

**Critical Review of Health Effects
of Traffic Related Air Pollution:
Synthesis of the Evidence
from Epidemiology
~Health Effects~**

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On Behalf of the Writing Panel
and
Contributing HEI Staff**



Goals for Review and Critique of Health Effects

- Update the status of the understanding of health effects associated with “primary” traffic-generated pollution since publication of the last HEI critical review-1988
- Provide a comprehensive summary of primary research studies that met inclusion criteria
 - 1980 through October 2008, published in English
- Provide a qualitative synthesis of the data across all traffic exposure metrics used in various summaries
 - Meta-analysis not used

Criteria for Inclusion of Studies

- Primary research studies had to include 1 or more of the following exposure methods
 - Distance from and/or length of roadways
 - Estimate of traffic density or intensity
 - Modeling of primary traffic-generated pollutant exposure
 - Studies of occupations characterized by exposure to traffic
 - Pollutant surrogates for traffic exposures (e.g., NO₂, EC/BS, CO, benzene, etc.) only if data provided to validate the pollutant as a reasonably specific surrogate for such exposure

Criteria for Causal Inference

- **Followed approach used in the 2004 Report of the Surgeon General on the Health Consequences of Smoking**
 - **Synthesis based on combination of:**
 - **theoretical concepts of causality (e.g., control of confounding, potential outcomes)**
 - **statistical inference**
 - **judgment (e.g., Hill's Criteria)**
 - **criterion of coherence articulated by Bates**

Criteria for Causal Inference

- 4 categories used by SGR categories to infer causal association were modified by the quality of the method to estimate exposure to primary traffic-generated pollutants
 - Sufficient evidence
 - SGR + at least 1 study measured traffic density or modeled exposure to traffic-generated pollutants OR
 - Measures of SES included in all distance-based studies
 - Suggestive but not sufficient
 - SGR + only distance-based studies metrics available OR
 - All criteria for “sufficient” met but not all distance-based studies included measures of SES

Criteria for Causal Inference

– Inadequate and insufficient evidence

- SGR +

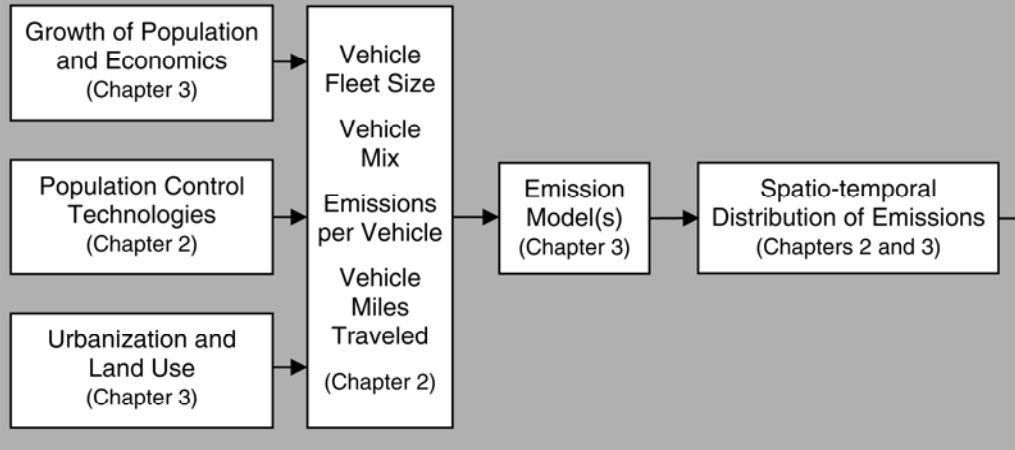
- Studies based on distance only metrics not consistent OR
- Results of all studies based on distance only metrics consistent but studies failed to include measures of SES OR
- Results for at least one study based on traffic density or modeled traffic exposure inconsistent with those from distance only studies OR
- Number of distance only studies was too small

– Suggestive of no association

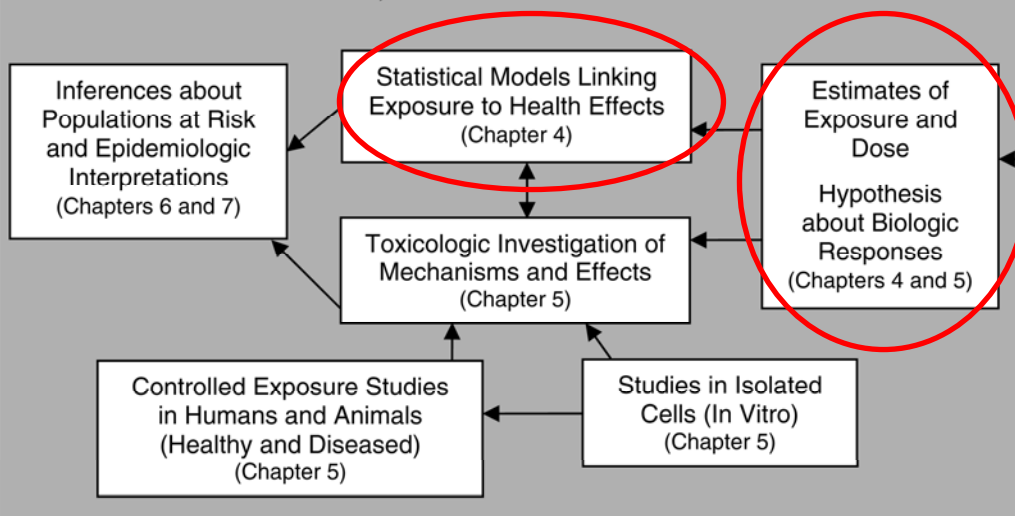
- SGR + studies were of adequate quality (based on distance only or some measure of traffic density or modeled exposure) and were consistent in failing to find an association

Criteria for Causal Inference

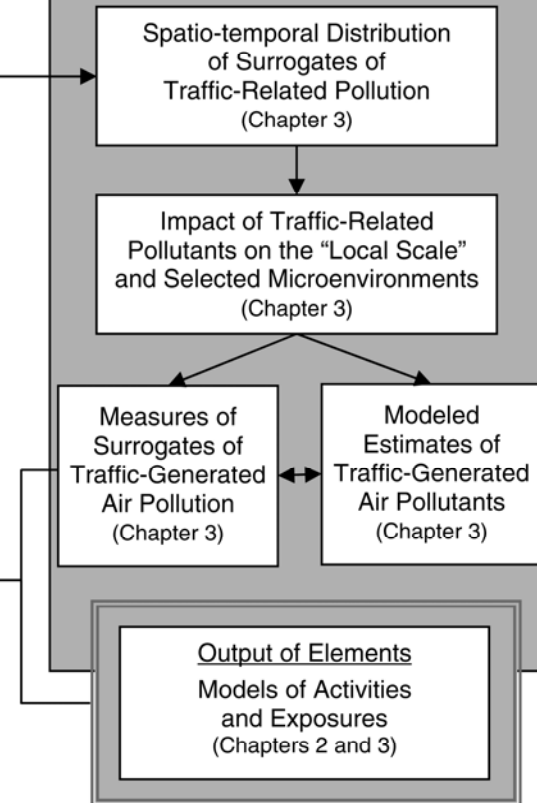
Characterization of Emissions



Relationships between Exposure, Biologic Mechanisms, and Effects on Human Health



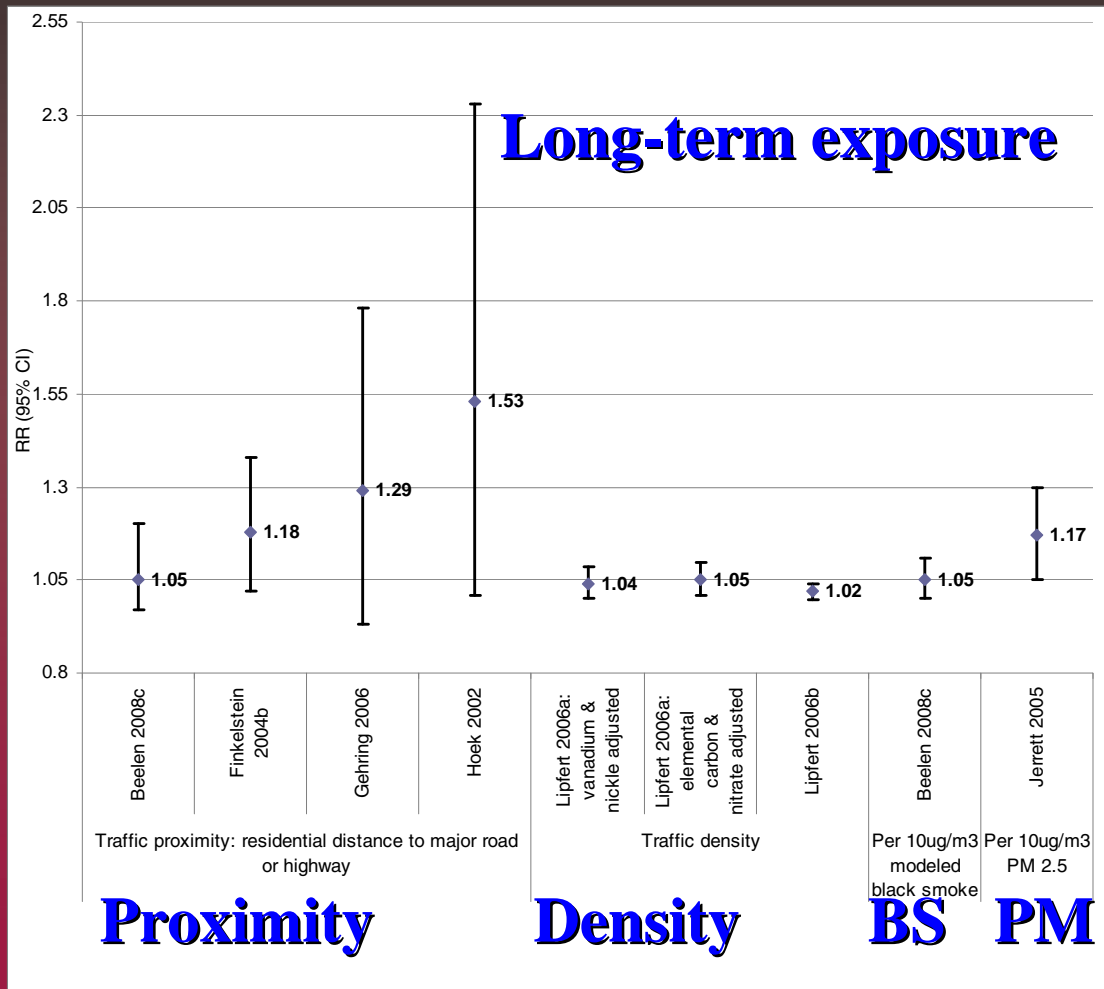
Sources of Data for Exposure Estimates and Models



