AIR POLLUTION AND ASTHMA NATIONAL STUDY

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Southern Transportation and Air Quality Summit
August 20-21, 2019

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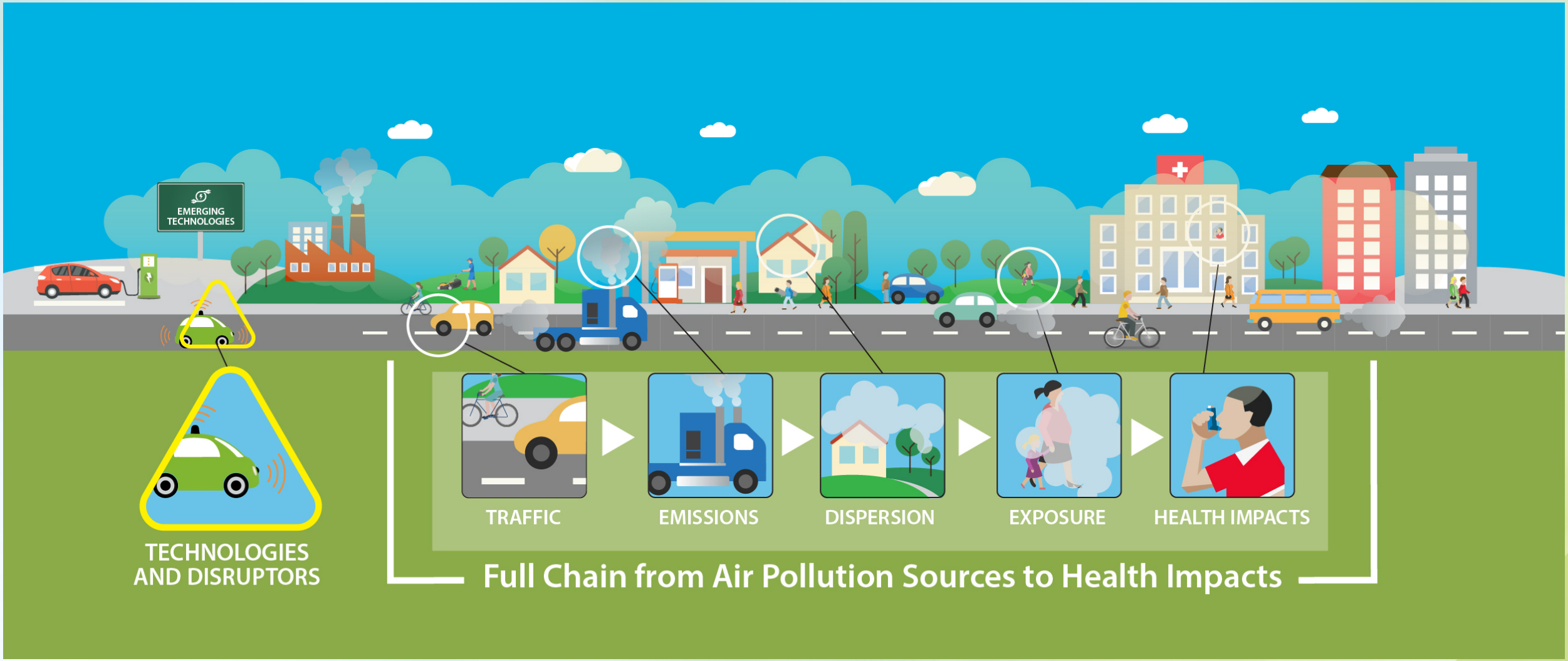
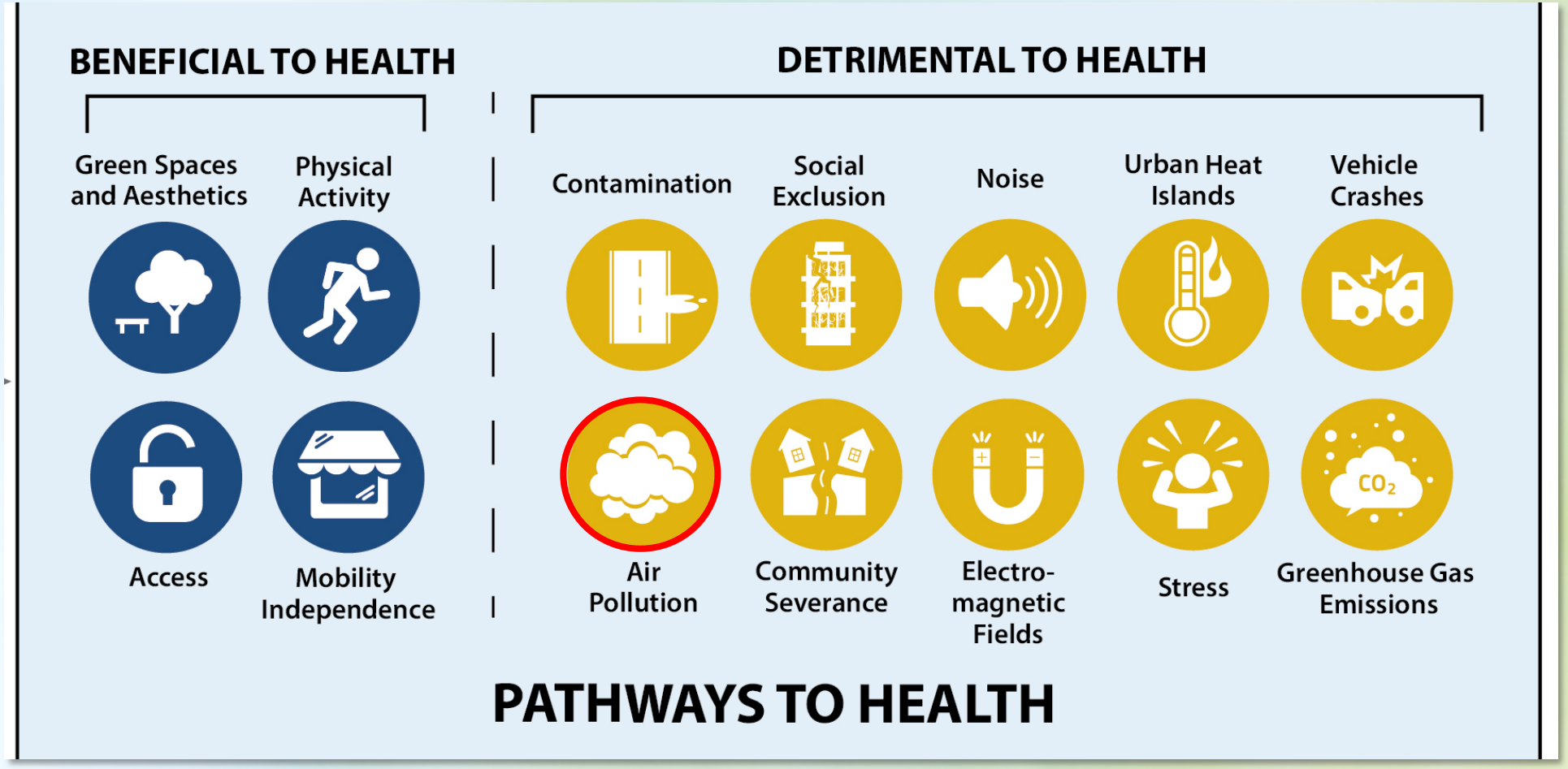
Transportation Emissions and Health Spectrum



