Epidemiologic Studies of Temperature and Mortality in California

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OEHHA Projects

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Questions to Address

1. What is the effect of temperature on mortality in California?
2. Are the effects of temperature independent of those from air pollution?
3. Can we identify subgroups that are particularly susceptible?
4. What were the full effects of the 2006 heat wave? How high are the effects/degree?
5. Do we observe effects of temperature on hospital admissions?
6. Based on these results, what is the potential public health impact of future changes in climate?

Background

- Few epidemiologic studies of temperature quantifying mortality risk, especially focusing on California
- Many heat-related deaths preventable by identifying vulnerable subgroups by county or region
- Previous studies did not always control for confounding by pollutants and other factors
- Heat-related deaths are underreported

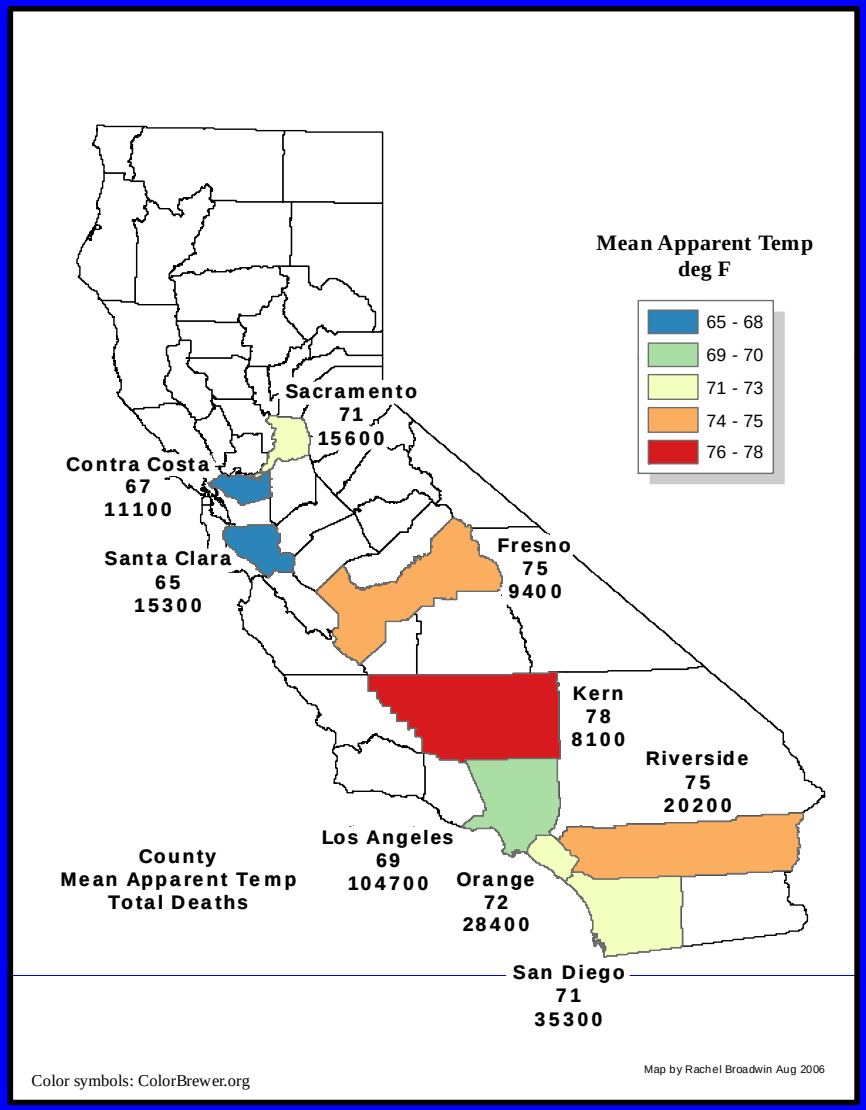
Data

- Mean daily apparent temperature (EPA AIRS database and California Irrigation and Management System)
  - Incorporates temperature and relative humidity

- Daily deaths (CA Department of Health Services)
- Daily hospital visits
  - All non-accidental deaths/visits
  - Cause-specific
  - Age, race/ethnicity, gender, education level

- Air pollutants (CA Air Resources Board)
  - $PM_{2.5}$, O_3, CO, NO_2

Mean Daily Apparent Temperature (°F) for Nine California Counties, May-September 1999-2003



Data Analysis

- Time-series and time-stratified case-crossover methods
  - Basu et al. 2005
- Separate analyses by county
- County estimates combined in meta-analysis

