Detroit-specific Asthma Research and Interventions

Community Action to Promote Health Environments (CAPHE)
Community Action Against Asthma (CAAA)
Healthy Environmental Partnerships (HEP)
Detroit Urban Research Center (DURC)

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WORKING TOGETHER TO IMPROVE DETROIT'S AIR
COMMUNITY ACTION TO PROMOTE HEALTHY ENVIRONMENTS
CA-PHE

Community Action Against Asthma

Healthy Environments Partnership

DETROIT URC
DETROIT COMMUNITY - ACADEMIC URBAN RESEARCH CENTER

HEI

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Detroiters Working for Environmental Justice
Fostering Clean, Healthy and Safe Communities

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Moving Research to Action to Reduce Adverse Health Effects of Air Pollution: Community Action to Promote Healthy Environments (CAPHE)

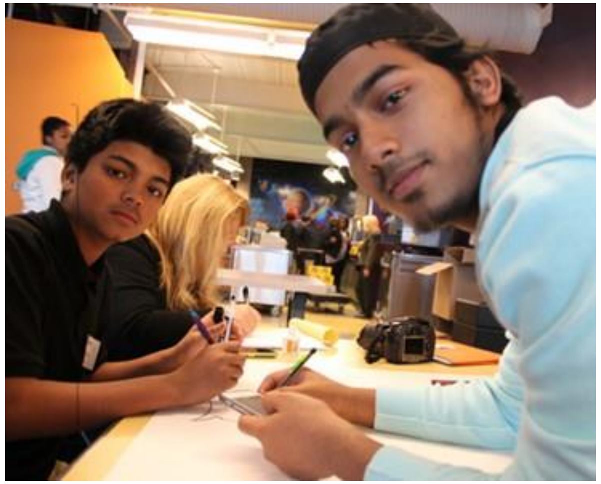
Overarching Goal of CAPHE

Develop and implement a scientifically-informed public health action plan (PHAP) designed to reduce exposure to air pollutants and mitigate adverse health effects in Detroit with a particular focus on vulnerable populations.

Aim 3: Develop a multilevel, integrated and scientifically-informed public health action plan to reduce air pollutant exposures and adverse health effects

Photo: Playground next to industrial land use in Detroit

Aim 4: Develop & implement campaigns, interventions & policies to promote recommendations in the public health action plan.



Photos 1, 2, 3 and 4: Youth Programming, Detroiters Working for Environmental Justice

Public Health Action Plan Resource Manual

CAPHE is developing a Public Health Action Plan Resource Manual to inform the PHAP

1. Introduction and Objectives
2. Background and Context
3. Air Quality, Health and Environmental Justice
4. Exposure and Monitoring
5. Air Pollutant Sources, Exposures and Health Impacts
6. Cumulative Risk: Air Pollution and Population Vulnerability
7. Mitigation Strategies, including point source controls, mobile source controls, diesel retrofits, monitoring, enforcement, *indoor particle filters*, buffers, and more.

Intervention and epidemiological research on environmental triggers of asthma. Community Action Against Asthma (CAAA)

Overarching Goals of CAAA

Overall goals of the CAAA partnership are to examine how the effects of air quality interact with social and environmental factors with childhood asthma, to test different interventions at reducing impact of environmental triggers, and to consider these findings in designing community and policy interventions.

Asthma Triggers in Homes

Children on average spend between 14 and 18.5 hours per day indoors at home, depending on age

Indoor asthma triggers include:

- Secondhand smoke
- Dust
- Molds
- Pests
- Pets
- Outdoor air pollution
- Chemical irritants
- Wood smoke

Community Action Against Asthma

Indoor mold: Environmental Relative Moldiness Index (ERMI)

Objective: quantify mold contamination in study participant's homes

- NEXUS participants were children ages 6-14 years with asthma in Detroit, MI
- ERMI study included homes of 112 participants

Approach:

- Collected dust samples in bedrooms and living rooms
- Measured 36 indicator species of mold, analysis using quantitative PCR techniques
- Calculated the ERMI for each home
- Examine effect of water damage, age of home, and other factors on concentration of molds found in homes