14 Pathways Between Transportation and Health



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Environment International

journal homepage: www.elsevier.com/locate/envint

Open access data and paper.

Traffic related air pollution and the burden of childhood asthma in the contiguous United States in 2000 and 2010

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ARTICLE INFO

Handling Editor: Xavier Querol

Keywords:
Traffic related air pollution

ABSTRACT

Background: Asthma is one of the leading chronic airway diseases among children in the United States (US). Emerging evidence indicates that Traffic Related Air Pollution (TRAP), as opposed to ambient air pollution, leads to the onset of childhood asthma. We estimated the number of incident asthma cases among children attributable

Asthma as a Major Health Concern

Asthma is the ***reversible*** or partially reversible ***obstruction*** *of* ***airflow***

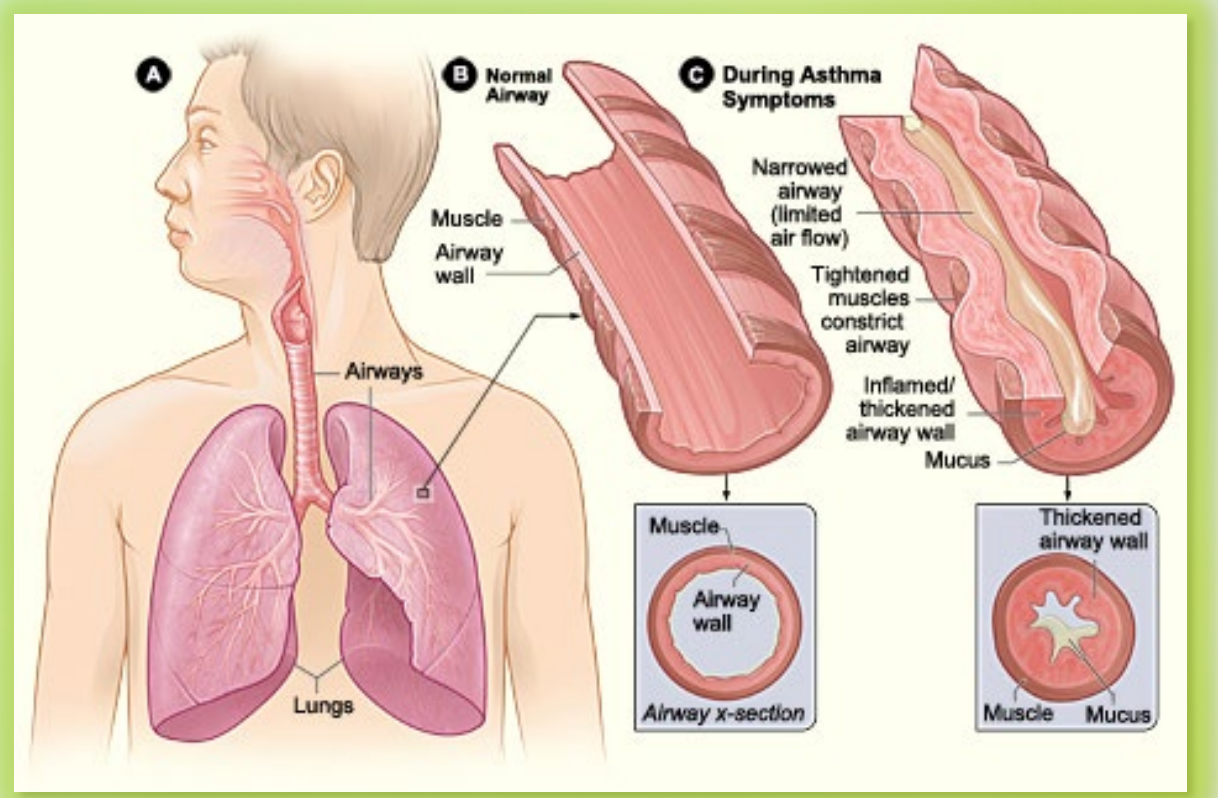
Globally

330+ million people with asthma

United States

20 million **adults** and 6 million **children**

Economic burden of asthma in the U.S. **was $81.9 billion in 2013**



By United States-National Institute of Health: National Heart, Lung, Blood Institute - http://www.nhlbi.nih.gov/health/health-topics/topics/asthma/, Public Domain, https://commons.wikimedia.org/w/index.php?curid=24760677

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Traffic Related Air Pollution (TRAP)

Estimated using **surrogates**

- Buffer zone (distance to road and traffic)
- Chemical surrogates (NO_2, PM, BC, etc.)

NO_2 is a good predictor of traffic

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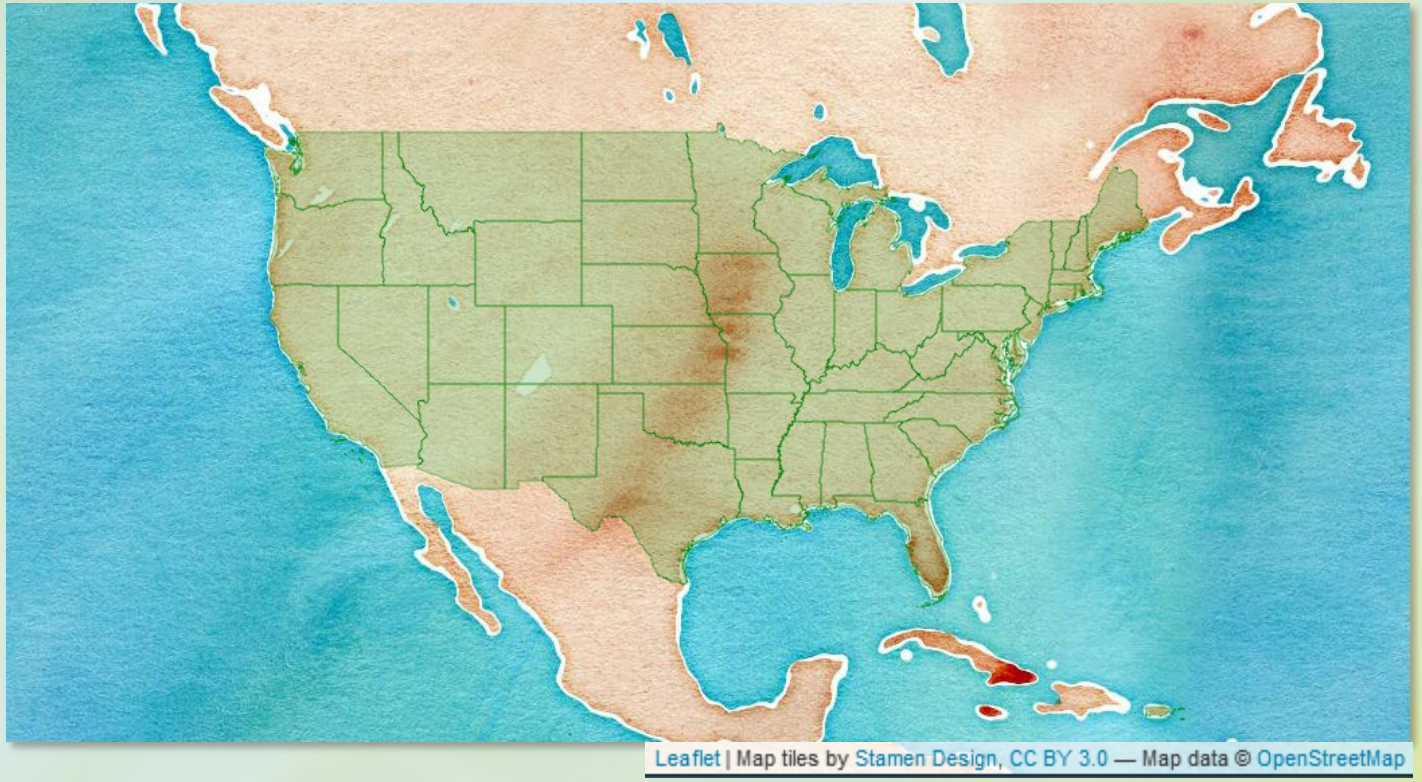
Scope of the Study

