

US EPA ARCHIVE DOCUMENT

# **Air Pollution and Children's Health**

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**Division of Environmental Health**

# Basic Questions

- What does air pollution do?
- What component is doing it?
- Who's it doing it to?
- How much does it take to do it?

# Central Scientific Issues

- Exposure vs. Host Factors
  - Quantify contributions
- Reversibility
  - Continuum of acute→chronic
- Differentiating Association from Causation
  - Unraveling colinearity
  - Ecologic bias

# Reason for Children's Health Study

- Are chronic respiratory effects caused by Southern California air pollution?



# Regional Pollution



Children's Health Study – August 23, 2005 – EPA Region 9

# Local Pollution



Children's Health Study – August 23, 2005 – EPA Region 9

# The USC Children's Health Study



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# The USC Children's Health Study

## Funding:

**California:** Air Resources Board

**Federal:** NIEHS  
NHLBI  
EPA

**Private:** Hastings Foundation

# Children's Health Study Goals

- Is childhood exposure to ambient pollutants associated with:
  - Lung function development?
  - Chronic respiratory symptoms?
  - School absence?
  - Onset of asthma?



# The USC Children's Health Study



Children's Health Study – August 23, 2005 – EPA Region 9

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## Southern California Children's Health Study Ambient Air Quality Monitoring Sites.

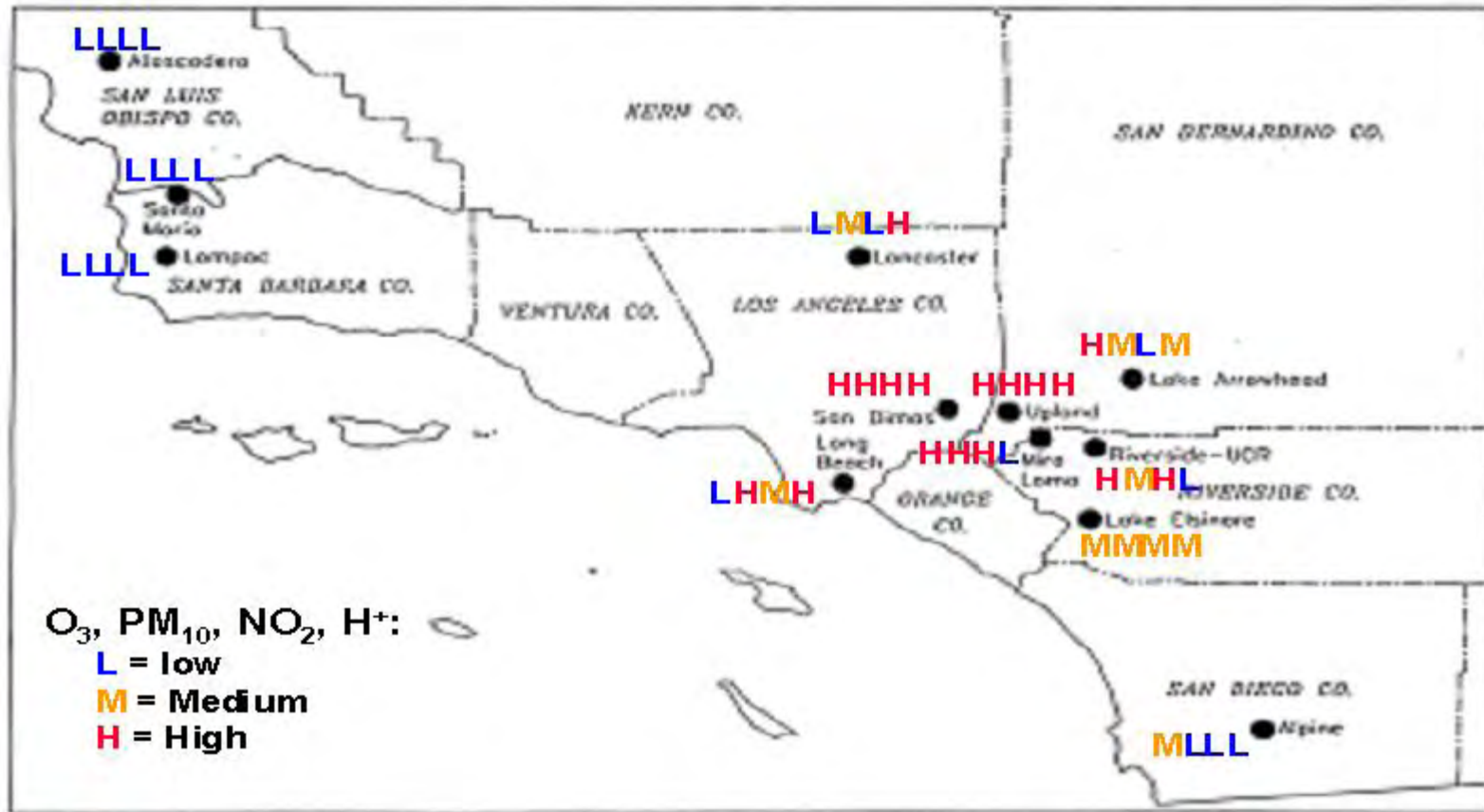


Figure 3-1. Locations of the ambient air monitoring sites.

# Summary of Pollutants

- Continuous monitoring in each study community since 1994
  - Particulate Matter:  $PM_{10}$ ,  $PM_{2.5}$ , EC, OC
  - Nitrogen Dioxide ( $NO_2$ )
  - Acid vapor: Primarily nitric acid
  - Ozone ( $O_3$ )

# Elements of CHS

## Exposure Assessment (Ambient)

- One Station Per Community
  - Hourly  $O_3$
  - Hourly  $NO_2$
  - Hourly  $PM_{10}$
  - Two week  $PM_{2.5}$  mass and chemistry
  - Two week acid vapor



# Elements of CHS

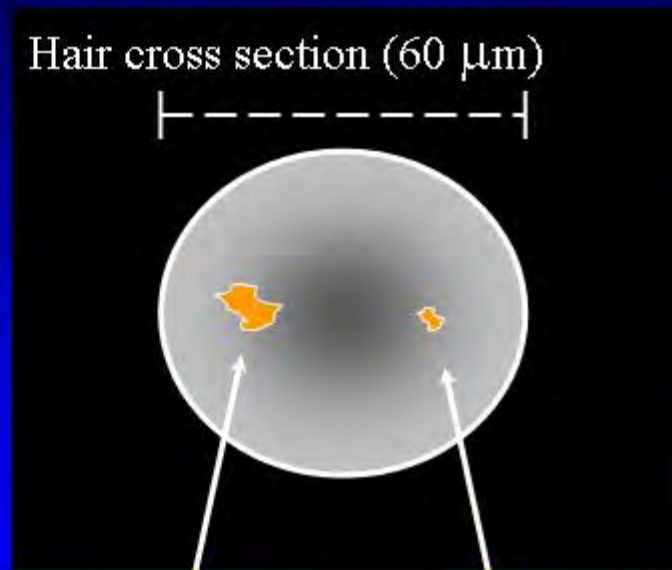
## Exposure Assessment (→ Personal)

- Spatial activity
- Temporal activity
- Physical activity
- Residential history
- Microenvironmental sampling–I/O ratios
- Intra-community variation
- Exposure modeling

# How Small is Particulate Matter?



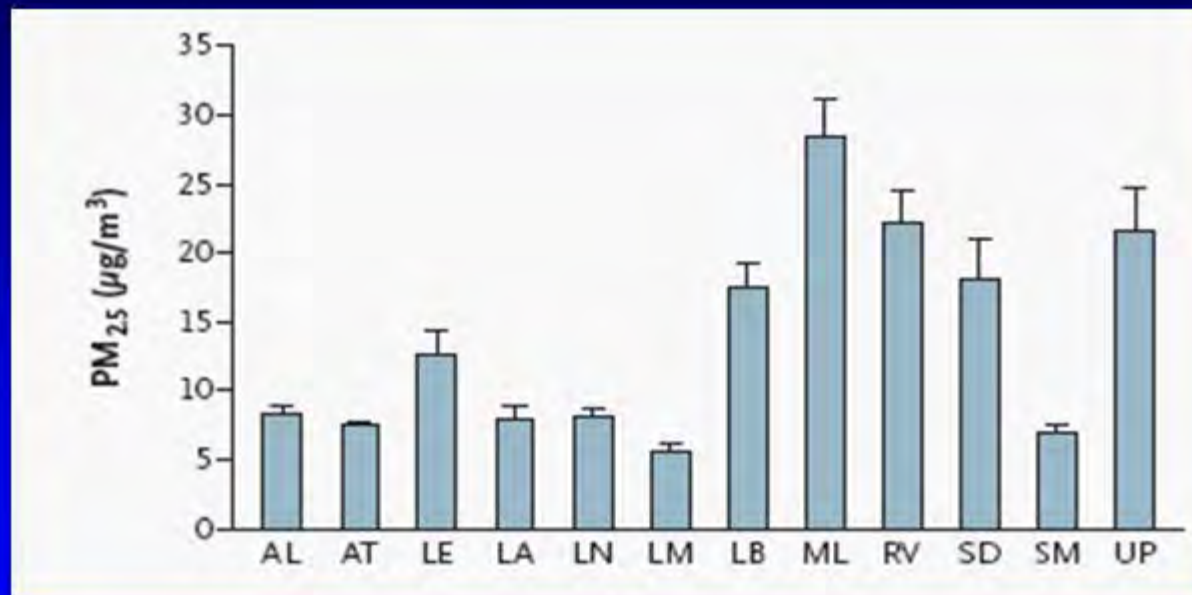
Human Hair  
(60  $\mu\text{m}$  diameter)



