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## Prevalence of antibodies against hepatitis E virus in wild boars (*Sus scrofa*) in Korea

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### Abstract

We determined the nationwide seroprevalence of hepatitis E virus (HEV) infection in the wild boar population in Korea. Enzyme-linked immunosorbent assay (ELISA) results showed that 42% of the 528 wild boars that were hunted between 2013 and 2014 were anti-HEV antibody positive. Furthermore, all Korean provinces showed an HEV seroprevalence between 9.8% and 51.1%, suggesting that wild boar HEV infection occurs throughout the country. Importantly, infected wild boar could act as a potential reservoir for HEV and could aid transmission to other animals and humans.

**Key words :** Hepatitis E virus, Seroprevalence, ELISA, Wild boar, Korea

### INTRODUCTION

The Hepatitis E virus (HEV) causes epidemic and endemic acute hepatitis in humans, which is transmitted mainly through water, food, and infected animals (Meng, 2013). HEV is a spherical, non-enveloped, single-stranded RNA virus belonging to the *Hepevirus* genus of *Hepeviridae* family, and is classified into four genotypes, 1~4 (Lu et al, 2006). Genotypes 1 and 2 are predominantly found in populations belonging to developing countries such as Asia, Africa, and South America; whereas genotypes 3 and 4 are zoonotic and are responsible for both sporadic and autochthonous infections worldwide (Meng, 2013; Yugo and Meng, 2013).

Animal species, including pigs and wild boars, seem to be responsible for human HEV infections (genotypes 3 and 4) (Meng et al, 1998). Therefore, a number of epidemiological studies have been conducted on domes-

tic and wild swine populations to determine the prevalence of HEV infection worldwide (de Deus et al, 2008; Kaba et al, 2010; Martelli et al, 2008; Rueter et al, 2009; Schielke et al, 2009, Takahashi et al, 2014). Previous serological studies performed on human, pig, and cat populations in Korea reported an 18%, 15%, and 8.1% prevalence of anti-HEV antibodies (Choi et al, 2003; Song et al, 2010). Moreover, anti-HEV antibodies were detected in 14 of 64 zoo animal species at different ratios (Song et al, 2013). However, no reports have addressed the seroprevalence of anti-HEV antibodies in wild boar populations in Korea, even though a wild boar-related human HEV infection has already been reported (Kim et al, 2011). Therefore, in the present study, we conducted a nationwide serological survey using enzyme-linked immunosorbent assay (ELISA) to investigate the prevalence of anti-HEV antibodies in wild boars in Korea.

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## MATERIALS AND METHODS

During the January 2013~December 2014 hunting season, serum samples were collected from 528 wild boars (279 in 2013 and 249 in 2014). Wild boars were hunted in 9 provinces of the ROK, including Seoul Metropolitan and Jeju Island (Jeju-do). Venous blood samples were collected from the wild boars immediately after hunting, preserved in blood collection tubes for transportation from the field to the laboratory, and then stored at  $-20^{\circ}\text{C}$  until serological analysis. The serum samples were analyzed according to the province where they were hunted.

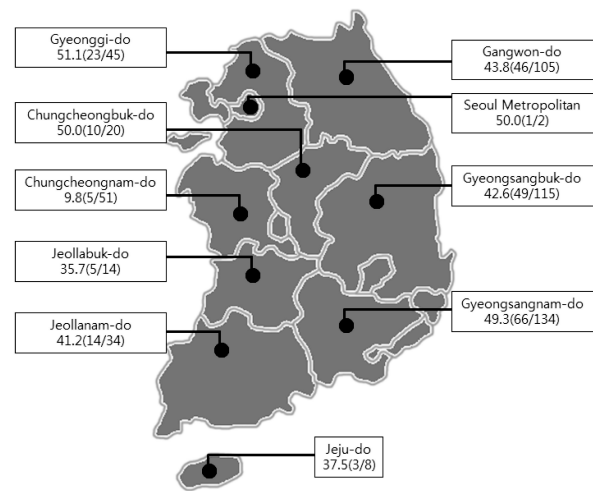
Serum samples were analyzed using a commercial ELISA test kit (MPD HEV ELISA 4.0v, MP Diagnostics, Singapore) following the manufacturer’s instructions to detect the presence of specific anti-HEV antibodies in serum samples including IgG, IgM, and IgA. Prevalence was calculated as the ratio of positive HEV samples to total number of samples. A 95% confidence interval was estimated through a binomial method. Prevalence differences among provinces were assessed by a Chi-squared test. The level of significance ( $\alpha$ ) for the statistical result was defined at 0.05. GraphPad Prism (version 5.04) software package (GraphPad Software Inc., La Jolla, CA, USA) was used for the statistical analysis.

