



Correlation between health discomforts and temperature steps in winter of China



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ABSTRACT

The investigation was carried out in typical wintertime (January 2016) of China. Relationships between health discomforts, which includes physiological effects to the nervous system, digestive system, respiratory system, skin and mucous membranes, and temperature steps were analyzed with the adjustment of subjects' anthropometric information. The Odds Ratio (OR) was applied to evaluate the possibility of suffering from certain kinds of discomforts for different groups of people in comparison to the control group. If the OR is higher than 1.0 ($P < 0.05$), it indicates that the focused group is more vulnerable than the control group. Results show that people in cold winter regions suffered higher risk (OR: 1.335–2.044) of several discomforts than those in warm winter areas. For hot summer and cold winter region, air-conditioning usage intensified discomforts ($OR > 1$) since the rates of 8 kinds of discomforts for people who use air-conditioning both at their offices and homes were significant higher than the control group (people use air-conditioning neither in their homes nor offices) with OR ranging from 1.455 to 2.276. Adaptability also has significant impact on human discomforts, showing as people whose residential period are less than 10 years have higher relative risks in several discomforts than people living here for more than 10 years (OR varying from 1.342 to 1.954), especially the psychological and nervous system effects. Body mass index, gender and age are also remarkable factors associated with human discomforts in winter.

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1. Introduction

In winter, temperature step is such a common phenomenon in daily life, especially in cold severe area of China. For example, when people move from air-conditioned room to outdoor, they may encounter sudden temperature change which is sometimes of pretty large intensities, thus causing health problems and thermal discomfort. There already exist many well controlled experiments concerning physiological and psychological responses to temperature alterations and some of them are about winter situation [1–8]. However, these studies are mainly focused on thermal stress reaction and cannot reflect health risks of temperature steps directly because of short-term exposure. Hence, survey, as a complementary method to climate chamber study, is of great importance as residents' thermal exposure conditions are always investigated

based on their real life, not as forced as in climate chamber experiments [9].

China is a country with wide range of winter temperature levels. For instance, winter temperature in Heilongjiang, a province in Northeast China, is sometimes as low as $-20\text{ }^{\circ}\text{C}$ or lower while that in Hainan, a place in South China, can be up to $20\text{ }^{\circ}\text{C}$ or higher [10]. In winter, various methods including central heating and air-conditioner are applied to develop a comfortable indoor thermal environment to protect occupants from winter coldness. In air-conditioned places, temperature in winter is usually at the range of $16\text{--}18\text{ }^{\circ}\text{C}$ in South China where split air conditioners are commonly used, and at the range of $20\text{--}22\text{ }^{\circ}\text{C}$ or even higher in North China where central heating systems are commonly used.

However, there still exists discrepancy in the occurrence of some health problems associated with winter climates. Fig. 1 describes the relationship between outdoor temperature levels [10] and cardio-cerebrovascular mortalities [11]. It is clear that there is a significantly negative correlation between cardio-cerebrovascular mortality and mean temperature of the coldest month ($r = -0.793$, $P < 0.05$). For example, in Heilongjiang, cardio-cerebrovascular

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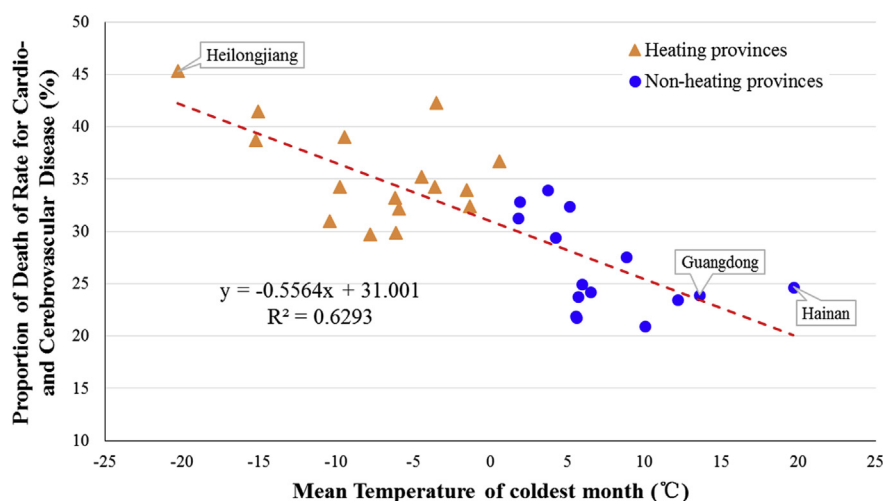


Fig. 1. Cardio-cerebrovascular mortalities and mean temperatures of the coldest month in 2008.

disease takes up about 45% of the all-cause mortality. By contrast, in Hainan the ratio was much lower at 25%. Actually, indoor thermal level in Heilongjiang with government-forced central heating is warm [10].