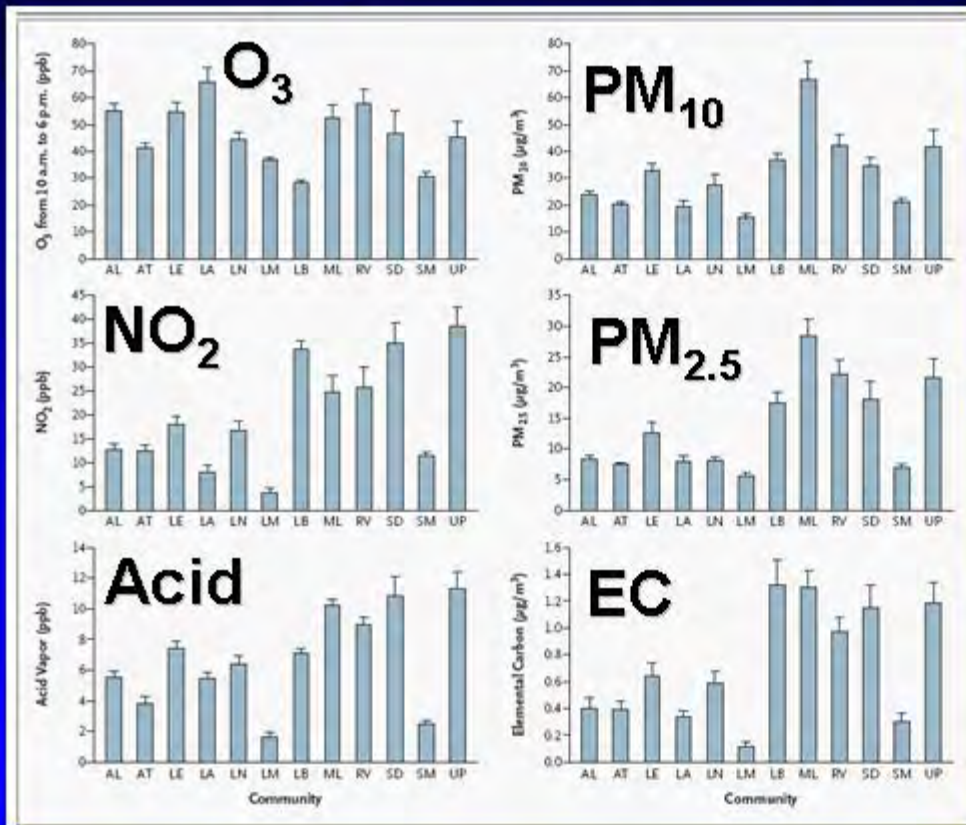
PM10  
(10  $\mu\text{m}$ )

PM2.5  
(2.5  $\mu\text{m}$ )

## Mean PM<sub>2.5</sub> levels, 1994-2000



# Mean pollutant levels, 1994-2000



**Southern California has the full range of most pollutants found in the U.S.**

## Child Groups Studied and Their Ages Each Year

Grade	# Kids	1993	94	95	96	97	98	99	00	01	02	03	04	
4 <sup>th</sup>	1,800	10	→								18			
7 <sup>th</sup>	900	13	→					18						
10 <sup>th</sup>	900	16	→		18									
4 <sup>th</sup>	2,000				10	→							18	

## Children's Health Study Goals

- Is childhood exposure to ambient pollutants associated with:
  - Lung function development?
  - Chronic respiratory symptoms?
  - School absence?
  - Onset of asthma?

# Elements of CHS

## 3 Health Outcomes

### 1. Pulmonary Function Tests (PFT)

Volume & flows assessed annually

### 2. Questionnaire-based

#### Conditions

Asthmatic

Bronchitis

Pneumonia

#### Symptoms

Wheeze

Cough

Sputum

### 3. School absence monitoring

*The* **NEW ENGLAND**  
**JOURNAL** *of* **MEDICINE**

ESTABLISHED IN 1812

SEPTEMBER 9, 2004

VOL. 351 NO. 11

The Effect of Air Pollution on Lung Development  
from 10 to 18 Years of Age

W. James Gauderman, Ph.D., Edward Avol, M.S., Frank Gilliland, M.D., Ph.D., Hita Vora, M.S.,  
Duncan Thomas, Ph.D., Kiros Berhane, Ph.D., Rob McConnell, M.D., Nino Kuenzli, M.D., Fred Lurmann, M.S.,  
Edward Rappaport, M.S., Helene Margolis, Ph.D., David Bates, M.D., and John Peters, M.D.

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ABSTRACT

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The Effect of Air Pollution on Lung Development  
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4 <sup>th</sup>	1,759	10	→ 18											
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10 <sup>th</sup>	900	16	→		18									
4 <sup>th</sup>	2,000				10	→							18	



## Annual lung function testing

4<sup>th</sup> grade through 12<sup>th</sup>

**FEV<sub>1</sub>**: Volume of air exhaled  
in 1 second

## Additional Data...

Active smoking?

Height?

Asthma?

Gas stove?

Respiratory illness?

Passive Smoking?

