Heart failure (HF) is a common, costly, disabling, and potentially deadly condition. It is the leading cause of hospitalization in people aged $\geq 65$ years. HF is an increasing important global public health issue, particularly in aging societies such as Hong Kong. HF is associated with significantly reduced physical and mental health, resulting in a markedly decreased quality of life. As a result of the costs of hospitalization, it is also associated with high healthcare expenditure, accounting for $\approx 2\%$ of all healthcare expenditure. Coronary artery disease, valvular heart disease, hypertension, overweight, and diabetes mellitus are the main causes and risk factors of HF. Despite the impressive number of effective treatments available, patients with HF continue to experience progressively worsening symptoms, frequent admission to hospital, and premature death. So studies are required to help decision-makers target resources toward implementing the prevention, which is of most importance for the elderly population.

Background—Although the seasonal variation and the effect of cold temperature on heart failure (HF) morbidity have been well documented, it is unknown whether the temperature variation within a day, that is, diurnal temperature range (DTR), is an independent risk factor for HF. We hypothesized that large DTR might be a source of additional environmental stress and, therefore, a risk factor for HF exacerbation. We aimed to test the association between DTR and HF hospitalization and to examine the effect modifiers, such as age, sex, and season.

Methods and Results—We collected daily meteorologic data and emergency HF hospital admissions from 2000 to 2007 in Hong Kong. We used Poisson regression models to fit the relationship between daily DTR and emergency HF hospitalizations, after adjusting for the time trend, seasonality, mean temperature, humidity, and levels of outdoor air pollution. We confirmed the seasonal variation of HF with peak hospital admissions in winter in Hong Kong. The adverse effects of DTR on emergency HF admissions were observed on the current day and lasted for the following several days. Every $1^\circ C$ increase of DTR at lag$_0$ corresponded to 0.86% (95% confidence interval, 0.31%–1.43%) increment of emergency hospital admissions for HF. DTR exhibited significantly greater effect in the cool season, and on female and elderly patients.

Conclusions—Greater temperature change within a day was associated with increased emergency hospital admissions for HF. Health policymakers and hospitals may want to take into account the increased demand of specific facilities for susceptible population in winter with greater daily temperature variations. 

Key Words: diurnal temperature range ■ emergency hospital admission ■ heart failure ■ temperature variation ■ time series study

Heart failure (HF) is a common, costly, disabling, and potentially deadly condition. It is the leading cause of hospitalization in people aged $\geq 65$ years. HF is an increasing important global public health issue, particularly in aging societies such as Hong Kong. HF is associated with significantly reduced physical and mental health, resulting in a markedly decreased quality of life. As a result of the costs of hospitalization, it is also associated with high healthcare expenditure, accounting for $\approx 2\%$ of all healthcare expenditure. Coronary artery disease, valvular heart disease, hypertension, overweight, and diabetes mellitus are the main causes and risk factors of HF. Despite the impressive number of effective treatments available, patients with HF continue to experience progressively worsening symptoms, frequent admission to hospital, and premature death. So studies are required to help decision-makers target resources toward implementing the prevention, which is of most importance for the elderly population.

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The environmental risk factors, such as cigarette smoking, air pollution, and low ambient temperature, for HF have been well documented in the literature. Weather changes associated with HF hospitalizations have also been studied. The diurnal temperature range (DTR), defined as the difference between maximal and minimal temperatures within 1 day, is a meteorologic indicator associated with global climate change, which may be related to a variety of health outcomes including cardiovascular (such as acute coronary syndrome, stroke and coronary heart disease) and respiratory diseases. Researchers have observed that patients with HF exhibit attenuated thermoregulatory response. Although the seasonal variations of the mortality and morbidity of HF have been well established, it is unknown whether the temperature variation within 1 day (ie, DTR) is the risk factor for HF exacerbations independent of the corresponding absolute temperature. We hypothesized that large diurnal temperature change might be a source of additional environmental stress and, therefore, a risk factor for HF exacerbation. Women or elderly would have less effect due to the lower body temperature and the reduced capability for temperature regulation.
effective thermoregulation and may be more sensitive to the
temperature change.20 Patients with HF showed much higher
hospital admissions in the winter months, which lead us to
examine the association between DTR and HF hospitalization
varied by season.

