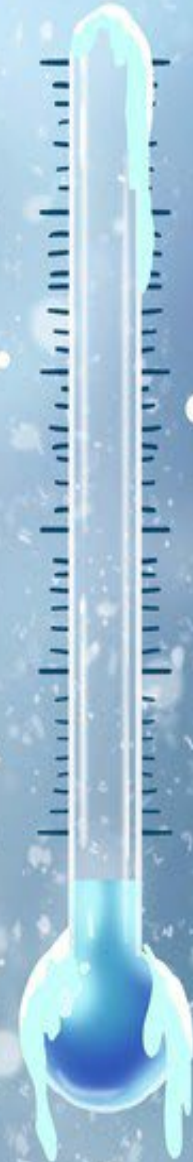


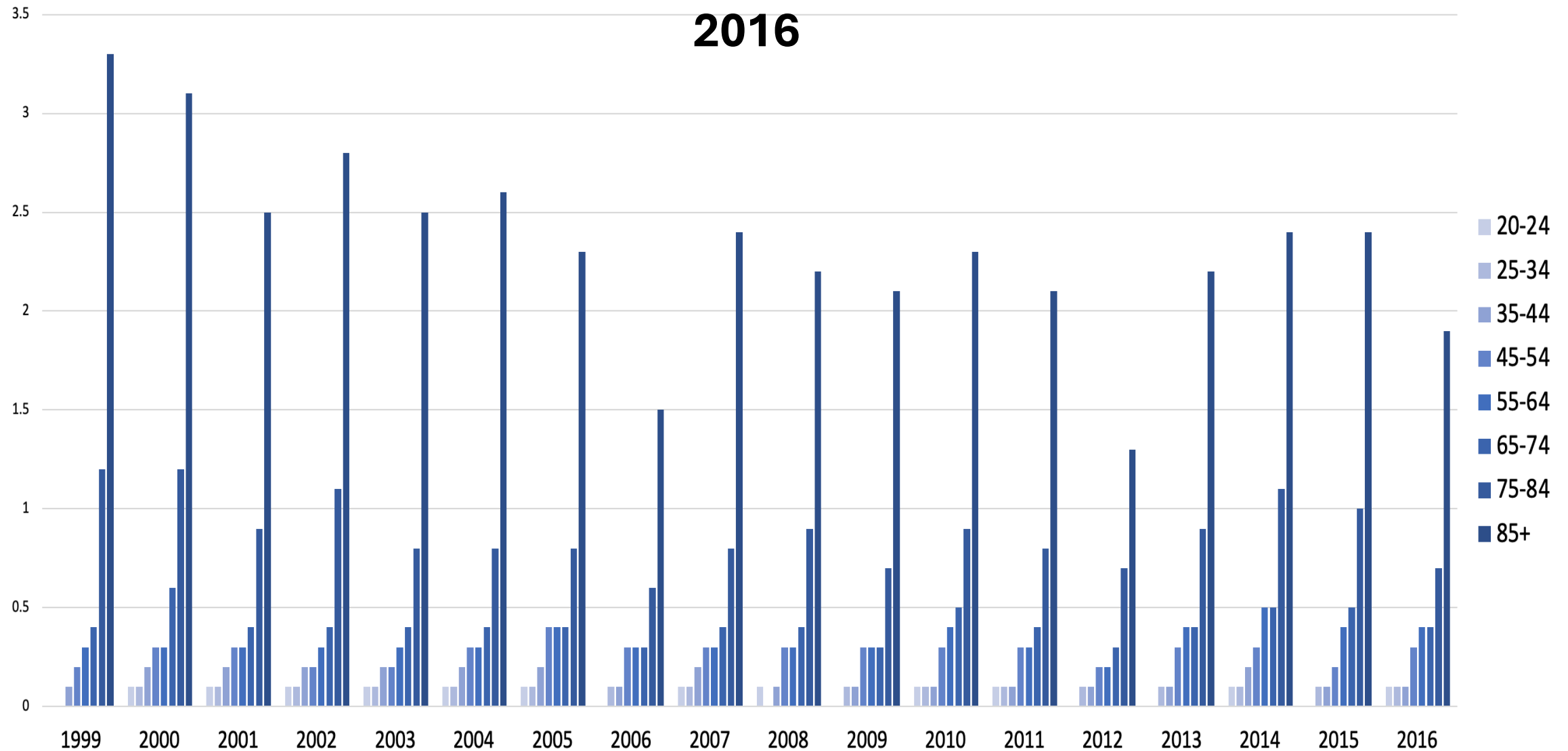
# Cold Snaps and Aging Population

**Dr. Kai Zhang**

University at Albany,  
State University of New York

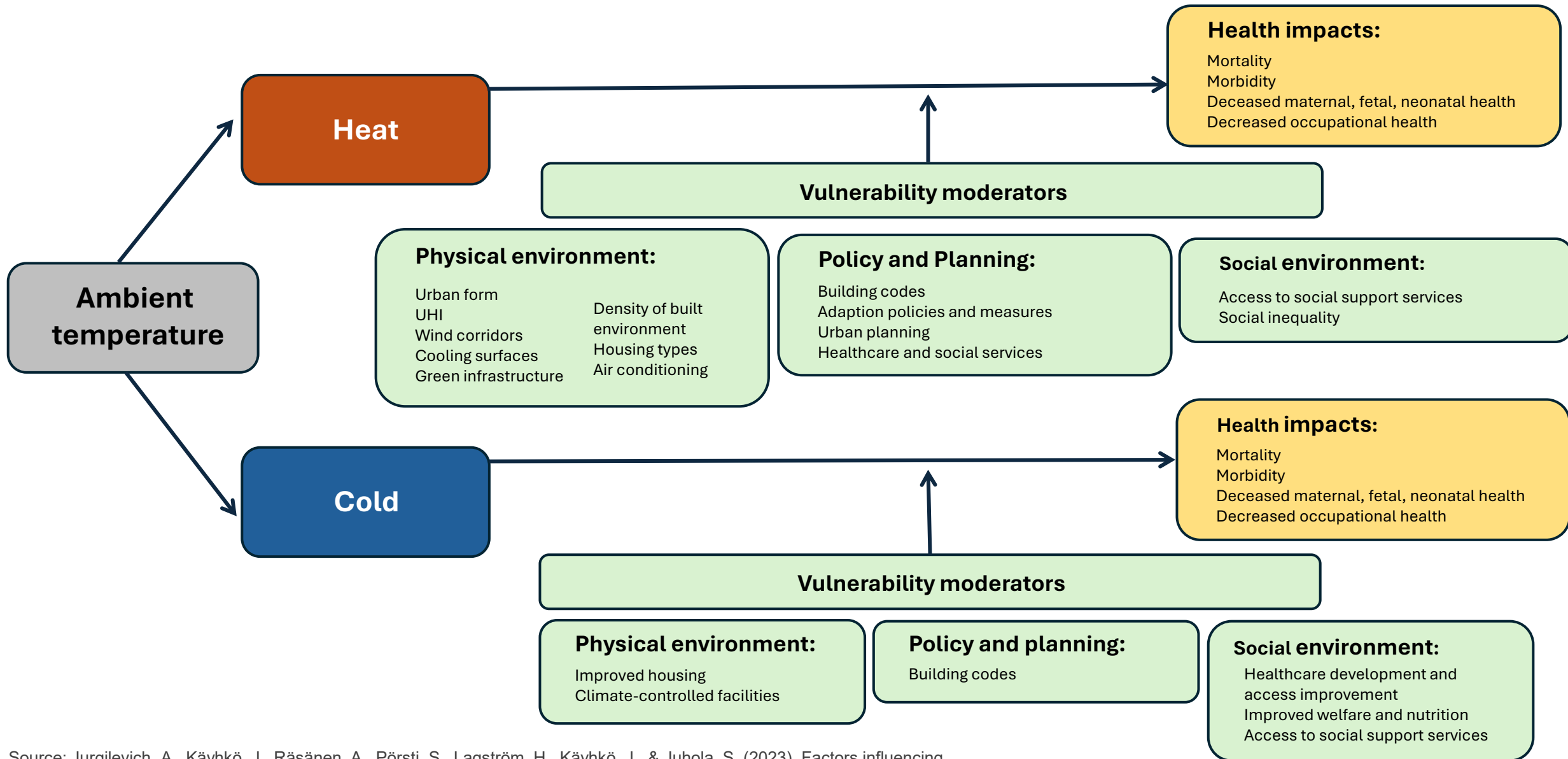


# Crude death rates (per 100,000) caused by exposure to excessive natural cold in the United States, 1996-2016



Source: Centers for Disease Control and Prevention, National Center for Health Statistics.