Time-series Study Design

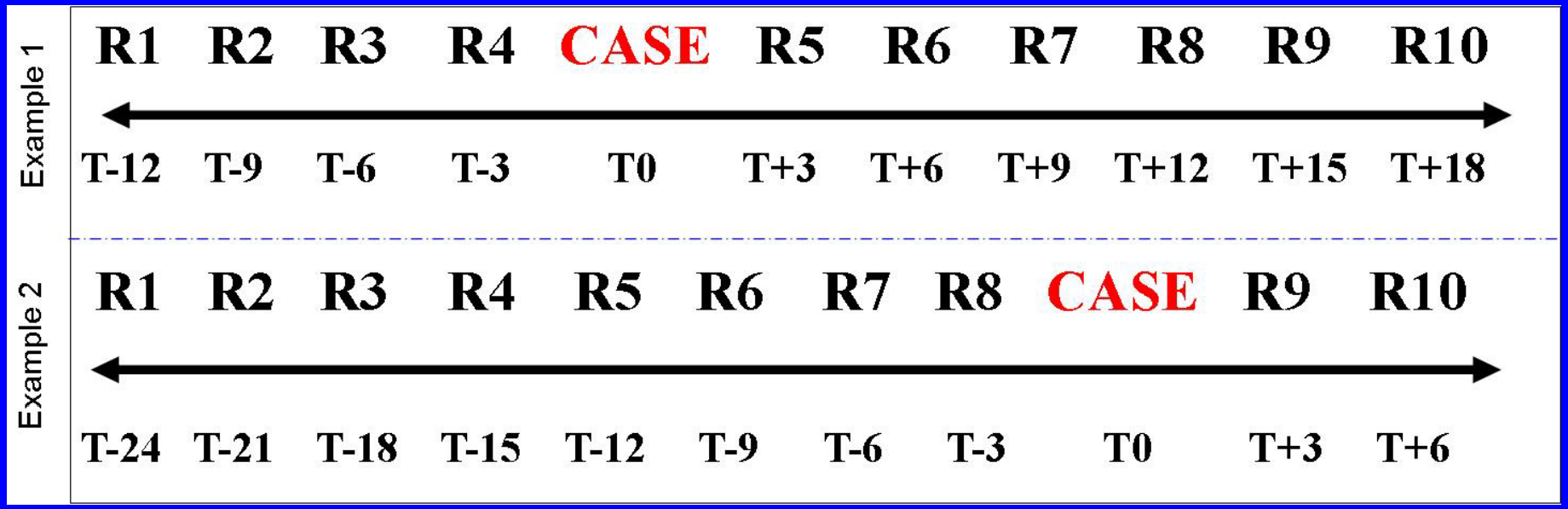
- Often used for epidemiologic studies of air pollution and temperature
- Examine association between daily apparent temperature and daily mortality counts
- Adjust for all other factors that change over time

Case-crossover Study Design

- Compare temperature on day of death (case) to temperature on different days for same person when death did not occur (control)

- Choose control periods within the same month as the cases
  - Addresses concerns about effects of seasonality and other time-varying factors

Time-Stratified Case-Crossover Design



CASE: Case period

R1-R10: Referent periods 1-10 every third day in the same month and year

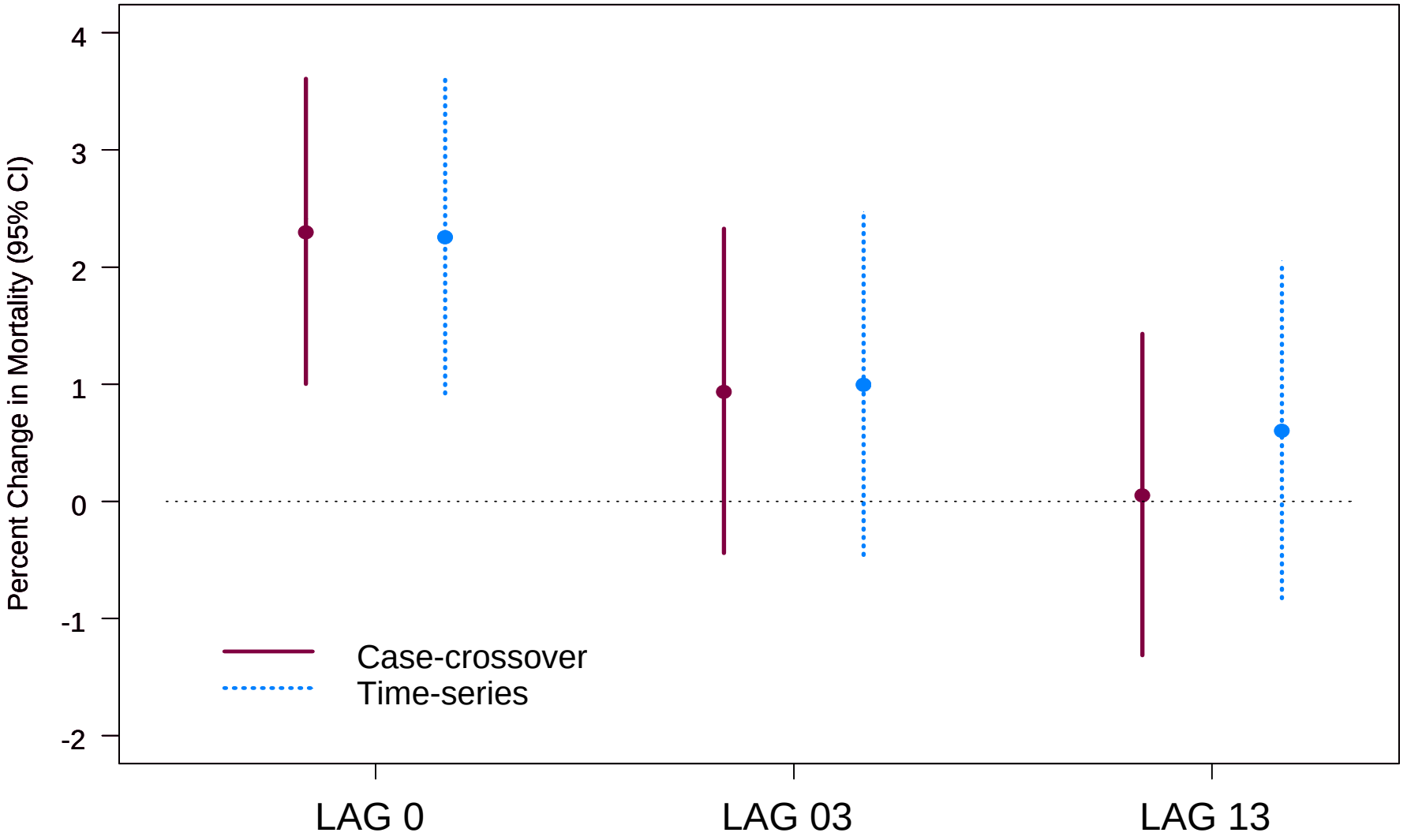
T0: Time that case occurred (death date)

