

Impact of Temperature on Morbidity: New Evidence from China

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Abstract

This paper investigates the relationship between temperature and hospitalization in China. Using inpatient visit claims of two major public insurance schemes covering 47 cities in 28 provinces for three years, we see a 7.3% increase in hospital admissions on days on which the average temperature is above 27°C, and a 2% increase in 31-day cumulative hospital admissions relative to a benchmark-temperature day in the subsequent weeks. Such an effect is much larger than evidence from developed economies. Using detailed information on medical bills, we calculate that an additional hot day nationwide is associated with approximately 2 billion yuan (roughly equivalent to 0.3 billion US dollars) increase in medical expenses that are related to inpatient services, 1.9 billion yuan (roughly equivalent to 0.29 billion US dollars) of which is borne by the public insurance system, and 0.2 billion yuan (roughly equivalent to 0.01 billion US dollars) of which is borne by the insured.

Keywords: Climate Change; Morbidity Costs; Extreme Temperature; China

JEL Codes: I10, I12, I18, Q50, Q51, Q54

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1. Introduction

With the increasing global concern regarding climate change, the need to understand its costs on economic activities and humans has increased. Among such costs, the impact on health is crucial and attracts considerable scholarly attention. Most discussions have focused on the temperature–mortality relationship, which generally suggests an increase in mortality on extremely cold and hot days. Another aspect equally worthy of investigation is the temperature–morbidity relationship, which may impose large expenses on medical systems because of the use of hospital facilities. This paper uses inpatient visit claims from two major public insurance schemes in China to study the temperature–morbidity relationship and, in the process, provides some of the first causal evidence of such a relationship in developing countries. Moreover, the information on medical bills associated with each claim allows us to precisely estimate the extra costs to the public insurance system and individuals insured for each additional extreme temperature day.

We use a random sample of inpatient visit claims of the Urban Resident Basic Medical Insurance (URBMI) and Urban Employee Basic Medical Insurance (UEBMI) programs from 47 Chinese cities across 28 provinces; the data comprise three years' worth of detailed information on hospitalization admission dates, patients' ages and genders, diagnosis of each visits, and billing information (i.e., total bills, bills reimbursed by insurance, copayment of the insured, and bills not covered by the insurance schemes [self-funded by the insured]). We aggregate patient visits to each city-day and merge them with temperature and other weather variables at the city-day level. Following the existing literature, 13 temperature bins are created based on the average daily temperature ranging from lower than -6°C to above 27°C at 3°C increments. Using a distributed lag model accounting for the cumulative effect of each temperature bin up to a 30-day lag and adopting city-year-week and exact-date fixed effects, we study the contemporaneous and cumulative effect of each temperature bin on the hospital admission rate.

Our results suggest three main findings. First, an additional day where the average temperature is higher than 27°C results in a 7.3% increase in hospitalization admissions, and 31-day cumulative hospital admissions increase by 2% relative to a benchmark-temperature day in the subsequent weeks. Moreover, an additional day where the average temperature is

less than -6°C results in a 3.6% increase in hospitalization admissions, and 31-day cumulative hospital admissions increase by 0.9% relative to a benchmark-temperature day in the subsequent weeks. Furthermore, we find some weak and suggestive evidence for the “harvesting” phenomenon, which is the brief temporal increase of mortality (or morbidity) among persons who are already ill/frail and at a high risk of dying (or hospitalization) (Basu and Samet, 2002), for both extremely cold and hot days.

Second, we show heterogeneity in the effect of temperature across various groups. We find that the contemporaneous and cumulative effects of extreme temperatures are stronger for adults, including the working-age population and seniors. Moreover, contemporaneous effects of extreme temperatures are similar across genders. However, the cumulative effects of extremely hot days are stronger for males, whereas those for extremely cold days appear to be stronger for females. Furthermore, regarding disease categories, the cumulative effects of cold weather are the most pronounced for neoplasms and respiratory and genitourinary diseases, whereas those for hot weather are the strongest for infectious/parasitic, nervous system, digestive, endocrine, nutritional, and metabolic diseases and immunity disorders.

Third, we estimate the impact of temperature on medical bills related to inpatient services, including bills from the two public insurance schemes and those from patients. Compared with the medical expenditure in the omitted temperature group ($9^{\circ}\text{--}12^{\circ}\text{C}$), the medical expenditure (particularly bills paid by the insured) increases by approximately 8.7% on extremely hot days (higher than 27°C). We then use such parameters to conduct a back-of-the-envelope calculation on costs related to inpatient services borne by the public insurance system and the insured at the national level for each additional extreme temperature day. The calculations show that each additional cold (hot) day (nationwide) is associated with a 1.4 (2.0) billion *yuan* increase in medical bills related to inpatient services, 1.3 (1.9) and 0.2 (0.2) billion *yuan* of which is borne by the public insurance system and the insured, respectively.

This paper contributes to the literature on climate and health by providing the first causal estimate on temperature and morbidity by using medical claims data from a developing economy. As discussed in Dell, Jones, and Olken (2014), the impact of extreme weather on health can be stronger in developing countries because of the lack of adaptation mechanisms (e.g., lack of air conditioners). Our medical claims data are a representative sample of 47 cities

across 28 provinces in China, including areas with various climate and economic conditions. Our estimation suggests the impact of extreme temperatures on morbidity costs in China is considerably higher than those found in the related studies in Germany and the United States, which further highlights the need for more research in developing countries to quantify the impact of climate change.

In addition, we estimate the impact of temperature on medical bills related to inpatient services separately for the public insurance scheme and the insured which has not been estimated in the previous literature on temperature and morbidity because of the lack of medical bill data for *each* claim. The data allow us to precisely quantify the monetary costs of an additional extreme temperature day on the public health system, which enables policymakers to predict the impact of climate change on public health expenditures and improve the public insurance design. Moreover, our estimates on the monetary costs of an additional extreme temperature day on the out-of-pocket expenses of the insured provide policymakers quantitative evidence to improve the design of wage subsidies paid by employers on extreme temperature days. Currently, in China, the “*Administrative Measures for Heatstroke Prevention and Cooling Measures*”⁶ implemented in 2012, stipulates that if an employer has employees working in outdoors or non-air conditioned indoor environments at high temperatures (the daily maximum temperature of higher than 35°C) and fails to take effective measures to reduce the workplace temperature to less than 33°C, the employer then must pay their workers high-temperature subsidies. The local subsidies standard for high temperatures is formulated by the provincial government or labor security department. Therefore, the amount and timing of high-temperature subsidies vary according to regions, and the monthly subsidies range from 150–300 *yuan*. The heterogeneity in our research results provides a useful reference to improving the subsidy’s design based on the vulnerability of different population groups.

The remainder of the paper is organized as follows. Section II discusses the related literature on temperature, mortality, and morbidity costs; Section III introduces major data sources, and Section IV describes the identification strategy and model setting; Section V

⁶ Please refer to http://www.cma.gov.cn/kppd/kppdqxyr/kppdshqx/201907/t20190726_531100.html for more details.

discusses the primary results and the heterogeneity analysis; Section VI calculates the monetary costs associated with an additional extreme temperature day; Section VII discusses the predicted impact of climate change; and Section VIII concludes the paper.

2. Related Literature

Our paper relates to those evaluating the mortality and morbidity consequences of extreme temperature. This section discusses previous literature on the temperature–mortality relationship and the growing literature on the temperature–morbidity relationship.

2.1. Temperature and Mortality

A large body of research has investigated the relationship between temperature and mortality, with the consensus being that this relationship is nonlinear: mortality is higher during extremely cold and hot temperatures. In the previous decade, a fast-growing literature in economics has investigated the causal impact of temperature on mortality.⁷ The majority of the evidence on the temperature–mortality relationship is in developed economies, particularly the US. The findings generally have shown that exposure to either extremely hot (definition of the threshold varies but usually ranges between 80–90°F) or extremely cold temperatures (the threshold usually ranges between 20–40°F) is associated with higher mortality (Deschênes and Greenstone, 2011; Barreca, 2012; Barreca et al., 2016). Karlsson and Ziebarth (2018) found a similar U-shaped relationship between temperature and mortality in Germany.⁸

Evidence on the temperature–mortality relationship is scarce for developing countries. Burgess et al. (2014) found a positive association between high temperatures and mortality in rural India; Geruso and Spears (2018) found higher impacts of hot days on infant mortality in 53 developing countries than in developed economies. A recent paper by Yu, Lei, and Wang

⁷ A strand of literature in epidemiology studies the temperature-mortality relationship. Please refer to Basu and Samet (2002) for a review, and Gasparrini et al. (2015) for a multi-country observational study. Methodological differences exist between the studies in economics and public health when examining the temperature-mortality relationship. Economists usually adopt fixed-effects models for annual or monthly mortality-rates panels, whereas epidemiologists generally use Poisson regressions for city-level daily mortality counts. (Deschênes, 2014)

⁸ Both epidemiologic and economic studies show the harvesting effect (or temporal displacement) exists in the short-term (Braga et al., 2001, 2002; Hajat et al., 2005; Deschênes and Moretti, 2009; Karlsson and Ziebarth, 2018).

(2019) documented the U-shaped relationship between temperature and mortality in China, and such a relationship is approximately three times stronger than evidence in the US.⁹

Literature on the temperature–mortality relationship further discusses the technologies that help individuals adapt to extreme temperatures and mitigate the adverse effects of temperature on mortality.¹⁰ Some limited empirical evidence has shown how such adaptation behaviors may mitigate the adverse impact of extreme temperatures. For example, Deschênes and Moretti (2009) found that geographical mobility from the northeast to the southwest region has contributed to increased longevity in the US. Graff-Zivin and Neidell (2014) found that individuals significantly increase their time indoors on extremely hot or cold days. Deschênes and Greenstone (2011) documented an increase in residential energy consumption in response to extreme temperatures; In a similar vein, Barreca et al. (2016) revealed a declining mortality impact of extremely hot days after the 1960s and found that residential air conditioning almost completely explains the decline in hot-day-related fatalities. Moreover, Heutel, Miller, and Molitor (2017) found that the mortality effect of hot days is considerably stronger in cool regions compared to warm ones, and the opposite is true for cold days, thereby suggesting adaptation may also be influenced by historical climate norms.

2.2. Temperature and Morbidity

Compared with temperature and mortality, discussion of the temperature–morbidity relationship is scant. In epidemiology, Bobb et al. (2014) found that periods of extreme heat increase the risk of hospitalization among older adults for fluid and electrolyte disorders, renal failure, urinary tract infection, septicemia, and heat stroke. In South Korea, Son, Bell, and Lee (2014) found that high and low ambient temperatures affect the risk of hospital admissions, particularly among women or younger people. In economics, three recent papers have documented the temperature–morbidity relationship. White (2017) employed hospitalization

⁹ Alongside the overall mortality rate, a strand of literature focusing on the impact of temperature on suicide finds a positive association between high temperatures and the suicide rate (Ajdacic-Gross et al., 2007; Kim et al., 2016).

¹⁰ Deschênes (2014) summarizes the main adaptation behaviors at the household level, naming air conditioners, changing outdoor/indoor time allocation, wearing sun-protective clothing, altering building designs, and moving to other geographical areas. The community level involves early warning systems, public outreach systems, local cooling centers, fans, and access to quality water.

data from California and found extremely cold temperatures are associated with a decrease in emergency department (ED) visits on a given day and an increase in ED visits when considering the cumulative effect on subsequent days. Moreover, extremely hot temperatures are associated with a same-day increase in ED visits and a cumulative increase in ED visits. Karlsson and Ziebarth (2018) studied the relationship between hospital admissions and temperature in Germany and documented the U-shaped relationship, with evidence of the harvesting effect. Mullins and White (2019) focused on mental health outcomes and found that cold temperatures reduce negative mental health outcomes, whereas hot temperatures increase them. The aforementioned papers have studied the temperature–morbidity relationship in developed countries, whereas evidence from developing countries is scarce.¹¹

3. Data Sources

3.1. Hospitalization Data

Hospitalization data are from the China Health Insurance Research Association (CHIRA) claims database, which comprises a random sample of inpatient visits (including overnight stays and same-day discharges) for those insured under the URBMI and UEBMI in 2008–2010. The URBMI is public health insurance for urban nonworking residents such as young children, adolescents, university students, seniors, and the disabled, whereas the UEBMI includes the urban working population. All employers in urban areas, including public and private sectors, are required to participate in the UEBMI, and thus, the URBMI and UEBMI are the largest public insurance schemes in urban areas. In 2010, their total enrollees reached 432.06 million,¹² thereby accounting for approximately 65% of China’s urban population.¹³

¹¹ Some papers also analyze the in utero exposure to extreme temperatures and find such exposure is associated with lower birth weight in the US (Deschênes, Greenstone, and Guryan, 2009), a higher chance of being diagnosed with dehydration at birth and hospital readmissions in the first year of life in the US (Kim, Lee, and Rossin-Slater, 2019), and lower education and earning outcomes in China (Hu and Li, 2019).

¹² Please refer to p. 74 of <http://www.chinacdc.cn/tjsj/gjwstjsj/201205/W020120517331408782774.pdf>

¹³ According to the 2010 population census, China’s urban population was 665.58 million. Yip et al. (2012) document that of the 65% of the urban population eligible for enrollment in the UEBMI and URBMI, 92% enrolled. The remaining 35% ineligible for either scheme—due to their rural or non-local status—consisted largely of migrant workers and temporary residents in the cities. Because migrant workers are more likely to be exposed to extreme temperatures under outdoor working conditions, our estimates of the effects of extreme temperatures on

The CHIRA data were collected using a two-stage sampling design. The first stage used convenience sampling to include four municipalities under the central government (e.g., Beijing, Shanghai, Tianjin, and Chongqing), and the majority of the provincial capitals and other cities and counties for which the Healthcare Security Administration could provide electronic medical record data. The second stage used systematic random sampling to extract 5% of the bills in a certain year from prefecture-level cities (nonprovincial capital cities), and 2% of the bills in a certain year from provincial capital cities and municipalities. For each record, we have information on the admission and discharge dates, diagnosis [based on International Classification of Diseases (ICD)-10 system], gender, and birth date of patients. Furthermore, the data comprise precise billing information on each claim, including the total spending, spending covered by the URBMI or UEBMI, patients' copayments, and spending not covered by the insurance schemes. The reimbursement policy varies slightly across different cities; the average reimbursement rate is approximately 80%–90% for the UEBMI and 50%–70% for the URBMI for the covered expenses. Moreover, data include all inpatient claims, including scheduled/unscheduled hospitalizations and hospitalizations transferred from the ED. However, we cannot separately identify the three types in our sample. This sample comprises 47 cities across 28 provinces. Because of data confidentiality, we cannot disclose the names of the cities.

3.2. Weather Data

Weather data are from the China Meteorological Data Service Center, which is an affiliate of the National Meteorological Information Center of China. The data report daily maximum, minimum, and average temperatures; precipitation; relative humidity; wind speed; sunshine duration; and atmospheric pressure for 844 stations in China. For each city in the sample, the stations within the city boundary are identified, and the average weather variables of each city-day are calculated. We have 117 stations within the 47 cities and 33,609 city-day observations during the sample period.

hospitalization rates are likely to be a lower bound of the true effects for the whole population.

4. Identification Strategy

To study the impact of temperature on hospitalization, the hospital claims data are aggregated to the city-day level, and thus, the total hospital admissions for each city-day, with the total bill, total spending covered by insurance, and total out-of-pocket expenses covered by patients are calculated. The research design then associates the city-day hospitalization information with the weather conditions to study temperature's impact on morbidity. The primary specification is as follows:

$$AdmissionRate_{i,t} = \alpha + \sum_{j=1}^{13} \sum_{h=0}^{30} \beta_{j,t-h} TempBin_{j,i,t-h} + \sum_{h=0}^{30} \gamma_{t-h} Precip_{i,t-h} + \delta_{city-yw} + \mu_t + \varepsilon_{i,t} \quad (1)$$

$AdmissionRate_{i,t}$ is the hospital admission rate for individuals living in city i on day t , which is calculated as the number of total hospital admissions in city i and day t per 100,000 individuals enrolled in the URBMI or UEBMI for the given year. Moreover, the admission rate is calculated by gender, age group (0–18, 19–64, and 65 and above), and disease category.¹⁴ Following White (2017), all the ICD-10 codes are categorized into 18 Clinical Classifications Software (CCS) codes, which the Healthcare Cost and Utilization Project developed to classify ICD codes into meaningful disease categories. Among the 18 CCS categories, the final two categories are “ill-defined conditions” and “residual codes,” and therefore, these two categories are excluded from the analysis.

Table 1 shows the summary statistics of the hospitalization data. We have 382,907 hospital admissions in 47 cities during 2008–2010. After converting the total count to the admission rate, the average admission rate is 31.36 per 100,000 individuals enrolled per city-day under the URBMI or UEBMI. The admission rates are 1.58, 17.61, and 12.17 per 100,000 individuals enrolled for ages 0–18, 19–64, and above 64 years, respectively. For gender, the admission rate is slightly higher for males (16.53) than females (14.84). Among the disease categories, the highest admission rates are observed for circulatory-related diseases, neoplasms, respiratory diseases, and digestive diseases. Note that new admissions are not equivalent to new symptoms,

¹⁴ Because we lack the age- and gender-specific numbers of enrollees per city, we use the total enrollee number as the denominator for age- and gender-specific visits.

which could be admissions caused by preexisting conditions that are triggered by external factors, such as weather.

[Table 1 about here]

On the right-hand side of the model, key variables are $TempBin_{j,i,t-h}$, which are indicator variables for whether the daily mean temperature falls into various bins. The temperature spectrum is divided into 13 bins: bin 1 is temperatures less than -6°C (21.2°F); bin 2 is temperatures from -6°C to -3°C ; ...; bin 12 include temperatures from 24°C to 27°C , and bin 13 include temperatures higher than 27°C (80.6°F). Bin 7 (9° , $12^{\circ}\text{C}/48.2^{\circ}$, 53.6°F) is omitted. In the literature, different omitted bins are selected in different country/region contexts. For example, Karlsson and Ziebarth (2018) omitted the 40° – 50°F (4.4° – 10°C) bin for Germany; White (2017) omitted the 60° – 65°F (15.6° – 18.3°C) bin for California; and Yu, Lei, and Wang (2019) omitted the 50° – 60°F (10° – 15.6°C) bin for China (focusing on mortality instead of morbidity). As explicitly stated in Yu, Lei, and Wang (2019), the existing literature commonly uses the most comfortable temperature bin as the reference group. In our data, the 9° – 12°C bin shows the smallest effects on hospitalization rates, and thus, we adopt this temperature bin as our omitted group.

Following the existing literature, the bins are created based on the average daily temperatures. Moreover, the cumulative effect of temperature on morbidity is allowed by imposing a lag structure on the temperature bins. In particular, we include the contemporaneous effect of temperature and the 1- to 30-day lag effects of each temperature bin. Therefore, j and h denote the bins and lag structure, respectively. In total, $12 \times 31 = 372$ coefficients are to be estimated for $TempBin_{j,i,t-h}$.

Table 2 shows the summary statistics of the temperature bins. Column 2 reports the frequency of each temperature bin in terms of the number of city-days. According to the table, each cell has a sufficient number of observations to ensure the statistical power of our analysis, particularly in extreme temperature cases. Furthermore, Figure 1 presents the share of extremely cold days, extremely hot days, and average daily inpatient admission rate (per 100,000 individuals enrolled) in maps. Because the city list is confidential, the maps are only plotted provincially. Therefore, the number for each province represents the average value of the sample cities belonging to that province. The maps show that extreme temperature days are

not concentrated in only a few cities. Rather, almost all the provinces are either subject to extremely cold or hot days or both. Figure 1C shows that our hospital admissions include wide geographic areas and are not concentrated in a few major cities. Furthermore, it shows that the hospitalization rates differ significantly across cities. Using the same data as those used in this paper, Li et al. (2020) investigated the geographic variation in China’s healthcare spending and its driving factors. They found that substantial geographic variation is primarily driven by variation in inpatient visits and variation in average expenditure per visit. Moreover, the supply-side factors, such as the reimbursement ratio and market structure, are correlated with the variation in inpatient visits.

[Figure 1 about here]

[Table 2 about here]

In addition to the primary coefficients of interest, based on the existing literature, we control for the level of precipitation in a lag structure (from the current day to 30 lagged days) because precipitation may affect morbidity. High-dimensional fixed effects in the model are introduced to control for city-level time-invariant and time varying unobservables [city-year-week fixed effects, i.e., $\delta_{city-yw}$ in equation (1)] and for the seasonality of hospital admissions (exact-date fixed effects, which offers a different intercept for a different day, thereby yielding 365×3 variables for three years). Furthermore, following the past studies (White 2017; Karlsson and Ziebarth, 2018; Yu, Lei, and Wang, 2019), a weighted OLS regression is employed using the number of unique enrollees (100,000 as a unit) as weights to ensure that the estimates can be interpreted as a representative of the population. Finally, we adopt standard errors two-way clustered at the city and day levels.

