

# Does Indoor Air Filtration Improve Health?



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上海市第一人民醫院  
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上海市紅十字醫院



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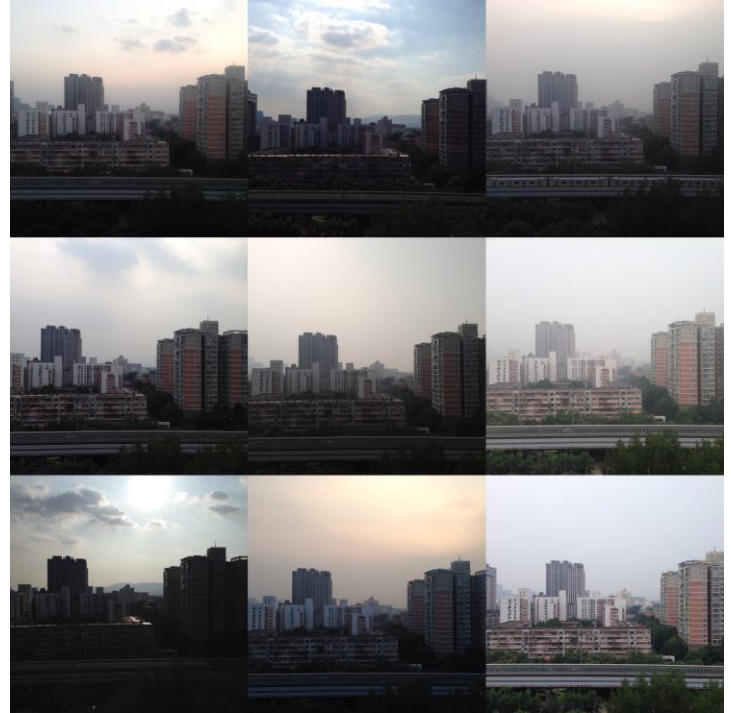
**Dr. Yanbo Teng**

*A rotating team of residents and field technicians assisted with data collection in Shanghai, undergraduate students in the Bergin lab assembled, tested, and prepared equipment for the field, and staff/students at Duke and the University of Wisconsin .*

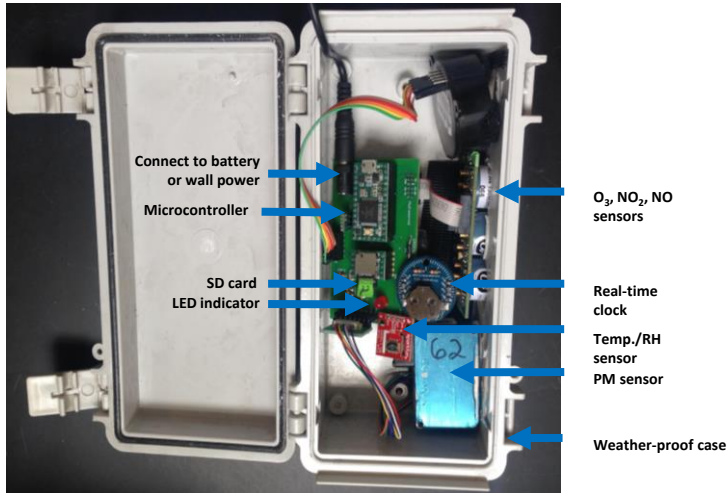
*We also acknowledge the participants in both Beijing and Shanghai for inviting us into their homes and for their cooperation throughout the project.*

# Rationale for the Project

- High levels of ambient pollution in China
- Individuals spend the majority of their time indoors
- Specific pollutants in the indoor environment in China have not been rigorously quantified (e.g., VOCs, O<sub>3</sub>, components of PM)
- If effective, purifiers may allow individuals to improve their indoor environment, with potential benefits for health