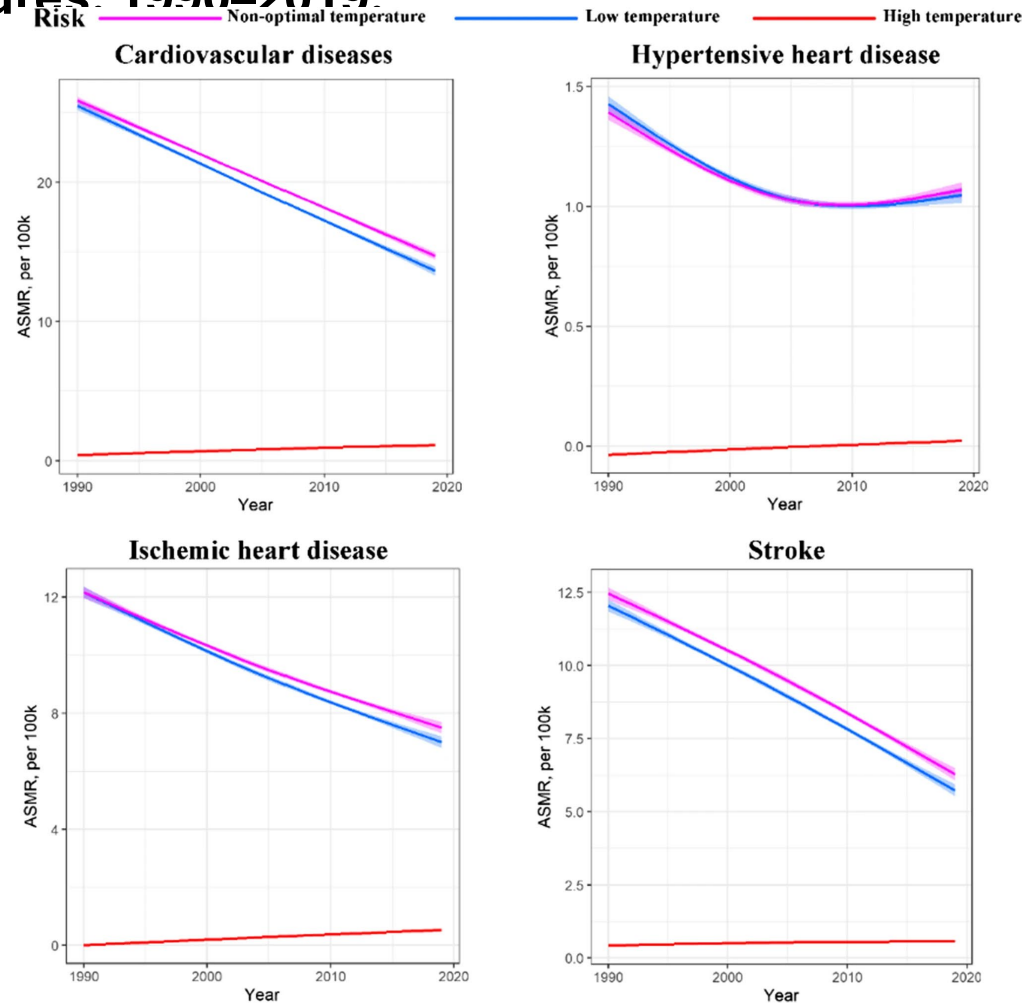
# How Ambient Temperature Affects Health



Source: Jurgilevich, A., Käyhkö, J., Räsänen, A., Pörsti, S., Lagström, H., Käyhkö, J., & Juhola, S. (2023). Factors influencing vulnerability to climate change-related health impacts in cities—A conceptual framework. *Environment International*, 173, 107837.