T-24…T+18: Time that referent periods occurred

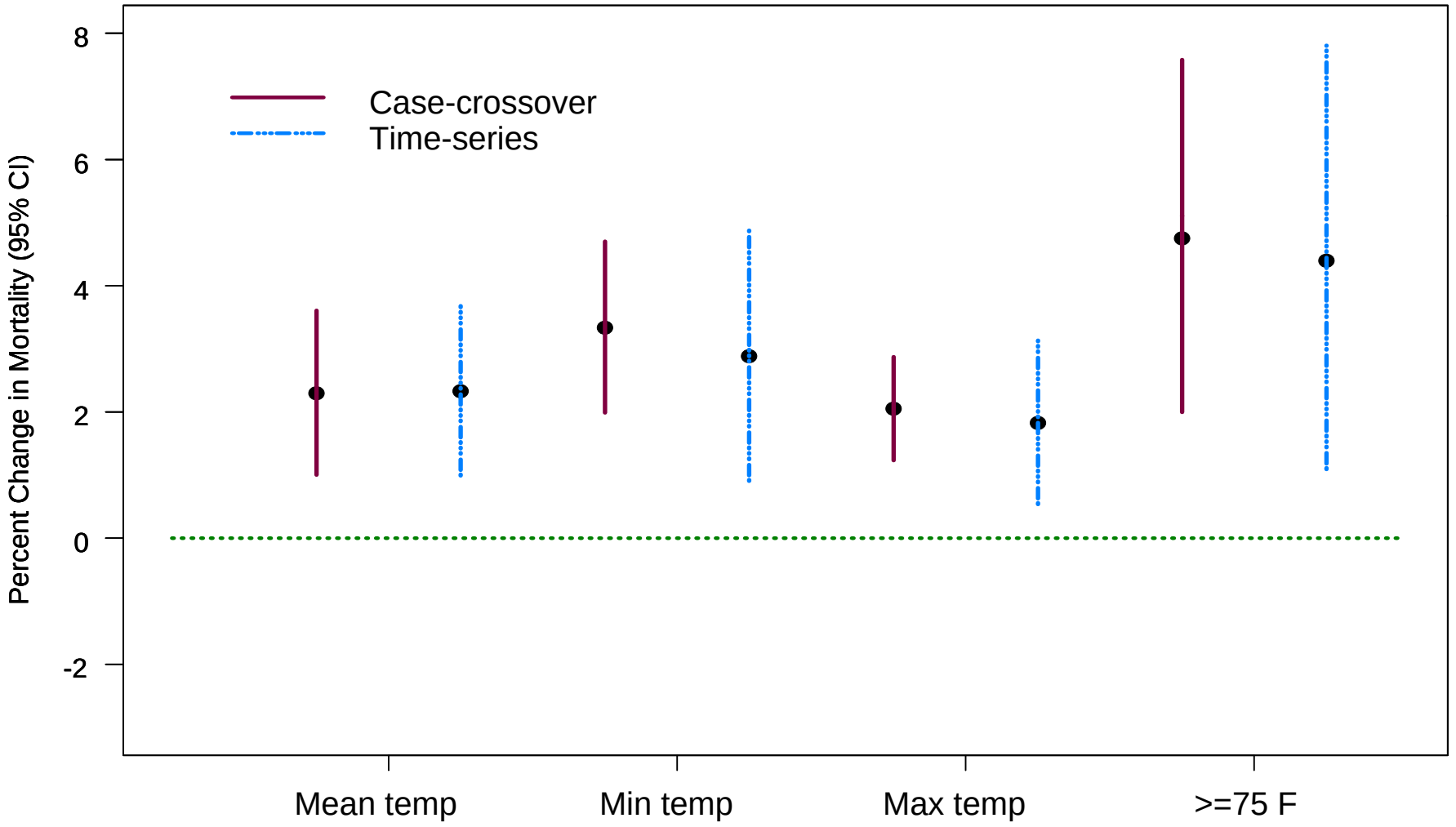
Souce: Basu and Ostro 2008

Results

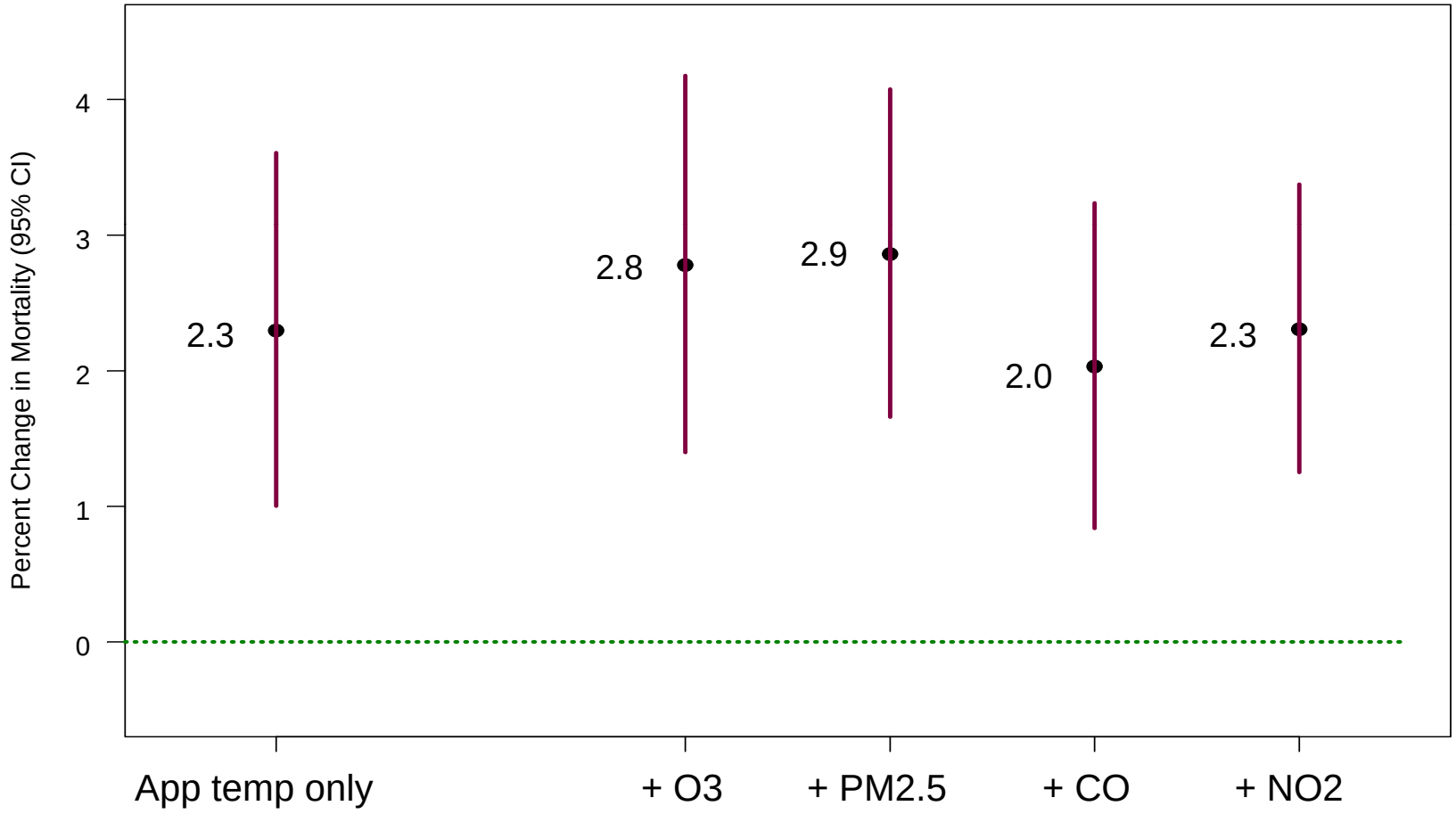
Apparent Temperature Per 10F and All-cause Mortality for Various Lags Times