Kamal et al. 2014. J Env Pub Health

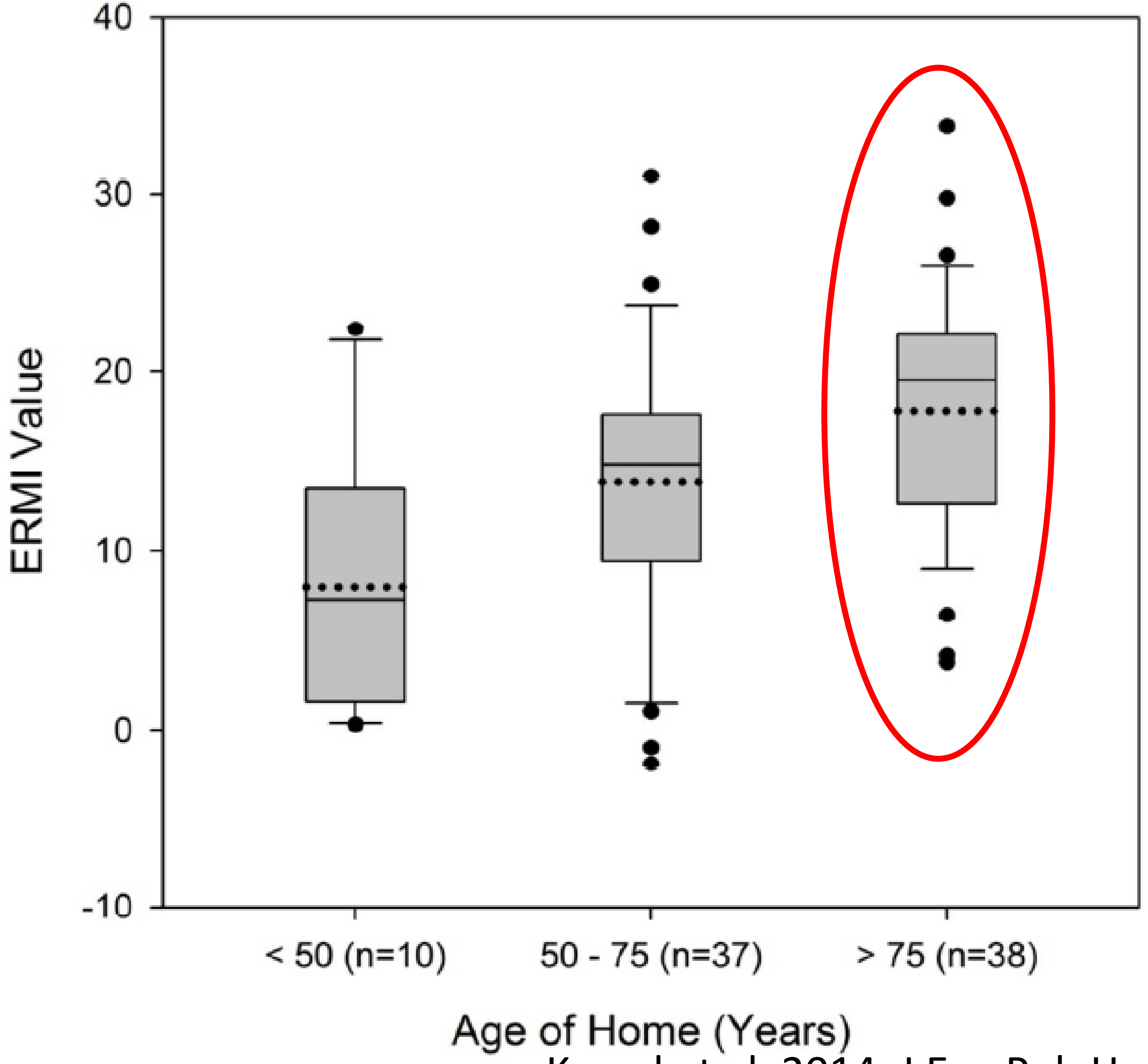
Environmental Relative Moldiness Index (ERMI)

Part of CAAA and NEXUS (EPA)

Findings:

1. Most homes (85%) had <u>exceptionally high ERMI values</u> -- highest quartile nationally.
2. Mold was present throughout the whole house.
3. Concentrations tended to be higher in bedrooms than living rooms (not statistically significant).
4. Age of the home was an important predictor of ERMI.

Highest ERMI values were calculated in older homes (over 75 years old)



Kamal et al. 2014. J Env Pub Health

Indoor Volatile Organic Compounds (VOCs)

Community Action Against Asthma

Objective: quantify VOC composition and levels in homes of Detroit children with asthma