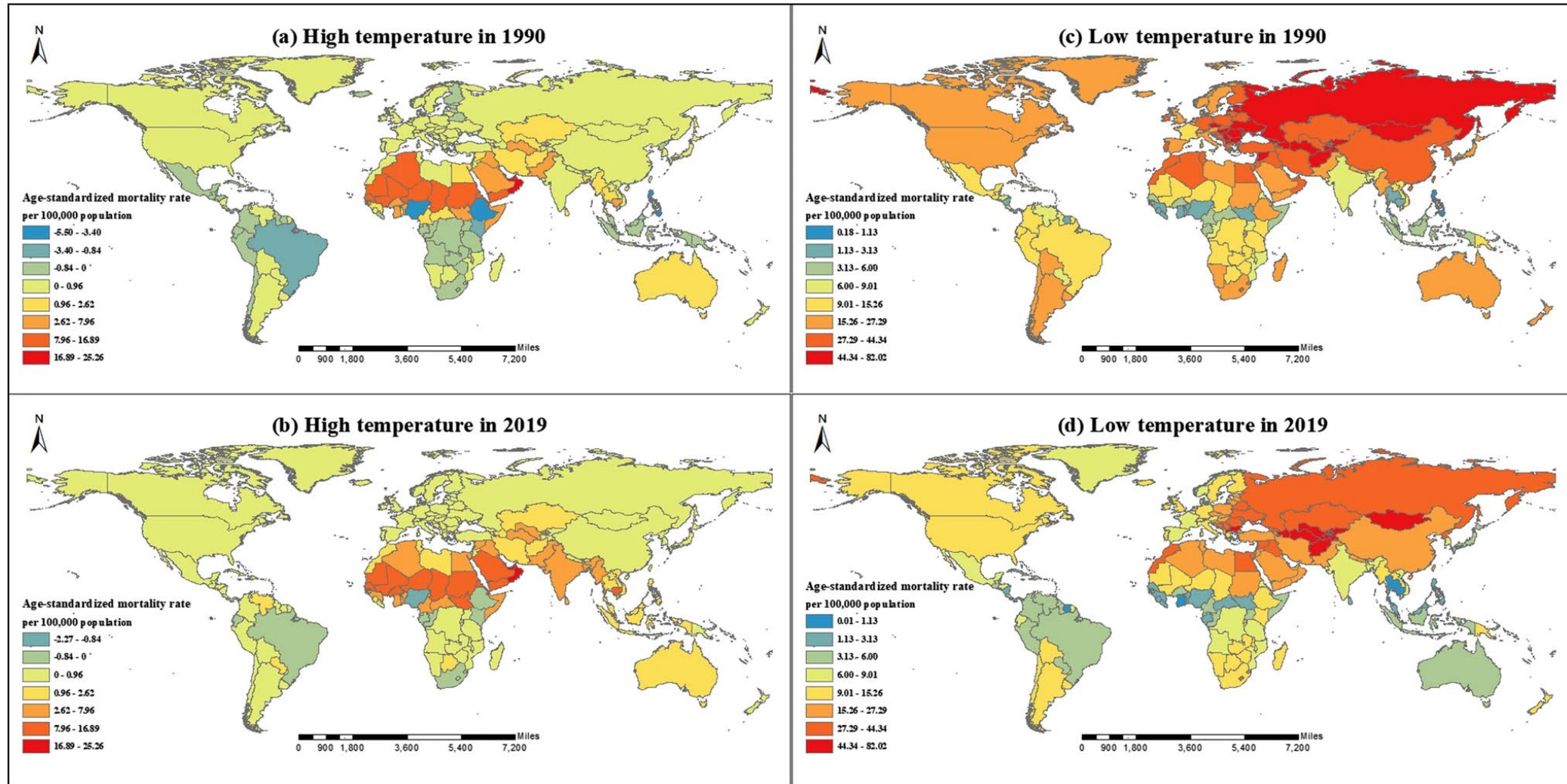
# Example 1: Cold Weather and Cardiovascular Diseases

The global temporal trends of age-standardized mortality rate (per 100,000) of cardiovascular diseases, hypertensive heart disease, ischemic heart disease, and stroke attributed to high, low, and non-optimal temperatures, 1990–2019.



# Example 1: Cold Weather and Cardiovascular Diseases

The global age-standardized mortality rate (per 100,000) of cardiovascular disease attributed to (a, b) high temperature and (c, d) low temperature in 1990 and 2019