Hong Kong is situated on the south coast of China. With a
land area of 1104 km² and a population of 7 million people,
it is one of the most densely populated areas in the world.
Hong Kong has a subtropical climate with hot and humid
summer and moderate cool winter. The mean temperature is
27.6°C from May to October (the warm season) and 19.5°C
from November to April (the cool season). HF in Hong Kong
is common and increasing according to the information from
Hospital Authority (the statutory body running all public hos-
pitals in Hong Kong: http://www.ha.org.hk). In this study, we
aimed to test the associations between DTR and HF hospital-
izations in Hong Kong and to study the effect modifiers, such
as age, sex, and season.

Methods

Data Collection

This is an ecological study using time series analysis. We collected
city-wide hospital admissions for all circulatory diseases and HF
from January 2000 to December 2007 in Hong Kong. The hospital
admission data were taken from the publicly funded hospitals pro-
viding 24-hour accident and emergency services and covering 90% of
hospital beds in Hong Kong for local residents.6 The patient data
captured from the computerized medical record system included age,
sex, date of admission, source of admission, and principal diagnosis
on discharge coded with International Statistical Classification of
Diseases, Ninth Revision (ICD-9). We abstracted the hospital admis-
sions through the accident and emergency services for diseases of
the circulatory system (ICD-9: 390–459) and HF (ICD-9: 428). We
also computed the emergency HF admissions by sex and by 3 age
groups (<65, 65–74, and ≥75 years) as the health outcomes. Daily
admissions for influenza (ICD-9: 487) were used to identify influenza
epidemics, which were then treated as a potential confounder in the
data analysis.21 The present study used grouped health information
(number of emergency hospital admissions on each day) collected on
a routine basis in the public hospital system provided by the Hospital
Authority, no specific institutional review committee approval and
informed consents from subjects were required, as information on
individuals was not involved.

We collected the meteorologic information, including the daily
maximum, minimum, mean temperature, and relative humidity, for
the same period from the Hong Kong Observatory. DTR was calcu-
lated by the maximum temperature minus the minimum temperature
within the same day.

As air pollutants have been identified as risk factors for emergency
HF hospitalizations,6–4 we also collected the air pollution concentra-
tions from the Environmental Protection Department. Hourly con-
centration of 4 criteria air pollutants (particles with an aerodynamic
diameter <10 μm, PM₁₀, nitrogen dioxide, NO₂, ozone, O₃; and sulfur
dioxide, SO₂) monitored in 10 general stations were used to generate
daily mean air pollution concentrations to denote the pollution level
in Hong Kong.22

Statistical Modeling

Generalized additive Poisson regression models were used to fit the
relationship between the daily DTR and the emergency HF hospi-
talizations. We used the smoothing spline, s(·), to filter out seasonal
patterns and long-term trends in daily hospitalizations, as well as the
daily mean temperature and relative humidity.21 We also included an
adjustment for the day of the week and dichotomous variables, such
as public holidays and influenza outbreaks.