- 48 states and D.C.
- 2000 & 2010
- Census Block level
- NO_2, $PM_{2.5}$ and PM_{10}
- Children under 18



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Methods - Overview

Estimated the Burden of Disease using the following *data*

1. Concentration Response Functions (*Literature*)
2. Concentration Estimation (Regression *Models*)
3. Asthma Incidence Rate (*Literature*)
4. Population Exposed (*Census Data*)

Using standard burden of disease assessment methods

- **Attributable number** of asthma incident cases
- **Percentage** of asthma incident cases
- Among Children (<18 years)

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1. Concentration Response Functions

Contents lists available at ScienceDirect

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Review article

Exposure to traffic-related air pollution and risk of development of childhood asthma: A systematic review and meta-analysis

Haneen Khreis [a,*], Charlotte Kelly [a,b], James Tate [a], Roger Parslow [c], Karen Lucas [a], Mark Nieuwenhuijsen [d,e,f]

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1. Concentration Response Functions (continued)

Exposure to traffic-related air pollution and risk of development of childhood asthma: A systematic review and meta-analysis

Haneen Khreis [a,*], Charlotte Kelly [a,b], James Tate [a], Roger Parslow [c], Karen Lucas [a], Mark Nieuwenhuijsen [d,e,f]

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Carlsten et al. 2010 - at 7 y.o.	0.2253	0.1448	0.6%	1.25 [0.94, 1.66]
Clark et al. 2010 LUR - at mean age of 4 y.o.	0.0489	0.0171	9.5%	1.05 [1.02, 1.09]
Dell et al. 2014 LUR - 5 to 9 y.o.	0.039	0.04	5.0%	1.04 [0.96, 1.12]
Deng et al. 2016 - 3 to 6 y.o.	0.1374	0.0689	2.4%	1.15 [1.00, 1.31]
Gehring et al. 2015 b - BAMSE birth to 16 y.o.	0.0397	0.0498	3.8%	1.04 [0.94, 1.15]
Gehring et al. 2015 b - PIAMA birth to 14 y.o.	0.0665	0.0246	7.8%	1.07 [1.02, 1.12]
Gehring et al. 2015b - GINI&LISA North birth to 15	-0.0679	0.1235	0.8%	0.93 [0.73, 1.19]
Gehring et al. 2015b - GINI&LISA South birth to 15	-0.0252	0.0602	2.9%	0.98 [0.87, 1.10]
Jerret et al. 2008 - 10 to 18 y.o.	0.0874	0.033	6.1%	1.09 [1.02, 1.16]
Kim et al. 2016 - 6 to 7 y.o.	-0.0214	0.0219	8.4%	0.98 [0.94, 1.02]
Krämer et al. 2009 - 4 to 6 y.o.	0.0698	0.069	2.3%	1.07 [0.94, 1.23]
Liu et al. 2016 - 4 to 6 years old	0.0877	0.0215	8.5%	1.09 [1.05, 1.14]
MacIntyre et al. 2014 - CAPPS&SAGE only birth to 8	0.1111	0.1268	0.8%	1.12 [0.87, 1.43]
McConnell et al. 2010 - 4th to 6th grade	0.0698	0.0281	7.1%	1.07 [1.01, 1.13]
Mölter et al. 2014 b - MAAS only birth to 8 y.o.	0.574	0.2374	0.2%	1.78 [1.11, 2.83]
Nishimura et al. 2013 - 8 to 21 y.o.	0.0632	0.0269	7.3%	1.07 [1.01, 1.12]
Oftedal et al. 2009 - birth to 10 y.o.	-0.0359	0.0196	8.9%	0.96 [0.93, 1.00]
Ranzi et al. 2014 - birth to 7 y.o.	0.0289	0.0701	2.3%	1.03 [0.90, 1.18]
Shima et al. 2002 - 6 to 12 y.o.	0.1136	0.0534	3.5%	1.12 [1.01, 1.24]
Tétreault et al. 2016 - birth to 12 y.o.	0.0153	0.0048	11.6%	1.02 [1.01, 1.03]
Total (95% CI)			**100.0%**	**1.05 [1.02, 1.07]**