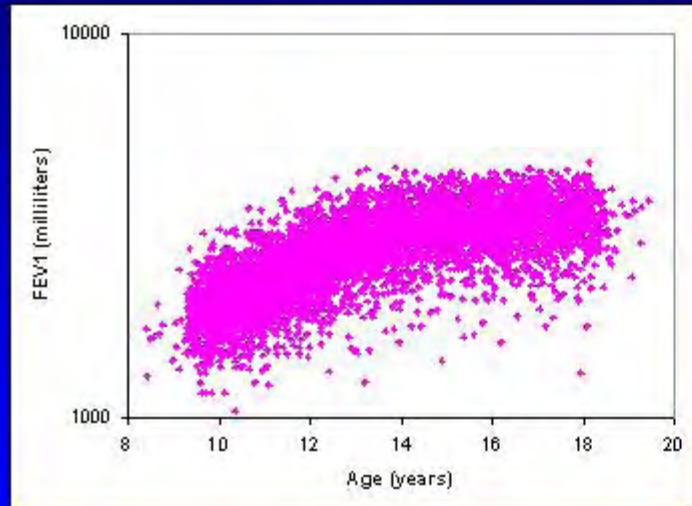
Diet

DNA

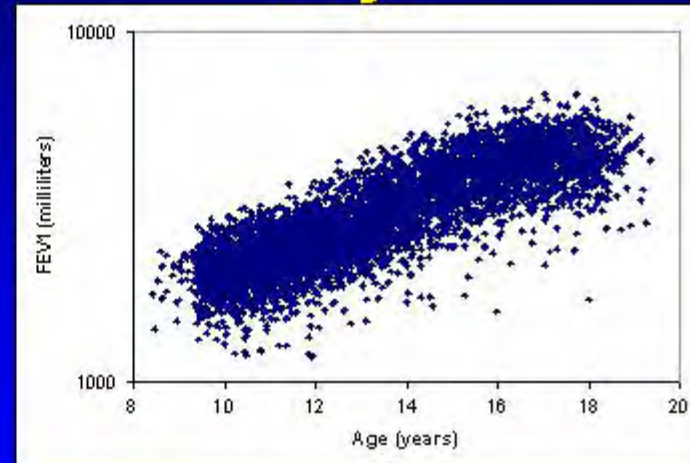


# FEV<sub>1</sub> Growth Over 8 Years

## Girls



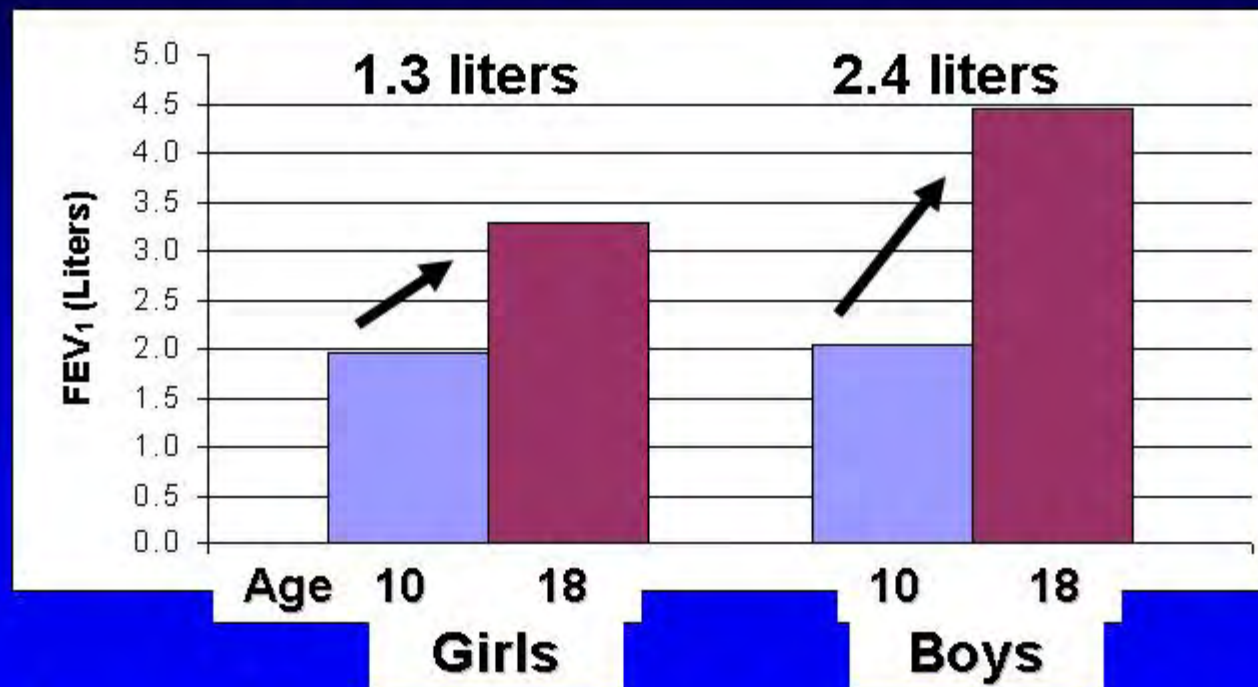
## Boys



# Average FEV<sub>1</sub> in Girls and Boys

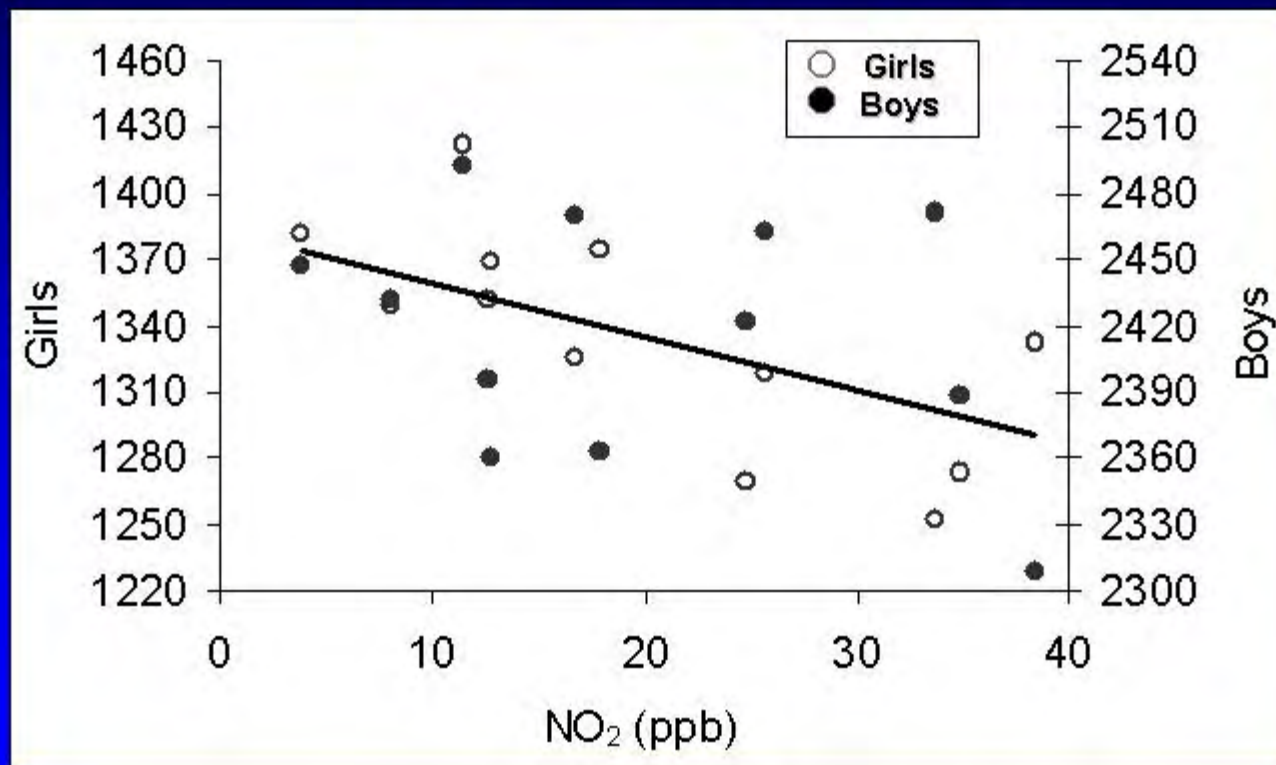


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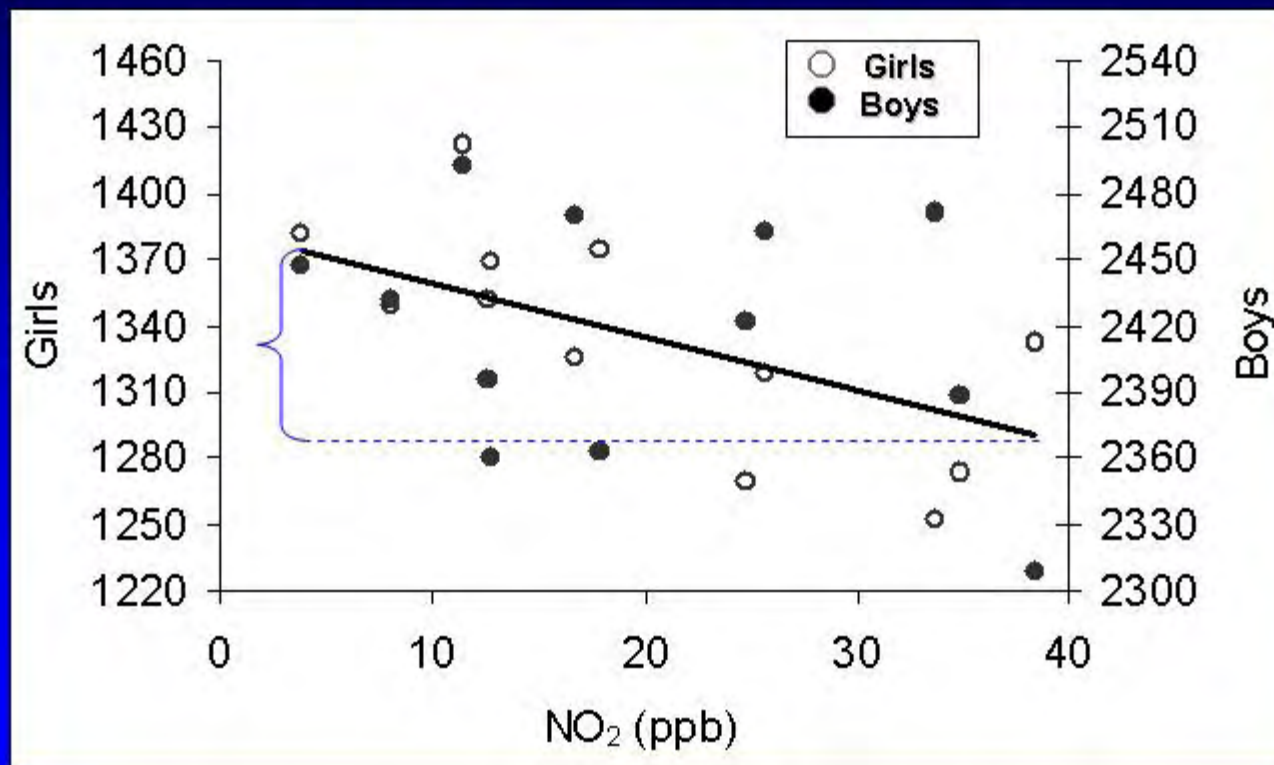


