Traffic, Asthma, and Lung Development
Living Near Busy Roads: What do the health studies tell us?

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Overview

- Introduction - traffic related pollution
- East Bay Children’s Respiratory Health Study – an example
- Other Studies on Health Effects of Living Near Busy Roads
- Policy Implications
Background

- Air pollution affects health
  - respiratory, cardiovascular, cancer, birth
  - regional air monitors often used to estimate exposures

- Traffic-related emissions-major source of air pollution in urban area
  - Contains many pollutants: (gases eg. NO2, ultrafine diesel particles, other toxic air contaminants e.g. acrolein, formaldehyde, benzene, 1,3 butadiene)
  - Includes: respiratory irritants, carcinogens
  - Laboratory studies: diesel gases and oxidant gases enhance IgE response
Traffic-related pollution: higher near and downwind of busy roads

Zhu et al. JAWMA, 2002.
Respiratory Health & Proximity to Traffic

- Over 40 epidemiological studies—many in children, many in Europe but also US - ??
  Applicable in CA

- Measures of traffic exposure
  - Self report
  - Distance to/traffic counts nearby road
  - Spatial model/measured pollutants

- Some health outcomes associated with traffic exposure
  - Increased respiratory symptoms (wheezing, cough)
  - Increased hospital admissions for asthma
  - Decreases in lung function
East Bay Children’s Respiratory Health Study – an example
Regional Air Quality
PM2.5 13.9 μg/m³
PM10 21.8 μg/m³
Ozone 0.081 ppm (8-hr max)

OEHHA: East Bay Children’s Respiratory Health Study

Vehicular AADT
Heavy Duty Truck AADT
AADT (vehicles per day)

0 - 9999
10000 - 24999
25000 - 49999
50000 - 99999
100000 - 330000

School locations
- Far from major road
- Near major road
1111 children in Alameda County:
- 10 elementary schools varying distance from freeway. Health questionnaire, monitored neighborhood levels of traffic pollutants at school- fall & spring
- Multivariate logistic regression analysis

In an area with good regional air quality:
- Levels of traffic pollutants up to 1.5 to 2x higher at locations near & downwind of freeway.
- Children from schools/neighborhoods with ↑ levels of traffic pollutants have an ↑ risk of bronchitis and current asthma
East Bay Children’s Respiratory Health Study – part 2

• Previous study used group level estimates of exposure based on neighborhood (school) levels of traffic pollutants

• Followup study
  – Same study population
  – Estimates traffic exposures on individual level based on traffic near residence
  – Evaluates associations between HOME exposures to nearby traffic and asthma symptoms in the last year
Methods:
Estimates of traffic exposure

- Development of Metrics:
  - Geo-coded home address
  - Circular buffer radius
  - Tried different Traffic Metrics
    - Highest daily traffic w/in 150 m
    - Traffic on closest road w/in 150 m
    - Traffic density w/in 150 m
    - Distance to major road

- For a subset of locations, determined how well metric correlated with measured levels.
Traffic exposures: measured vs estimated

- Traffic pollutants (NOx, NO2) at 52 outdoor sites (10 schools, 42 locations in 3 neighborhoods)
- Found increased levels of traffic pollutants near & downwind of freeway
- Confirmed computer-generated traffic metrics correlated

B Singer et al. Atmos Environ 2004; 38:393-403
Methods: Estimates of traffic exposures (continued)

- Developed land use regression model of NO2 to estimate residential outdoor NO2
  - model variables evaluated included:
    - traffic density within given radius
    - wind direction
    - land use indicator
    - urban impervious factor
Methods: (continued)

• Health outcome
  – Current asthma (history of doctor’s diagnosed asthma and asthma symptoms within last 12 months based on health questionnaire)

• Health analysis: mult-variate logistic regression

• Examine associations between residential traffic and current asthma
  - Model covariates evaluated included risk factors previously identified such as: (e.g., family history of asthma, demographics, early childhood factors, health insurance status and home environmental factors e.g. smoking in home, mold, pets, etc)
Results:

- Higher rates of asthma symptoms with increasing residential traffic:
  - Odds of asthma symptoms (highest 20% vs lowest 20%) adjusted for family hx, home environmental factors, demographics
    \[ \text{OR}_{\text{adj}} : 2.3 \ (95\% \ CI \ 1.0, \ 5.4) \]
- Highest risks among those living < 75 m of freeway
- Modeled residential NO2 also associated with increased asthma
East Bay Kids Summary

• In a region with good AQ, neighborhood level traffic associated with resp symptoms

• Residential traffic associated with increased risk of current asthma

• Risk greatest for those living within 75 m of a freeway
  – Kim et al. ARJCCM 2004
  – Kim et al. Env Health Perspect 2008
The Team

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**East Bay Kids Partners**
- 3 school districts
- 10 schools
- 64 teachers
- parents & kids

**Funding**
- US EPA Region IX
- CA Air Resources Board
Other CA studies: proximity to traffic and asthma

- Increased doctor’s visits for asthma among Medical Cal children San Diego County Among those with traffic flow >41,000 vehicles/day within 550 ft (160 m) buffer (P English et al. Env Health Perspect. 1999)
- Repeated respiratory hospitalizations in asthmatic children living within 300 m of a major road – Orange County (Chang et al. Occup Environ Med 2008:66 90-98)
USC Children’s Health Study
Other CA studies: proximity to traffic and asthma: USC Children’s Health Study

