Acute cardio-respiratory effects of SO_2 and NO_2 exposure in southern Israel

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Background (1)

- 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 NO_2 and SO_2 on cardiovascular and respiratory emergency department patient load in southern Israel
- Adjust for effects of other pollutants (NO_2, SO_2, $PM_{2.5}$) 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:
  - NO_2, SO_2, O_3, $PM_{2.5}$
  - temperature, relative humidity, barometric pressure
  - precipitation, wind speed, wind direction
- 12-hour means, cut at 6AM and 6PM, 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)

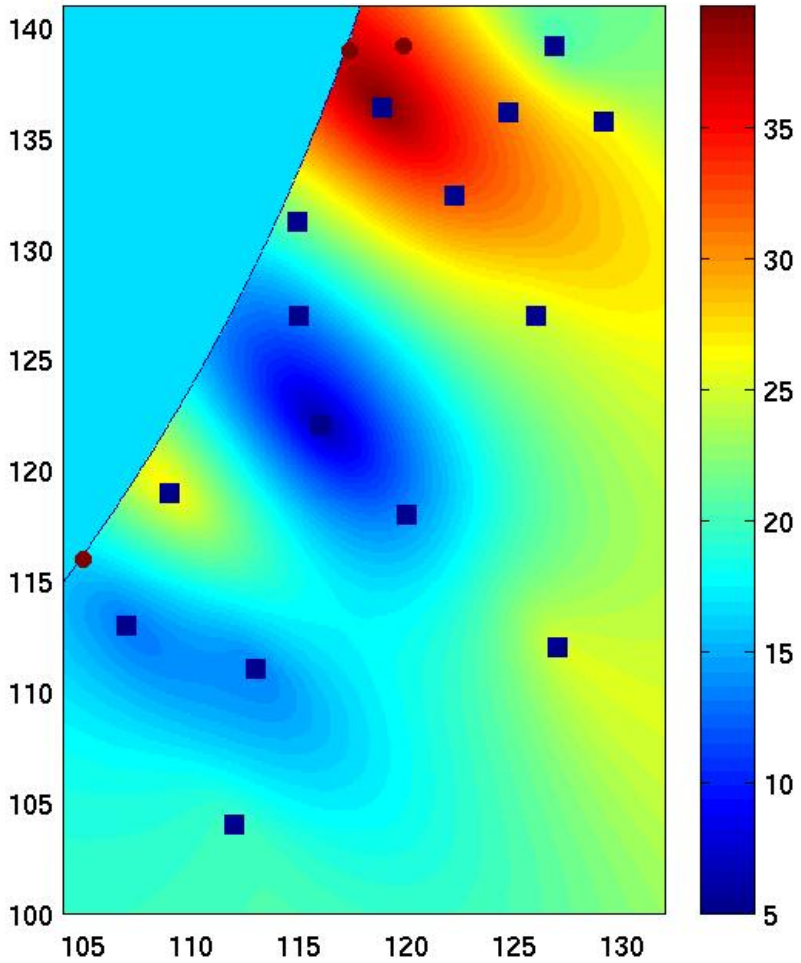
- Data management
  - Categorization of outcome variables
    - heaviest vs lightest ED loads (highest 20% vs lowest 20%)
  - Logarithmic transformation of pollutant data, entered as continuous variables
- Data analysis
  - Logistic regression, adjusted for potential confounders
  - Poisson regression (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)