**Key Question:** Does 8-year growth vary across communities with respect to pollution?

# Yes, Pollution Slows Lung Function Growth



# Yes, Pollution Slows Lung Function Growth

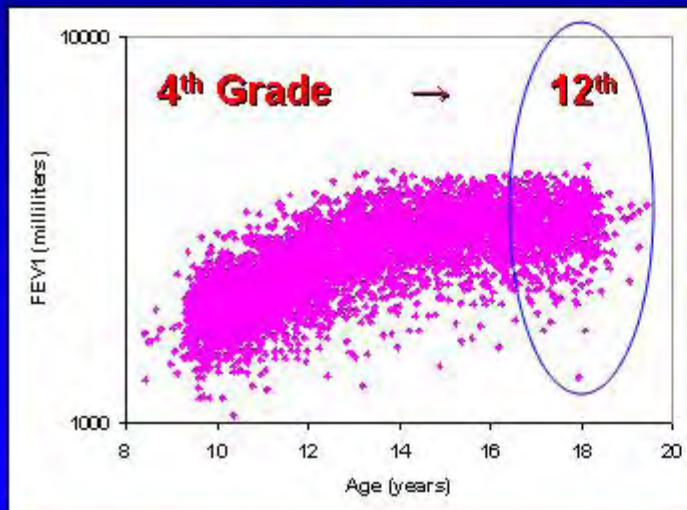




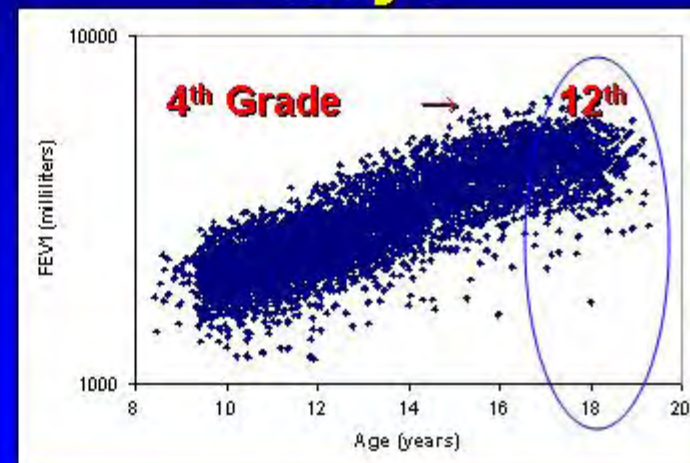
# Deficit in growth: What does it mean?

- Clinically significant deficits at age 18?
  - FEV<sub>1</sub> below 80% of normal?

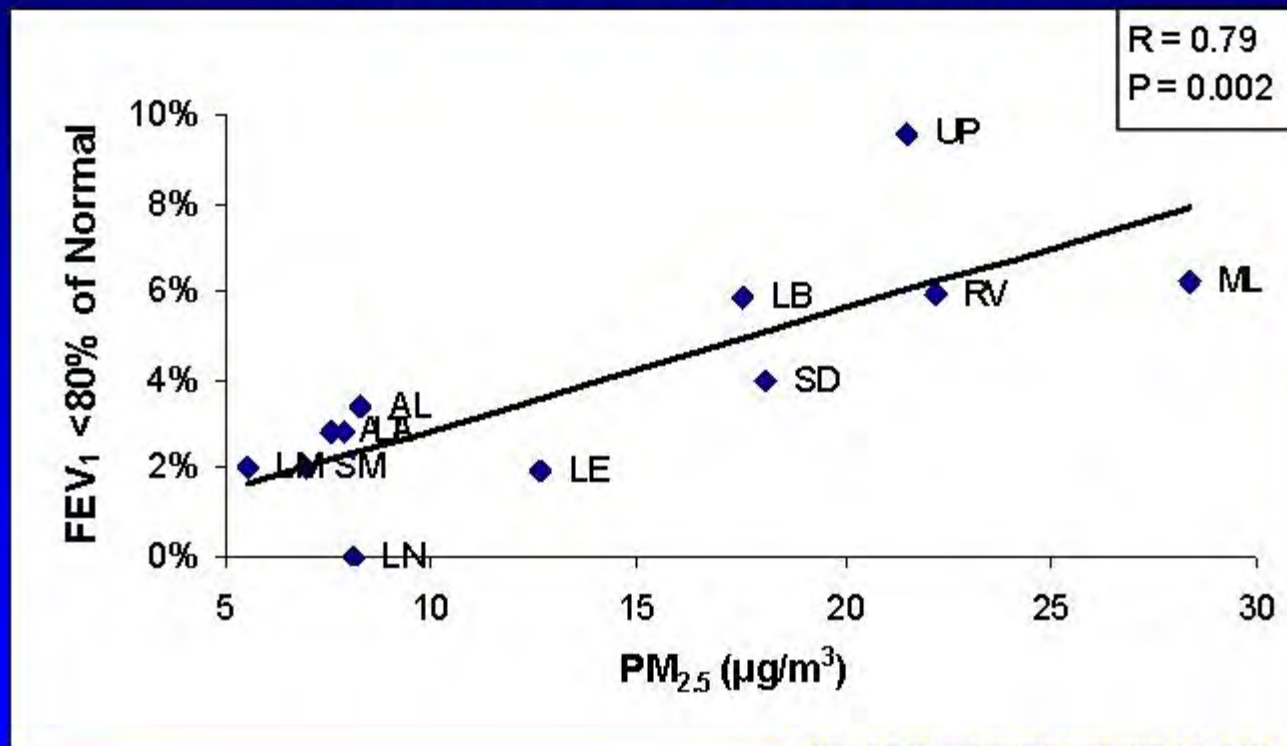
## Girls



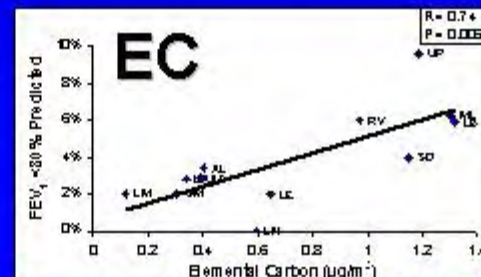
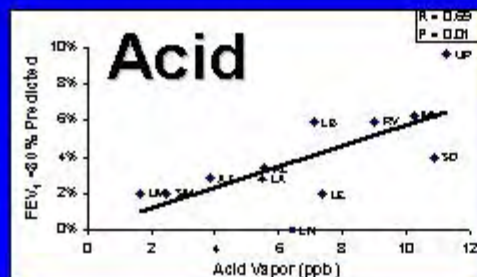
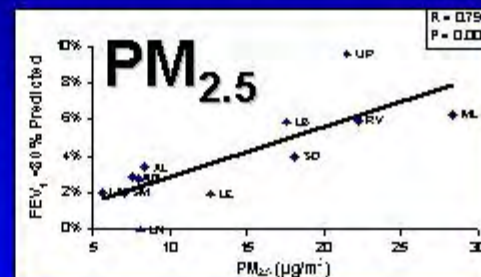
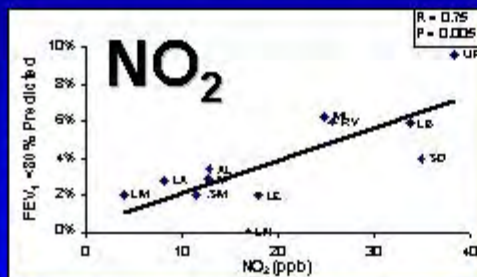
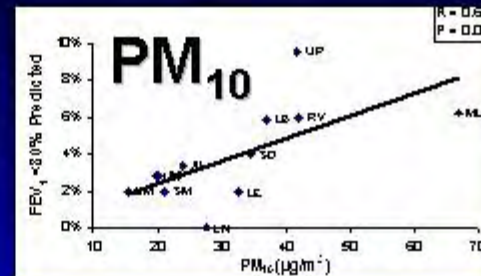
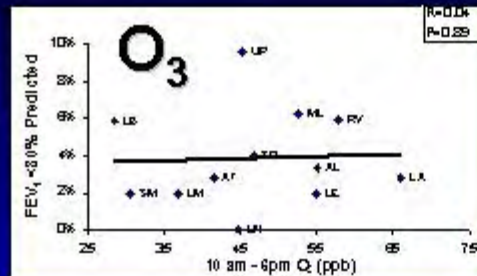
## Boys



