Extreme Heat Events and Health Risk Patterns in Urban and Rural Communities

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Rationale for community-engaged research in the Deep South

• Previously identified vulnerability factor rates are high in Deep South.
• Historically based mistrust of government and medical authorities.
• Disaster-prone region.
• Minimal state or local government climate change adaptation planning.
Rural Health Challenges

Compared with their urban counterparts, residents of rural areas:

– Report fair or poor health.
– More often have chronic conditions such as diabetes.
– Die from heart disease.

Rural residents have fewer visits to health care providers and are less likely to receive recommended preventive services.

Rural minorities appear to be particularly disadvantaged, and differences are observed in cancer screening, management of cardiovascular disease and diabetes, and mental health.
Heat-related illnesses and rurality

ADPH, 2012
Are urban and rural communities different?

Establish environmental health priorities in underserved urban and rural communities

Health outcomes associated with extreme heat events
1990-2010 birth/death records analysis

Pilot community research to determine individual level exposures
Determining environmental health priorities in urban and rural communities

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Aims:
1. To determine the positive attributes of their communities.
2. To determine how the communities define the term environment.
3. To understand how views in urban vs. rural communities differ regarding environmental health issues.

Methods:
• A total of 8 focus groups were conducted.
• Participants identified environmental priorities through open discussion and then prioritized based on a pre-made list of environmental issues.
### Study Populations

#### Summary of Rural and Urban Demographics

<table>
<thead>
<tr>
<th></th>
<th>Camden, AL</th>
<th>Birmingham, AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Median Age</td>
<td>52</td>
<td>56</td>
</tr>
<tr>
<td>% Female</td>
<td>80.0</td>
<td>72.7</td>
</tr>
<tr>
<td>% Black or African American</td>
<td>97.5</td>
<td>84.8</td>
</tr>
<tr>
<td>%Some College Courses or Associate's Degree</td>
<td>32.5</td>
<td>42.4</td>
</tr>
<tr>
<td>% Income Less than $20,000</td>
<td>50.0</td>
<td>48.5</td>
</tr>
</tbody>
</table>

Bernhard et al. 2013 *Public Health* 127(11)
**Aim 1:** Determine the Positive Attributes of their Communities

- **Urban**
  - Location convenience (7,3)
  - Community Involvement (6,3)

- **Rural**
  - Quiet: (4,2), (14,4)
  - Family-oriented: (4,3), (11,4)
  - Friendly people: (13,4), (2,1)
  - Outdoors (4,3)
  - Low crime (2,1)

**Aim 2:** Determine how the communities define the term environment

- There were no clear differences
- Physical environment (Rural N=16, Urban N=15)
- Social environment (Rural N=7, Urban N=6)
- Both physical and social environment (Rural N=6, Urban N=8)

Bernhard et al. 2013 *Public Health* 127(11)
Priorities are built environment and industrial pollution

Urban Environmental Priorities

- Abandoned Houses
- Litter
- Burning Houses/Overgrown Lots
- Dumping & Garbage
- Garbage Piling Up
- Sewer Issues
- Unsafe Draining Water
- Air Pollution: Cars
- Air Pollution: Plants
- Dangerous Chemicals in Soil
- Summer Heat
- Tornadoes & Other Natural Disasters
- Crimes
- Speeding
- No Community Places for Seniors, Kids, Groceries
- Noise
- Noise
- Drugs
- Drugs
- Strays
- Strays
- Rats, Snakes, Other Pests
- Molds

Rural Environmental Priorities

- Litter
- Garbage and Dumping
- Landfills/Dumps
- Unsafe Draining Water
- Fertilizer
- Fertilizer
- Pollution in Local Streams & Lakes
- Dangerous Chemicals in Soil
- Summer Heat
- Tornadoes & Other Natural Disasters
- Road Maintenance, Logging Trucks
- TOQ Too Much Traffic
- Flooding
- Graffiti
- Youth Need Curfew & Place to Play
- Insufficient Fire Dept., Trucks, Hydrants
- Papermill: Lack Regulations Enforcement & Workplace Safety
- Toxic Waste
- No Water Access - Wells Dry
- Unclean Drinking Water Taste, Smell, Chlorine
- Septic Tanks Leakage and Improper Sewage Control

Color: Category
- Transportation
- Weather/Geology
- Built Environment
- Waste & Emissions
- Pests
- Other

Shape: Discussion/List
- Discussion
- List

Bernhard et al. 2013 *Public Health* 127(11)
Alabama birth and death record analysis (1990-2010)

Time-stratified case-crossover design

**Responses:**
- Non-accidental mortality (ICD-9 code<800 and ICD-10 codes A-R) (N=301,126)
- Preterm Birth (< 37 weeks clinical estimate of gestational age) (N=60,466 out of 543,980 live births)

**Exposure metric:**
Heat wave days at zipcode level derived from the North American Land Data Assimilation System Phase 2 (NLDAS-2), NASA
## Heat wave definitions

