucellosis transmission to farmers and veterinarians. Moreover, transmission of brucellosis can be minimized by educating residents and travelers in BB risk areas on health and proper sanitary.

Finally, all control measures applied in the EEPBOC, based principally on intensive test-and-slaughter, contributed significantly to the reduction in number of brucellosis outbreaks, thus improving public health in Korea (2,4–8,12).

In conclusion, HB in Korea was mainly concerned with the livestock industry, and infection by unprotected contact was its major route of transmission. This study provides a quantitative analysis of EEPBOC in Korea and on the better planning of future control strategies. Additionally, this study investigated the epidemiological aspects of EEPBOC among cattle and humans in Korea and compared the related risk factors. We hope that this information will be a useful for public health service as a reference for further studies on brucellosis.

Conflict of interest None to declare.

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