**18-year-olds living in polluted communities are 4 to 5 times more likely to have abnormal lung function.**



# Low Lung Function Associated w/ Many Pollutants



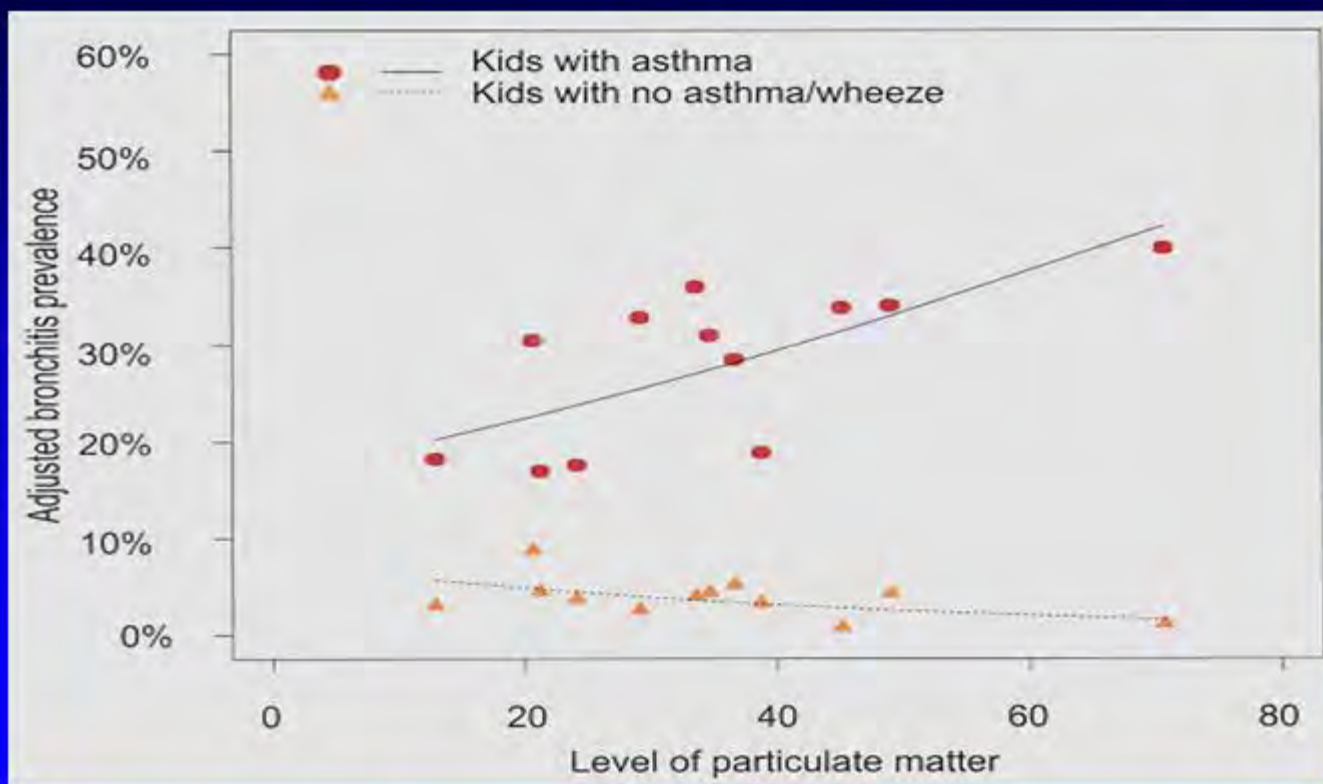
## Other studies of lung function and pollution

- Longitudinal studies (growth)
  - Young children in Poland (Jedrowski et al., 1999)
  - Young children in Austria (Horak et al., 2002)
- Cross-sectional studies
  - 6-cities study (Dockery et al., 1989)
  - 24-cities study (Raizenne et al., 1996)
  - NHANES II (Schwartz, 1989)

## Children's Health Study Goals

- Is childhood exposure to ambient pollutants associated with:
  - Lung function development?
  - **Chronic respiratory symptoms?**
  - School absence?
  - Onset of asthma?

## PM<sub>10</sub> and Bronchitis in Asthmatics



(McConnell, et al., 1999; see also McConnell et al., 2003)

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## Children's Health Study Goals

- Is childhood exposure to ambient pollutants associated with:
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  - Chronic respiratory symptoms?
  - **School absence?**
  - Onset of asthma?

## Ozone and School Absence

- 20 ppb increase in O<sub>3</sub> was associated with an 83% increase in school absence due to acute respiratory disease (Gilliland et al., 2001)
- Large economic impact of pollution-related absences (Hall and Lurmann, 2003)



## Children's Health Study Goals

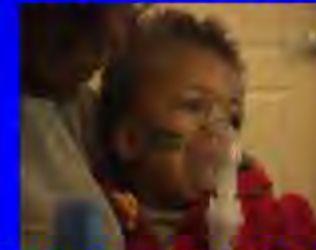
- Is childhood exposure to ambient pollutants associated with:
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  - Chronic respiratory symptoms?
  - School absence?
  - Onset of asthma?

# Ozone and New-onset Asthma



<u>Sports</u>	<u>Low O<sub>3</sub> Towns</u>		<u>High O<sub>3</sub> Towns</u>	
	<u># asthma</u>	<u>RR</u>	<u># asthma</u>	<u>RR</u>
0	58	1.0	46	1.0
1	50	1.3	40	1.3
2	20	0.8	16	1.3
≥3	9	0.8	<b>20</b>	<b>3.3</b>

(McConnell et al., 2002)



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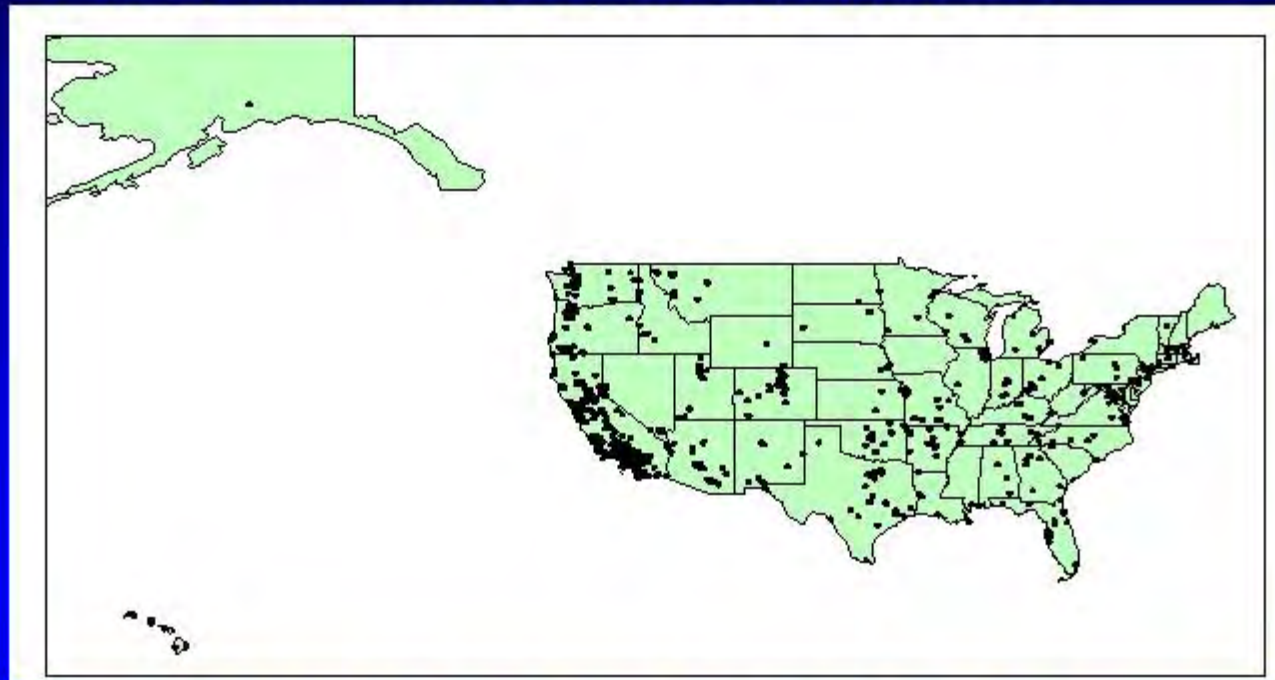
# Will Reductions in Pollution Improve Health?