We followed previous studies to select a priori the model specifica-
tion and the df for the time trend and other meteorologic variables.22–24
We used a df of 8/7 for the time trend, a df of 6 for the mean tem-
perature of the current day (Tempₜ), and the previous 3 days’ moving
average (Tempₜ₋₃), and a df of 3 for the current day relative humidity
(Humidₜ). We included the day of the week (DOW) and public holi-
days (Holiday) in the model as dummy variables.25 To adjust for the
confounder effect of an influenza epidemic on emergency hospital
admissions, we entered a dummy variable for the weeks with several
influenza hospital admissions exceeding the 75 percentile in a year
into the core model.26

Briefly, we set up a core model to remove the long-term trends, sea-
sonal variations, and adjust for time varying confounders as follows:

\[
\log(E(Y)) = \alpha + \beta_1(Temp_{t}, df = 6) + \beta_2(Humid_{t}, df = 6) + \beta_3(DOW) + \beta_4(Holiday) + \beta_5(influenza) \]

where \(E(Y)\) is the expected daily emergency HF hospital admission
counts on day \(t\) and \(s(\cdot)\) is the smoothing spline function for nonlinear
variables. We examined the residuals of the core model to check
whether there were discernible patterns and autocorrelation by means
of residual plot and partial autocorrelation function plot. The partial
autocorrelation function of residuals of the core model (Equation 1)
was <0.1 for all the lags, which meant no serial correlation in the
residuals and sufficient confounder control.27 No discernible patterns
and no autocorrelation in the residuals are the criteria for an adequate
core model set up, which is intended to remove all potential con-
founders in the daily variations of health outcome. The linear effect of
DTR on emergency HF admissions was then estimated for the same
day and ≤5 days before the outcome (single-lag effect from lagₜ to
lagₜ₋₅). The overall cumulative effect of DTR lasting for 0 to 5 days
was estimated by distributed lag model.28 To justify the assumption
of linearity between the logarithm of emergency HF hospital admissions
and DTR, we graphically examined the dose–response relationship
derived using a smoothing function.26 Sensitivity analyses were con-
ducted to test such association by further adjusting for the confound-
ing effects from air pollution. Sensitivity analysis was also conducted
to test whether the DTR effect is stable by replacing the mean tem-
perature with the minimum temperature in core model (Equation 1).

In addition to the whole period analysis, we examined the effect
of DTR for the warm season (from May to October) and the cool season
(November to April) separately, using half the df of 4/7 for the time
trend.23 Modified effects of sex and age group were also examined us-
ing the subgroups of HF hospitalizations as the health outcomes.29 We
tested the statistical significance of differences among season, sex,
or age group by calculating \(\beta_1 - \beta_2 \sqrt{SE_1^2 + SE_2^2}\), where \(\beta_1\) and
\(\beta_2\) are the estimates for the 2 categories (eg, warm and cool season
or women and men), and \(SE_1\) and \(SE_2\) are their respective standard
errors.20–21 A factor >1.96 was considered as statistically significant
difference at α=0.05 level.

The results were expressed in terms of the percentage increase (ex-
cess relative risk, %) in emergency HF hospital admissions for 1°C
increase of DTR and respective 95% confidence intervals (CIs). All
analyses were conducted in the statistical environment R2.15.1 (R
Development Core Team, 2012: http://www.r-project.org).

Results

Data Description

From 2000 to 2007, there has been ≥20% increase in hospital admis-
sions for HF. The emergency admissions for HF were
11066 in 2000, whereas this number increased to 13290 in
2007. During our study period, a total of 95897 emergency
hospital admissions for HF were recorded in our study popu-
lation, accounting for ≥21% of emergency hospitalizations
because of total circulatory diseases. On average there were
33 emergency admissions per day for HF, of which ≥56.4%
were women. The percentage of HF hospitalizations were 10.4%, 22.9%, and 66.8% in the 3 age groups (<65, 65–74, and ≥75 years), respectively. The daily mean emergency HF admissions were significantly higher in the cool season than those in the warm season (39 versus 27; t test: P value <0.01; Table 1). The daily mean air temperature was 23.6°C with a mean DTR of 4.0°C. The daily mean concentration of air pollutants was 53.6, 57.8, 41.6, and 20.3 μg/m³ for PM₁₀, NO₂, O₃, and SO₂, respectively.

