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

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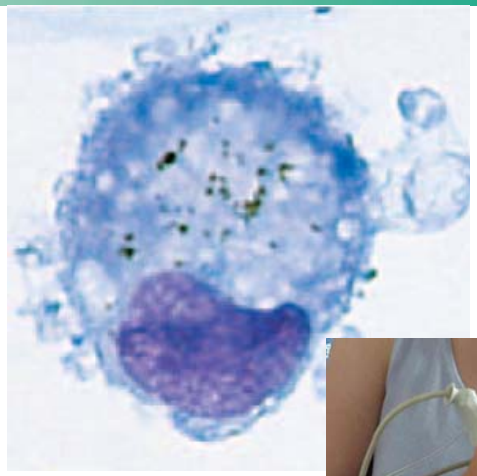

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Effects of air pollution on respiratory health

Acute effects on:

- Symptoms (e.g. cough)[1]
- Lung function in adults (FEV_1)[2]
- Inflammation (eNO)[3]

Chronic effects on lung growth:

- 3200 children in Mexico: regional pollution[4]
- 1150 children in Austria: seasonal exposure[5]

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

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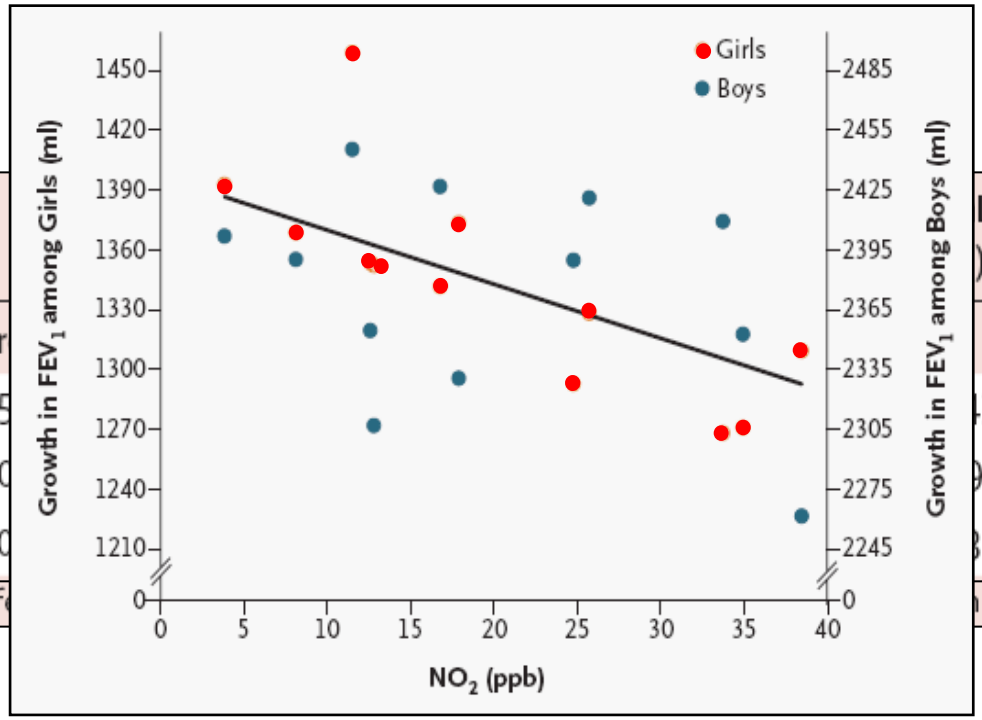
Chronic effects on lung growth

- Californian Health Study, 1700 children, 10-18 years:
  - background pollution[1]:



1 Gauderman et al., NEJM, 2004

2 Gauderman et al., Lancet, 2007

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Growth and development of the airways

- Pre- and early postnatal phase important [1]
- Dependent on genetics and environment[1]
- Effect of prenatal smoke exposure well known[2]
- E.g. on tidal breathing[3] and lung growth[4]
- 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 Respirology, 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

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Question

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

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Subjects

- Prospective birth cohort since 1999

  (unselected term-born infants of healthy mothers)

- Lung function at age 5 weeks (unsedated)