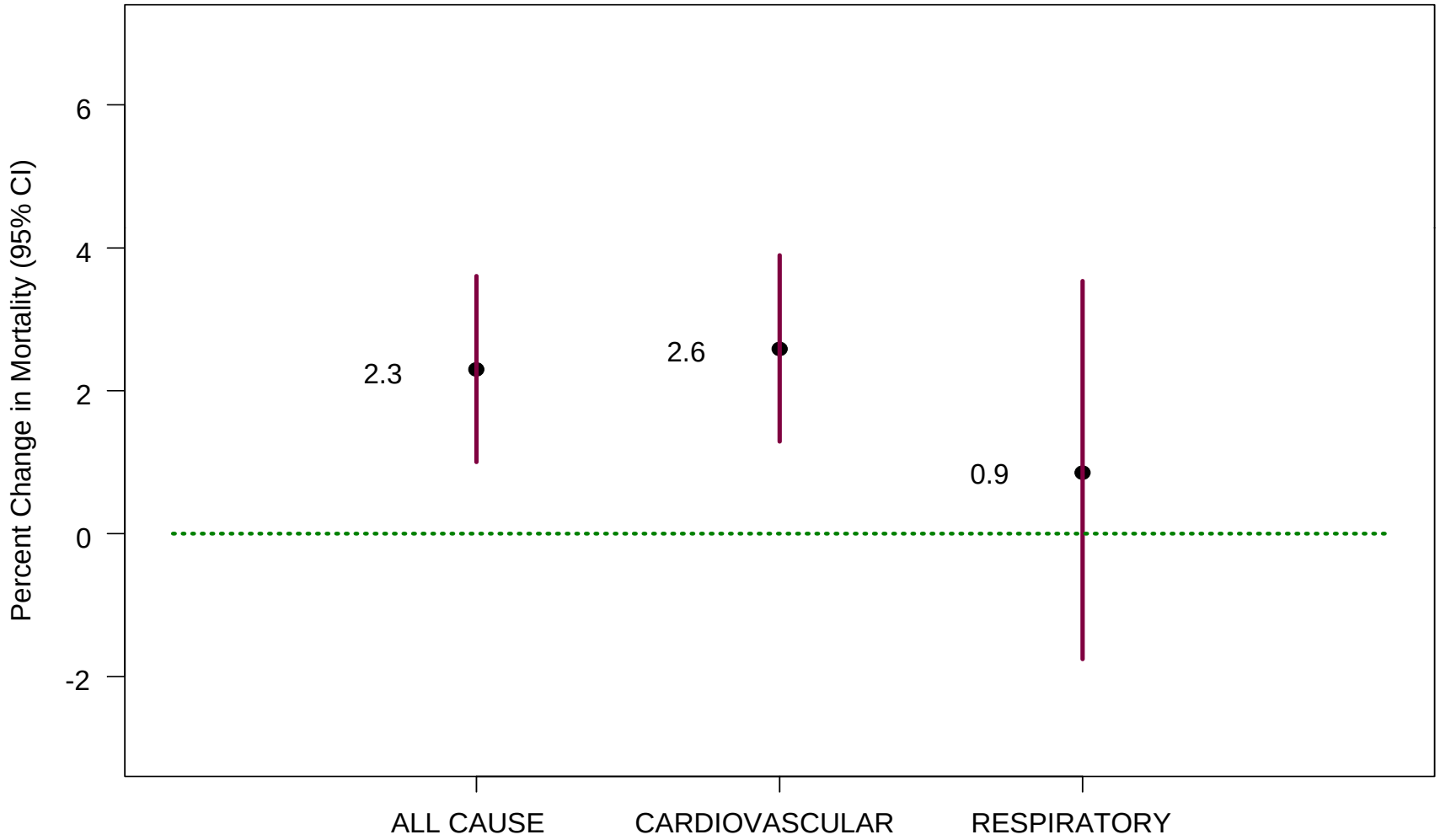
All-cause Mortality Using Various Definitions for Temperature (per 10ºF)