5. Findings

5.1. Primary Results

Table 3 reports the impact of temperature on hospital admission rates. The five columns present different specifications for the same outcome variable to exhibit robustness. Column 1 controls for city-year-month fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The coefficients within column 1 are the contemporaneous effects (the temperature bins of the current day). Column 2 replaces city-year-month fixed effects with city-

year-week fixed effects, which controls for higher-order city-time-variant unobservables and is thus the preferred specification. The coefficients are positive and significant for the highest five bins, thereby suggesting that higher average daily temperatures increase hospital admissions on the current day, benchmarked with the hospital admission rate when the average daily temperature is in the 9°–12°C bin. However, low temperatures on the current day do not significantly impact hospital admissions. Column 3 presents more restricted sample results by not using some city-day outliers having a spurious frequency (e.g., zero admissions on some days in December, which may be because of data-reporting issues near the year end), and the effect size increases. Column 4 adopts one-way clustered errors at the city level rather than two-way clustering at the city and day levels. The significance level remains similar to that in column 2. Finally, column 5 presents the cumulative effect by adding the coefficients of $\sum_{h=0}^{30} \beta_{j,t-h}$ for each temperature bin in the preferred specification (column 2). The results suggest a large and positive cumulative effect of extremely hot temperatures. Moreover, the cumulative effect of cold days is large in magnitude but not statistically significant. Figure 2 visualizes the contemporaneous and cumulative effects. Consistent with the existing literature, the coefficients exhibit a general U-shape for both the effects.

[Figure 2 about here]

[Table 3 about here]

Two additional robustness checks are conducted to ensure our results are not sensitive to different definitions of temperature bins. First, we use a daily maximum temperature to define the temperature bins. Second, we run a robustness check by using 12°–16°C as the omitted category. Overall, the patterns on the contemporaneous and cumulative effects are consistent with the primary specification (Appendix Table A1).

To compare the estimates with those in previous papers, particularly papers on the temperature–morbidity relationship in California and Germany, we calculate the relative effect by dividing the coefficients by the average hospital admission rates in the omitted bin, which is 32.055 visits per 100,000 individuals enrolled under the URBMI or UEBMI. We prefer columns 2 and 5 in Table 3 as specification for the contemporaneous and cumulative effects. Therefore, the contemporaneous effect of the average daily temperatures in the 24–27°C bin

and higher-than-27°C bin correspond to a 9.5% and 7.3% increase, respectively, in the hospital admission rate. The magnitude of such a contemporaneous effect is higher than the California estimates, for which White (2017) documented a 3.4% increase in hospital admission rates when temperatures are higher than 80°F (26.67°C) for inpatient emergency visits and an *insignificant* effect for nonemergency visits. Considering our data comprise emergency and nonemergency hospitalizations, the estimates (7.3%) should be compared with the weighted average of 3.4% and 0 in the California case. Compared with the estimates in Germany (Karlsson and Ziebarth, 2018), the relative effect of extremely hot days ranges from 0.7% (with 30-day lags) to 5.9% (without 30-day lags and additional weather controls). The effect yielded in this study is stronger than the Germany case if we compare similar specifications. For cold temperatures, the contemporaneous effect of the average daily temperatures in the -3°C to 6°C bin and the less than -6°C bin correspond to a 4.4% and 3.6% increase, respectively, in the hospital admission rate; however, these findings are insignificant at the 10% level. The estimates in California (White, 2017) suggest a negative contemporaneous effect on cold days, and those in Germany (Karlsson and Ziebarth, 2018) suggest a positive contemporaneous effect on extremely cold days (<10°F or -12.2°C) and an unclear effect on less extreme cold days (10°-40°F).

Column 5 is used to calculate the relative size of the cumulative effect. The cumulative effect of the average daily temperatures in the 24°-27°C and higher-than-27°C bins correspond to a significant increase of 1.9% and 2.0% of the 31-day cumulative hospital admissions relative to a benchmark-temperature day. White (2017) reported insignificant and small coefficients for the cumulative effect (30 days) of extremely hot days in California (3.3% and 1.5% for emergency and nonemergency, respectively, relative to the mean daily visit rate instead of mean 31-day visit rate). Therefore, the magnitude of the effect is significantly higher than the California case. Regarding Germany (Karlsson and Ziebarth, 2018), the cumulative effect of a hot day is only pronounced in the first week and has a negative and insignificant coefficient in the following three weeks. However, because of different model specifications, comparing the aforementioned results for Germany with those in this study is difficult. For cold weather, based on the first two rows in column 5, the cumulative effects of the average daily temperatures in the less than -6°C and from -3° to -6°C bins are 0.9% and 2.0%, respectively,

of the 31-day cumulative hospital admissions relative to a benchmark-temperature day, although the estimate is imprecise. Such an effect is considerably stronger than the cumulative effect of cold days in California (5.3% for inpatient emergencies relative to the mean daily visit rate and 0 for non-emergencies if the average temperature is less than 40°F). Karlsson and Ziebarth (2018) provided no estimate for the cumulative effect of cold days, and therefore, we cannot compare these results with those from Germany.

Another issue worth highlighting is the temporal patterns of the cumulative effects. The existing literature studying the impact of temperature on mortality and morbidity investigates the harvesting phenomenon. For example, if the phenomenon exists, an increase in mortality or morbidity on the current day caused by extreme temperatures may follow a decrease in mortality or morbidity in the subsequent days because the temperature shock accelerates the timing of mortality or morbidity that would have occurred later in the absence of such shocks. To evaluate the harvesting effect, the cumulative effects of extremely hot ($>27^{\circ}\text{C}$) and extremely cold ($\leq -6^{\circ}\text{C}$) temperatures from the current day until the 30th lag day are plotted. For example, the coefficient of day 9 represents $\sum_{h=0}^9 \beta_{j,t-h}$ in equation (1). Panel A of Figure 3 presents the cumulative effect of extremely cold days, which exhibits some temporal displacement in some lags. However, the cumulative effect is generally increasing in the first nine days and flattening afterward. Panel B shows the cumulative effect of extremely hot days. An insignificant decline in the coefficient for day 1, which is -0.832 with a p-value of 0.32, with some other insignificant drops in the following days, provides some weak evidence of an intertemporal shift in hospital admissions. However, similar to the patterns in Panel A, the net cumulative effect is increasing over time, thereby suggesting the limited role of the harvesting effect.

[Figure 3 about here]

In summary, our primary results have some crucial implications. First, extremely hot days significantly increase hospital admissions both contemporaneously and cumulatively, whereas extremely cold days do not. Second, the effect found in this paper is substantially stronger than the cases in developed economies, particularly the cumulative effects of extreme temperature. This finding complements Yu, Lei, and Wang (2019), who found that China's temperature–

mortality relationship is more than three times stronger than the effect in developed economies. Third, we only found weak and suggestive evidence of the harvesting effect.

5.2. Heterogeneity Analysis

We further investigate the heterogeneity in our findings across different age groups, gender, and disease category. First, Table 4 (and Figure 4) presents the contemporaneous and cumulative effects by age group. Columns 1 and 2 report the effect for the youngest group (aged 0–18 years): extremely cold weather ($<-6^{\circ}\text{C}$) significantly increases their contemporaneous hospital admission rate by 24.2% (0.317/1.311). However, extremely hot weather has an insignificant effect on the contemporaneous hospital admission rate. Moreover, none of the coefficients is significant for the cumulative effect. For ages 19–64 and more than 64 years, the results are quite different: extremely hot weather significantly increases the contemporaneous hospital admission rate, with a 6.1% and 9% increase, respectively. For the cold domain, the cumulative effect is more pronounced for ages 19–64 years, whereas the contemporaneous effect is more pronounced for ages higher than 64.

[Figure 4 about here]

[Table 4 about here]

Second, Table 5 (and Figure 5) presents the heterogeneity analysis by gender. Comparing columns 1 (contemporaneous effect for females) and 3 (contemporaneous effect for males), no significant difference is noted in the contemporaneous effects of extremely cold and hot weather. However, the cumulative effects of extremely hot days are stronger for males.

[Figure 5 about here]

[Table 5 about here]

Third, the impact of temperature on various disease categories is investigated. Based on the CCS categorization, all ICD-10 codes are categorized into 16 major types of diseases: (1) infectious and parasitic diseases (infectious/parasitic); (2) neoplasms; (3) endocrine, nutritional, and metabolic diseases and immunity disorders; (4) diseases of the blood and blood-forming organs; (5) mental illness; (6) diseases of the nervous system and sense organs (nervous system); (7) diseases of the circulatory system (circulatory); (8) diseases of the respiratory system (respiratory); (9) diseases of the digestive system (digestive); (10) diseases of the genitourinary

system (genitourinary); (11) complications due to pregnancy, childbirth, and the puerperium; (12) diseases of the skin and subcutaneous tissue; (13) diseases of the musculoskeletal system and connective tissue (musculoskeletal); (14) congenital anomalies (congenital); (15) certain conditions originating in the perinatal period (perinatal); and (16) injury and poisoning (injury/poisoning).

Because of space limitations, Table 6 only reports the five disease categories that are most sensitive to temperature: neoplasms; endocrine, nutritional, and metabolic diseases and immunity disorders; circulatory; respiratory; and digestive diseases (please refer to Appendix Table A2 for the regression results for all 16 CCS categories). For neoplasms, according to columns 1 and 2, the contemporaneous effects of extremely hot days ($>27^{\circ}\text{C}$) are significantly positive. The relative size of the contemporaneous effect is 10.3% ($0.444/4.313$). The estimate on the cumulative effect is insignificantly positive for the hot domain; however, positive and large for the cold domain. These results do not suggest that extreme temperatures cause neoplasms because neoplasms take time to develop. An appropriate interpretation would be that extreme temperatures trigger hospital admission because of neoplasms, which are likely preexisting conditions.

Columns 3 and 4 present the contemporaneous and cumulative effects of endocrine, nutritional, and metabolic diseases and immunity disorders. Hospital admissions significantly increase by 22.1% ($0.389/1.759$) contemporaneously if the daily average temperature is higher than 27°C . The cumulative effect of extremely hot days on endocrine and related diseases is an increase of 8.7% [$4.749/(1.759 \times 31)$] of the 31-day cumulative hospital admissions relative to a benchmark-temperature day if the average temperature is higher than 27°C . For circulatory diseases, the contemporaneous effect is evident on the hot days (although insignificant in the highest temperature bin). For respiratory diseases, the contemporaneous effect is significant in the extremely hot and cold domains, whereas the cumulative effect of cold temperatures is more pronounced than that of hot days. Finally, the final two columns indicate that hot temperatures have a cumulative positive impact on digestive diseases (Refer to Figure 6 for the contemporaneous and cumulative effects of all 16 CCS categories).

[Figure 6 about here]

[Table 6 about here]

We further compare our heterogeneity results with those in the literature. In terms of age, in this study and White (2017), positive cumulative effects on hospitalization are noted for extremely cold days. However, White (2017) found a negative contemporaneous effect of extremely cold days for the young cohort, whereas we found a positive and insignificant effect for the same. This contrast in results between this study and White (2017) is also existent for the complete population as suggested in Table 3. For the hot days, our results are generally consistent with those in White (2017). Nevertheless, the coefficients of the contemporaneous and cumulative effects on extremely hot days in our study are positive but insignificant for the youngest cohort. Such insignificance can be attributed to the lack of statistical power considering we only have 19,756 hospital visits from individuals aged less than 18 years. In Karlsson and Ziebarth (2018), the relative increase in admissions caused by extremely hot temperatures is relatively stable across age groups and similar in magnitude for all age groups. Concerning gender, neither of the two papers (White, 2017; Karlsson and Ziebarth, 2018) studied the heterogeneous effects by gender, and no comparisons can be made. Regarding heterogeneity by disease category, White (2017) found disease categories, such as infectious/parasitic, circulatory, and respiratory diseases, are most responsive to cold weather, and almost all the disease categories (excluding circulatory and congenital) respond to hot weather. Findings in Karlsson and Ziebarth (2018) suggest that respiratory, infectious, or metabolic diseases are most responsive to hot weather, whereas disease heterogeneity on cold days is not analyzed. Our results primarily complement these findings: the cumulative effects of cold weather are most pronounced for neoplasms, respiratory, and genitourinary diseases, whereas those of hot weather are the strongest for infectious/parasitic diseases; endocrine, nutritional, and metabolic diseases and immunity disorders; nervous system diseases; and digestive diseases. Finally, Appendix Figures A1, A2, and A3 present the cumulative effects over time for the highest and lowest temperature bins by age, gender, and disease category, respectively. Tables A3, A4, and A5 present the results by age, gender, and disease category by using one-way clustered standard errors at the city level, respectively, which are substantially similar to the primary results obtained using two-way clustered standard errors.

6. Costs Analysis

An advantage of our data is that we have rich information on medical bills for each inpatient visit claim. The expense information comprises all the costs incurred during hospitalization, including the prescribed drugs. Therefore, we can precisely estimate the impact of an additional hot or cold day on total medical bills related to inpatient services, medical bills imposed on the public insurance system, and the out-of-pocket expenses imposed on the patients, which are the sum of the copayment and expenses not covered by insurance.

The model specification in equation (1) is employed. The outcome variables are the total sum of medical bills related to inpatient services (and the different components of the bills) per 100,000 individuals enrolled under the URBMI or UEBMI for each city-day in monetary value (yuan). Following the primary specification, we control for city-year-week fixed effects, exact-date fixed effects, and 30-day lags for each temperature bin. The standard errors are two-way clustered at the city and day levels. Table 7 presents the analysis for four outcomes: total bills for a city-day (columns 1 and 2), bills covered under the URBMI/UEBMI (columns 3 and 4), bills covered by patients as copayment (columns 5 and 6), and bills not covered under the URBMI/UEBMI (columns 7 and 8). For each outcome, the first column reports the contemporaneous effects of each temperature bin, whereas the second column reports the cumulative effects. Consistent with our primary findings, a positive effect of extreme temperature is noted on medical bills related to inpatient services and its different components. On average, an extremely hot day (temperature higher than 27°C) increases the total medical bill related to inpatient services for a city by 167,896 *yuan* per 100,000 insured in the current and subsequent 30 days, the total bills covered under the insurance system by 153,399 *yuan* per 100,000 insured, and the out-of-pocket expenses of patients by 14,497 *yuan* (2,742 + 11,755) per 100,000 insured.

[Table 7 about here]

Further, the estimates in Table 7 are used to conduct a back-of-the-envelope calculation on the total costs related to inpatient services, costs borne by the public insurance system, and costs borne by the insured for an additional cold or hot day. We focus on the cumulative estimates, which represent the most comprehensive impact of an additional extreme temperature day. Columns 1, 3, and 5 of Table 8 provide the estimated increase in medical bills that are related to inpatient services per 100,000 individuals enrolled associated with an

extreme temperature day. In 2018, the number of enrollees under the URBMI and UEBMI was 0.897 billion and 0.317 billion, respectively;¹⁵ in other words, the total number of enrollees used in our sample is 1.214 billion. We can calculate the costs caused by extreme temperature scaling up to the national level by multiplying the values in columns 1, 3, and 5 by a scale factor of 12,141.7, and the results are reported in columns 2, 4, and 6.¹⁶

[Table 8 about here]

The calculation shows that an additional cold (hot) day nationwide is associated with a 1.4 (2.0) billion yuan increase in medical bills for inpatient services, 1.3 (1.9) billion yuan from the public insurance system, and approximately 0.2 (0.2) billion yuan from the insured. Considering the total reimbursement of the URBMI and UEBMI for inpatient visits in 2018 was approximately 999.8 billion yuan,¹⁷ an additional cold day increases the total costs for the inpatient services of the two insurance schemes by 1.3‰, and an additional hot day increases the total costs by 1.9‰.

Alongside the medical expenditure for all the visits, we further decompose bills by age group, gender, and disease category to acquire estimates on the impact of temperature (Appendix Tables A6–A14). Note the relative increase in medical expenditure caused by an additional cold day is particularly high for respiratory diseases, which may be attributed to the seriousness of diseases in this category (e.g., pneumonia).

7. Predicted Impact of Climate Change

¹⁵ The revenue, costs, and enrollees number for the URBMI and UEBMI in 2018 are available at http://www.nhsa.gov.cn/art/2019/6/30/art_7_1477.html

¹⁶ Please note that rural residents in most of the provinces in China have been eligible for the URBMI plan since 2016, and there may be heterogeneous temperature effects on hospitalization rate between the urban and rural populations. However, it is difficult to determine whether the projection is over-estimated or under-estimated. On the one hand, we expect that the people in rural areas are more likely to be exposed to extreme temperature due to the outdoor working conditions and lower air conditioner penetration rate in these areas. On the other hand, the relatively limited supply of medical resources in the rural areas may decrease the hospitalization rate, which consequently offset the effects of extreme temperatures on total hospitalization rate for the rural residents.

¹⁷ The total reimbursement costs of the URBMI and UEBMI are 1698.4 billion yuan. The reimbursement for inpatient visits is 630.3 billion yuan for the UEBMI, while this information is missing for the URBMI. If we assume the same proportion of inpatient reimbursement costs for the URBMI and UEBMI, their total inpatient costs should be 999.81 billion yuan.

This section attempts to estimate the impact of climate change on hospitalization rates in China. To obtain these calculations, we use one of the commonly used future-climate-projection models, the Hadley Centre Global Environment Model version2 (Hadley GEM2-ES), which provides daily predicted values of mean temperature for each grid-point in different time horizons.¹⁸ In particular, the Hadley GEM2-ES is available for various Representative Concentration Pathways representing different policy scenarios. To compare these results with those in White (2017), we focus on the RCP8.5, which provides a simulation under the “business-as-usual” emissions growth rates. Finally, we obtain the daily predictions of mean temperature for 2070–2099.

We first aggregate the pixel-level prediction data up to the city level, which provides the average number of days per year for each city in each temperature bin for 2070–2099. We then calculate the predicted changes in the number of days in each temperature bin by taking the differences between our sample period (2008–2010) and prediction period (2070–2099). Finally, we follow White (2017) and Yu, Lei, and Wang (2019) to estimate the total impact of climate change as follows:

$$\sum_1^{13} cumu_j \times \frac{\sum_c \Delta TEMP_c^j \times enrollee_c}{\sum_c enrollee_c} \quad (2)$$

where $cumu_j$ indicates the 31-day cumulative effect of temperature bin j on hospital admissions, and $\Delta TEMP_c^j$ represents the change in the number of days in temperature bin j of city c . Because this equation is a linear combination of the estimated coefficients, calculating the standard errors is straightforward.¹⁹ Table 9 reports the estimated results of climate change on hospital admissions.²⁰ We first present the predicted impacts of temperature change in the lowest (less than -6°C) and highest (more than 27°C) temperature bins.

[Table 9 about here]

¹⁸ The data is available at

<https://cera-www.dkrz.de/WDCC/ui/cersearch/q?query=CMIP5&page=0&rows=15>

¹⁹ It should be noted that the uncertainty of the total impact prediction could also come from daily projection of the climate change model.

²⁰ In Table A15 in the appendix, we report the effect of predicted climate change on total medical bills that are related to inpatient services.

However, after considering the predicted changes in days for all temperature bins, the final column in Table 9 shows statistically insignificant point estimates of aggregate temperature impacts for our prediction model. A possible explanation is that the climate change model tends to predict a right shift of the temperature distribution in the future, particularly showing more frequent occurrence of extremely hot days (above 27°C). However, since the cumulative effects of nonextreme temperature bins are positive and with similar magnitude, the overall effect of future climate change is offset by the less-frequent nonextreme hot bins. Overall, our results are similar to those in White (2017), where the estimates of the effect of climate change on hospital visits and costs in California are statistically and economically insignificant.

8. Conclusion

This paper uses inpatient visit claims data from China's two major public health insurance schemes to understand the temperature–morbidity relationship. A distributed lag model with city-year-week and exact-date fixed effects reveals a 7.3% increase in hospital admissions on days on which the average temperature is higher than 27°C and a 2% increase in the 31-day cumulative hospital admissions relative to a benchmark-temperature day in the subsequent weeks, along with a 3.6% increase in the hospital admission rate on days on which the average temperature is less than -6°C and a 0.9% increase in the 31-day cumulative hospital admissions relative to a benchmark-temperature day in the subsequent weeks. The magnitude of such an effect is considerably higher than comparable research findings in developed economies. Furthermore, such effects exhibit heterogeneity by age, gender, and disease categories.

Finally, the billing information of each claim indicates that each additional cold (hot) day (nationwide) is associated with a 1.4 (2.0) billion yuan increase in medical bills, 1.3 (1.9) billion yuan from the public insurance system, and approximately 0.2 (0.2) billion yuan borne by the insured. These parameters aid policymakers in predicting the additional expenses to the public health system with different climate change scenarios.

This study has a few limitations. First, our analysis is likely to be lower bound on the effect of extreme temperature days for the following reasons: 1) The data only comprise inpatient visit claims. The effect of temperature is likely to be larger for outpatient visit claims,

particularly for outpatient visits to the emergency department.²¹ 2) The data have no information regarding population living in cities that is ineligible for the two public insurance schemes (i.e., migrant workers who do not have urban *Hukou*). The health response to extreme temperature is possibly stronger among these individuals because migrant workers are more likely to engage in outdoor labor activities. 3) Our estimate does not consider human suffering that is not reported via medical bills. Second, we do not have a sufficiently long panel (e.g., more than 10 years) to understand individuals' adaptation to extreme temperatures in the long run. Third, we lack information on the mortality outcomes of each claim. We hope the availability of new data will further enrich our knowledge regarding the temperature–morbidity relationship in developing countries in the future.

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²¹ White (2017) has shown temperature's effect is the largest for outpatient emergency visits in California.

