Can Access to Health Care Mitigate the Effects of Temperature on Mortality?

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Heterogeneity in Environmental Health Damages

Studies have shown causal effects of environment on health

- **Air pollution**  Currie and Neidell (2005), Schlenker and Walker (2015)
- **Water pollution**  Ebenstein (2012), Alsan and Goldin (forthcoming)
- **Weather**  Deschenes and Greenstone (2011), Barreca et al. (2016)

Damages are heterogeneous across populations

Banzhaf, Ma and Timmins (2019)

- Larger health effects of air pollution for blacks vs. whites
  Chay and Greenstone (2003b); Currie and Walker (2011)
- Mortality effects of CO are 10x larger in Mexico vs. US
  Arceo, Hanna and Oliva (2016)
- Mortality effects of temperature are larger for poor populations  Carleton et al. (2019)
What Drives Heterogeneity in Damages?

Hsiang, Oliva and Walker (2019) note heterogeneity arises from:

1. Different levels of baseline exposure across populations combined with a non-linear damage function.

2. Different damage functions across populations.
   - Damage functions may differ for many reasons (e.g., differences in health stock or defensive investments).

Source: Hsiang, Oliva and Walker (2019)
Our Study

Environmental shocks

- **Cold** and **hot** ambient temperature exposure
  
  ▶ Temperature shocks are repeated over time, occur at any geographic scale, and are conditionally random. Deschenes and Greenstone (2011), Barreca et al. (2016), Heutel et al. (2019)
  
  ▶ Different mechanisms underly the health effects of cold vs. hot temperature. Deschenes and Moretti (2009), White (2017)

Access to health care

- Establishment of community health centers (CHCs) in the 1960s-1970s
  
    
    - Use a DiD design and find that CHC access significantly reduces general mortality rates.
Background: Community Health Centers

- CHC program initiated in 1965 as part of President Johnson’s War on Poverty.

- Early CHCs (established 1965-1974) were in high poverty urban areas, and funded by the OEO during the “great administrative confusion”.
  - BG show timing of CHC establishment was essentially random, and uncorrelated with other War on Poverty programs.

- CHCs provided direct provision of primary care services for low-income individuals.
  - Often employed multiple clinics locations or mobile units.
Effect of CHCs

\[
\text{AMR}_{cym} = \gamma \text{CHC}_{cy}^{t \geq 0} + \beta X_{cym} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}
\]

- \text{AMR}_{cym} is the Adjusted Mortality Rate per 100,000 population in county \( c \), year \( y \), and month \( m \).

- \( \text{CHC}_{cy}^{t \geq 0} \) is an indicator for the presence of a CHC.
  - Sometimes a vector of indicators for time relative to treatment (\( t = -1 \) omitted).

- \( X_{cym}, \delta_{sy}, \delta_{cm}, \delta_{uy}, \delta_{ym} \) are county-level time-varying covariates and fixed effects.
  - Can replace these with more parsimonious county and time fixed effects for similar results.
Effect of CHCs and Temperature

\[ \text{AMR}_{cym} = \gamma \text{CHC}_{cy}^{t \geq 0} + \pi g(\text{Temp}_{cmy}) + \beta X_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy} \]

\( g(\text{Temp}_{cmy}) \) is a nonlinear function of daily mean temperatures.

- **Bins:** each bin is the number of days in a given range (e.g., Deschenes and Greenstone, 2011)
  - e.g., Temp\(^{>80}\) is the number of days above 80\(^\circ\)F
  - Estimate effect of one extra day in bin \( j \) relative to a day in the omitted bin (40-80 degrees, or 60-70 degrees)

- **Polynomial:** polynomials constructed at the daily level, then summed over months (e.g., Carleton et al., 2019)
  - Estimate effect of one extra day at temperature \( t \) relative to a day at 65 degrees
## Effect of CHCs and Temp: Results