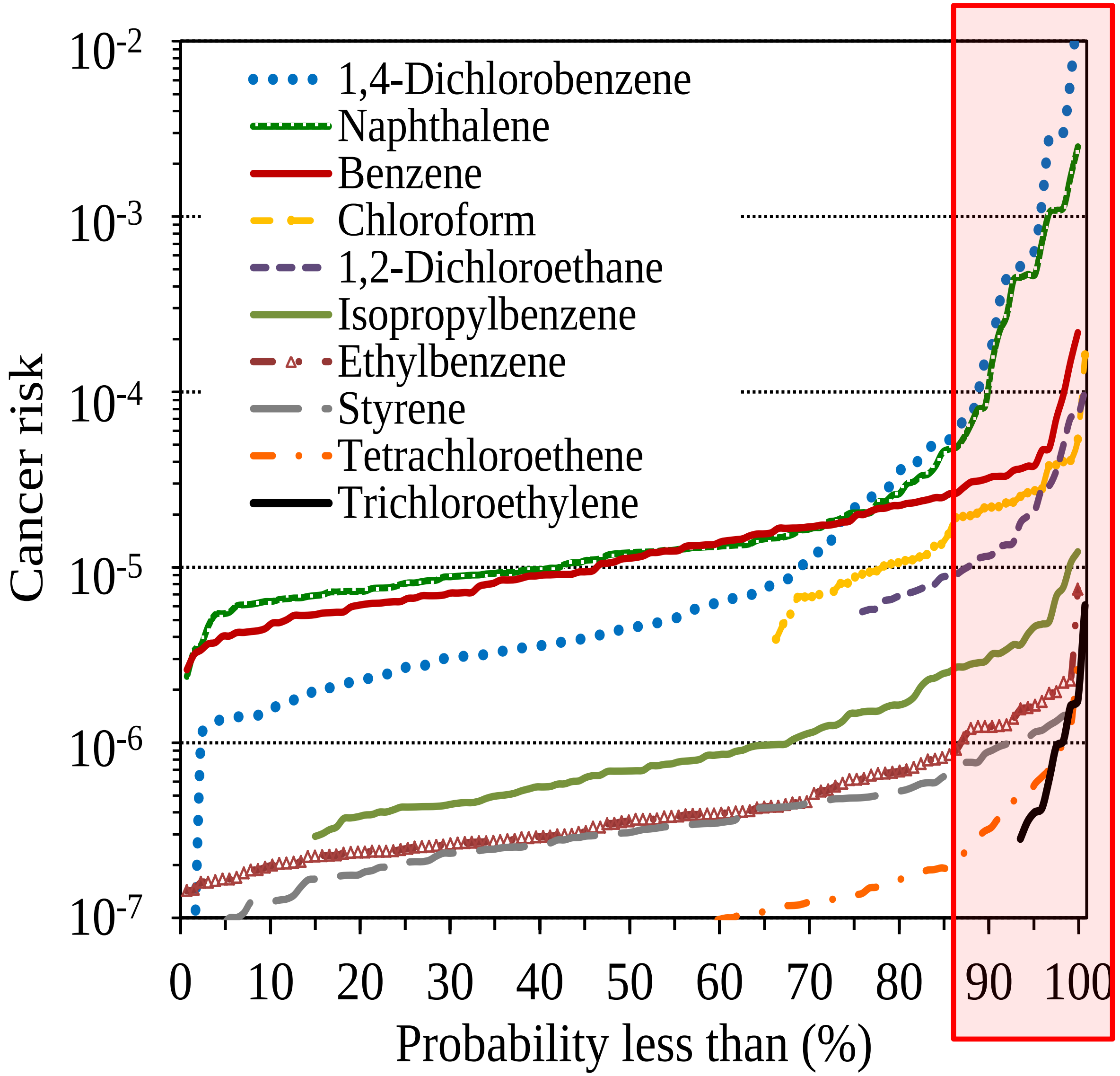
Findings: A total of 56 VOCs detected

Concentrations generally lower than levels elsewhere in North America.

Major source include cigarette smoking, vehicle related emissions, renovation, solvents, household product and pesticides.

Some VOCs pose cancer risks that exceed guideline levels (naphthalene, benzene, 1,4-dichlorobenzene, isopropylbenzene, ethylbenzene and styrene

Some very high levels of naphthalene and 1,4-dichlorobenzene in a subset of residences.



Chin et al.,. Indoor Air, 2013

Community Action Against Asthma

CAAA Free-standing Filter Intervention Study

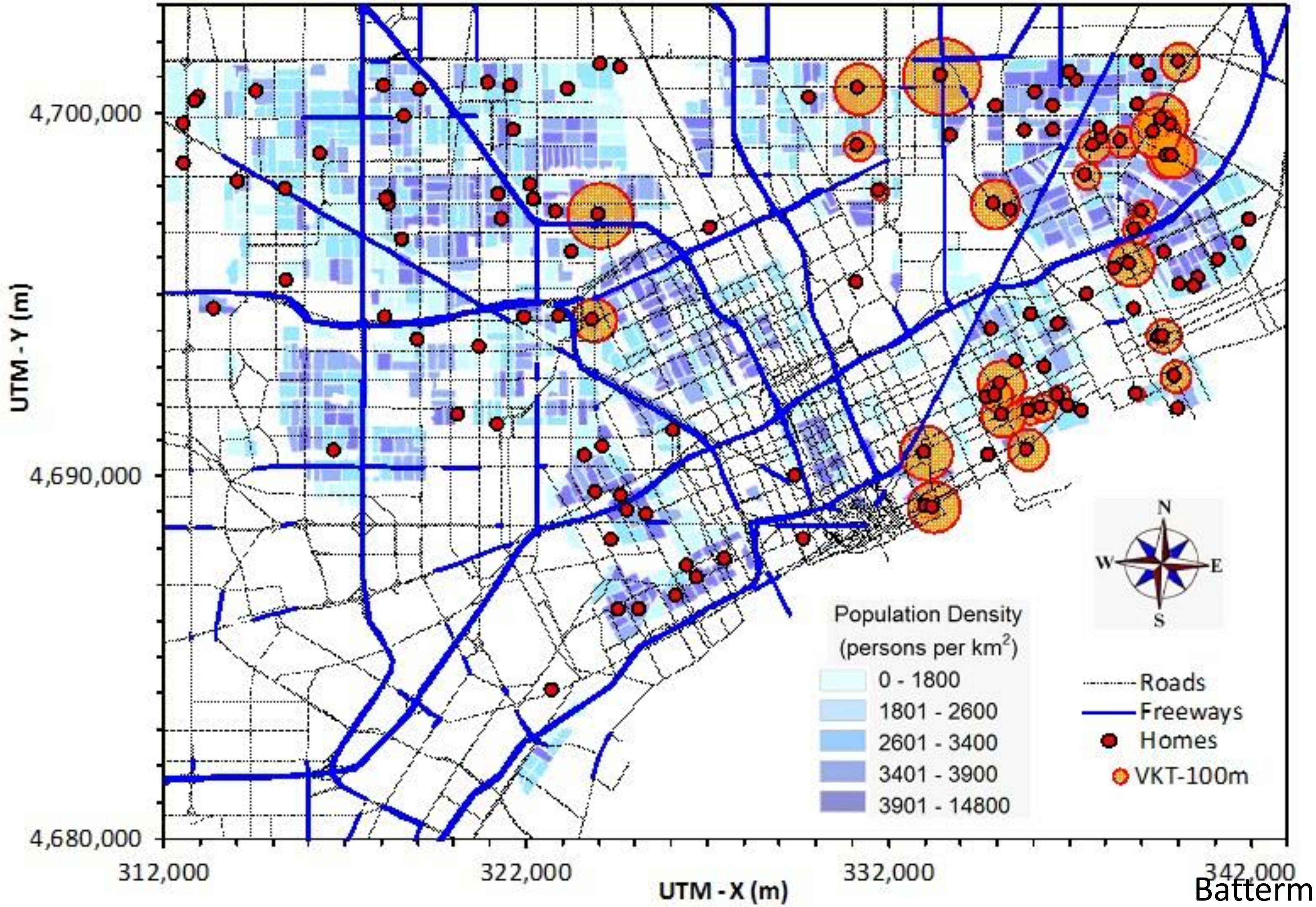
Objectives:

1. Characterize pollutant exposures in homes of children with asthma living in Detroit, Michigan.
2. Determine effects of providing HEPA filters and room air conditioners in child's bedroom on indoor pollutant concentrations and exposures.
3. Investigate effects of providing HEPA filters and room air conditioners on children's respiratory health, e.g., lung function, medication usage, ER visits.

