

Air pollution during pregnancy and lung function in newborns: a birth cohort study

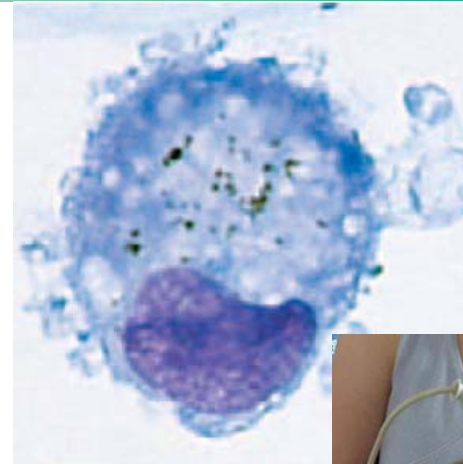
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Effects of air pollution on respiratory health

Acute effects on:

- Symptoms (e.g. cough)¹
- Lung function in adults (FEV₁)²
- Inflammation (eNO)³

Chronic effects on lung growth:

- 3200 children in Mexico: regional pollution⁴
- 1150 children in Austria: seasonal exposure⁵

1 Ward et al., Occup Env Med, 2001

2 McCreanor et al., NEJM, 2007

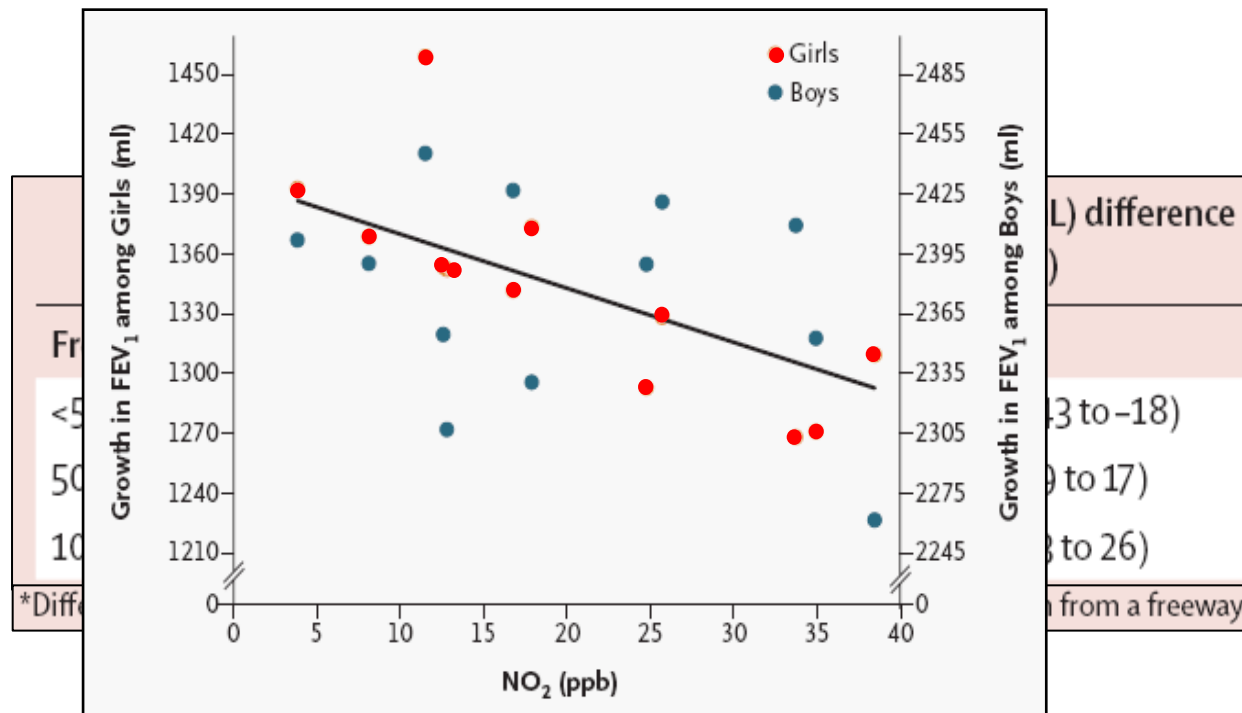
3 Nickmilder et al., JAMA 2003

4 Rojas-Martinez et al., AJRCCM, 2007

5 Frischer et al., AJRCCM 1999

Chronic effects on lung growth

- Californian Health Study, 1700 children, 10-18 years:
 - background pollution¹:



