Traffic Density, Frequent Asthma Symptoms, and Asthma-Related Emergency Room Visits or Hospitalizations

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Background

- **Part of a CDC/ATSDR-funded study "Uncontrolled Asthma and Exposure to Air Pollutants"**
- **Research Team**
  - Ying-Ying Meng, DrPH; Beate Ritz, MD, PhD; Paul English, PhD; E. Richard Brown, PhD; Michelle Wilhelm, PhD; Rudy Rull, PhD; Marlena Kane

The 2001 California Health Interview Survey

- CHIS is a biannual survey of the California population and employs a two-stage, geographically stratified random-digit-dial (RDD) sample design for its primary survey.
  - Between November 2000 & September 2001, 55,428 households completed the survey in either English, Spanish, or one of four Asian languages.
    - Respondents were asked to name the zip code of residence.
  - Obtained demographic, health-related behavior, health status & condition, access to health care, and insurance coverage information.
- Los Angeles and San Diego County respondents were asked to name the street of residence and the nearest cross-street.
  - 19,664 individuals from 14,868 households surveyed.
  - Sample of 1 adult per household, and included 1,391 adolescents and 3,405 children.

Asthma Outcomes

- CHIS respondents were asked to report whether they had ever been diagnosed with asthma by a physician.
  - **11.4% (n = 2,237) in San Diego and Los Angeles Counties.**

- If yes, respondents were also asked about:
  - The frequency of asthma symptoms such as coughing, wheezing, shortness of breath, chest tightness, or phlegm over the previous 12 months.
  - Whether they had ever visited a hospital emergency room (ER) or been hospitalized due to asthma during this period.

- Responses were used to generate two study outcomes:
  - Daily or weekly (persistent) vs. less than weekly (intermittent) symptoms. (GINA categories)
  - Asthma-related ER visit or hospitalization vs. none.

Distribution of Asthma-Related Outcomes

Total	Daily or Weekly Symptoms 428 (19.4%) of 2204		ER Visit or Hospitalization 192 (8.6%) of 2237	
	n	Percent	n	Percent
Los Angeles County	342	19.2%	162	8.9%
San Diego County	86	20.5%	30	7.1%
Age ≤ 17	56	9.3%	68	**11.1%**
Age 18-34	71	15.6%	37	8.1%
Age 35-64	211	23.2%	71	7.7%
Age ≥ 65+	90	**37.5%**	16	6.5%
Male	156	17.4%	71	7.8%
Female	272	20.8%	121	9.1%
Latino	66	15.5%	45	**10.4%**
Asian/Other	50	16.6%	30	9.8%
African American	50	16.5%	39	**12.7%**
White	262	**22.4%**	78	6.6%
< 100% FPL	86	**27.5%**	40	**12.6%**
100-299% FPL	140	19.5%	76	10.4%
≥ 300%+ FPL	202	15.4%	76	6.4%
Currently Uninsured	40	17.6%	17	7.3%
Unins. Anytime Past 12 Months	18	16.8%	12	11.2%
Insured All Past 12 Months	370	19.8%	163	8.6%