Heterogeneity: Tau² = 0.00; Chi² = 54.38, df = 19 (P < 0.0001); I² = 65%
Test for overall effect: Z = 3.76 (P = 0.0002)

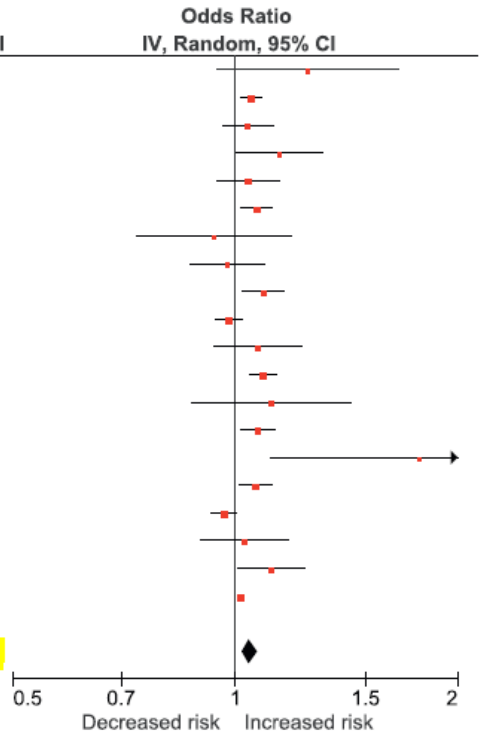

Fig. 4. NO_2 random-effects meta-analyses. Individual and summary random-effects estimates for associations between NO_2 per 4 μg/m³ and asthma at any age. Abbreviations: BAMSE, Barn (children), Allergy, Milieu, Stockholm, an Epidemiology project; CAPPS, The Canadian Asthma Primary Prevention Study; GINI, German Infant study on the influence of Nutrition Intervention on allergy development; LISA, Life style Immune System Allergy; MAAS, The Manchester Asthma and Allergy Study; PIAMA, The Prevention and Incidence of Asthma and Mite Allergy; SAGE, The Study of Asthma, Genes and the Environment.

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2. Concentration Estimation

National Spatiotemporal Exposure Surface for NO_2: Monthly Scaling of a Satellite-Derived Land-Use Regression, 2000–2010

Matthew J. Bechle,[†] Dylan B. Millet,[†,‡] and Julian D. Marshall*[,†]

[†]Department of Civil, Environmental, and Geo- Engineering and [‡]Department of Soil, Water, and Climate, University of Minnesota, Minneapolis, Minnesota 55455, United States

- Annual average concentrations (ug/m^3)
  - ***EPA*** air quality monitor readings
  - Satellite data
  - GIS (impervious surfaces, elevation, major roads, residential roads, and distance to coast)
  - Centroid of each census blocks
  - Highly predictive of spatial variability ($R^2 = 0.82$)

