BROWN
School of Public Health

Reducing Morbidity and Mortality due to Extreme Heat

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Background

- Very large studies demonstrate:
  - Extreme heat is associated with higher rates of death and hospitalization
  - Moderate heat is associated with higher rates of death and probably with hospitalization
  - Vulnerability varies by personal, housing, and community characteristics
  - The US has already warmed and is projected to warm further through the end of the century

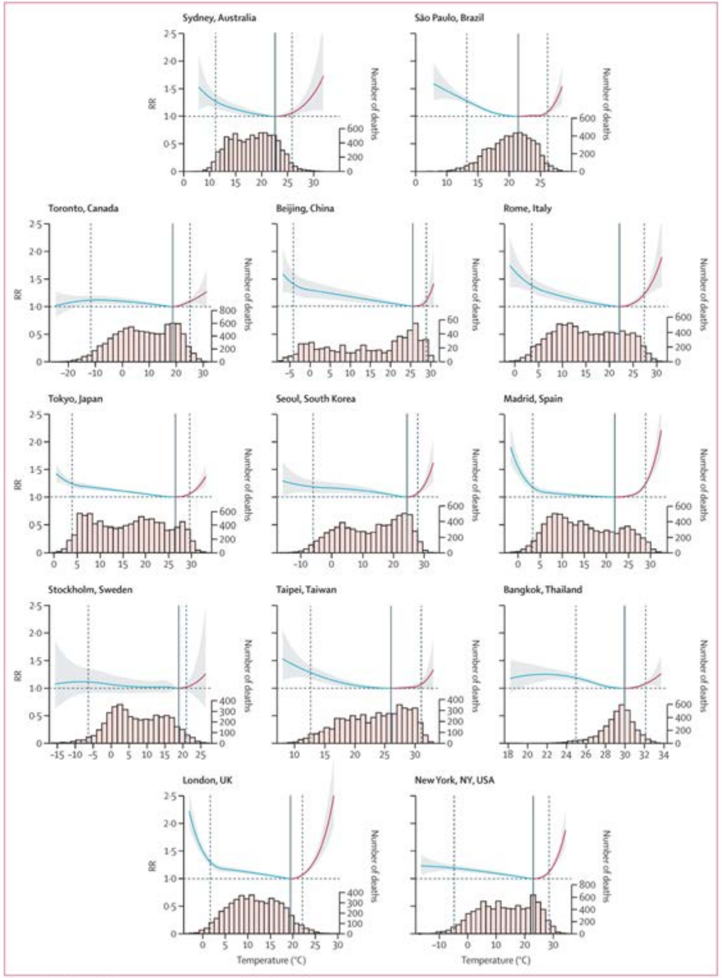
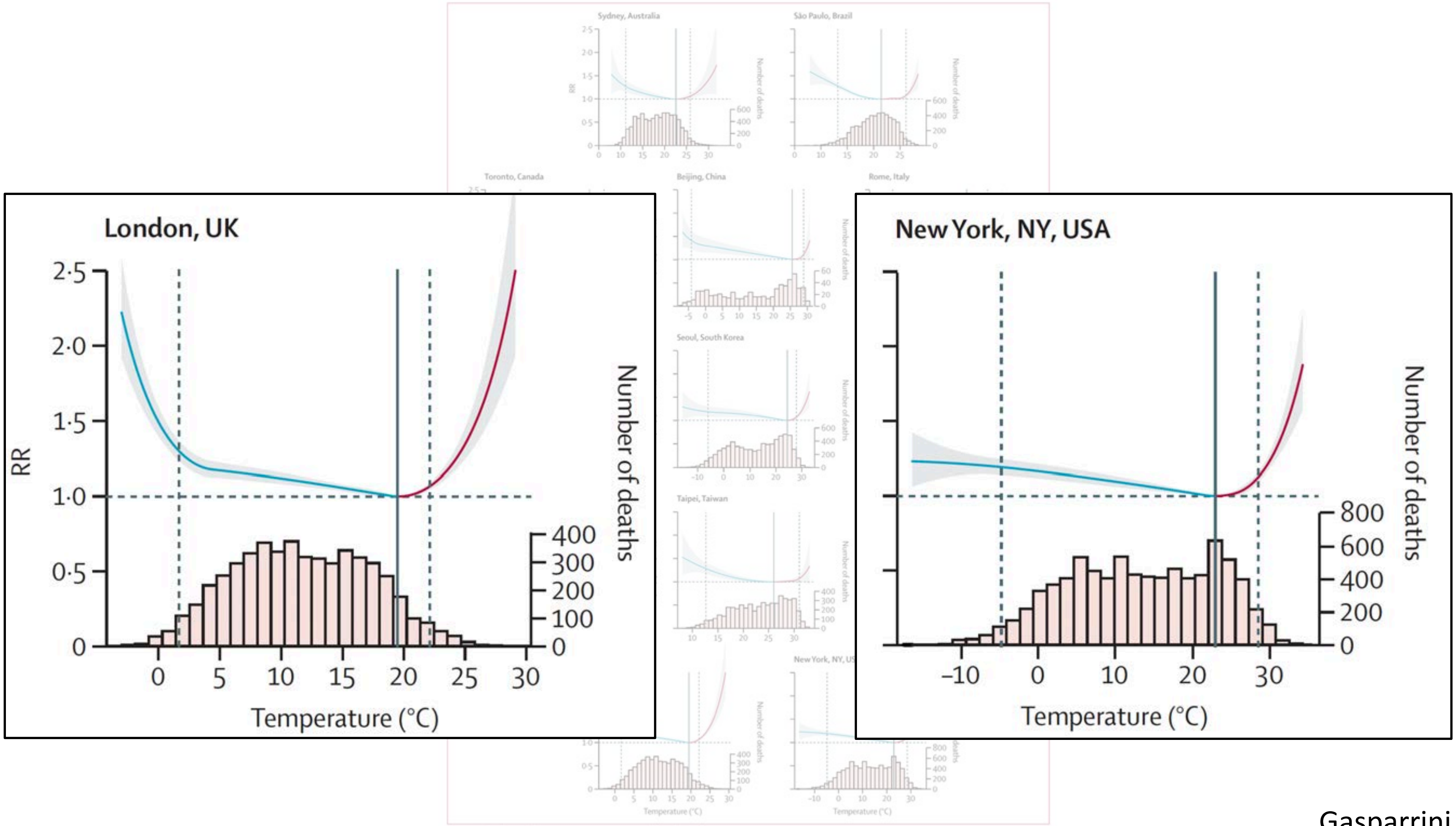