Health Outcomes Evaluated

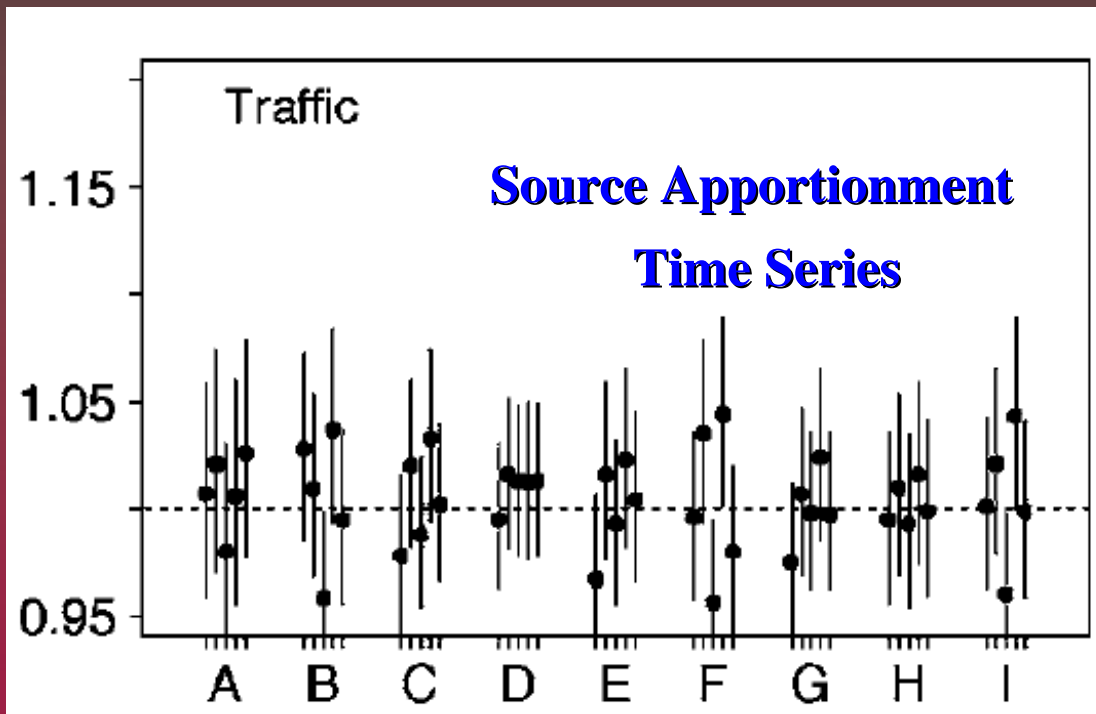
- Mortality (all cause, cardiorespiratory)
- Cardiovascular morbidity
- Respiratory disease
 - Asthma—childhood/adult
 - General respiratory symptoms
 - Lung function-childhood/adult/COPD
 - Health care utilization
- Non-asthmatic allergy
- Birth Outcomes
- Cancer
- Exposure in occupational settings

Long-Term Exposure to Traffic Pollution and All-Cause Mortality



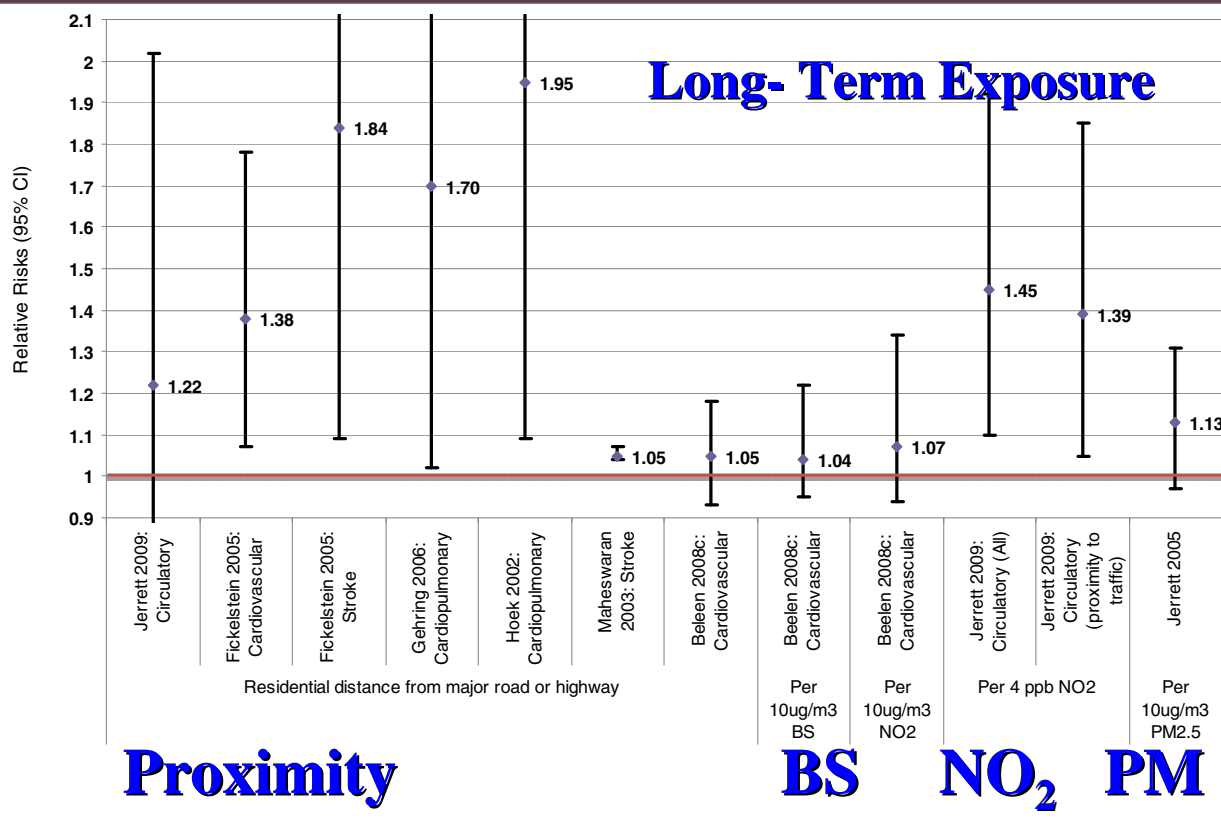
- Synthesis of Evidence
 - “Suggestive but insufficient” to infer causal association
- Reasons
 - Too few studies
 - Second Dutch study found smaller associations than in original publication
 - One set of studies estimated exposure on the county level only, which may provide inadequate spatial resolution

