

Long-term exposure to ambient air pollution and the respiratory health of Australian children

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Background

- Children are generally more vulnerable to the respiratory effects of air pollution
- Most previous studies of long-term AP exposure and resp. health done in locations with moderate levels
 - annual mean NO₂ ~12 to ~30 ppb (Favarato *et al.* 2014; AQAH 7:459-466)
- Effects generalisable to Australian context? High asthma BoD.
- More 'complex' exposure assessment better than simpler?



Image: The Guardian, 2015

Aims

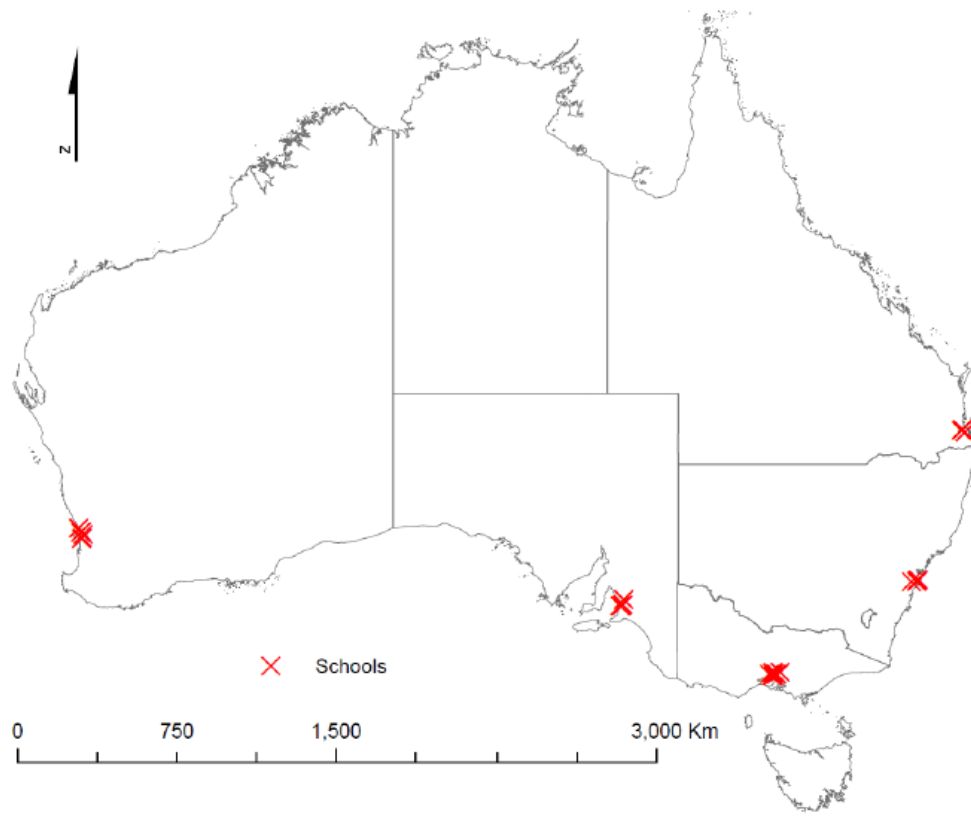
- Assess respiratory effects of long-term ambient AP exposure in Australia
- Add to existing (limited) data on low-level exposure



Methods

- National cross-sectional study of 7-11 y.o. children (2007-2008), all six states
- Identify regulatory monitoring (background) sites that have at least 3 schools within 2km (n=29).
- Randomly select at least two schools per site.
- 55 schools agreed (64%) – randomly selected whole classes to yield >100 children per school
- No exclusions; 7,618 children invited to take park and q'aire sent to parents
- Asthma (current, lifetime), wheeze, SES, indoor etc. etc. (70 items/ISAAC)
- 2,880 returned a complete q'aire (37.8%)





