



# Epidemiological trends and characteristics of Japanese encephalitis changed based on the vaccination program between 1960 and 2013 in Guangxi Zhuang Autonomous Region, southern China



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## SUMMARY

Japanese encephalitis (JE) is one of the most severe kinds of viral encephalitis and is prevalent in Asia and the Western Pacific. In China, JE was first reported in the 1940s and became the main cause of viral encephalitis, including in the Guangxi Zhuang Autonomous Region. In 1951, JE was included in the Chinese mandatory disease reporting system. In the pre-vaccine era of the 1960s and 1970s, the incidence of JE continued to rise without any vaccine supply. Since JE vaccines became available in the late 1970s (MBD) and 1989 (LAV-SA-14-14-2), and as JE vaccine became freely available to patients beginning in 2008, the incidence of JE has declined significantly. Despite these gains, outbreaks continue to occur among children in rural and suburban areas. Strengthening vaccine delivery models and improving swine vaccine production are important in order to sustain continuous declines in the incidence of JE in Guangxi.

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## 1. Introduction

Japanese encephalitis (JE) is a serious threat to human lives and is caused by the Japanese encephalitis virus (JEV), which belongs to the *Flaviviridae* family. The first major epidemic of JE occurred in 1924 in Japan.<sup>1</sup> Since then, JE has been found increasingly in most countries of Asia, especially in the south-east areas.<sup>2</sup> Over three billion individuals have been found in JE epidemic/ endemic countries.<sup>3</sup> According to a report by the World Health Organization, the number of cases worldwide in 2007 was 9487, including 4330 cases in China, 4017 cases in India, and 435 cases in Nepal.<sup>1</sup>

JEV generally affects young children (<15 years old) and elderly people (>65 years old), who have a weak immune system and hence are vulnerable.<sup>4</sup> The fatality in JE cases ranges from 20% to 30%, with neurological and/or psychiatric sequelae observed in 30% to 50% of survivors.<sup>15</sup> JE was first reported in the 1940s and became the main cause of viral encephalitis in China.<sup>5</sup> Guangxi, which is in the south-east area of Asia, is a southern province of China. The

geographic distribution of *Culex gelidus* Theobald, which is the vector of JEV and a mosquito native to Southeast Asia, has increased during recent decades, covering the whole of Southeast Asia, Australia, and several Pacific Islands.<sup>6,7</sup>

## 2. Materials and methods

### 2.1. Data

The data for the period 1960 to 1998 were provided by the Department of Epidemic Information, Centre for Disease Control and Prevention of Guangxi Zhuang Autonomous Region. The data for the period 1999 to 2013 were extracted from the National Notifiable Disease Reporting System (NNDRS) of P. R. China. Statistics on the population were obtained from the Guangxi Statistical Almanac.

### 2.2. Methods

IBM SPSS Statistics for Windows, version 19.0 (IBM Corp., Armonk, NY, USA) was used for the data analysis. The administrative divisions of the Province, as suggested by the Provincial

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Government Administration of 2003, were used to assess geographical variations in the incidence of JE. Guangxi Province is divided into 14 regions.

### 3. Results

#### 3.1. Epidemic situation and trends

Between 1960 and 2013, 65 520 cases were reported in Guangxi, including 11 879 deaths. The average incidence rate of JE over the 53 years was 3.39/100 000, the average mortality rate was 0.61/100 000, and the case fatality rate was 18.13%. The peak incidence (25.64/100 000) was reached in 1969. The lowest incidence of 0.03/100 000 was found in 2013. The incidence of JE in Guangxi increased continuously during the 1960s and 1970s, with an average incidence rate of 9.24/100 000 (the lowest rate was 1.69/100 000 and the highest was 21.82/100 000). The incidence decreased by degrees starting in the 1980s. In addition, the variability in the annual incidence rate ceased and regional outbreaks became more sporadic (Table 1, Figure 1).

#### 3.2. Epidemic characteristics

##### 3.2.1. Seasonal distribution

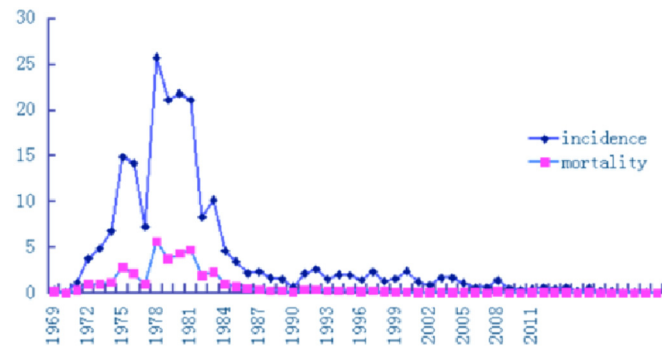
All of the cases in the 53 years from 1960 to 2013 were distributed across every month, with 95.83% of the cases concentrated in five consecutive months of each year: May, June, July, August, and September. July, accounting for 45.21% of the total number of cases during the years 1950–2013, was the month with the most serious epidemic (Figure 2).