Batterman et al. 2012. Indoor Air

Location of participating households

also showing highways and secondary streets, and vehicle-kilometers-driven (VKT) per day within a 100 m buffer of the home (orange circle)



Batterman et al. 2012. Indoor Air

Home characteristics

Home characteristics		Unit	Average	Range	Percent
House	Floor area	m^2	147	63 - 483	-
	Interior house volume	m^3	368	156 - 1192	-
	Single family house		-	-	79
	No. of bedrooms	n	3.0	1 - 6	-
	Heating system (Forced air)		-	-	88
	Central AC		-	-	30
	Furnace filter change frequency	times/yr	2.5	1 - 12	47
Child's sleeping area	Floor area	m^2	12	4 - 46	-
	Room volume	m^3	28	13 - 110	-
	No. of windows	n	1.7	1 - 5	-
Occupancy	No. of adults	n	1.7	1 - 5	-
	No. of children	n	2.4	1 - 8	-
Smoking	Never any smokers indoors		-	-	55
	Any smokers in household		-	-	60
	No. of smokers	n	1.7	1 - 5	60
Cleaning	Vacuumed CSA in the last 2 weeks	n	3.1	1 - 5	44
	Swept or dusted CSA in the last 2	n	3.3	1 - 5	100

Batterman et al. 2012. Indoor Air

Monitored environmental parameters

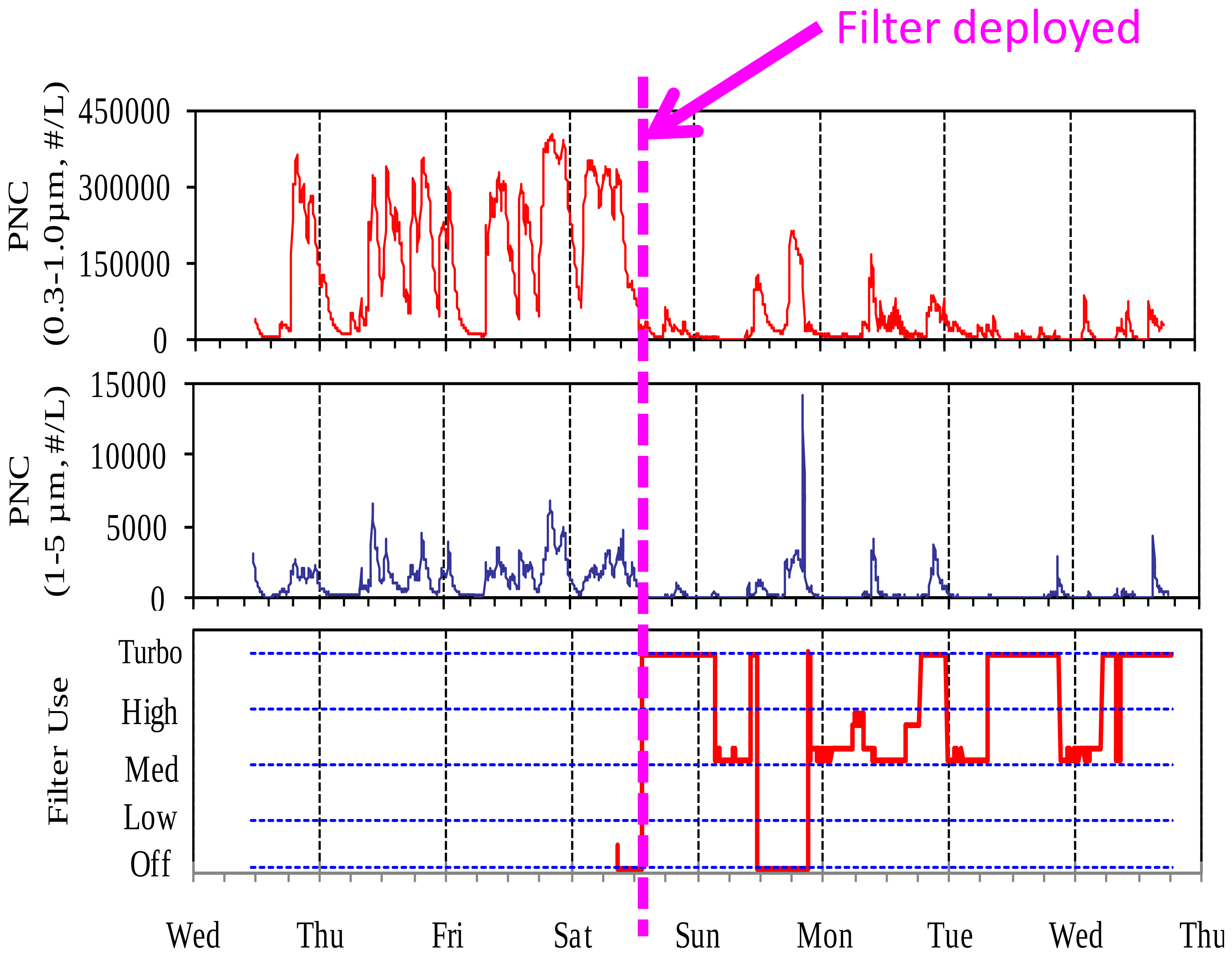
- Particulate matter (PM)
- Particle number (0.3-1.0 µm/1-5 µm)
- Carbon dioxide (CO_2)
- Volatile organic compounds (VOCs)
- Environmental tobacco smoke (ETS)
- Air exchange rates (AERs) in bedroom & living room
- Temperature and RH
- Filter use

Weeks of data

	Baseline	Seasonal	Total
Control	37	59	94
Standard	47	90	137
Enhanced	42	73	115
Total	126	222	346

Batterman et al. 2012. Indoor Air

Trends of fine and coarse PM and filter use



Particle number counts (0.3-1.0 µm)

Particle number counts (1-5 µm)

Air filter use (showing fan speed)

