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The effect of ambient temperature on the activity of influenza and influenza like illness in Jiangsu Province, China

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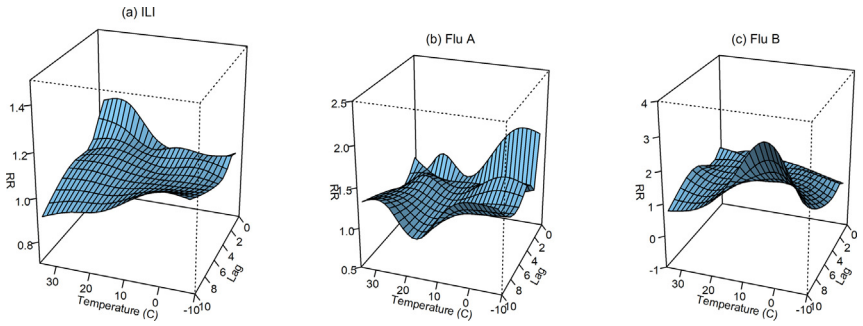
HIGHLIGHTS

- Flu-A circulated throughout the year with two peaks, while Flu-B were usually tested positive in winter or early spring.
- The RR of ILI increased with time and peaked 1 day later at low temperature, while peaked on day 0 at high temperature.
- The influenza viruses activity did drive up the rising of ILI%, particularly the Flu-A which circulated throughout the year.
- The cumulative association between influenza activity and temperature presented regional homogeneity in Jiangsu Province.

GRAPHICAL ABSTRACT



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ABSTRACT

Objective: We aimed to evaluate and quantify the association between ambient temperature and activity of influenza like illness (ILI) and influenza in Jiangsu Province, China.
Method: Daily data of meteorology, influenza-like illness and detected influenza virus from 1 April 2013 to 27 March 2016 were collected. Distributed lag non-linear model (DLNM) was used to quantify the exposure-lag-response of ILI and influenza activity to daily average temperature.
Result: Influenza A virus (Flu-A) circulated throughout the year with two peaks at −4 °C and 28 °C respectively, while influenza B (Flu-B) viruses were usually tested positive in winter or early spring and peaked at 5 °C. The lag-response curves revealed that the RR of ILI increased with time and peaked 1 day later at low temperature (3 °C), however, the maximum RR of ILI caused by high temperature (26 °C) appeared immediately on day 0, the similar phenomena of immediate effect to ILI at high temperature were also observed in the lag-response curve for Flu-A or Flu-B.
Conclusion: ILI and Flu-A experienced two peaks of circulates at both low and high temperature in Jiangsu. The influenza viruses activity did drive up the rising of ILI%, particularly the activity of Flu-A which circulated throughout the year played a crucial role. Regional homogeneity was the relatively mainstream in aspects of cumulative association between influenza activity and temperature in Jiangsu Province.

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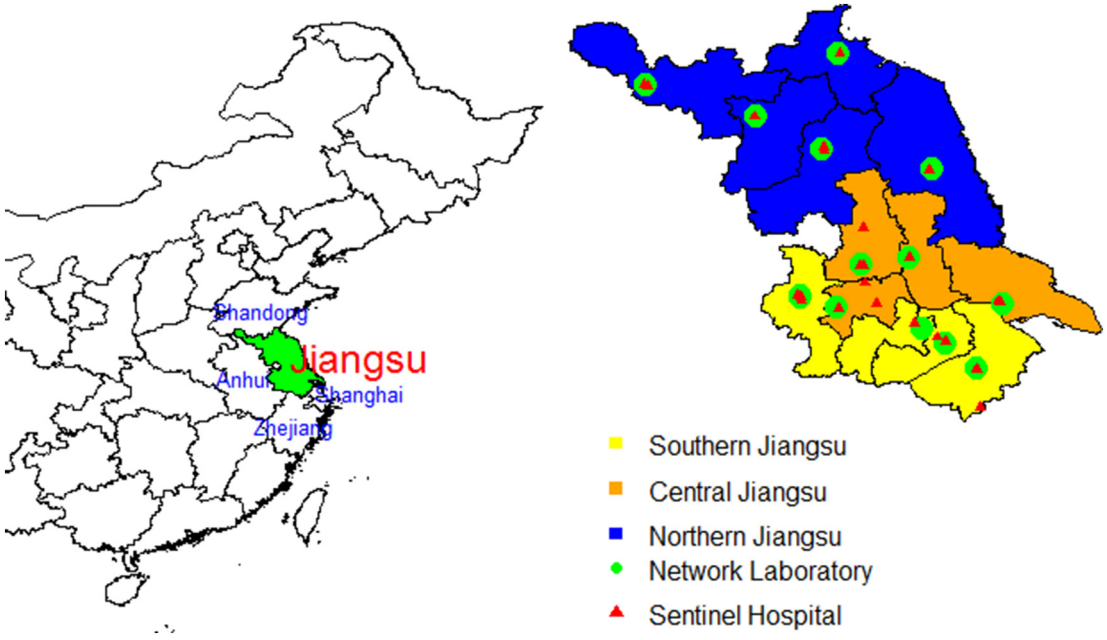

Fig. 1. The geographical location of Jiangsu in eastern coastal China, network laboratories and sentinel hospitals.