Regression Results
Figure 1 shows the time series of the daily count of observed HF hospitalizations (a typical seasonal variation with peak admissions in winter months) and the predicted values fitted by the Poisson regression core model. Dose–response curve (Figure 2) shows that the association between the risk of emergency HF hospitalizations and DTR was essentially linear. The adverse effects of DTR on emergency HF admissions were observed in our study for all the lags we examined, after adjusting for the time trend, seasonality, absolute air temperature, calendar effect, and influenza epidemics. Every 1°C increase of DTR at lag₀ corresponded to 0.86% (95% CI, 0.31%–1.43%) increase of emergency hospital admissions for HF. The overall cumulative effect of DTR lasting for 0–5 days was associated with 3.76% (95% CI, 3.36%–4.16%) increment of emergency HF hospitalizations. The effects were significantly higher in the cool season than those in warm season at lag₁, lag₂, and 5-day distributed lags (Figure 3).

Further adjustment for the possible confounding effects from air pollutants at the same lags resulted in decreased excess relative risk in general, especially when adjusted for NO₂, although the cumulative effect of DTR was still statistically significant (Table 2). Replacing the terms of mean temperature with the minimum temperature in core model (Equation 1) showed that the association between DTR and HF hospitalizations was also robust to the adjustment for daily minimum temperature (Table 2).

Stratified analyses by sex (Table 3) showed that DTR exposure exhibited greater effect on female patients with HF than on male patients with HF, with the cumulative effect estimates of 4.41% (95% CI, 3.89%–4.92%) and 2.93% (95% CI, 2.37%–3.50%) increase of HF admissions per 1°C increase of DTR, respectively. At the same time, DTR exposure exhibited greater effect on patients aged ≥75 years; the corresponding cumulative effect size was 4.13% (95% CI, 3.66%–4.60%) per 1°C increase of DTR (Table 3). Results demonstrated that

| Table 1. Distribution of Emergency HF Hospital Admissions, Meteorologic Factors, and Air Pollution Concentrations in Hong Kong, 2000–2007 (2922 Days) |
|------------------------------------------|-------|-----|-----|-----|-----|-----|-----|
| Emergency hospital admissions (counts/d) | Mean  | SD  | Min. | P₂₅ | P₅₀ | P₇₅ | Max. |
| All circulatory diseases                  | 156.1 | 23.7 | 66   | 141 | 155 | 171 | 243  |
| Heart failure                            | 32.8  | 10.8 | 10   | 25  | 31  | 39  | 86   |
| In cool season                           | 39.2  | 10.8 | 15   | 32  | 38  | 46  | 86   |
| In warm season                           | 26.6  | 6.1  | 10   | 22  | 26  | 30  | 49   |
| Women                                    | 18.5  | 6.7  | 4    | 14  | 18  | 22  | 57   |
| Men                                      | 14.3  | 5.6  | 2    | 10  | 13  | 17  | 41   |
| Age, y                                    |       |      |      |     |     |     |      |
| <65                                      | 3.4   | 2    | 0    | 2   | 3   | 5   | 12   |
| 65–74                                    | 7.5   | 3.4  | 0    | 5   | 7   | 10  | 22   |
| ≥75                                      | 21.9  | 8.3  | 4    | 16  | 20  | 26  | 65   |
| Meteorologic factors                     |       |      |      |     |     |     |      |
| Mean temperature, °C                     | 23.6  | 4.9  | 8.2  | 19.6| 24.8| 27.8| 31.8 |
| Max. temp, °C                            | 25.8  | 5.2  | 9.3  | 21.7| 26.8| 30.1| 35.4 |
| Min. temp, °C                            | 21.7  | 5.0  | 6.4  | 17.9| 23.1| 25.9| 29.4 |
| DTR, °C                                  | 4.0   | 1.4  | 0.7  | 3.1 | 4.0 | 4.9 | 12.2 |
| In cool season                           | 3.9   | 1.5  | 0.7  | 2.9 | 3.9 | 4.9 | 12.2 |
| In warm season                           | 4.1   | 1.3  | 0.8  | 3.3 | 4.1 | 5   | 9.8  |
| Humidity, %                              | 78.3  | 9.8  | 31.0 | 74.0| 79.0| 85.0| 98.0 |
| Air pollution concentrations, μg/m³      |       |      |      |     |     |     |      |
| PM₁₀                                     | 53.6  | 27.6 | 14.0 | 31.5| 47.9| 70.2| 196.0|
| NO₂                                      | 57.8  | 20.6 | 14.9 | 43.2| 55.6| 69.0| 168.2|
| O₃                                       | 41.6  | 25.1 | 2.3  | 22.0| 35.2| 56.1| 180.0|
| SO₂                                      | 20.3  | 13.8 | 2.8  | 11.3| 16.9| 24.4| 134.9|