Short-Term Exposure to Traffic Pollution and All-Cause Mortality



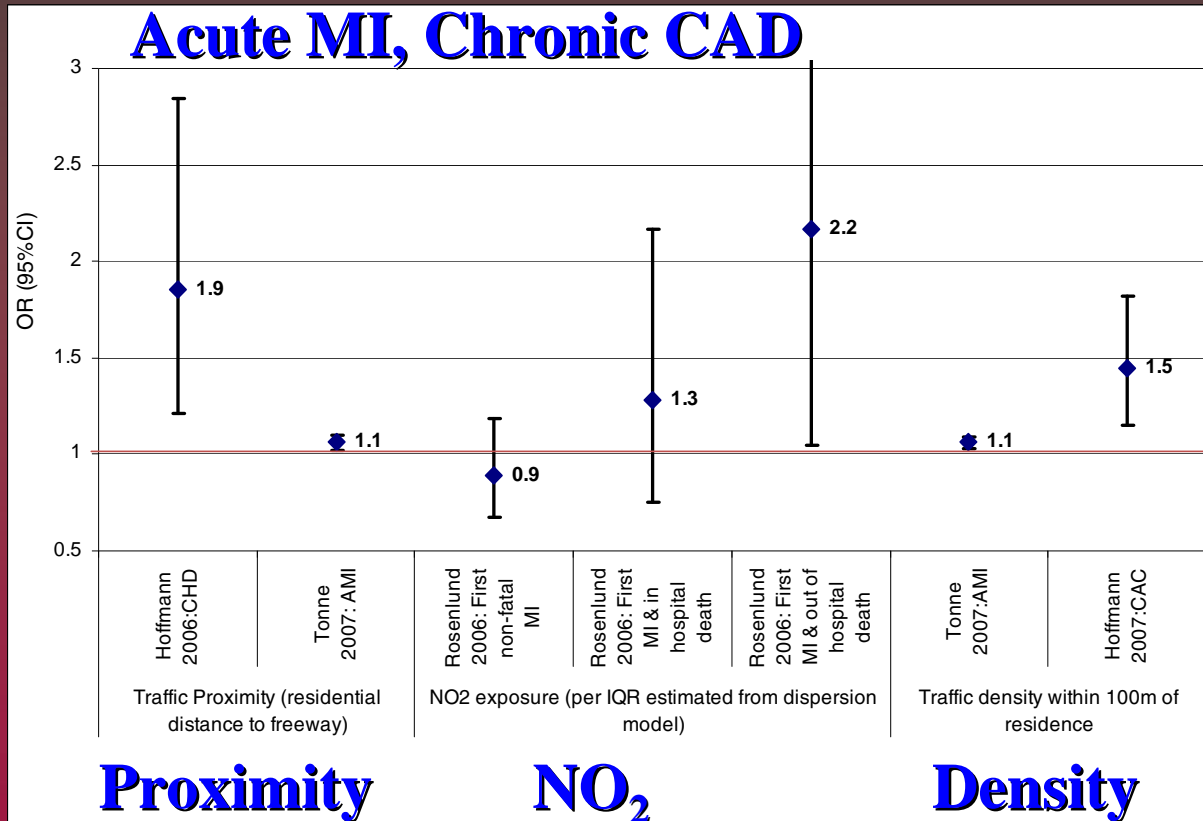
- **Synthesis of Evidence**
 - “Suggestive but insufficient” to infer causal association
- **Reasons**
 - Only 4 studies met criteria
 - Two were difficult to interpret--based on source apportionment from central monitors
 - Two provide consistent data based on estimates at residence

Long-Term Exposure to Traffic Pollution and Cardiopulmonary Mortality



- **Synthesis of Evidence**
 - “Suggestive but insufficient” to infer causal association
- **Reasons**
 - Too few studies
 - Relative imprecision of most estimates,

Long-Term Exposure to Traffic Pollution and Cardiovascular Morbidity



- Synthesis of Evidence
 - “Suggestive but insufficient”
- Reasons
 - Noise and stress not evaluated in several important studies
 - Need for more studies in real-world settings

Studies of Exposure to Traffic and Cardiac Electrophysiological Responses—Selected Examples

Study Location	Protocol	Selected Traffic Marker	Selected Outcomes	Estimated Effect (95% CI or \pm SD)
Adar et al. 2007 St. Louis, MO U.S.	1-hr bus trip, several hours off bus activity, 1-hr bus trip	<ul style="list-style-type: none"> •5, 30, 60 minute and 4, 24-hr BC and PM_{2.5} prior to bus trip •BC IQR magnitude: On bus: 2.6 μg/m³ Off bus: 0.27 μg/m³ 	<i>SDNN</i> (ms) 5-min mean-tot 24-hr mean-tot 5 min on bus 5 min off bus	QR BC -0.3 (-0.01, -0.05) -4.7 (-3.5, -5.9) -4.6 (-3.0, -6.1) -0.1 (0.1, -0.3)
Riediker et al. 2004a North Carolina, U.S.	4 consecutive Days of monitoring	<ul style="list-style-type: none"> •In-vehicle (police Patrol car) •PM_{2.5} by gravimetric & light scattering 	<u>Morning Post Exposure</u> <i>SDNN</i> (ms) Light scattering Mass Total Power Light scattering Mass	<u>Per 10μg/m³ PM_{2.5}</u> 15.2 (\pm 5.02) 10.3 (\pm 9.45) 13.4 (\pm 8.20) 20.7 (\pm 13.7)



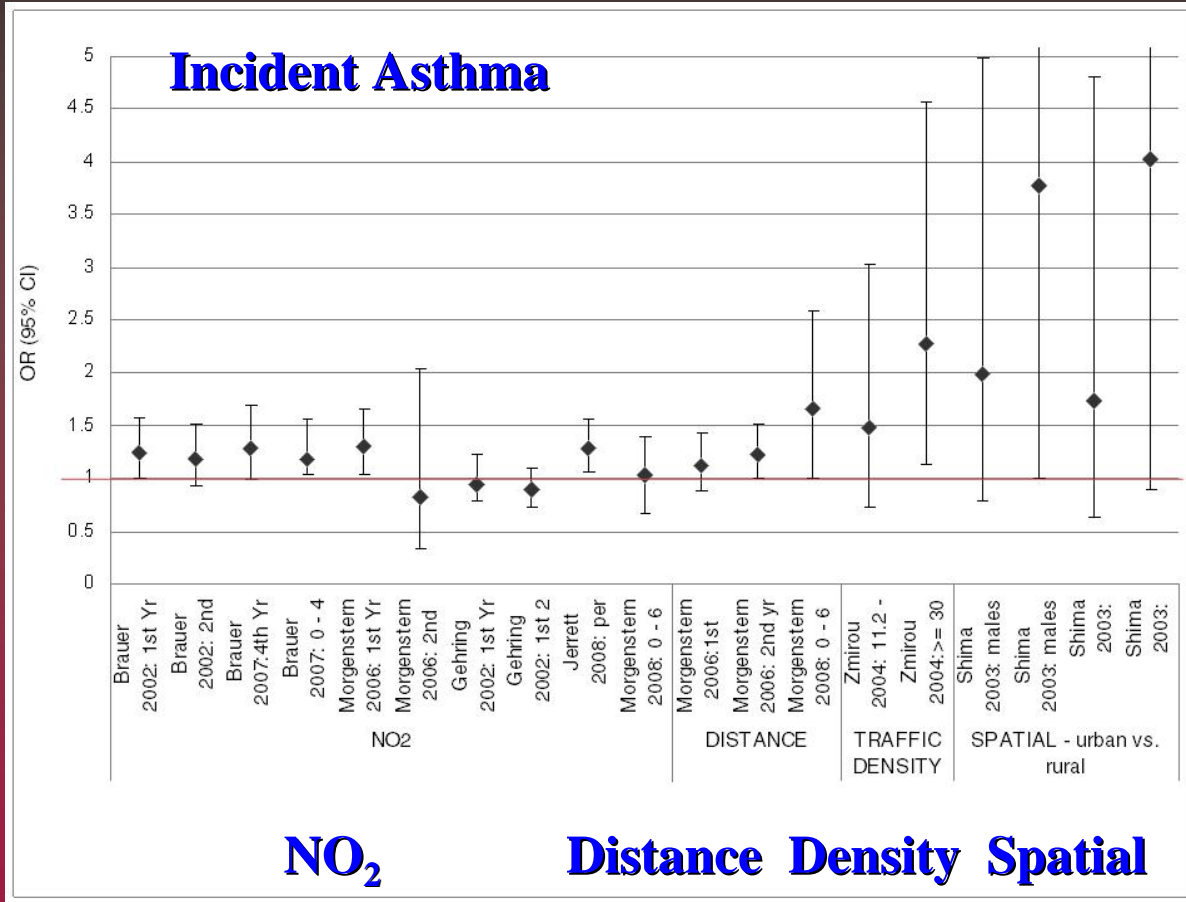
Effects of Traffic Exposure on Respiratory Disease and Symptoms

- **Areas Covered**
 - Asthma, respiratory symptoms and asthma-related health problems
 - Pulmonary Function and objectively assessed COPD
 - Allergy and allergic sensitivity
- **Separate evaluations for association between traffic exposure and childhood and adult respiratory disease and symptoms**

Effects of Traffic Exposure on Respiratory Disease and Symptoms

- **Important issues considered**
 - Phenotypic heterogeneity of asthma and COPD
 - Variability of definitions used in different studies
 - Separation of new onset asthma from exacerbations
 - Difficulty in separation of risk factors for asthma onset from those related to exacerbation
 - Use of cross-sectional asthma studies with retrospective reconstruction of exposure
 - Potential that childhood-onset and adult-onset may be distinct phenotypes