<table>
<thead>
<tr>
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<th>(2)</th>
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<tbody>
<tr>
<td>CHC${t \geq 0}$</td>
<td>-1.136***</td>
<td>-1.146***</td>
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<tr>
<td></td>
<td>(0.307)</td>
<td>(0.307)</td>
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<td>CHC${t \leq -2}$</td>
<td>-0.0976</td>
<td>-0.102</td>
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<td></td>
<td>(0.168)</td>
<td>(0.168)</td>
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<tr>
<td>CHC$^{0 \leq t \leq 4}$</td>
<td>-0.836***</td>
<td>-0.850***</td>
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<td></td>
<td>(0.157)</td>
<td>(0.158)</td>
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<td>CHC$^{5 \leq t \leq 9}$</td>
<td>-1.554***</td>
<td>-1.566***</td>
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<td></td>
<td>(0.271)</td>
<td>(0.270)</td>
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<tr>
<td>CHC$^{t \geq 10}$</td>
<td>-1.562***</td>
<td>-1.578***</td>
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<tr>
<td></td>
<td>(0.390)</td>
<td>(0.390)</td>
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<tr>
<td>Temp${&lt; 40}$</td>
<td>0.116***</td>
<td>0.116***</td>
<td>0.116***</td>
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<tr>
<td></td>
<td>(0.0159)</td>
<td>(0.0158)</td>
<td>(0.0158)</td>
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<tr>
<td>Temp$^{\geq 80}$</td>
<td>0.182***</td>
<td>0.183***</td>
<td>0.183***</td>
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<td></td>
<td>(0.0187)</td>
<td>(0.0187)</td>
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<tr>
<td>$N$</td>
<td>1,094,760</td>
<td>1,094,760</td>
<td>1,094,760</td>
<td>1,094,760</td>
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</tr>
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</table>

Notes: Estimates from each column are from a single regression. The covariates and fixed effects described above are included in all specifications. Standard errors in parentheses are two-way clustered at the county and year-month levels. *, **, *** indicate significance at the 10%, 5%, and 1% levels.
Effects of CHCs and Temp: Flexible Specifications

Panel A: CHC Full Event Study

Panel B: Five Temp. Bins (Pre-CHC Sample)

Panel C: 3rd Order Polynomial (Pre-CHC Sample)
Interaction Model – Naive Approach

\[
\text{AMR}_{cmy} = \phi (\text{CHC}_{cy}^{t \geq 0} \times g(\text{Temp}_{cmy})) + \gamma \text{CHC}_{cy}^{t \geq 0} + \pi g(\text{Temp}_{cmy}) \\
+ \beta X_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}
\]

Naive approach: simply add the interaction effect (\(\phi\)) to the replication model. This model assumes:

1. No **cross-sectional differences** in the temperature-mortality relationship between treated and untreated counties.

2. No **trends** in the temperature-mortality relationship unrelated to CHC establishment.
Interaction Model – Preferred Approach

\[ AMR_{cmy} = \phi(CHC^{t\geq0}_{cy} \times g(Temp_{cmy})) + \gamma CHC^{t\geq0}_{cy} + \pi g(Temp_{cmy}) + \theta(g(Temp_{cmy}) \times Treated_{c}) + g(Temp_{cmy}) \times \delta_y + \kappa(g(Temp_{cmy}) \times AC_{sy}) + \beta X_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy} \]

- \( g(Temp_{cmy}) \times Treated_{c} \) allows for time-invariant differences in the temp-mortality relationship across treated and untreated counties.
  - Analogous to a treatment group indicator or county fixed effects in a standard DiD design

- \( g(Temp_{cmy}) \times \delta_y \) allows the temp-mortality relationship to vary over time in a manner common across all counties.
  - Analogous to time fixed effects in a standard DiD design

- \( g(Temp_{cmy}) \times AC_{sy} \) allows for temperature effects to vary across air conditioning penetration rates Barreca et al. (2016)
Interaction Results

<table>
<thead>
<tr>
<th>Interaction</th>
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<th>(5)</th>
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</thead>
<tbody>
<tr>
<td>CHC(^{t \geq 0} \times \text{Temp}^{&lt;40})</td>
<td>-0.00294</td>
<td>-0.00346</td>
<td>-0.00336</td>
<td>-0.00324</td>
<td>-0.0221**</td>
</tr>
<tr>
<td></td>
<td>(0.0114)</td>
<td>(0.0115)</td>
<td>(0.0151)</td>
<td>(0.0155)</td>
<td>(0.0101)</td>
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<tr>
<td>CHC(^{t \geq 0} \times \text{Temp}^{\geq 80})</td>
<td>-0.0484**</td>
<td>-0.0518**</td>
<td>-0.0499*</td>
<td>-0.0603**</td>
<td>-0.0314**</td>
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<tr>
<td></td>
<td>(0.0201)</td>
<td>(0.0197)</td>
<td>(0.0273)</td>
<td>(0.0288)</td>
<td>(0.0131)</td>
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<table>
<thead>
<tr>
<th>Term</th>
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<th>(2)</th>
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<tbody>
<tr>
<td>Temp × Treated</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Temp × δ_y</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp × AC</td>
<td>X</td>
<td></td>
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<td></td>
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<tr>
<td>Temp × δ_c</td>
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<tr>
<td>Temp × δ_s_y</td>
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<td>X</td>
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<tr>
<td>δ_cy</td>
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<td>X</td>
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Notes: For reference, the baseline estimates for CHC counties in the pre-CHC period (1959-1965) for the effect of a \(<40\) and \(\geq 80\) day are 0.241 (s.e.=0.081) and 0.339 (s.e.=0.070), respectively. Standard errors are two-way clustered at the county and year-month levels. *, **, *** indicate significance at the 10%, 5%, and 1% levels.