Figure 1: **Overall cumulative exposure–response associations in 13 cities**

Exposure–response associations as best linear unbiased prediction (with 95% empirical CI, shaded grey) in representative cities of the 13 countries, with related temperature distributions. Solid grey lines are minimum mortality temperatures and dashed grey lines are the 2·5th and 97·5th percentiles. RR=relative risk.

Gasparrini et al.
Lancet, 2015



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Challenge in US

- Excess heat is a recognized threat to public health
- Despite some gains, a substantial number of people die from heat each year
  - In the US, more people reportedly die of extreme heat each year than of any other meteorologic event
- This suggests the need for greater translation of scientific knowledge into public health action

What Policy-Makers Need to Know

- Local public health and emergency preparedness officials need to know:
  - Locally, what is the current health risk associated with heat?
  - What local actions can be taken to protect public health?
  - Do these actions actually reduce risk?
  - How is this local risk likely to change in the future?

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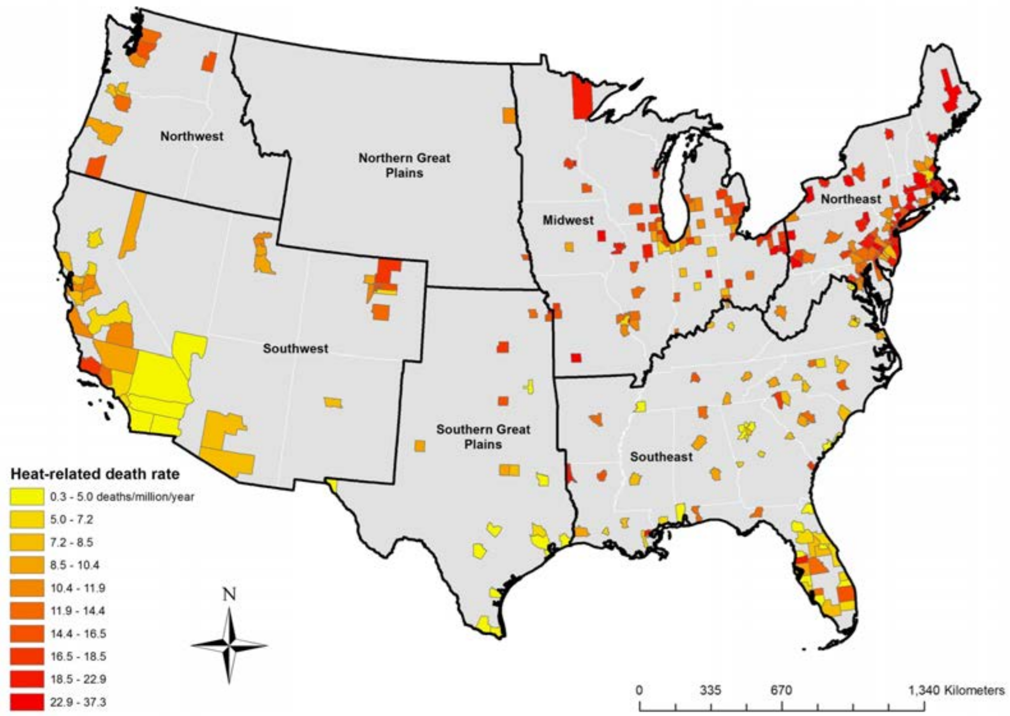
Excess Deaths/Year Attributable to Heat

Counties	297
Total Population in 2000	174,235,013
Deaths Attributable to Moderate Heat	3094 (2420, 3689)
Deaths Attributable to Extreme Heat	2218 (1985, 2379)
Total Deaths Attributable to Heat	5313 (4502, 5972)

Source: Kate Weinberger, unpublished

Excess Deaths/Year Attributable to Extreme Heat* per Million People in 297 US counties



* Defined as temperatures > 97.5th percentile of the county-specific distribution

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Public Health Response to Extreme Heat

- In the US, the National Weather Service (NWS) issues heat advisories and warnings when the heat index (HI) is forecast to be “high”
  - Warnings provide information the public can take to protect their health
  - Warnings may trigger activation of local heat response plans
  - Optimal thresholds for issuing heat advisories or warnings unknown

Research

Summer Heat and Mortality in New York City: How Hot Is Too Hot?

Kristina B. Metzger,[1] Kazuhiko Ito,[2] and Thomas D. Matte[1]

[1]Bureau of Environmental Surveillance and Policy, New York City Department of Health and Mental Hygiene, New York, New York, USA; [2]Department of Environmental Medicine, New York University School of Medicine, New York, New York, USA

BACKGROUND: To assess the public health risk of heat waves and to set criteria for alerts for excessive heat, various meteorologic metrics and models are used in different jurisdictions, generally without systematic comparisons of alternatives. We report such an analysis for New York City that compared maximum heat index with alternative metrics in models to predict daily variation in warm-season natural-cause mortality from 1997 through 2006.

MATERIALS AND METHODS: We used Poisson time-series generalized linear models and generalized additive models to estimate weather–mortality relationships using various metrics, lag and averaging times, and functional forms and compared model fit.