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Batterman et al. 2012. Indoor Air

Pollutant levels in residences with and without filter

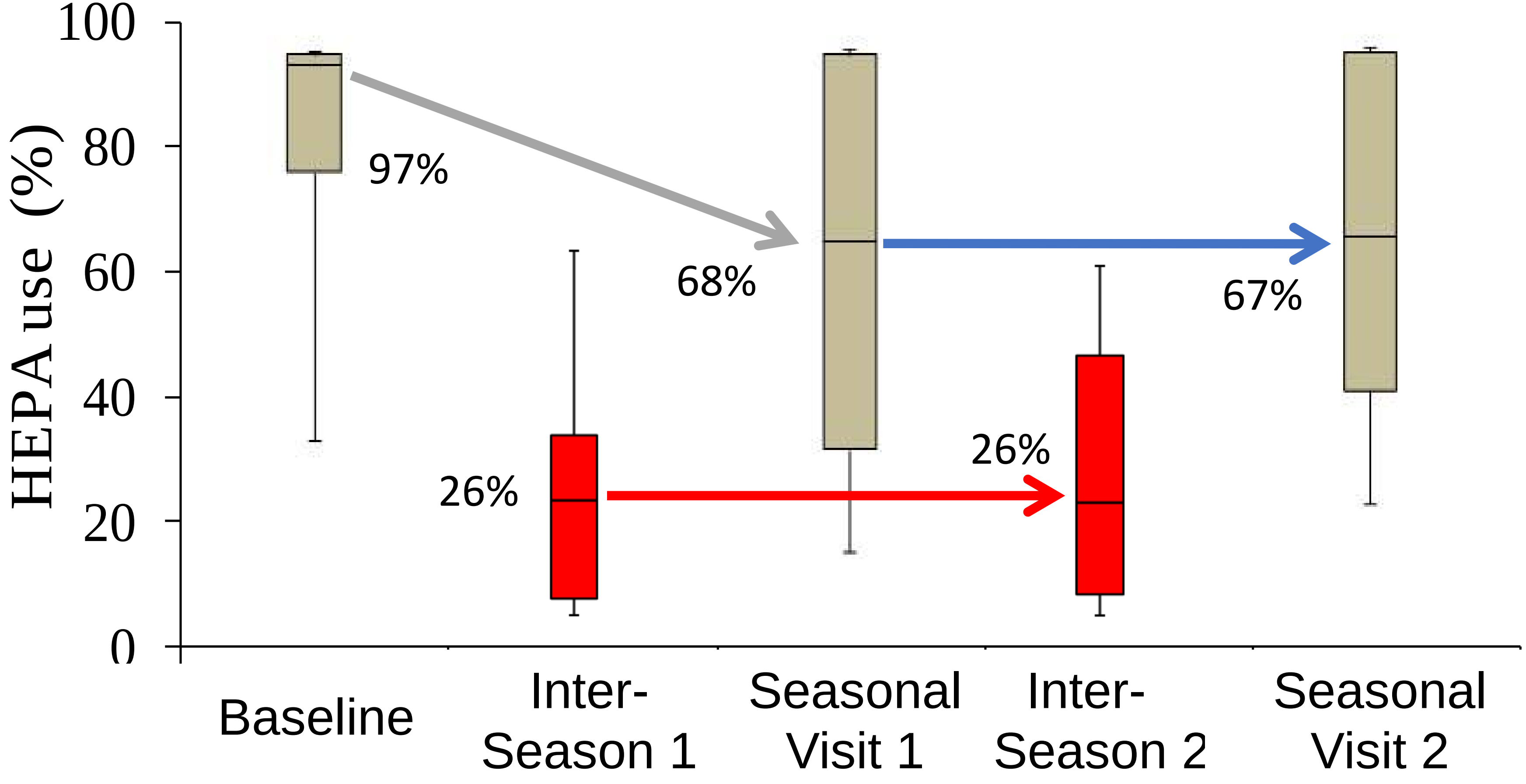
Statistic		Without filter				With filter			
		N	Average	SD	Median	N	Average	SD	Median
PM ($\mu g/m^3$)	Control	35	32.5	14.7	30.4				
	Standard /Enhanced	79	26.7	25.3	14.2	83	14.1	10.1	11.4
	All	114	28.5	22.7	21.8				
0.3-1.0 μm PNC (#/liter)	Control	35	94,757	46,653	80,498				
	Standard /Enhanced	78	64,504	61,159	40,328	83	36,277	27,161	27,802
	All	113	73,875	58,564	58,101				
1-5 μm PNC (#/liter)	Control	35	1,774	1,470	1,306				
	Standard /Enhanced	78	1,434	1,408	933	83	532	438	399
	All	116	1,298	1,325	846				

50% reduction

Each house is weighted equally.

Batterman et al. 2012. Indoor Air

How do occupants use filters?



Initially high use may reflect a **"novelty"** effect when the filter was first introduced to the participants, and remained quite high in our weekly visits.

Use dropped in periods between home visits reflecting a **"good behavior"** effect, reflecting participants' understanding of intended filters use, and **"economy"** effect associated with perception of filter cost.

