The Japanese encephalitis (JE) vaccine was introduced to the national immunization program in 1985, which has led to a dramatic decrease in the number of reported cases, but JE continues to occur in foreign nationals residing in or traveling to Korea. Although the incidence is low, this study demonstrated that more Koreans were infected with JE than foreign-born expatriates. The incidence rates of Korean-born nationals were between 0.01 and 0.08 cases per 100,000. In contrast, the incidence rates of foreign-born nationals ranged between 0 and 0.26 cases per 100,000. The incidence rates clearly showed that foreign-born expatriates were more at risk, which underscores the importance of vaccination. We recommend heightened surveillance among JE-susceptible individuals and promote vaccination among foreign-born nationals living in Korea.

©2018 Korea Centers for Disease Control and Prevention. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
in Korea from 2007 to 2016.

**Materials and Methods**

In Korea, the surveillance of JE has been in place since 1954 and involves passive reporting of clinically diagnosed cases to the National Notifiable Disease Surveillance System [7]. A confirmed JE case is defined as a patient that has a febrile illness associated with neurological symptoms suggestive of JE infection, which is confirmed by laboratory diagnosis [4].

National Notifiable Disease Surveillance System data was used to describe the incidence of JE in Korea from 2007-2016. To explore the difference in epidemiology between Korean-born nationals and foreign-born expatriates, the results from an epidemiological investigation survey were reviewed.

The survey included the nationality of the affected patient and other variables. For Korean nationals, the crude incidence rate per 100,000 population was calculated according to nationality using population data from the Korea Statistical Information Service [8]. To obtain the population denominator to calculate the crude incidence rate for foreign nationals, the number of foreign nationals was derived from the Status of Foreign Resident statistics of the Ministry of Legislation [8].

**Ethics statement**

All data were collected as part of routine surveillance and all personal information was anonymized. The present study protocol was reviewed and approved by the Institutional Review board of the KCDC Korea National Institute of Health (IRB NO. 2017-07-04-P-A).

**Results**

From 2007 to 2016, a total of 175 Korean-born nationals and 13 foreign-born nationals were confirmed as JE cases. One case from Thailand was considered as an imported JE case following a 2-day interval between arrival in Korea and onset of symptoms and was excluded from cases of foreign-born nationals in Korea (Figure 1). The highest incidence of JE was in 2015 with 40 cases, and the lowest incidence was in 2011 with 3 cases. The fatality rate in foreign-born nationals in Korea was 4 deaths out of 13 cases (30.8%). The incidence rates of Korean-born nationals were between 0.01 and 0.08 cases per 100,000 (Figure 2). The incidence rates of foreign-born nationals ranged between 0 and 0.26 cases per 100,000.

Characteristics of JE cases among foreign-born nationals show that most of the cases were male (77%, 10/13), and the median age was 47 years (range: 2 months - 62 years). Three were identified as factory workers, with 1 English teacher, 1 pigsty worker, and 3 restaurant workers. The citizenships of the JE cases were identified as 8 patients from China, 2 from Nepal, 2 from the US, and 1 from Canada (Table 1).

The suspected places of transmission were mostly the metropolitan areas where 10 out of 13 cases occurred (Table 1).

**Discussion**

In this study, the status of JE infection in foreign-born nationals residing in Korea was reviewed in the light of increased incidences in recent decades of JE cases. JE cases in foreign-born nationals were observed primarily in adult males and a higher incidence rate was reported compared to cases in Korean-born nationals. Recently, a significant shift in age distribution amongst JE cases has been identified in

---

![Figure 1. Reported cases of Japanese encephalitis in the Republic of Korea.](image1)

![Figure 2. Incidence rates (per 100,000 per year) of Japanese encephalitis in the Republic of Korea by nationalities.](image2)