¹ Gauderman et al., NEJM, 2004

² Gauderman et al., Lancet, 2007

Growth and development of the airways

- Pre- and early postnatal phase important¹
- Dependent on genetics and environment¹
- Effect of prenatal smoke exposure well known²
- E.g. on tidal breathing³ and lung growth⁴
- No data on effects of prenatal air pollution
- Longterm effects of early lung function changes^{5,6}

1 Kotecha, Ped Resp Rev, 2000;

2 Stocks et al., Review in Respiriology, 2003

3 Stick et al., Lancet, 1996

4 Hoo et al., AJRCCM 1998

5 Bush et al., COPD 2008

6 Kuehni et al., Lancet 2008

Question

Does prenatal exposure to air pollution influence lung growth and inflammation in the healthy newborn?

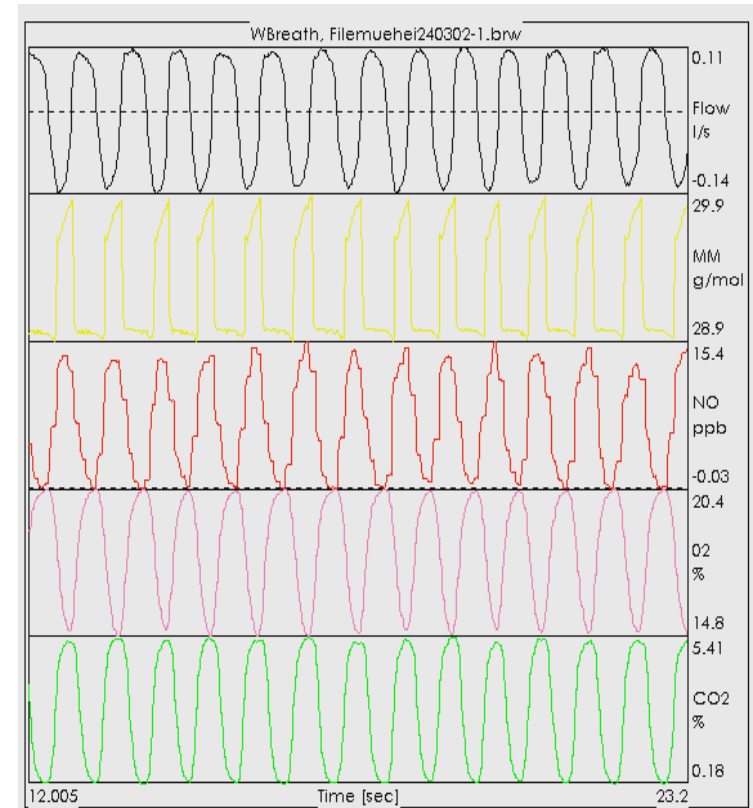
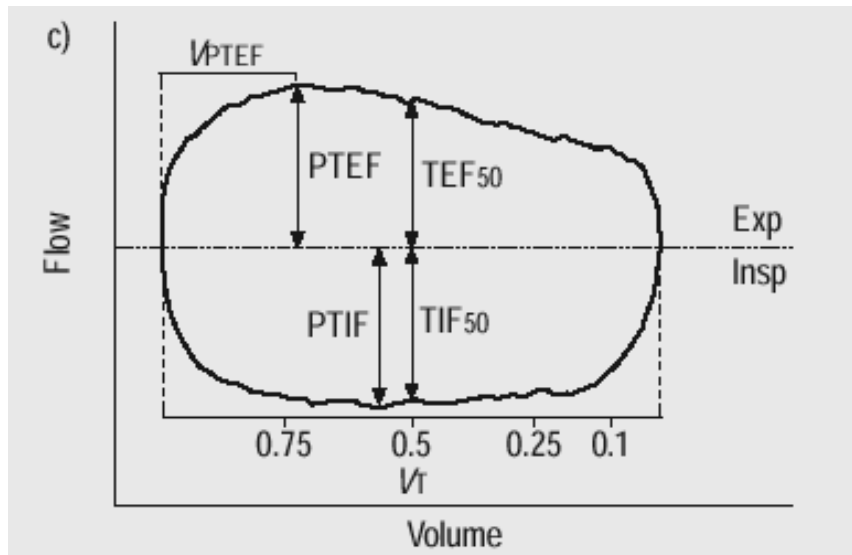
Subjects