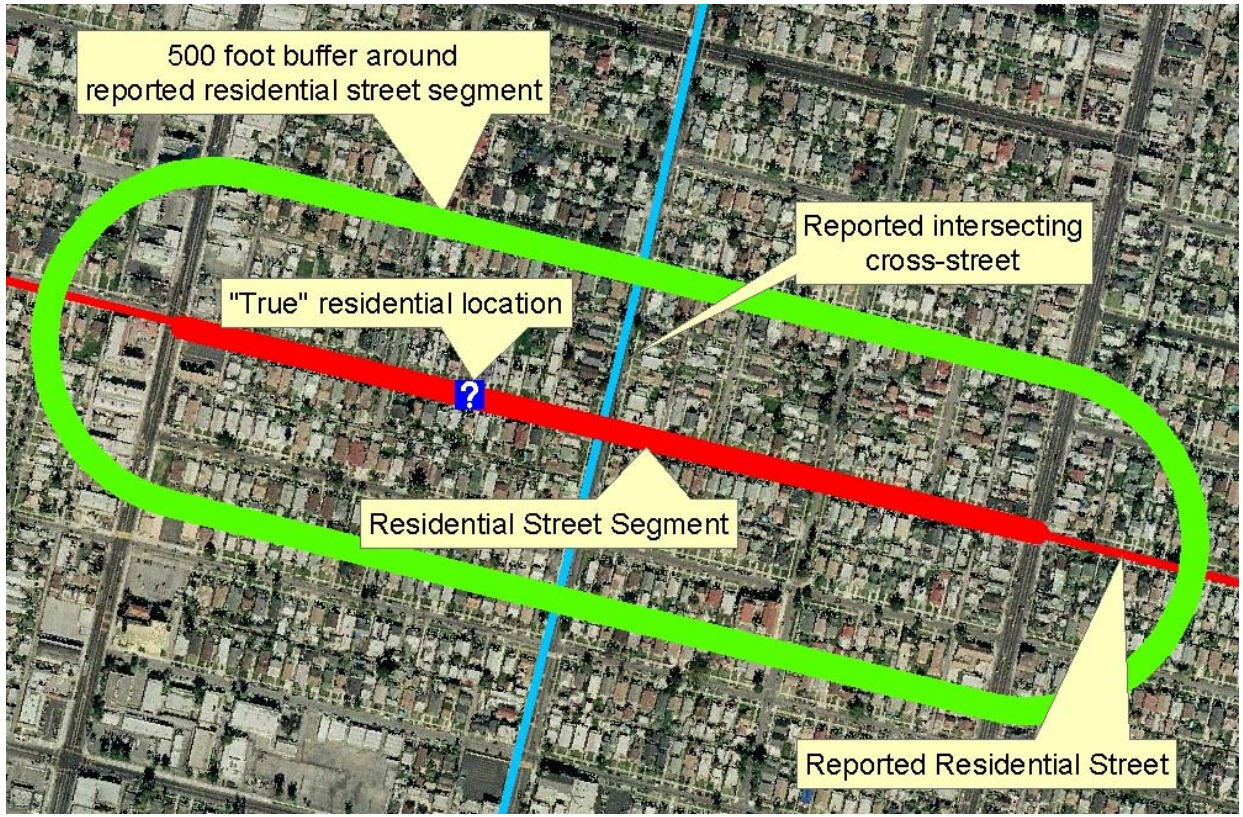
Residential Traffic Density

- Vehicular traffic is major source of outdoor air pollutants, including particulate matter & NO_2.
  - Background measurements from ambient air monitoring stations may not adequately capture spatial variability in concentrations of certain pollutants that are emitted directly in vehicle exhaust, especially for homes near freeways or major roads.

- To estimate traffic density (TD) around residential cross-street intersections of Los Angeles & San Diego County CHIS respondents with asthma, we obtained 2000 annual average daily traffic (AADT) counts from the California Department of Transportation (Caltrans).
  - AADT counts collected at least once every 3 years and extrapolated during non-count years to reflect traffic growth trend.
  - Note: Cross-street is proxy of unknown “true” residential location.

Estimation of Residential Traffic Density

- We created a buffer of 500 feet around the residential street segment and identified all the roadways within the buffer with AADT counts.



$$\text{Traffic Density (TD)} = [\Sigma(\text{AADT} \times \text{L})] \div A_B$$

AADT: (vehicles/day)

L: Length of AADT-count roadway segment (miles)

A_B: Area of the 500-ft radius buffer around the residential street segment (miles^2).

Statistical Analysis

- TD categorized into quintiles, then categorized into 3 categories.
  - **Low** (≈ ≤20th percentile): <20,000 daily VMT/mi^2 †.
    - Includes respondents with buffers without AADT counts that could be assumed to have low TD.
  - **Medium** (≈ 21-80th percentile): 20,001-200,000 daily VMT/mi^2.
  - **High** (≈ >80th percentile): ≥200,001 daily VMT/mi^2.