- The estimate of -0.0484 in Column 2 (preferred specification) implies that CHC access mitigates the relationship between hot temperatures and mortality by 14.2%. 

Summary Statistics
Interaction Results: Bin and Polynomial Specifications

- Bin specification: implies mitigation of 13.6% for >80°F days.
- Polynomial specification: implies mitigation of 13.0% for 85°F days.
Why the difference between heat and cold?

Different mechanisms underlie heat vs. cold-related mortality

Deschenes and Moretti (2009), Gasparrini et al. (2015), White (2017)

• Heat-induced deaths more concentrated in disease categories prevented by CHC access.
  - CHCs mostly prevented cardio/cerebrovascular deaths; these deaths account for 50% of cold-related mortality and 71% of heat-related mortality.

• Heat-induced deaths are immediate (i.e., day of or day after); cold-induced deaths are delayed (up to 3 weeks later).
  - Highlights different mechanisms underlying these relationships
  - Suggests that cold-induced deaths might be more responsive to medical treatment, where heat-induced deaths are more responsive to preventative care (like CHCs).

• Supplementary analysis: We use Southern hospital desegregation as a source of variation in access to medical/hospital treatment
  - Desegregation significantly mitigated the cold-mortality relationship.
Conclusions – What Do We Learn?

1. Access to health care *can* mitigate environmental damages
   - Differential access to health care can explain heterogeneity in environmental damages

2. Expanding access to health care – especially primary care – has potential as an adaptive tool for climate change

3. The setting matters
   - The type of care must be highly relevant to ailments triggered by the environmental shock
     - E.g., improving access to care as an adaptive tool for climate change will only be effective if the mode of care is well-targeted
Thank You!
Data

Sample: County by Year and Month, 1959-1988

Mortality – National Vital Statistics System
  • Outcome: Adjusted Mortality Rate per 100,000 population.

Weather – PRISM and Schlenker and Roberts (2009)
  • Gridded (2.5×2.5 mile) daily temperature and precipitation data aggregated to counties. Daily data is used to construct monthly counts of days within six temperature bins <40 to >80.

Community Health Centers – Bailey & Goodman-Bacon (2015)
  • The county and implementation year of all CHCs established 1965-1975, as well as all covariates used in Bailey and Goodman-Bacon (2015)

Population – SEER and US Census
  • Data from SEER and the US Census (1950 and 1960). Missing years are linearly interpolated.

Air Conditioning – US Census
## CHC Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>CHC Counties</th>
<th></th>
<th>Non-CHC Counties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1959-1965</td>
<td>All Years</td>
<td>1959-1965</td>
<td>All Years</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>AMR</td>
<td>81.26</td>
<td>(11.16)</td>
<td>70.97</td>
<td>(13.25)</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td>55.26</td>
<td>(16.89)</td>
<td>55.37</td>
<td>(16.8)</td>
</tr>
<tr>
<td>Num. Days &lt;40</td>
<td>6.56</td>
<td>(10.24)</td>
<td>6.42</td>
<td>(10.1)</td>
</tr>
<tr>
<td>Num. Days 40-50</td>
<td>4.53</td>
<td>(5.84)</td>
<td>4.55</td>
<td>(5.85)</td>
</tr>
<tr>
<td>Num. Days 50-60</td>
<td>5.54</td>
<td>(6.61)</td>
<td>5.7</td>
<td>(6.67)</td>
</tr>
<tr>
<td>Num. Days 60-70</td>
<td>6.15</td>
<td>(6.94)</td>
<td>6.18</td>
<td>(6.97)</td>
</tr>
<tr>
<td>Num. Days 70-80</td>
<td>5.83</td>
<td>(8.18)</td>
<td>5.67</td>
<td>(8.10)</td>
</tr>
<tr>
<td>Num. Days &gt;80</td>
<td>1.83</td>
<td>(5.51)</td>
<td>1.91</td>
<td>(5.65)</td>
</tr>
<tr>
<td>AC</td>
<td>0.13</td>
<td>(0.07)</td>
<td>0.36</td>
<td>(0.26)</td>
</tr>
</tbody>
</table>

|                      |               |               |
| Num. Counties        | 114           | 2,927         |

Notes: All summary statistics are weighted by the county’s 1960 population. Temperature is measured as the mean daily temperature.