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# CHS Movers Study

Where have CHS children moved?

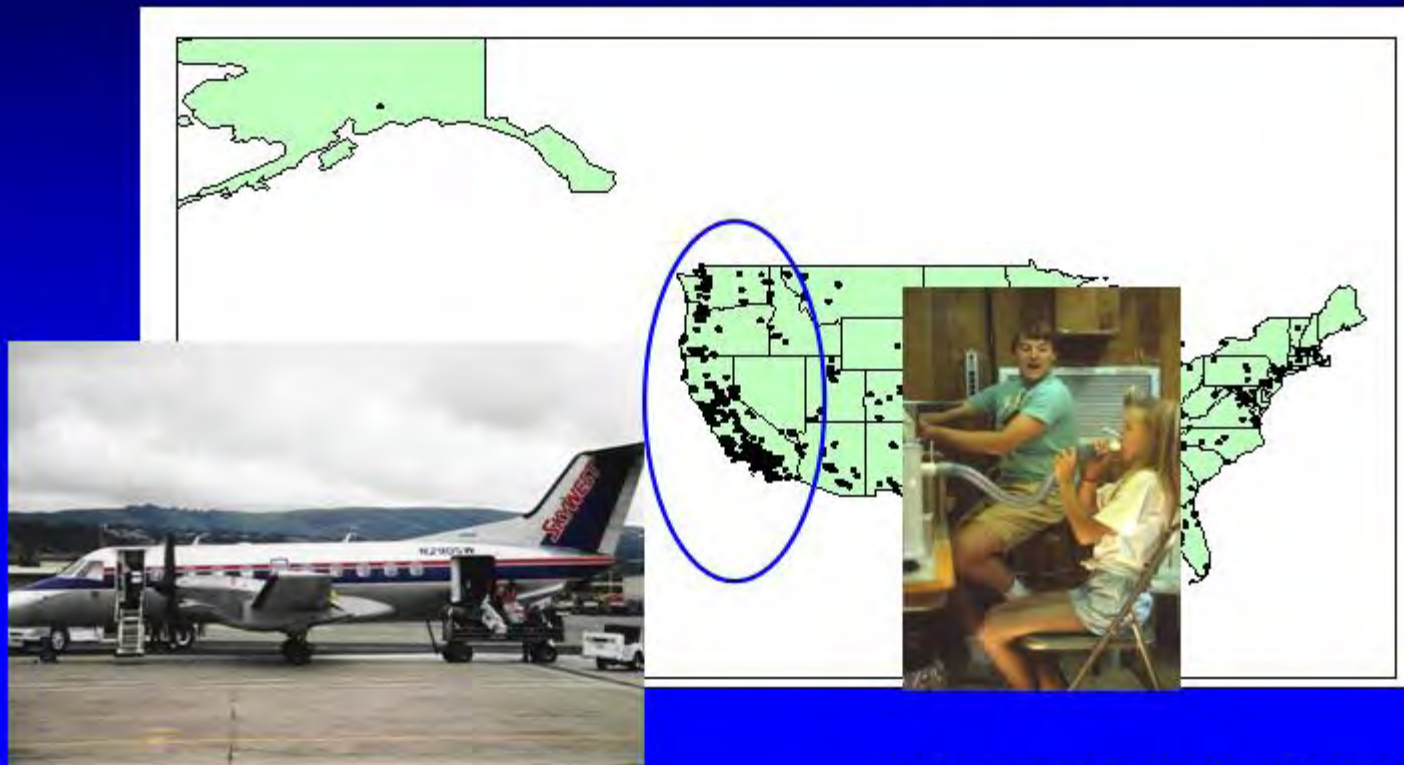


Some to higher pollution, some to lower

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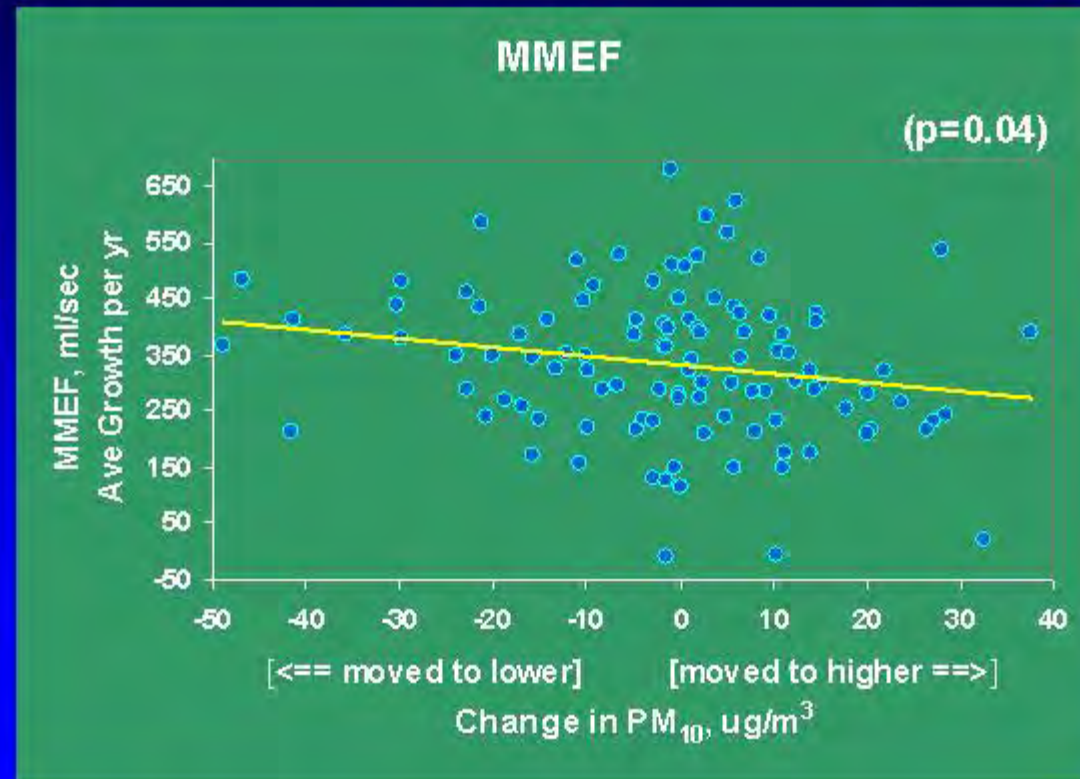
# CHS Movers Study

We tested lung function of 110 movers in the western U.S.



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# Lung Function Growth in Movers



(Avol et al., 2001)

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# Air Pollution and Health

- High pollution communities vs. low pollution
  - Lower lung function
  - Increased symptoms
  - Increased asthma



# What About Local Exposures?



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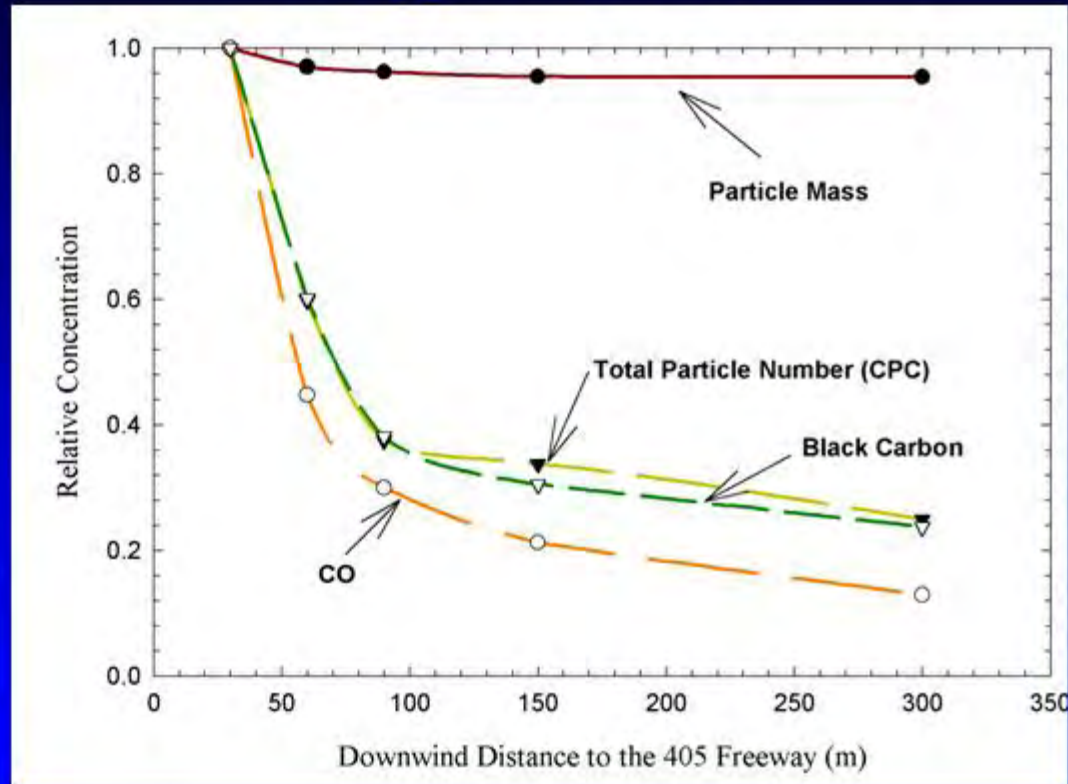