- Effects for both outcomes (daily or weekly symptoms, ER visit or hospitalization) estimated using logistic regression.
  - Crude and adjusted for **age** (≤17, 18-34, 35-64, ≥65), **sex**, **race/ethnicity** (white, Latino, Black, Asian/other), and household federal **poverty level** (<100, 100-299, ≥300% FPL).
  - Also conducted stratified analyses by demographic categories.
  - Also adjusted for annual background air pollutant concentrations (O_3, PM_{10}, $PM_{2.5}$, NO_2, CO) to assess changes in TD effect estimates.

† Vehicle miles traveled per square mile.

Traffic Density Effect Estimates

Traffic Density (Daily VMT/miles^2)	**Daily or Weekly Symptoms** 311 cases, 1452 noncases Odds Ratio (95% CI)	**ER Visit or Hospitalization** 141 cases, 1647 noncases Odds Ratio (95% CI)
<20,000	1.00	1.00
20,001 - 200,000	1.38 (0.96, 1.98)	2.52 (1.35, 4.69)
≥200,001	1.72 (1.14, 2.60)	3.21 (1.64, 6.26)

- Based on respondents who reported a residential cross-street near traffic-counted roadways (~80% of study population).
  - ORs adjusted for age, sex, race/ethnicity, and household poverty level.
  - OR for medium TD approximates ORs for 21-40%, 41-60%, and 61-80% quintiles, and OR for high TD approximates OR for >80% quintile.
- Including covariates for annual ambient air pollutant concentrations based on nearest monitoring station did not appear to change TD ORs or trends.
- No observed differences within strata of poverty level or race/ethnicity (small samples in strata).

Daily or Weekly Symptom Effect Estimates by Age

Traffic Density (Daily VMT/miles^2)	**Age <18[a]** 40 cases, 453 noncases Odds Ratio (95% CI)	**Age ≥18[b]** 271 cases, 999 noncases Odds Ratio (95% CI)
<20,000	1.00	1.00
20,001 - 200,000	0.95 (0.44, 2.06)	1.52 (1.01, 2.28)
≥200,001	0.61 (0.22, 1.69)	2.20 (1.40, 3.48)

[a] Adjusted for race/ethnicity and household poverty level.

[b] Adjusted for age, sex, race/ethnicity and household poverty level.

- No observed age differences in TD for ER visits or hospitalizations.

Healthy Workers or Exposure Misclassification? Daily or Weekly Symptom Effect Estimates by Employment

Traffic Density (Daily VMT/miles^2)	**Employed** 118 cases, 667 noncases Odds Ratio (95% CI)	**Unemployed** 149 cases, 325 noncases Odds Ratio (95% CI)
<20,000	1.00	1.00
20,001 - 200,000	1.08 (0.62, 1.88)	2.43 (1.32, 4.45)
200,001+	1.49 (0.79, 2.81)	4.07 (2.08, 7.97)

- Employed includes part-time. Unemployed includes those not in labor force (classification of non-working elderly).
- Odds ratios adjusted for age, sex, race/ethnicity, and household poverty level.
- Adding employment as a covariate in a model with all adults did not change TD effect estimates.

Discussion

- Asthmatics living near high-traffic roadways may have an increased risk of frequent symptoms or severe symptoms that require emergency services or hospitalization.
  - Exposure-response trend observed for both outcomes.

- Study limitations
  - Cross-sectional design using annual summaries of exposures and self-reported health outcomes.
  - No information on other proximate sources of air pollution exposure, including indoor or occupational sources.
  - Potential misclassification from traffic exposures away from home, including work or school.
    - A stronger exposure-response trend for frequent symptoms, however, was observed among unemployed adults, who are more likely to stay at home than employed adults.

Future Directions

- Subsequent CHIS (2003, 2005, etc.) will geocode residential addresses for all respondents.
- This will allow for opportunities to:
  - Improve quality of exposure assessment with use of exact addresses.
  - Assess TD impacts on a larger study population in a larger area.
    - Identify disparities in TD effects across categories of race/ethnicity, socioeconomic status, geographic region.
    - Improve precision of TD effect estimates.
  - Evaluate changes in TD effects over time.
    - Turnover of the vehicle fleet with newer vehicles with cleaner engines replacing older vehicles may reduce exposures to hazardous pollutants from vehicle emissions, even as traffic density on roadways increases.

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