Batterman et al. 2012. Indoor Air

Influences on indoor PM levels and filters

Environmental tobacco smoke (ETS)

- Had both survey data & unique ETS tracer (2,5-DMF) to measure smoking.
- Smoking (ETS) increased bedroom PM levels by 12 ± 35 $\mu m/m^3$, comparable to literature findings
- ETS found in 30% of households, and sometimes levels appear equal or higher in child's bedroom
- Concordance between survey & tracer data is not great, which means that survey data results often is not accurate (exposure misclassification)

Other factors

- Seasonal variation is often strong, e.g., indoor PM levels lower in winter
- Indoor levels affected by outdoor PM concentrations, the number of children in the house, and sweeping/dusting.
- Furnace filters can be very helpful

Batterman et al. 2012. Indoor Air

Health impact assessment (HIA) of indoor filters to reduce asthma impacts among children in Detroit

Objective: assess the potential for asthma health benefits of installing filters in children's homes to reduce exposures to ambient $PM_{2.5}$

- Exposures based on area monitoring data
- Daily mean exposure concentrations at the block level

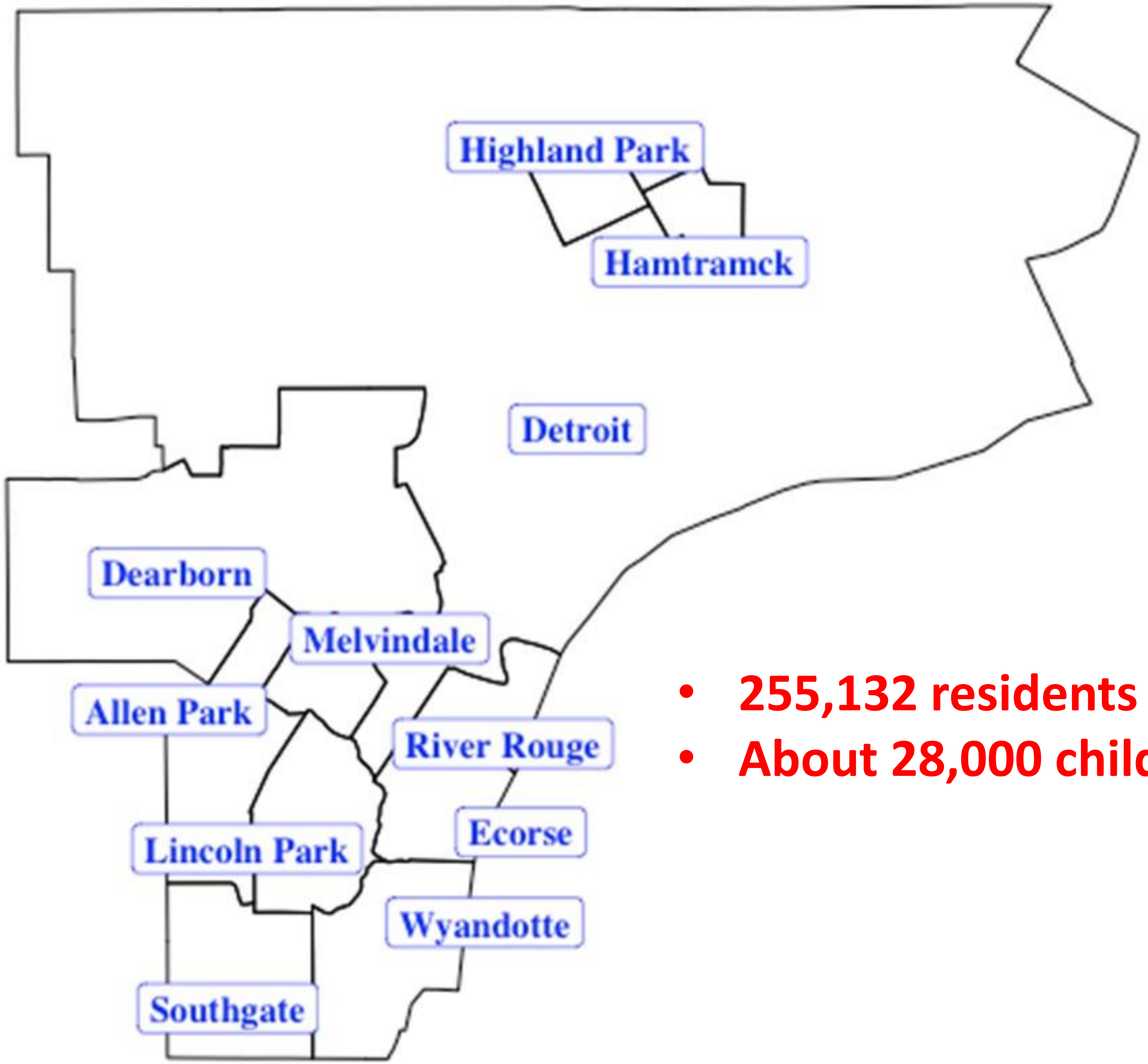
Local population and health outcome data

- Asthma ED visit data from MDHHS surveillance report (deGuire et al. 2016)
- Exacerbation data (cough, wheeze, shortness of breath) from NEXUS study

Health impact functions

- Concentration-response coefficient from epidemiological studies
- Estimated impacts attributable to $PM_{2.5}$ exposures at homes and schools
- Estimated benefits of using filters to reduce exposures