RESULTS: A model that included cubic functions of maximum heat index on the same and each of the previous 3 days provided the best fit, better than models using maximum, minimum, or average temperature, or spatial synoptic classification (SSC) of weather type. We found that goodness of fit and maximum heat index–mortality functions were similar using parametric and nonparametric models. Same-day maximum heat index was linearly related to mortality risk across its range. The slopes at lags of 1, 2, and 3 days were flat across moderate values but increased sharply between maximum heat index of 95°F and 100°F (35–38°C). SSC or other meteorologic variables added to the maximum heat index model moderately improved goodness of fit, with slightly attenuated maximum heat index–mortality functions.

CONCLUSIONS: In New York City, maximum heat index performed similarly to alternative and more complex metrics in estimating mortality risk during hot weather. The linear relationship supports issuing heat alerts in New York City when the heat index is forecast to exceed approximately 95–100°F. Periodic city-specific analyses using recent data are recommended to evaluate public health risks from extreme heat.

Metzger et al. *EHP.* 2010

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MATERIALS AND MET
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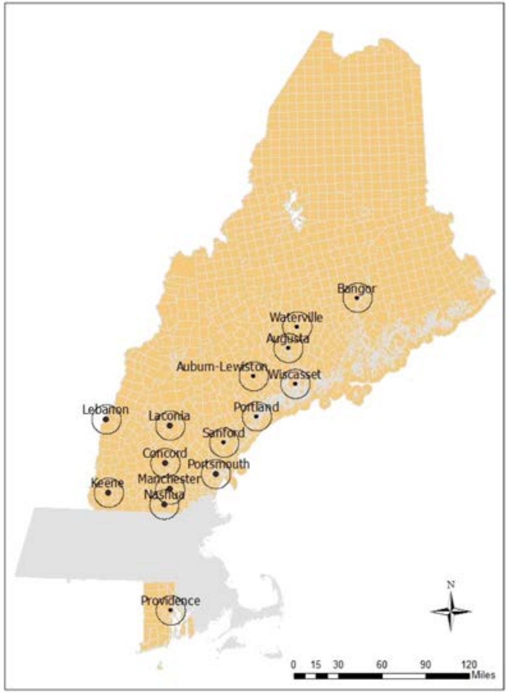
Health Risks Associated with Moderate and Extreme Heat in New England

- Partnered with public health agencies in Rhode Island, New Hampshire and Maine
- Engaged regional offices of National Weather Service
- Research targeted to providing locally actionable evidence



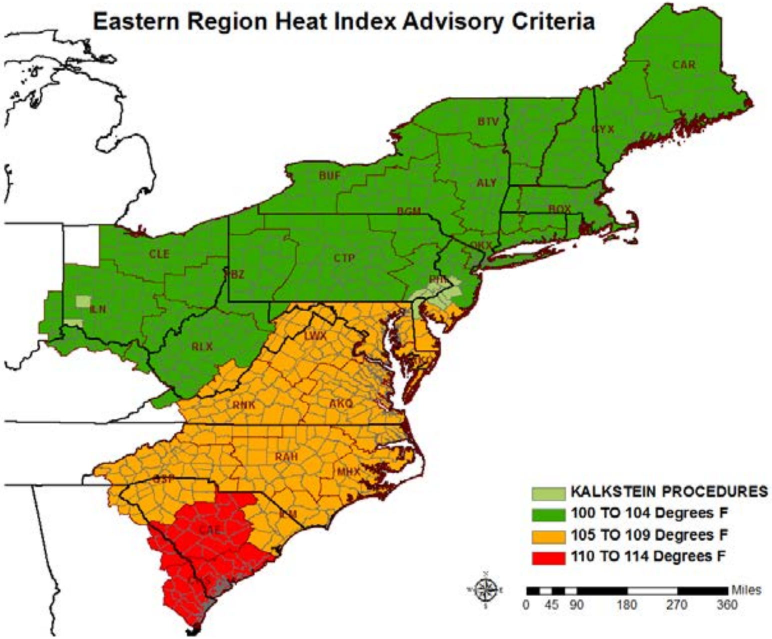
Wellenius et al. *Environ Res.* 2017

Annual Excess ED Visits and Deaths Attributable Days At or Above a Given Maximum Heat Index

