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Diurnal temperature range in relation to death from stroke in China

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ABSTRACT

Background: Stroke is the second leading cause of death in the world. It has multiple risk factors of which some, such as ambient temperature, are less well documented.
Objective: We aimed to examine the association between diurnal temperature range (DTR) and stroke mortality, and to test the possible effect modification of this association according to gender, age and educational level.
Methods: Daily data on weather and stroke mortality from 16 provincial capital cities in China for the years 2007–2013 were obtained, with a total of 788,783 deaths from stroke. A quasi-Poisson generalized linear regression combined with a distributed lag non-linear model was used to examine the city-specific DTR effect on stroke mortality. The pooled effects of DTR on stroke mortality were then obtained using a meta-analysis, which was based on restricted maximum likelihood estimation.
Results: The DTR impacts were generally limited to a period of eight days, while significant effects during lag 0–8 days were only found in the cities of Beijing, Zhengzhou, Nanjing, Hefei, Chongqing and Changsha. The DTR effects were significantly and negatively associated with latitudes at lag 0–10 days ($r_s = -0.640$, $P = 0.008$). An increase of 1 °C in DTR was associated with pooled estimate of 0.66% (95%CI: 0.28–1.05%), 0.12% (−0.26% to 0.51%) and 0.67% (0.26–1.07%) increases in stroke mortality at lag 0–10 days during the total, hot and cold days, respectively. The impact of DTR was much higher in southern China than in northern China [1.02% (0.62% to 1.43%) versus 0.10% (-0.27% to 0.47%)]. For the individual characteristics, only females, the elderly aged ≥ 65 years, and those with lower educational attainment were vulnerable to DTR.
Conclusions: DTR has considerable effects on risk of mortality from stroke in various cities in China, especially among the elderly, females, those with low educational level, and people living in southern China. The results can inform decisions on developing programs to protect vulnerable subpopulations from adverse impacts of DTR.

1. Introduction

Stroke, also known as cerebrovascular disease, including ischemic and haemorrhagic stroke, was the second leading cause of death worldwide (WHO, 2017). According to the Global Burden of Disease, stroke resulted in 6.45 million deaths in 2013, increasing from 4.58 million deaths in 1990 (Wang et al., 2016). In the past few decades, the risk of death from stroke has decreased in many developed countries but rapidly increased in many developing countries (Feigin et al., 2009). Therefore, quantitative assessment of stroke-related risk factors in developing countries is important to inform policymakers and local governments on managing and controlling these fatal events.

Diurnal temperature range (DTR) is the difference between daily maximum and minimum temperature, and is an important

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meteorological index relating to global climate change and weather variation (Braganza et al., 2004; Hansen et al., 1995). Large variation in daily DTR causes additional environmental stress with adverse impact on human health, particularly for those suffering from pre-existing chronic health problem, such as cardiovascular diseases and respiratory diseases (Bhaskaran et al., 2009; Dilaveris et al., 2006; Lim et al., 2012; Yang et al., 2013). As one of the sensitive diseases to weather variability, there are only few single-city studies examining the association between DTR and stroke mortality (Chen et al., 2007; Yang et al., 2013; Zhang et al., 2017), which may limit their applicability to the country level scale.

In this study, we aimed to investigate the association between DTR and mortality from stroke in 16 Chinese capital cities, and to test whether the effect estimates differed by individual characteristics, such as gender, age and educational attainment.

2. Methods

2.1. Study sites

This study included 16 provincial capital cities in China, including eight southern cities (Shanghai, Nanjing, Hefei, Chengdu, Wuhan, Chongqing, Changsha and Guangzhou) and eight northern cities (Harbin, Changchun, Shenyang, Beijing, Tianjin, Yinchuan, Jinan and Zhengzhou). The Qin Mountains and the Huai River near 33° N latitude were used to classify cities as northern or southern (Fig. 1).

2.2. Data collection

Daily counts of stroke mortality during 2007–2013 were collected from the National Center for Chronic and Noncommunicable Disease Control and Prevention , Chinese Center for Disease Control and Prevention. The stroke mortality was coded following the International Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10): I60–I69. In addition, data were further stratified by gender, age group (0–64 and 65+ years) and educational attainment (primary school or lower and secondary school or higher).

Daily weather data were acquired from the National Meteorological Information Center, China Meteorological Administration, comprising daily maximum, mean and minimum temperatures, relative humidity and atmospheric pressure.