Effects of Traffic Exposure on Doctor-Diagnosed Asthma in Children



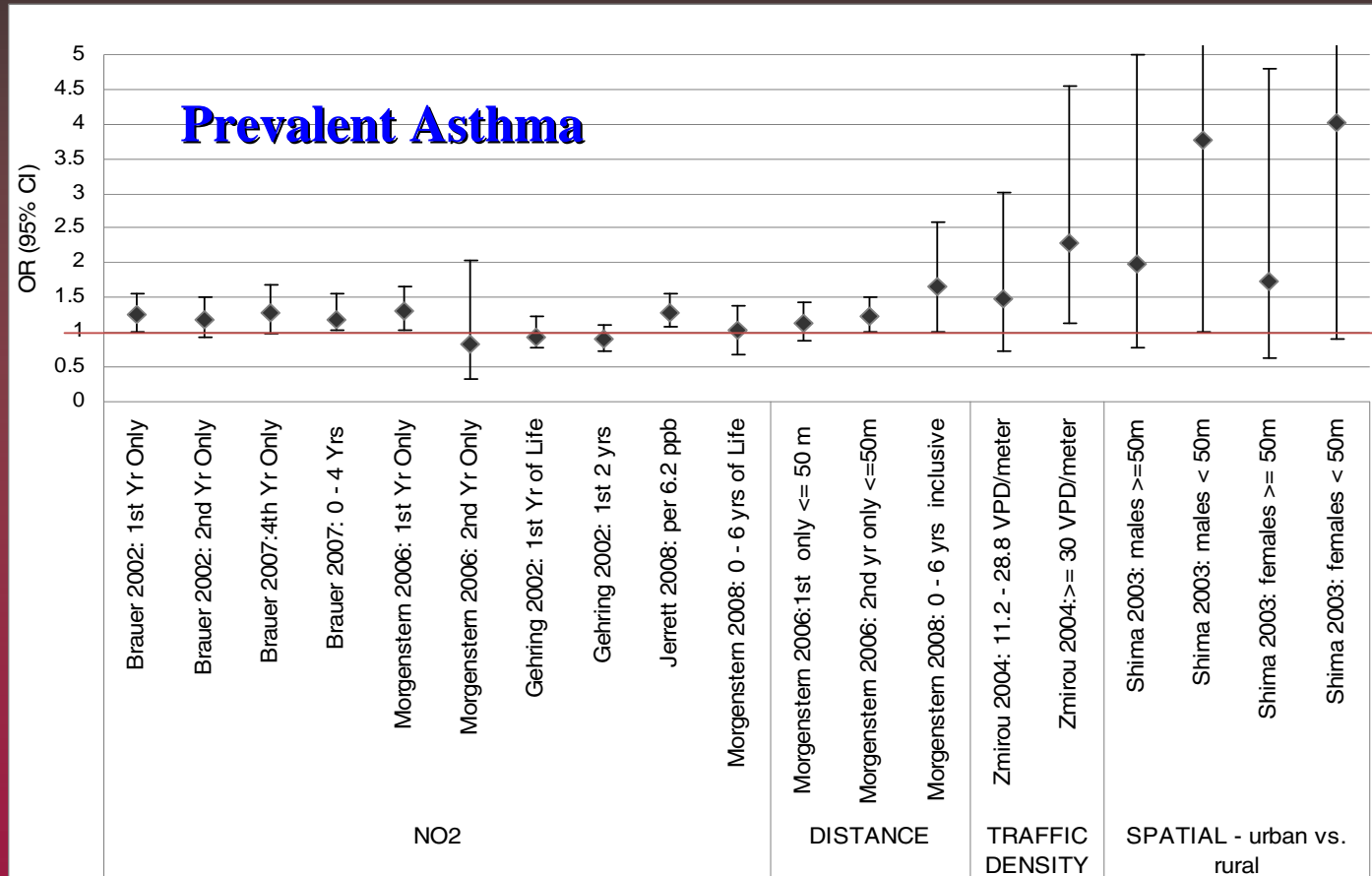
Synthesis of Evidence

- “Sufficient” OR
- “suggestive but insufficient” to infer causal association

Reasons

- Some concern about the imprecision of estimates
- Studies that included both traffic-specific pollutants and density measures provided most consistent results
- Role of allergic status as a modifier not entirely consistent

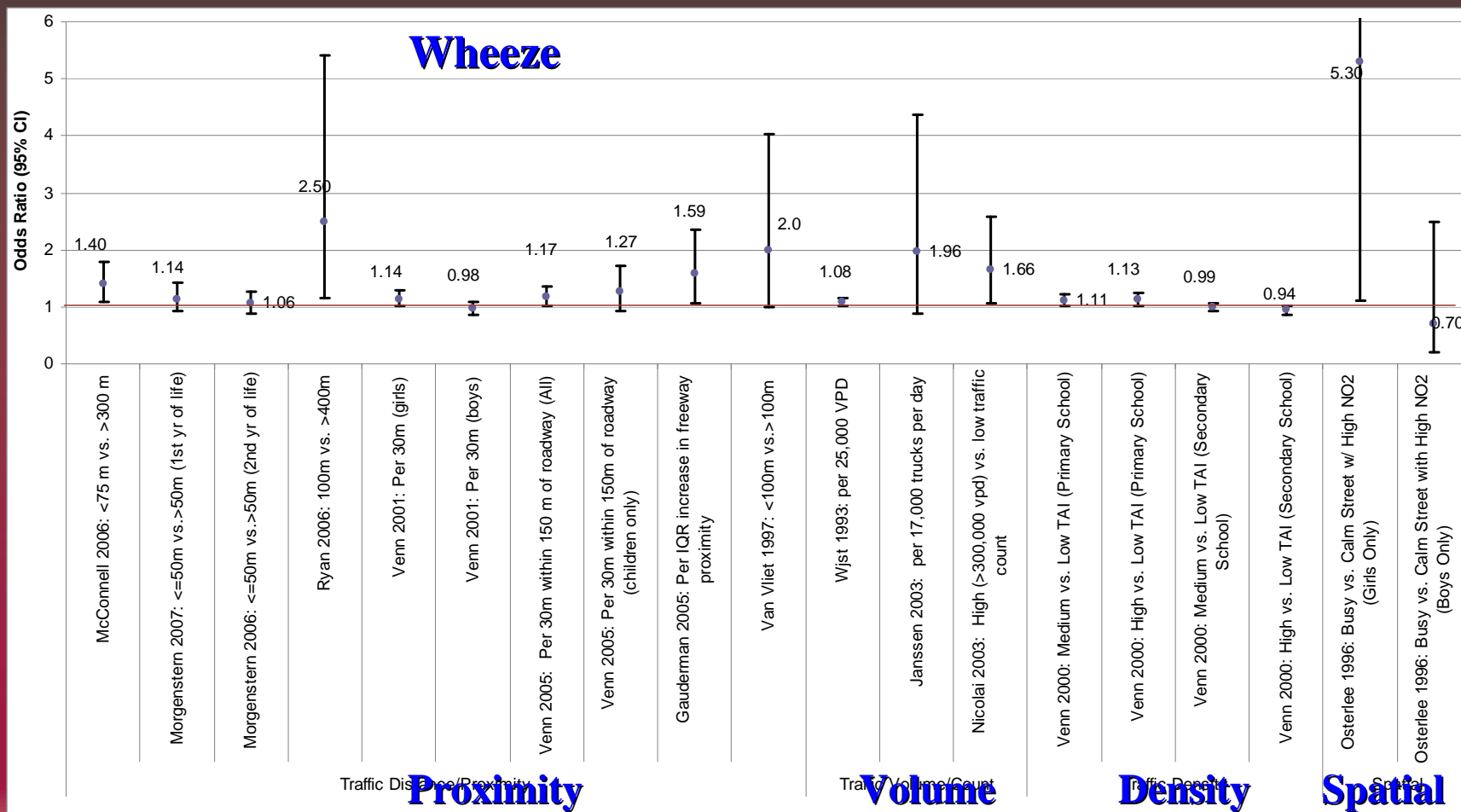
Effects of Traffic Exposure on Doctor-Diagnosed Asthma in Children



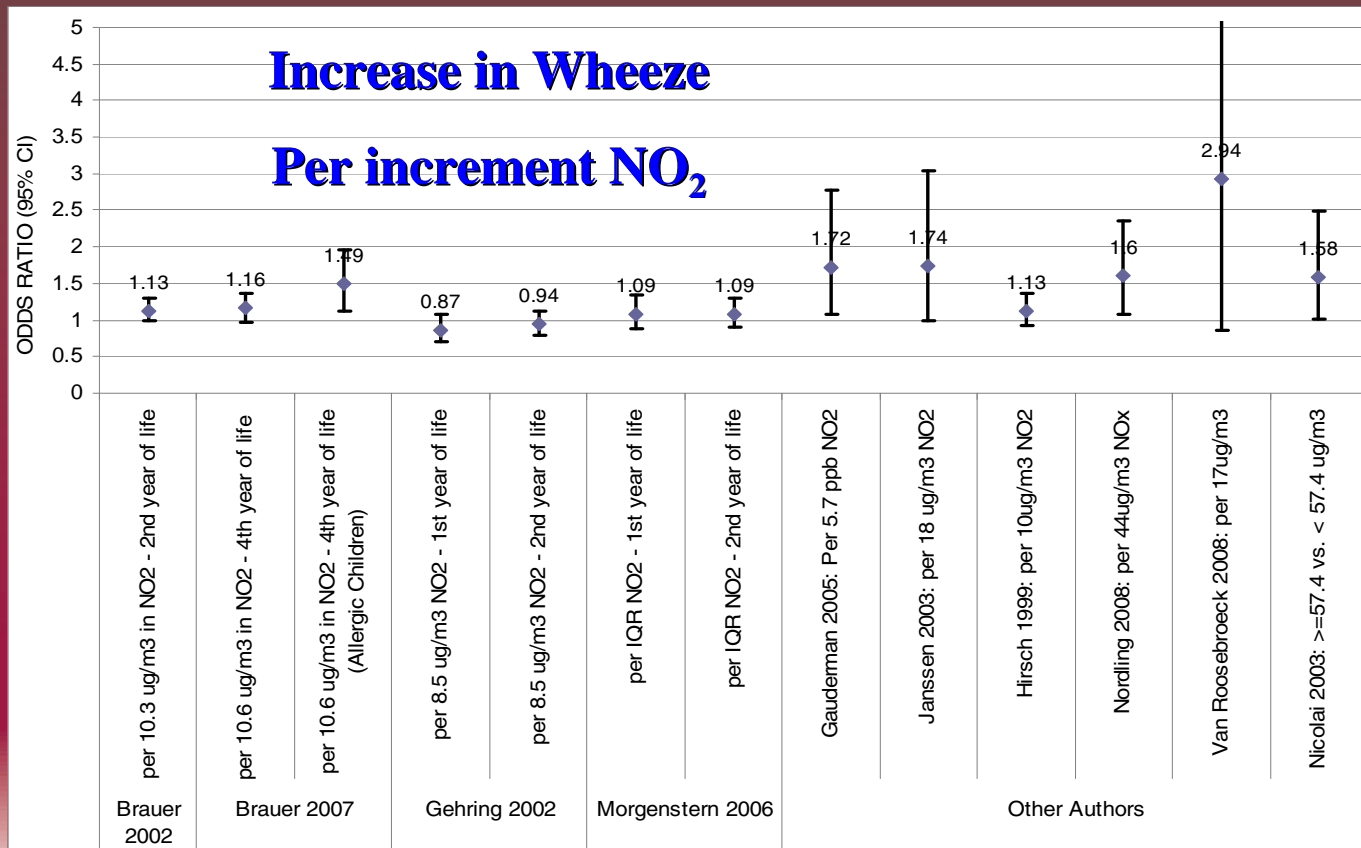
NO₂ (per IQR)

