Air Pollution Impacts on Infants and Children

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Millions exposed to ambient air pollution above US standards

- Globally, millions of mothers and children are exposed to complex mixtures of particles and gases from traffic and industry.

- US Environmental Protection Agency estimates 120 million people living in counties which exceed US air quality standards.

- The South Coast Air Basin continues to be one of the highest air pollution areas in the US:
  - Currently violates standards for ozone and fine particles.
Pregnancy
Why Study Air Pollution in Relation to Pregnancy?

- Developing organism uniquely sensitive to environmental toxins within a short time window
- Adverse outcomes are common; in US:
  - ~ 10% are preterm
  - ~ 5% are low weight
- Immediate and long term health effects
  - Early life: Impaired lung function, respiratory illnesses
  - Adult life: Cardiovascular disease, diabetes, hypertension
- Tobacco smoke known risk factor
Implications of the Observed Effect of Air Pollution on Birth Weight

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ABSTRACT: The purpose of this study was to ascertain whether air pollution in the Los Angeles Basin is affecting birth weight. The data base for the study consisted of daily air pollutant averages from the Air Pollution Control District of Los Angeles County, California, obstetric records of births at the University of California at Los Angeles Hospital for the year 1973, and smoking information on each gravida. The effect of total pollution level was significantly negatively associated with birth weight after removing the effects of other variables significantly associated with birth weight. Infants born to nonsmoking women who lived in the more polluted areas of the city weigh an average of 314 grams less than infants born to women living in the less polluted areas.
New Studies at UCLA on Pregnancy Outcomes Ongoing since 1996

- One of highest air pollution regions in US
- Large number of births (~half of all CA births, most in LA County)
- Dense air pollution monitoring network
Air Pollution Impacts on Pregnancy Now A Focus of Studies Worldwide

- Since 2000, studies conducted in South Coast Air Basin, Australia, Brazil, Canada, China, Czech Republic, Great Britain, S. Korea, Mexico, US...
Methods Used in Early UCLA Studies

➢ Use birth certificates to identify:
  • Number of births & type of adverse outcome (term low birth weight, preterm birth)
  • Residential location during pregnancy
  • Other risk factors for outcomes we need to accounted for in analysis
    - Maternal age, race/ethnicity, education, parity

➢ Linked to nearest air monitoring station to estimated air pollution exposures during:
  • Entire pregnancy, trimesters, months
Findings: Term Low Birth Weight & Preterm Birth

- For SoCAB births during 1989-1993 and 1994-2000 we saw:
  - Elevation in risk for term low birth weight and preterm birth (10-30% increase)
  - Most consistent for CO and for PM$_{10}$
  - Exposures are important in early and late in pregnancy

![Graph showing risk ratios for CO and PM$_{10}$ at early and late stages of pregnancy]
Environment and Pregnancy Outcome Study (UCLA-EPOS) funded by NIH-NIEHS

- **Question:** Are the associations for preterm births and LBW with CO and PM$_{10}$ due to other risk factors not listed on birth certificates?

- Survey of 2,543 LA County mothers who gave birth in 2003 to normal, low weight, and preterm infants; collected information on
  - smoking and second hand smoke
  - alcohol consumption
  - occupational exposures
  - psychosocial stress
  - indoor air pollution
  - commuting etc.

- **Answer:** NO; adjusting for all known risk factors, the air pollutants are still associated with these outcomes!!
Additional Findings:
Cardiac Birth Defects

- Records obtained from the California Birth Defect Monitoring Program (1987-1993)
- Risk of certain cardiac heart defects increased at high levels of exposure to
  - Carbon monoxide and ventricle septum defects (3-fold increase in risk for highest exposure level)
  - Ozone and aortal and pulmonary artery and valve defects
- Increased risks found for exposures in the 2nd month of pregnancy when the heart forms in a fetus
Are CO, PM\textsubscript{10}, PM\textsubscript{2.5} markers of other unmeasured exhaust toxins from traffic?

- Carbon monoxide (CO) and particles are directly emitted by motor vehicles
- Traffic exhaust is a complex mixture of many unmeasured air toxics, some of whom may be causing health effects
- Freshly emitted ultrafines carry large amounts of air toxics like polycyclic aromatic hydrocarbons (PAHS)
- Ultrafine (nano) particles, penetrate into blood stream, move to other organs, cross blood/brain and possibly the placental barrier
Levels of CO and ultrafine particles elevated in close proximity to roadways

- Ultrafine particle levels are high within ~150 meters of freeways and roadways
- CO levels closely mimic ultrafine levels

Y. Zhu and W. Hinds, UCLA Particle center
Alternative Exposure Measure:
Residential Traffic Density
collaboration with Dr Wilhelm, UCLA


Traffic Density and Preterm Birth/LBW

collaboration with Dr Wilhelm, UCLA

- Mapped home locations for births during 1994-96 in LA
- Estimated Residential traffic density at birth certificate address