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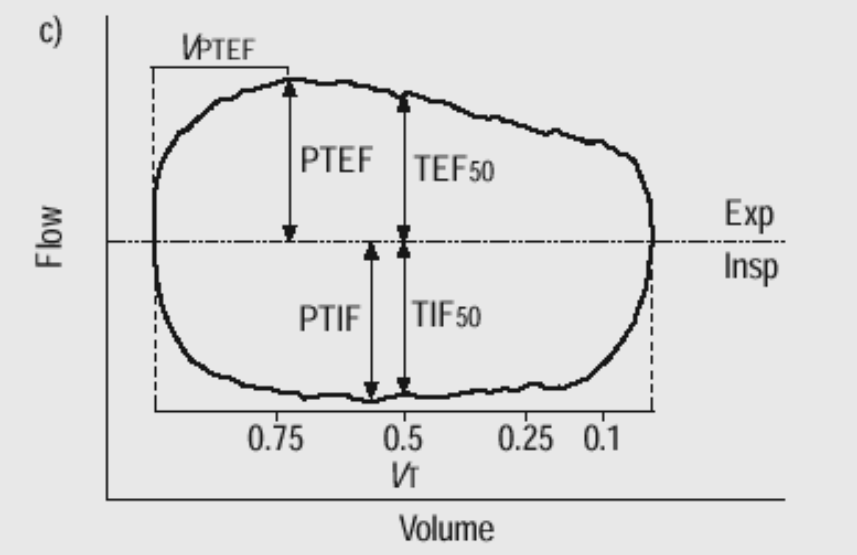
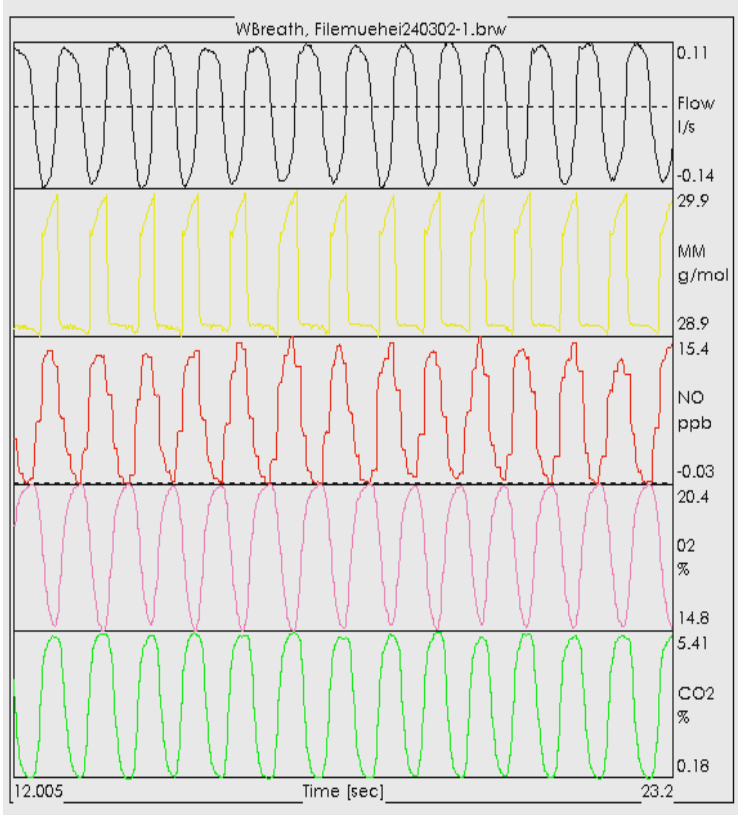
Outcome parameters

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





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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 (O_3), NO_2 & PM_{10}

Spatial variability:

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

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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)

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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 µg/m^3 increase in air pollution
- Results on PM_{10} 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