HF indicates heart failure; Pₓ, xth percentiles; Max., maximum; and Min., minimum.
women and elders were more vulnerable to the temperature change within a day.

**Discussion**

Although the seasonal variation of HF hospitalizations\(^9,19\) or the association between cold temperature and HF morbidity\(^10,18\) has been well documented, the temperature change within a day or DTR is still a novel environmental risk factor that should be aware of by patients with HF and caretakers. In this time series study, we compared the day-to-day variations of DTR and the day-to-day variations of emergency HF hospitalizations and estimated the short-term effects of DTR on HF exacerbations. We found significantly adverse effects of DTR on HF admissions on the current day and lasting for the following several days. The effects of DTR were robust to the adjustment for daily absolute temperature (mean or minimum) and air pollution concentrations and were significantly greater in the cool season. Female and elderly subjects were the subgroups that were more sensitive to the DTR effects.

Seasonal variation of HF hospital admissions was obvious in Hong Kong (Figure 1), displaying a significant winter-peak, as previous studies have shown not only in the northern hemisphere,\(^8,19\) but also in the southern hemisphere.\(^9\) Physiological mechanisms underlying the association between the cold temperature and greater HF hospitalizations have been well documented.\(^18\) For example, the hemodynamic stresses and neurohumoral activation that accompany a reduction in temperature may exacerbate HF, induce myocardial ischemia, and precipitate arrhythmias. Furthermore, both ischemia and arrhythmias could further increase the risk of HF decompensation. Other mechanisms may relate to the pulmonary infection in seasonal variation. Respiratory infections are more frequent in winter and could precipitate HF. The short-term cold exposure in young healthy subjects could also initiate a mild inflammatory reaction and a tendency for an increased state of hypercoagulability.\(^35\)

Several previous studies have also found the adverse effects of temperature change within a day on cardiorespiratory morbidity\(^12,13\) and mortality.\(^14-16\) Plausible biological mechanisms of DTR on cardiovascular diseases have been hypothesized. Greater DTR may cause cardiovascular-related diseases by increasing blood pressure, oxygen uptake, heart rate, and cardiac workload.\(^12\) Keatinge et al\(^13\) found that increases in blood platelets, red cells, and viscosity were associated with normal thermoregulatory adjustments to temperature change. Bull\(^34\) argued that weather changes may affect either humoral or cellular immunity. Female or elderly subjects might have either lower thermoregulatory responses or weaker immunity so that they were more vulnerable to the temperature change within a day.

The impact of colder temperature on cardiovascular morbidity or mortality has been found not only in the regions with cold winter climate, but also in the regions with relatively warmer weather. Those single-location studies

**Table 2. Sensitivity Analyses for the Effects of DTR on Emergency HF Hospital Admissions by Lags (Lag\(_0\)=Lag\(_6\) and Overall Cumulative)**