1. Introduction

Recently there has been increasing interest in the relationship between climatic factors and health outcomes (Barnett et al., 2010; Gasparrini and Armstrong, 2010; Yang et al., 2016). Health outcomes such as mortality and morbidity of infectious or chronic non-infectious diseases induced by climate change and air pollution, had been becoming hot issues in the interdisciplinary field of meteorological and medical science (Basu and Samet, 2002; Gasparrini et al., 2015; Lubczynska et al., 2015; Ye et al., 2012; Yin et al., 2016). Influenza is an acute respiratory infectious disease related to climate and with seasonal clustering cycles (Nimbalkar and Tripathi, 2016), there remains the public concern about the new pandemic influenza may cause severe complications and deaths over the world. The activity of influenza has an immense influence on peoples' health all the time, and also, brings huge burden of disease (Klepser et al., 2015; Mughini-Gras et al., 2016).

In intermediate latitudes provinces of China, the activity of Flu-A viruses usually peaks twice, one in winter and another in summer, in contrast, Flu-B activity predominated in colder months (Gasparrini et al., 2015; Meng et al., 2016; Yang et al., 2008). The causes of seasonality in influenza may depend on a variety of hypothesis, including seasonal host heath, socioeconomic level, subtype of influenza virus and environmental factors (Lofgren et al., 2007). By now, we have no thorough understanding of the relationship, especially the exposure-lag-response between the activity of various types of influenza viruses and climatic condition such as temperature, now available researches on such association between influenza and meteorological factors are either based on animal models (Lowen et al., 2007) or traditional statistical models (Jaakkola et al., 2014; Soebiyanto et al., 2014; van Noort et al., 2012; Xu et al., 2013) those didn't reveal the cumulative or lag effects of environmental factors on influenza. In order to supplement the deficiency, we attempted to introduce the distributed lag non-linear model (DLNM) to illuminate the influence of temperature to ILI and the activity of different subtypes of influenza viruses, based on the surveillance and laboratory data, in the scope of Jiangsu Province.

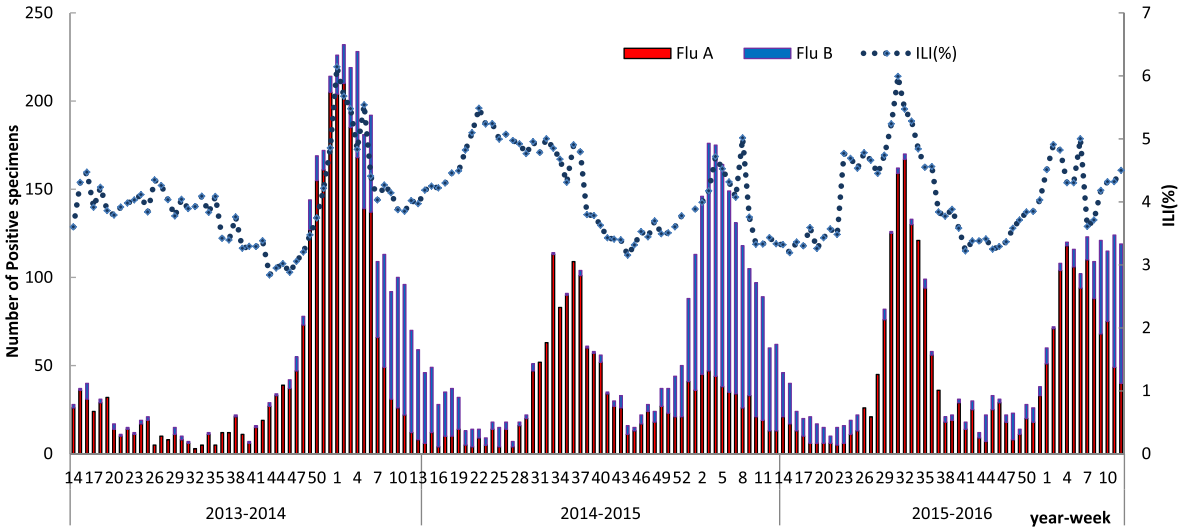

Fig. 2. ILI and number of specimens positive for influenza by subtype in 2013–2016.