Health Impact Assessment Study Area

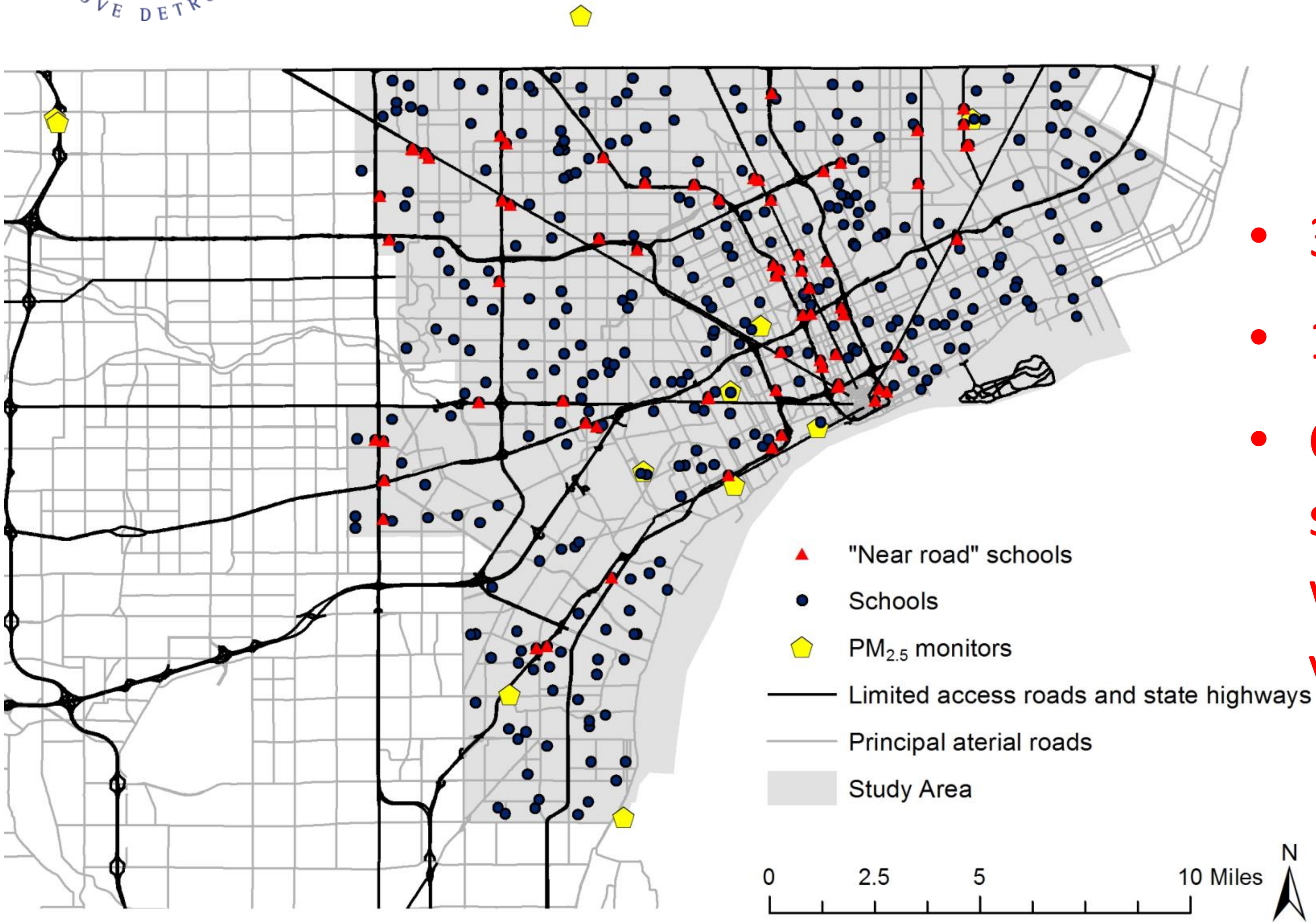


- 255,132 residents under the age of 18
- About 28,000 children with asthma

Health Impact Assessment Results: Filters in Homes

Outcome (age group)	Estimated cases per year	Estimated cases per year due to ***ambient*** $PM_{2.5}$ exposure at home	% Attributable	Estimated cases per year due to ***ambient*** $PM_{2.5}$ exposure at home after installing filters — Filter Efficiency 25%	50%	75%
Asthma ED visit (0-17 years)	9,616	374	3.89	283	183	96
Cough (6-14 years)	1,778,282	138,782	7.80	105,376	67,701	35,939
Wheeze (6-14 years)	1,130,220	11,115	0.98	8,352	5,537	2,794
Shortness of breath (6-14 years)	1,073,190	14,096	1.31	10,599	7,012	3,551

Health impact assessment (HIA) of filters to reduce asthma impacts among children in *Detroit schools*



- 392 Schools (75 “near road”)
- 145,593 students
- Considered exposures on school days (excludes weekends and summer vacation)

Health Impact Assessment Results: Filters in Schools

Outcome (age group)	Estimated cases per year	Estimated cases per year due to ***ambient*** $PM_{2.5}$ exposure at schools	% Attributable	Estimated cases per year due to ***ambient*** $PM_{2.5}$ exposure at schools after installing filters in ***all schools*** — Filter Efficiency			Estimated cases per year due to ***ambient*** $PM_{2.5}$ exposure at schools after installing filters in ***near-road schools*** — Filter Efficiency		
				25%	50%	75%	25%	50%	75%
Asthma ED visit (0-17 years)	7,166	46	0.64	35	23	12	43	41	38
Cough (6-14 years)	1,778,282	25,735	1.45	19,539	13,179	6,663	24,704	23,641	22,547
Wheeze (6-14 years)	1,130,220	2,061	0.18	1,548	1,034	518	1,974	1,888	1,801
Shortness of breath (6-14 years)	1,073,190	2,613	0.24	1,965	1,313	658	2,504	2,394	2,284

Some conclusions

- Many Detroit homes have high levels of mold in bedrooms, living rooms, and other areas. House age is an important predictor.
- Some homes have very high VOC levels.
- PM exposure is determined by indoor sources (smoking, children, sweeping/dusting), house factors (AER, AC, existing filters), environment (outdoor PM levels, season), and filters (filter type, use)
- Filters in homes can reduce indoor PM concentrations by 25 to 50% or more, but filter use can vary considerably for many reasons.
- The use of stand-alone and enhanced central furnace filters in Detroit homes is a strategy to reduce adverse asthma outcomes among children and adults.
- Use of enhanced filters in schools, particularly schools near major highways and industrial sources, is feasible and beneficial.