<table>
<thead>
<tr>
<th>Lag Days</th>
<th>Effect Estimate*</th>
<th>PM(_{10})</th>
<th>NO(_2)</th>
<th>O(_3)</th>
<th>SO(_2)</th>
<th>Effect Estimate†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag(_0)</td>
<td>0.87 (0.31 to 1.43)§</td>
<td>0.91 (0.36 to 1.47)§</td>
<td>0.41 (−0.16 to 0.97)</td>
<td>0.88 (0.32 to 1.44)§</td>
<td>0.57 (0.00 to 1.15)§</td>
<td>1.44 (0.89 to 1.99)§</td>
</tr>
<tr>
<td>Lag(_1)</td>
<td>0.89 (0.34 to 1.43)§</td>
<td>0.82 (0.28 to 1.37)§</td>
<td>0.52 (−0.04 to 1.08)</td>
<td>0.78 (0.23 to 1.32)§</td>
<td>0.77 (0.20 to 1.34)§</td>
<td>0.48 (−0.06 to 1.02)</td>
</tr>
<tr>
<td>Lag(_2)</td>
<td>0.81 (0.28 to 1.34)§</td>
<td>0.69 (0.16 to 1.22)§</td>
<td>0.46 (−0.09 to 1.00)</td>
<td>0.59 (0.06 to 1.12)§</td>
<td>0.79 (0.23 to 1.34)§</td>
<td>0.32 (−0.20 to 0.84)</td>
</tr>
<tr>
<td>Lag(_3)</td>
<td>0.86 (0.35 to 1.38)§</td>
<td>0.69 (0.17 to 1.21)§</td>
<td>0.32 (−0.21 to 0.85)</td>
<td>0.62 (0.10 to 1.14)§</td>
<td>0.80 (0.26 to 1.35)§</td>
<td>0.43 (−0.08 to 0.95)</td>
</tr>
<tr>
<td>Lag(_4)</td>
<td>0.63 (0.12 to 1.14)§</td>
<td>0.49 (−0.02 to 0.10)</td>
<td>0.26 (−0.27 to 0.79)</td>
<td>0.40 (−0.12 to 0.91)</td>
<td>0.69 (0.15 to 1.23)§</td>
<td>0.56 (0.05 to 1.07)§</td>
</tr>
<tr>
<td>Lag(_5)</td>
<td>0.63 (0.12 to 1.14)§</td>
<td>0.50 (−0.01 to 1.02)</td>
<td>0.34 (−0.19 to 0.88)</td>
<td>0.51 (−0.01 to 1.03)</td>
<td>0.56 (0.02 to 1.10)§</td>
<td>0.62 (0.10 to 1.13)§</td>
</tr>
<tr>
<td>Overall cumulative‡</td>
<td>3.76 (3.36 to 4.16)§</td>
<td>3.02 (2.63 to 3.42)§</td>
<td>2.33 (1.94 to 2.73)§</td>
<td>2.85 (2.45 to 3.25)§</td>
<td>3.39 (2.99 to 3.79)§</td>
<td>3.16 (2.76 to 3.56)§</td>
</tr>
</tbody>
</table>

Values represent ERR\(\%\) (95% CI) per 1°C increment of DTR. CI indicates confidence interval; DTR, diurnal temperature range; ERR, excess relative risk; HF, heart failure; NO\(_2\), nitrogen dioxide; O\(_3\), ozone; PM\(_{10}\), particles with an aerodynamic diameter <10 \(\mu\)m; and SO\(_2\), sulfur dioxide.

*Effects were estimated from core model (Equation 1).
†Effects were estimated by replacing the terms of mean temperature with the minimum temperature in core model (Equation 1).
‡Overall cumulative effects of DTR lasting for 0 to 5 days were estimated by distributed lag models.
§Statistically significant effect estimates.
conducted in warmer areas with higher long-term mean temperatures tended more frequently to report detrimental effects of cold and tended to report effect estimates of greater magnitude.10,35 Hong Kong has a moderate cool winter with mean temperature 19.5°C (range, 8.2°C–22.0°C) in cool season; residents may be more vulnerable to low temperature and daily temperature change. Furthermore, indoor heating system is uncommon in Hong Kong. Hence, a decrease in the outdoor temperature can affect indoor temperature rather quickly in winter and affect the patients at risk. In contrast, during the hot and humid summer in Hong Kong (temperatures of 25°C–30°C and humidity of 70%–90% between 10th and 90th percentiles), people usually use air-conditioning indoors and engage in less outdoor activities, thus reducing the risks of temperature change. This might be the reason that we did not find the association between the DTR and HF admissions in the warm season.