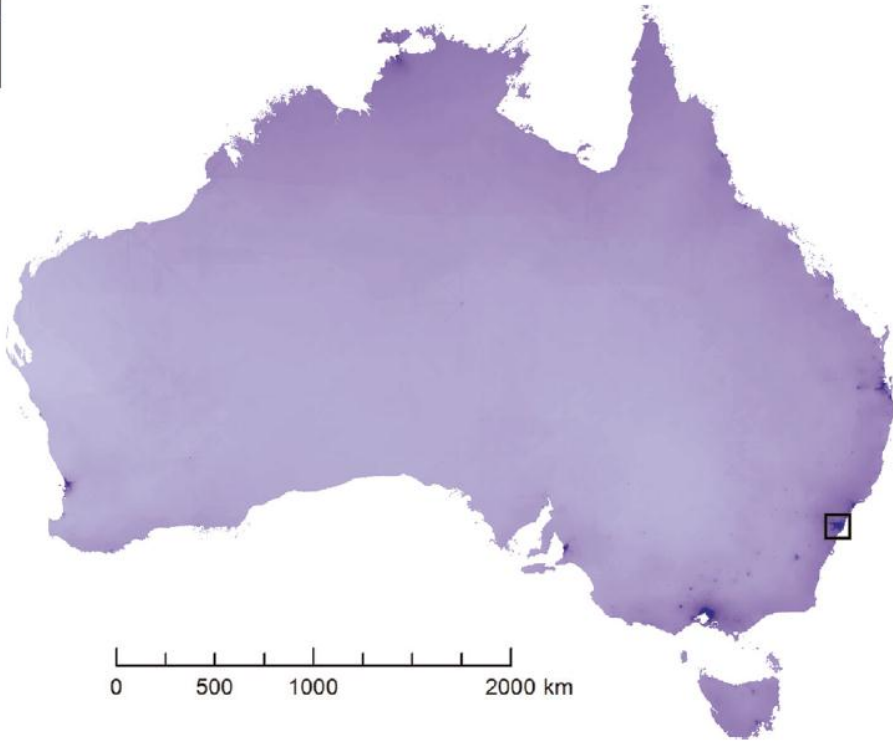
Methods

- Individual measurements
 - FEV₁, FVC, Fe_{NO} using standard methods pre-/post- BD
 - Height, weight, BMI
- 2,630/2,880 (91.3%) with q'aire had valid spirometry
 - Analytical group
 - 1,815 (69%) had valid Fe_{NO} – malfunction

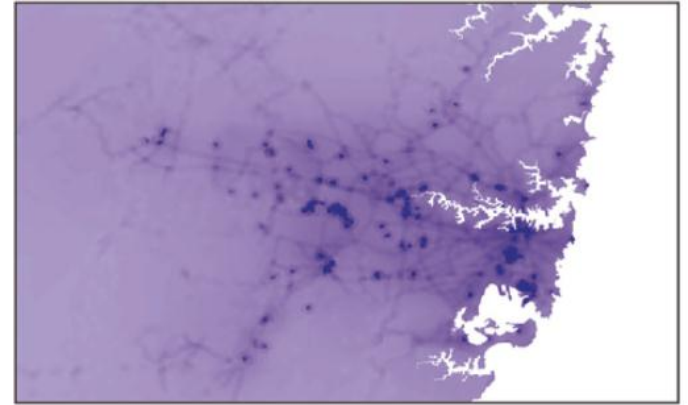


Methods

- Exposure assessment
 - NO₂ as a surrogate for urban AP
 - Other measured pollutants used for adjustment in two-pollutant models (O₃, PM_{2.5}, PM₁₀, CO, SO₂)
 - Measured (at schools, as a proxy for home)
 - National sat-LUR model (home, school, combined – geocoded)
 - Recent exposure (last 12 mths)
 - Lifetime exposure (d.o.b or date moved to that address) – m'ments only

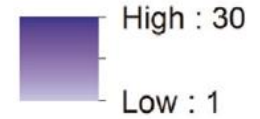


0 500 1000 2000 km



0 10 20 40 km

Predicted NO₂ (ppb)



Methods

- Analysis
 - Main outcomes
 - Current asthma
 - Lung function (FEV₁, FVC)
 - Fe_{NO} (% increase; 'high' = 97.5%ile in non-atopic children using SPT)
 - Logistic regression (hierarchical), linear regression
 - Non-linearity checks
 - Covariates
 - Age, sex, SES (indiv. and area), temperature (LF)
 - Sensitivity analyses
 - Indoor SHS, gas appliances, maternal smoking in pregnancy, prematurity, daycare in first year of life, NO₂ on day of/prior test, include/exclude people living further away from monitor, etc.