# Project Objectives

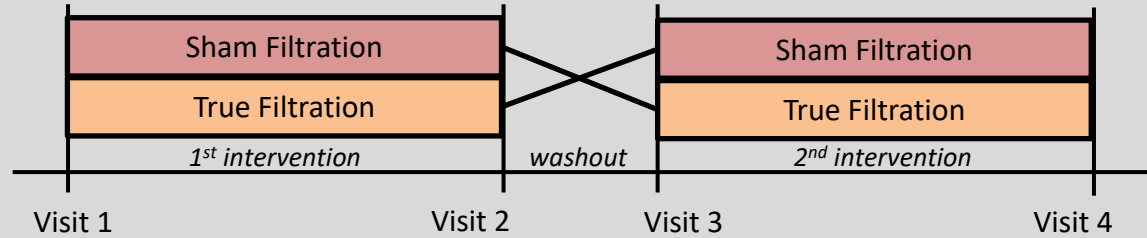


- To quantify air pollutants in homes in urban China
- To assess the feasibility of measuring pollutants using low-cost sampling equipment
- To determine if air purifiers reduce pollutants a) indoors b) for personal exposure
- To evaluate the impact of air purification on the respiratory health of asthmatic children

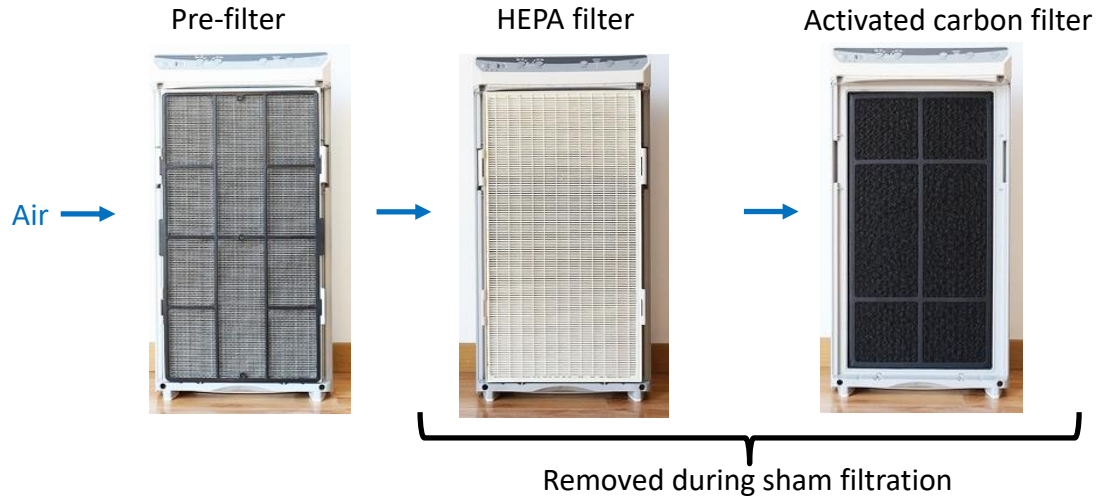


# Project Overview

**Study design:** randomized, double-blind crossover trial

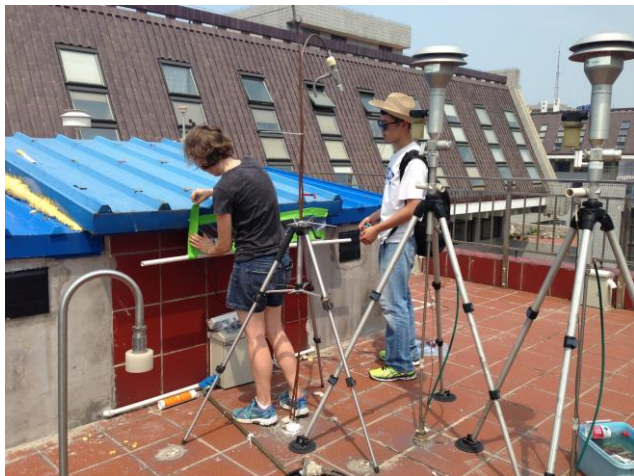


**Air purifier:**  
Used in  
bedroom

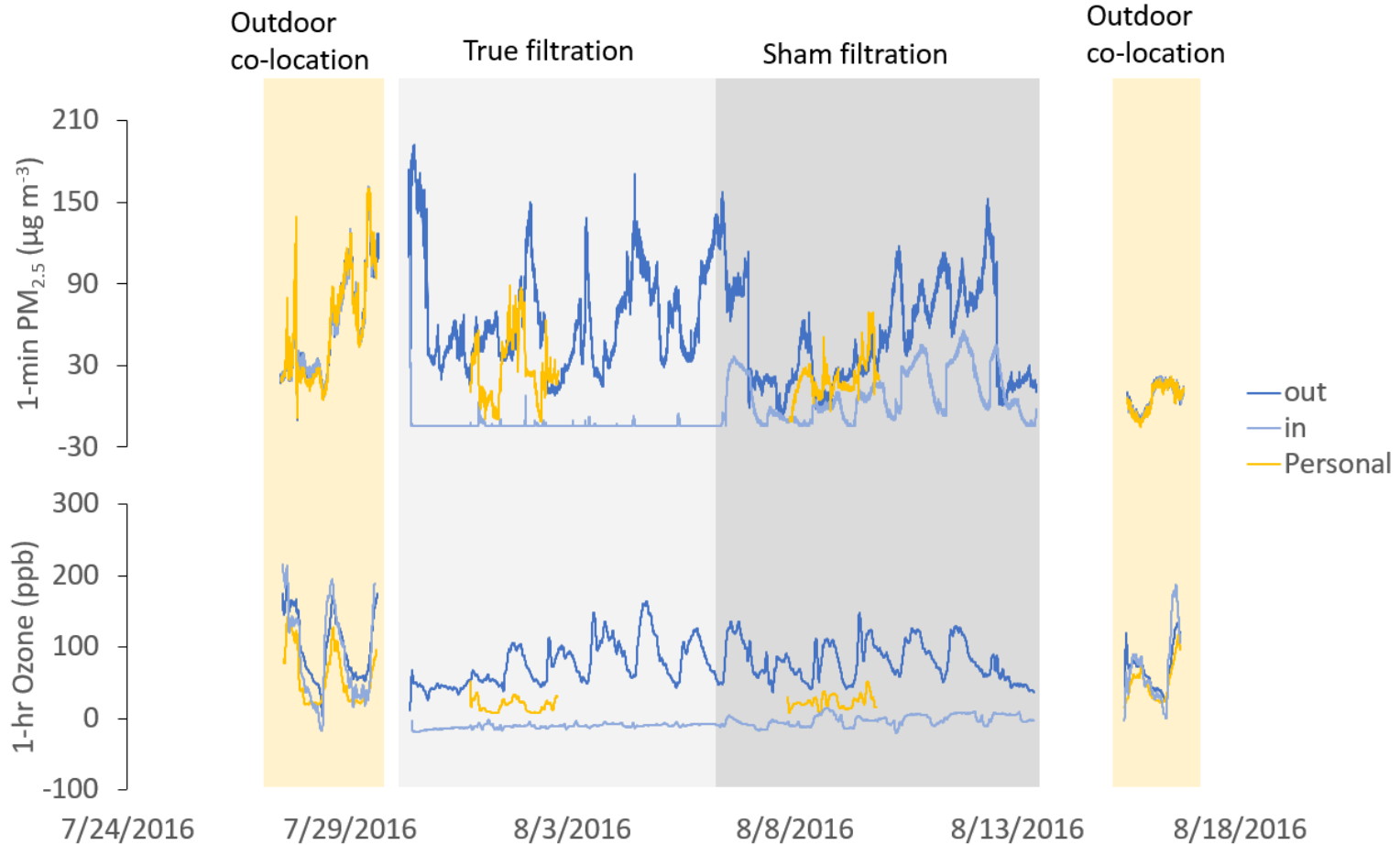


# Sampling Overview: Calibration

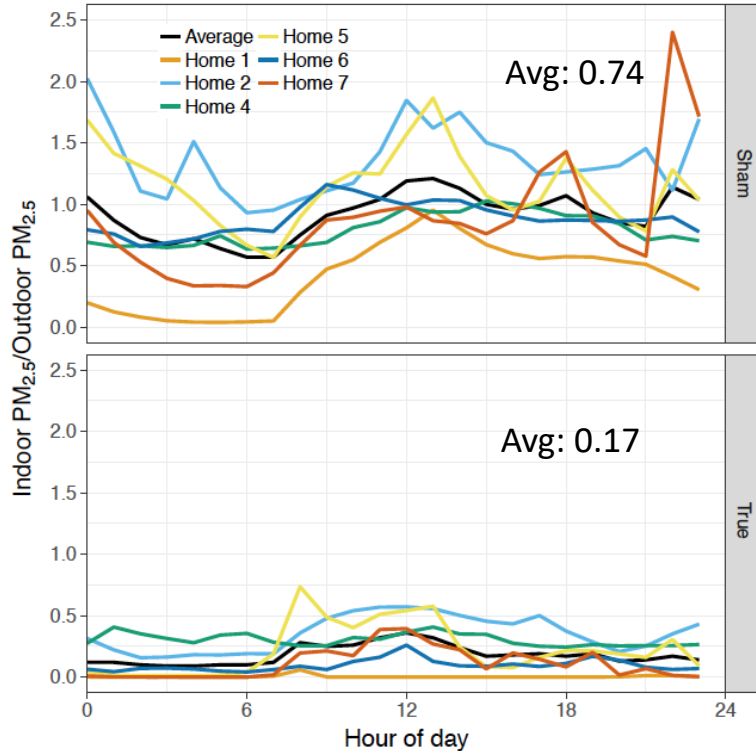
- Co-location of real-time sensors with reference monitors pre- and post - in-home sampling



# PM<sub>2.5</sub> and Ozone Concentrations in Beijing (Outdoor/Indoor/Personal Exposure)



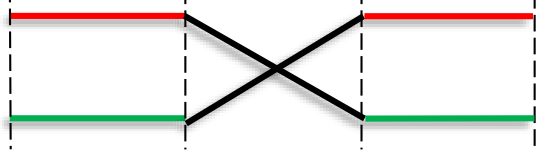
# Beijing: Real-time PM<sub>2.5</sub> Indoor/Outdoor Ratios



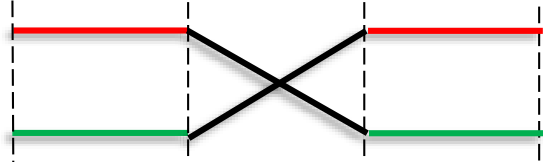
- Indoor/outdoor PM<sub>2.5</sub> ratios as averaged by hour of the day during true and sham filtration



