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Original Research

Effect of increasing temperature on daily hospital admissions for schizophrenia in Hefei, China: a time-series analysis

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ABSTRACT

Objective: To investigate the relationship between ambient temperature and hospital admissions for schizophrenia in Hefei, China.

Study design: An ecological design was used to explore the effect of ambient temperature on hospital admissions for schizophrenia.

Methods: Daily data on hospital admissions for schizophrenia and meteorological data for the warm season (May–October) in 2005–2014 were obtained from Anhui Mental Health Centre and Hefei Bureau of Meteorology, respectively. Poisson generalised linear regression model combined with a distributed lag non-linear model was used to analyse the effects of temperature on admissions for schizophrenia. Stratified analyses according to individual characteristics, such as age and sex, were also conducted.

Results: A significant relationship was found between ambient temperature and admissions for schizophrenia. High temperature appeared to have a delayed effect on admissions for schizophrenia, and a temperature of 28°C (75th percentile) at lag 0–4 days was associated with a 7% (95% confidence interval: 4–11%) increase in admissions for schizophrenia. Stratified analyses showed that male patients, patients aged 21–60 years and married patients were more vulnerable to high temperature, and the temperature effects for those groups occurred at a lag of 1 day.

Conclusion: High temperature poses significant risks for schizophrenia in subtropical regions. Future preventive measures for reducing the occurrence of schizophrenia should be considered for susceptible populations.

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Introduction

Schizophrenia is a common complex neuropsychiatric disorder characterised by psychosis, cognitive dysfunction, delusion, hallucination and negative symptoms,[1,2] which affects almost every aspect of a patient's life and the lives of their family members.[3] Globally, it is estimated that 21 million people are affected by schizophrenia and other mental disorders.[4] Schizophrenia places a heavy burden on health care and the economy.[5,6] A 2007–2010 follow-up study in China showed that 0.37% of men and 0.44% of women were living with schizophrenia in China.[7] Given this situation, it is important to identify potential risk factors to develop effective prevention and control strategies.

There are many potential triggers for schizophrenia, including genetic, social and environmental factors.[8] In recent years, global warming has been a great threat to human health worldwide. Abundant evidence has shown that higher temperature is associated with increased risk for many diseases, such as cardiovascular and respiratory diseases.[9,10] Several studies have also been conducted to investigate if ambient temperature affects the risk of onset of schizophrenia.[11–15] Some studies found that an increase in temperature increased the number of hospital admissions for schizophrenia,[11–13] but other studies found that high temperature was associated with decreased risk of admission for schizophrenia.[14,15] To date, the relationship between temperature and schizophrenia has only been investigated in tropical and temperate areas, such as Taiwan, Toronto and Adelaide.[11,12,14] No studies have investigated this relationship in subtropical districts where temperature effects (e.g. effect size and direction) may differ from previous research findings because of different climatic patterns, socio-economic characteristics and adaptation to local weather.[16] As such, this study investigated the impact of high temperature on admissions for schizophrenia in the Hefei area, which has a subtropical climate.

This study aimed to (1) examine the relationship between ambient temperature and admission for schizophrenia; (2) analyse whether ambient temperature has an acute or delayed effect; and (3) assess whether temperature effect varied with sex, age and marital status.

Methods

Study area

This study was conducted in Hefei, the capital city of Anhui Province, located in central-eastern China (31° 52′ N, 117° 17′ E). Hefei covers 11,408 km^2 with a population of approximately 7.61 million. It has a typical subtropical humid monsoon climate, with hot summers and milder winters. The annual average temperature and mean temperature for the warm season (May–October) are 17.6°C and 24.8°C, respectively.

Schizophrenic data

Daily hospital admission data during the warm season in 2005–2014 were obtained from Anhui Mental Health Centre. The clinical diagnostic criteria for schizophrenia were coded using the International Classification of Diseases, 10th Revision (ICD F20–29).[11] Patient information included age, sex, marital status, season of onset, residential address, etc. Ethical approval was obtained from the Ethics Committee of Anhui Medical University.

Meteorological data

Daily meteorological data, mean temperature, maximum temperature, minimum temperature, relative humidity, wind velocity and rainfall were obtained from Hefei Bureau of Meteorology for 2005–2014.

Statistical analyses

A previous study showed that ambient temperature had a lagged effect on emergency admissions for schizophrenia,[11] and the association was non-linear. Meanwhile, the daily number of schizophrenia cases typically presented a Poisson distribution. A Poisson generalised linear regression model combined with a distributed lag non-linear model (DLNM)[17] was used to examine the relationship between mean temperature and admissions for schizophrenia in different age, sex and marital status groups.

Yt ~ Poisson(μt)

$$Log(\mu t) = \alpha + \beta MeanT_{t,l} + + ns(RH_{t,l},3) + ns(Time_t,3) + \eta DOW_t + \gamma Holiday_t$$

where t is the day of observation, Y_t denotes the observed daily number of admissions for schizophrenia on day t, α is the model intercept, $MeanT_{t,l}$ and $RH_{t,l}$ are cross-basis matrices obtained by applying the DLNM, β is the vector of coefficients for $MeanT_{t,l}$ and l is lag days. ns($Time_t$,3) was used to control for long-term trend and seasonality with three degrees of freedom (*df*). ns($RH_{t,l}$,3) was used to control for relative humidity with three degrees of freedom (lag0–6). *DOW* (dummy variable) and reference day of Sunday as well as public holiday (categorical variable) were adjusted for[18,19] Public holiday was adjusted for in the model. In all cases, the Akaike Information Criterion and residual analysis were used to estimate the goodness-of-fit and validate the choice of *df*.

After controlling for these covariates in the DLNM model, the relationship between ambient temperature and admissions for schizophrenia was explored. To identify the effect of temperature on admissions for schizophrenia, the relative risks (RRs) and 95% confidence intervals (CIs) of hospital admissions for schizophrenia at the 75th percentile of temperature were calculated, compared with the reference median temperature for specific lag effect from 0 to 6 days. Meanwhile, the cumulative effects of mean temperature at lag 0–6 days were calculated using a lag stratified analysis.

To examine the robustness of the findings, sensitivity analyses were performed by varying the *df* for time (3–5 *df*/year), mean temperature (3–5 *df*) and relative humidity (3–5 *df*). All data analyses were completed using R Version 3.2.1 with the 'dlnm' package.

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