Acute cardio-respiratory effects of SO$_2$ and NO$_2$ exposure in southern Israel

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• Impact of NO$_2$ and SO$_2$ on morbidity and mortality has been widely reported

• Population-based studies of air pollution have shown an association with cardiac and respiratory mortality

• NO$_2$, SO$_2$(and O$_3$, PM$_{2.5}$) have been shown to be associated with increased hospital admissions:
  – acute cardiovascular disease
  – pneumonia
  – COPD exacerbation
  – stroke
Background (2)

- Effects on cardiovascular and respiratory disease assessed in North America, Europe, Australia, Asia

- Few reports to date from Middle Eastern countries
  - climate differs from other areas
  - temperature shown to modify effects of air pollution
  - characteristics and composition of air pollution
  - background illness and lifestyles
  - magnitude of effect
Study objective

• Quantify short-term effects of NO₂ and SO₂ on cardiovascular and respiratory emergency department patient load in southern Israel

• Adjust for effects of other pollutants (NO₂, SO₂, PM₂.5) and for additional potential confounding variables

• Examine effects of lag period
Methods: study area

- Ashkelon located on the southern Mediterranean coast of Israel
- Population approximately 110,000
Methods: exposure data

• Network of 9 ambient outdoor air monitoring stations

• Continuous 5-minute data collection:
  – NO₂, SO₂, O₃, PM₂.5
  – temperature, relative humidity, barometric pressure
  – precipitation, wind speed, wind direction

• 12-hour means, cut at 6_AM and 6_PM, based on:
  – primary analysis of meteorological characteristics
  – traffic and work day patterns

• Study window 2000-2004 = 3,162 half-day periods

• >99% data completeness

• Interpolation of grid values using kriging method
Methods: outcome data

- ~400,000 computerized ED records obtained from Barzilai Medical Center – sole Ashkelon hospital
- ED data based on ICD-9 diagnostic codes
- High specificity conditions, likely to be assigned accurately (low false positive rate)
- Acute ischemic heart disease, MI, chest pain
  - ICD-9 codes 410, 411, 413, 786.5
- Asthma, wheezing, cough
  - ICD-9 codes 493, 786.07, 786.2
- ED patient count data, summed by 12-hour periods
- Same-period counts and 12-hour lag counts
Methods: model construction (1)

- **Data management**
  - Categorization of outcome variables
    - heaviest vs lightest ED loads (highest 20% vs lowest 20%)
  - Logarithmic transformation of pollutant data, entered as continuous variables

- **Data analysis**
  - Logistic regression, adjusted for potential confounders
  - Poisson regression (number of daily admissions) – assess the risks of single-unit increase in pollutant concentration
  - Separate analyses for day and night data
Methods: model construction (2)

• Univariate model
• Multivariate, single-pollutant model, adjusted for:
  – month
  – weekday/weekend
  – time of day (12 hr period)
  – precipitation
  – wind speed
• Multivariate, multiple-pollutant model
  – NO₂
  – SO₂
  – PM_{2.5}
Results: mean NO₂ concentration, by type of day

Mean weekday NO₂ (µg/m³)

Mean weekend NO₂ (µg/m³)
Mean SO$_2$ concentration, by wind direction

Wind from northwest (300-330°)

Wind from southeast (120-150°)

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### Results: Air pollution and ED patient load

**odds ratio for heavy patient load**

<table>
<thead>
<tr>
<th></th>
<th>Cardiac</th>
<th>Respiratory</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SO\textsubscript{2}</strong></td>
<td>1.21 (0.92-1.59)</td>
<td>1.16 (0.86-1.56)</td>
<td><strong>1.45</strong> (1.09-1.93)</td>
</tr>
<tr>
<td><strong>NO\textsubscript{2}</strong></td>
<td>1.27 (0.94-1.73)</td>
<td><strong>1.82</strong> (1.28-2.58)</td>
<td><strong>2.34</strong> (1.69-3.23)</td>
</tr>
</tbody>
</table>

Adjusted for: month, weekday/weekend, time of day, precipitation, wind speed, \textit{NO}_2, \textit{SO}_2, \textit{PM}_2\textsubscript{.5
## Results: AP and ED patient load – 12hr lag
odds ratio for heavy patient load

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</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>0.94 (0.72-1.22)</td>
<td>1.02 (0.77-1.37)</td>
<td>1.13 (0.86-1.49)</td>
</tr>
<tr>
<td>NO₂</td>
<td>1.31 (0.96-1.79)</td>
<td>1.99 (1.40-2.83)</td>
<td>2.39 (1.74-3.30)</td>
</tr>
</tbody>
</table>

Adjusted for: month, weekday/weekend, time of day, precipitation, wind speed, NO₂, SO₂, PM₂.₅
• Poisson regression demonstrated similar associations with overall ED load:
  – NO₂: RR=1.002 (95%CI 1.001-1.003)
  – SO₂: RR=1.007 (95%CI 1.003-1.010)

• A 10 mcg/m³ increase in ambient NO₂ concentration increased the probability of an unusually heavy ED patient load by 2%.

• The same increase in SO₂ increased the probability of an unusually heavy ED patient load by 7%.
Conclusions

• Overall acute cardiac and respiratory ED patient load
  – stronger association with NO₂; significant in all models
• High-specificity respiratory diagnoses
  – substantial association with NO₂, none – with SO₂
• High-specificity cardiac diagnoses
  – significant in adjusted single-pollutant models
  – non-significant in 3-pollutant models, likely due to insufficient study power
• Similar results for 0 and 12hr lag periods
• Day of week and time of day are strong confounders
  – importance of 12hr data frame
  – must be included in multivariate analyses
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Oversight: Dr Shlomo Sarig