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Figure 1. Distribution of Extreme Temperatures and Inpatient Admission Rate in China

Figure 1A. Distribution of Extremely Cold Days (<-6°C)

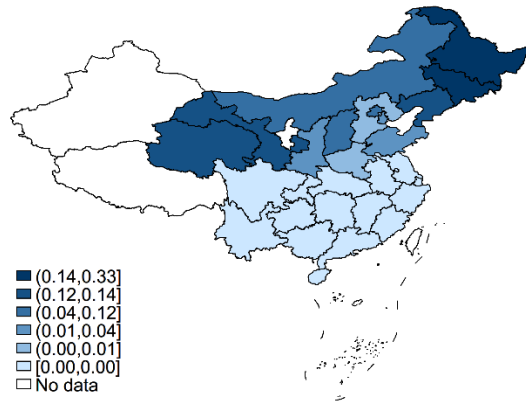


Figure 1B. Distribution of Extremely Hot Days (>27°C)

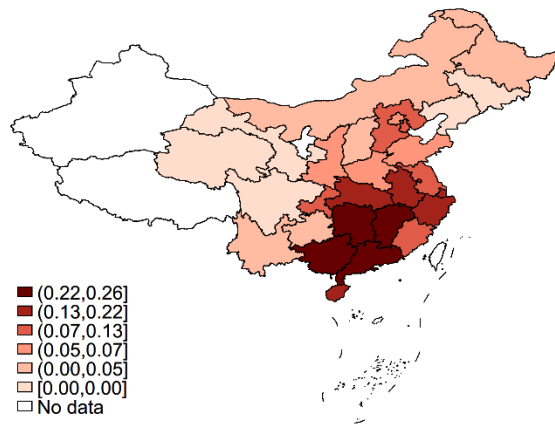
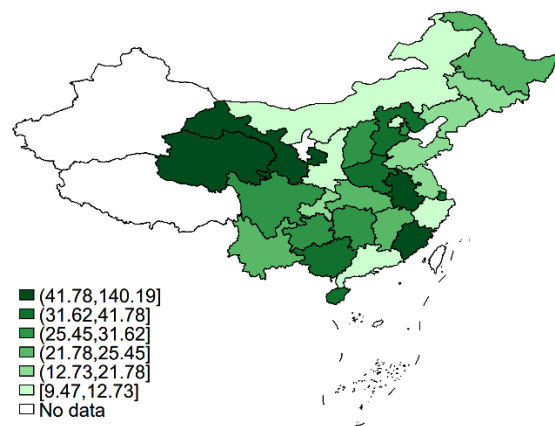
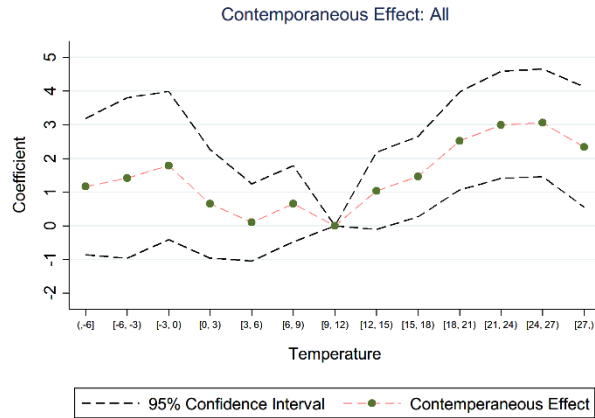


Figure 1C. Distribution of Inpatient Admission Rate

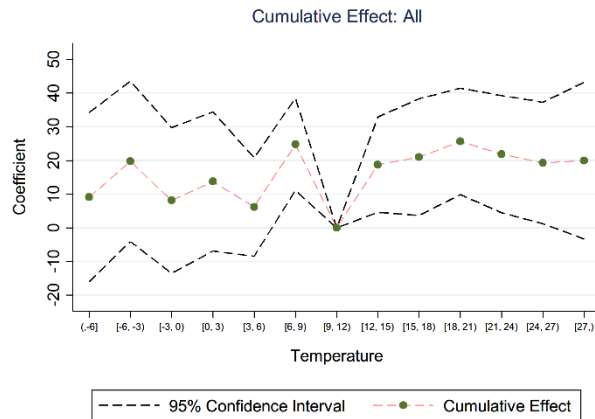


Notes. The three maps describe the share of extremely cold days, extremely hot days, and average daily inpatient admission rate (per 100,000 individuals enrolled in either URBMI or UEBMI) in our 47 sample cities. The number for each province represents the average value of the sample cities that belong to that province. -

Figure 2. Contemporaneous Effect and Cumulative Effect
Panel A

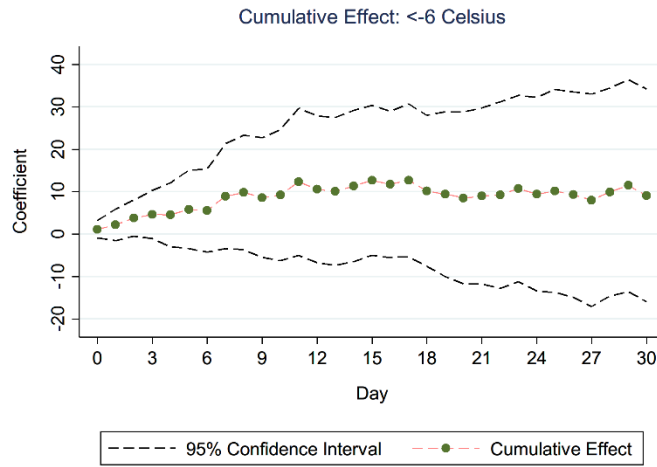


Panel B

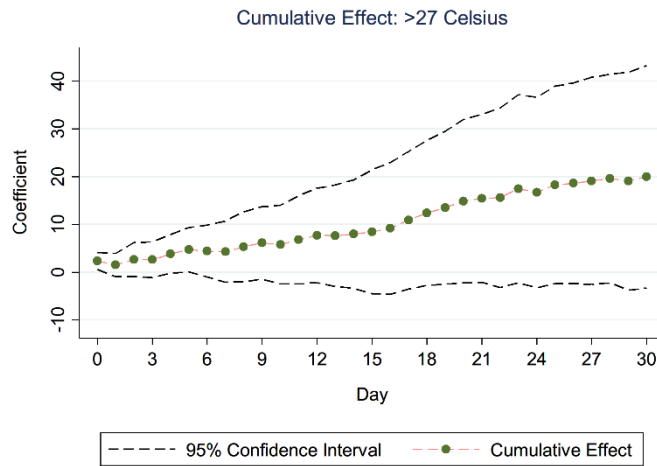


Notes. These graphs present the contemporaneous and cumulative effects of all the temperature bins in which the outcome variable is the total hospital admissions per 100,000 individuals enrolled. The x-axis indicates the bins that the daily mean temperature belongs to. Bin $[9^{\circ}\text{C}, 12^{\circ}\text{C})$ is the omitted category. The y-axis is the size of the coefficient. Panel A corresponds to $\beta_{j,t}$ in equation (1). Panel B corresponds to $\sum_{h=0}^{30} \beta_{j,t-h}$ in equation (1).

Figure 3. Cumulative Effect Over Time for Extremely Cold and Hot Days
 Panel A



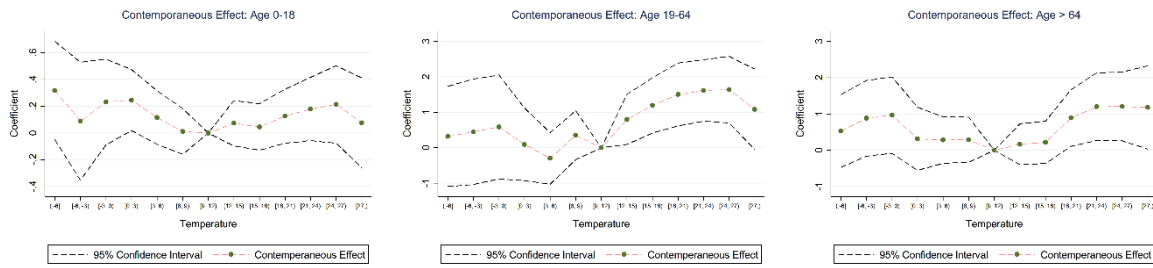
Panel B



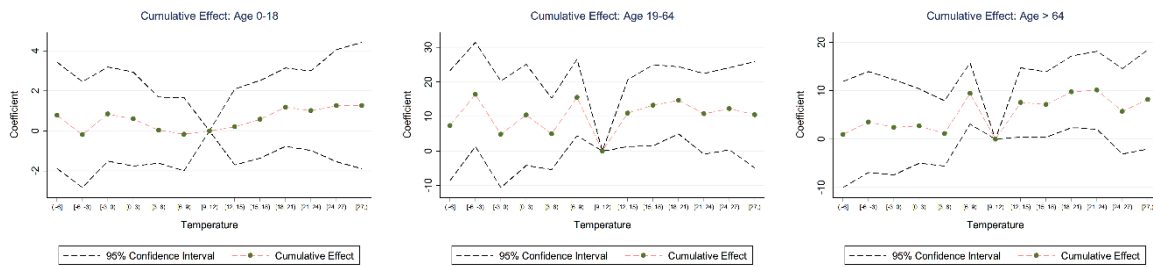
Notes. Panel A presents the cumulative effect for bin 1 (<-6°C) as Panel B presents bin 13 (>27°C); the outcome variable is the total hospital admissions per 100,000 individuals enrolled. The x-axis indicates the cumulative days. For example, the coefficient on x = 9 refers to $\sum_{h=0}^9 \beta_{j,t-h}$ in equation (1). The y-axis is the size of the coefficient..

Figure 4. Heterogeneity by Age

Panel A. Contemporaneous Effect by Age



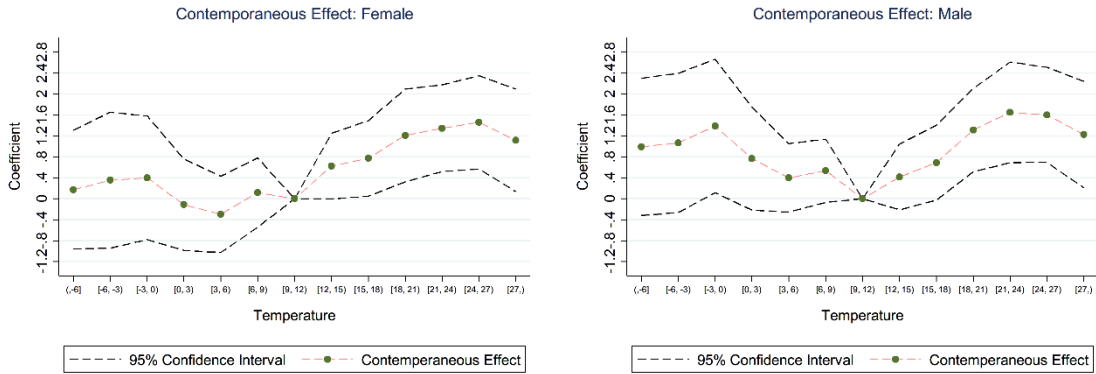
Panel B. Cumulative Effect by Age



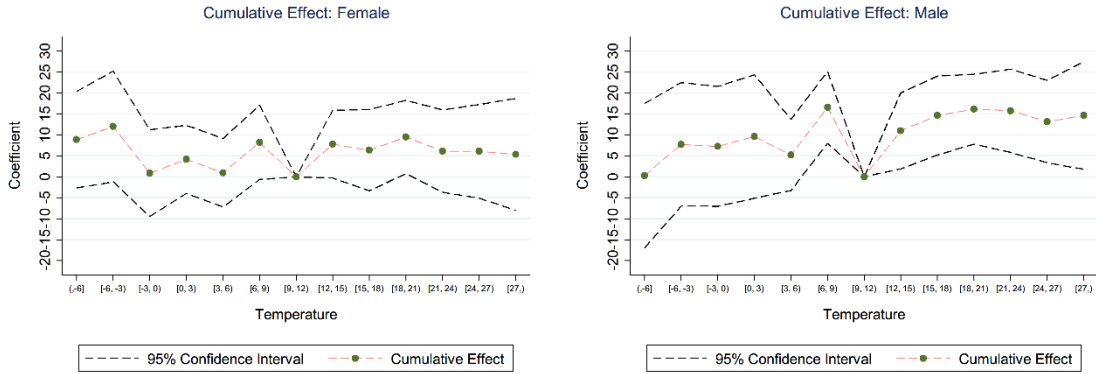
Notes. These graphs present the contemporaneous and cumulative effects of all the temperature bins in which the outcome variables are the total hospital admissions for ages 0–18, 19–64, and 65 and above per 100,000 individuals enrolled. The x-axis indicates the bins that the daily mean temperature belongs to. Bin [9° C,12°C) is the omitted category. The y-axis is the size of the coefficient. Panel A corresponds to $\beta_{j,t}$ in equation (1). Panel B corresponds to $\sum_{h=0}^{30} \beta_{j,t-h}$ in equation (1).

Figure 5. Heterogeneity by Gender

Panel A. Contemporaneous Effect by Gender



Panel B. Cumulative Effect by Gender

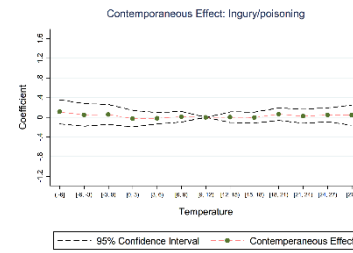
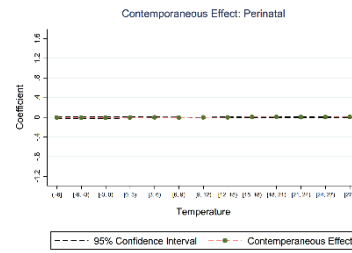
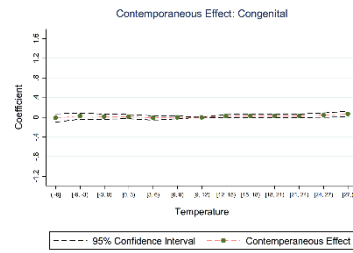
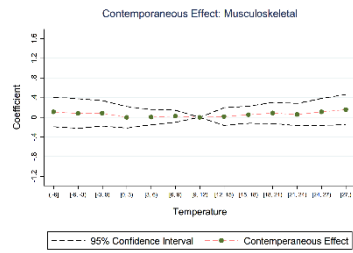


Notes. These graphs present the contemporaneous effect and cumulative effect of all the temperature bins in which the outcome variable is the total number of hospital admissions for genders per 100,000 individuals enrolled. The x-axis indicates the bins that the daily mean temperature belongs to. Bin $[9^{\circ}\text{C}, 12^{\circ}\text{C})$ is the omitted category. The y-axis is the size of the coefficient. Panel A corresponds to $\beta_{j,t}$ in equation (1). Panel B corresponds to $\sum_{h=0}^{30} \beta_{j,t-h}$ in equation (1).

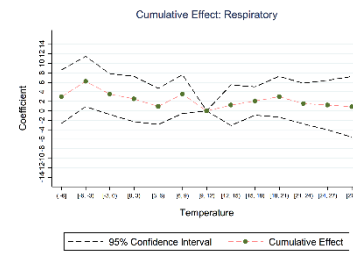
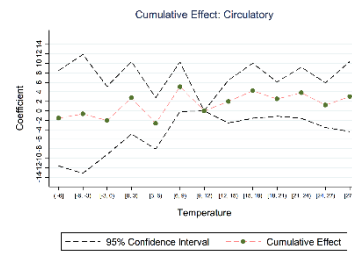
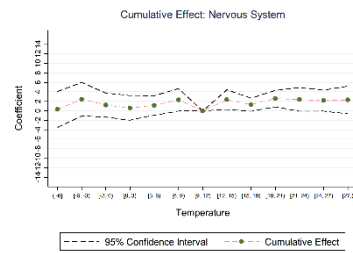
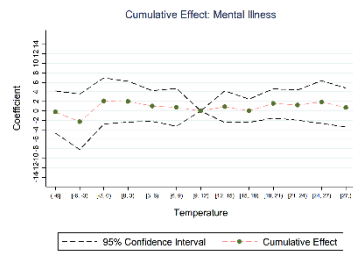
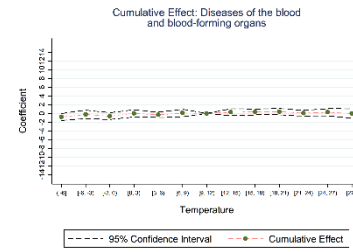
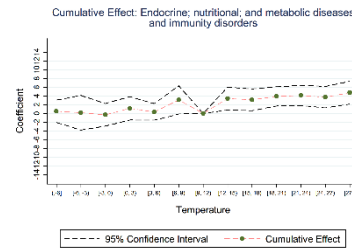
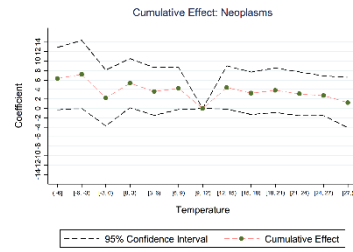
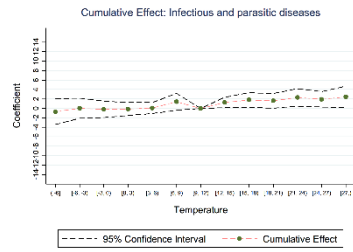
Figure 6. Heterogeneity by Disease Category

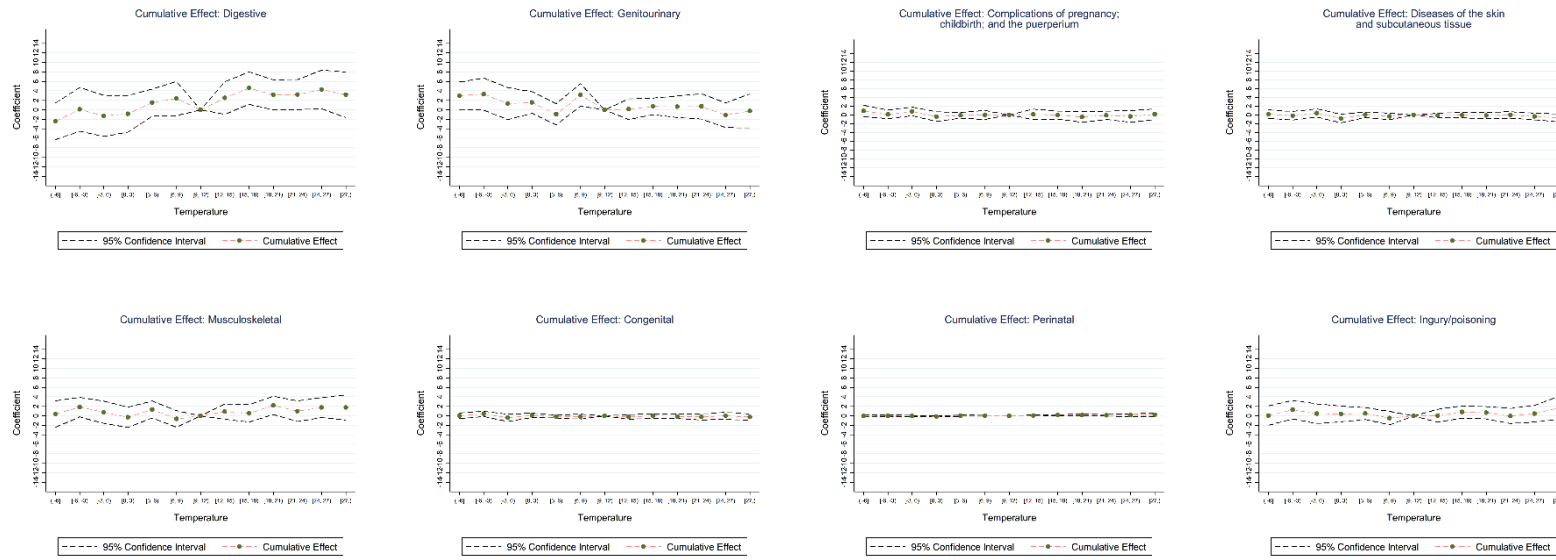
Panel A. Contemporaneous Effect by Disease





Panel B. Cumulative Effect by Disease Category





Notes. These graphs present the contemporaneous and cumulative effects of all the temperature bins in which the outcome variables are the total hospital admissions for the 16 different CCS disease categories per 100,000 individuals enrolled. The x-axis indicates the bins that the daily mean temperature belongs to. Bin $[9^{\circ}\text{C}, 12^{\circ}\text{C})$ is the omitted category. The y-axis is the size of the coefficient. Panel A corresponds to $\beta_{j,t}$ in equation (1). Panel B corresponds to $\sum_{h=0}^{30} \beta_{j,t-h}$ in equation (1).