## RESULTS AND DISCUSSION

Out of the 528 serum samples examined, 222 (42.0%) samples were positive for anti-HEV antibodies, which were detected using ELISA (Table 1). Although the seroprevalence of anti-HEV antibodies in wild boars hunted in 2014 (43.4%) was higher than that in 2013 (40.9%), there were no significant differences between

the tested years (Table 1). Furthermore, analysis of the seroprevalence of anti-HEV antibodies between provinces showed a relatively high percentage in Gyeonggi-do (51.1%), Chungcheongbuk-do (50.0%), Seoul Metropolitan (50.0%), and Gyeongsangnam-do (49.3%) provinces and a relatively low percentage in Chungcheongnam-do (9.8%) province (Fig. 1), there were significant among ( $X^2=27.16$ ,  $P<0.01$ , Table 2). Prevalence of anti-HEV antibodies in wild boars in Korea was found to be similar to or relatively higher than that in other countries, which ranges from 17% to 50.3% based on country level (de Deus et al, 2008; Kaba et al, 2010; Martelli et al, 2008; Rueter et al, 2009; Schielke et al, 2009; Takahashi et al, 2014).

HEV causes sporadic and epidemic acute viral hepatitis in humans. In endemic areas, such as the Indian subcontinent, Southeast and Central Asia, and northern and western parts of Africa, HEV causes frequent epidemics of hepatitis E, most of which are due to con-



**Fig. 1.** Prevalence of anti-hepatitis E virus antibodies in serum samples of wild boars (*Sus scrofa*) from different Korean provinces. Grey areas indicate Korean provinces where seropositive wild boars were detected, and figures in the box represent the seropositivity ratio (%) (No. of HEV-positive serum samples/total number of samples).

**Table 1.** Prevalence of anti-hepatitis E virus antibodies in serum samples of wild boars hunted in Korea (2013~2014)

Year	No. of samples	No. of HEV positive samples	Prevalence (%)	95% CI (%)*
2013	279	114	40.9	35.1~46.6
2014	249	108	43.4	37.2~49.5
Total	528	222	42.0	37.8~46.3

\*CI=confidence interval.

**Table 2.** Prevalence of anti-hepatitis E virus antibodies in serum samples of wild boars hunted in different provinces in Korea during 2013~2014

Province	No. of samples	No. of HEV positive samples	Prevalence (%) <sup>a</sup>	95% CI (%) <sup>b</sup>
Gangwon-do	105	46	43.8	34.3~53.3
Gyeonggi-do	45	23	51.1	36.5~65.7
Seoul Metropolitan	2	1	50.0	0~100
Chungcheongbuk-do	20	10	50.0	28.1~71.9
Chungcheongnam-do	51	5	9.8	1.6~18.0
Jeollabuk-do	14	5	35.7	10.6~60.8
Jeollanam-do	34	14	41.2	24.6~57.7
Gyeongsangbuk-do	115	49	42.6	33.6~51.6
Gyeongsangnam-do	134	66	49.3	40.8~57.7
Jeju-do	8	3	37.5	4.0~71.0
Total	528	222	42.0	37.8~46.3

<sup>a</sup>Sero-prevalence of anti-HEV antibodies between provinces was significantly different ( $X^2=27.16$ ,  $P<0.01$ ).

<sup>b</sup>CI=confidence interval.

taminated drinking water. In contrast, hepatitis E infection is rare in non-endemic, mostly developed countries, where some sporadic cases occur due to travel to endemic areas (Meng, 2013; Yugo and Meng, 2013). However, reports of locally acquired HEV infection have recently increased in non-endemic areas; these cases were associated with zoonotic transmission, particularly by consumption of uncooked animal meat (Tamada et al, 2004). Additionally, Kim et al, (2011) reported the first case of zoonotic transmission of HEV (genotype 4) in a patient who developed acute hepatitis E after ingestion of raw bile juice from a wild boar living on a domestic mountain in Korea. It was suggested that wild boar could be a potential risk factor for zoonotic HEV transmission to humans (Tamada et al, 2014; Yugo and Meng, 2013). However, to date, no studies have aimed to determine the prevalence of anti-HEV antibodies in wild boars in Korea. On this study, we conducted a nationwide survey to determine the prevalence of anti-HEV antibodies in wild boar populations in Korea. ELISA results showed that 42% of a total of 528 wild boars that were hunted between 2013 and 2014 were HEV positive (Table 1). The positive results suggest that these wild boars were previously infected with HEV. Furthermore, all provinces that were studied had seroprevalence rates between 9.8% and 51.1%, suggesting that HEV infection occurred in wild boar populations throughout the country (Fig. 1, Table 2). The results of this study suggest that HEV is highly common in wild boar populations, and, consequently, HEV

could be transmitted from infected wild boar to other wildlife, domestic pig, or humans in Korea. However, the etiology of HEV in wild animals, including wild boar, is still unclear. Therefore, more comprehensive studies in epidemiology, virology (virus detection and characterization from infected animals), and prevention of HEV infection from domestic and wild animals, especially wild boar, are needed to minimize the risk of zoonotic infection and improve public health.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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