Impact of Heat Index on Emergency Department Visits and Deaths in the Northeast: A Regional Collaborative Study

Rebecca Lincoln, Sc.D.
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Background & Motivation

- Extreme heat is a major public health threat
- No research on heat/health for the Northeast/New England region...
  - but the region might be vulnerable
    - Aging population
    - Rural
    - Limited adaptation (AC)
• A recent study of New York City showed heat effects on mortality even below NWS advisory thresholds

• Time-series model with terms for same-day and lagged-day effects

• Results were used by NWS to lower NYC’s heat advisory threshold from 100°F to 95°F

Metzger et al. 2010. 118:80-86.
### Current Heat Product Thresholds

<table>
<thead>
<tr>
<th>Product</th>
<th>Heat Index</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Northeast Region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advisory</td>
<td>100-104°F</td>
<td>2 or more hours</td>
</tr>
<tr>
<td>Excessive Heat Warning</td>
<td>≥105°F</td>
<td>2 or more hours</td>
</tr>
<tr>
<td><strong>New York City Region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advisory</td>
<td>≥95°F</td>
<td>2 or more days</td>
</tr>
<tr>
<td>Excessive Heat Warning</td>
<td>≥100°F</td>
<td>Any exceedance</td>
</tr>
</tbody>
</table>
Background & Motivation: Maine

Hot days and Heat Illness ED Visits

Days > Heat Index 95

ED visits for heat illness

2001 2002 2003 2004 2005 2006 2007 2008 2009
Regional Working Group: Northeast Regional Heat Collaborative

- Northeastern states (ME, NH, RI, VT) with corresponding grants began collaborating to assess regional heat effects
- Similar goals and questions, similar populations
- Collaboration on methods, code, model selection, etc.
- Separate analyses to maintain data privacy policies
Project Goals

1. Evaluate the association between maximum daily heat index and daily emergency department (ED) visits & death in the Northeast (ME-NH-RI)

2. Use this evidence to evaluate thresholds for Excessive Heat Advisories and Warnings

3. Inform public health action in response to extreme heat events at the local level
Data

• Study Period
  – May 1-September 30

• Study Area
  – All towns within 10 miles of a NOAA 1st order weather station (7 stations in ME, NH), and all of RI
  – Population included 60% of ME, 66% of NH, 100% of RI
Data

- **Exposure**
  - Daily maximum heat index (calculated from hourly NWS monitor data)

- **Outcome**
  - Rates of daily all-cause ED visits
  - Rates of daily heat-related illness ED visits
  - Rates of daily all-cause mortality
Time Series Analysis

- Standard method for this type of exposure/outcome
- Controls for long-term and seasonal trends in health outcomes
Time-Series Methods

• Time-series regression analysis:
  – Overdispersed Poisson Regression
  – Distributed Lag Non-linear Model (R Package: DLNM)
  – Modeled non-linear effects of heat on the same day (Lag Day 0) and across the following 7 days (Cumulative 7-Day Lag)
  – Controlled for long-term time trends, day of week, and federal holidays

• Location-specific results were pooled using meta-analysis methods to provide state-level and regional summary estimates
Results: ED Visits (Same-Day)

- Risk of same-day ED visit (any cause) increases significantly with increasing heat index.

- Risk increases by **2.4%** (95% CI: 1.9-2.9) on days with max HI of 95°F (as compared to 75°F).
Results: ED Visits (7-Day Cumulative)

- Cumulative risk, over a 7-day lag, is greater than risk on the same day.
- Risk increases by **6.6%** (95% CI: 5.5-7.6) on days with max HI of 95°F (as compared to 75°F)
Results: ED Visits (7-Day Cumulative)

Risk of all-cause ED visit on a day with a maximum heat index of 95°F as compared to 75°F, by location
Results: Heat-Related ED Visits (Same-Day)

- Risk of heat-related ED visit is much larger

- Risk increases by 59% (95% CI: 51-67) on days with max HI of 95°F (as compared to 75°F)
Results: Heat-Related ED Visits (7-Day Cumulative)

- Cumulative effects are even stronger
- Risk increases by **89%** (95% CI: 78-100) on days with max HI of 95°F (as compared to 75°F)
Results: Deaths (Same-Day)

- Risk increases by 7.4% (95% CI: 3.3, 11.8) on days with max HI of 95°F (as compared to 75°F)
Results: Deaths (Same Day, by Location)

Risk of all-cause death on a day with a maximum heat index of 95°F as compared to 75°F, by location
Results: Deaths (7-Day Cumulative)

- Risk increases by 3.6% (95% CI: -1.0, 8.4) on days with max HI of 95°F (as compared to 75°F)

- Increase is not statistically significant
Summary and Conclusions

• Higher daily heat indices in ME/NH/RI are associated with significantly higher rates of morbidity and mortality

• For a day when the max heat index was 95°F (as compared to 75°F):
  – All-cause ED visits ↑ 2% on the same day; ↑ 7% over a week
  – Heat-related ED visits ↑ 59% on the same day; ↑ 89% over a week
  – Deaths ↑ 7% on the same day

• Effects occurred at levels below the current NWS thresholds
Acknowledgements

• Maine Center for Disease Control
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  – Katie Bush
  – Dennis Holt

• Rhode Island Department of Health
  – Julia Gold

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  – Greg Wellenius
  – Melissa Eliot

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Questions?

Rebecca Lincoln, Sc.D.
Toxicologist
rebecca.lincoln@maine.gov
207-287-6445
Results from a previous study: Rates of hospitalizations for various causes on “hot” days (at least 85F heat index; top 5% of the climate normal for that date) as compared to all other (“not hot”) days
# Summary of Weather and Health Outcome Variables

<table>
<thead>
<tr>
<th></th>
<th>Portland, ME</th>
<th>Manchester, NH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Median</td>
</tr>
<tr>
<td>Daily maximum HI (F)</td>
<td>44.6</td>
<td>73.2</td>
</tr>
<tr>
<td>Daily all-cause deaths</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Daily heat-related ED visits</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Daily all-cause ED visits</td>
<td>191</td>
<td>268</td>
</tr>
</tbody>
</table>
Results: Effect of Heat on Deaths By Lag Day

Risk of All-Cause Deaths by Lag in ME, NH, and RI at 95°F Compared to 75°F
## Risk at Various Thresholds: A Balancing Act?

<table>
<thead>
<tr>
<th>Study Area</th>
<th>Heat Index Threshold</th>
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<tbody>
<tr>
<td></td>
<td>95°F</td>
</tr>
<tr>
<td><strong>Days per Year</strong></td>
<td></td>
</tr>
<tr>
<td>Portland, ME</td>
<td>3</td>
</tr>
<tr>
<td>Sanford, ME</td>
<td>6</td>
</tr>
<tr>
<td>Nashua, NH</td>
<td>9</td>
</tr>
<tr>
<td>Manchester, NH</td>
<td>4</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>2</td>
</tr>
<tr>
<td><strong>Percent Change in Regional Risk</strong></td>
<td></td>
</tr>
<tr>
<td>All-cause ED visits (Lag 0-7)</td>
<td>6.6</td>
</tr>
<tr>
<td>Heat-specific ED visits (Lag 0-7)</td>
<td>88.5</td>
</tr>
<tr>
<td>All-cause Mortality (Lag 0)</td>
<td>7.1</td>
</tr>
</tbody>
</table>