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3. Asthma Incidence Rate

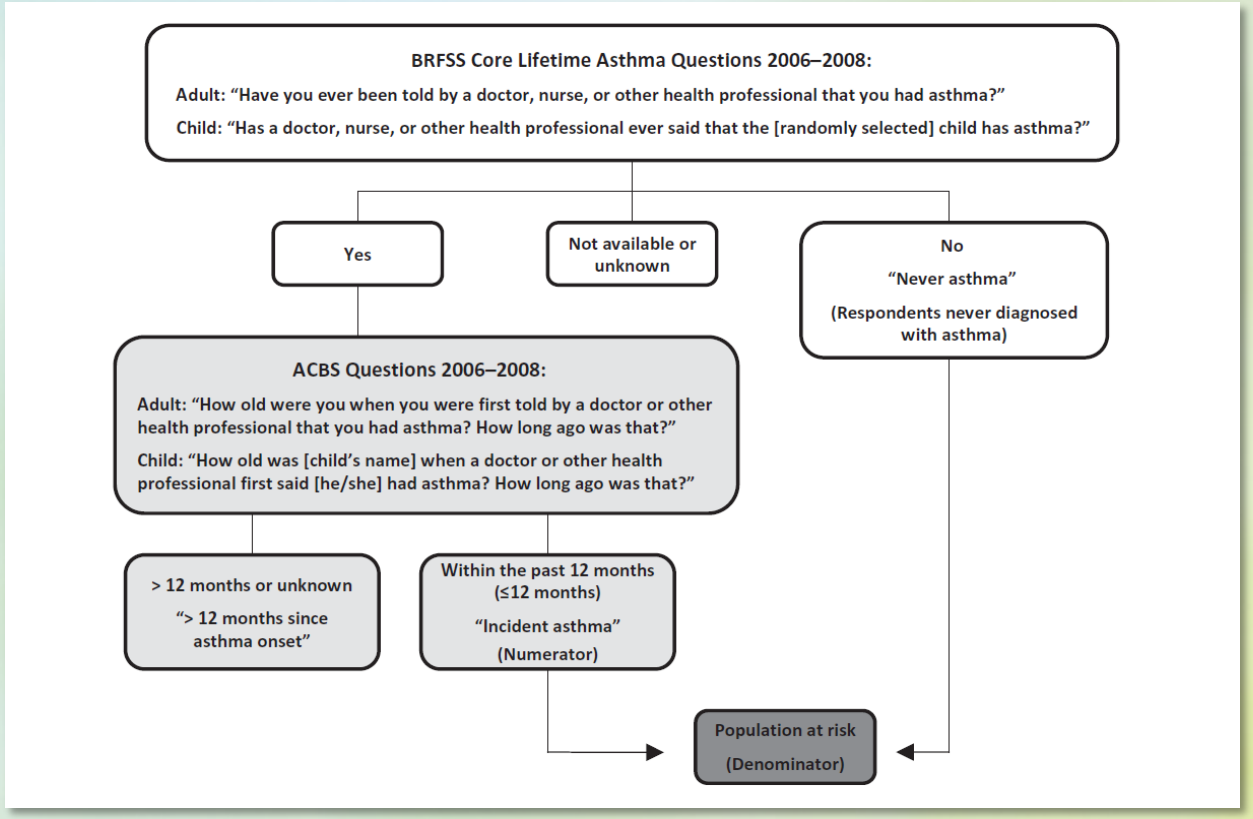
EPIDEMIOLOGY

Asthma Incidence among Children and Adults: Findings from the Behavioral Risk Factor Surveillance System Asthma Call-back Survey—United States, 2006–2008

RACHEL A. WINER, B.A.,* XIAOTING QIN, M.S., THERESA HARRINGTON, M.D., M.P.H., JEANNE MOORMAN, M.S., AND HATICE ZAHRAN, M.D., M.P.H.

Air Pollution and Respiratory Health Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, Chamblee, GA, USA.

- Asthma Call Back Survey
- Period 2006-2008
- 12.5 per 1,000 at-risk children
- Not all states included



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4. Population Exposed

Census data

National Historical Geographic Information System (NHGIS)

- Population count (including children)
- Urban/Rural areas
- Median household income

4. Population Exposed (continued)

- 5+ million populated census blocks
- 70+ million children
- (80%) live in Urban areas

Census Data			
	2000	2010	Change (%)
Geographic characteristics			
Total number of census blocks	8,164,718	11,007,989	35%
Total census blocks included	5,280,214 (65%)	6,182,882 (56%)	17%
Total census blocks within urban areas	2,970,347 (36%)	3,590,278 (33%)	21%
Demographic characteristics			
Total population	279,583,437	306,675,006	10%
Total population of children (birth - 18)	71,807,328 (26%)	73,690,271 (24%)	3%
Mean (range) number of children in census blocks	14 (0-4,713)	12 (0-2,214)	-12%
Population of children by living location			
Urban	56,504,832 (79%)	59,927,088 (81%)	6%
Rural	15,302,496 (21%)	13,763,183 (19%)	-10%

