Heat-Related Illness in North Carolina: Who’s at Risk?

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Why Heat?

- The #1 weather-related killer (~700 deaths annually across the US; more than from floods, lightning, tornadoes, and hurricanes combined)

- Heat stroke is deadly; mortality rates exceed 80%; about 15% of those who survive heat stroke suffer impairments to the nervous, renal, or respiratory system

- Heat-related illness is entirely preventable with access to air conditioning and aggressive public health messaging and education

- Many locations (including NC) are expected to see an increase in temperature and in the intensity, frequency, and duration of extreme heat events due to climate change
Heat-Health Research and Activities in NC

- A set of collaborative projects focused on the prevention of heat-related morbidity in North Carolina by reducing vulnerability

- Vulnerability = sensitivity, exposure, coping capacity

- Reducing vulnerability involves

  - *an understanding of intrinsic sensitivities (identifying and mapping at-risk groups and communities)*
  
  - *accurate and timely prediction of exposure (heat advisories and warnings)*
  
  - *building adaptive capacity (strategic planning, response plans)*
North Carolina Disease Event Tracking and Epidemiologic Tool (NC DETECT)

Follows a state-wide mandate for near-real time ED data
Rate of ED visits (per capita) for HRI by county from 2007 to 2008

Total Visits:
Urban 1186
Rural 1404 (+218)

Annual Visit Rate (per 100,000):
Urban 13.0
Rural 15.6 (+2.6)

Age distribution of per capita ED visits for HRI between urban and rural counties.
Possible at-risk groups

Agricultural workers*

*NC accounts for 57% of all US heat-related deaths among crop workers from 1992-2006

Young Athletes
Socioeconomic Indicators of Heat-Related Morbidity in North Carolina

- Examines the statistical relationships between HRI ED visits and various socio-economic and land cover variables
- Analysis conducted by region and climate division
- Socio-economic data retrieved from the American Community Survey (2006-2010); land cover and cropland variables retrieved from the 2008 National Land Cover database
- Relationships evaluated using Pearson correlations and regression analyses (GWR and stepwise regression)
<table>
<thead>
<tr>
<th>2006 – 2010 ACS 5 Year Estimates</th>
<th>Potential Relationship to HRI</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic: (Age, Race, Gender)</td>
<td>Populations most vulnerable to heat</td>
<td>Harlan et al. (2006); Chow et al. (2011); Kilbourne (1997); Knowlton et al. (2009)</td>
</tr>
<tr>
<td>Socioeconomic: (Nativity, Educational Attainment, Household Income, Population movement)</td>
<td>Agricultural workers/social isolation, Wealth or poverty</td>
<td>Fouilett et al. (2006); Chow et al. (2011); Klinenberg (2002); Semenza et al. (1999),</td>
</tr>
<tr>
<td>Built Environment: (Median year home built, Mobile Home Density)</td>
<td>Wealth or poverty/Social isolation/Rural or Urban</td>
<td>Meehl &amp; Tebaldi (2004)</td>
</tr>
<tr>
<td>National Land Cover Database (2008)</td>
<td>Potential Relationship to HRI</td>
<td>Literature</td>
</tr>
<tr>
<td>Built Environment: (Developed Land)</td>
<td>Rural or Urban/Geographic Locations</td>
<td>Ruddell et al. (2009); Buyantuyev and Wu (2009); Oke (1997)</td>
</tr>
<tr>
<td>Cultivated Crops: 30 total crops (e.g. tobacco, corn, apples, oats, peanuts)</td>
<td>Agriculture workers/Microclimate of fields</td>
<td>Ruddell et al. (2009); Buyantuyev and Wu (2009); Oke (1997)</td>
</tr>
<tr>
<td>Vegetation: Deciduous, Evergreen Forest</td>
<td>Cooling potential/Rural areas</td>
<td>Ruddell et al. (2009); Buyantuyev and Wu (2009); Oke (1997)</td>
</tr>
</tbody>
</table>
Where is HRI geographically located?

<table>
<thead>
<tr>
<th>Variables</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Land</td>
<td>-0.40</td>
</tr>
<tr>
<td>Evergreen Land</td>
<td>0.38</td>
</tr>
<tr>
<td>Cropland</td>
<td>0.34</td>
</tr>
</tbody>
</table>

*p-values < 0.05

Rural populations of North Carolina are at increased rates for heat related illness compared to urban populations.
Crops and Heat Stress
Is poverty associated with increased HRI?