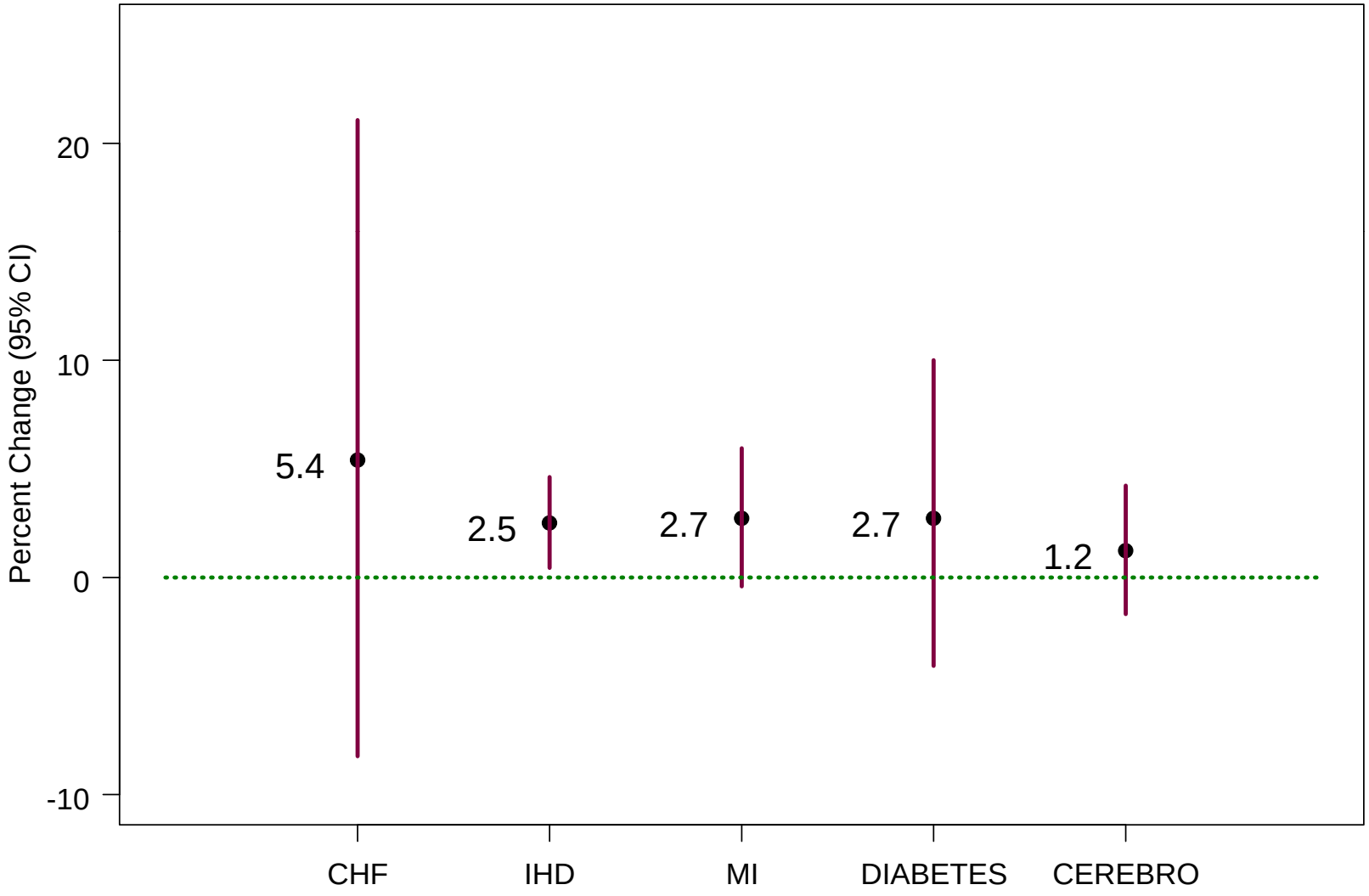
Apparent Temperature per 10ºF and All-cause Mortality Adjusted by Pollutant