# Example 1: Cold Weather and Cardiovascular Diseases

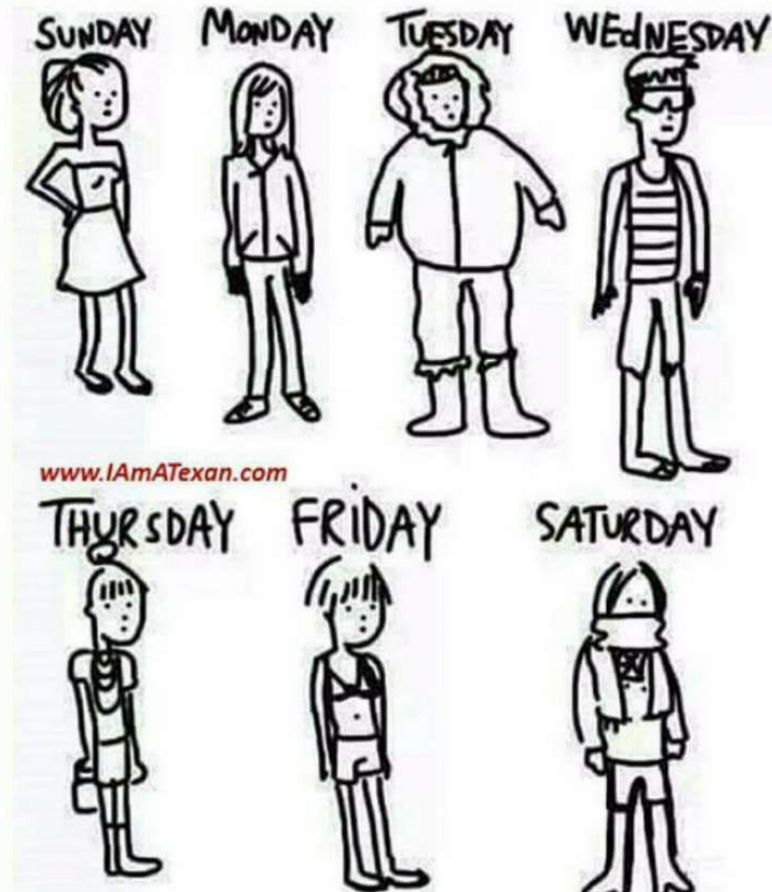
Age-specific, sex-specific mortality rate (per 100,000), and disability-adjusted life rate (per 100,000) of cardiovascular disease attributed to a, d low temperature, b, e high temperature, and c, f non-optimal temperature in 2019



Source: Liu C, Luo B, Wang B, He L, Wu H, Hou L, Zhang K. "Global spatiotemporal trends of cardiovascular diseases due to temperature in different climates and socio-demographic index regions from 1990 to 2019." *Environmental Science And Pollution Research* 30 (2023): 3282-3292.

# Example 2: Cold Weather and Emergency Hospital Admission in Texas

## December in Texas



Dena Miller @MRSTXFabFace · 4h  
#Texas #winter



Amanda  
@recoveringmama



Follow

Winter has hit Texas!!! I had to dig the real jackets out of the closet.

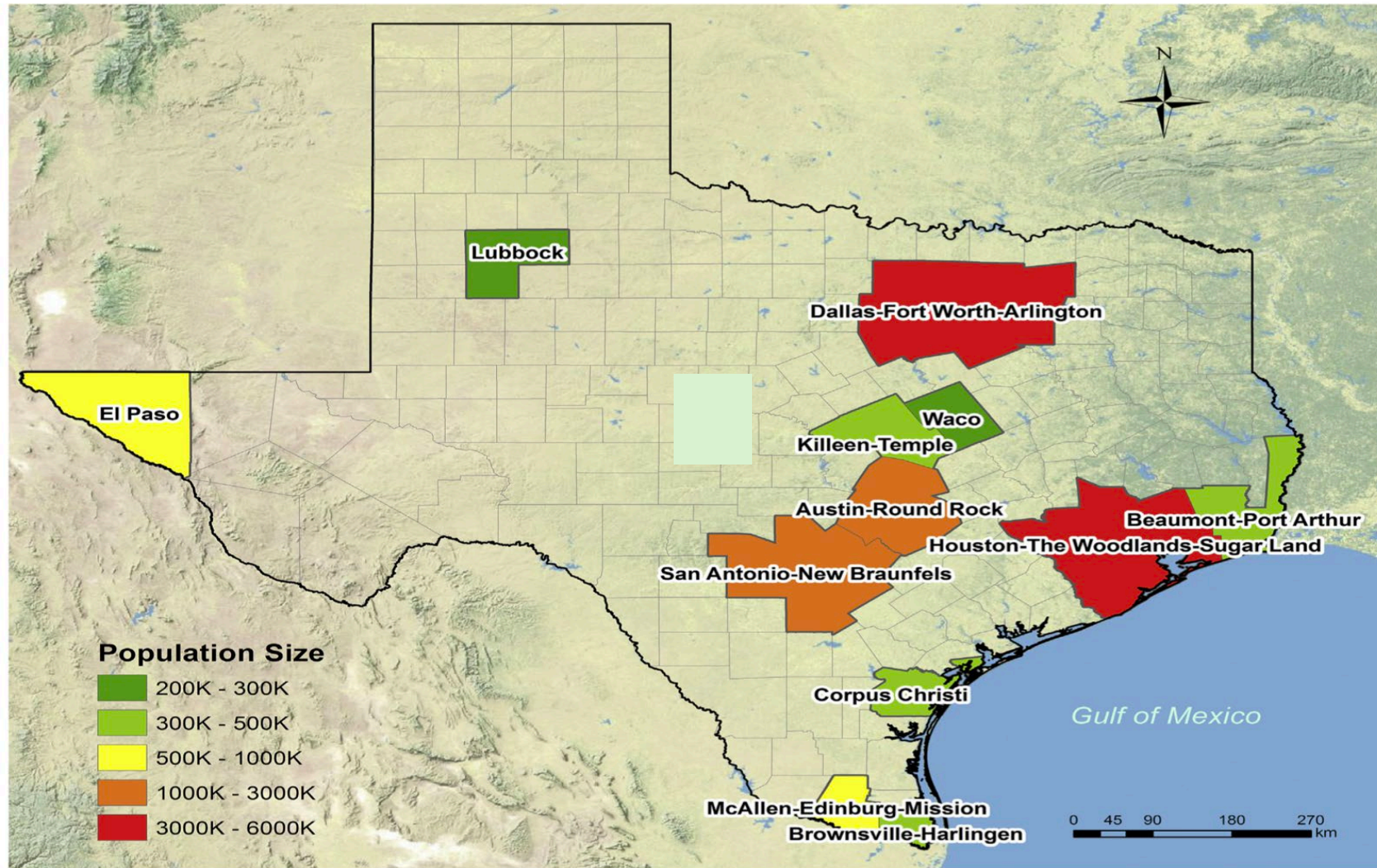


6:53 AM - 8 Dec 2016



<https://www.chron.com/news/houston-weather/article/Texas-is-freaking-out-over-the-first-cold-front-10782841.php#photo-12010652>  
<http://www.chron.com/news/houston-weather/article/Texas-is-freaking-out-over-the-first-cold-front-10782841.php#photo-12010652>