- Gauderman et al., Epidemiology, 2005
  - Subset of children (n= 208) from 12 communities
  - Increased risk of asthma ever-diagnosed
    - among those closer to freeway

- McConnell et al., Env Health perspect 2006
  - New cohort – 13 communities in So CA (n >5000)
  - Increased risk of life-time & current asthma
    among those living within 75 m of a major road (freeway/highway/arterial) vs >300 m
Other CA studies: proximity to traffic and lung function

- **USC Children’s Health Study (Gauderman et al Lancet 2007))**
  - Original cohort – 12 communities in So CA
  - Followed lung function yearly for 8 years
  - Compared lung function growth at age 18
    - Previously – those from communities with
      - Higher NO2, PM, acid vapor had higher percentage with deficits in lung function e.g. FEV1
    - **This study- those within 500 m of freeway**
      - Had larger deficits in FEV1 and MMEF
Respiratory Health & Proximity to Traffic – truck vs car

- **Dutch study** (N Janssen, B Bruekreef et al Env Health Perpect, 2003, 111:1212-1318)

  Children (n=2083) from 24 schools located within 400 m of major roads with a range of car traffic and truck traffic. (Homes < 1km from major roads)

  Resp symptoms, conjuctivitis, and allergy to pollens (skin test) were increased in communities near high *truck* traffic counts but not high car traffic counts

  aOR (wheeze) 1.96 (0.88-4.38)    truck traffic
  aOR (wheeze) 0.58 (0.27-1.15)    car traffic
Residential proximity to Traffic & Other Adverse Health Impacts

- Newer studies finding links between residential proximity to traffic and
  - death due to heart or lung disease (Netherlands)
  - stroke (UK)
  - cancer (Sweden, Denmark, US)
  - premature births (Los Angeles, CA, Wilhelm & Ritz)
Randomized, crossover study of 60 mild to moderate asthmatic adults in London McCreanor et al. NEJM 2007
- 2 hr walk along Oxford Street- diesel traffic only or 2 hr walk Hyde Park on a separate day

Measured-traffic pollution exposures (ultrafine and NO2) and lung function and biomarkers of inflammation

Outcomes after Oxford walks compared with Hyde Park walks
- Oxford walks- higher traffic pollution
  - small but significant decreased FEV1 and FVC up to 22 h after exposure
  - increase in sputum myeloperoxidase

Respiratory effects of short term exposure to diesel traffic in asthmatics
Proposed mechanism - role of traffic pollutants in enhance allergic response

- NO2, DEP enhances recall IgE response in sensitized individuals
- DEP Induces an IgE response to new antigen

Krishna & Holgate 1999
Traffic pollution genetics and asthma and lung development in children

- USC Children’s health study
- TGF—beta 1 variants associated with lifetime asthma. Effect increased in those living within 500 m of freeway
- glutathione S-transferase (GST) and microsomal epoxide hydrolase (EPHX) increase susceptibility to development of asthma. Effects greatest among those <75 m from a major road

Salam et al. AJRCCM 2007
Salam et al. Thorax 2007
Sandstrom and Kelley editorial Thorax 2009
California’s Children: Proximity to Traffic

Children live & play near busy roads
(photo, courtesy A Hricko, USC)

Schools are located near busy roads

High exposure in traffic & diesel school buses
California’s Children: Proximity to Traffic & Environmental Justice

- **CDHS study**: RB Gunier et al. *J Expo Anal Environ Epidemiol.* 2003
  - In CA—children of low income & children of color 3X more likely to live in high-traffic density areas

- **OEHHA study**: RS Green et al, *Environ Health Perspect* 2004
  - Proximity of CA public schools to busy roads
  - Schools located near busy roads have a disproportionate number of children economically disadvantaged and nonwhite
Proximity to traffic & health risks, information for policy makers

• OEHHA/DHS/ARB traffic fact sheets:
  – Air Pollution from Nearby Traffic and Children’s Health: Information for Parents & Schools

• CA legislation enacted January 2004
  – SB 352 (Escutia) limits new school sites within 500 ft. (168 m) of a freeway

• Air Resources Board (ARB) efforts
  – focus on diesel emissions reduction
  – limit diesel idling near schools/residences
Proximity to traffic & health risks, information for policy makers (cont)

- Land use decisions often made by local government
  - ARB guidance document: Air Quality and Land Use Handbook: A Community Health Perspective."
    www.arb.ca.gov/ch/landuse.htm

  - San Francisco Board adopts air pollution hot spot rule November 2008
    - Requires developers to take into account traffic in CEQA
    - Requires mitigation (HVAC) if a traffic model of PM2.5 exceeds 0.2 mcg/m3 over ambient
Proximity to traffic & health: some unresolved issues

- Levels of traffic pollutants on some high traffic streets may equal levels near freeways – what constitutes a “busy road” – risks difficult to quantify

- Source control: traffic exhaust, a complex mixture
  - What pollutant(s) are causing health impacts

- Ongoing studies to evaluate role of ventilation filtration systems to reduce exposures
Thank You!