Distance Density Spatial

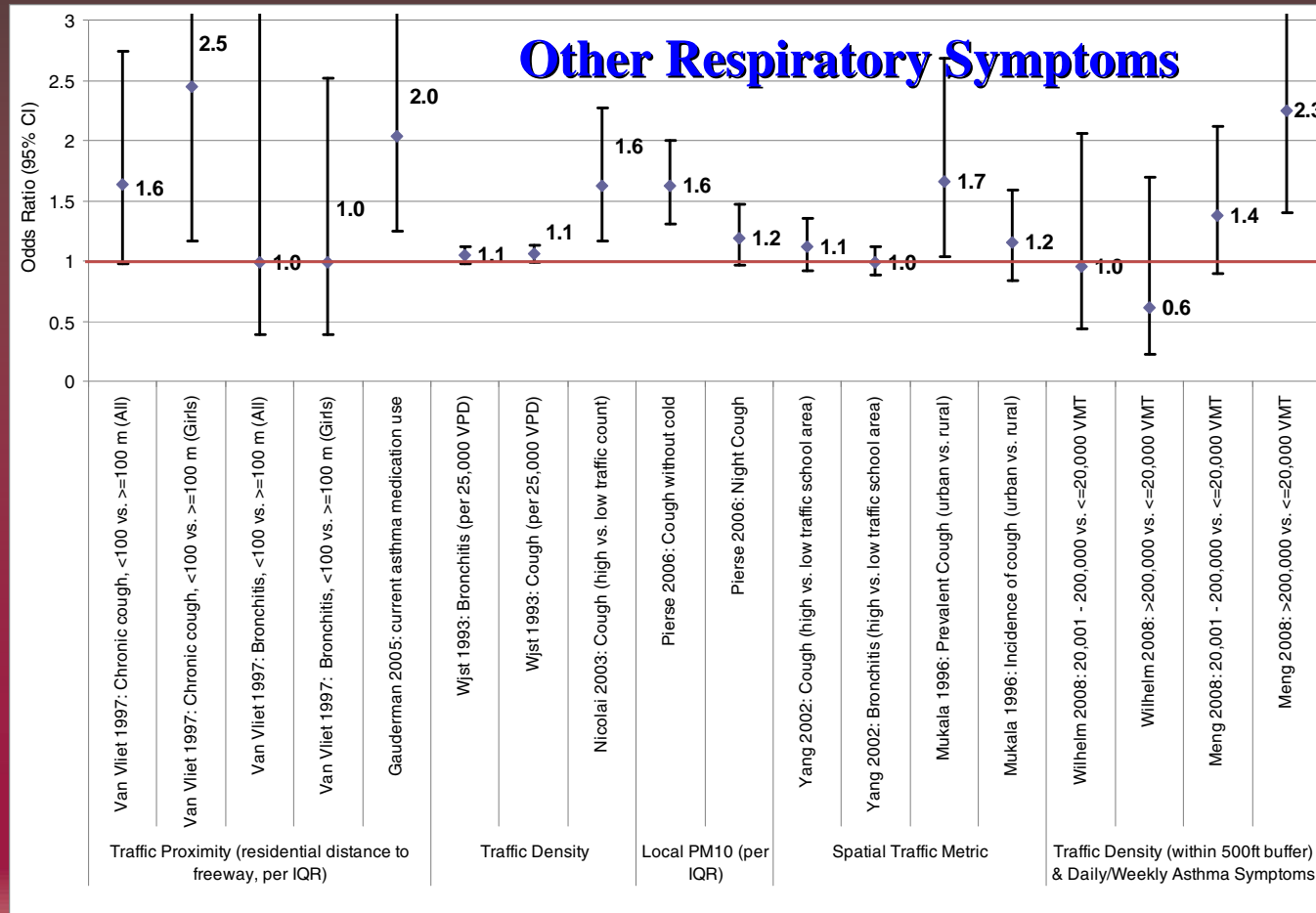
Effects of Traffic Exposure on Exacerbation of Symptoms in Asthmatic in Non-asthmatic Children



- **Synthesis of Evidence**
 - Exacerbations with asthma—”Sufficient” to infer causal association
 - Symptoms in non-asthmatics -“inadequate and insufficient” to infer causal associations
- **Reasons (non-asthmatics)**
 - Most studies not restricted to subjects with asthma
 - results seem to be driven by children with asthma



Effects of Traffic Exposure on Exacerbation of Symptoms in Asthmatic in Non-asthmatic Children



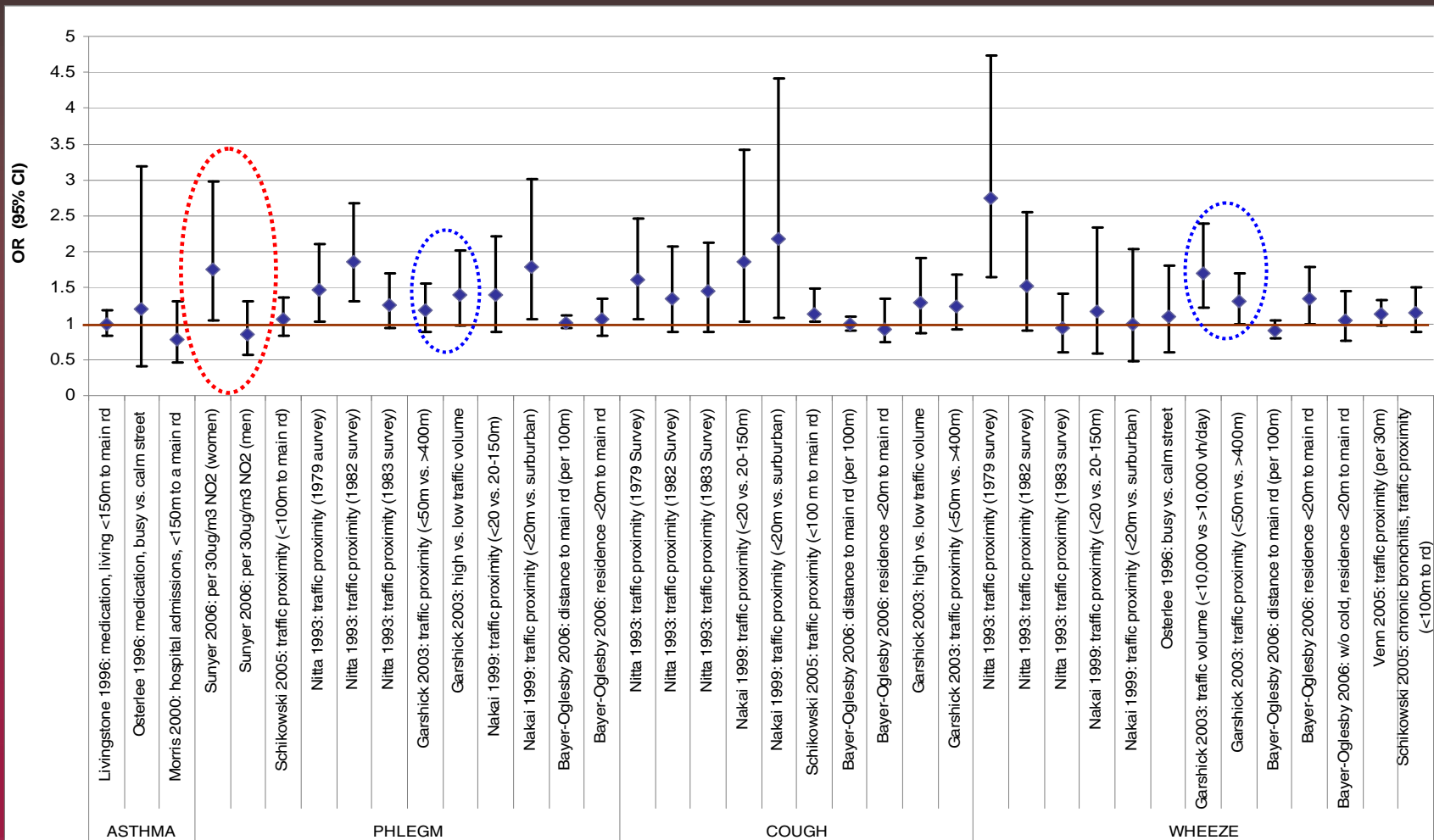
Effects of Traffic Exposure on Onset of Asthma in Adults

- **Synthesis of Evidence**
 - “Inadequate and insufficient” to infer causal association
- **Reasons:**
 - Only one study separated adult from childhood onset asthma

Effects of Traffic Exposure on Respiratory Symptoms in Adults

- **Synthesis of Evidence**
 - “Suggestive but not sufficient” to infer causal association
- **Reasons**
 - Inconsistent results between proximity and model-based estimates of association