- Prospective birth cohort since 1999
(unselected term-born infants of healthy mothers)
- Lung function at age 5 weeks (unsedated)



Outcome parameters

- Minute-Ventilation (Frequency x Tidal volume)
- Mean expiratory flow
- Lung volume (FRC)
- Ventilation homogeneity (LCI)
- Inflammation (eNO)



Exposure to air pollution

Exposure to air pollution during pregnancy depends on temporal and spatial variability:

Temporal variability:

Mean background pollution level in pregnancy measured at regional monitor:

Ozone (O₃), NO₂ & PM₁₀

Spatial variability:

Local exposure (home address) GIS coded as distance to next class-II road (> 6m wide)

Analyses

Inclusion of 260 infants

No lung function (sleep status): 27 subjects

Respiratory tract infection at time of lung function (± 1 wk): 10 subjects

Technical problems with eNO-analyser: 11 subjects

- Tidal breathing data in 223 (86%) infants.
- eNO data in 212 (82%) infants.

Analysis:

Linear regression analysis using 2 models:

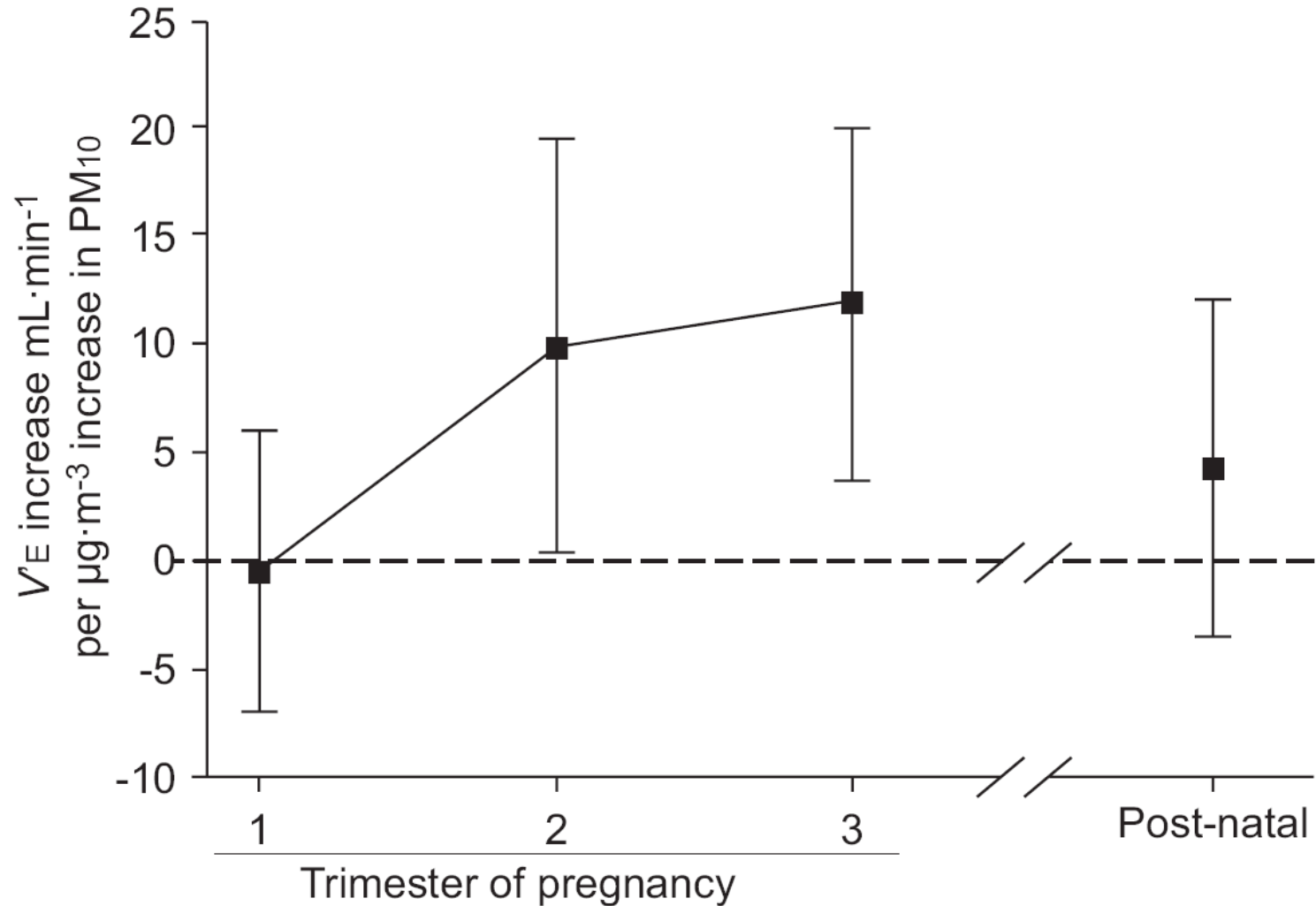
- “Basic model” for mean pollution level and distance to street
- “Full model” adjusted additionally for possible confounders (gender, age at measurement, season of birth, outdoor temperature and smoking in pregnancy)