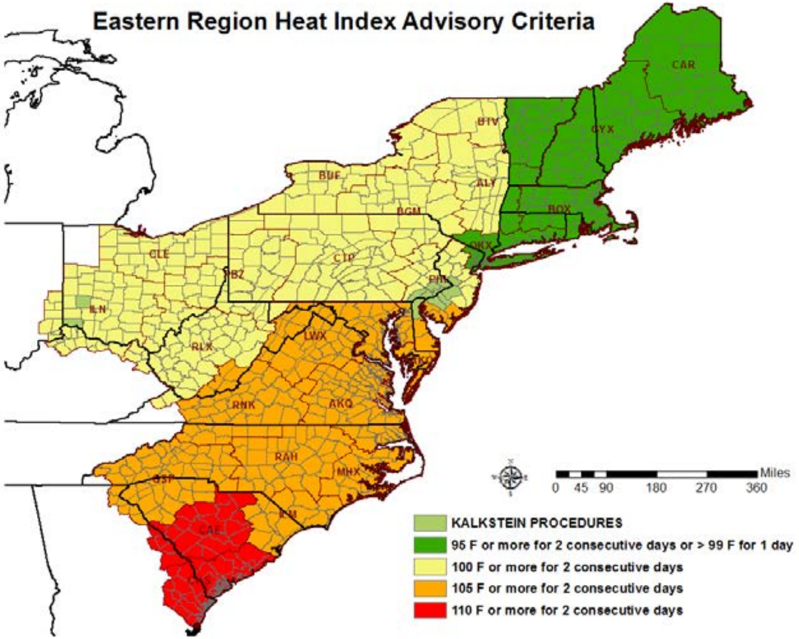
Maximum Daily Heat Index (°F)	All-Cause ED Visits		All-Cause Deaths	
	Same Day (Lag 0)	Cumulative Effect over Next 7 days (Lag 0-7 days)	Same Day (Lag 0)	Cumulative Effect over Next 7 days (Lag 0-7 days)
90	694 (539,849)	2127 (1863, 2391)	26 (2, 64)	36 (0.3, 70)
95	197 (127,268)	784 (658, 908)	12 (-1, 30)	22 (3, 39)
100	39 (16, 62)	232 (187, 277)	4 (-1, 9)	8 (2, 14)

Towards Evidence-Based Policy

Summer 2016



Summer 2017



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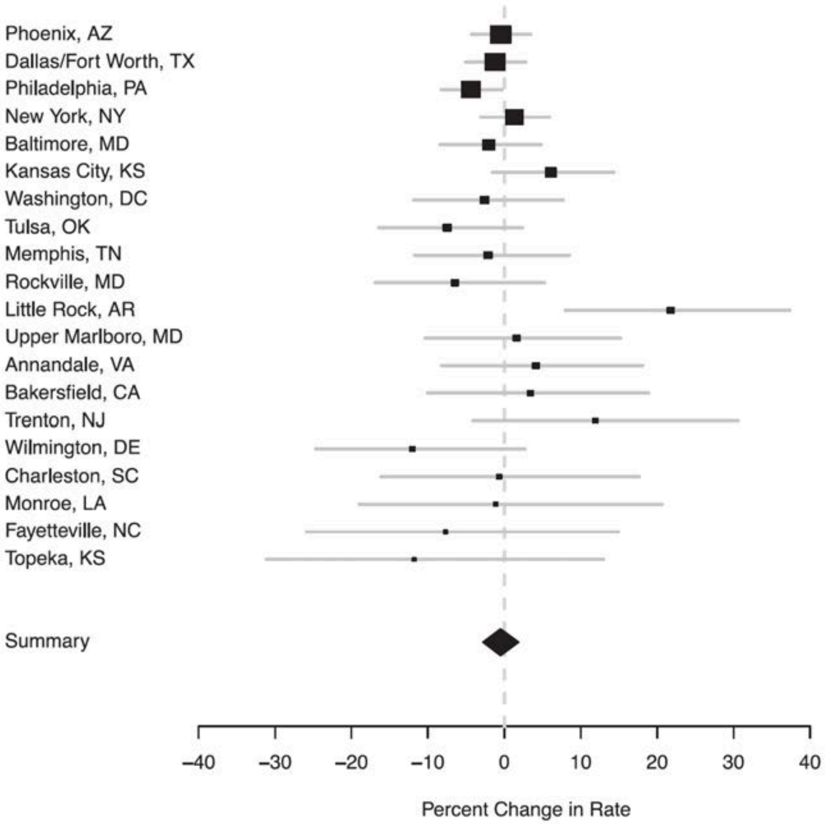
But Are NWS Heat Warnings Effective?