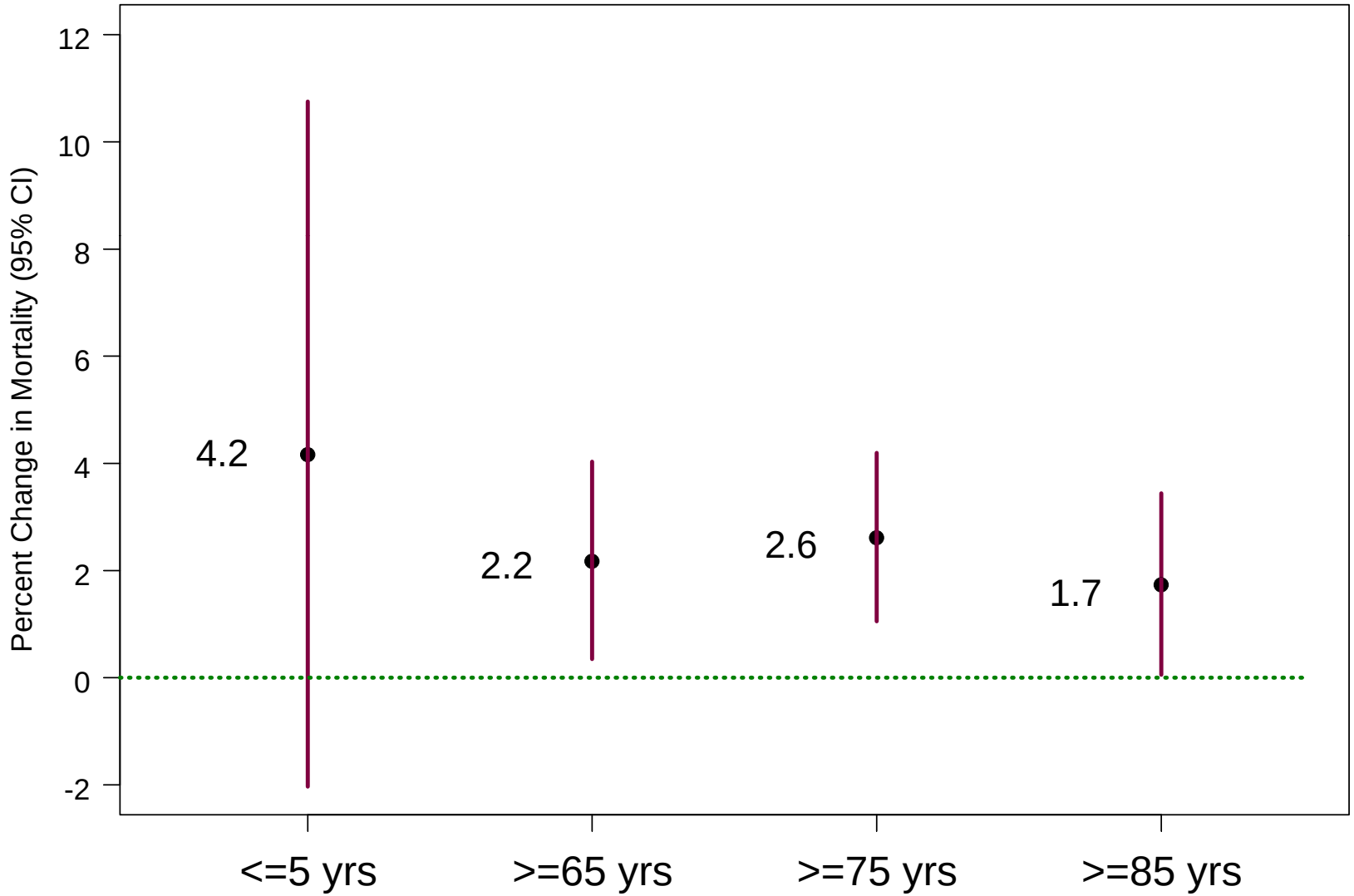
Apparent Temperature per 10ºF and Cause-Specific Mortality