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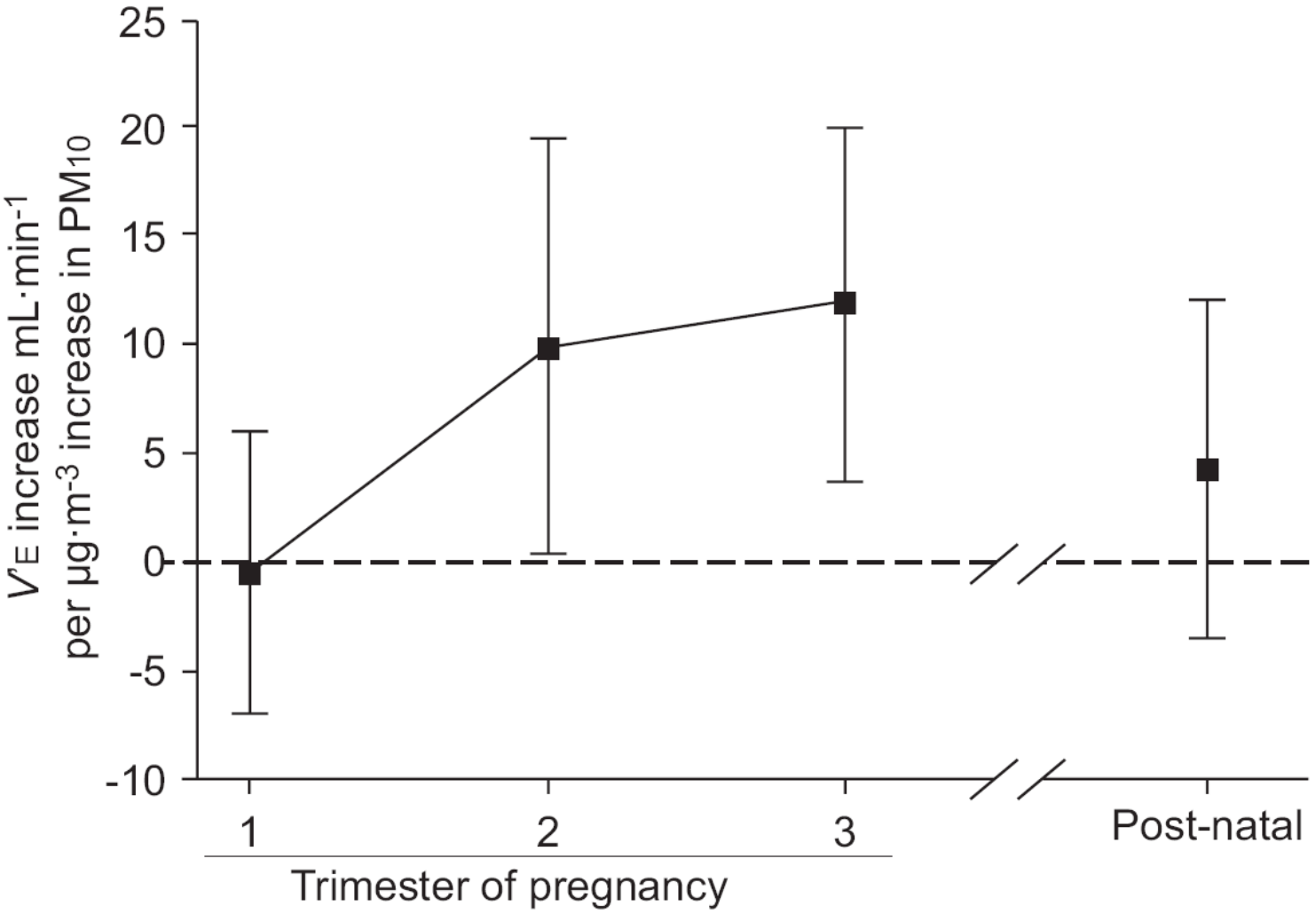
Results II – time of exposure



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Results III – stratification

	Risk factor present		No risk factor		
	coefficient	CI 95%	coefficient	CI 95%	p-value for interaction
PM_{10} and minute ventilation					
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 NO_2 and eNO in the newborns.

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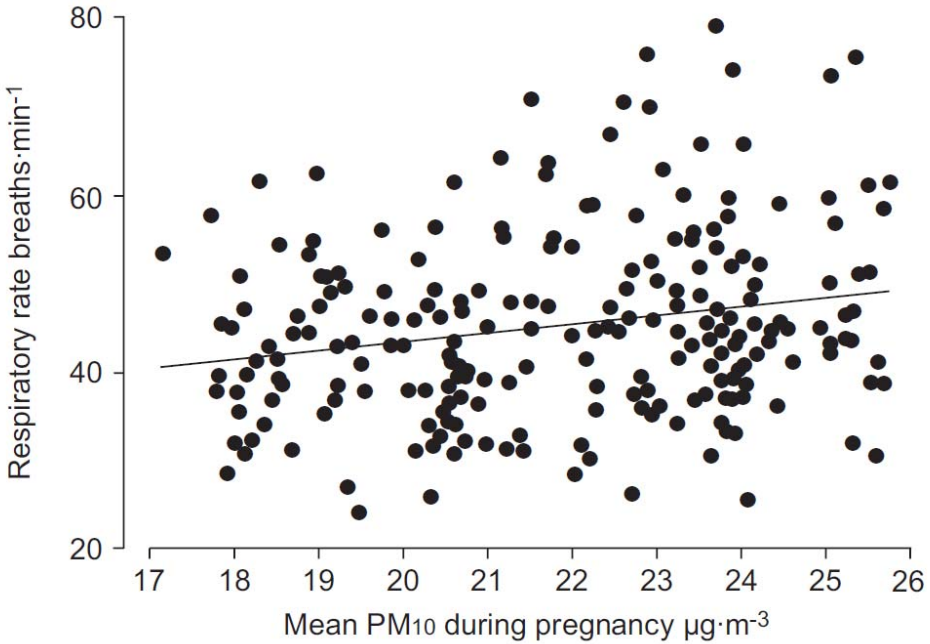
Results IV – relevance

What do the results mean?

