Air pollution, racial disparities, and COVID-19 mortality

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What is COVID-19?

- Coronaviruses (CoV) are a large family of viruses:
  - Middle East Respiratory Syndrome (MERS-CoV)
  - Severe Acute Respiratory Syndrome (SARS-CoV)
- Transmitted between animals and people.
- Wide range of disease symptoms:
  - Elevated inflammatory response
  - Respiratory symptoms
  - Fever, cough
  - Shortness of breath
  - Pneumonia, renal failure and even death.

Phylogeny

- 2003 Outbreak
- 2015 Outbreak

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Global Prevalence & Trends


Bacillus Calmette-Guérin (BCG) vaccination coverage map by country (http://www.bcgatlas.org/index.php)
Global variation in COVID-19 prevalence and mortality

- Climate hypothesis
  - seasonality/climate: tropical, temperate zones
- Genetic hypothesis
  - racial differences in ACE-2 gene polymorphisms
- Evolutionary and natural selection hypothesis
  - Th1/Th2 cytokine responses to infections
- Trained immunity hypothesis
  - Bacillus Calmette-Guérin (BCG) vaccination
  - Cytokine storm

Mersha et al. (under review)
U.S. map for COVID-19 epidemic: racial and PM2.5 variations

Johns Hopkins University COVID-19 Case Tracker: https://coronavirus.jhu.edu
(Accessed on July 11, 2020)
Air pollution, racial disparities, and COVID-19 death

**Racial minority populations**
- Live in densely populated cities & neighborhoods
- Live near highways/polluting industries
- They are hospitalized and die from COVID-19 more than whites.

**COVID-19 risk factors**
- Age (older than 65; live in a nursing home)
- Sex (male)
- Obesity (BMI >30)
- Diabetes
- Heart conditions
- Hypertension
- Immuno-compromised
  - Cancer
- Kidney disease
- Liver disease
- Chronic lung disease
  - COPD (smoking)
  - Severe asthma
- Racial minorities are more likely to suffer from these comorbidities
- Genetic variability

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Brandt, Beck and Mersha *J Allergy Clin Immunol*. 2020 May 07 [Online ahead of print]
Average PM 2.5 inequality by racial groups

blacks >56%
Hispanics > 63%
Whites < 17%

PNAS March 26, 2019 116 (13) 6001-6006
<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>White</th>
<th>African Americans</th>
<th>Hispanic</th>
<th>Asian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td>165.5</td>
<td>203.1</td>
<td>113.9</td>
<td>85.0</td>
</tr>
<tr>
<td>Coronary heart disease</td>
<td>101.2</td>
<td>114.8</td>
<td>75.3</td>
<td>55.3</td>
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<tr>
<td>Stroke</td>
<td>35.4</td>
<td>50.9</td>
<td>30.2</td>
<td>28.5</td>
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<tr>
<td>Cancer</td>
<td>170.9</td>
<td>194.2</td>
<td>115.2</td>
<td>102.6</td>
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<tr>
<td>Diabetes mellitus</td>
<td>18.6</td>
<td>38.2</td>
<td>25.1</td>
<td>15.1</td>
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<tr>
<td>COPD</td>
<td>41.8</td>
<td>24.7</td>
<td>15.6</td>
<td>10.3</td>
</tr>
<tr>
<td>Asthma</td>
<td>8.2</td>
<td>22.3</td>
<td>7.8</td>
<td>-</td>
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<tr>
<td>Pneumonia/Influenza</td>
<td>15.1</td>
<td>16.3</td>
<td>12.8</td>
<td>12.9</td>
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<td>HIV infection</td>
<td>0.9</td>
<td>8.6</td>
<td>2.0</td>
<td>0.3</td>
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<tr>
<td>Infant mortality (/1000)</td>
<td>5.1</td>
<td>11.1</td>
<td>5.0</td>
<td>4.1</td>
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<tr>
<td>Life expectancy at birth</td>
<td>78.9</td>
<td>75.1</td>
<td>81.6</td>
<td>85</td>
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<tr>
<td>HIV mortality (/1000)</td>
<td>18</td>
<td>21</td>
<td>14</td>
<td></td>
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<tr>
<td>COVID-19 mortality</td>
<td>30.2</td>
<td>70.0</td>
<td>34</td>
<td>29</td>
</tr>
</tbody>
</table>

Age-adjusted Death rates (per 100,000)

Phenome-wide association study of COVID-19 using EHR data

PheWAS Data:

- 5,698 COVID-19 patients
- 7,211 controls

medRxiv preprint doi: https://doi.org/10.1101/2020.06.29.20141564
Genome-wide association study of COVID-19

Sample size: Italy (835 patients, 1255 control) and Spain (775 patients and 950 control)

They are still underpowered, and also do not directly address functional variants

Summary

- No evidence so far for SNPs in ACE-2 gene linked with African ancestry
- Link between air pollution and COVID-19:
  - ✓ High COVID-19 risks with higher #s of minorities:
    - live in zip codes close to highways, industry
    - low income, poor housing and worse pollution
    - compromised respiratory, cardiac and other systems
    - worse COVID-19 outcome.

Solution: Address racial disparities-- multilevel interventions!
Future direction
Socio-environmental Determinants of COVID-19

Risks of COVID-19 exposure are not evenly distributed. We need to address to socio-economical disparities.

JAMA Network. 2020;3(1):e1919928
Prevention is better than cure

- Case isolation and contract tracing
- Social distancing (6 ft)
- Limiting public interactions/gathering
- Maintain hand hygiene
- Avoid droplet Containment
- No vaccine at the moment, but research is in progress at a lightning speed!
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Time for Questions