Table 1. Summary Statistics of Hospital Visits

| | Number of Visits | Mean | SD |
|-------------------------|------------------|-------|-------|
| All Visits | 382,907 | 31.36 | 43.40 |
| Age Groups: | | | |
| 0–18 | 19,756 | 1.58 | 3.90 |
| 19–64 | 210,830 | 17.61 | 27.17 |
| 65 and above | 152,321 | 12.17 | 18.72 |
| Gender: | | | |
| Male | 193,431 | 16.53 | 26.93 |
| Female | 189,476 | 14.84 | 20.20 |
| CCS Disease Categories: | | | |
| Infectious/Parasitic | 8,635 | 0.75 | 2.51 |
| Neoplasms | 54,856 | 4.21 | 8.54 |
| Endocrine | 18,935 | 1.77 | 5.06 |
| Blood | 2,002 | 0.17 | 1.13 |
| Mental Illness | 8,398 | 0.67 | 8.21 |
| Nervous System | 18,301 | 1.51 | 3.85 |
| Circulatory | 102,001 | 8.15 | 11.93 |
| Respiratory | 49,835 | 4.00 | 6.86 |
| Digestive | 41,190 | 3.77 | 8.34 |
| Genitourinary | 25,411 | 2.14 | 4.89 |
| Pregnancy | 6,806 | 0.44 | 1.98 |
| Skin | 2,910 | 0.22 | 1.34 |
| Musculoskeletal | 18,400 | 1.62 | 4.10 |
| Congenital | 1,194 | 0.09 | 0.75 |
| Perinatal | 168 | 0.01 | 0.33 |
| Injuries | 11,382 | 0.89 | 2.63 |

Notes. Column 3 shows the average daily admission rate per 100,000 individuals enrolled for each category and column 4 shows the standard deviation of column 3. The data cover 47 cities across 2008–2010.

Table 2. Summary Statistics of Mean Daily Temperature by City-Day

| Temperature Bins: | #of city-day |
|-------------------|--------------|
| (, -6°C) | 1,747 |
| [-6°C, -3°C) | 910 |
| [-3°C, 0°C) | 1,343 |
| [0°C, 3°C) | 1,646 |
| [3°C, 6°C) | 1,835 |
| [6°C, 9°C) | 2,302 |
| [9°C, 12°C) | 2,647 |
| [12°C, 15°C) | 2,913 |
| [15°C, 18°C) | 3,157 |
| [18°C, 21°C) | 3,655 |
| [21°C, 24°C) | 4,108 |
| [24°C, 27°C) | 3,749 |
| [27°C,) | 3,597 |

Notes. Column 2 shows the number of city-days belonging to each temperature bin.

Table 3. Impact of Temperature on Hospital Admissions

| Daily Mean Temperature | All Contemp. | All Contemp. | All (Outlier Dropped) Contemp. | All Contemp. | All Cumul. |
|------------------------|---------------------|---------------------|--------------------------------|---------------------|----------------------|
| (, -6°C) | -0.655 (1.277) | 1.165 (1.005) | 0.904 (1.088) | 1.165 (0.770) | 9.112 (12.477) |
| [-6°C, -3°C) | 0.514 (1.070) | 1.419 (1.185) | 1.239 (1.280) | 1.419 (1.041) | 19.745 (11.827) |
| [-3°C, 0°C) | 0.292 (1.030) | 1.791 (1.093) | 1.596 (1.193) | 1.791* (1.043) | 8.131 (10.755) |
| [0°C, 3°C) | 0.248 (0.733) | 0.653 (0.801) | 0.545 (0.869) | 0.653 (0.727) | 13.769 (10.260) |
| [3°C, 6°C) | 0.125 (0.565) | 0.101 (0.569) | 0.018 (0.617) | 0.101 (0.496) | 6.198 (7.265) |
| [6°C, 9°C) | 0.611 (0.536) | 0.655 (0.562) | 0.615 (0.580) | 0.655 (0.524) | 24.787*** (6.800) |
| [12°C, 15°C) | 0.475 (0.539) | 1.038* (0.570) | 1.182* (0.590) | 1.038** (0.504) | 18.754** (7.029) |
| [15°C, 18°C) | 0.744 (0.603) | 1.461** (0.591) | 1.679*** (0.617) | 1.461** (0.562) | 21.008** (8.614) |
| [18°C, 21°C) | 1.754** (0.699) | 2.521*** (0.723) | 2.835*** (0.765) | 2.521*** (0.699) | 25.651*** (7.852) |
| [21°C, 24°C) | 2.127*** (0.714) | 2.997*** (0.790) | 3.372*** (0.844) | 2.997*** (0.791) | 21.895** (8.640) |
| [24°C, 27°C) | 2.023*** (0.717) | 3.061*** (0.794) | 3.378*** (0.860) | 3.061*** (0.783) | 19.262** (8.963) |
| [27°C,) | 1.182 (0.748) | 2.338** (0.887) | 2.672*** (0.987) | 2.338*** (0.866) | 19.973* (11.567) |

| | | | | | |
|-----------------------|---------------|---------------|---------------|---------------|---------------|
| Mean Dep. Var. | 32.055 | 32.055 | 32.055 | 32.055 | 32.055 |
| N | 31,714 | 31,714 | 30,691 | 31,714 | 31,714 |
| R-square | 0.707 | 0.764 | 0.762 | 0.764 | 0.764 |
| City-Year-Month FE | √ | × | × | × | × |
| City-Year-Week FE | × | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | one-way | two-way |

Notes. The table presents the impact of temperature on hospital admission rates. The omitted group is the bin in which the daily average temperature belongs to the 9°–12°C bin. The “Mean Dep. Var.” represents the average hospital admission rate when the average daily temperature falls in the 9°–12°C bin. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4. Impact of Temperature on Hospital Admissions: Heterogeneity by Age

| Daily Mean Temperature | Ages 0–18 | | Ages 19–64 | | Ages 65 and Higher | |
|---------------------------|-----------|---------|------------|-----------|-----------------------|----------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, –6°C) | 0.317* | 0.780 | 0.319 | 7.379 | 0.529 | 0.954 |
| | (0.182) | (1.318) | (0.702) | (7.905) | (0.498) | (5.451) |
| [–6°C, –3°C) | 0.088 | –0.187 | 0.450 | 16.392** | 0.881* | 3.540 |
| | (0.219) | (1.313) | (0.739) | (7.479) | (0.518) | (5.185) |
| [–3°C, 0°C) | 0.232 | 0.841 | 0.589 | 4.843 | 0.970* | 2.447 |
| | (0.159) | (1.168) | (0.727) | (7.658) | (0.523) | (4.901) |
| [0°C, 3°C) | 0.246** | 0.595 | 0.093 | 10.459 | 0.314 | 2.714 |
| | (0.113) | (1.167) | (0.508) | (7.268) | (0.432) | (3.820) |
| [3°C, 6°C) | 0.115 | 0.037 | –0.299 | 4.975 | 0.284 | 1.185 |
| | (0.099) | (0.819) | (0.362) | (5.141) | (0.318) | (3.351) |
| [6°C, 9°C) | 0.012 | –0.166 | 0.353 | 15.519*** | 0.290 | 9.434*** |
| | (0.085) | (0.907) | (0.342) | (5.502) | (0.308) | (3.144) |
| [12°C, 15°C) | 0.072 | 0.203 | 0.799** | 10.975** | 0.166 | 7.576** |
| | (0.084) | (0.942) | (0.350) | (4.815) | (0.279) | (3.553) |
| [15°C, 18°C) | 0.045 | 0.579 | 1.196*** | 13.272** | 0.219 | 7.157** |
| | (0.086) | (0.964) | (0.387) | (5.822) | (0.289) | (3.360) |
| [18°C, 21°C) | 0.126 | 1.183 | 1.504*** | 14.687*** | 0.892** | 9.781** |
| | (0.100) | (0.970) | (0.441) | (4.827) | (0.387) | (3.676) |
| [21°C, 24°C) | 0.180 | 1.010 | 1.616*** | 10.766* | 1.201** | 10.119** |
| | (0.117) | (0.987) | (0.430) | (5.807) | (0.462) | (4.008) |
| [24°C, 27°C) | 0.213 | 1.258 | 1.639*** | 12.256** | 1.209** | 5.748 |
| | (0.144) | (1.388) | (0.467) | (5.905) | (0.472) | (4.388) |
| [27°C,) | 0.076 | 1.264 | 1.084* | 10.497 | 1.179** | 8.212 |
| | (0.167) | (1.567) | (0.564) | (7.641) | (0.569) | (5.091) |

| | | | | | | |
|-----------------------|--------------|--------------|---------------|---------------|---------------|---------------|
| Mean Dep. Var. | 1.311 | 1.311 | 17.678 | 17.678 | 13.066 | 13.066 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.561 | 0.561 | 0.705 | 0.705 | 0.705 | 0.705 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. The table presents the impact of temperature on hospital admission rates by age groups. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate for the three age groups, respectively, when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 5. Impact of Temperature on Hospital Admissions: Heterogeneity by Gender

| Daily Mean Temperature | Female Contemp. | Female Cumul. | Male Contemp. | Male Cumul. |
|------------------------|---------------------|--------------------|---------------------|----------------------|
| (, -6°C) | 0.173 (0.563) | 8.857 (5.713) | 0.993 (0.651) | 0.256 (8.561) |
| [-6°C, -3°C) | 0.354 (0.645) | 12.017* (6.563) | 1.065 (0.661) | 7.729 (7.339) |
| [-3°C, 0°C) | 0.400 (0.587) | 0.875 (5.144) | 1.390** (0.633) | 7.256 (7.106) |
| [0°C, 3°C) | -0.114 (0.433) | 4.165 (4.042) | 0.767 (0.488) | 9.604 (7.325) |
| [3°C, 6°C) | -0.298 (0.362) | 0.965 (4.065) | 0.399 (0.325) | 5.233 (4.212) |
| [6°C, 9°C) | 0.119 (0.329) | 8.213* (4.405) | 0.536* (0.300) | 16.574*** (4.247) |
| [12°C, 15°C) | 0.622* (0.312) | 7.783* (4.017) | 0.416 (0.312) | 10.971** (4.510) |
| [15°C, 18°C) | 0.771** (0.358) | 6.375 (4.829) | 0.689* (0.355) | 14.632*** (4.682) |
| [18°C, 21°C) | 1.210*** (0.440) | 9.506** (4.343) | 1.312*** (0.395) | 16.145*** (4.144) |
| [21°C, 24°C) | 1.347*** (0.411) | 6.124 (4.880) | 1.650*** (0.477) | 15.772*** (4.939) |
| [24°C, 27°C) | 1.459*** (0.443) | 6.083 (5.556) | 1.601*** (0.452) | 13.178** (4.886) |
| [27°C,) | 1.114** (0.486) | 5.345 (6.644) | 1.224** (0.506) | 14.628** (6.381) |
| Mean Dep. Var. | 14.867 | 14.867 | 17.188 | 17.188 |
| N | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.726 | 0.726 | 0.702 | 0.702 |
| City-Year-Week FE | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate for females and males, when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 6. Impact of Temperature on Hospital Admissions: Heterogeneity by Disease Category

| Daily Mean Temperature | Neoplasms | | Endocrine, Nutritional, and Metabolic Diseases and Immunity Disorders | | Circulatory | | Respiratory | | Digestive | |
|------------------------|---------------------|--------------------|---|---------------------|---------------------|-------------------|--------------------|--------------------|-------------------|---------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.282 (0.291) | 6.321* (3.281) | 0.154 (0.175) | 0.491 (1.263) | 0.221 (0.475) | -1.551 (4.995) | 0.367 (0.256) | 2.988 (2.798) | -0.101 (0.318) | -2.413 (1.917) |
| [-6°C, -3°C) | 0.243 (0.227) | 7.203* (3.577) | 0.212 (0.165) | 0.159 (1.964) | 0.397 (0.471) | -0.624 (6.217) | 0.461** (0.217) | 6.203** (2.629) | -0.046 (0.264) | 0.104 (2.293) |
| [-3°C, 0°C) | 0.228 (0.191) | 2.204 (2.929) | 0.113 (0.115) | -0.309 (1.277) | 0.318 (0.392) | -2.029 (3.555) | 0.420** (0.170) | 3.527 (2.136) | 0.018 (0.206) | -1.280 (2.153) |
| [0°C, 3°C) | 0.119 (0.169) | 5.350** (2.577) | 0.004 (0.100) | 1.158 (1.327) | 0.014 (0.334) | 2.756 (3.794) | 0.297** (0.139) | 2.513 (2.367) | 0.160 (0.180) | -0.821 (1.916) |
| [3°C, 6°C) | -0.099 (0.155) | 3.597 (2.510) | 0.001 (0.085) | 0.338 (0.945) | 0.099 (0.308) | -2.626 (2.697) | 0.238* (0.133) | 0.948 (1.886) | 0.055 (0.144) | 1.532 (1.423) |
| [6°C, 9°C) | 0.111 (0.167) | 4.236* (2.212) | 0.075 (0.070) | 3.089* (1.608) | 0.091 (0.222) | 5.089* (2.594) | 0.093 (0.104) | 3.546* (2.030) | 0.111 (0.116) | 2.387 (1.782) |
| [12°C, 15°C) | 0.246* (0.140) | 4.428* (2.271) | 0.249*** (0.074) | 3.392** (1.306) | 0.128 (0.198) | 1.973 (2.242) | 0.126 (0.104) | 1.210 (2.130) | 0.089 (0.080) | 2.506 (1.707) |
| [15°C, 18°C) | 0.259 (0.157) | 3.213 (2.226) | 0.238*** (0.074) | 3.118** (1.234) | 0.419* (0.223) | 4.241 (2.880) | 0.148 (0.137) | 2.090 (1.486) | 0.165 (0.104) | 4.588*** (1.692) |
| [18°C, 21°C) | 0.375** (0.168) | 3.835 (2.335) | 0.313*** (0.097) | 3.893*** (1.088) | 0.605** (0.266) | 2.497 (1.796) | 0.257* (0.147) | 2.987 (2.138) | 0.236* (0.136) | 3.185** (1.572) |
| [21°C, 24°C) | 0.507*** (0.183) | 3.096 (2.302) | 0.378*** (0.093) | 4.117*** (1.149) | 0.830*** (0.297) | 3.811 (2.677) | 0.269* (0.159) | 1.529 (2.130) | 0.277* (0.157) | 3.207** (1.575) |
| [24°C, 27°C) | 0.525*** (0.180) | 2.698 (2.087) | 0.389*** (0.102) | 3.733*** (1.216) | 0.807** (0.328) | 1.210 (2.340) | 0.348* (0.190) | 1.235 (2.594) | 0.314* (0.170) | 4.303** (2.015) |
| [27°C,) | 0.444** | 1.233 | 0.389*** | 4.749*** | 0.638 | 3.024 | 0.397* | 0.855 | 0.178 | 3.183 |

| | (0.211) | (2.648) | (0.108) | (1.295) | (0.395) | (3.669) | (0.207) | (3.175) | (0.197) | (2.388) |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Mean Dep. | | | | | | | | | | |
| Var. | 4.313 | 4.313 | 1.759 | 1.759 | 8.435 | 8.435 | 4.283 | 4.283 | 3.960 | 3.960 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.573 | 0.573 | 0.410 | 0.410 | 0.663 | 0.663 | 0.554 | 0.554 | 0.524 | 0.524 |
| City-Year-Week | | | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate for each CCS category, when the average daily temperature falls in the 9°–12°C. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 7. Impact of Temperature on Medical Bills

| | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|-----------------------|----------------------------|------------------------|----------------------------|------------------------|--------------------------|--------------------------|--------------------------|-------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 18102.241 (16299.530) | 116381.1 (214337) | 12923.473 (10327.127) | 103238.2 (152160.1) | 2579.015 (4272.195) | 28071.29 (39878.28) | 2599.754 (3069.875) | -14928.42 (34193) |
| [-6°C, -3°C) | 23946.441* (12205.964) | 267278.4 (162039.9) | 16921.192** (8010.875) | 187627.4 (115838.5) | 3600.610 (3624.676) | 62819.38** (28157.53) | 3424.640 (2290.065) | 16831.58 (32540.02) |
| [-3°C, 0°C) | 22458.442* (12150.326) | 82326.23 (170050.6) | 15584.515* (8651.341) | 77302.78 (119078.9) | 3371.089 (3025.252) | 18441.42 (28158.78) | 3502.840* (1797.566) | -13417.98 (33395.67) |
| [0°C, 3°C) | 10428.688 (9411.570) | 272011.4 (137603.4) | 6914.086 (6525.170) | 198822.3 (103658.7) | 794.757 (2579.136) | 53650.58 (27999.54) | 2719.847* (1611.494) | 19538.58 (17059.11) |
| [3°C, 6°C) | 6362.540 (7030.404) | 133746.8 (92495.01) | 4568.858 (4639.821) | 105903.5 (67597.66) | -55.085 (2318.351) | 14148.84 (15676.53) | 1848.768 (1310.614) | 13694.42 (20105.45) |
| [6°C, 9°C) | 3166.682 (7179.139) | 204322 (93382.96) | 3619.674 (4693.790) | 180422 (73249.1) | -963.690 (2393.126) | 26158.28 (19880.77) | 510.700 (1244.726) | -2258.213 (20213.17) |
| [12°C, 15°C) | 16644.838** (7919.329) | 127496.9 (100237.9) | 11175.438* (5576.844) | 126691.7 (76707.8) | 3670.728** (1774.535) | 4591.225 (16287.95) | 1798.672 (1318.901) | -3786.009 (22331.67) |
| [15°C, 18°C) | 19513.725** (8523.232) | 192978.8 (128908.5) | 12975.222** (6067.901) | 159692.5 (95338.51) | 4213.845** (1834.609) | 22579.19 (19325.83) | 2324.658* (1332.850) | 10707.17 (20893.28) |
| [18°C, 21°C) | 30073.924** (12896.660) | 185735.5 (92560.9) | 19477.932** (8777.825) | 150043.3 (75014.04) | 6611.017** (2950.911) | 8283.522 (13361.53) | 3984.976** (1826.012) | 27408.62 (16323.81) |
| [21°C, 24°C) | 33357.619** (15385.404) | 146276.7 (105964.6) | 21986.038** (10315.729) | 144534.7 (83888.88) | 7919.166* (4098.184) | 1275.654 (19084.39) | 3452.414* (1782.306) | 466.3337 (15355.92) |
| [24°C, 27°C) | 32507.030** (12256.231) | 119748.9 (109606.1) | 21240.068** (8153.077) | 122231.6 (86395.11) | 6841.361** (3086.982) | -7058.029 (18392.29) | 4425.601** (1951.438) | 4575.392 (19232.76) |
| [27°C,) | 24395.708* (12156.737) | 167895.5 (159583.5) | 14807.785* (7685.087) | 153399.3 (121830.6) | 5127.623* (3047.208) | 2741.673 (24504.34) | 4460.299* (2480.124) | 11754.6 (26617.43) |
| Mean Dep. Var. | 280906.1 | 280906.1 | 189007.5 | 189007.5 | 60500.93 | 60500.93 | 31397.71 | 31397.71 |

| | | | | | | | | |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.678 | 0.678 | 0.672 | 0.672 | 0.610 | 0.610 | 0.641 | 0.641 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills when the average daily temperature falls in 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 8. Cumulative Medical Bills of an Additional Cold/Hot Day

| | Total bill | | Covered by insurance | | Covered by patient | |
|--------------|--------------|-------------|----------------------|-------------|--------------------|---------------|
| | per 100k pop | Total pop | per 100k pop | Total pop | per 100k pop | Total pop |
| (, -6°C) | ¥116,381.1 | ¥1.4Billion | ¥103,238.2 | ¥1.3Billion | ¥13,142.8 | ¥0.2Billion |
| [-6°C, -3°C) | ¥267,278.4 | ¥3.2Billion | ¥187,627.4 | ¥2.3Billion | ¥79,650.9 | ¥0.9Billion |
| [24°C, 27°C) | ¥119,748.9 | ¥1.5Billion | ¥122,231.6 | ¥1.5Billion | ¥-2,482.6 | ¥-0.03Billion |
| [27°C,) | ¥167,895.5 | ¥2.0Billion | ¥153,399.3 | ¥1.9Billion | ¥14,496.3 | ¥0.2Billion |

Notes. This table provides a back-of-the-envelope calculation on the 31-day cumulative monetary costs associated with each additional cold/hot day. Column 5 is based on the sum of coefficients in columns 6 and 8 of Table 7.