##### 3.2.2. Distribution of different geographic areas

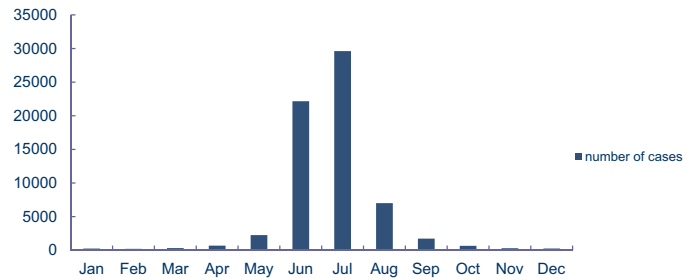
All of the 14 cities in the province reported cases of JE in the 53 years from 1960 to 2013. Guigang City had the highest incidence rate of 5.40/100 000, followed by the cities of Fangchenggang, Beihai, Laibin, and Yulin with incidence rates of

**Table 1**  
Number and rates of Japanese encephalitis cases by decade, 1960–2013; Guangxi, China

Decade	Number of cases	Number of cases from May to September	Proportion
1960–	21 583	20 611	95.50%
1970–	28 541	27 324	95.74%
1980–	7 113	6 861	96.46%
1990–	5 814	5 573	95.85%
2000–	2 278	2 236	98.16%
2010–2013	191	185	96.86%
Total	65 520	62 790	95.83%



**Figure 1.** Japanese encephalitis incidence by year, 1960–2013; Guangxi, China.



**Figure 2.** Case number of Japanese encephalitis by month, 1960–2013; Guangxi, China.

4.12/100 000, 4.02/100 000, 3.88/100 000, and 3.81/100 000, respectively. In addition, with a proportion of 14.28% of the accumulated cases and a total incidence rate of 5.40/100 000, Guigang City was considered to be the geographic area with the most serious JE epidemic situation.

The 14 cities were sorted in descending order of JE incidence rate for six different time-periods and the top five were ranked. In the 1960s, the cities of Guigang, Beihai, Fangchenggang, Chongzuo, and Yulin led the way with incidence rates of 19.60/100 000, 16.43/100 000, 14.01/100 000, 10.17/100 000, and 9.56/100 000, respectively. In the 1970s, the top five were Fangchenggang, Laibin, Guilin, Guigang, and Beihai with rates of 11.98/100 000, 11.33/100 000, 11.25/100 000, 10.89/100 000, and 10.31/100 000, respectively. In the 1980s, the order was Yulin, Guigang, Fangchenggang, Laibin, and Hechi and their incidence rates were 3.36/100 000, 3.28/100 000, 2.69/100 000, 2.01/100 000, and 1.75/100 000, respectively. In the 1990s, Hezhou City, with an incidence rate of 2.49/100 000, became the most seriously affected area, followed by the cities of Hechi, Qinzhou, Yulin, and Baise with incidence rates of 2.28/100 000, 1.87/100 000, 1.74/100 000, and 1.66/100 000, respectively. The highest incidence rate of 1.19/100 000 was found for Hechi City in the 2000s and the other cities in the top five were Baise (1.10/100 000), Hezhou (0.74/100 000), Guigang (0.50/100 000), and Chongzuo (0.42/100 000). Finally, from 2010 to 2013, the order was Hechi (0.34/100 000), Yulin (0.17/100 000), Guigang (0.16/100 000), Laibin (0.14/100 000), and Wuzhou (0.09/100 000).

##### 3.2.3. Distribution of different population subgroups

Population distribution data were extracted from the NNDRS, which provided the data since 2004. There were 1288 JE cases reported between 2004 and 2013 in Guangxi, including 764 males and 524 females (sex ratio 1.44:1.98). Sixty percent of the JE cases were younger than 15 years old. Across all categories of profession, housebound preschool children comprised the main JE population (68.48%), followed by students (22.75%) and kindergarten children (6.60%).

## 4. Discussion

### 4.1. Trends and characteristics of JE in Guangxi

Two epidemiological patterns of JE are recognized: epidemic and endemic.<sup>8,9</sup> Epidemic patterns are observed mainly in northern areas, including P.R. China, Korea, and Vietnam.<sup>3</sup> The JE case reporting system has been mandated by law since 1951 in P.R. China.<sup>10</sup> Accumulated JE cases and average incidence rates for Guangxi changed with a similar trend, increasing in the 1960s, reaching a peak in the 1970s, and decreasing dramatically from the 1980s. However, its ranking increased. The JE incidence rate of Guangxi ranked between 9<sup>th</sup> and 14<sup>th</sup> between 1990 and 2002 in China, and rose to 5<sup>th</sup> in 2005.

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