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Assessment on the burden of bacillary dysentery associated with floods during 2005–2009 in Zhengzhou City, China, using a time-series analysis

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ABSTRACT

Background: We aimed to quantify the impact of few times floods on bacillary dysentery in Zhengzhou during 2005–2009.

Methods: The Spearman correlation test was applied first to examine the lagged effects of floods on monthly morbidity of bacillary dysentery during 2005–2009 in Zhengzhou. We further quantified the effects of 7 flood events on the morbidity of bacillary dysentery using the time-series Poisson regression controlling for climatic factors, seasonality, gender and age groups. We estimated years lived with disability (YLDs) to estimate the burden of bacillary dysentery attributed to floods among different population groups.

Results: A total of 15,841 cases of bacillary dysentery were reported in the study region over the study period. The relative risks of floods on the morbidity of bacillary dysentery and attributable YLDs among the whole study population, males, females, below 14 years old group, 15–64 years old group, and over 65 years old group were 2.80, 3.13, 2.53, 2.75, 3.03, 2.48, and 1.206, 1.513, 0.913, 3.593, 0.638, 0.880, respectively.

Conclusions: Our findings contribute to developing local strategies to prevent and reduce health impact of floods.

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Introduction

Climate change is a complex global environmental problem with the significant impacts on human health. Much of these impacts may be due to the perception that climate change is leading to an increase in the occurrence and magnitude of extreme flood events

[1], and that problem is not going away [2]. Due to frequent heavy precipitation, Zhengzhou, as the capital city of Henan Province in China adjacent to Yellow River, has suffered from many times of floods since the 21st century [3].

The damages of floods include direct and indirect damages, which are acknowledged that playing an important role in evaluating flood impacts [4]. Some studies have examined the epidemics of water-borne diseases associated with flood events, such as cholera, gastro-enteritis, dysentery and typhoid [5–8]. The reason for increased morbidity could be due to drinking water or food contaminated by pathogens [9,10].

Bacillary dysentery is a bacterial infection of intestines caused by *Shigella* bacteria that results in severe diarrhea. Although the health burden due to bacillary dysentery has decreased considerably in

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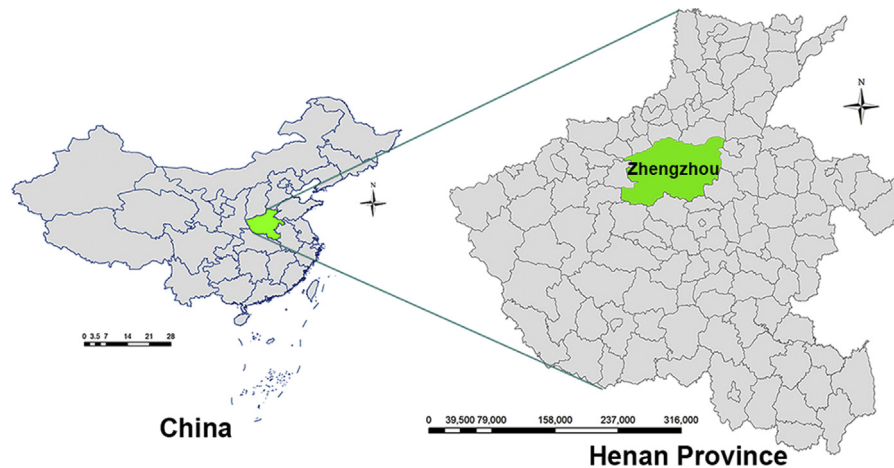


Fig. 1. Location of Zhengzhou in Henan Province, China.

China, it is still a public health problem in Zhengzhou. According to the National Report of Notifiable Diseases from Ministry of Health of China, there were 15,841 notified cases of bacillary dysentery during 2005–2009 in Zhengzhou, which was the third highest notified communicable disease, following Tuberculosis and Hepatitis B.

Years Lost with Disability (YLDs), as an indicator of burden of disease, is able to represent health outcomes appropriately, considering both mortality and morbidity. It can assist evidence-based allocation of limited health resources in public health disaster [11]. However, there has been little research to calculate the burden of bacillary dysentery under flooding scenarios, measured in terms of the comprehensive measurement-YLDs. To our knowledge, there have been four studies that attempted to quantify a wide range of health impacts resulting from flooding using YLDs [12–15]. However, these studies did not estimate the burden of diseases that can be attributed to more than one flood event in one region.

This study aimed to quantify the impact of a few flood events on bacillary dysentery in Zhengzhou during 2005–2009. Results are expected to provide scientific evidence for policy makers and public health practitioners to inform action to reduce future risks of bacillary dysentery infections associated with floods.

Materials and methods

Study area

As shown in Fig. 1, Zhengzhou City, the capital city of Henan Province, is located in the middle reaches of the Yellow River. Zhengzhou is located between latitude $34^{\circ}16'–34^{\circ}58'N$ and longitude $112^{\circ}42'–114^{\circ}14'E$. It has a warm temperate continental monsoon climate with an annual average temperature from $13.7^{\circ}C$ to $14.2^{\circ}C$ and an average annual rainfall approximately 640.9 mm. The population of Zhengzhou was relatively stable during 2005–2009, ranging from 677 to 683 million.

Data collection and management

Disease surveillance data

Disease surveillance data on bacillary dysentery from 2005 January to 2009 December were obtained from the National Notifiable Disease Surveillance System (NDSS). The definition of bacillary dysentery from the NDSS is an infectious disease that is caused by *Shigellae*, which has fever, abdominal pain, tenesmus and bloody or mucus stool as the typical clinical presentation. In our study, all bacillary dysentery cases were defined based on the diagnostic criteria and principles of management for dysentery (GB 16002-1995)

issued by Ministry of Health of the People's Republic of China [16]. Only the cases confirmed clinically and by laboratory tests, including microscopic examination and biochemical identification, were included in our study. Information of patients included age, gender, occupation, address, name of disease, cases classification, date of onset, and date of death. According to the National Communicable Disease Control Act, physicians in hospitals must report every case of dysentery to the local health authority. Then, the local health authority must report these cases to the next level of the organization within 24 h [17]. Therefore, it is believed that the degree of compliance in disease notification over the study period was consistent.

Data on floods

The Yearbooks of Meteorological Disasters in China recorded the occurrence, deaths, damage area and economic loss of floods in detail from 2005 to 2009 [18]. The definition of flooding in the Yearbook of Meteorological Disasters of China is a natural disaster resulting from the rivers overflowing due to short-term heavy precipitation, which leads to farmland and cities submerged, casualties and economic losses. According to the Yearbooks of Meteorological Disasters in China, there were 7 flood events occurred in Zhengzhou between 2005 and 2009, which took place in July 2005, July 2006, August 2006, August 2007, June 2008, July 2008 and June 2009, respectively.

Demographic and meteorological data

Demographic data were obtained from the Center for Public Health Science Data in China (<http://www.phsciencedata.cn/>). Monthly meteorological data were obtained from the China Meteorological Data Sharing Service System (<http://cdc.cma.gov.cn/>). The meteorological variables included monthly cumulative precipitation (MCP), monthly average temperature (MAT), monthly average relative humidity (MARH), monthly average wind velocity (MAWV), monthly average air pressure (MAAP) and monthly sunshine duration (MSD).

Statistical analysis

To quantifying the association between floods and morbidity of bacillary dysentery

Firstly, a descriptive analysis was performed to analyze the distribution of bacillary dysentery and climatic factors in flooded and non-flood months. Secondly, Spearman's correlation was used to examine the association between the monthly morbidity of dysentery, floods and climate factors at various lag values. The significant

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