# Study Area



12 major metropolitan areas (MSAs) in Texas in the study

# Study design

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- Multi-city study using time series data in Texas
- Major exposure:
  - Daily mean temperature
  - National Oceanic and Atmospheric Administration (NOAA) Integrated Surface Database (ISD)
- Major outcomes:
  - Daily counts of emergency hospital admissions (EHA)
    - Cause-specific
    - Age-stratified (0-64, 65-74, 75+)
  - Texas Department of State Health Services
- Study period: 2004-2013

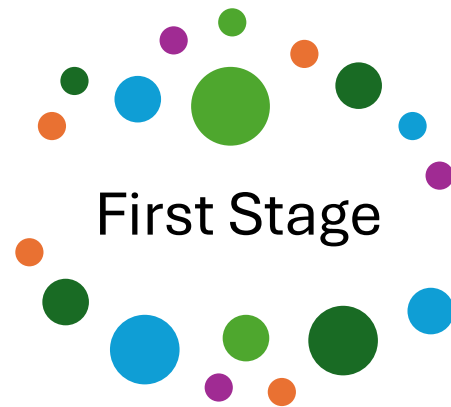
# The international classification of Disease (ICD)

---

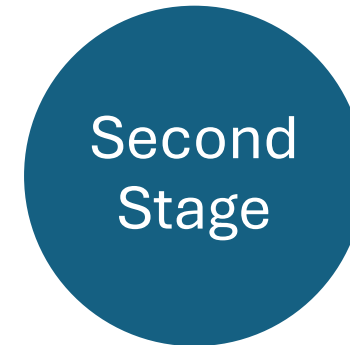
<b>Outcome</b>	<b>Description</b>	<b>ICD-9</b>	<b>ICD-10</b>
All-cause	Including external causes	000-999 E and V	A00-U99
CVD	Cardiovascular disease	390-429	I01-I52
IHD	Ischemic heart disease	410-414	I20-I52
MI	Myocardial infarction	410	I21, I22
STROKE	Stroke	430-438	I60-I69
RESP	Respiratory disease	460-519	J00-J99
COPD	Chronic obstructive pulmonary disease	490-496 except 493	J40-J44, J47
PNEU	Pneumonia	480-486	J12-J1

# Statistical analysis: Two stage approach

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- MSA-specific temperature-hospital admission association
- Poisson regression model