Effects of Traffic Exposure on Respiratory Symptoms in Adults

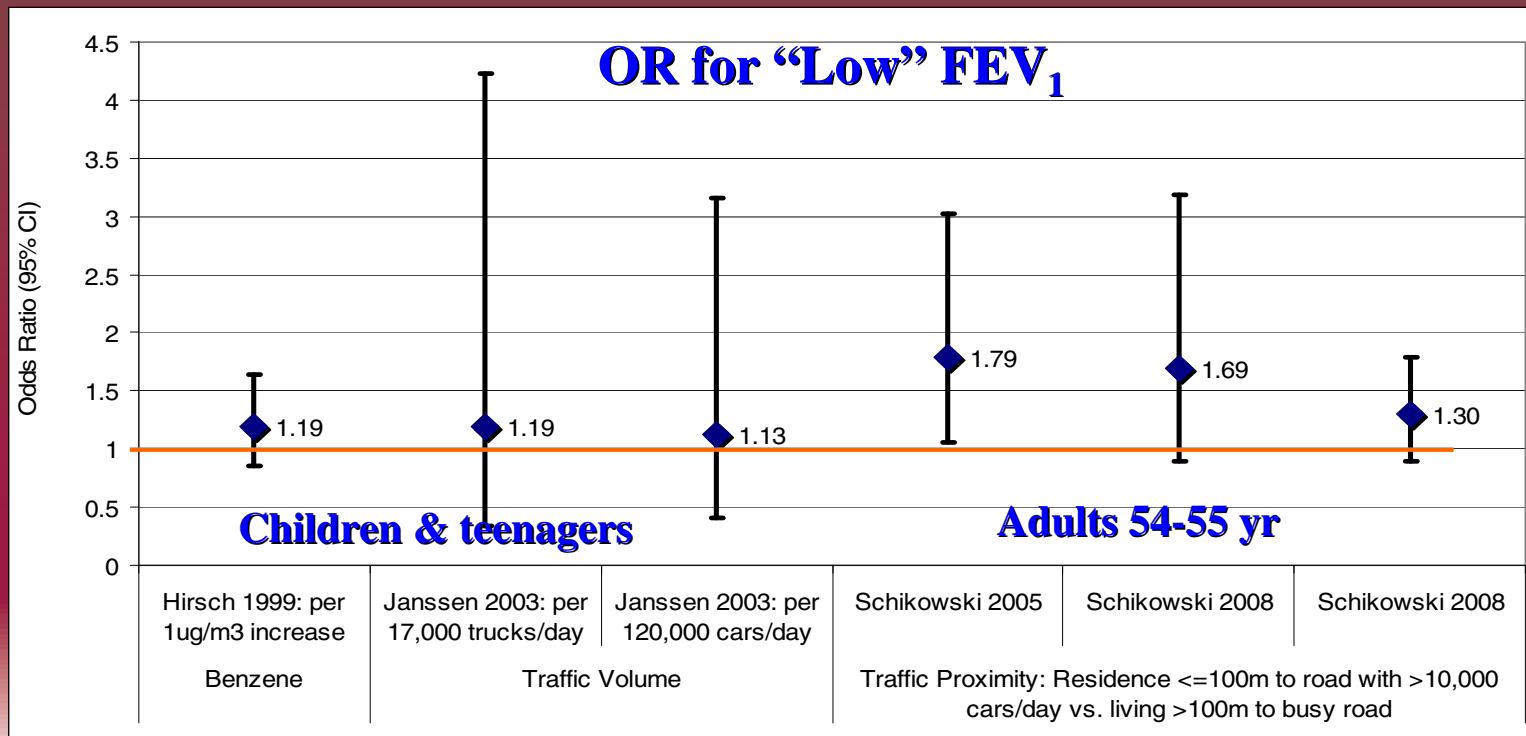


Effects of Traffic Exposure on Lung Function

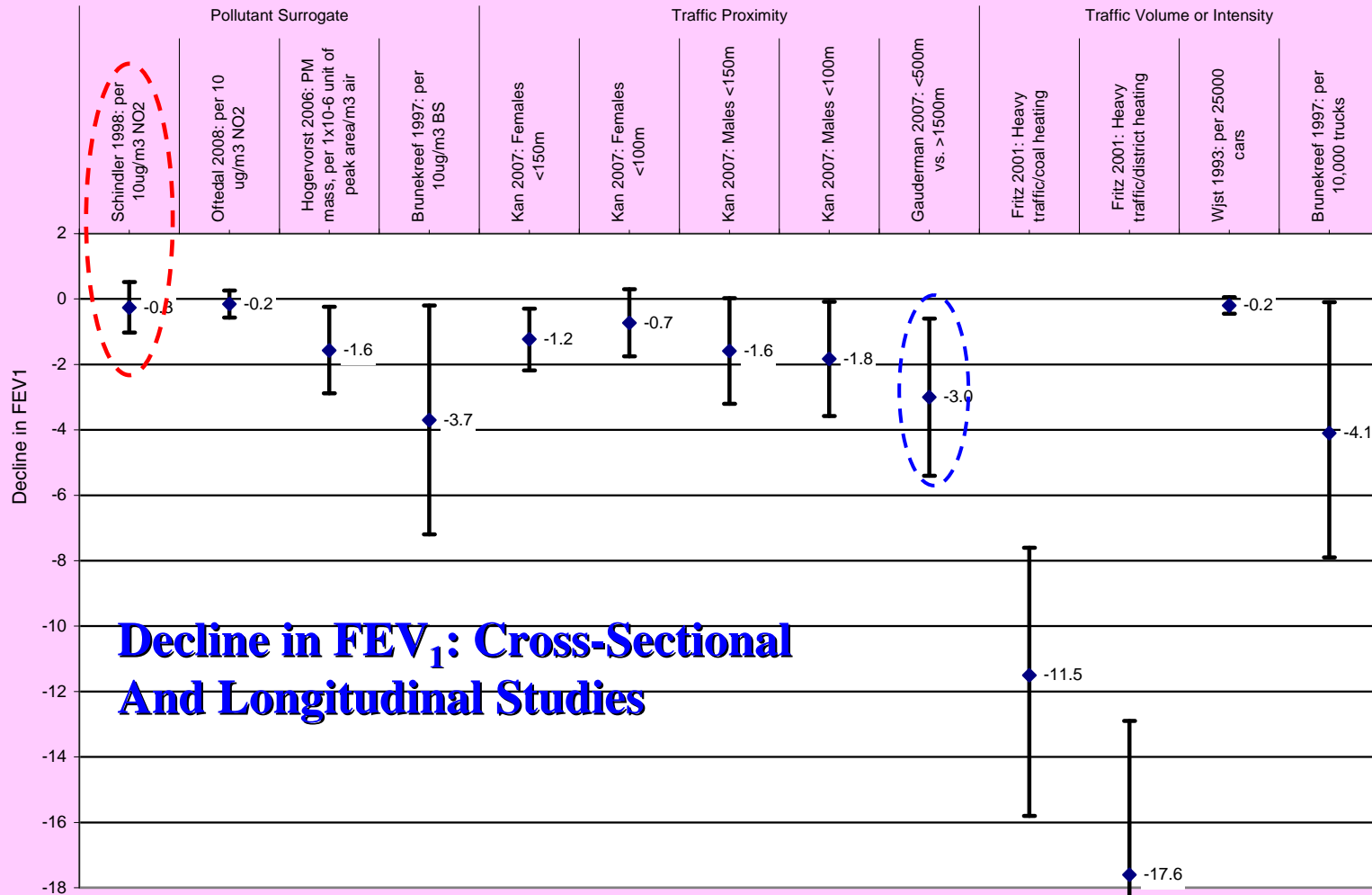
- Some general issues
 - Most studies do not report on full range of measurements available with spirometry
 - Forced expiratory volume one-second (FEV_1) and FVC used most frequently, although not necessarily the most physiologically relevant
 - FEV_1 /FVC ratio has problem of specificity for early stage COPD
- Cross-sectional studies reflect effects of long-term exposure superimposed on short-term effects