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Results

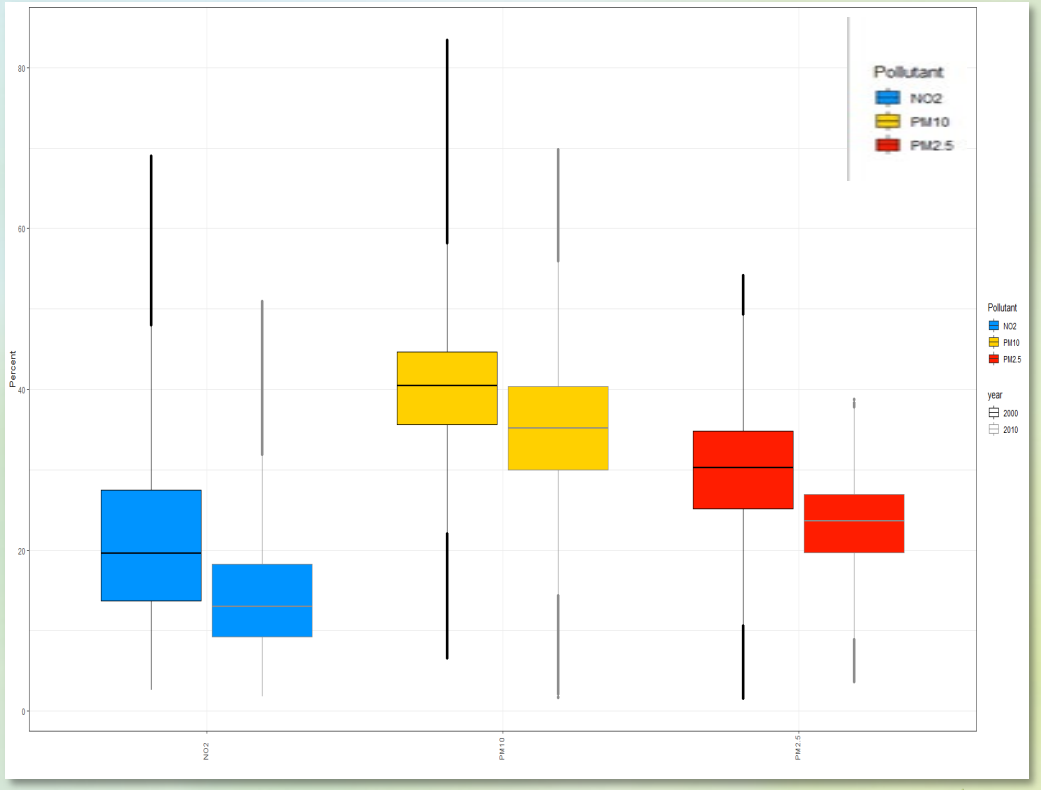
Childhood Asthma Incident Cases due to TRAP

Attributable number of cases and percentage of all cases						
	AC		% of all asthma cases		Change (%)	
	2000	2010	2000	2010	AC	% of all cases
NO_2	***209,100***	***142,000***	***27%***	***18%***	***-32%***	***-33%***
$PM_{2.5}$	247,100	190,200	31%	24%	-23%	-24%
PM_{10}	331,200	286,500	42%	36%	-13%	-14%

*Number and Percentage of cases (**NO_2**)*

- **209,100** → **142,000** (*Attributable Cases*)
- **27%** → **18%** (*of all asthma cases*)

Percentage of childhood asthma incident cases due to pollutant by year



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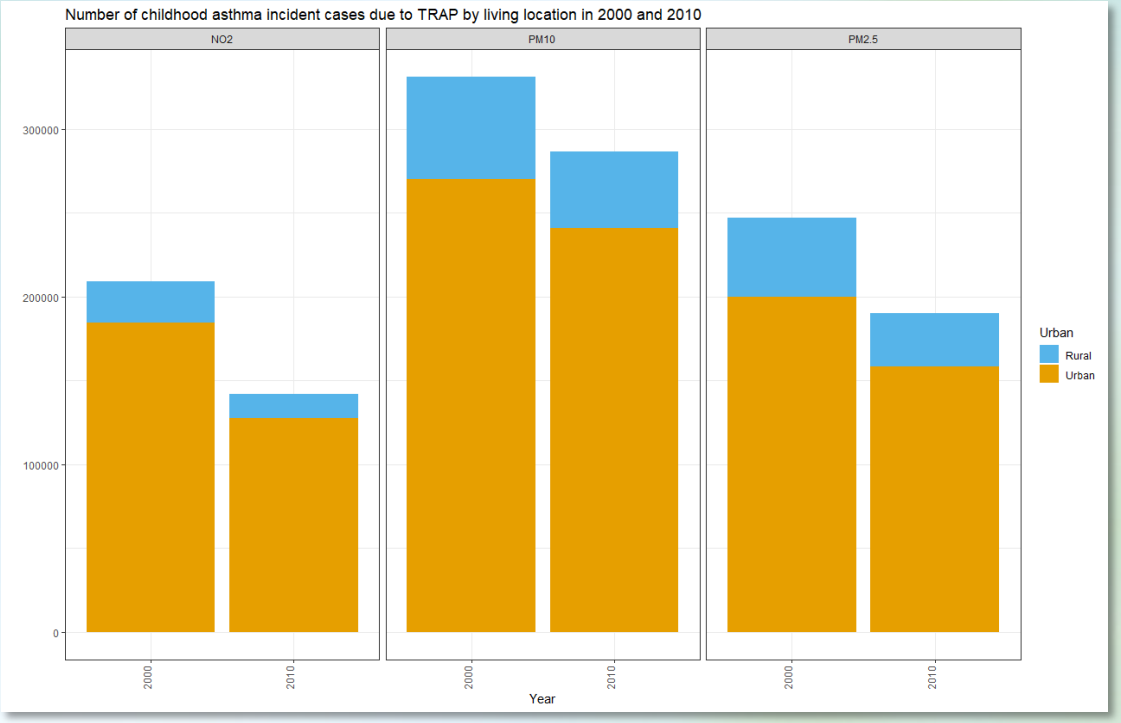
Urban vs Rural