## Local Exposures

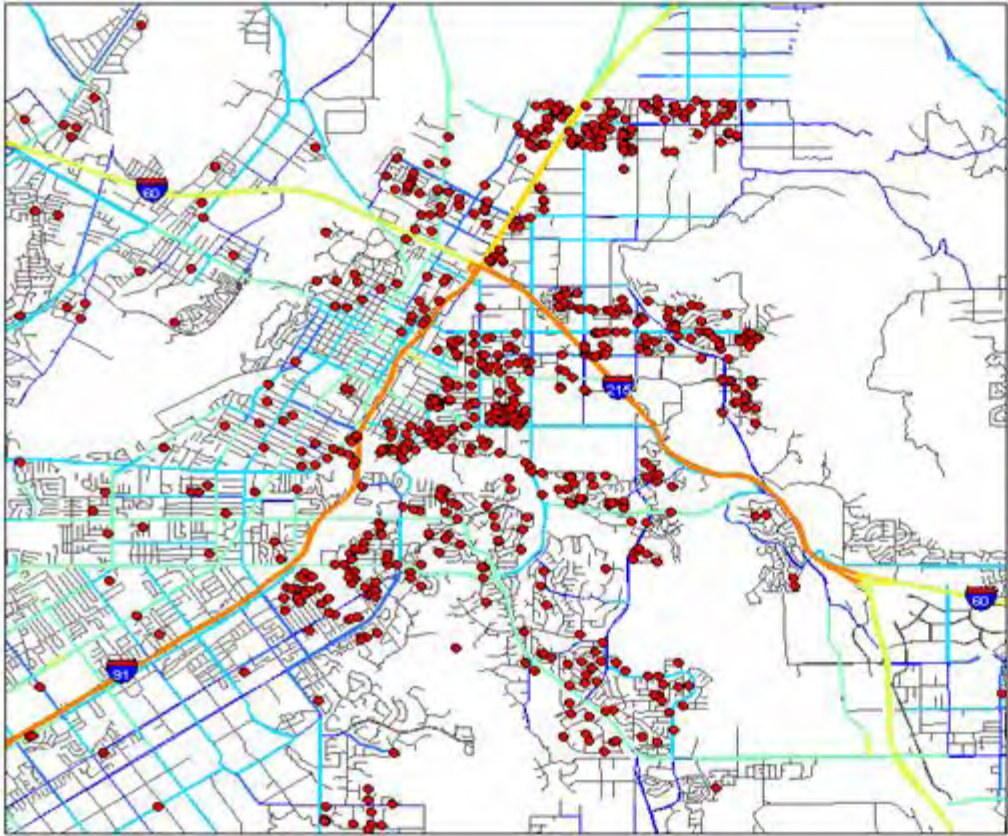
- Several studies in Europe linking traffic exposure to respiratory symptoms
- S.F. bay area study relating pollution exposure at schools to symptoms (Kim et al. 2004)
- We studied residential NO<sub>2</sub>, traffic, and asthma (Gauderman et al., *Epidemiology*, in press)

# PM Dynamics

- Fine particles, CO, and roadside distance



# Riverside



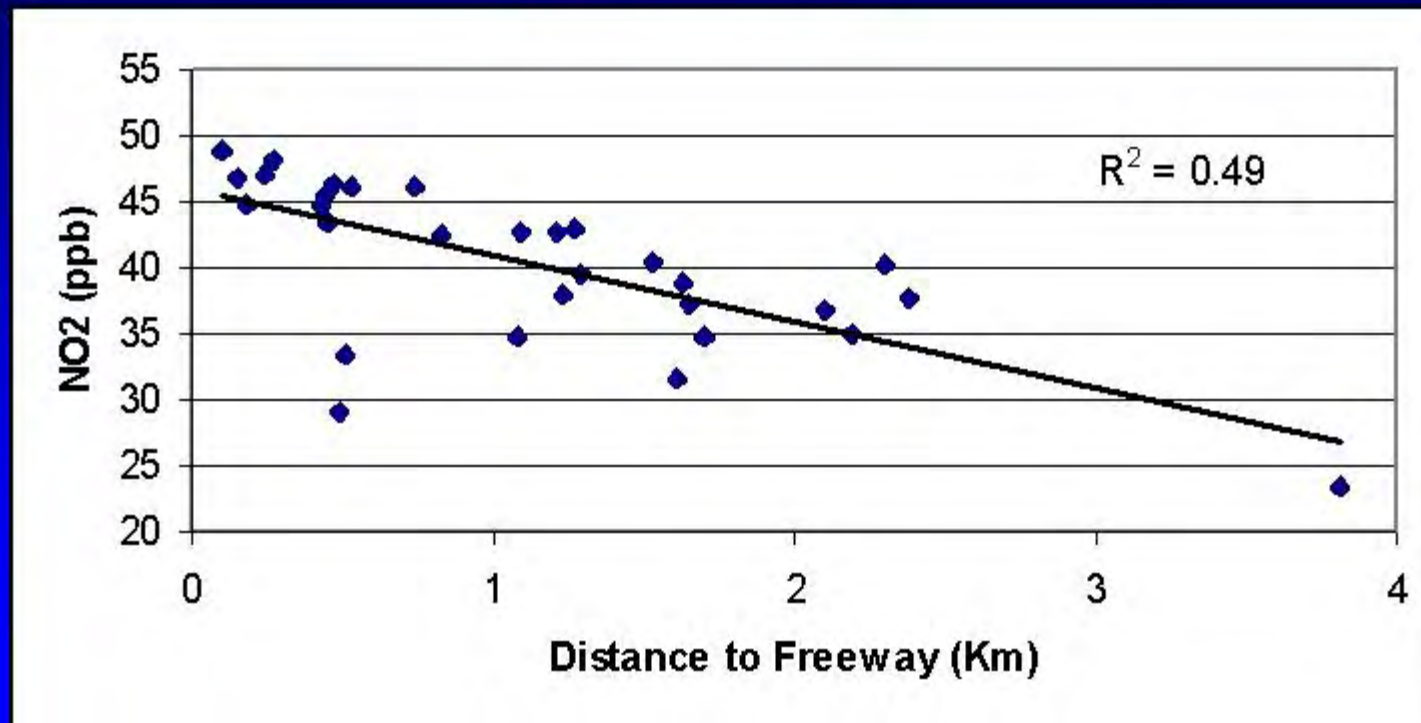
### Legend

- Residence Locations
- TeleAtlas Road Links
- Annual Average Daily Traffic
  - 10 - 3,000
  - 3,001 - 5,000
  - 5,001 - 10,000
  - 10,001 - 25,000
  - 25,001 - 50,000
  - 50,001 - 75,000
  - 75,001 - 150,000
  - 150,001 - 231,000
- Local Road

0 1 2 Kilometers



## Measured NO<sub>2</sub> vs. Distance to Freeway (Riverside)



## How Do NO<sub>2</sub> and Traffic Correlate with Asthma Prevalence?

Exposure metric	Odds Ratio per IQR	
	OR <sup>a</sup>	(95% C.I.)
Measured NO <sub>2</sub>	1.83	(1.04, 3.21)
Distance to Freeway	1.89	(1.19, 3.02)