Key Results

Asthma history and medication use - recent

Current asthma	385/2593 (14.9)
Any asthma/wheezing medication in the last 12 months	574/2479 (23.2)
Visit doctor for asthma last 12 months	322/2394 (13.5)
Current wheeze	438/2601 (16.8)
Wheeze after exercise last 12 months	304/2250 (13.2)
Itchy rash for 6 months in the last 12 months	440/2616 (16.8)
Rhinitis last 12 months	823/2617 (31.5)

Key Results

Measure	N sites	Median exposure duration	1 st to 3 rd quartile of exposure duration	Mean exposure (ppb)	Median exposure (IQR) (ppb)	Between-site SD (ppb)	Between-site minimum to maximum (ppb)	Mean within-site SD (ppb)
NO ₂ at nearest monitor to school								
Lifetime	29	5.7 y	3.2 to 8.3 y	9.3	8.8 (4.3)	3.6	3.0 to 17.1	0.50
Previous	29	4.7 y	2.3 to 7.4 y	9.5	9.0 (4.1)	3.6	3.0 to 17.7	0.52
Recent	27	11.7 m	10.4 to 12.0 m	8.8	7.9 (4.0)	3.2	3.4 to 15.6	0.21
Satellite-based LUR NO ₂								
School	55	12 m	n/a	8.8	8.4 (2.9)	2.2	4.2 to 13.1	-
Residence	2630	12 m	n/a	8.8	8.3 (3.4)	2.4	2.9 to 24.1	-
Combined	2630	12 m	n/a	8.8	8.3 (3.3)	2.3	3.2 to 21.3	-

Key Results

Outcome	NO ₂ at nearest monitor to school					
	Lifetime exposure		Previous exposure		Recent exposure	
	Effect (95% CI)	P	Effect (95% CI)	P	Effect (95% CI)	P
Odds ratios^a for IQR increase:						
Current asthma	1.19 (1.04, 1.38)	0.014	1.21 (1.05, 1.41)	0.010	1.24 (1.08, 1.43)	0.003
Lifetime asthma	1.06 (0.98, 1.16)	0.17	1.09 (1.00, 1.19)	0.045	1.08 (0.98, 1.19)	0.13
High Fe _{NO}	1.56 (1.17, 2.07)	0.003	1.54 (1.16, 2.05)	0.003	1.77 (1.32, 2.38)	< 0.001
Current wheeze	1.13 (1.01, 1.27)	0.036	1.12 (1.00, 1.26)	0.048	1.17 (1.03, 1.33)	0.014

a. Adjusted for age, sex, parental education, index of education and occupation (IEO), and index of relative socio-economic advantage and disadvantage (IRSAD).

IQR = 4 ppb

Key Results

Outcome	NO ₂ from satellite-based LUR					
	School Address		Home Address		Combined (school and home)	
	Effect (95% CI)	P	Effect (95% CI)	P	Effect (95% CI)	P
Odds ratios^a for:						
Current asthma	1.46 (1.20, 1.79)	< 0.001	1.49 (1.23, 1.81)	< 0.001	1.54 (1.26, 1.87)	< 0.001
Lifetime asthma	1.22 (1.02, 1.47)	0.031	1.27 (1.07, 1.52)	0.008	1.29 (1.06, 1.56)	0.010
High Fe _{NO}	3.34 (1.90, 5.85)	< 0.001	2.45 (1.55, 3.86)	< 0.001	2.83 (1.70, 4.71)	< 0.001
Current wheeze	1.19 (0.97, 1.47)	0.10	1.24 (0.99, 1.54)	0.06	1.25 (0.99, 1.57)	0.06

a. Adjusted for age, sex, parental education, index of education and occupation (IEO), and index of relative socio-economic advantage and disadvantage (IRSAD).