- Local health departments are initiating conversations with NWS about changing the thresholds for issuing heat warnings
- Assumes issuing heat advisories/warnings reduces heat-related morbidity and mortality
- Few studies have evaluated this question

Do Heat Warnings Reduce Mortality?

- Heat warnings are issued based on forecast heat index (HI),
  - But forecasts can be wrong
  - Heat warnings are issued by people
- There should be a set of days with similar HI, with and without heat warnings
- On days of similar HI, is the rate of death lower if a heat warning is issued?

Percent Change in Rate of Death on Days With versus Without a Heat Warning, 2001-2006



Philadelphia: -4.4% (-8.3, -0.3)
NYC: 1.3% (-3.1, 5.9)

Summary: -0.5% (-2.9, 2.0)

Weinberger et al. *Environ Int.* 2018

Association Between Heat Alerts and Mortality in 9 Northeastern Cities

2001-2006:

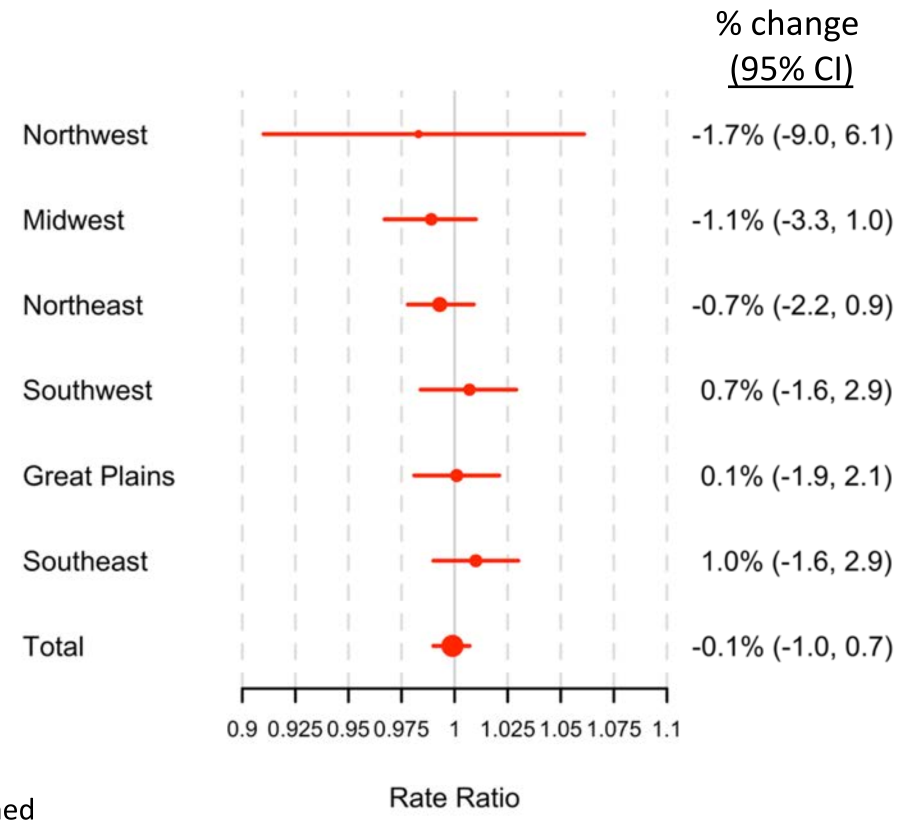
-0.9% (95% CI: -3.7, 2.0)