What's the main reason for the relationship between cardio-cerebrovascular mortalities and mean temperatures of the coldest month as shown in Fig. 1? In our opinion, the contrasting indoor and outdoor thermal levels are among possible factors. Take Heilongjiang and Hainan for example, the gap between indoor and outdoor temperatures in Heilongjiang can be up to 40 °C which creates a really heavy burden on occupants' thermal regulation system and may cause discomforts while the gap for Hainan is really small in winter. In other words, the difference between indoor and outdoor temperatures is regarded as a threat to human health. However, this result was derived on the basis of data from medical statistics yearbook which was published several years ago [11]. Besides, people's background such as gender, age, residential period, height and weight also need modification [12,13].

Unlike the necessity and popularity of central heating in severe cold areas, the most common tool in hot summer and cold winter areas of China is air-conditioner. In fact, air-conditioning usage here is neither government-enforced nor essential since outdoor temperature level in hot summer and cold winter zone is not as cold as that in North China [10]. Hence, indoor spaces equipped with air-conditioning coexist with those without air-conditioning in hot summer and cold winter areas.

There are also many studies showing correlation between air-conditioning usage habit and human health. Cao conducted a survey in Shanghai and Jiangsu during the summertime of 2002 and concluded that some discomforts were related to long-term exposure to air-conditioning environments, showing as the discomfort rate in air-conditioned groups were significantly higher than people didn't use air-conditioning [9]. Similarly, low air-conditioned indoor temperature and the resulting big difference between indoor and outdoor temperatures are considered as main reasons for Sick Building Syndrome in both living environments and working places in some studies [14–16]. Besides, people who are exposed to air-conditioned environment for a long period will suffer from heat stroke when moving between indoor and outdoor [17,18]. However, most of these studies were mainly associated with summer condition and winter data is still not sufficient.

In this study, the online investigation concerning winter situation was conducted, aiming to reveal the relationship between temperature steps and health discomforts. Firstly, we divided the

nationwide data into four groups based on winter outdoor thermal levels and explored the difference in discomfort distributions for people from areas of different winter climates. Besides, specific attention was paid to the influence of air-conditioning usage habit in winter of hot summer and cold winter region of China. In addition, human anthropometric information such as gender, age, adaption and body mass index were also considered.

2. Methods

2.1. Data collection

This study is an epidemiological investigation instead of a well-controlled chamber experiment. It concentrates on the prevalence of health discomforts and significant factors closely related to these discomforts. The investigation was carried out in January of 2016 (typical wintertime of China) in the form of online survey. Participants were asked to fill out a questionnaire of three parts, namely personal profiles, health discomforts and subjective perceptions. Each person is only allowed to answer once. The background part contained information like gender, weight, height, age, residence and residential period of time. Health symptoms (Table 1), were composed of 12 kinds of discomforts that covered syndromes in the digestive system, the respiratory system, the neural system as well as irritation in skin and mucous membranes [9]. Additionally, occupants' perception at their homes and offices, which included heating method, thermal sensation, humidity sensation and indoor air quality perception, was also surveyed.

Table 1
Different kinds of health discomforts.

Number	Symptoms
S-1	Eye dryness, itching or tearing
S-2	Nasal dryness, itching, congestion, discharge or bleeding
S-3	Throat discomfort or dryness, mouth dryness
S-4	Chest distress, chest pain or labored respiration
S-5	Shortness of breath, dry cough or throat inflammation
S-6	Skin dryness with systemic or regional itching
S-7	Fatigue, weakness or drowsiness
S-8	Repression, irritability or anxiety
S-9	Dizziness, headache or indigestion
S-10	Nausea, anorexia or indigestion
S-11	Distracted, error-prone or tired of work
S-12	Other discomforts

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