ASTHMA AND DETROIT PUBLICATIONS (1)

Asthma Epidemiology and Health Impact Assessment in Detroit

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S. Li, S. Batterman, E. Wasilevich, R. Wahl, J. Wirth, F.C. Su, B. Mukherjee. "Association of Ambient Air Pollutants with Daily Asthma Emergency Department Visits and Hospital Admissions among the Pediatric Medicaid Population in Detroit: Time-Series and Time-Stratified Case-Crossover Analyses with Threshold Effects," *Environmental Research,* 111*,* 8, 1137-1147, 2011. doi:10.1016/j.envres.2011.06.002 PMID: 21764049

Sheena E. Martenies, Donele Wilkins, Stuart A. Batterman, "Health impact metrics for air pollution management strategies, *Environment International*, 85, 84–95, 2015. http://dx.doi.org/10.1016/j.envint.2015.08.013.

VOCs in Detroit Homes

C. Jia, S. Batterman, C. Godwin, "VOCs in industrial, urban and suburban neighborhoods: Part 1: Indoor and outdoor concentrations, variation, and risk drivers", *Atmospheric Environment*, 42, 9, 2083-2100, 2008. doi:10.1016/j.atmosenv.2007.11.055

C. Jia, S. Batterman, C. Godwin, 2008. "VOCs in industrial, urban and suburban neighborhoods: Part 2: Factors affecting indoor and outdoor concentrations", *Atmospheric Environment*, 42, 9, 2101–2116. 2008. doi:10.1016/j.atmosenv.2007.11.047

C. Jia, S Batterman, "A critical review of sources and exposures of naphthalene relevant to indoor and outdoor air", *International Journal of Environmental Research and Public Health*, 7, 2903-2939, 2010. doi:10.3390/ijerph7072903 PMID: 20717549 PMCID: PMC2914002

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JY Chin, C Godwin, C Jia, T Robins, T Lewis, S Batterman, "Concentrations and risks of 1,4 p-dichlorobenzene in indoor and outdoor air ," *Indoor Air*, 23(1), 40-49, 2013. doi: 10.1111/j.1600-0668.2012.00796.x. PMCID: PMC3501547

Jo-Yu Chin, Christopher Godwin, Edith Parker, Thomas Robins, Toby Lewis, Paul Harbin, Stuart Batterman, Levels and Sources of Volatile Organic Compounds in Homes of Children with Asthma, *Indoor Air*, Online 3 January, 2014. DOI: 10.1111/ina.12086.

Stuart Batterman, Luilui Du, Christopher Godwin, Zachary Rowe, Jo-Yu Chin, "Air exchange rates and migration of VOCs in basements and residences," *Indoor Air*, accepted, December, 2015.

ASTHMA AND DETROIT PUBLICATIONS (2)

Air Filters in Detroit Homes

L. Du, S. Batterman, E. Parker, C. Godwin, J-Y Chin, A. O'Toole, T. Robins, W. Brakefield-Caldwell, T. Lewis. "Particle concentrations and effectiveness of free-standing air filters in bedrooms of children with asthma in Detroit, Michigan", *Building and Environment*, 46, 2303-2313, 2011. http://dx.doi.org/10.1016/j.buildenv.2011.05.012 PMCID: PMC3161201

S Batterman, L Du, Graciela Mentz, B Mukherjee, E Parker, C Godwin, J-Y Chin, A O'Toole, T Robins, Z Rowe, T Lewis, "Particulate matter concentrations in residences: an intervention study evaluating stand-alone filters and air conditioners", *Indoor Air*, 22: 235–252, 2012. PMID: 22145709

Liuliu Du, Stuart Batterman, Christopher Godwin, Jo-Yu Chin, Edith Parker, Michael Breen, Wilma Brakefield, Thomas Robins, Toby Lewis "Air change and interzonal flows in residences, and the need for multi-zone models for exposure and health analyses, *International Journal of Environmental Research and Public Health*, 2012 9(12): 4639-4661. PMCID: PMC3546781

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ASTHMA AND DETROIT PUBLICATIONS (3)

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C. Godwin, S. Batterman, "Indoor Air Quality in Michigan Schools", *Indoor Air*, 17, 2, 109-121, 2007. http://www.blackwell-synergy.com/doi/abs/10.1111/j.1600-0668.2006.00459.x. PMID: 17391233

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Stuart Batterman, Janet Burke, Vlad Isakov, Toby Lewis, Bhramar Mukherjee, Thomas Robins. A Comparison of Exposure Metrics for Traffic-Related Air Pollutants: Application to Epidemiology Studies in Detroit, Michigan. *International Journal of Environmental Research and Public Health*, 11, 9553-9577, 2014. doi:10.3390/ijerph110909553

Nichole Baldwin, Owais Gilani, Suresh Raja, Stuart Batterman, Rajiv Ganguly, Philip Hopke, Veribuca Berrocal, Thomas Robins, Sarah Hoogterp. "Factors Affecting Pollutant Concentrations in the Near-Road Environment." *Atmospheric Environment*. 115, 223-235, 2015. http://dx.doi.org/10.1016/j.atmosenv.2015.05.024

Stuart Batterman, Rajiv Ganguly, Paul Harbin, High Resolution Spatial and Temporal Mapping of Traffic-Related Air Pollutants. *International Journal of Environmental Research and Public Health*, 12(4), 3646-3666, 2015. doi:10.3390/ijerph120403646.

Chad Milando, Lei Huang, Stuart Batterman, "Trends in $PM_{2.5}$ emissions, concentrations and apportionments in Detroit and Chicago," *Atmospheric Environment*, 129, 197-209, 2016.

Michael S. Breen, Janet M. Burke, Stuart A. Batterman, Alan F. Vette, Gary A. Norris, Christopher Godwin, Carry W. Croghan, Bradley D. Schultz, Thomas C. Long. Modeling Spatial and Temporal Variability of Residential Air Exchange Rates for the Near-Road Exposures and Effects of Urban Air Pollutants Study (NEXUS). *International Journal of Environmental Research and Public Health*, *11*(11), 11481-11504, 2014; doi:10.3390/ijerph111111481. http://www.mdpi.com/1660-4601/11/11/11481/htm

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