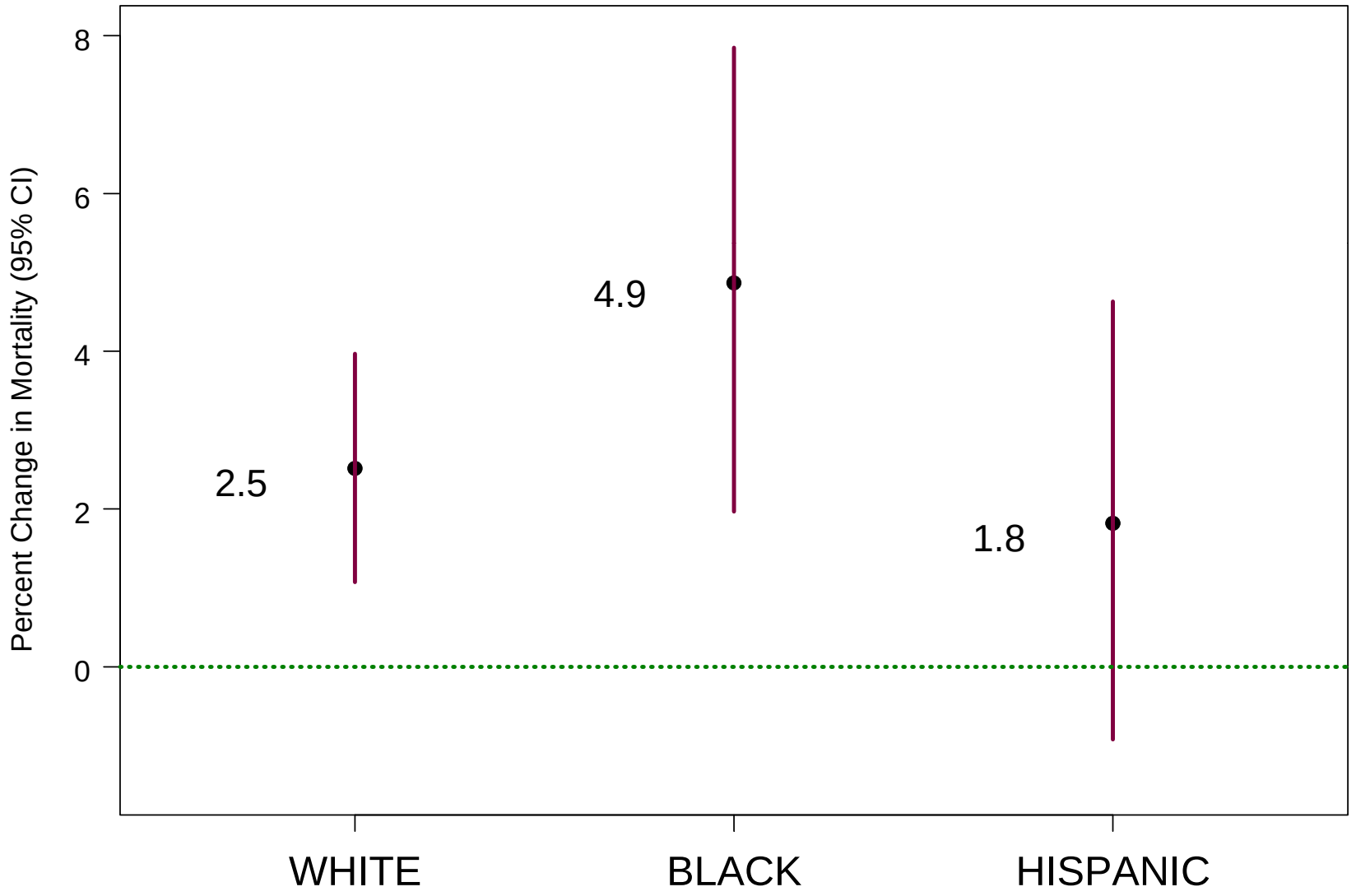
Apparent Temperature per 10ºF and Disease-Specific Mortality



