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Original Research

Impact of temperature variability on childhood hand, foot and mouth disease in Huainan, China



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ABSTRACT

Objectives: The short-term temperature variation has been shown to be significantly associated with human health. However, little is known about whether temperature change between neighbouring days (TCN) and diurnal temperature range (DTR) have any effect on childhood hand, foot and mouth disease (HFMD). This study aims to explore whether temperature variability has any effect on childhood HFMD.

Study design: Ecological study.

Methods: The association between meteorological variables and HFMD cases in Huainan, China, from January 1st 2012 to December 31st 2014 was analysed using Poisson generalized linear regression combined with distributed lag non-linear model (DLNM) after controlling for long-term trend and seasonality, mean temperature and relative humidity.

Results: An adverse effect of TCN on childhood HFMD was observed, and the impact of TCN was the greatest at five days lag, with a 10% (95% CI: 4%–15%) increase of daily number of HFMD cases per 3 °C (10th percentile) decrease of TCN. Male children, children aged 0–5 years, scattered children and children in high-risk areas appeared to be more vulnerable to the TCN effect than others. However, there was no significant association between DTR and childhood HFMD.

Conclusions: Our findings indicate that TCN drops may increase the incidence of childhood HFMD in Huainan, highlighting the importance of protecting children from forthcoming TCN drops, particularly for those who are male, young, scattered and from high-risk areas.

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Introduction

Hand, foot and mouth disease (HFMD) is an infectious gastrointestinal disease caused by a group of enteroviruses, most frequently Coxsackie A 16 (CAV16) and Enterovirus 71 (EV 71) and occurring mainly in children under five years old.¹ In most cases, HFMD follows a benign and self-limiting course. However, some patients rapidly develop neurological and systemic complications that can be fatal, and such cases are mainly associated with EV 71 infection.² Since the first case records in 1957,³ outbreaks and epidemics of HFMD have been reported worldwide.^{4–7} Over the past decades, many large outbreaks of HFMD occurred in Asian countries.^{4,5,8–12} In particular, the epidemic situation of HFMD in mainland China was quite serious.⁵ In 2009, for example, an epidemic in mainland China led to 1,155,525 cases, 13,810 severe cases and 353 deaths.¹³ Despite decades of research, there is still no vaccine or antiviral treatment specifically for HFMD, hence it is particularly important to identify HFMD-related risk factors and further to prevent children from being exposed to these risk factors.

As climate change proceeds, the possible impact of meteorological factors on HFMD has attracted increasing research attention. In particular, the relationship between ambient temperature and HFMD has been documented in many studies.^{14–19} Along with the increased weather variability and climate instability,²⁰ the frequency, intensity and duration of temperature change are projected to increase in specific areas, where people might not be adapting to temperature change abruptly. In this context, more studies are urgently needed to explore the underlying effect of temperature variability on human health. To date, there are several ways to define temperature variability (e.g. diurnal temperature range (DTR), temperature change between neighbouring days (TCN)),^{21,22} Previous studies have highlighted that large DTR or TCN might be associated with many communicable diseases (e.g. diarrhoea, pneumonia and respiratory syncytial virus (RSV)).^{23,24,26} HFMD are mainly transmitted through the fecal-oral route or via respiratory droplets, which are similar to the transmission of diarrhoea (fecal-oral route) and RSV (respiratory tract).^{23,25,26} In addition, Bull et al. reported that temperature variability may affect humoral or cellular immunity.²⁷ At the same time, young children generally have poor self-care ability and relatively immature immune system.²⁸ Large temperature change might reduce immunity and cause them to be more vulnerable to virus infection. Thus it was probable that large temperature change could also pose a threat to childhood HFMD. Nonetheless, to date, the potential impact of temperature variability on childhood HFMD has received less attention, and no studies have both investigated the effects of TCN or DTR on childhood HFMD. Therefore, the objective of this study was to examine the relationship between temperature variability (TCN and DTR) and childhood HFMD using surveillance data collected in Huainan, China, from 2012 to 2014. Moreover, stratified analyses were conducted to explore which groups were sensitive to larger temperature change.

Methods

Study area

This study was conducted in Huainan, an inland city located in the North Anhui Province, China (32° 65' N, 117° 02' E). Huainan features a temperate monsoon climate, experiencing four distinct seasons. It has a population density of 950 persons per km² (total area: 2596.4 square kilometres, total population: 2.43 million by the end of 2013). Huainan consists of six districts (Bagongshan district (BGS), Datongqu district (DTQ), Xiejiaji district (XJJ), Fengtaixian district (FTX), Tianjiaan district (TJA) and Panjiqu district (PJQ)). We chose three districts (FTX, TJA and PJQ) for high-risk areas due to the high incidence of HFMD (Fig. 1).

Data collection

Daily cases of HFMD in children younger than 14 years old covering the period 2012–2014 were obtained from Huainan Center for Disease Control and Prevention. According to China's notifiable infectious disease regulations, each district was required to report HFMD cases to the infectious disease surveillance system with unified format, in which the information included name, sex, age, address, date of symptom onset. The clinical criteria for diagnosis of HFMD have been provided in a guidebook published by the Ministry of the People's Republic of China in 2010 (MHC).²⁹ Patients with the occurrence of the following clinical symptoms are defined as having HFMD: papular or vesicular rash on hands, feet, mouth, buttocks or knees, with or without fever. Ethical approval was obtained from the Ethics Committee of Anhui Medical University prior to the HFMD cases being collected.

In terms of exposure data, daily meteorological data including maximum temperature, mean temperature, minimum temperature, relative humidity, pressure and rainfall were obtained from Huainan Bureau of Meteorology. TCN was calculated as the current day's mean temperature minus the previous day's mean temperature. DTR was calculated as daily maximum temperature minus daily minimum temperature.

Statistical analysis

Late spring and early summer (March–June) were chosen as the main study period because it has a relatively high incidence of childhood HFMD (Fig. 2). A Poisson generalized linear regression model combined with a distributed lag non-linear model was applied to quantify the effect of TCN (or DTR) on childhood HFMD. Mean temperature and relative humidity were controlled in the model, as previous studies had suggested potential confounding effects of mean temperature and relative humidity.^{1,30} Long-term trend and seasonal patterns were controlled by using a nature cubic spline with four degree of freedom (df) per year. Day of week was controlled as a categorical variable with a reference day of Sunday. In all cases, the Akaike Information Criterion (AIC) and analysis of residuals were applied to evaluate the model fit and the choice of df.

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