Results I – associations

	Basic model			Full model		
	coefficient	CI 95%	p Value	coefficient	CI 95%	p Value
Prenatal PM ₁₀ and Minute ventilation [mL/min]	19.9	4.7 – 35.0	0.010	24.7	8.9 – 40.5	0.002
Prenatal PM ₁₀ and Mean expiratory flow [mL/sec]	0.59	0.01 – 1.17	0.045	0.80	0.21 – 1.40	0.008
Prenatal NO ₂ and eNO [ppb]	0.67	0.23 – 1.10	0.003	0.96	0.44 – 1.48	<0.001

- Results are given as change per $\mu\text{g}/\text{m}^3$ increase in air pollution
- Results on PM₁₀ confirmed using other parameters of tidal breathing
- No association for ozone exposure
- No association for distance to street
- No association for FRC or ventilation inhomogeneity

Results II – time of exposure



Results III – stratification

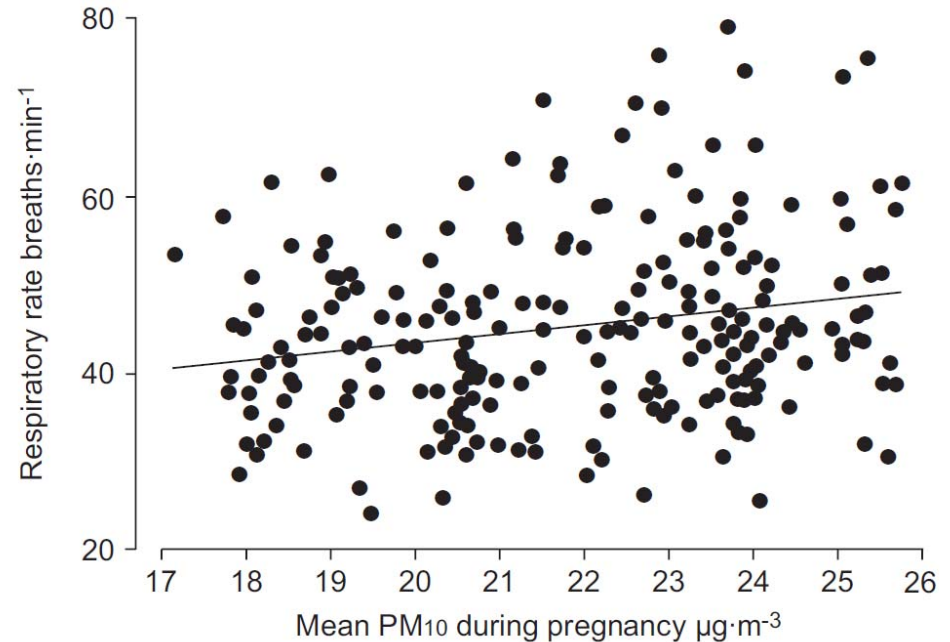
	<u>Risk factor present</u>		<u>No risk factor</u>		p-value for interaction
	coefficient	CI 95%	coefficient	CI 95%	
<u>PM₁₀ and minute ventilation</u>					
Living within 200 m to major road (110 subjects)	41.2	19.1 – 63.4	8.7	-13.8 – 31.2	0.009
Maternal smoking in pregnancy (26 subjects)	81.8	27.2 – 136	18.3	1.9 – 34.7	0.07

- Results were comparable for the association between prenatal NO₂ and eNO in the newborns.

Results IV – relevance

What do the results mean?

IQR (25.-75. Percentile)
increase in PM₁₀ is
associated with an
increase in respiratory rate
of 6.4/min (mean 44/min).