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender / age (y, mon)</th>
<th>Occupation</th>
<th>Citizenship</th>
<th>Suspected transmission location</th>
<th>Date of symptom onset</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F/50</td>
<td>Factory worker</td>
<td>China</td>
<td>Pyeongtaek, Gyeonggi</td>
<td>9/25/2008</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>M/58</td>
<td>Factory worker</td>
<td>China</td>
<td>Namdong, Incheon</td>
<td>9/25/2008</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>M/48</td>
<td>Factory worker</td>
<td>China</td>
<td>Goryeong, Gyeongbuk</td>
<td>10/13/2008</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>M/46</td>
<td>English teacher</td>
<td>Canada</td>
<td>Yangju, Gyeonggi</td>
<td>9/20/2010</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>M/28</td>
<td>Unknown</td>
<td>Nepal</td>
<td>Yeoju, Gyeonggi</td>
<td>9/27/2010</td>
<td>Y</td>
</tr>
<tr>
<td>6</td>
<td>M/62</td>
<td>Pigsty worker</td>
<td>China</td>
<td>Hwacheon, Gangwon</td>
<td>10/21/2010</td>
<td>Y</td>
</tr>
<tr>
<td>7</td>
<td>M/42</td>
<td>Unknown</td>
<td>United States</td>
<td>Pyeongtaek, Gyeonggi</td>
<td>8/29/2012</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>F/62</td>
<td>Restaurant</td>
<td>China</td>
<td>Iansan, Gyeonggi</td>
<td>8/19/2013</td>
<td>Y</td>
</tr>
<tr>
<td>9</td>
<td>M/59</td>
<td>Unemployed</td>
<td>China</td>
<td>Hwaseong, Gyeonggi</td>
<td>9/11/2014</td>
<td>Y</td>
</tr>
<tr>
<td>10</td>
<td>M/28</td>
<td>Unknown</td>
<td>Nepal</td>
<td>Dalseong, Daegu</td>
<td>9/22/2014</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>F/51</td>
<td>Unknown</td>
<td>China</td>
<td>Suwon, Gyeonggi</td>
<td>9/8/2015</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>M/51</td>
<td>Restaurant</td>
<td>China</td>
<td>Paju, Gyeonggi</td>
<td>10/29/2016</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>M/2</td>
<td>Unknown</td>
<td>United States</td>
<td>Yongsan, Seoul</td>
<td>10/20/2016</td>
<td>-</td>
</tr>
</tbody>
</table>

F = female; M = male; Y = death.

Korea. Between 2007 and 2010, the median age was 49.4 years in 45 JE affected patients, which increased to 53 years of age between 2010 and 2015 amongst 129 cases [4,9]. The vaccination program introduced in 1985 has ensured that JE is no longer a common disease in children, however it now presents a problem for adults and foreign-born nationals without prior history of JE vaccination.

This study was conducted in a JE endemic country and surveillance data showed severe and fatal JE infection amongst foreign adults. This could be due to the higher proportion of adults travelling or long-term expatriates compared to children. The first description of JE infection in Korea amongst foreign nationals was recorded in the 1940s, during the Korean War [3]. A similar pattern also observed in the 1950s, in US soldiers. The US citizen infected by JE in 2012 had not been vaccinated against JE and had no other relevant travel history other than visiting south Seoul.

Travelers or long-term expatriates from non-endemic countries are typically not vaccinated for JE before arriving in Korea. Amongst >8,000 US citizens traveling to JE endemic countries between 2009 to 2012, over 70% were not vaccinated against JE [10]. Although the overall incidence of JE remains very low in travelers, JE can be a life threatening disease that can be spread worldwide with today's ease of international travel. Therefore, preventive measures should be implemented.

Recently, the American Society of Tropical Medicine Hygiene has revised its recommendation to advise travelers to receive JE vaccination when visiting rural or peri-urban areas of JE endemic countries, irrespective of the duration of visit [11]. In 2015, the Korean Society of Infectious Diseases issued an immunization recommendation to foreigners from non-endemic countries and JE endemic countries without a vaccination program [12]. With the increased number of travelers visiting and expatriates living in Korea, a prophylactic implementation of vaccination guidelines should be in place.

Our review is limited by documentation of clinical information. Moreover, the number of cases is too small to elaborate on epidemiological significance. Despite these limitations, this brief report reflects national data with public health implications. Efforts are needed to promote JE vaccination amongst travelers and expatriates living in Korea, which is still a JE-harboring endemic country.

In conclusion, our study demonstrates that while there were more Korean individuals infected with JE than foreign-born expatriates, the proportion per 100,000 population was lower amongst Korean born nationals. The higher incidence rate per 100,000 foreign-born nationals clearly shows these individuals are more at risk, which underscores the importance of vaccination. We recommend heightened surveillance among JE-susceptible individuals and strongly support vaccination.
among expatriates living in Korea. There is a high chance that Korean adults aged 40 or older might have been infected with JE in their youth. As such, this age group shows a high prevalence of JE neutralizing antibodies [13]. Therefore, vaccination is recommended only for those in this age group who do not show evidence of JE immunity [14].

Conflicts of Interest

The authors have no potential conflicts of interest to disclose

References