Random effects  
meta-analysis

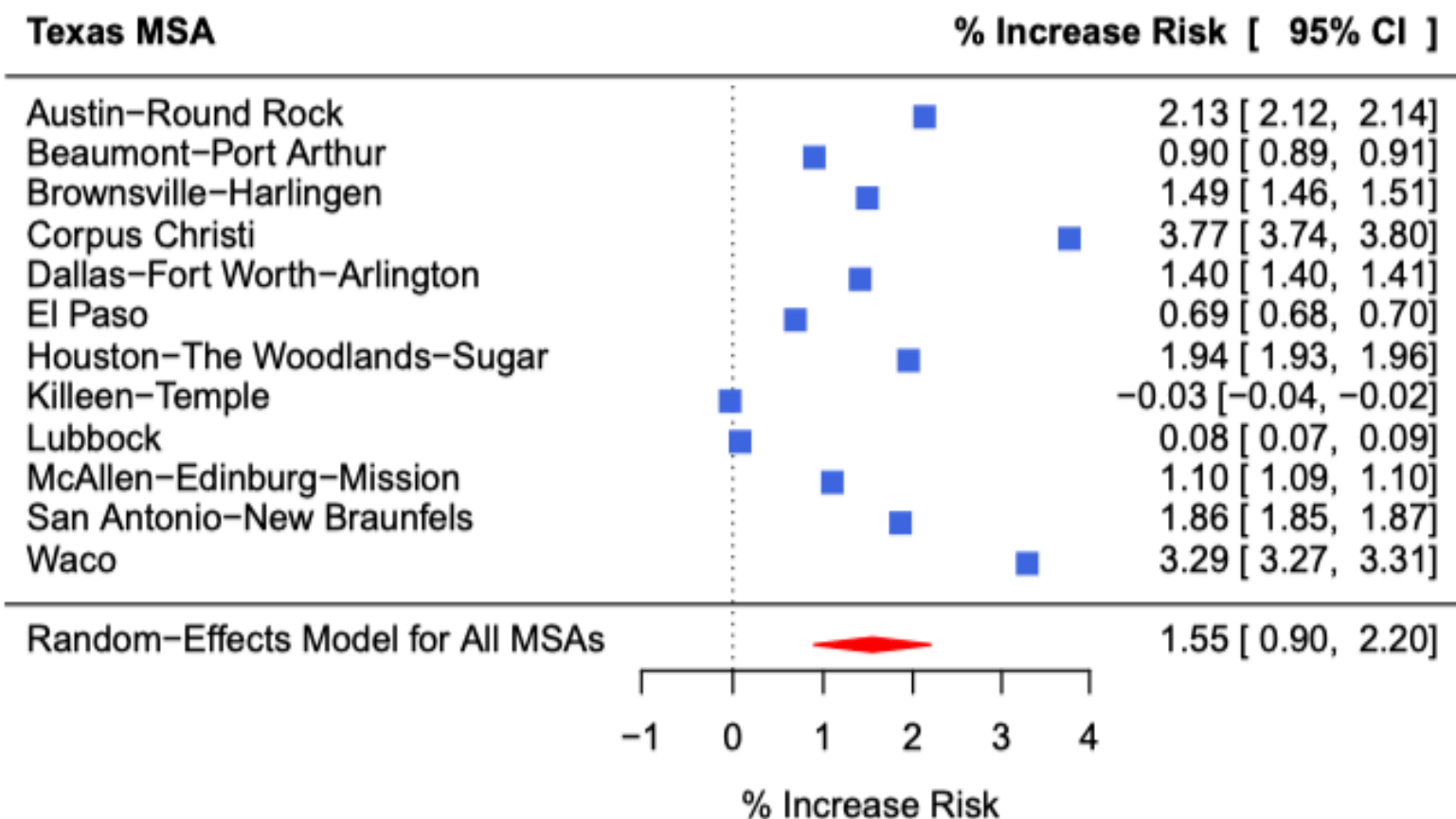
# Poisson regression Model

---

$$\text{Log}[E(Y_t)] = \alpha + cb(meTMP_{t,l}) + \beta CW_t + \gamma DOW_t + s(DOY_t, 7/year) + s(meDWP_t, 3)$$

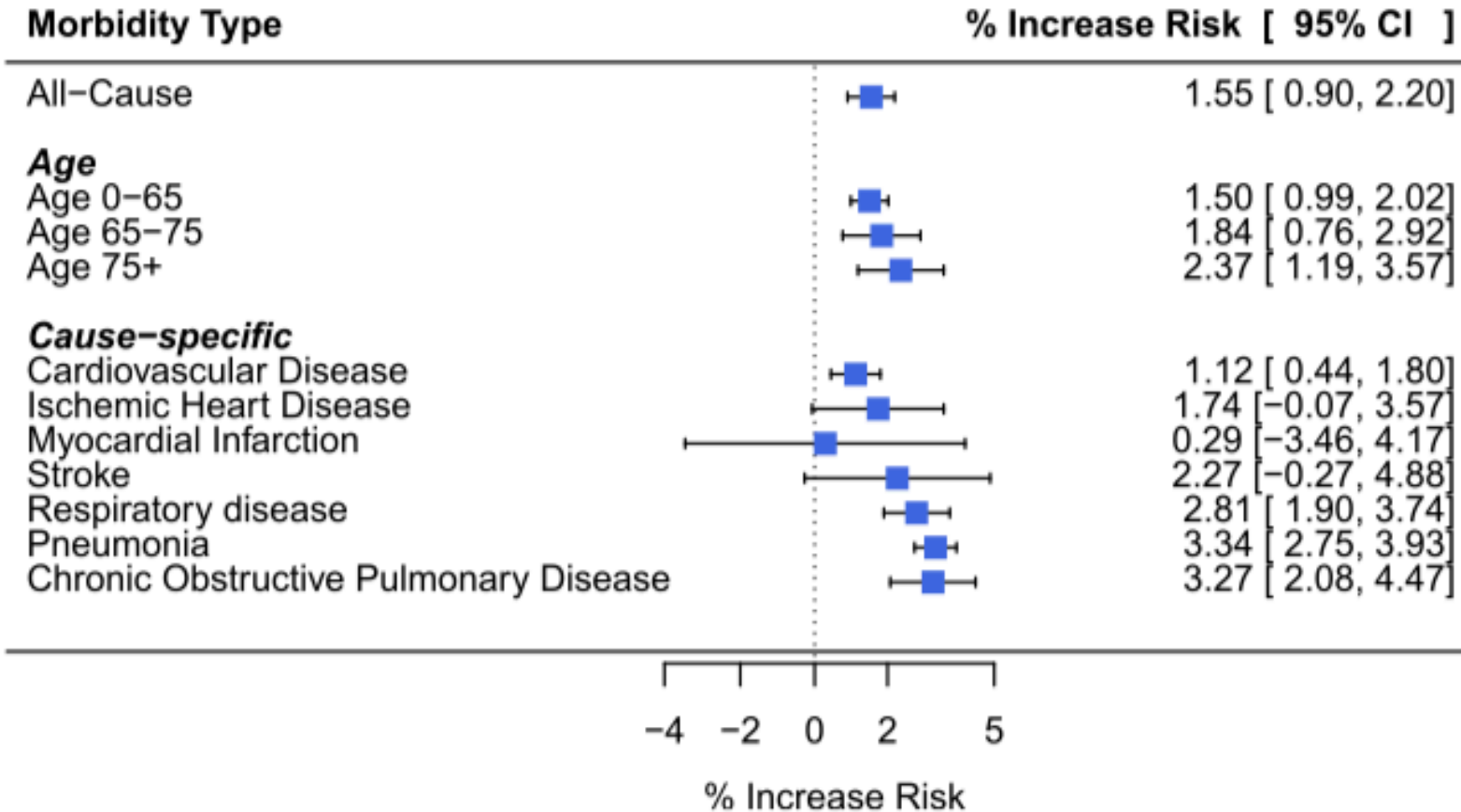
- $Y_t$ : number of deaths or hospital admissions on day  $t$
- $\alpha$ : intercept
- $cb()$ : cross-basis function
- $meTMP_{t,l}$ : mean temperature on day  $t$  with lag effects  $l$  up to 25 days
- $CW_t$ : binary variable for cold wave days (0/1)
- $s()$ : a smooth function with degrees of freedom specified
- $meDWP_t$ : mean dew point temperature on day  $t$
- $DOW_t$ : day of the week
- $DOY_t$ : day of year
- $\beta, \gamma$  : regression coefficients

## Cold effects on all-cause emergency hospital admissions at lag 0–25 in 12 major Texas MSAs during 2004–2013.



- A 1°C decrease in temperature below cold thresholds was associated with a **1.6%** increase in all-cause EHA.