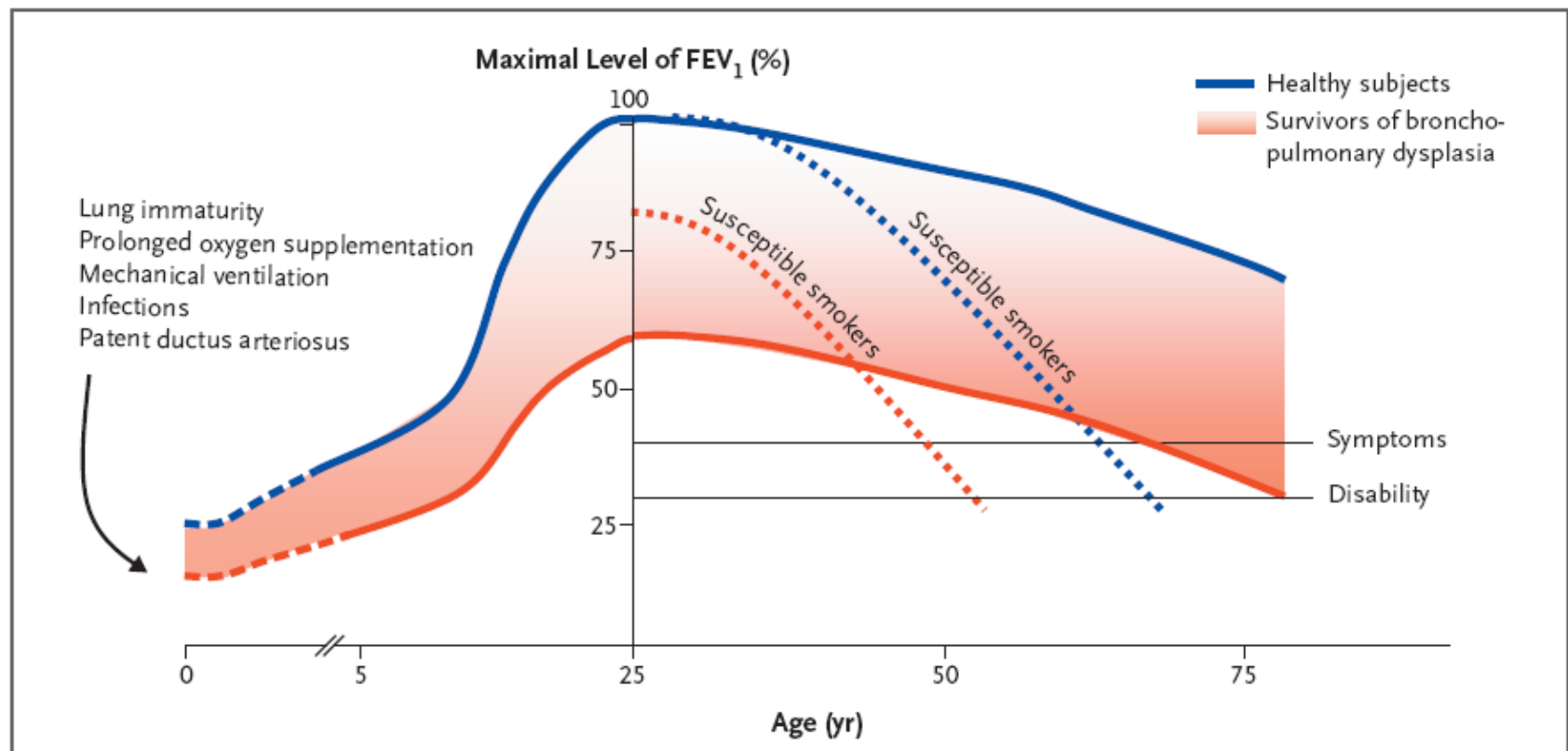


Mean (IQR) Bern: 22 (20-24) µg/m³

Mean (IQR) Mexico-City: 68 (56-92) µg/m³

Possible relevance

“Tracking” of lung function into older age



Baraldi & Fillipone, NEJM 2007

Conclusions

Our results suggest that:

- Prenatal exposure to NO_2 leads to airway inflammation in the newborn (NO)
- Higher levels of PM_{10} during pregnancy lead to increased respiratory need of the newborn
- Effects are more pronounced in infants exposed to additional risk factors
- Later pregnancy seems to be more important

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