Our findings provide some insight into the prevention of temperature change–related emergency HF hospitalizations. Early warning system for impending large temperature change may reduce the impact of DTR on population health. Female and elderly subjects, especially the socially isolated and economically disadvantaged, should be given advice on appropriate clothing when a rapid drop in temperature is predicted. They should be given access to heated indoor environments to reduce the DTR exposure. Furthermore, studies in other settings separately, which may help to identify specific target group(s) for focused prevention. Furthermore, studies in other settings with different climate and larger DTR are recommended to provide a better understanding of the effects of temperature change on health.

In conclusion, we found significantly short-term adverse effects of DTR on emergency HF admissions. The effects of DTR were significantly greater in the cool season. Women and elders were much more vulnerable to the temperature change. Policymakers and hospitals should take into account the increased demand of specific facilities for susceptible population in cool season with wider daily temperature variations.

Acknowledgments
We thank the Hospital Authority for providing hospital admission data, the Hong Kong Observatory for providing temperature and humidity data, and the Hong Kong Environmental Protection Department for providing air pollution data.

Disclosures
None.

References

Table 3: Modification of Sex and Age Group on DTR Effects on Emergency HF Admissions in Hong Kong

<table>
<thead>
<tr>
<th>Lag Days</th>
<th>Women</th>
<th>Men</th>
<th>Stratified by Age Group, y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;65</td>
</tr>
<tr>
<td>Lag0</td>
<td>1.31 (0.60 to 2.02)***</td>
<td></td>
<td>0.29 (−0.49 to 1.09)*</td>
</tr>
<tr>
<td>Lag1</td>
<td>0.68 (−0.01 to 1.38)</td>
<td></td>
<td>1.15 (0.38 to 1.93)**</td>
</tr>
<tr>
<td>Lag2</td>
<td>0.72 (0.05 to 1.40)*</td>
<td></td>
<td>0.93 (0.19 to 1.69)**</td>
</tr>
<tr>
<td>Lag3</td>
<td>1.15 (0.50 to 1.81)</td>
<td></td>
<td>0.49 (−0.24 to 1.22)</td>
</tr>
<tr>
<td>Lag4</td>
<td>0.88 (0.23 to 1.54)</td>
<td></td>
<td>0.30 (−0.42 to 1.03)</td>
</tr>
<tr>
<td>Lag5</td>
<td>0.75 (0.10 to 1.41)</td>
<td></td>
<td>0.47 (−0.26 to 1.20)</td>
</tr>
<tr>
<td>Overall cumulative</td>
<td>4.41 (3.89 to 4.92)***</td>
<td></td>
<td>2.93 (2.37 to 3.50)**</td>
</tr>
</tbody>
</table>

Values represent ERR% (95% CI) per 1°C increment of DTR. Overall cumulative effects of DTR lasting for 0 to 5 days were estimated by distributed lag models. CI indicates confidence interval; DTR, diurnal temperature range; ERR, excess relative risk; and HF, heart failure.

*Differences between female and male group were significant at α=0.05.
†Differences between age ≥75 and <65 group were significant at α=0.05.
‡Differences between age ≥75 and 65 to 74 group were significant at α=0.05.
§Differences between age 65 to 74 and <65 group were significant at α=0.10.
||Statistically significant effect estimates.
Is Greater Temperature Change Within a Day Associated With Increased Emergency Hospital Admissions for Heart Failure?
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