Table 9. Predicted Impact of Climate Change on Hospital Admissions

| | Climate Change Model | Impact of change in cold/hot day | | Total temperature impact |
|-----------|-------------------------|----------------------------------|------------------------|--------------------------|
| | | (, -6°C) | [27°C,) | |
| 2070–2099 | Hadley GEM2-ES (RCP8.5) | -30.365 (41.458) | 1296.221* (753.725) | 23.511 (522.088) |

Notes. The results are based on the estimates of 31-day cumulative effects on hospital admissions per 100,000 individuals enrolled, and the predicted changes of days in various temperature bins according to the Hadley GEM2-ES climate change model for the RCP8.5. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

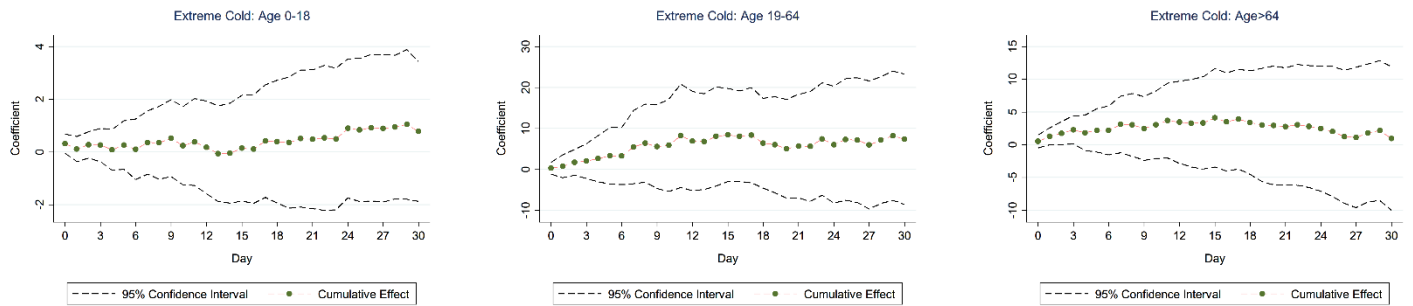
Impact of Temperature on Morbidity: New Evidence from China

Online Appendix (not for publication)

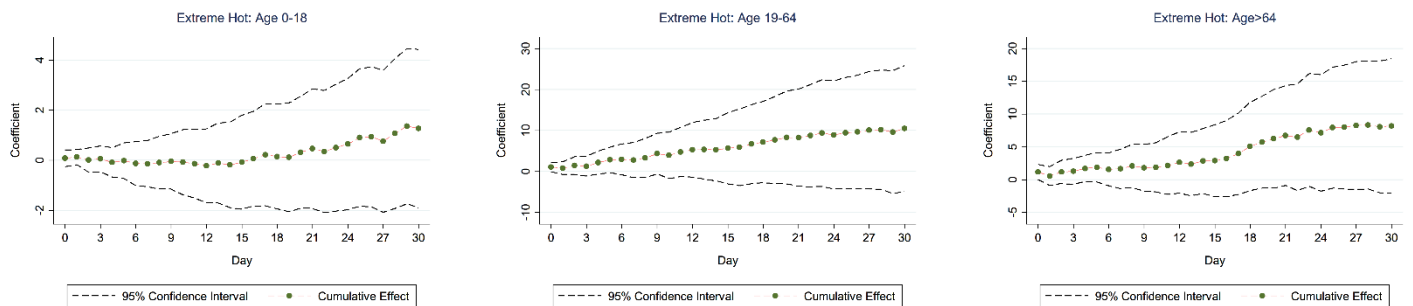
Figures

Figure A1. Cumulative Effect of Extremely Hot and Cold Temperatures: by Age Group

Panel A. Cumulative Effect by Age Group (Extreme Cold)



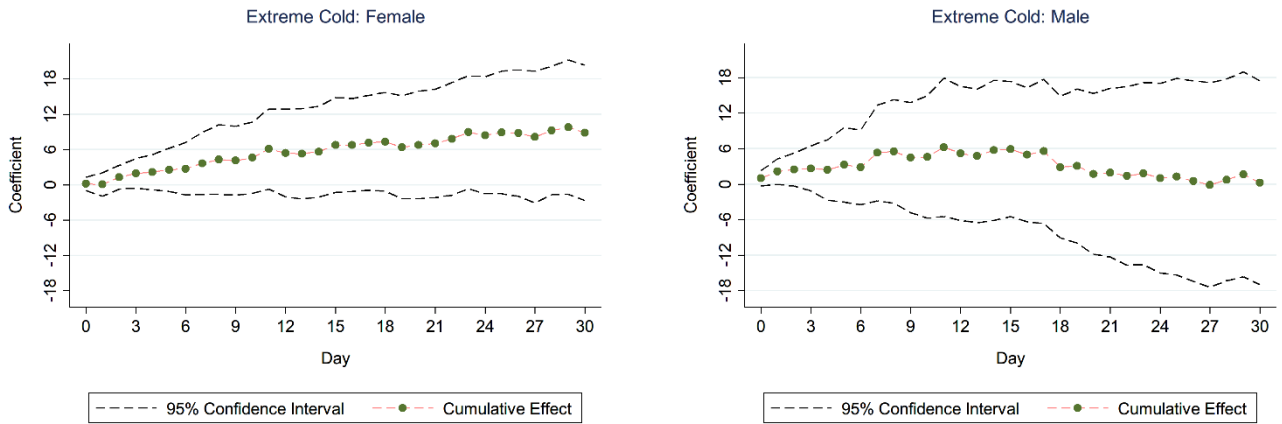
Panel B. Cumulative Effect by Age Group (Extreme Hot)



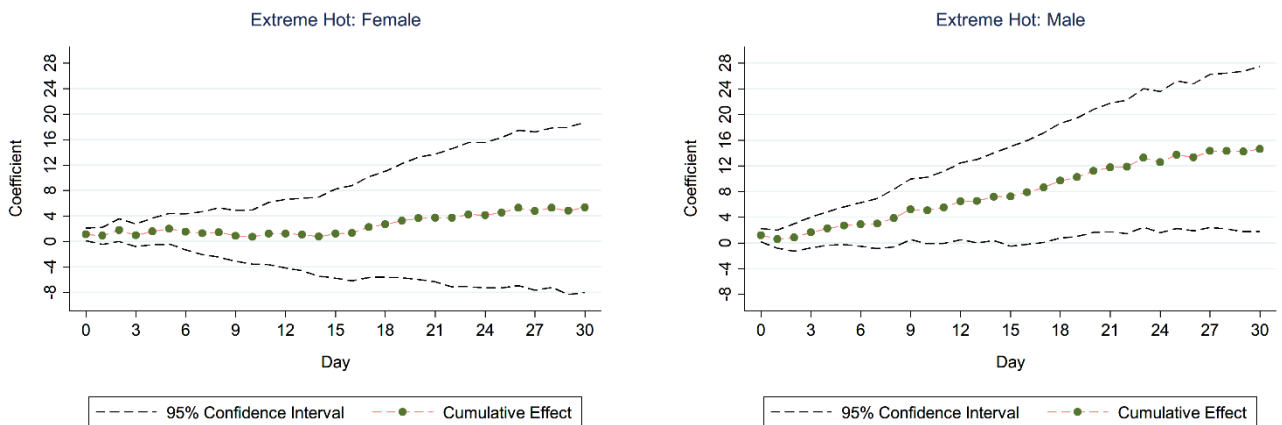
Notes. These graphs present the cumulative effects of bin 1 ($< -6^{\circ}\text{C}$), Panel A, and bin 13 ($> 27^{\circ}\text{C}$), Panel B, where the outcome variable is the total number of hospital admissions for the three age groups per 100,000 individuals enrolled in either the URBMI or UEBMI. The x-axis indicates the cumulative days. For example, the coefficient on $x=9$ refers to $\sum_{h=0}^9 \beta_{j,t-h}$ in equation (1). The y-axis is the size of the coefficient.

Figure A2. Cumulative Effect of Extremely Hot and Cold Temperature by Gender

Panel A. Cumulative Effect by Gender (Extreme Cold)



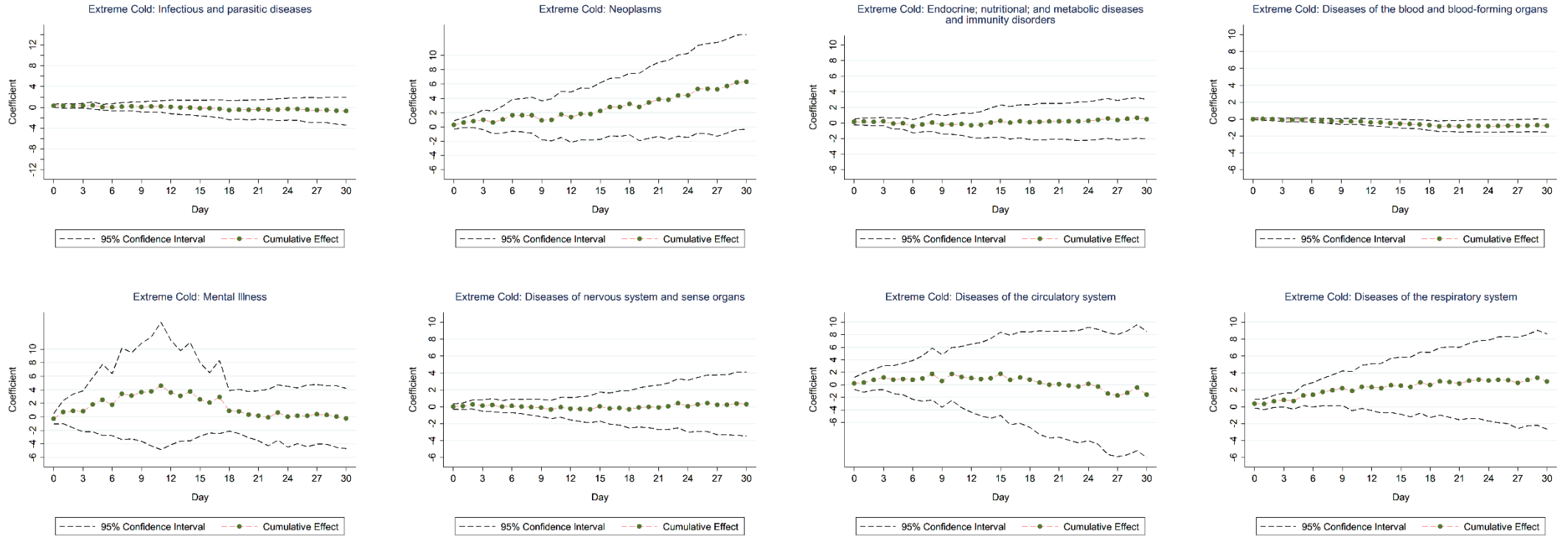
Panel B. Cumulative Effect by Gender (Extreme Hot)

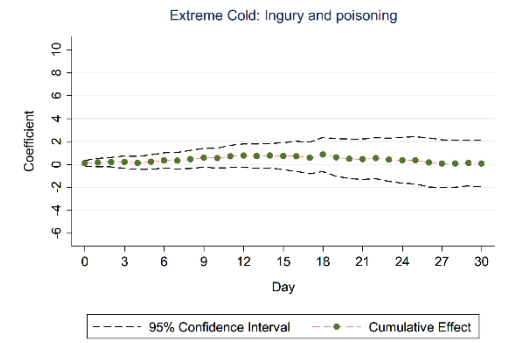
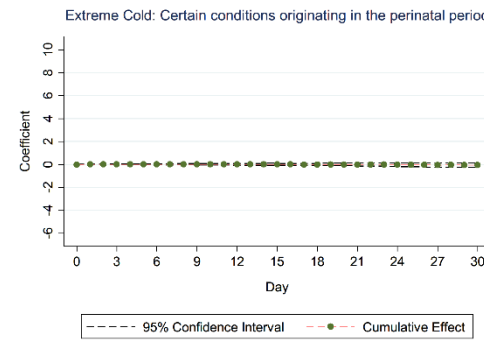
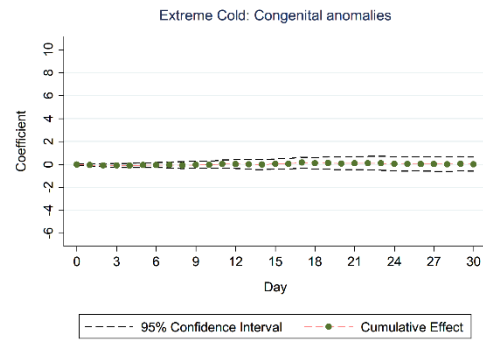
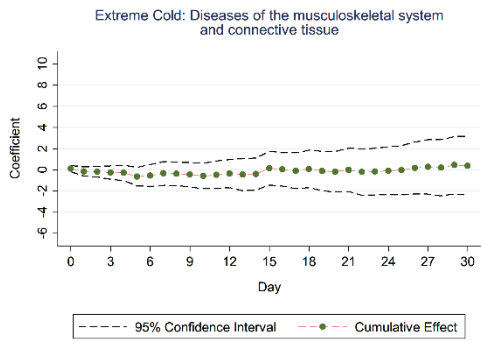
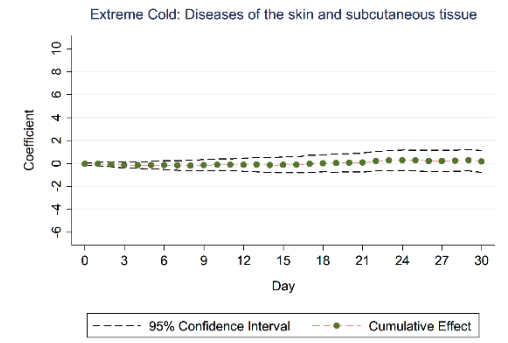
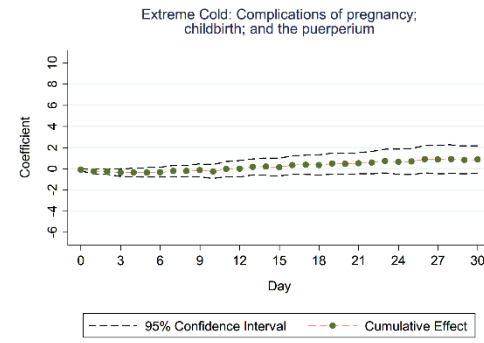
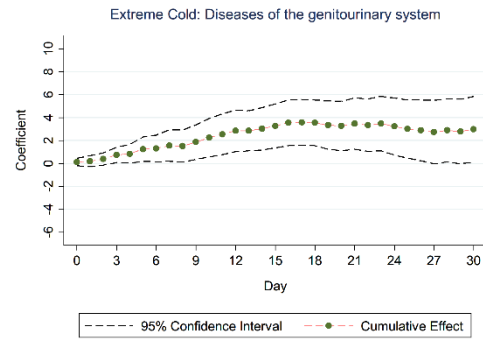
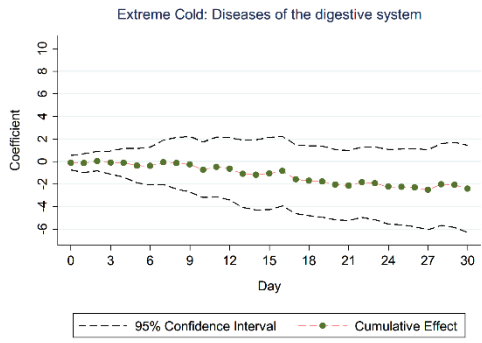


Notes. These graphs present the cumulative effects of bin 1 ($< -6^{\circ}\text{C}$), Panel A, and bin 13 ($> 27^{\circ}\text{C}$), Panel B, where the outcome variable is the total number of hospital admissions by gender per 100,000 individuals enrolled in either the URBMI or UEBMI. The x-axis indicates the cumulative days. For example, the coefficient on $x=9$ refers to $\sum_{h=0}^9 \beta_{j,t-h}$ in equation (1). The y-axis is the size of the coefficient.

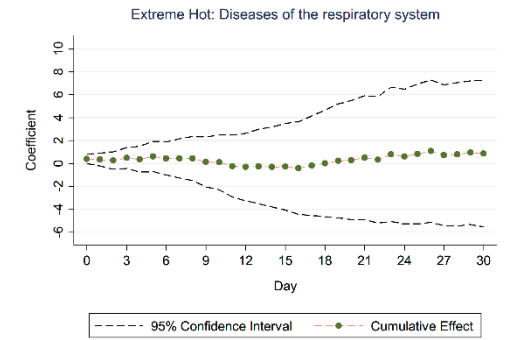
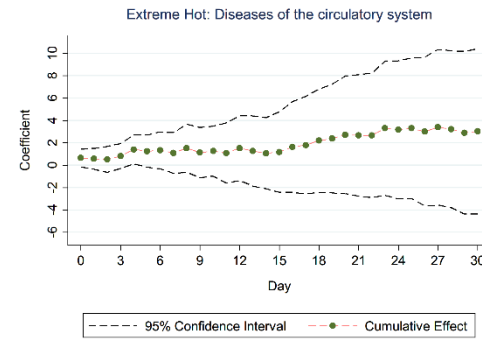
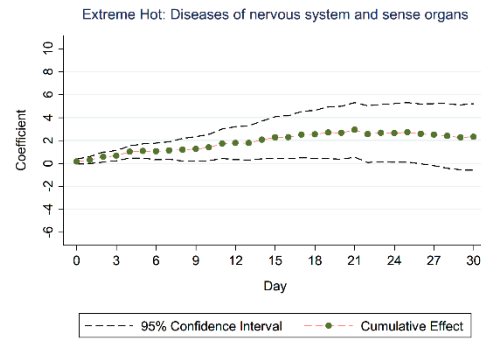
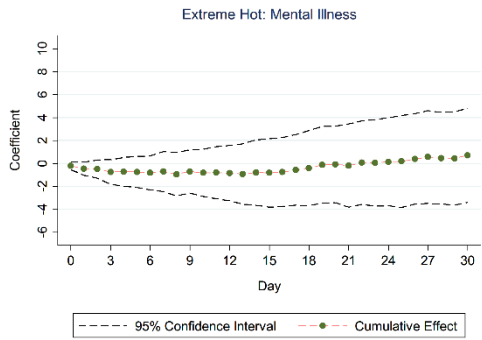
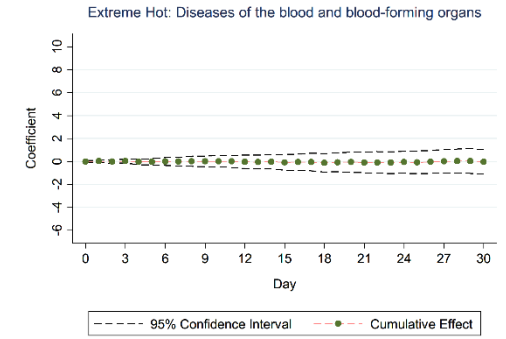
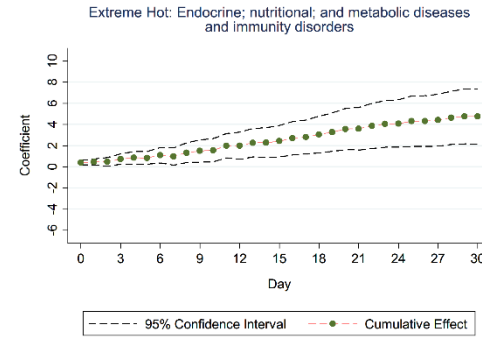
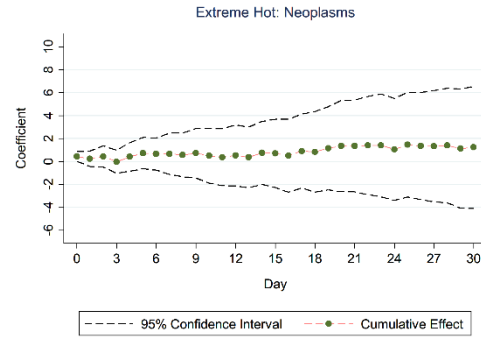
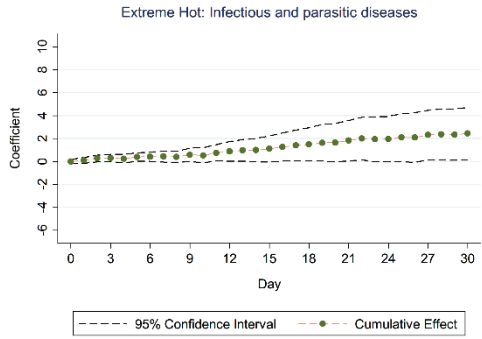
Figure A3. Cumulative Effect of Extremely Hot and Cold Temperature by Disease Category

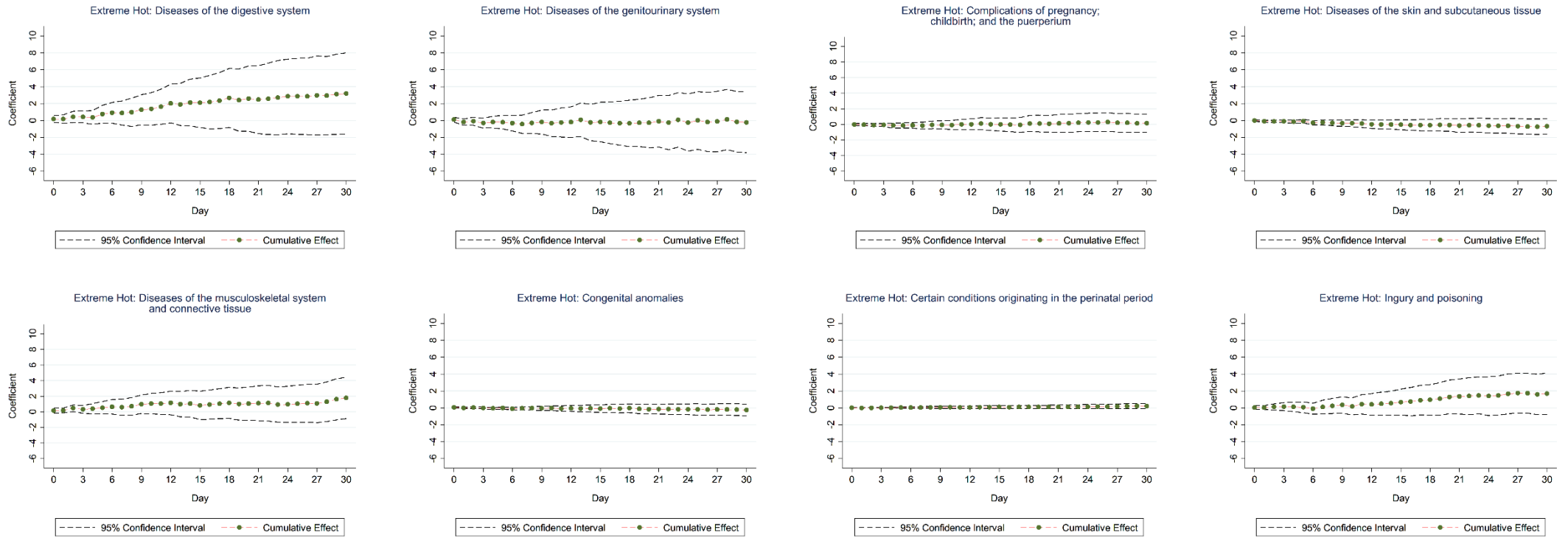
Panel A. Cumulative Effect by Disease Category (Extreme Cold)





Panel B. Cumulative Effect by Disease Category (Extreme Hot)





Notes. These graphs present the cumulative effects of bin 1 ($<-6^{\circ}\text{C}$), Panel A, and bin 13 ($>27^{\circ}\text{C}$), Panel B, where the outcome variable is the total hospital admissions by disease group per 100,000 individuals enrolled in either the URBMI or UEBMI. The x-axis indicates the cumulative days. For example, the coefficient on $x=9$ refers to $\sum_{h=0}^9 \beta_{j,t-h}$ in equation (1). The y-axis is the size of the coefficient.