Effects of Traffic Exposure on Lung Function

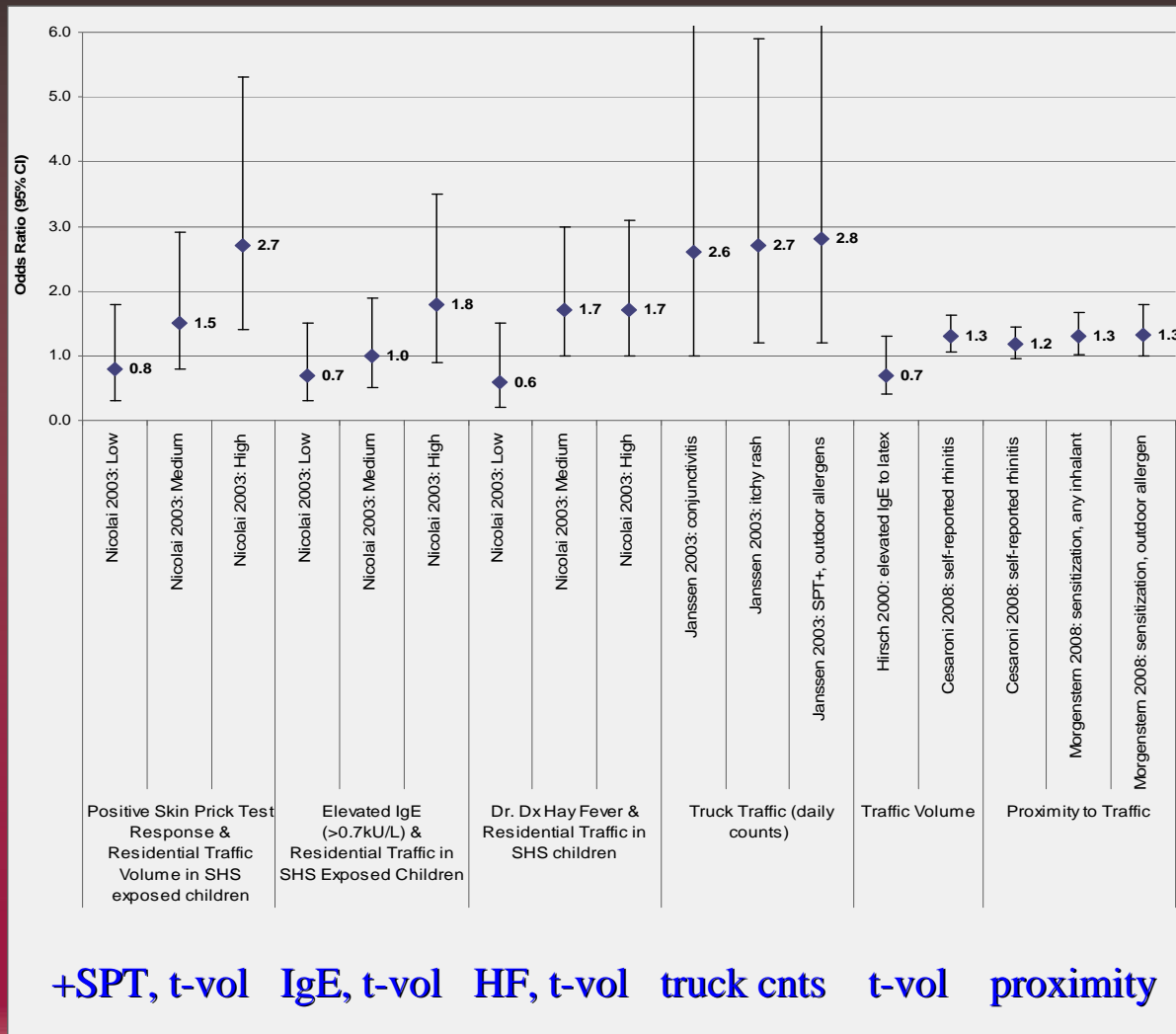
- Synthesis of Evidence
 - “Suggestive but insufficient” to infer for causal association
- Reasons
 - Heterogeneous study designs
 - Difficult to separate specific traffic surrogates from background urban pollution
 - Limited exposure contrasts in cross-sectional studies
 - Heterogeneous measures of lung function



Effects of Traffic Exposure on Lung Function



Effects of Traffic Exposure on Non-asthmatic Allergy



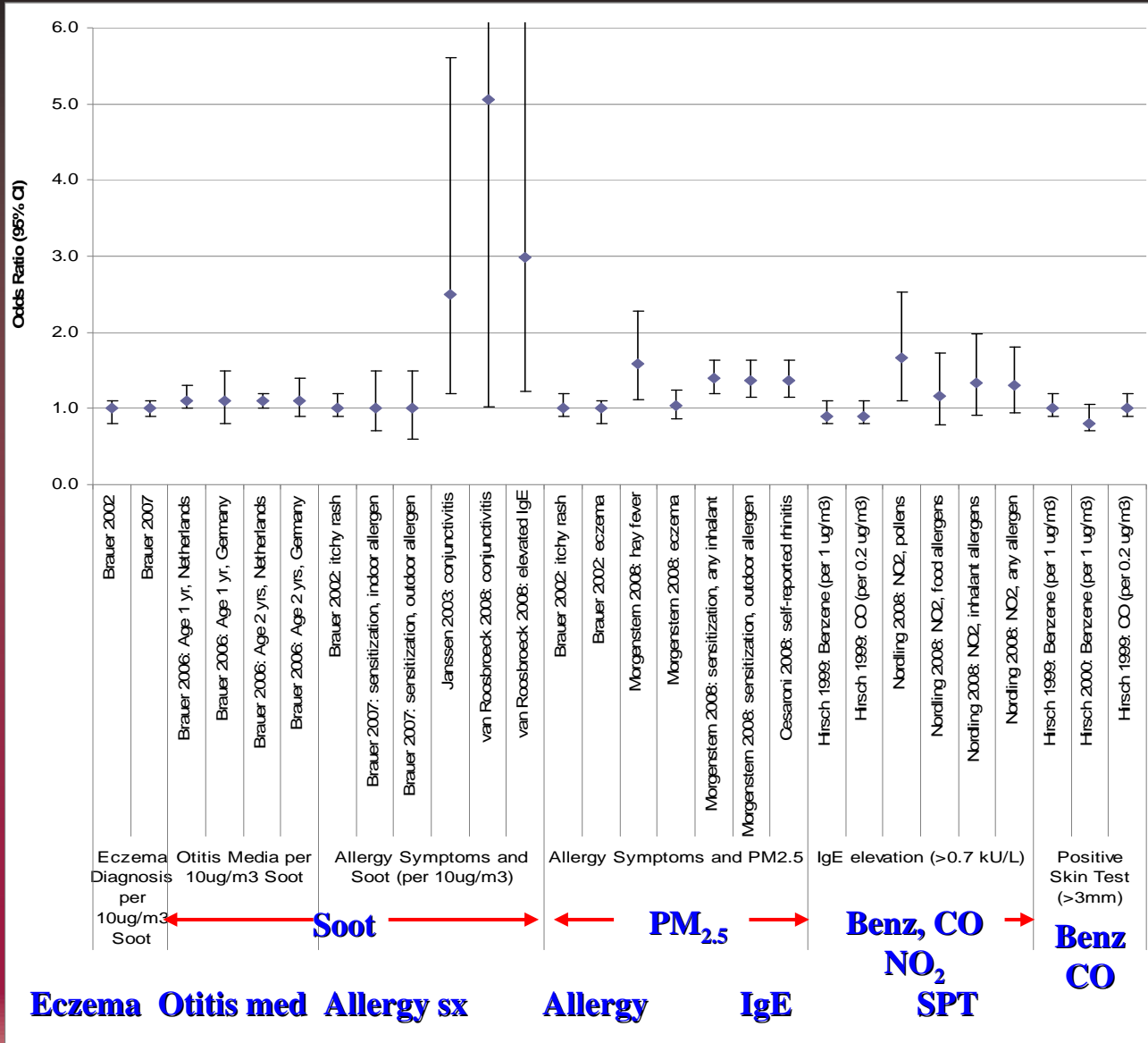
Synthesis of Evidence

- “Inadequate and insufficient” data to infer causal association

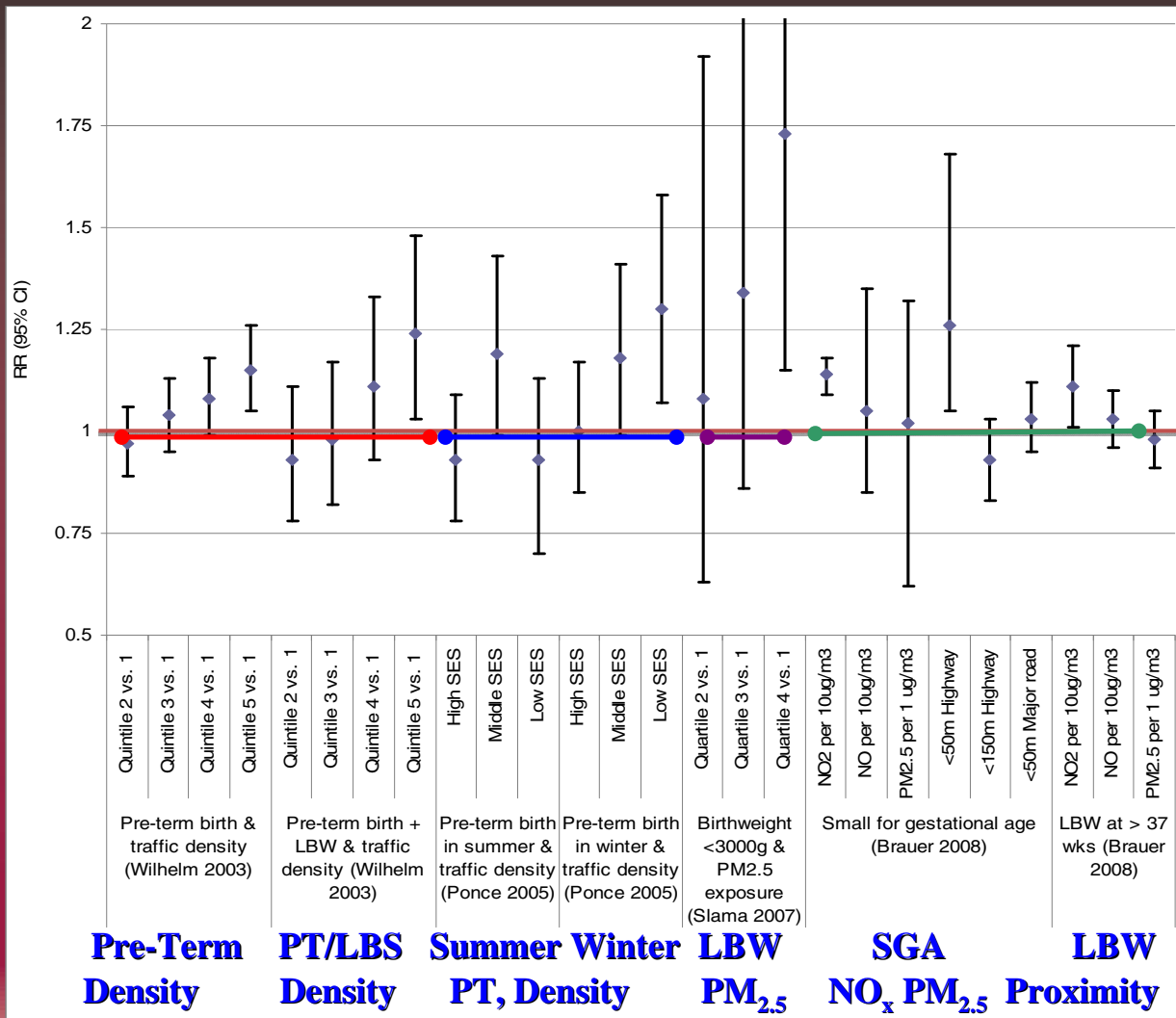
Reasons

- Inconsistent choice of methods to identify allergy
- Inadequate exploration of response heterogeneity
- Minor point
 - Lack of consideration of antigens in road dust