*Percentage of all asthma cases (**NO_2**)*

- **30%** vs **15%** (Urban vs Rural - 2000)
- **20%** vs **10%** (Urban vs Rural - 2010)

Attributable number of cases and percentage of all cases					
	AC		% of all asthma cases		Change (%)
	2000	2010	2000	2010	AC
NO_2					
Urban	**184,500**	**127,500**	**30%**	**20%**	**-31%**
Rural	**24,600**	**14,500**	**15%**	**10%**	**-41%**
$PM_{2.5}$					
Urban	200,100	158,200	32%	24%	-21%
Rural	47,000	32,000	28%	22%	-32%
PM_{10}					
Urban	270,100	240,800	44%	37%	-11%
Rural	61,100	45,700	36%	31%	-25%

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DataTEEH

Datahub for Transportation, Emissions, Energy, & Health

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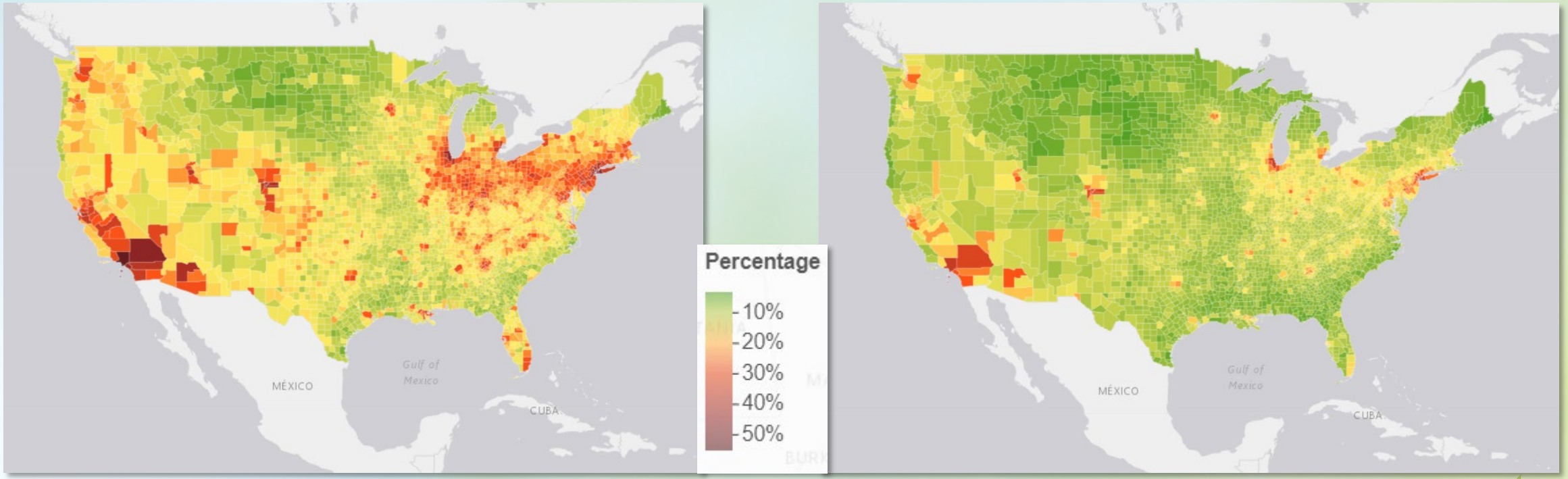

2000 ***2010***

https://carteehdata.org/library/webapp/trap-asthma-usa

Discussion – Key Findings

- Up to **142,000** of childhood asthma cases attributable to **TRAP** in 2010
- **18%** of all asthma cases attributable to NO_2
- Urban areas **>** Rural areas
- 2010 **<** 2000 burden, due ⬇ air pollution levels
- Future analyses is focusing on:
  - Exploring impact of median household income
  - Using state-specific rather than national asthma incidence rates
  - Comparing year 2020 with 2010 and 2000

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2nd CARTEEH Symposium

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