2007-2012:

-3.0% (95% CI: -5.8, -0.1)*

Source: Kate Weinberger, unpublished

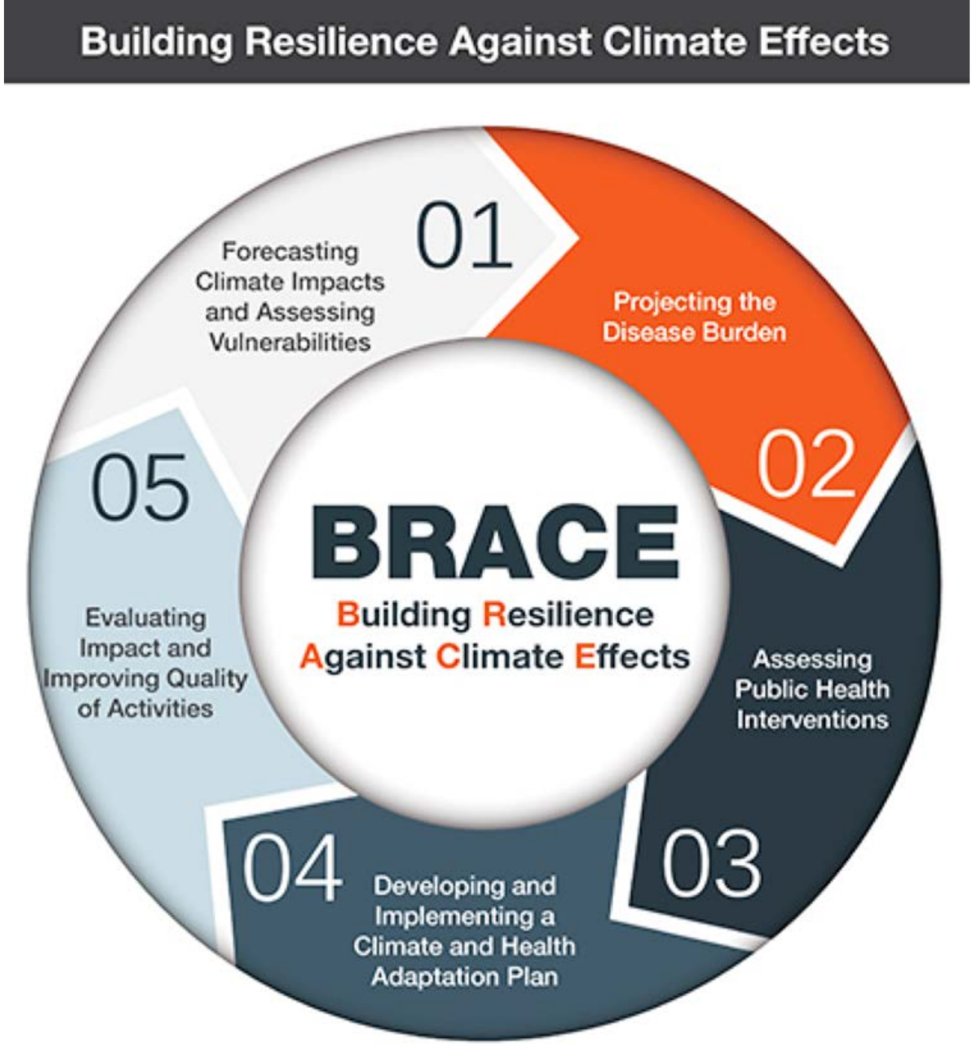
Heat Alerts and Emergency Hospitalizations among the Elderly in 97 Counties, 2007-2012



Source: Kate Weinberger, unpublished

Unanswered Questions

- Locally, what are the optimal criteria for issuing heat warnings?
- What actions should individuals or local government agencies take to protect people from heat?
- How well do these interventions work?
- Repeat



Hazard Mitigation Framework

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