# Cold effect to age-stratified and cause-specific emergency hospital admissions at State-level in Texas.



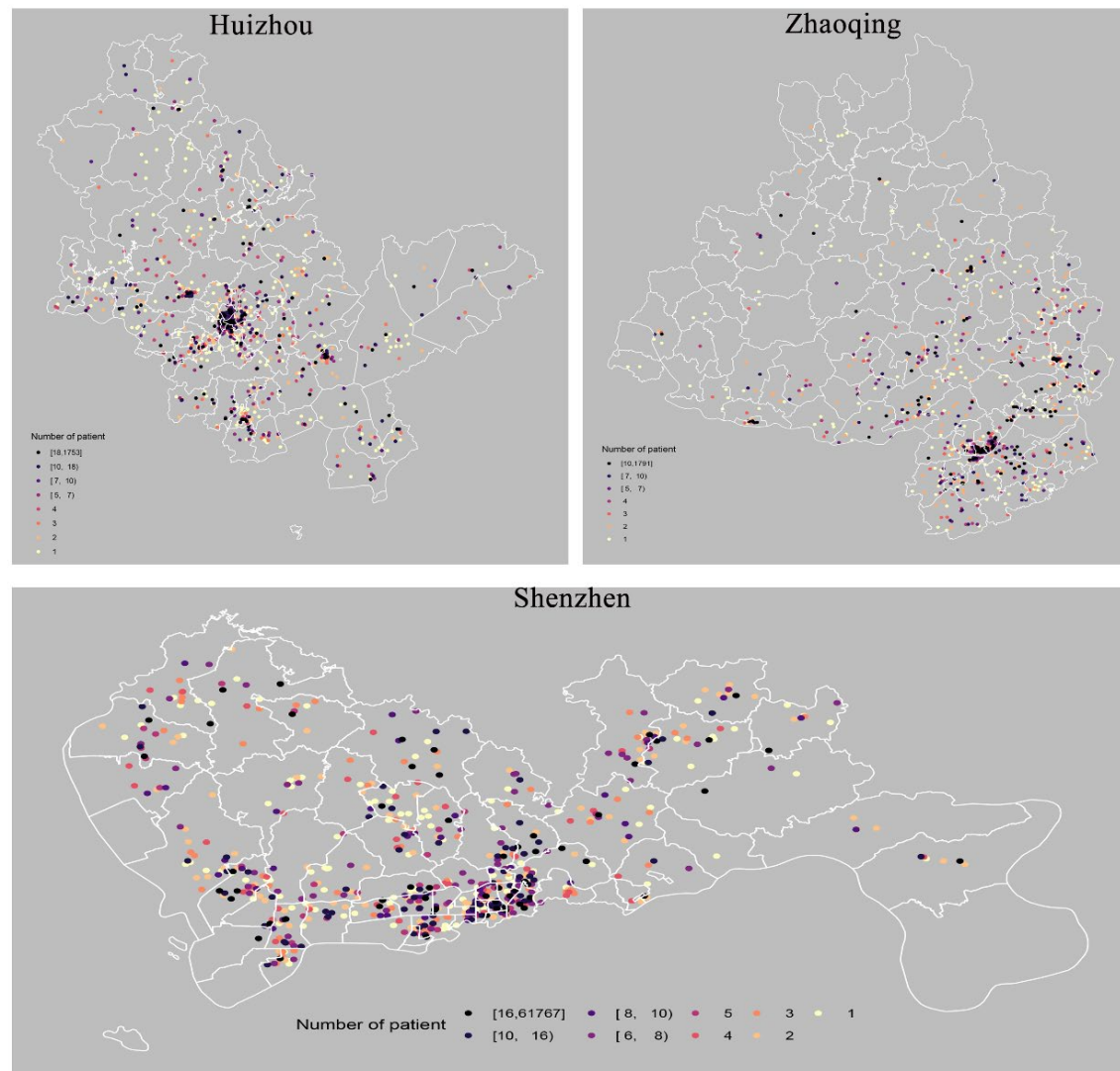
Risk of EHA was highest among elderly individuals aged 75 years and older, with a **2.4%** increase.

Cause-Specific Emergency Hospital Admissions:

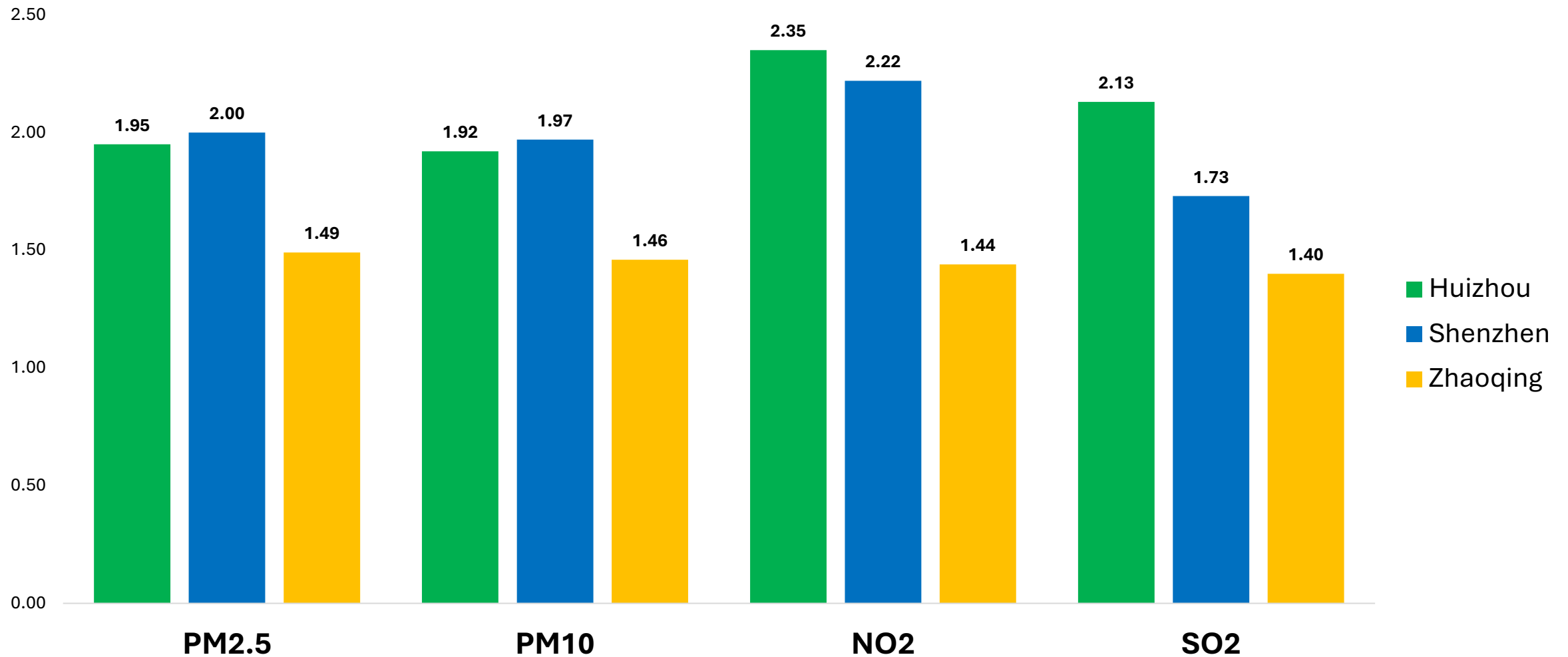
- Pneumonia: **3.3%** increase
- Chronic Obstructive Pulmonary Disease: **3.3%** increase
- Respiratory Diseases: **2.8%** increase