Findings:
- ~10% increase in risk for preterm & low weight birth for women residing in close proximity to heavy traffic
- Risk greater for women whose 3rd trimesters fell primarily during fall/winter months when stagnant air conditions prevail
- Women in low-income and disadvantaged neighborhoods especially impacted

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[Graph showing OR (95%CI) for Winter Births only]
Pre-ecclampsia, Very Preterm Births and Traffic Pollution
collaboration with UC Irvine Dr. Wu

- 81,186 birth records from four hospitals (1997-2006) in Los Angeles and Orange Counties
- used a line-source dispersion model (CALINE4) to estimate traffic-generated pollution
  - NOx and PM2.5 during entire pregnancy
- Findings:
  - ~20-40% increase in risk for pre-ecclampsia and 80% increase in very preterm birth near sources of high traffic pollution
Infants and Children
Why Study Air Pollution in Relation to Early Childhood?

- Newborns are most vulnerable to succumb to infant death
  - Lungs are immature at birth until age 6
  - Immune system is immature at birth

- Larger lung surface area per body weight
- Breathe 50% more air per body weight than adults

- Children spend more time outside
  - Particularly in summer, late afternoon
Linked death to birth certificates for infants who died in Southern CA between 1989 and 2000

Based on nearest air monitoring station to birth address, calculated average CO and PM$_{10}$ exposures before death

Findings:

- For each 1 ppm CO increase the risk of respiratory death increased up to 36% 2 weeks before death in early infancy
- For each 10g/m3 increase in PM$_{10}$ up to 12% risk increases for respiratory deaths
- For each 1pphm NO$_2$ increase in sudden infant death syndrome up to 19% 2 months before death.

Low birth weight and preterm infants seemed to be more susceptible to air pollution-related death
Background: Air Pollution Impacts on Respiratory Health in Children

- A growing literature links outdoor air pollution exposure ($O_3$, $PM_{10}$, $PM_{2.5}$, $NO_2$) to:
  - **asthma exacerbations** in children
  - **chronic respiratory problems** (reduction in lung function, slowed lung growth, chronic cough, bronchitis)

- New research focus on **motor vehicle exhaust**
  - UF, PAHs, $NO_x$

- USC Children’s Health Study follows 6,000-10,000 school-aged children in 12 S CA communities
  - Residential proximity to freeways linked to lifetime history of asthma & lower lung function at age 18
California Health Interview Survey (CHIS)
Collaboration with Drs. Meng and Wilhelm (UCLA)


- Data collected in 2001 for
  - 1,391 adolescents and
  - 3,405 children
  in LA and San Diego

- Mapped home locations of ~600 asthmatic children
  in LA and San Diego Counties (2001)

- Estimated residential traffic density
Findings:

• For asthmatic children, living in homes with high traffic volume nearby:
  – *Triples* chance of emergency room visits and hospitalizations for asthma (mostly children under age 6)

• Currently performing additional research using 2003 & 2005 data for all Californian children
In 2001: Cohort of 3,090 families with children in 65 LA census tracts, 2/3 from disadvantaged neighborhoods
  – 345 reported doctor-diagnosis of asthma (~11%)
  – 144 of these reported asthma attacks in past 12 months (~42%)

**Finding: Asthmatics** have a 2-fold increase in **attacks** per 1 ppm increase in CO (ambient station)

In 2006-2008:

- Conducted NO/NO2 passive monitoring at 200 locations in LA FANS neighborhoods in 2 seasons
- Created a **land-use based regression (LUR) model** developed to **predict traffic related exposures**
Prelim. Findings

Increase in traffic pollutant exposures in homes and near schools of LAFANS children is related to

– Increase in asthmatic wheeze

– Decreased lung volume and expiratory flow assessed with portable spirometers
Conclusions

- Growing number of studies from around the world report adverse impacts of air pollution on pregnancy
- Based on our own research in Southern California, pollutants from traffic appear to be the most important
- Traffic pollutants also implicated in worsening respiratory health in children
- This body of research highlights importance of traffic exposure as a public health issue
Traffic Important Public Health Issue

- Growth in population and vehicle miles travelled will challenge pollution reduction measures here and around the world.

**Figure 3: Growth in number of vehicles in China**

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What can pregnant women do to reduce exposure?

- Reduce the time spent in high traffic areas
- On days when air quality is poor, limit time spent outdoors
- Help reduce air pollution by using fuel-efficient vehicles, public transit, or by walking
- Avoid tobacco smoke, obtain early prenatal care
Papers Published by the UCLA-research group

- Wilhelm M, **Ritz, B**. Local Variations In CO And Particulate Air Pollution And Adverse Birth Outcomes In Los Angeles County, California. Environ Health Perspect; 2005 Sep;113(9):1212-21.
Papers Published by the UCLA-research group ....continued

- Hoggatt KJ*, Greenland S, Ritz B. Ambient air pollution and LBW: employing a 2 stage design. In Press: Epidemiology