Apparent Temperature per 10ºF and All-cause Mortality by Age Group



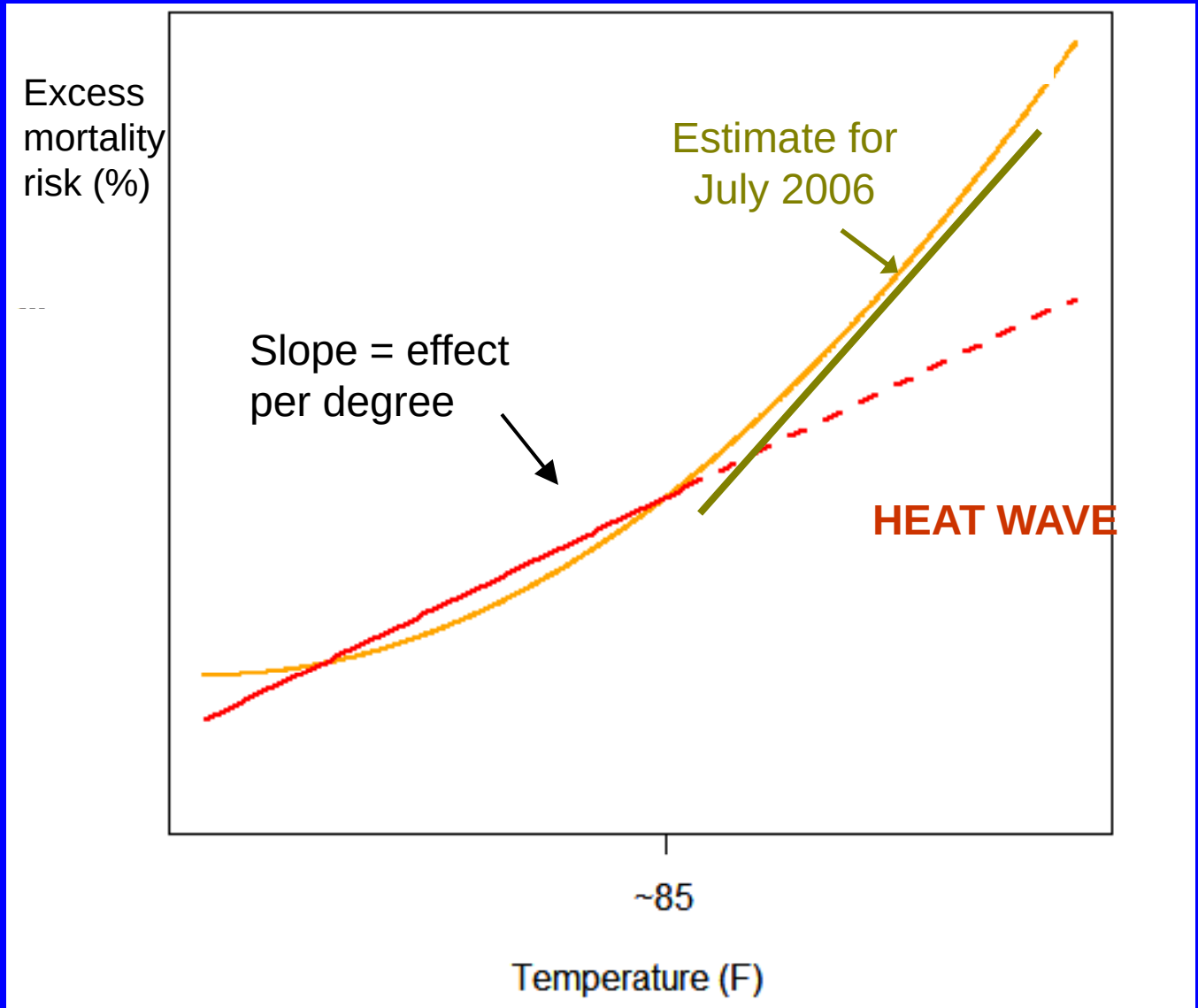
Apparent Temperature per 10ºF and All-cause Mortality by Race



Summary

- Mortality effect of apparent temperature is immediate
- 2.3% increase in nonaccidental mortality associated with 10°F increase apparent temperature
- Case-crossover and time-series estimates similar
- Temperature effect appears independent of air pollutants
- Increased risk especially found for cardiovascular mortality, elderly, and young children and infants; modified by race/ethnic group
- Heat wave not necessary to find a temperature-mortality association in California

Mortality effect per degree likely to be higher during heat wave periods



CA July 2006 Heat Wave Study

- Included counties with at least 5 reported deaths: Fresno, Imperial, Los Angeles, Kern, Merced, Sacramento and San Bernardino
- Estimated effect of apparent temperature on death
- Used this estimate to calculate expected number of deaths

Results of Heat Wave Study

- Effects on death/degree are ~4 times greater than non-heat wave study
- Estimated number of deaths during the heat wave of 2006 may be 1.5-3 times larger than coroner reports (147)

Articles Published in Peer-Reviewed Journals

- **Basu R, Ostro BD. A Case-Crossover Analysis Identifying the Vulnerable Populations for Mortality Associated with Temperature Exposure in California. *American Journal of Epidemiology 168*(*6*):*632-7, 2008*.**

- **Basu R, Feng W-Y, Ostro BD. Characterizing Temperature and Mortality in Nine California Counties, 1999-2003. *Epidemiology,* 19(1):138-45, 2008.**

- **Ostro BD, Roth L, Green S, Basu R. Estimating the Mortality Effect of the July 2006 California Heat Wave. *Environmental Research*, 109(5):614-9, 2009.**

Summary of Hospitalization Study

- Mean apparent temperature associated with multiple causes of hospital admissions in California during the warm season:
  - Respiratory associations
  - Ischemic stroke
  - Diabetes
  - GI disease
  - Dehydration
  - Heat stroke
  - Acute renal failure
- Associations valid even after controlling for air pollution

Future Studies

1. Effects of temperature increases and heat wave on emergency room visits
2. Hospital visits and air conditioning use summarized by climate zone
3. Adverse birth outcomes
4. Harvesting/mortality displacement
5. Development of indicators for heat warnings
6. Personal monitoring for individuals

Thank you for your attention! ☺