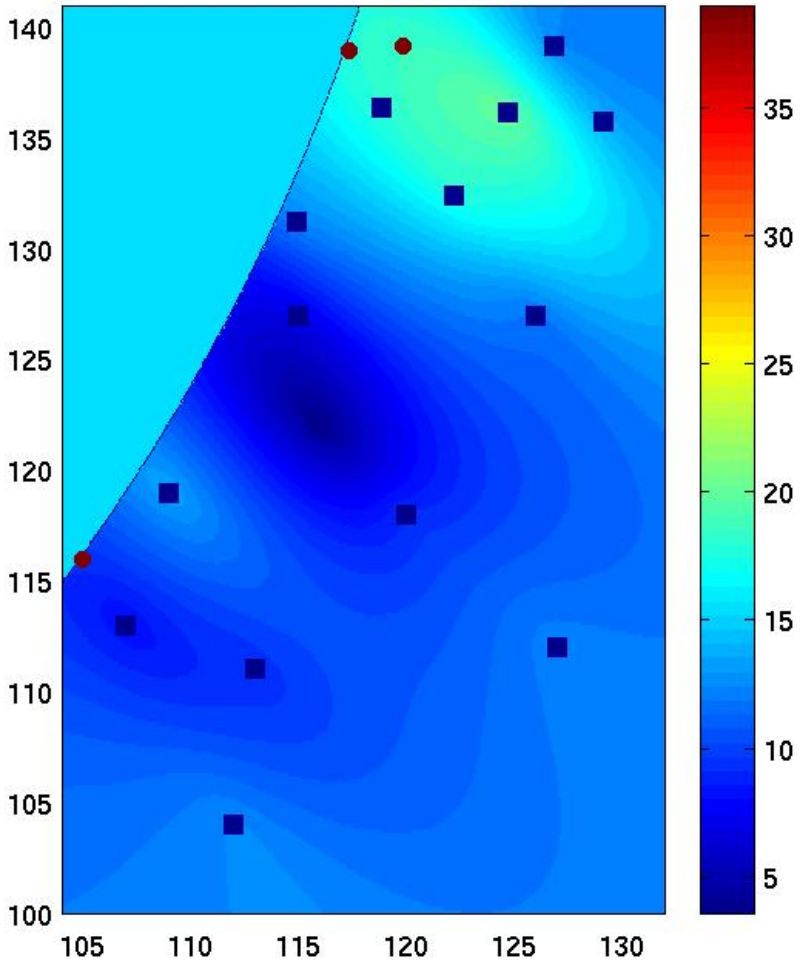
- Univariate model
- Multivariate, single-pollutant model, adjusted for:
  - month
  - weekday/weekend
  - time of day (12 hr period)
  - precipitation
  - wind speed
- Multivariate, multiple-pollutant model
  - NO_2
  - SO_2
  - $PM_{2.5}$

Results: mean NO_2 concentration, by type of day

Mean weekday NO_2 ($\mu g/m^3$)

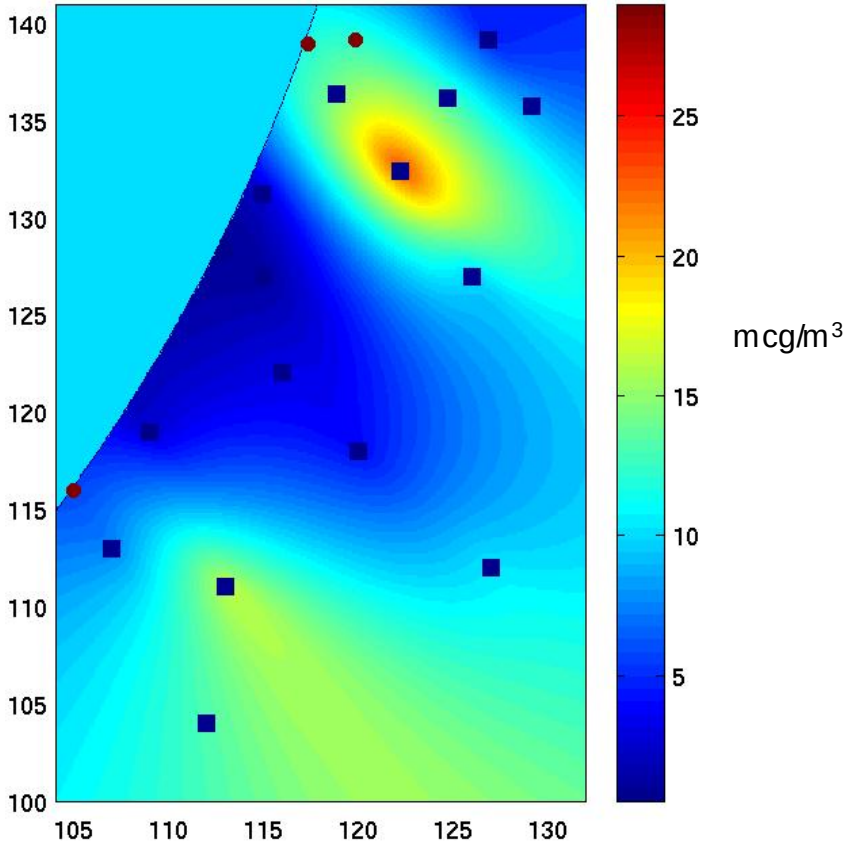


Mean weekend NO_2 ($\mu g/m^3$)