Effects of Traffic Exposure on Non-asthmatic Allergy



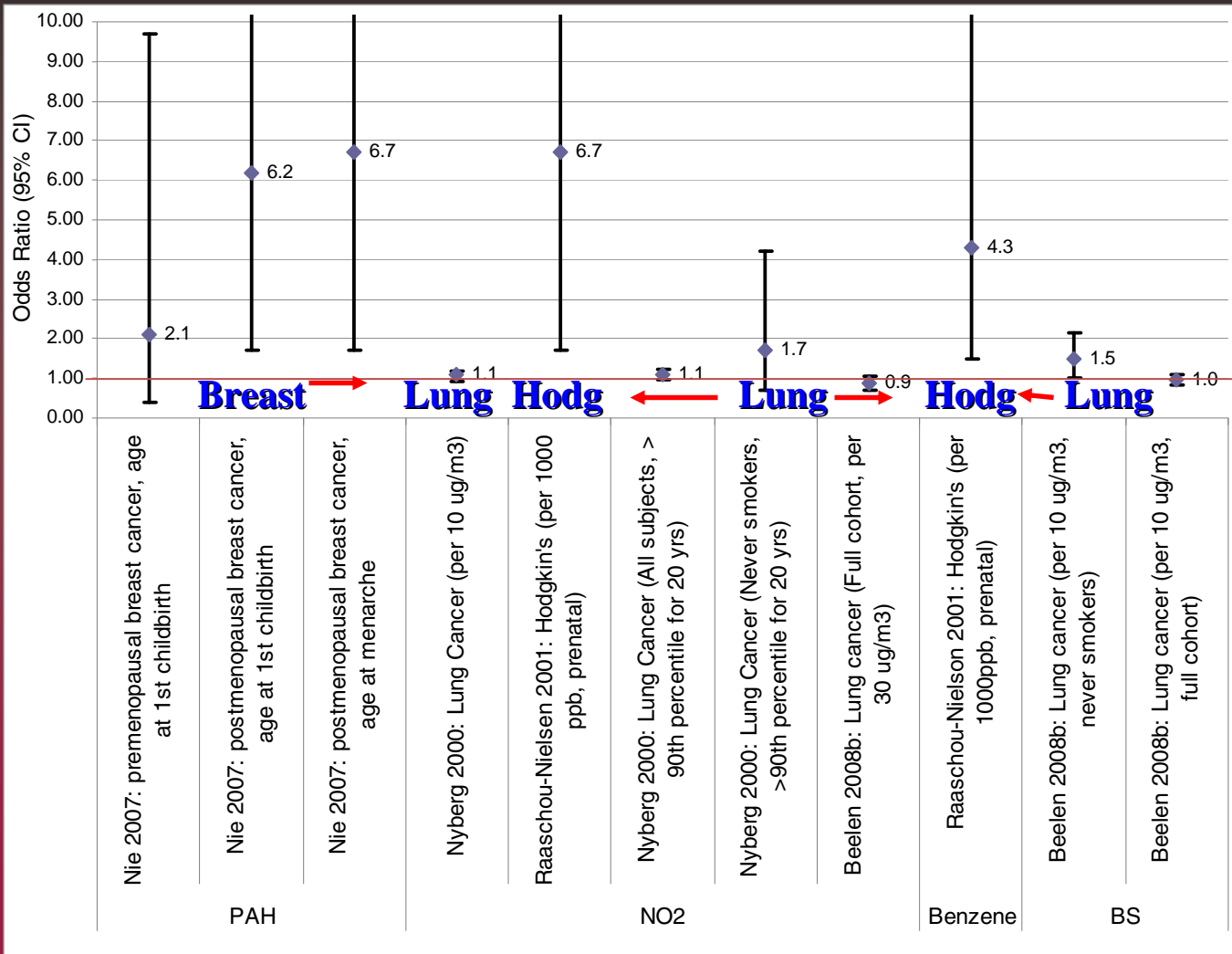
Effects of Traffic Exposure on Birth Outcomes



- Synthesis of Evidence
 - “Insufficient evidence” to infer causal association
- Reasons
 - Only 4 studies met criteria for inclusions

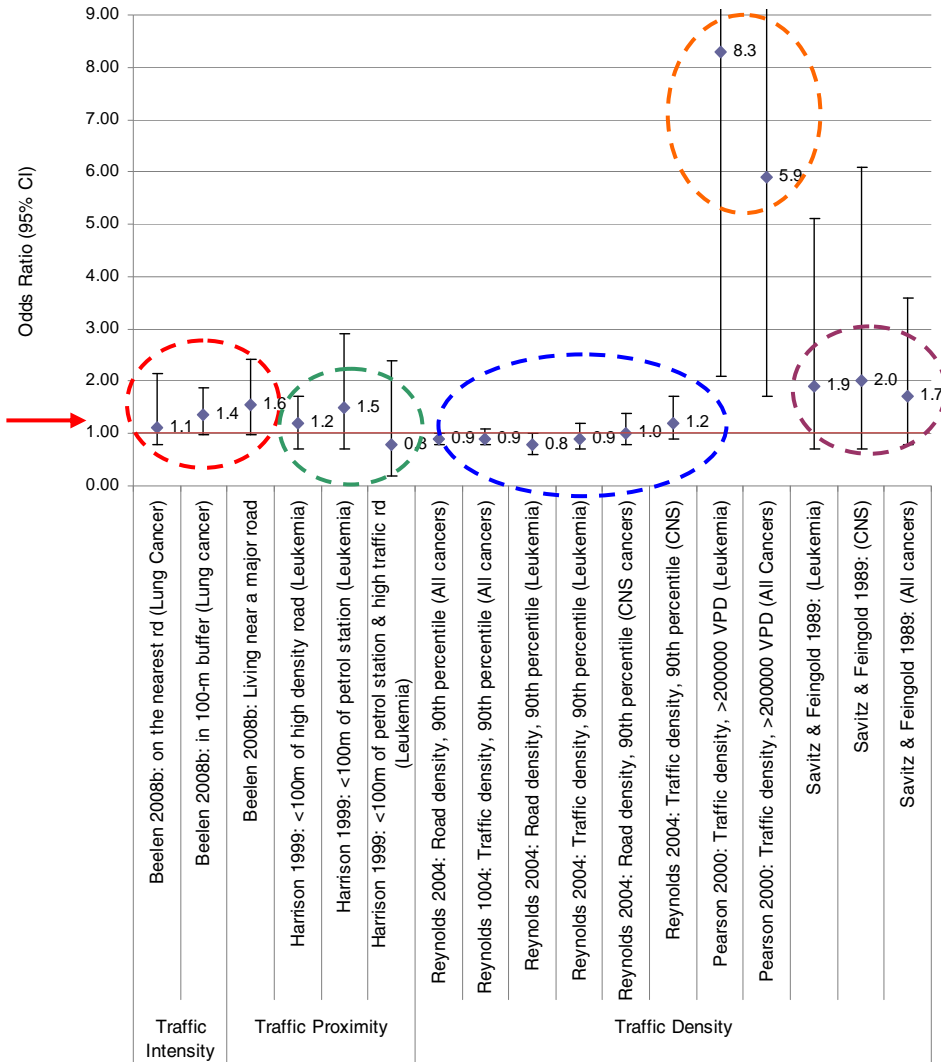


Effects of Traffic Exposure on Cancer



- Synthesis of Evidence
 - “Insufficient” evidence to infer causal association
- Reasons
 - Too few studies of any one type of cancer

Effects of Traffic Exposure on Cancer



- **Synthesis of Evidence**
 - “Insufficient” evidence to infer causal association
- **Reasons**
 - Too few studies of any one type of cancer

Conclusions From Epidemiologic Studies

- “Sufficient ” evidence to Infer causal associations
 - **Exacerbations of asthma**
 - *Asthma incidence and prevalence in children*
- “Suggestive but insufficient” evidence
 - Mortality (all-cause and cardiovascular)
 - Decreases in lung function
 - General respiratory symptoms
- “Inadequate and insufficient” evidence to Infer causal associations
 - Adult onset asthma
 - Health care utilization for childhood and adult respiratory diseases
 - COPD
 - Non-asthmatic allergy
 - Birth outcomes
 - Cancers

THE END

May 3, 2009

HEI Annual Meeting 2009