Gauderman et al., *Epidemiology*, in press

# What Have We Learned About What Pollutant “Causes” What Outcomes?

## OZONE

- School absence for acute respiratory disease
- Asthma medication
- Exercise and asthma incidence

# What Have We Learned About What Pollutant “Causes” What Outcomes?

NO<sub>2</sub>, PM, Acid\*

Part of correlated package of pollutants

- Chronic bronchitis in asthmatics
- Slowed lung growth
- Asthma prevalence
- Clinically significant lung impairment

\* possibly stronger for slowed lung growth

# CHS: Ongoing Studies

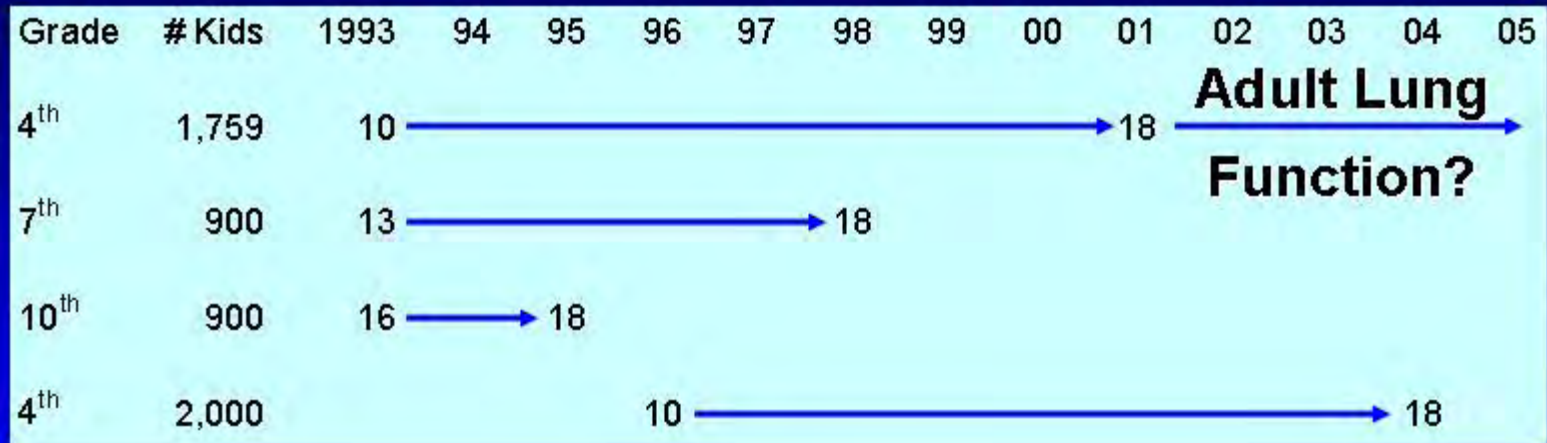
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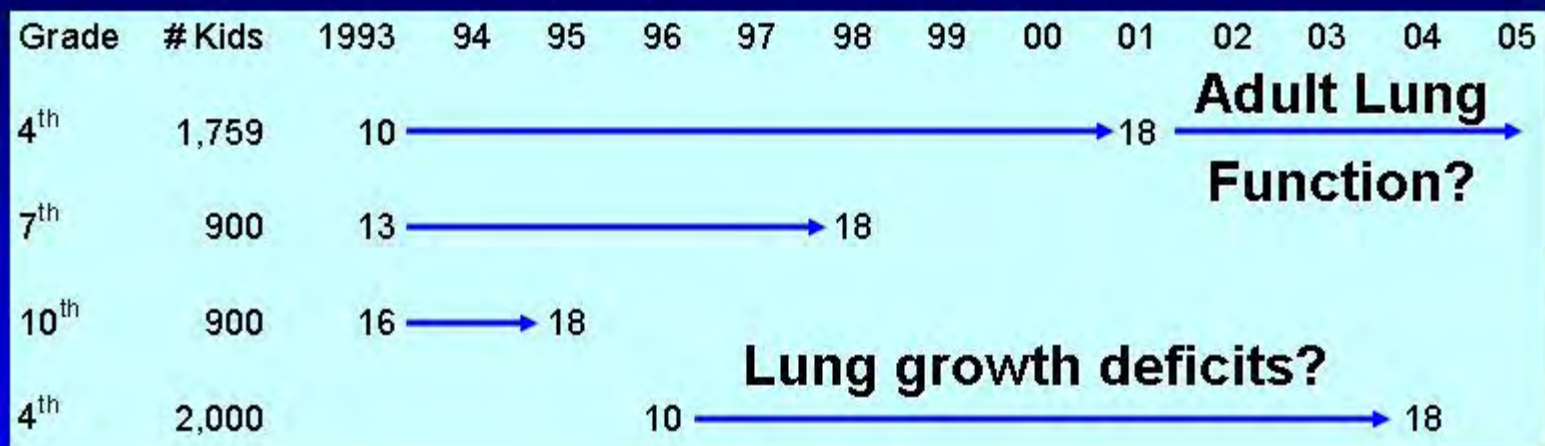
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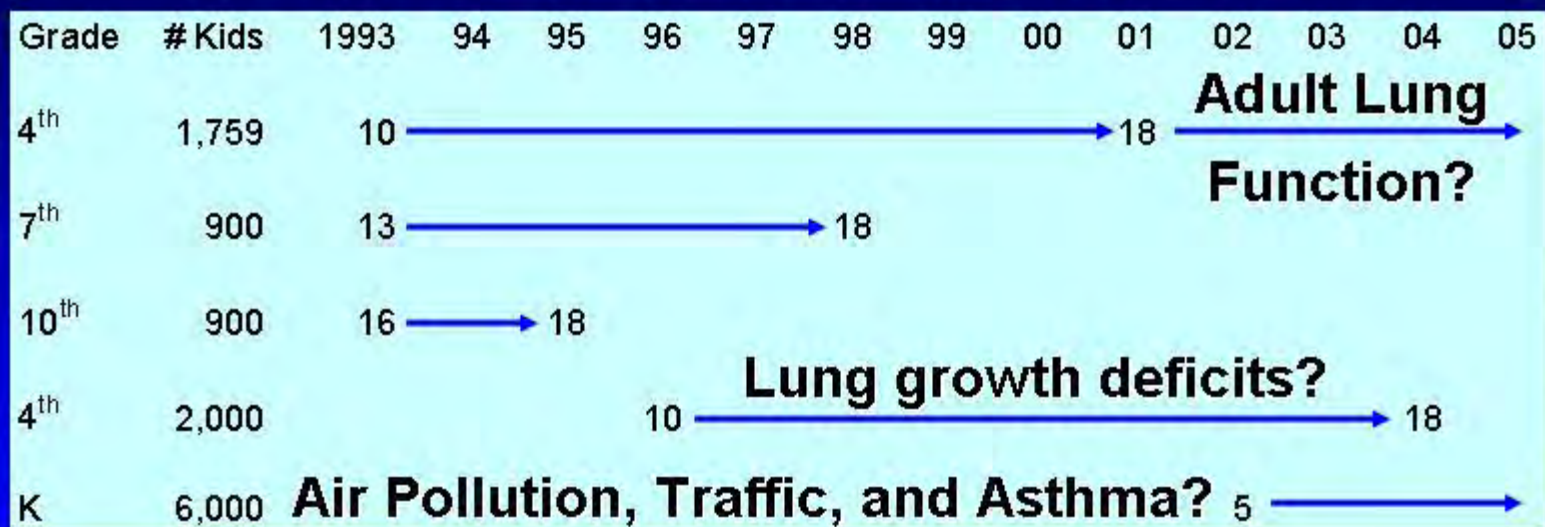
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Grade	# Kids	1993	94	95	96	97	98	99	00	01	02	03	04	05	
4 <sup>th</sup>	1,759	10	→							18	<b>Adult Lung Function?</b>				
7 <sup>th</sup>	900	13	→				18								
10 <sup>th</sup>	900	16	→		18										
4 <sup>th</sup>	2,000				10	→							18	<b>Lung growth deficits?</b>	
K	6,000	<b>Air Pollution, Traffic, and Asthma?</b>									5	→			

**New cohort of kindergarten children**

# CHS: Ongoing Studies

(Funding: NIEHS, NHLBI, EPA)



Genetics: Do genes affect above relationships?

# Summary

- Air pollution associated with acute *and* chronic effects



- Regional and local pollution are important



- Health effects at pollution levels that meet current US/EPA standards

# Summary

- Reductions in air pollution should lead to measurable improvements in children's health



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