# Example 3: Cold Weather, Air Pollution and Anxiety

## Three subtropical Chinese cities in the study



# Relative Excess Risk Due to Interaction (RERI) of Cold Spells and Air Pollution on Anxiety in Three Subtropical Cities in China



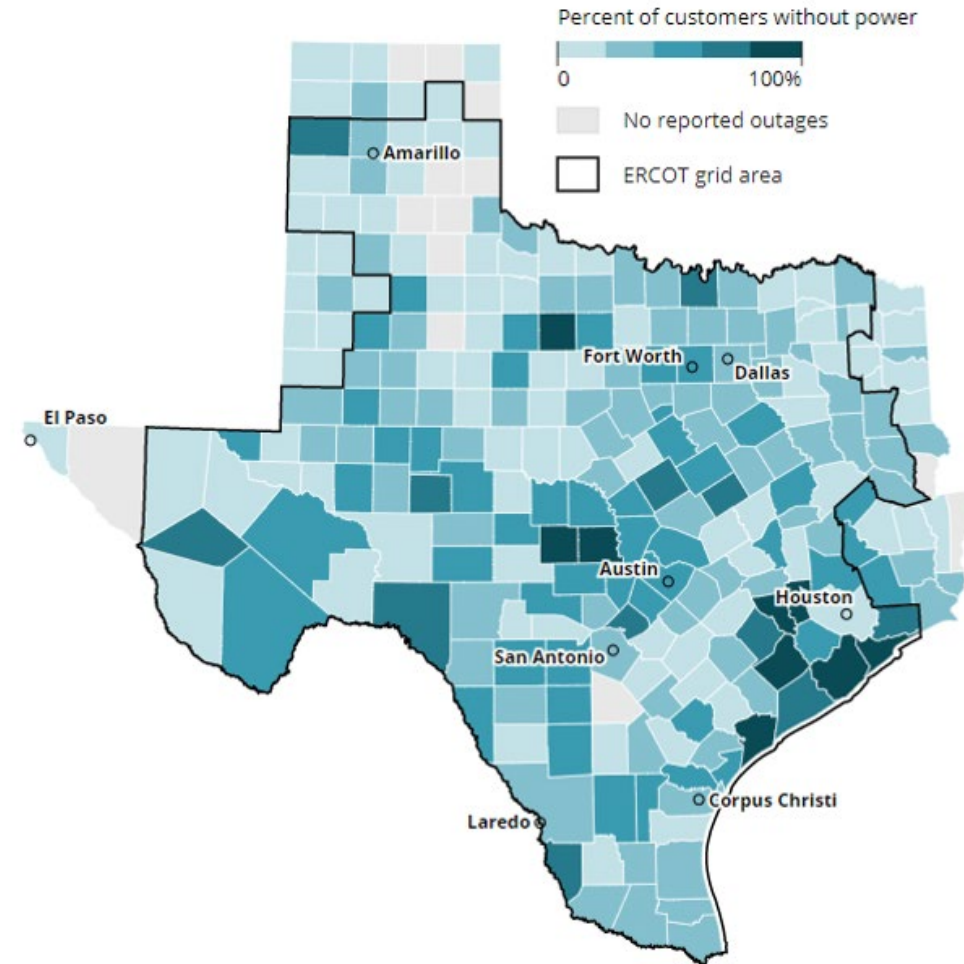
# Future Direction: Resilience



[https://www.youtube.com/watch?v=9fL\\_dX0axTk](https://www.youtube.com/watch?v=9fL_dX0axTk)

<https://abcnews.go.com/US/photos-texans-struggle-catastrophic-winter-storm/story?id=75973171>

[https://sustainability.utdallas.edu/news/20210212a/img/URI\\_04.png](https://sustainability.utdallas.edu/news/20210212a/img/URI_04.png)



# Future Directions

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- ❖ Synergistic Effects of Cold Weather and Other Environmental and Social Stressors
- ❖ Biological mechanisms
- ❖ Vulnerable Populations
- ❖ Innovative Solutions

# Acknowledgement

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- ❖ NIA R01AG081244
- ❖ NIA U01AG088658
- ❖ AHA 19TPA34830085
- ❖ SUNY Empire Innovation Award



# Questions?

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