IQR = 4 ppb

Key Results

Change^b per IQR in:

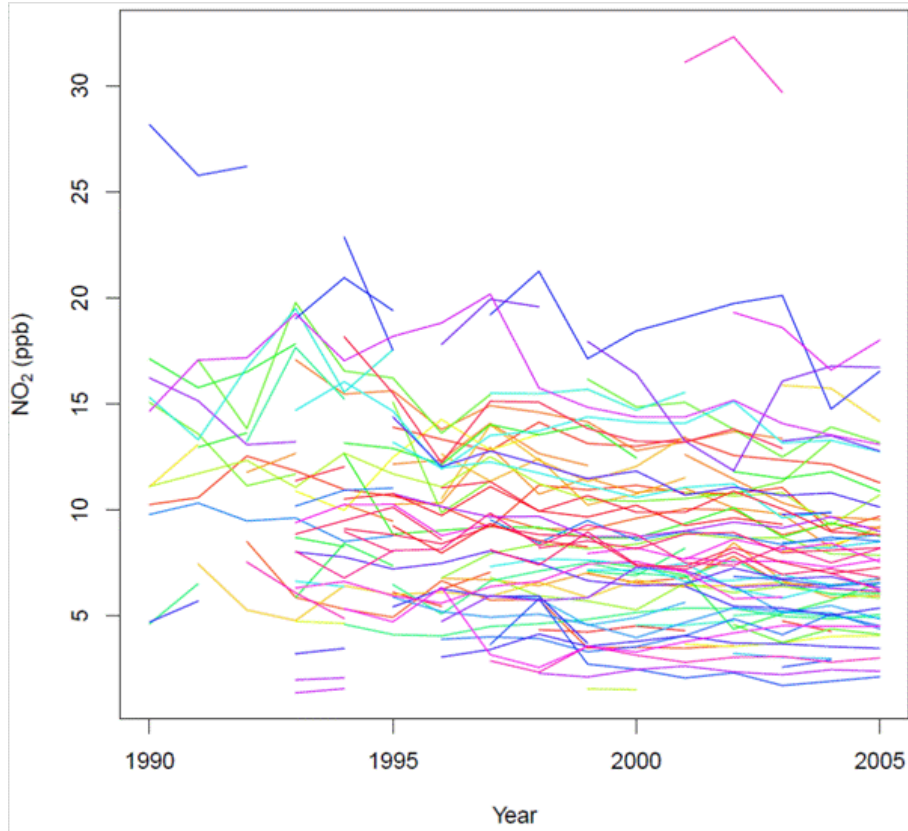
FEV ₁ Pre-bronchodilator (% predicted)	-1.03 (-1.89,-0.17)	0.020	-0.96 (-1.82,-0.10)	0.029	-1.23 (-2.08,-0.39)	0.005
FEV ₁ Post-bronchodilator (% predicted)	-1.11 (-1.91,-0.30)	0.008	-1.13 (-1.97,-0.30)	0.009	-1.35 (-2.21,-0.49)	0.003
FVC Pre-bronchodilator (% predicted)	-0.95 (-1.71,-0.19)	0.015	-0.82 (-1.62,-0.02)	0.046	-1.11 (-1.87,-0.34)	0.006
FVC Post-bronchodilator (% predicted)	-1.02 (-1.84,-0.20)	0.016	-1.00 (-1.83,-0.16)	0.020	-1.19 (-2.04,-0.35)	0.007
FEV ₁ /FVC Pre-bronchodilator (% predicted)	-0.09 (-0.69, 0.51)	0.77	-0.14 (-0.74, 0.45)	0.63	-0.10 (-0.58, 0.38)	0.68
FEV ₁ /FVC Post-bronchodilator (% predicted)	0.02 (-0.49, 0.52)	0.95	-0.03 (-0.52, 0.46)	0.90	-0.10 (-0.50, 0.30)	0.62
FeNO (% increase)	32 (14,53)	< 0.001	32 (14,52)	< 0.001	37 (19,58)	< 0.001

b. Adjusted for age, sex, parental education, IEO, IRSEAD, monthly (for month of testing) and annual average daily mean temperature.

IQR = 4 ppb

Interpretation

- Strong evidence of association between NO_2 (urban AP proxy) and current asthma in low-exposure setting
- Effects per IQR for current asthma are relatively large c/w literature
 - LUR estimates > fixed-site estimates – reduced misclassification?
- Evidence of stat sig decrement in FEV_1 and FVC, increase in Fe_{NO}
- Flip side: gains to be made by further exposure reduction?





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The Australian Child Health and Air Pollution Study (ACHAPS): A national population-based cross-sectional study of long-term exposure to outdoor air pollution, asthma, and lung function



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Image: The Guardian, 2015