IQR (25.-75. Percentile) increase in PM_{10} 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

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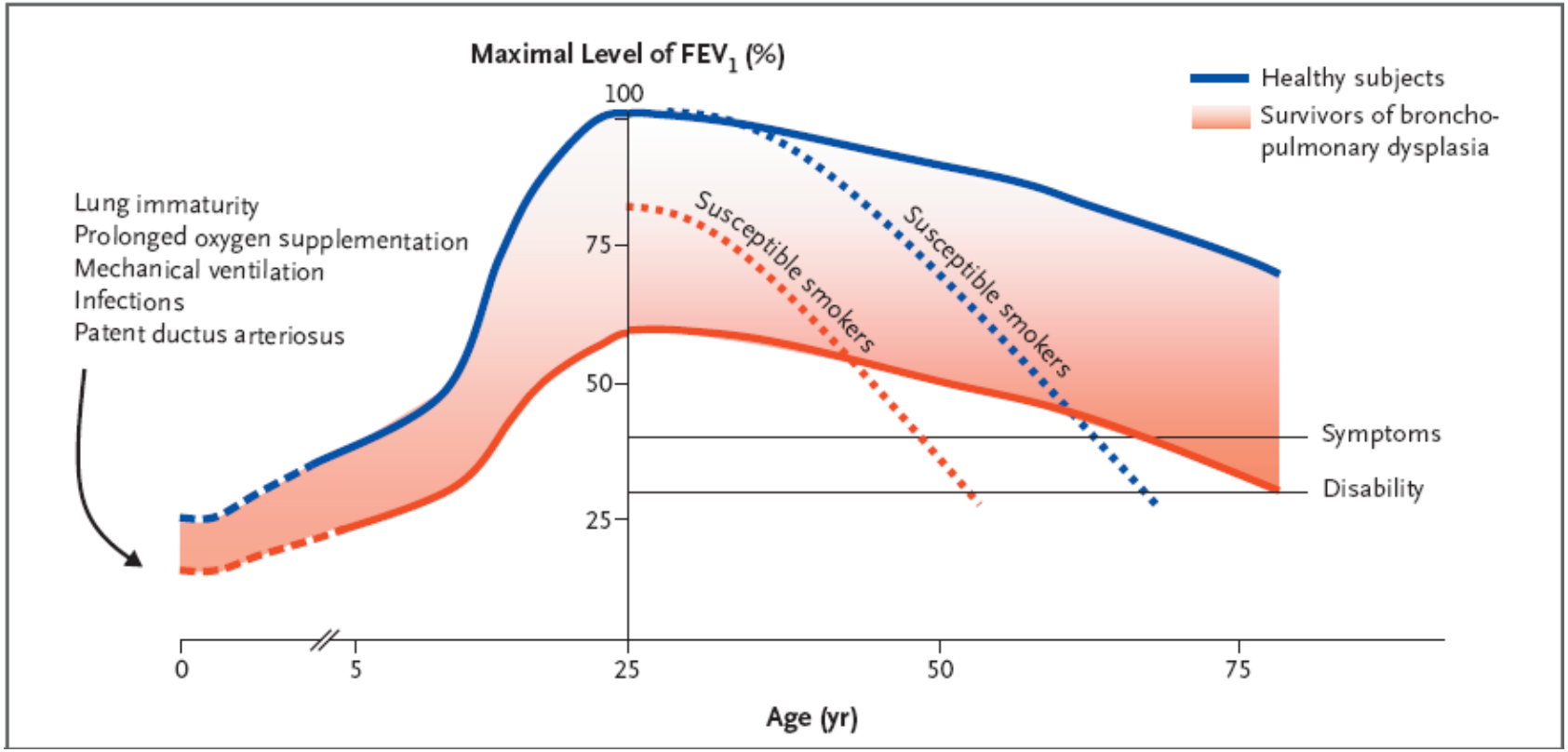
Possible relevance

“Tracking” of lung function into older age



Baraldi & Fillipone, NEJM 2007

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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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