Tables

Table A1. Robustness Check by Changing the Definition of Temperature Bins

| Daily Max Temperature | All Contemp. | All Cumul. | Daily Mean Temperature | All Contemp. | All Cumul. |
|-----------------------|---------------------|---------------------|------------------------|-------------------|---------------------|
| (, -6°C) | 0.570 (0.993) | 5.747 (14.886) | (, -8°C) | 1.140 (1.903) | -12.183 (13.139) |
| [-6°C, -3°C) | -0.110 (1.056) | -7.869 (13.459) | [-8°C, -4°C) | -0.316 (1.009) | -1.712 (11.395) |
| [-3°C, 0°C) | 0.789 (0.911) | 2.889 (15.528) | [-4°C, 0°C) | 0.731 (1.042) | -4.263 (8.868) |
| [0°C, 3°C) | 0.415 (1.118) | 0.971 (10.643) | [0°C, 4°C) | -0.284 (0.815) | -10.221 (8.252) |
| [3°C, 6°C) | 0.237 (0.567) | -13.252 (13.391) | [4°C, 8°C) | -0.589 (0.631) | 1.428 (5.273) |
| [6°C, 9°C) | 0.582 (0.725) | -0.831 (10.930) | [8°C, 12°C) | -0.821 (0.502) | -8.389 (6.390) |
| [12°C, 15°C) | 1.068* (0.577) | -9.504 (12.252) | [16°C, 20°C) | 0.400 (0.504) | 6.580* (3.876) |
| [15°C, 18°C) | 0.584 (0.568) | -6.679 (10.225) | [20°C, 24°C) | 0.987* (0.578) | 7.339 (5.679) |
| [18°C, 21°C) | 1.400* (0.744) | -2.527 (8.866) | [24°C, 28°C) | 0.963* (0.551) | 3.6809 (5.713) |
| [21°C, 24°C) | 2.140*** (0.688) | 5.373 (8.180) | [28°C,) | 1.558* (0.840) | 6.457 (9.095) |
| [24°C, 27°C) | 2.707*** (0.759) | 3.977 (8.963) | | | |
| [27°C,) | 2.784*** | 2.428 | | | |

| | | | | | |
|-----------------------|---------------|---------------|-----------------------|---------------|---------------|
| | (0.862) | (9.377) | | | |
| Mean Dep. Var. | 30.053 | 30.053 | Mean Dep. Var. | 35.495 | 35.495 |
| N | 31,714 | 31,714 | N | 31,714 | 31,714 |
| R-square | 0.764 | 0.764 | R-square | 0.763 | 0.763 |
| City-Year-Week FE | √ | √ | City-Year-Week FE | √ | √ |
| Exact Date | √ | √ | Exact Date | √ | √ |
| 30 Days Lag | √ | √ | 30 Days Lag | √ | √ |
| Cluster | two-way | two-way | Cluster | two-way | two-way |

Notes. The table presents the impact of temperature on hospital admission rates using two alternative definitions of temperature bins. Columns 1 and 2 use the daily maximum temperature to define the temperature bins. Columns 3 and 4 define the temperature bins using a bigger bin size, which allows for 11 bins from below -8°C to above 28°C , with 4°C increments. We use $12^{\circ}\text{--}16^{\circ}\text{C}$ as the omitted bin. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate when the max (average) daily temperature falls in the omitted temperature bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A2. Impact of Temperature on Hospital Admissions: Heterogeneity by Disease Category (Full Results)

Panel A. Infectious and parasitic diseases; Neoplasms; Endocrine, nutritional, and metabolic diseases and immunity disorders; and Diseases of the blood and blood-forming organs

| Daily Mean Temperature | Infectious and parasitic diseases | | Neoplasms | | Endocrine, nutritional, and metabolic diseases and immunity disorders | | Diseases of the blood and blood-forming organs | |
|------------------------|-----------------------------------|---------|-----------|---------|---|----------|--|----------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.296* | -0.702 | 0.282 | 6.321* | 0.154 | 0.491 | -0.008 | -0.796** |
| | (0.154) | (1.337) | (0.291) | (3.281) | (0.175) | (1.263) | (0.056) | (0.388) |
| [-6°C, -3°C) | 0.145 | 0.042 | 0.243 | 7.203* | 0.212 | 0.159 | 0.028 | -0.231 |
| | (0.089) | (1.060) | (0.227) | (3.577) | (0.165) | (1.964) | (0.044) | (0.481) |
| [-3°C, 0°C) | 0.086 | -0.182 | 0.228 | 2.204 | 0.113 | -0.309 | 0.027 | -0.614 |
| | (0.075) | (0.864) | (0.191) | (2.929) | (0.115) | (1.277) | (0.037) | (0.388) |
| [0°C, 3°C) | 0.074 | -0.115 | 0.119 | 5.350** | 0.004 | 1.158 | 0.013 | 0.022 |
| | (0.065) | (0.679) | (0.169) | (2.577) | (0.100) | (1.327) | (0.029) | (0.403) |
| [3°C, 6°C) | -0.018 | 0.083 | -0.099 | 3.597 | 0.001 | 0.338 | -0.001 | -0.329 |
| | (0.056) | (0.577) | (0.155) | (2.510) | (0.085) | (0.945) | (0.027) | (0.306) |
| [6°C, 9°C) | 0.059 | 1.401 | 0.111 | 4.236* | 0.075 | 3.089* | 0.003 | 0.099 |
| | (0.045) | (0.889) | (0.167) | (2.212) | (0.070) | (1.608) | (0.025) | (0.426) |
| [12°C, 15°C) | 0.057 | 1.262** | 0.246* | 4.428* | 0.249*** | 3.392** | 0.002 | 0.285 |
| | (0.041) | (0.549) | (0.140) | (2.271) | (0.074) | (1.306) | (0.020) | (0.390) |
| [15°C, 18°C) | 0.024 | 1.799** | 0.259 | 3.213 | 0.238*** | 3.118** | 0.014 | 0.339 |
| | (0.044) | (0.765) | (0.157) | (2.226) | (0.074) | (1.234) | (0.027) | (0.332) |
| [18°C, 21°C) | 0.054 | 1.607** | 0.375** | 3.835 | 0.313*** | 3.893*** | -0.004 | 0.418 |
| | (0.052) | (0.765) | (0.168) | (2.335) | (0.097) | (1.088) | (0.033) | (0.352) |
| [21°C, 24°C) | 0.079 | 2.335** | 0.507*** | 3.096 | 0.378*** | 4.117*** | -0.009 | 0.064 |
| | (0.062) | (0.920) | (0.183) | (2.302) | (0.093) | (1.149) | (0.031) | (0.331) |
| [24°C, 27°C) | 0.023 | 1.925** | 0.525*** | 2.698 | 0.389*** | 3.733*** | -0.002 | 0.280 |

| | | | | | | | | |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | (0.072) | (0.811) | (0.180) | (2.087) | (0.102) | (1.216) | (0.035) | (0.404) |
| [27°C,) | -0.010 | 2.442** | 0.444** | 1.233 | 0.389*** | 4.749*** | -0.008 | -0.020 |
| | (0.090) | (1.129) | (0.211) | (2.648) | (0.108) | (1.295) | (0.043) | (0.543) |
| Mean Dep. | | | | | | | | |
| Var. | 0.610 | 0.610 | 4.313 | 4.313 | 1.759 | 1.759 | 0.164 | 0.164 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.394 | 0.394 | 0.573 | 0.573 | 0.410 | 0.410 | 0.195 | 0.195 |
| City-Year-Week | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Panel B. Mental illness; Nervous system; Circulatory; and Respiratory Diseases

| Daily Mean Temperature | Mental illness | | Nervous system | | Circulatory | | Respiratory | |
|---------------------------|----------------|---------|----------------|---------|-------------|---------|-------------|---------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | -0.269 | -0.232 | 0.020 | 0.296 | 0.221 | -1.551 | 0.367 | 2.988 |
| | (0.388) | (2.207) | (0.154) | (1.877) | (0.475) | (4.995) | (0.256) | (2.798) |
| [-6°C, -3°C) | -0.229 | -2.299 | -0.061 | 2.455 | 0.397 | -0.624 | 0.461** | 6.203** |
| | (0.326) | (2.909) | (0.131) | (1.754) | (0.471) | (6.217) | (0.217) | (2.629) |
| [-3°C, 0°C) | 0.395 | 2.094 | -0.023 | 1.229 | 0.318 | -2.029 | 0.420** | 3.527 |
| | (0.358) | (2.411) | (0.132) | (1.255) | (0.392) | (3.555) | (0.170) | (2.136) |
| [0°C, 3°C) | 0.070 | 1.951 | -0.040 | 0.630 | 0.014 | 2.756 | 0.297** | 2.513 |
| | (0.153) | (2.143) | (0.127) | (1.294) | (0.334) | (3.794) | (0.139) | (2.367) |
| [3°C, 6°C) | -0.058 | 1.023 | -0.026 | 1.145 | 0.099 | -2.626 | 0.238* | 0.948 |
| | (0.092) | (1.602) | (0.094) | (1.016) | (0.308) | (2.697) | (0.133) | (1.886) |

| | | | | | | | | |
|------------------|-------------------|------------------|---------------------|---------------------|---------------------|-------------------|-------------------|-------------------|
| [6°C, 9°C) | −0.006 (0.067) | 0.761 (1.987) | −0.028 (0.078) | 2.327* (1.175) | 0.091 (0.222) | 5.089* (2.594) | 0.093 (0.104) | 3.546* (2.030) |
| [12°C, 15°C) | −0.067 (0.084) | 0.880 (1.659) | 0.054 (0.060) | 2.365** (1.029) | 0.128 (0.198) | 1.973 (2.242) | 0.126 (0.104) | 1.210 (2.130) |
| [15°C, 18°C) | −0.075 (0.087) | 0.019 (1.216) | 0.139* (0.081) | 1.305* (0.686) | 0.419* (0.223) | 4.241 (2.880) | 0.148 (0.137) | 2.090 (1.486) |
| [18°C, 21°C) | −0.019 (0.105) | 1.555 (1.533) | 0.242*** (0.080) | 2.594*** (0.854) | 0.605** (0.266) | 2.497 (1.796) | 0.257* (0.147) | 2.987 (2.138) |
| [21°C, 24°C) | 0.056 (0.126) | 1.230 (1.574) | 0.200** (0.089) | 2.396* (1.239) | 0.830*** (0.297) | 3.811 (2.677) | 0.269* (0.159) | 1.529 (2.130) |
| [24°C, 27°C) | −0.019 (0.119) | 1.858 (2.235) | 0.224** (0.097) | 2.152* (1.096) | 0.807** (0.328) | 1.210 (2.340) | 0.348* (0.190) | 1.235 (2.594) |
| [27°C,) | −0.212 (0.162) | 0.711 (2.036) | 0.173 (0.111) | 2.311 (1.449) | 0.638 (0.395) | 3.024 (3.669) | 0.397* (0.207) | 0.855 (3.175) |
| Mean Dep. | | | | | | | | |
| Var. | 0.545 | 0.545 | 1.645 | 1.645 | 8.435 | 8.435 | 4.283 | 4.283 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.240 | 0.240 | 0.389 | 0.389 | 0.663 | 0.663 | 0.554 | 0.554 |
| City-Year-Week | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Panel C. Digestive; Genitourinary; Complications of pregnancy; childbirth; and the puerperium; and Diseases of the skin and subcutaneous tissue

| Daily Mean Temperature | Digestive | | Genitourinary | | Complications of pregnancy; childbirth; and the puerperium | | Diseases of the skin and subcutaneous tissue | |
|------------------------|-------------------|---------------------|-------------------|--------------------|--|-------------------|--|-------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | -0.101 (0.318) | -2.413 (1.917) | 0.132 (0.164) | 2.986** (1.421) | -0.080 (0.058) | 0.885 (0.646) | -0.036 (0.049) | 0.176 (0.472) |
| [-6°C, -3°C) | -0.046 (0.264) | 0.104 (2.293) | 0.157 (0.150) | 3.323* (1.685) | -0.070 (0.052) | 0.131 (0.488) | 0.039 (0.052) | -0.196 (0.489) |
| [-3°C, 0°C) | 0.018 (0.206) | -1.280 (2.153) | 0.105 (0.169) | 1.318 (1.671) | -0.077 (0.052) | 0.787 (0.497) | 0.037 (0.045) | 0.419 (0.462) |
| [0°C, 3°C) | 0.160 (0.180) | -0.821 (1.916) | 0.055 (0.123) | 1.560 (1.134) | -0.048 (0.037) | -0.385 (0.542) | -0.005 (0.036) | -0.809 (0.484) |
| [3°C, 6°C) | 0.055 (0.144) | 1.532 (1.423) | -0.021 (0.103) | -0.928 (1.111) | -0.041 (0.034) | -0.095 (0.327) | 0.029 (0.031) | 0.045 (0.319) |
| [6°C, 9°C) | 0.111 (0.116) | 2.387 (1.782) | 0.063 (0.076) | 3.169** (1.174) | -0.028 (0.032) | -0.018 (0.507) | 0.045* (0.027) | -0.357 (0.369) |
| [12°C, 15°C) | 0.089 (0.080) | 2.506 (1.707) | 0.055 (0.077) | 0.140 (1.082) | -0.006 (0.026) | 0.116 (0.597) | 0.038 (0.026) | -0.130 (0.256) |
| [15°C, 18°C) | 0.165 (0.104) | 4.588*** (1.692) | 0.035 (0.088) | 0.738 (0.873) | -0.017 (0.030) | -0.047 (0.449) | 0.019 (0.028) | -0.053 (0.306) |
| [18°C, 21°C) | 0.236* (0.136) | 3.185** (1.572) | 0.199* (0.101) | 0.652 (1.130) | -0.018 (0.040) | -0.489 (0.594) | 0.030 (0.031) | -0.142 (0.361) |
| [21°C, 24°C) | 0.277* (0.157) | 3.207** (1.575) | 0.198* (0.106) | 0.731 (1.322) | 0.019 (0.050) | -0.111 (0.465) | 0.044 (0.038) | -0.020 (0.375) |
| [24°C, 27°C) | 0.314* (0.170) | 4.303** (2.015) | 0.161 (0.129) | -1.126 (1.285) | -0.005 (0.051) | -0.360 (0.651) | 0.028 (0.039) | -0.359 (0.367) |
| [27°C,) | 0.178 (0.197) | 3.183 (2.388) | 0.096 (0.142) | -0.225 (1.780) | -0.013 (0.060) | 0.155 (0.588) | 0.001 (0.047) | -0.688 (0.454) |

| | | | | | | | | |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Mean Dep. | | | | | | | | |
| Var. | 3.960 | 3.960 | 2.176 | 2.176 | 0.371 | 0.371 | 0.275 | 0.275 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.524 | 0.524 | 0.424 | 0.424 | 0.458 | 0.458 | 0.215 | 0.215 |
| City-Year-Week | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Panel D. Musculoskeletal; Congenital; Perinatal; and Injury/poisoning-related Diseases

| Daily Mean Temperature | Musculoskeletal | | Congenital | | Perinatal | | Injury/poisoning | |
|---------------------------|------------------|-------------------|-------------------|-------------------|--------------------|--------------------|-------------------|-------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.110 (0.149) | 0.382 (1.381) | -0.012 (0.042) | 0.022 (0.309) | -0.006 (0.009) | -0.047 (0.100) | 0.112 (0.122) | 0.082 (1.020) |
| [-6°C, -3°C) | 0.078 (0.150) | 1.848* (1.027) | 0.026 (0.031) | 0.409 (0.277) | -0.008 (0.008) | -0.006 (0.099) | 0.049 (0.114) | 1.289 (0.965) |
| [-3°C, 0°C) | 0.082 (0.129) | 0.754 (1.159) | 0.014 (0.026) | -0.402 (0.383) | -0.008 (0.007) | -0.043 (0.068) | 0.058 (0.100) | 0.466 (1.023) |
| [0°C, 3°C) | 0.000 (0.108) | -0.290 (1.058) | 0.014 (0.021) | 0.107 (0.226) | -0.003 (0.005) | -0.120* (0.065) | -0.026 (0.083) | 0.417 (0.823) |
| [3°C, 6°C) | 0.005 (0.077) | 1.351 (0.884) | -0.011 (0.022) | -0.144 (0.163) | -0.003 (0.005) | 0.037 (0.070) | -0.019 (0.059) | 0.498 (0.612) |
| [6°C, 9°C) | 0.023 (0.061) | -0.653 (0.863) | -0.001 (0.014) | -0.163 (0.253) | -0.005* (0.003) | 0.032 (0.042) | 0.012 (0.054) | -0.467 (0.711) |
| [12°C, 15°C) | 0.016 | 0.909 | 0.025 | -0.226 | -0.000 | 0.076 | 0.002 | 0.028 |

| | | | | | | | | |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | (0.089) | (0.801) | (0.016) | (0.251) | (0.004) | (0.065) | (0.053) | (0.673) |
| [15°C, 18°C) | 0.053 | 0.529 | 0.030* | -0.008 | 0.008 | 0.136* | -0.003 | 0.819 |
| | (0.086) | (0.911) | (0.016) | (0.234) | (0.005) | (0.068) | (0.055) | (0.652) |
| [18°C, 21°C) | 0.088 | 2.210** | 0.028 | -0.104 | 0.005 | 0.148 | 0.065 | 0.664 |
| | (0.108) | (0.958) | (0.018) | (0.232) | (0.005) | (0.100) | (0.062) | (0.640) |
| [21°C, 24°C) | 0.058 | 0.990 | 0.031* | -0.217 | 0.002 | 0.123 | 0.022 | -0.025 |
| | (0.112) | (1.072) | (0.017) | (0.322) | (0.005) | (0.081) | (0.071) | (0.795) |
| [24°C, 27°C) | 0.111 | 1.762 | 0.045* | 0.025 | 0.004 | 0.152 | 0.049 | 0.458 |
| | (0.136) | (1.054) | (0.023) | (0.354) | (0.006) | (0.157) | (0.071) | (0.872) |
| [27°C,) | 0.155 | 1.775 | 0.068** | -0.247 | 0.006 | 0.223 | 0.045 | 1.698 |
| | (0.153) | (1.315) | (0.029) | (0.335) | (0.007) | (0.163) | (0.102) | (1.212) |
| Mean Dep. | | | | | | | | |
| Var. | 1.594 | 1.594 | 0.081 | 0.081 | 0.009 | 0.009 | 0.856 | 0.856 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.440 | 0.440 | 0.231 | 0.231 | 0.220 | 0.220 | 0.337 | 0.337 |
| City-Year-Week | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var” represents the average hospital admission rate for each CCS category, when the average daily temperature falls in the 9°–12°C bin. All columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A3. Impact of Temperature on Hospital Admissions: Heterogeneity by Age (Robustness Check)

| Daily Mean Temperature | Ages 0–18 | | Ages 19–64 | | Age 65 and above | Age 65 and above |
|---------------------------|--------------------|-------------------|---------------------|----------------------|---------------------|---------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.317* (0.179) | 0.780 (1.093) | 0.319 (0.599) | 7.379 (7.691) | 0.529 (0.427) | 0.954 (5.307) |
| [-6°C, -3°C) | 0.088 (0.217) | -0.187 (1.014) | 0.450 (0.659) | 16.392** (6.791) | 0.881* (0.463) | 3.540 (4.916) |
| [-3°C, 0°C) | 0.232 (0.155) | 0.841 (1.040) | 0.589 (0.707) | 4.843 (6.925) | 0.970* (0.504) | 2.447 (4.574) |
| [0°C, 3°C) | 0.246** (0.108) | 0.595 (1.132) | 0.093 (0.468) | 10.459 (7.201) | 0.314 (0.410) | 2.714 (3.768) |
| [3°C, 6°C) | 0.115 (0.093) | 0.037 (0.725) | -0.299 (0.303) | 4.975 (4.442) | 0.284 (0.300) | 1.185 (2.836) |
| [6°C, 9°C) | 0.012 (0.081) | -0.166 (0.887) | 0.353 (0.304) | 15.519*** (5.508) | 0.290 (0.288) | 9.434*** (2.931) |
| [12°C, 15°C) | 0.072 (0.080) | 0.203 (0.940) | 0.799** (0.301) | 10.975** (4.400) | 0.166 (0.256) | 7.576** (3.381) |
| [15°C, 18°C) | 0.045 (0.081) | 0.579 (0.969) | 1.196*** (0.353) | 13.272** (5.626) | 0.219 (0.286) | 7.157** (3.107) |
| [18°C, 21°C) | 0.126 (0.098) | 1.183 (0.965) | 1.504*** (0.406) | 14.687*** (4.775) | 0.892** (0.391) | 9.781*** (3.557) |
| [21°C, 24°C) | 0.180 (0.116) | 1.010 (1.008) | 1.616*** (0.403) | 10.766* (5.362) | 1.201** (0.472) | 10.119** (3.855) |
| [24°C, 27°C) | 0.213 (0.143) | 1.258 (1.380) | 1.639*** (0.436) | 12.256** (6.033) | 1.209** (0.482) | 5.748 (4.312) |
| [27°C,) | 0.076 (0.163) | 1.264 (1.548) | 1.084** (0.537) | 10.497 (7.014) | 1.179** (0.577) | 8.212* (4.805) |