<table>
<thead>
<tr>
<th>Heat Wave Indices (HI)</th>
<th>Temperature Metric</th>
<th>Threshold</th>
<th>Duration</th>
<th>HI Type</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI01</td>
<td>Mean daily temperature</td>
<td>&gt;95th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
</tr>
<tr>
<td>HI02</td>
<td>Mean daily temperature</td>
<td>&gt;90th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
</tr>
<tr>
<td>HI03</td>
<td>Mean daily temperature</td>
<td>&gt;98th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
</tr>
<tr>
<td>HI04</td>
<td>Mean daily temperature</td>
<td>&gt;99th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
</tr>
<tr>
<td>HI05</td>
<td>Minimum daily temperature</td>
<td>&gt;95th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
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<tr>
<td>HI06</td>
<td>Maximum daily temperature</td>
<td>&gt;95th percentile</td>
<td>2+ consecutive days</td>
<td>Relative</td>
<td>Anderson and Bell (2011)</td>
</tr>
<tr>
<td>HI07</td>
<td>Maximum daily temperature</td>
<td>T1: &gt;81st percentile; T2: &gt;97.5th percentile</td>
<td>Everyday, &gt;T1; 3+ consecutive days, &gt;T2; Avg T_max&gt;T1 for whole time period</td>
<td>Relative</td>
<td>Peng et al. (2011); Meehl and Tebaldi (2004)</td>
</tr>
<tr>
<td>HI08</td>
<td>Maximum daily apparent temperature</td>
<td>&gt;85th percentile</td>
<td>1 day</td>
<td>Relative</td>
<td>Steadman (1984)</td>
</tr>
<tr>
<td>HI09</td>
<td>Maximum daily apparent temperature</td>
<td>&gt;90th percentile</td>
<td>1 day</td>
<td>Relative</td>
<td>Steadman (1984)</td>
</tr>
<tr>
<td>HI10</td>
<td>Maximum daily apparent temperature</td>
<td>&gt;95th percentile</td>
<td>1 day</td>
<td>Relative</td>
<td>Steadman (1984)</td>
</tr>
<tr>
<td>HI11</td>
<td>Maximum daily temperature</td>
<td>&gt;35 °C</td>
<td>1 day</td>
<td>Absolute</td>
<td>Tan et al. (2007)</td>
</tr>
<tr>
<td>HI12</td>
<td>Minimum &amp; maximum daily temperature</td>
<td>T_min&gt;26.7 °C; T_max&gt;40.6 °C</td>
<td>≥1 threshold for 2+ consecutive days</td>
<td>Absolute</td>
<td>Robinson (2001)</td>
</tr>
<tr>
<td>HI13</td>
<td>Maximum daily heat index</td>
<td>&gt;80 °F</td>
<td>1 day</td>
<td>Absolute</td>
<td>National Weather Service, Rothfusz and Scientific Services Division (1990); Steadman (1979)</td>
</tr>
<tr>
<td>HI14</td>
<td>Maximum daily heat index</td>
<td>&gt;90 °F</td>
<td>1 day</td>
<td>Absolute</td>
<td>National Weather Service, Rothfusz and Scientific Services Division (1990); Steadman (1979)</td>
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<tr>
<td>HI15</td>
<td>Maximum daily heat index</td>
<td>&gt;105 °F</td>
<td>1 day</td>
<td>Absolute</td>
<td>National Weather Service, Rothfusz and Scientific Services Division (1990); Steadman (1979)</td>
</tr>
<tr>
<td>HI16*</td>
<td>Maximum daily heat index</td>
<td>&gt;130 °F</td>
<td>1 day</td>
<td>Absolute</td>
<td>National Weather Service, Rothfusz and Scientific Services Division (1990); Steadman (1979)</td>
</tr>
</tbody>
</table>
Average number of heat wave days (1979-2011)
Temporal Trends: HWs in the SE have increased at 2X the rate of HWs in the NE

Smith et al. 2013 Climatic Change 118 (3-4)
Number of AL zip-code level avg. heat wave days per year

Kent et al. 2014 Environ Health Persp. 122 (2)
Relative, avg. and max temp heat waves are associated with increased PTB and NAD

Kent et al. 2014 *Environ Health Persp.* 122 (2)
Definitions of rurality

Figure 1 Spatial Distributions of (A) Rural–urban Commuting Area Code categories and (B) Population Density Tertiles Across Alabama.
Association between heat waves and NAD are greater in urban areas

Kent et al. 2014 Environ Health Persp. 122 (2)
How well do outdoor temperature measures reflect personal exposure?

– Are personal exposures different across the urban-rural gradient?

– Are microclimates within cities or rural communities important for determining heat exposure?
Sample of Monitor’s Output
Demographics of participants

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rural (SW Alabama)</th>
<th>Urban (Birmingham)</th>
<th>Birmingham groundskeepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>21</td>
</tr>
<tr>
<td>%Black or African-American</td>
<td>97%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Some College or Associate's Degree</td>
<td>17%</td>
<td>57%</td>
<td>38%</td>
</tr>
<tr>
<td>Income Less than $20,000</td>
<td>66%</td>
<td>47%</td>
<td>24%</td>
</tr>
<tr>
<td>% Female</td>
<td>83%</td>
<td>83%</td>
<td>14%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>50 (20-65)</td>
<td>51 (20-64)</td>
<td>50 (40-53)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>52 (25-58)</td>
<td>47 (44-62)</td>
<td>44 (24-57)</td>
</tr>
</tbody>
</table>
Personal heat exposure versus weather station data
Conclusions

• Tangible adaptation strategies that also address community priorities may be most effective.
• Heatwave definitions—relative daily mean predicts health outcomes as well as apparent temperature.
• Birth records analysis suggests premature births increase during heat waves.
• Our analysis suggests stronger NAM relationships with heat waves in urban areas.
• Personal monitors may be feasible for determining urban/rural differences in heat exposure.
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