Demographic data for each city were collected from China's 2010 population census, including the percentage of those with percentage of those with high school level or above and percentage of those with aged 65 years old or above. City-level economic data, such as gross regional domestic product (GDP), capital and percentage of green space were collected from the Chinese National Bureau of Statistics (http://www.stats.gov.cn/tjsj/ndsj/). The detailed information of city-level variables was presented in Supplementary Table A1.

2.3. Exposure definition

Diurnal temperature range (DTR) was computed as the difference between the daily maximum temperature and daily minimum temperature in one day.

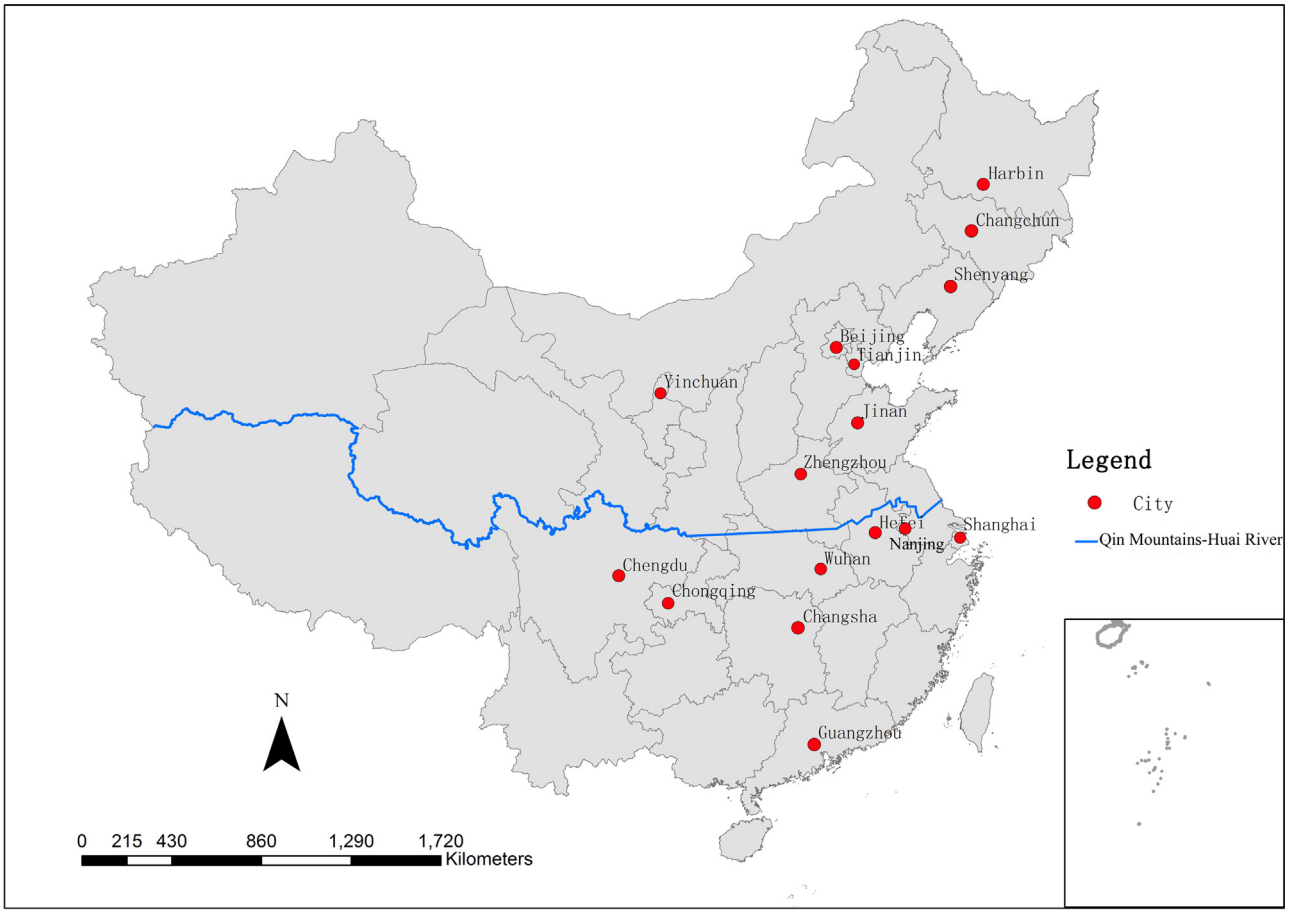

Fig. 1. Locations of the 16 cities in China included in the study. These cities were categorized as northern cities (Harbin, Changchun, Shenyang, Beijing, Tianjin, Yinchuan, Jinan and Zhengzhou) and southern cities (Shanghai, Nanjing, Hefei, Chengdu, Wuhan, Chongqing, Changsha and Guangzhou).