| | | | | | | |
|-----------------------|--------------|--------------|---------------|---------------|---------------|---------------|
| Mean Dep. Var. | 1.311 | 1.311 | 17.678 | 17.678 | 13.066 | 13.066 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.561 | 0.561 | 0.705 | 0.705 | 0.705 | 0.705 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ |
| Cluster | one-way | one-way | one-way | one-way | one-way | one-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate for the three age groups, respectively, when the average daily temperature falls in the 9°–12°C bin. All the columns adopt clustered standard errors at the city level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A4. Impact of Temperature on Hospital Admissions: Heterogeneity by Gender (Robustness Check)

| Daily Mean Temperature | Female | Female | Male | Male |
|---------------------------|---------------------|--------------------|---------------------|----------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.173 (0.488) | 8.857 (5.395) | 0.993* (0.514) | 0.256 (8.576) |
| [-6°C, -3°C) | 0.354 (0.599) | 12.017* (5.994) | 1.065* (0.550) | 7.729 (6.809) |
| [-3°C, 0°C) | 0.400 (0.555) | 0.875 (4.565) | 1.390** (0.602) | 7.256 (6.475) |
| [0°C, 3°C) | -0.114 (0.388) | 4.165 (3.761) | 0.767* (0.455) | 9.604 (7.455) |
| [3°C, 6°C) | -0.298 (0.330) | 0.965 (3.567) | 0.399 (0.280) | 5.233 (3.408) |
| [6°C, 9°C) | 0.119 (0.312) | 8.213* (4.139) | 0.536** (0.261) | 16.574*** (4.265) |
| [12°C, 15°C) | 0.622** (0.279) | 7.783** (3.670) | 0.416 (0.274) | 10.971** (4.151) |
| [15°C, 18°C) | 0.771** (0.336) | 6.375 (4.664) | 0.689** (0.342) | 14.632*** (4.531) |
| [18°C, 21°C) | 1.210*** (0.426) | 9.506** (4.351) | 1.312*** (0.379) | 16.145*** (4.129) |
| [21°C, 24°C) | 1.347*** (0.405) | 6.124 (4.562) | 1.650*** (0.471) | 15.772*** (4.857) |
| [24°C, 27°C) | 1.459*** (0.442) | 6.083 (5.650) | 1.601*** (0.432) | 13.178** (5.036) |
| [27°C,) | 1.114** (0.472) | 5.345 (6.202) | 1.224** (0.485) | 14.628** (6.042) |

| | | | | |
|-----------------------|---------------|---------------|---------------|---------------|
| Mean Dep. Var. | 14.867 | 14.867 | 17.188 | 17.188 |
| N | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.726 | 0.726 | 0.702 | 0.702 |
| City-Year-Week FE | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ |
| Cluster | one-way | one-way | one-way | one-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average hospital admission rate for females and males, when the average daily temperature falls in the 9°–12°C bin. All the columns adopt clustered standard errors at the city level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A5. Impact of Temperature on Hospital Admissions: Heterogeneity by Disease Categories (Robustness Check)

| Daily Mean Temperature | Neoplasms | | Endocrine, nutritional, and metabolic diseases and immunity disorders | | Circulatory | | Respiratory | | Digestive | |
|------------------------|---------------------|--------------------|---|---------------------|---------------------|-------------------|--------------------|--------------------|-------------------|---------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 0.282 (0.260) | 6.321* (3.260) | 0.154 (0.171) | 0.491 (1.170) | 0.221 (0.453) | -1.551 (4.751) | 0.367 (0.261) | 2.988 (2.807) | -0.101 (0.305) | -2.413 (1.837) |
| [-6°C, -3°C) | 0.243 (0.189) | 7.203** (3.358) | 0.212 (0.155) | 0.159 (1.899) | 0.397 (0.457) | -0.624 (6.171) | 0.461** (0.212) | 6.203** (2.517) | -0.046 (0.253) | 0.104 (2.060) |
| [-3°C, 0°C) | 0.228 (0.156) | 2.204 (2.868) | 0.113 (0.108) | -0.309 (1.176) | 0.318 (0.376) | -2.029 (3.475) | 0.420** (0.160) | 3.527 (2.120) | 0.018 (0.191) | -1.280 (2.019) |
| [0°C, 3°C) | 0.119 (0.134) | 5.350** (2.596) | 0.004 (0.088) | 1.158 (1.284) | 0.014 (0.315) | 2.756 (3.736) | 0.297** (0.127) | 2.513 (2.334) | 0.160 (0.170) | -0.821 (1.886) |
| [3°C, 6°C) | -0.099 (0.131) | 3.597 (2.257) | 0.001 (0.073) | 0.338 (0.872) | 0.099 (0.290) | -2.626 (2.589) | 0.238* (0.127) | 0.948 (1.785) | 0.055 (0.133) | 1.532 (1.271) |
| [6°C, 9°C) | 0.111 (0.151) | 4.236* (2.126) | 0.075 (0.060) | 3.089* (1.548) | 0.091 (0.201) | 5.089* (2.572) | 0.093 (0.095) | 3.546* (2.099) | 0.111 (0.105) | 2.387 (1.721) |
| [12°C, 15°C) | 0.246* (0.124) | 4.428** (2.161) | 0.249*** (0.071) | 3.392** (1.289) | 0.128 (0.178) | 1.973 (2.205) | 0.126 (0.093) | 1.210 (2.114) | 0.089 (0.072) | 2.506 (1.688) |
| [15°C, 18°C) | 0.259* (0.142) | 3.213 (2.136) | 0.238*** (0.071) | 3.118** (1.203) | 0.419* (0.221) | 4.241 (2.850) | 0.148 (0.132) | 2.090 (1.540) | 0.165* (0.093) | 4.588*** (1.653) |
| [18°C, 21°C) | 0.375** (0.159) | 3.835 (2.320) | 0.313*** (0.098) | 3.893*** (1.085) | 0.605** (0.265) | 2.497 (1.907) | 0.257* (0.146) | 2.987 (2.167) | 0.236* (0.128) | 3.185** (1.571) |
| [21°C, 24°C) | 0.507*** (0.178) | 3.096 (2.319) | 0.378*** (0.094) | 4.117*** (1.141) | 0.830*** (0.299) | 3.811 (2.726) | 0.269 (0.161) | 1.529 (2.201) | 0.277* (0.151) | 3.207** (1.574) |
| [24°C, 27°C) | 0.525*** (0.172) | 2.698 (2.111) | 0.389*** (0.101) | 3.733*** (1.215) | 0.807** (0.327) | 1.210 (2.446) | 0.348* (0.189) | 1.235 (2.661) | 0.314* (0.166) | 4.303** (2.046) |
| [27°C,) | 0.444** | 1.233 | 0.389*** | 4.749*** | 0.638 | 3.024 | 0.397* | 0.855 | 0.178 | 3.183 |

| | | | | | | | | | | |
|-----------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|
| | (0.202) | (2.588) | (0.108) | (1.304) | (0.398) | (3.637) | (0.202) | (3.219) | (0.193) | (2.374) |
| Mean Dep. Var. | 4.313 | 4.313 | 1.759 | 1.759 | 8.435 | 8.435 | 4.283 | 4.283 | 3.96 | 3.96 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.573 | 0.573 | 0.410 | 0.410 | 0.663 | 0.663 | 0.554 | 0.554 | 0.524 | 0.524 |
| City-Year-Week | | | | | | | | | | |
| FE | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | one-way | one-way | one-way | one-way | one-way | one-way | one-way | one-way | one-way | one-way |

Notes. Only five CCS groups are reported in this table, because temperature has significant impacts on these diseases. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var” represents the average hospital admission rate for each CCS category, when the average daily temperature falls in the 9°–12°C bin. All the columns adopt clustered standard errors at the city level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A6. Impact of Temperature on Medical Bills Related to Inpatient Services
(Ages 0–18)

| | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|-----------------------|------------------------|---------------------------|----------------------|--------------------------|----------------------|--------------------------|----------------------|-------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 1633.776 (1197.931) | 5135.809 (7277.777) | 678.587 (499.457) | 2204.836 (3346.953) | 545.822 (476.795) | 1475.753 (2701.952) | 409.366 (292.508) | 1455.220 (2237.603) |
| [-6°C, -3°C) | 997.015 (1000.649) | -12012.870* (6552.258) | 452.903 (433.124) | -4310.954 (2982.745) | 173.170 (378.959) | -4525.321* (2689.468) | 370.942 (289.421) | -3176.595 (2598.830) |
| [-3°C, 0°C) | 1196.279 (847.590) | 12209.17** (6049.739) | 432.887 (299.569) | 5548.214** (2528.174) | 419.909 (318.593) | 3329.162 (2603.171) | 343.483 (293.620) | 3331.791* (1901.985) |
| [0°C, 3°C) | 1163.227 (716.810) | -5348.771 (6533.223) | 364.300 (265.878) | -755.412 (2214.639) | 430.400 (278.937) | -1590.73 (2388.123) | 368.527 (273.170) | -3002.628 (3486.677) |
| [3°C, 6°C) | 551.406 (484.624) | -1035.367 (3951.661) | 223.119 (228.032) | 1014.085 (1600.261) | 198.478 (186.471) | -1688.405 (2104.172) | 129.808 (153.592) | -361.047 (1169.165) |
| [6°C, 9°C) | 203.133 (388.271) | -4464.115 (5959.586) | 123.965 (166.604) | -747.355 (1675.382) | -19.836 (167.756) | -4146.265 (3792.547) | 99.004 (96.147) | 429.504 (1598.738) |
| [12°C, 15°C) | 283.533 (325.297) | -7480.042 (6182.005) | 8.290 (141.017) | -2207.415 (1943.583) | 192.079 (167.517) | -2988.324 (3362.618) | 83.164 (88.292) | -2284.303 (2959.658) |
| [15°C, 18°C) | 179.024 (410.310) | -2473.994 (6384.431) | 9.597 (174.973) | -1255.028 (2488.024) | 64.841 (157.322) | -2346.555 (2794.553) | 104.586 (132.279) | 1127.589 (1920.294) |
| [18°C, 21°C) | 535.464 (467.658) | -28.579 (6627.927) | 99.264 (230.440) | 613.634 (2459.532) | 288.525 (186.655) | -1063.395 (3706.7) | 147.676 (128.525) | 421.181 (1757.684) |
| [21°C, 24°C) | 332.454 (512.816) | -6368.2 (7654.319) | -3.140 (255.532) | -2072.712 (3007.867) | 248.681 (185.439) | -3787.595 (3977.954) | 86.913 (159.121) | -507.893 (1794.834) |
| [24°C, 27°C) | 495.958 (545.741) | -2852.945 (9167.066) | 103.827 (260.248) | -766.935 (3904.952) | 331.698 (238.074) | -1384.557 (4044.836) | 60.433 (159.291) | -701.453 (2769.720) |
| [27°C,) | 957.912 (760.085) | -1423.811 (10588.790) | 161.851 (305.807) | -1447.317 (4682.773) | 449.905 (349.113) | -293.907 (3780.564) | 346.156 (270.112) | 317.413 (2858.639) |
| Mean Dep. Var. | 4323.227 | 4323.227 | 1726.662 | 1726.662 | 1679.665 | 1679.665 | 916.9004 | 916.9004 |

| | | | | | | | | |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.349 | 0.349 | 0.332 | 0.332 | 0.309 | 0.309 | 0.387 | 0.387 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills for ages 0–18 when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A7. Impact of Temperature on Medical Bills Related to Inpatient Services
(Ages 19–64)

| | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|--------------|---------------------------|---------------------------|---------------------------|--------------------------|------------------------|-----------------------------|------------------------|--------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, –6°C) | 6914.961 (10846.863) | 93005.810 (139046.7) | 5466.668 (6806.688) | 70094.480 (101026.7) | 1387.885 (3008.535) | 29136.620 (21821.350) | 60.408 (2176.867) | –6225.287 (26308.440) |
| [–6°C, –3°C) | 9059.596 (8579.458) | 226774.6** (109773.60) | 7617.832 (5345.478) | 153523* (80873.070) | 1136.685 (2550.373) | 58827.860*** (17334.770) | 305.079 (1787.736) | 14423.670 (22809.350) |
| [–3°C, 0°C) | 10130.417 (6713.077) | 39193.29 (111834.6) | 8099.686* (4288.112) | 38960.43 (75914.22) | 1041.047 (1940.365) | 8631.004 (18385.09) | 989.683 (1687.170) | –8398.138 (28256.38) |
| [0°C, 3°C) | 3873.020 (5511.669) | 184822.2** (86153.28) | 2819.519 (3315.849) | 117444.3* (63427.58) | 43.949 (1724.845) | 47972.14** (19324.22) | 1009.551 (1385.102) | 19405.69 (13363.77) |
| [3°C, 6°C) | 81.249 (4935.444) | 80891.6 (67305.34) | 501.482 (2888.868) | 63460.28 (48824.58) | –894.684 (1526.388) | 7900.047 (11730.85) | 474.451 (1259.289) | 9531.277 (14893.25) |
| [6°C, 9°C) | 613.133 (4759.927) | 146838.2 (63760.21) | 1502.579 (2998.758) | 115677.7** (52344.29) | –680.782 (1600.665) | 25604.87* (14297.88) | –208.665 (1012.658) | 5555.596 (13711.26) |
| [12°C, 15°C) | 9562.662*** (3536.615) | 56005.52 (48873.59) | 6576.702*** (2375.375) | 52775.1 (34639.2) | 1864.598* (933.601) | 2180.212 (12447.19) | 1121.362 (832.383) | 1050.2 (14095) |

| | | | | | | | | |
|-----------------------|----------------------------|--------------------------|----------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| [15°C, 18°C) | 13029.660*** (3615.075) | 121791.3** (60365.71) | 8384.151*** (2331.193) | 91370.31** (41591.17) | 2130.128* (1070.638) | 13962.68 (12415.98) | 2515.381** (961.348) | 16458.29 (13903.36) |
| [18°C, 21°C) | 15764.071*** (5092.565) | 87234.66** (41315.02) | 10466.725*** (3322.472) | 69612.95** (29257.65) | 2850.387** (1262.701) | -3436.304 (13451.61) | 2446.960** (1157.457) | 21058.02** (9875.698) |
| [21°C, 24°C) | 17144.081** (7318.908) | 41342.470 (51402.92) | 10821.466** (4601.381) | 48363.37 (38024.04) | 3698.472* (2128.268) | -12038.13 (14172.48) | 2624.144** (1261.256) | 5017.222 (10602.35) |
| [24°C, 27°C) | 15018.759*** (5463.399) | 41874.39 (53360.41) | 9128.221** (3537.492) | 45430.01 (34619.600) | 2478.341* (1467.024) | -14410.33 (17182.77) | 3412.196** (1286.787) | 10854.71 (12022.85) |
| [27°C,) | 8166.174 (6327.243) | 48737.30 (84713.27) | 4599.145 (4213.469) | 54561.05 (59660.09) | 1386.239 (1708.405) | -17512.93 (20587.06) | 2180.790 (1645.149) | 11689.18 (17428.44) |
| Mean Dep. Var. | 151606.2 | 151606.2 | 98979.48 | 98979.48 | 34670.14 | 34670.14 | 17956.59 | 17956.59 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.612 | 0.612 | 0.607 | 0.607 | 0.529 | 0.529 | 0.529 | 0.529 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills for ages 19–64 when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A8. Impact of Temperature on Medical Bills Related to Inpatient Services
(Age 65 and Above)

| | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|--------------|-------------------------|-------------------------|------------------------|-------------------------|------------------------|-------------------------|-------------------------|-------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 9553.506 (8868.862) | 18239.430 (96671.10) | 6778.217 (5869.036) | 30938.870 (66147.85) | 645.308 (2160.735) | -2541.075 (25849.49) | 2129.981 (1753.055) | -10158.36 (14012.53) |
| [-6°C, -3°C) | 13889.831 (8585.966) | 52516.680 (76695.46) | 8850.457 (6023.969) | 38415.360 (52270.65) | 2290.756 (1996.050) | 8516.839 (15842.22) | 2748.619* (1574.606) | 5584.503 (17454.10) |

| | | | | | | | | |
|-----------------------|--------------------------|------------------------|-------------------------|------------------------|-------------------------|------------------------|------------------------|-------------------------|
| [−3°C, 0°C) | 11131.747 (10458.338) | 30923.76 (80557.64) | 7051.941 (7193.661) | 32794.15 (55339.49) | 1910.133 (2162.615) | 6481.258 (16526.69) | 2169.673 (1529.190) | −8351.629 (13863.87) |
| [0°C, 3°C) | 5392.443 (7503.742) | 92538.04 (74124.26) | 3730.267 (5022.513) | 82133.37 (55376.89) | 320.408 (1721.804) | 7269.174 (16305.88) | 1341.769 (1288.970) | 3135.521 (10647.22) |
| [3°C, 6°C) | 5729.886 (5248.855) | 53890.51 (51961.44) | 3844.256 (3734.121) | 41429.12 (35213.28) | 641.121 (1218.438) | 7937.199 (11124.04) | 1244.509 (895.062) | 4524.193 (10358.82) |
| [6°C, 9°C) | 2350.418 (3927.486) | 61948 (63728.01) | 1993.130 (2857.087) | 65491.66 (44954.51) | −263.073 (1073.979) | 4699.674 (13958.61) | 620.361 (547.944) | −8243.311 (12296.47) |
| [12°C, 15°C) | 6798.643 (5924.728) | 78971.45 (71495.82) | 4590.447 (4393.121) | 76124.03 (55325.25) | 1614.051 (1156.411) | 5399.338 (12208.47) | 594.146 (843.099) | −2551.903 (10967.77) |
| [15°C, 18°C) | 6305.042 (6370.154) | 73661.54 (85886.56) | 4581.474 (4796.998) | 69577.19 (62769.87) | 2018.876 (1383.230) | 10963.07 (15545.56) | −295.308 (763.285) | −6878.705 (11342.94) |
| [18°C, 21°C) | 13774.389 (8954.457) | 98529.38 (80047.19) | 8911.944 (6482.203) | 79816.74 (61003.07) | 3472.104* (1900.092) | 12783.22 (13820.9) | 1390.341 (1032.151) | 5929.423 (11211.49) |
| [21°C, 24°C) | 15881.083 (9620.480) | 111302.4 (78362.69) | 11167.713 (6942.286) | 98244.07 (58442.51) | 3972.013* (2199.748) | 17101.38 (14233.28) | 741.357 (1014.016) | −4042.992 (12023.29) |
| [24°C, 27°C) | 16992.313* (9831.805) | 80727.50 (107965.6) | 12008.02 (7187.585) | 77568.51 (82197) | 4031.321* (2147.536) | 8736.858 (17309.90) | 952.971 (1141.364) | −5577.86 (14705.40) |
| [27°C,) | 15271.621* (8857.936) | 120582 (115763.5) | 10046.789 (6160.455) | 100285.5 (87007.49) | 3291.479* (1951.277) | 20548.51 (18524.77) | 1933.353 (1259.847) | −251.99 (15048.86) |
| Mean Dep. Var. | 124976.7 | 124976.7 | 88301.33 | 88301.33 | 24151.12 | 24151.12 | 12524.22 | 12524.22 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.555 | 0.555 | 0.551 | 0.551 | 0.473 | 0.473 | 0.512 | 0.512 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills for age 65 and above when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A9. Impact of Temperature on Medical Bills Related to Inpatient Services
(Males)

| | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|--------------|----------------------------|--------------------------|---------------------------|--------------------------|--------------------------|--------------------------|------------------------|--------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 7392.510 (12906.961) | 42154.440 (169068.2) | 7339.540 (8217.725) | 54478.160 (121399.4) | -218.217 (3358.929) | -5516.183 (34596.740) | 271.188 (2649.582) | -6807.541 (25139.200) |
| [-6°C, -3°C) | 10684.918 (8461.963) | 143138.7 (136197.4) | 9264.608 (5550.041) | 106810 (95861.840) | 743.700 (2571.317) | 14335.670 (23603.970) | 676.609 (2031.110) | 21993.060 (29035.890) |
| [-3°C, 0°C) | 9957.729 (7611.751) | 65861.88 (130828.8) | 8796.953 (5269.750) | 70581.06 (95753) | 942.286 (2150.569) | 12486.96 (21399.97) | 218.489 (1792.342) | -17206.15 (20343.31) |
| [0°C, 3°C) | 3403.976 (7019.258) | 223668.4* (120128.9) | 3728.091 (4654.811) | 161704.8* (89735.47) | -511.320 (1969.781) | 33542.43 (24348.05) | 187.204 (1763.979) | 28421.1** (14021.05) |
| [3°C, 6°C) | 5307.573 (5726.104) | 133643.8* (71410.34) | 4592.365 (3493.584) | 105984* (55492.33) | -196.119 (1818.564) | 15009.1 (10490.1) | 911.327 (1293.754) | 12650.71 (13118.52) |
| [6°C, 9°C) | -967.481 (4470.846) | 195759.9** (84959.48) | 871.913 (2840.878) | 151596.9** (67872.47) | -1005.143 (1431.894) | 27063.06* (13864.84) | -834.252 (1178.800) | 17099.95 (12199.83) |
| [12°C, 15°C) | 6025.497 (4551.852) | 139002.2 (89609.5) | 4966.601 (3442.462) | 118000.4 (70275.89) | 720.289 (920.728) | 8184.908 (14886.68) | 338.607 (786.602) | 12816.95 (12616.72) |
| [15°C, 18°C) | 10333.331** (5031.818) | 152900.3 (95098.47) | 7180.674* (3595.048) | 115919.6 (69703.92) | 2115.261** (1030.166) | 26093.04 (18549.06) | 1037.396 (959.152) | 10887.59 (10968.36) |
| [18°C, 21°C) | 18251.763** (8226.157) | 143725.9* (75613.29) | 13158.180** (5856.988) | 115764.4* (61993.27) | 3404.351* (1730.810) | 8607.27 (11213.8) | 1689.232 (1328.405) | 19354.2* (10454.82) |
| [21°C, 24°C) | 22840.569** (10814.599) | 123813.5 (83229.69) | 16572.204** (7898.680) | 121455.1* (67581.89) | 4324.944* (2355.642) | -836.68 (13741.11) | 1943.422 (1266.853) | 3195.112 (10016.96) |
| [24°C, 27°C) | 20245.442** (8365.241) | 84204.51 (83841.49) | 14429.404** (5710.877) | 88685.29 (67733.10) | 3504.018 (2175.155) | -3710.698 (17225.61) | 2312.021 (1387.511) | -770.079 (11537.12) |
| [27°C,) | 13226.592 | 120561.6 | 8960.878 | 118853.9 | 2339.046 | 4450.397 | 1926.669 | -2742.611 |

| | | | | | | | | |
|-----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | (8894.075) | (117476.3) | (5601.541) | (89255.97) | (2406.407) | (23240.48) | (2025.113) | (19187.81) |
| Mean Dep. Var. | 162837.4 | 162837.4 | 111080.3 | 111080.3 | 34611.31 | 34611.31 | 17145.79 | 17145.79 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.578 | 0.578 | 0.568 | 0.568 | 0.534 | 0.534 | 0.537 | 0.537 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills for male when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A10. Impact of Temperature on Medical Bills Related to Inpatient Services
(Females)

| f | Total bill | | Covered by insurance | | Copoly | | Self-financed | |
|--------------|--------------------------|-----------------------------|------------------------|----------------------------|------------------------|-----------------------------|--------------------------|--------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 10709.732 (7800.283) | 74226.610 (66502.670) | 5583.934 (4916.607) | 48760.020 (42920.400) | 2797.232 (2259.006) | 33587.480** (16141.020) | 2328.566 (1775.364) | -8120.883 (16398.150) |
| [-6°C, -3°C) | 13261.523* (7784.146) | 124139.700** (59359.480) | 7656.583 (4808.739) | 80817.430** (38524.340) | 2856.909 (1996.666) | 48483.700*** (17061.160) | 2748.031 (1833.359) | -5161.480 (14002.530) |
| [-3°C, 0°C) | 12500.714* (7155.765) | 16464.35 (66029.15) | 6787.561 (4599.222) | 6721.72 (39591.37) | 2428.803 (1742.031) | 5954.462 (17190.31) | 3284.350** (1622.246) | 3788.171 (18364.56) |
| [0°C, 3°C) | 7024.713 (5539.088) | 48343.06 (43164.13) | 3185.994 (3584.536) | 37117.43 (28360.01) | 1306.076 (1252.280) | 20108.15* (11741.89) | 2532.643* (1318.279) | -8882.526 (10214.49) |
| [3°C, 6°C) | 1054.967 (4673.209) | 102.948 (51361.32) | -23.508 (2946.971) | -80.513 (30041.76) | 141.033 (1135.230) | -860.259 (12529.54) | 937.442 (1329.216) | 1043.716 (15713) |
| [6°C, 9°C) | 4134.164 (3989.350) | 8562.136 (64973.8) | 2747.760 (2544.636) | 28825.09 (41030.11) | 41.452 (1290.995) | -904.790 (18852.02) | 1344.952* (695.211) | -19358.16 (13564.18) |

| | | | | | | | | |
|-----------------------|---------------------------|-------------------------|--------------------------|------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
| [12°C, 15°C) | 10619.341** (4564.999) | -11505.31 (47927.05) | 6208.837** (2926.041) | 8691.332 (29483.37) | 2950.439** (1316.662) | -3593.682 (13858.95) | 1460.065* (863.628) | -16602.96 (13034.38) |
| [15°C, 18°C) | 9180.394* (5414.529) | 40078.56 (48367.63) | 5794.548 (3865.215) | 43772.82 (33789.75) | 2098.585* (1205.007) | -3513.842 (9475.342) | 1287.261 (815.613) | -180.417 (13514.95) |
| [18°C, 21°C) | 11822.161** (5859.859) | 42009.54 (37730.58) | 6319.752* (3740.230) | 34278.87 (25471.97) | 3206.665* (1689.956) | -323.746 (11416.36) | 2295.744** (953.515) | 8054.416 (10019.46) |
| [21°C, 24°C) | 10517.049* (5937.793) | 22463.22 (49736.37) | 5413.835 (3391.672) | 23079.66 (32634.67) | 3594.222 (2218.810) | 2112.336 (13492.89) | 1508.992* (879.052) | -2728.779 (10339.67) |
| [24°C, 27°C) | 12261.587** (5506.180) | 35544.43 (50704.58) | 6810.664** (3361.568) | 33546.29 (32510.72) | 3337.342* (1696.742) | -3347.328 (13127.91) | 2113.580** (1049.700) | 5345.471 (12915.96) |
| [27°C,) | 11169.114* (5804.272) | 47333.87 (65051.41) | 5846.907 (3715.156) | 34545.38 (43693.38) | 2788.577 (1699.530) | -1708.721 (15346.70) | 2533.630** (1044.766) | 14497.21 (17095.23) |
| Mean Dep. Var. | 118068.7 | 118068.7 | 77927.2 | 77927.2 | 25889.62 | 25889.62 | 14251.92 | 14251.92 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.606 | 0.606 | 0.608 | 0.608 | 0.471 | 0.471 | 0.529 | 0.529 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills for females when the average daily temperature falls in 9–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A11. Impact of Temperature on Medical Bills Related to Inpatient Services
(Neoplasms)

| Neoplasms | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|-----------|------------|--------|----------------------|--------|----------|--------|---------------|--------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |

| | | | | | | | | |
|-----------------------|---------------------------|-------------------------|--------------------------|------------------------|------------------------|---------------------------|--------------------------|------------------------|
| (, -6°C) | 12825.374** (5536.596) | 171188.6 (122282.3) | 8632.339** (3678.201) | 121362 (91292.790) | 1718.954 (1656.110) | 32035.70 (22281.410) | 2474.081** (1213.113) | 17790.83 (12803.70) |
| - | 9725.562** (4619.281) | 144363.20 (88535.90) | 7108.190** (3200.332) | 99801.90 (66096.28) | 904.213 (1275.957) | 32369.86* (16286.48) | 1713.159 (1051.020) | 12191.47 (12461.67) |
| [-3°C, 0°C) | 7419.948* (4195.279) | 92721.85 (86310.39) | 5470.669* (3134.674) | 60293.47 (64441.12) | 577.877 (1019.644) | 14708.87 (14677.31) | 1371.401 (881.479) | 17719.51 (13956.31) |
| [0°C, 3°C) | 4719.615 (3408.993) | 138650.3* (75534.6) | 3029.565 (2332.876) | 91808.08 (55473.24) | 147.334 (1022.589) | 28738.68** (12969.38) | 1542.717** (754.400) | 18103.54 (12027.23) |
| [3°C, 6°C) | 1105.423 (3059.902) | 105201.8 (70044.1) | 1547.878 (2003.498) | 72077.73 (51346.02) | -575.975 (967.191) | 17753.47 (12363.45) | 133.520 (597.310) | 15370.6 (10705.15) |
| [6°C, 9°C) | -187.052 (3243.308) | 69258.25 (44230.4) | 652.042 (1995.914) | 61164.28* (35703.8) | -872.413 (1086.217) | -486.740 (10516.14) | 33.320 (566.169) | 8580.715 (9312.576) |
| [12°C, 15°C) | 3188.141 (2494.895) | 47801.29 (63890.98) | 1869.664 (1694.169) | 36723.72 (49624.44) | 514.462 (641.098) | 955.307 (11310.14) | 804.015 (501.132) | 10122.27 (9923.782) |
| [15°C, 18°C) | 3588.814 (2806.235) | 37642.44 (38572.72) | 2931.500 (2175.872) | 30851.19 (28334.7) | -82.770 (620.442) | -5757.453 (7822.994) | 740.083 (575.111) | 12548.71 (10452.14) |
| [18°C, 21°C) | 4536.947 (3912.528) | 6058.643 (35320.84) | 3377.419 (2905.750) | 7508.881 (28778.72) | 26.021 (847.548) | -11077.41 (8753.056) | 1133.508* (654.252) | 9627.175 (9808.813) |
| [21°C, 24°C) | 8038.188 (5515.754) | 18630.48 (43644.74) | 5234.773 (3662.444) | 26340.58 (31452.1) | 1619.407 (1768.647) | -17349.91* (9581.089) | 1184.009* (610.649) | 9639.818 (11606.75) |
| [24°C, 27°C) | 4747.806 (4029.949) | -10442.42 (39753.50) | 3194.631 (2854.793) | 5568.595 (32431.47) | 528.693 (1021.624) | -21176.66** (10073.47) | 1024.482 (679.554) | 5165.653 (11683) |
| [27°C,) | 3800.085 (5360.329) | 15281.14 (61436.42) | 2720.754 (3784.253) | 23403.25 (45383.99) | -213.679 (1209.008) | -16817.42 (11397.20) | 1293.011 (990.286) | 8695.314 (16058.78) |
| Mean Dep. Var. | 65357.1 | 65357.1 | 44051.98 | 44051.98 | 13697.24 | 13697.24 | 7607.873 | 7607.873 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.445 | 0.445 | 0.438 | 0.438 | 0.326 | 0.326 | 0.404 | 0.404 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |

| | | | | | | | | |
|-----------------------|-----------------|-----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|
| | (931.824) | (13412.41) | (640.456) | (10471) | (251.503) | (2499.012) | (123.269) | (1370.051) |
| [18°C, 21°C) | 2217.734** | 18996.36 | 1797.959** | 16436.6* | 293.960 | 2051.836 | 125.815 | 507.920 |
| | (984.283) | (12004.52) | (718.053) | (8504.066) | (257.708) | (3118.498) | (122.216) | (1174.32) |
| [21°C, 24°C) | 2923.031** | 20787.32* | 2374.814*** | 18352.5** | 411.340 | 2870.763 | 136.876 | -435.949 |
| | (1176.510) | (11017.98) | (858.476) | (7840.734) | (270.920) | (2824.322) | (146.362) | (1477.015) |
| [24°C, 27°C) | 2766.250** | 19284.15 | 2249.826** | 18054.13 | 437.405 | 2185.487 | 79.018 | -955.464 |
| | (1304.342) | (15685.92) | (935.429) | (11386.84) | (309.636) | (3251.786) | (176.380) | (2174.285) |
| [27°C,) | 2680.752* | 32084.81*** | 2126.577** | 26209.56*** | 454.302 | 4254.047 | 99.873 | 1621.209 |
| | (1391.080) | (10875.35) | (996.576) | (8269.714) | (359.180) | (2891.845) | (199.260) | (1920.266) |
| Mean Dep. Var. | 13207.73 | 13207.73 | 9237.67 | 9237.67 | 2925.342 | 2925.342 | 1044.714 | 1044.714 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.308 | 0.308 | 0.297 | 0.297 | 0.279 | 0.279 | 0.288 | 0.288 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills on endocrine, nutritional, and metabolic diseases and immunity disorders when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A13. Impact of Temperature on Medical Bills Related to Inpatient Services
(Circulatory Diseases)

| Circulatory | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|--------------|------------|------------|----------------------|------------|------------|------------|---------------|------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | -5292.577 | -60325.66 | -1764.248 | -15236.02 | -1360.097 | -15702.06 | -2168.232 | -29387.58 |
| | (7918.776) | (63340.57) | (5501.673) | (37020.63) | (1953.745) | (19445.33) | (1617.733) | (18530.49) |
| [-6°C, -3°C) | 2005.883 | -1435.087 | 2342.030 | 6005.652 | 353.594 | -2149.924 | -689.741 | -5290.815 |
| | (5716.962) | (77490.55) | (3815.570) | (48625.15) | (1488.893) | (19091.29) | (1344.631) | (18341.53) |

| | | | | | | | | |
|-----------------------|----------------------------|-------------------------|---------------------------|--------------------------|--------------------------|-------------------------|-------------------------|-------------------------|
| [-3°C, 0°C) | -820.719 (5102.825) | -57902.88 (63391.96) | 524.012 (3479.962) | -20788.26 (39243.41) | -284.506 (1246.003) | -9273.234 (14154.49) | -1060.226 (1031.249) | -27841.39 (17324.76) |
| [0°C, 3°C) | -631.773 (4660.623) | 56950.08 (48792.22) | 30.173 (3187.045) | 54298.6 (33459.22) | -556.923 (1248.615) | 8224.925 (13603.03) | -105.024 (784.590) | -5573.444 (13302.79) |
| [3°C, 6°C) | 2783.166 (3767.428) | 9997.318 (34412.75) | 2001.567 (2487.889) | 12930.8 (22462.37) | 309.020 (977.279) | 1882.298 (9736.265) | 472.579 (877.432) | -4815.781 (9438.537) |
| [6°C, 9°C) | 496.566 (3103.991) | 60518.17 (55832.17) | 182.760 (1999.743) | 64846.16* (37287.76) | -42.387 (787.044) | 2647.915 (13080.86) | 356.193 (679.574) | -6975.903 (12265.1) |
| [12°C, 15°C) | 5322.508 (3448.702) | 31964.88 (45016.92) | 3747.008 (2466.824) | 40448.11 (29292.41) | 1253.559 (829.642) | -798.475 (9326.53) | 321.941 (793.021) | -7684.762 (11157.14) |
| [15°C, 18°C) | 10523.181** (5078.188) | 73209.26 (61682.62) | 7021.797* (3586.389) | 60972.64 (43197.47) | 2510.978** (1239.761) | 9040.667 (11229.94) | 990.406 (680.389) | 3195.952 (10432.54) |
| [18°C, 21°C) | 11885.035** (5059.790) | 52213.24 (33946.39) | 7816.143** (3249.902) | 45454* (23774.16) | 2882.951** (1285.693) | 2583.071 (7795.742) | 1185.942 (922.995) | 4176.16 (6994.535) |
| [21°C, 24°C) | 14411.021** (5902.680) | 59901.28 (40041.34) | 10118.159** (4052.560) | 53134.7* (29028.43) | 2695.988* (1454.879) | 2111.742 (9384.593) | 1596.873* (924.731) | 4654.834 (7450.446) |
| [24°C, 27°C) | 14917.926*** (4828.989) | 61763.52 (37543.13) | 9961.417*** (3158.278) | 53944.87** (26339.25) | 2499.681* (1269.406) | 4684.929 (9521.747) | 2456.827** (932.094) | 3133.716 (8205.195) |
| [27°C,) | 12939.902** (6204.696) | 78564.34 (56085.69) | 8604.481** (3903.231) | 60300.97 (38439.75) | 2683.774* (1551.201) | 13886.46 (12574.62) | 1651.646 (1327.933) | 4376.904 (10974.17) |
| Mean Dep. Var. | 74768.11 | 74768.11 | 50946.33 | 50946.33 | 15536.84 | 15536.84 | 8284.943 | 8284.943 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.491 | 0.491 | 0.494 | 0.494 | 0.427 | 0.427 | 0.386 | 0.386 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills on circulatory diseases when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A14. Impact of Temperature on Medical Bills Related to Inpatient Services
(Respiratory Diseases)

| Respiratory | Total bill | | Covered by insurance | | Copay | | Self-financed | |
|--------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------|-------------------------|-----------------------|-------------------------|
| | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. | Contemp. | Cumul. |
| (, -6°C) | 6015.339** (2956.206) | 19484.06 (24426.55) | 4721.495** (2239.012) | 15648.61 (17014.43) | 893.799 (610.165) | 4306.326 (6504.646) | 400.045 (473.029) | -470.874 (4718.393) |
| [-6°C, -3°C) | 7080.251** (3112.044) | 49943.57 (30643.30) | 5582.004** (2357.426) | 44699.61** (20210.52) | 1106.772* (574.103) | 6894.946 (6304.099) | 391.476 (591.336) | -1650.984 (6835.121) |
| [-3°C, 0°C) | 6153.884** (2940.206) | 47360.16** (18251.68) | 4612.118* (2362.876) | 31068.34** (12412.29) | 1148.302** (532.361) | 8784.9** (3904.7) | 393.464 (412.943) | 7506.919 (5140.08) |
| [0°C, 3°C) | 1319.530 (2109.976) | 19119.77 (21815.95) | 1600.787 (1702.491) | 13268.58 (14607.4) | 69.922 (360.106) | 3791.328 (5762.797) | -351.179 (324.033) | 2059.862 (3524.589) |
| [3°C, 6°C) | 1236.856 (1803.172) | -4282.513 (18696.59) | 1449.557 (1555.917) | 2125.13 (12522.59) | 91.544 (299.951) | -3464.16 (4588.986) | -304.246 (259.904) | -2943.483 (3640.77) |
| [6°C, 9°C) | -49.465 (1744.619) | 12481.53 (17375.26) | 284.060 (1446.461) | 7587.166 (13571.7) | -321.789 (268.915) | 4636.896 (4163.091) | -11.736 (246.571) | 257.471 (2975.775) |
| [12°C, 15°C) | 1505.850 (2010.991) | -453.570 (19008.98) | 987.039 (1480.372) | -758.814 (13772.31) | 400.708 (431.672) | 1096.933 (3830.829) | 118.104 (224.026) | -791.688 (2823.85) |
| [15°C, 18°C) | 727.536 (1794.998) | -11293.08 (13027.68) | 177.672 (1244.074) | -11283.56 (9468.029) | 557.321 (498.632) | 1936.118 (2895.604) | -7.458 (213.409) | -1945.632 (2457.759) |
| [18°C, 21°C) | 1793.408 (2563.586) | 813.997 (19039.36) | 899.651 (1823.494) | -1227.515 (13906.44) | 897.812 (551.768) | 2790.176 (3719.269) | -4.056 (293.905) | -748.661 (2748.935) |
| [21°C, 24°C) | 671.230 (2449.623) | -14519.81 (18447.17) | -89.298 (1737.545) | -13418.69 (13405.56) | 728.560 (566.296) | 379.154 (3869.98) | 31.969 (314.912) | -1480.266 (2888.472) |
| [24°C, 27°C) | 3100.266 (3304.098) | -24670.81 (26169.22) | 1716.759 (2386.334) | -22116.25 (19816.47) | 1132.148 (747.460) | -898.566 (4901.395) | 251.359 (390.136) | -1655.984 (3319.104) |
| [27°C,) | 1031.381 (2872.006) | -41435.57 (33888.52) | -239.681 (2122.609) | -31393.35 (25188.74) | 776.709 (623.284) | -4728.410 (6947.212) | 494.352 (439.528) | -5313.805 (4203.548) |

| | | | | | | | | |
|-----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mean Dep. Var. | 26879.84 | 26879.84 | 18857.73 | 18857.73 | 5906.543 | 5906.543 | 2115.571 | 2115.571 |
| N | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 | 31,714 |
| R-square | 0.325 | 0.325 | 0.310 | 0.310 | 0.335 | 0.335 | 0.312 | 0.312 |
| City-Year-Week FE | √ | √ | √ | √ | √ | √ | √ | √ |
| Exact Date | √ | √ | √ | √ | √ | √ | √ | √ |
| 30 Days Lag | √ | √ | √ | √ | √ | √ | √ | √ |
| Cluster | two-way | two-way | two-way | two-way | two-way | two-way | two-way | two-way |

Notes. All the columns control for city-year-week fixed effects, exact-date fixed effects, and 30-day lag structures of the temperature bins. The “Mean Dep. Var.” represents the average size of the four types of bills on respiratory diseases when the average daily temperature falls in the 9°–12°C bin. All the columns adopt two-way clustered standard errors at the city and day level. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table A15. Predicted Impact of Climate Change on Total Medical Bills Related to Inpatient Services

| | Climate Change Model | Impact of change in cold/hot day | | Total temperature impact |
|-----------|-------------------------|----------------------------------|------------------------|--------------------------|
| | | (, -6°C) | [27°C,) | |
| 2070–2099 | Hadley GEM2-ES (RCP8.5) | -387815 (714233) | 10900000 (10400000) | -349221 (5636016) |

Notes. The results are based on the estimates of 31-day cumulative effects on hospital admissions per 100,000 individuals enrolled in either the URBMI or UEBMI, and the predicted changes of days in various temperature bins according to the Hadley GEM2-ES climate change model for the RCP8.5. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.