<table>
<thead>
<tr>
<th>Variables</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Homes</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Are specific populations at greater risk HRI?

<table>
<thead>
<tr>
<th>Variables</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop over 65</td>
<td>0.02</td>
</tr>
<tr>
<td>Pop over 85</td>
<td>-0.08</td>
</tr>
<tr>
<td>Foreign Born</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

*p-values < 0.05
North Carolina State Emergency Response Team (SERT)

Tactical Heat Emergency Response Plan

North Carolina Division of Public Health

North Carolina Division of Emergency Management
## NC Heat Plan Response Trigger Guide

State Emergency Response Team determines status for each state / county / division based on judgment.

State Emergency Response Team deploys available resources through ICS.

Communicate response status to State Emergency Operations Center and agree priorities for critical resources.

<table>
<thead>
<tr>
<th>NWS Trigger Level</th>
<th>State Actions</th>
<th>County Actions</th>
</tr>
</thead>
</table>
| Heat Advisory       | • Outreach to local health agencies  
                      • Outreach to local emergency mgrs.  
                      • ID locations of vulnerable populations | • Review local emergency heat response plan  
                      • Notify all responsible emergency heat response plan agencies  
                      • Identify locations of vulnerable populations  
                      • Prepare cooling centers  
                      • Contact Operation Fan/Heat Relief  
                      • Execute outreach to public |
| Excessive Heat Watch| • State Emergency Operations Center Activated @ Level 3  
                      • Outreach to public from Joint Information Center  
                      • Public Health Coordinating Center Activated  
                      • Public Health Preparedness Offices Alerted  
                      • Governor’s Hotline Activated | In Addition to Heat Advisory  
                      • Possible county emergency operations center activation  
                      • Initiate cooling center plan  
                      • Initiate fan distribution plan |
| Excessive Heat Warning| • Request Emergency Declaration from Governor’s Office  
                           • Public Health executes risk assessments & performs predictive modeling | In Addition to Heat Watch  
                           • Continue to manage emergency heat response and be prepared to escalate as required |

- Goal is to evaluate the effectiveness of the heat advisory and warning thresholds used by NWS Raleigh in accounting for summer heat morbidity.

- Following the methods of Dixon (1999), will investigate alternative thresholds by creating a cost-benefit ratio whereby the benefit of lowered morbidity is compared to the cost of increased issuance of advisories and warnings.
Heat-Related Products from the National Weather Service

- **Heat Advisory** – issued when the heat index is expected to reach between 105-109 degF for 2 or more hours OR is expected to reach between 102-105 degF for 3 or more consecutive days

- **Excessive Heat Warning** – issued when the heat index is expected to reach 110 degF or higher for any duration (considered a “dangerous situation”)
### Raleigh NWS Heat Products and HRI ED Visits (Primary and Secondary) in the Raleigh NWS County Warning Area (JJA, 2007-2010)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sum</th>
<th>Daily Avg</th>
<th>Max</th>
<th>Min</th>
<th>% of ED Visits</th>
<th>% of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI Below 100°F</td>
<td>1502</td>
<td>5.7</td>
<td>22</td>
<td>0</td>
<td>40.5</td>
<td>77.2</td>
</tr>
<tr>
<td>At least 100°F but below HA</td>
<td>854</td>
<td>11.7</td>
<td>39</td>
<td>3</td>
<td>23.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Heat Advisory*</td>
<td>1043</td>
<td>26.7</td>
<td>54</td>
<td>4</td>
<td>28.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Excessive Heat Warning**</td>
<td>313</td>
<td>46.6</td>
<td>69</td>
<td>25</td>
<td>8.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>3712</td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*No Advisories issued JJA 2009
**No Warnings issued JJA 2008 and 2009
Summary and Recommendations

- Rural populations in NC may be most at-risk for HRI
  - Strong relationship with cropland/agriculture, but no relationship with minority populations
  - Strong relationship with mobile homes

- Recreational heat stress is prevalent across NC, particularly with organized/interscholastic sports

- Heat wave versus non-heat wave morbidity
  - Are at-risk groups the same?
  - How does this affect our response plans?
  - Research need: Long-term exposure to increasing temperatures versus short-term exposure to extreme temperatures

- Consider other public health consequences of heat: violence, depression, suicide, alcohol/drug use, productivity
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- NC Division of Public Health
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