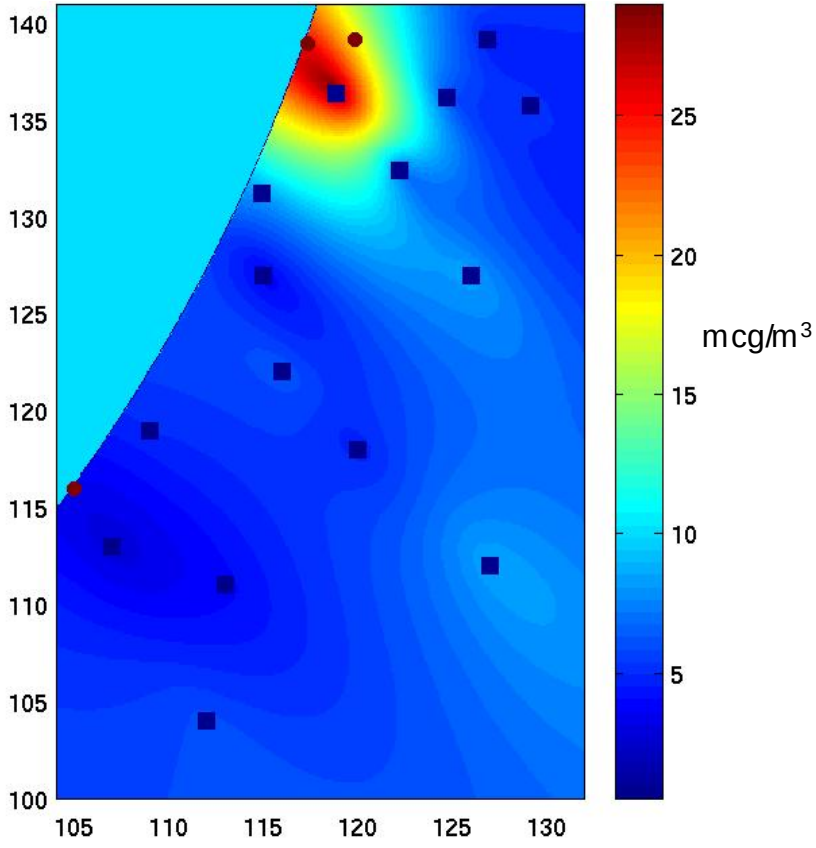


Mean SO_2 concentration, by wind direction

Wind from northwest (300-330^0)



Wind from southeast (120-150^0)



Results: Air pollution and ED patient load
odds ratio for heavy patient load

	Cardiac	Respiratory	Overall
SO_2	1.21 (0.92-1.59)	1.16 (0.86-1.56)	**1.45** (1.09-1.93)
NO_2	1.27 (0.94-1.73)	**1.82** (1.28-2.58)	**2.34** (1.69-3.23)

Adjusted for: month, weekday/weekend, time of day, precipitation, wind speed, NO_2 SO_2, $PM_{2.5}$

Results: AP and ED patient load – 12hr lag
odds ratio for heavy patient load

	Cardiac	Respiratory	Overall
SO_2	0.94 (0.72-1.22)	1.02 (0.77-1.37)	1.13 (0.86-1.49)
NO_2	1.31 (0.96-1.79)	1.99 (1.40-2.83)	2.39 (1.74-3.30)

Adjusted for: month, weekday/weekend, time of day, precipitation, wind speed, NO_2 SO_2, $PM_{2.5}$

Poisson regression - relative risks for unit increase in pollutant concentration

- Poisson regression demonstrated similar associations with overall ED load:
  - NO_2: RR=1.002 (95%CI 1.001-1.003)
  - SO_2: RR=1.007 (95%CI 1.003-1.010)

- A 10 mcg/m^3 increase in ambient NO_2 concentration increased the probability of an unusually heavy ED patient load by 2%.
- The same increase in SO_2 increased the probability of an unusually heavy ED patient load by 7%.

Conclusions

- Overall acute cardiac and respiratory ED patient load
  - stronger association with NO_2; significant in all models
- High-specificity respiratory diagnoses
  - substantial association with NO_2, none – with SO_2
- 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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