Original Research

Daily temperature change in relation to the risk of childhood bacillary dysentery among different age groups and sexes in a temperate city in China

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ABSTRACT

Background: In recent years, many studies have found that ambient temperature is significantly associated with bacillary dysentery (BD). However, there is limited evidence on the relationship between temperature and childhood BD in temperate areas.

Objectives: To investigate the relationship between daily mean temperature (MT) and childhood BD in China.

Methods: Data on daily MT and childhood BD between 2006 and 2012 were collected from the Bureau of Meteorology and the Centre for Disease Control and Prevention in Hefei, Anhui Province, China. A Poisson generalized linear regression model combined with a distributed lag non-linear model was used to analyse the effects of temperature on childhood BD across different age and sex subgroups.

Results: An increase in temperature was significantly associated with childhood BD, and each 1 °C increase corresponded to an increase of 1.58% [95% confidence interval (CI) 0.46 −2.71%] in the number of cases of BD. Children aged 0–5 years and girls were particularly sensitive to the effects of temperature.

Conclusions: High temperatures may increase the risk of childhood BD in Hefei. Children aged 0–5 years and girls appear to be particularly sensitive to the effects of high temperature.

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Introduction

Bacillary dysentery (BD) is mainly caused by Shigella. Common clinical manifestations include fever, chills, abdominal pain and diarrhoea after an incubation period of one or two days.[1] BD is mainly spread through the faecal−oral route and person-to-person contacts. BD epidemics are common among over-crowded populations with poor sanitation. Previous studies have found that trends in BD transmission show significant seasonality, and its incidence peaks in summer and autumn.[2−4]

In recent decades, although the incidence of BD has declined considerably in developing countries,[5] the considerable burden of BD is still a great public health concern in impoverished areas.[6−8] Globally, BD remains an important cause of mortality among children aged <5 years, especially in China.[8,9] According to the National Notifiable Diseases of China, the number of cases of BD reached almost 0.19 million, with an incidence of 138.2 per million, in 2013 and approximately 85% of cases occur in summer and autumn.[10,11] The burden of childhood BD has been reported to be much greater than the burden of other age groups (>14 years),[12−14] suggesting that research into childhood BD would be of more practical significance.

Many individual, social and environmental factors are associated with the occurrence of BD.[15] In northeast China, Huang et al. found that climatic factors (including temperature, evaporation, precipitation and relative humidity) were positively correlated with cases of BD.[11] Associations between mean and maximum temperatures and BD have also been observed in Taiwan.[16] Available evidence strongly suggests that children are more susceptible to BD, while few studies to date have focused on assessing the impact of temperature on BD among children, and little is known about whether the relationship between temperature and childhood BD varies by age and sex.

The incidence of BD in China is high, which can be largely attributable to the extremely high population mobility and high population density. Adverse effects of mean temperature (MT) on BD may exist in different areas with various socio-economic statuses, population characteristics and weather conditions. As such, an eastern inland city of China (Hefei) was selected as the study site. This study attempted to address the following research issues using a Poisson generalized linear regression model combined with a distributed lag non-linear model (DLNM):[17]

- What is the relationship between daily MT and childhood BD?
- Which subgroups are more vulnerable to the effects of MT on BD?
- Is there a delayed effect of MT on childhood BD?

Methods

Setting

Hefei, the capital city of Anhui Province, is located in the east of China (31°52′ N, 117°17′ E) (see Fig. 1). The city has an area of 11,408 km², a population of approximately 7.61 million, and 18.1% of the population are aged 0−14 years.[18] Hefei has a typical subtropical humid monsoon climate, with hot summers and mild winters.

Data collection

Daily data on BD morbidity in children (aged 0−14 years) between 2006 and 2012 were collected from Hefei Centre for Disease Control and Prevention. Age (0−5 years and 6−14 years) and sex (male and female) stratified analyses were conducted.

The quality of BD data used in this study is reliable. BD occurs frequently in China, and it is easy for doctors to make a correct diagnosis. In addition, all cases of BD need to be reported to the local infectious disease surveillance system by the surveillance system network in a standardized format. Meteorological data were collected from the Hefei Bureau of Meteorology between 2006 and 2012, including daily MT, maximum temperature, minimum temperature, precipitation and relative humidity (RH). The prevalence of BD in children aged <10 years was relatively high.[19,20] May−October was selected as the main study period, as the incidence of childhood BD is highest at this time of year.

Statistical analyses

A DLNM was used to analyse the relationship between daily BD cases and MT between 2006 and 2012.[21] The model was designed to describe the response of the two-dimensional MT relationship with the dimensions of MT and lag day using the cross-basis function, which controlled confounding variables including humidity, precipitation and day of the week (DOW).

A Poisson generalized linear regression model combined with a DLNM was used to analyse the relationship between MT and cases of BD in different age and sex groups. The dependent variable obeys Poisson regression, and the relationship between the dependent variable and the independent variable is assumed to be non-linear; as such, a Poisson generalized linear regression model combined with a DLNM was used. A DLNM has greater flexibility to fit the delayed effects and potential non-linear exposure−response dependencies for time series data (such as daily meteorological data and daily cases of BD).[17] Precipitation, relative humidity, DOW, long-term trends and seasonal trends were controlled for potential confounders.[21,22] In order to evaluate the model fit and choice of degrees of freedom (df), residual analysis and Akaike information criterion were used in the whole process.

$$Y_d \sim Poisson\ (V_d)$$

$$Log(V_d) = a + bMT_{d,l} + NS(MT_{d,3}) + NS(Time_{d,4}) + NS(RH_{d,3}) + gDOW_d$$

where V_d is Poisson distribution in observed days; d is day of observation; a is constant of model; b is the coefficient of coefficients for $MT_{d,l}$; g is the coefficient of coefficients for DOW_d; l is lag days; $MT_{d,l}$ is a matrix obtained by applying the DLNM to MT; NS is natural cubic spline; NS ($MT_{d,3}$) was used to control MT with three degrees of freedom; NS ($Time_{d,4}$) was used to control long-term trends with four degrees of freedom; NS ($RH_{d,3}$) was used to control relative humidity with three