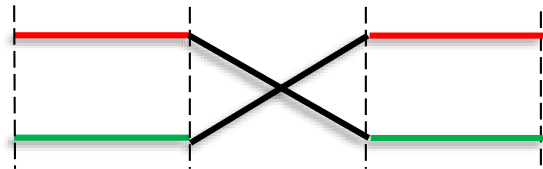
Week 1 3 5 7 9 11 13



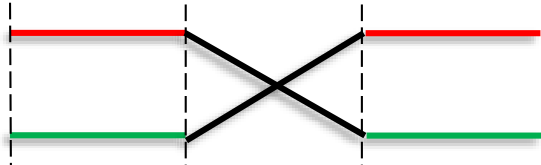
N = 11



N = 11



N = 11



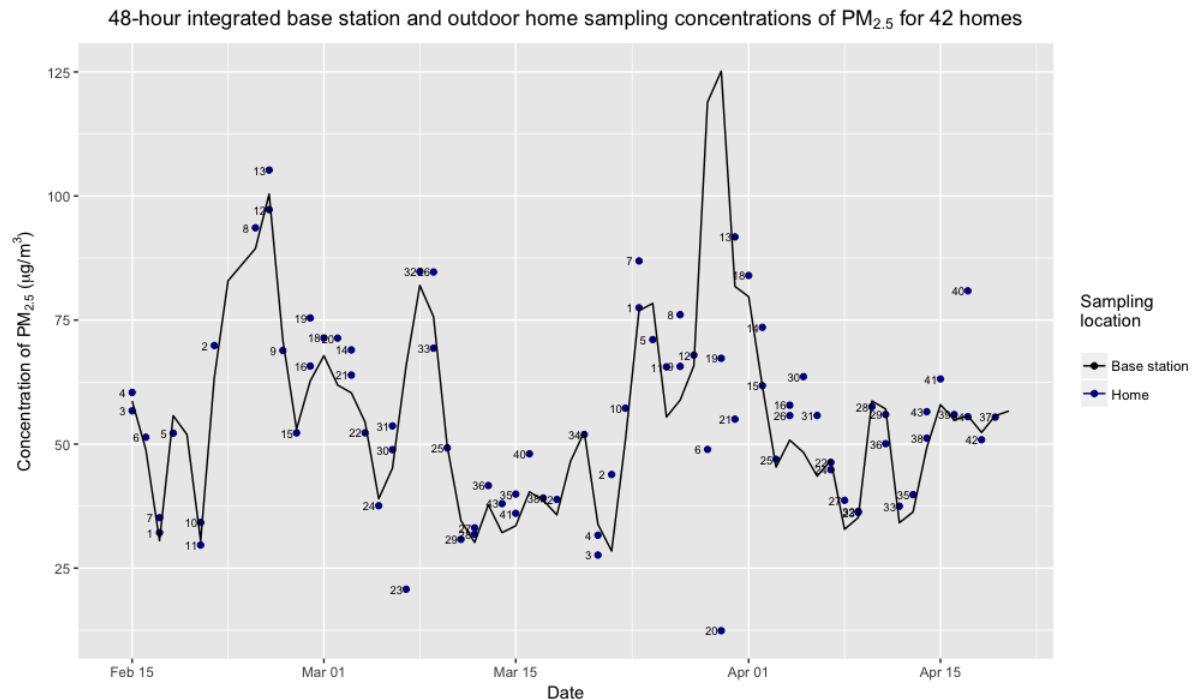
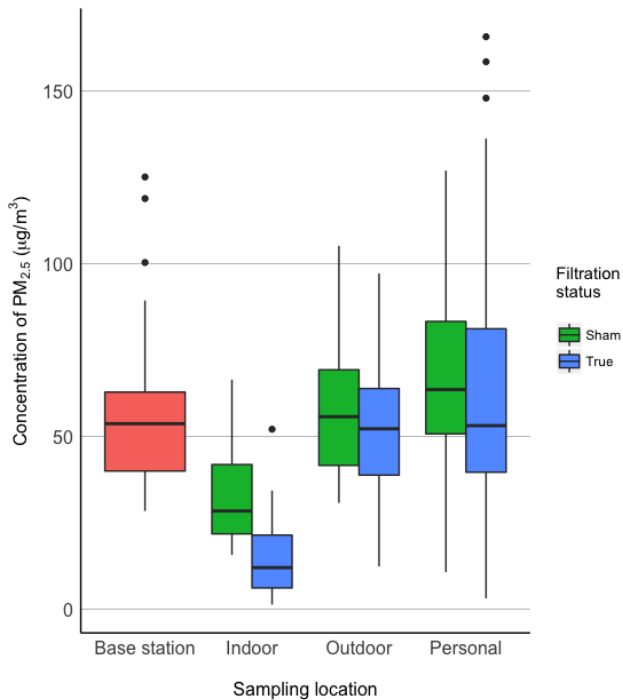
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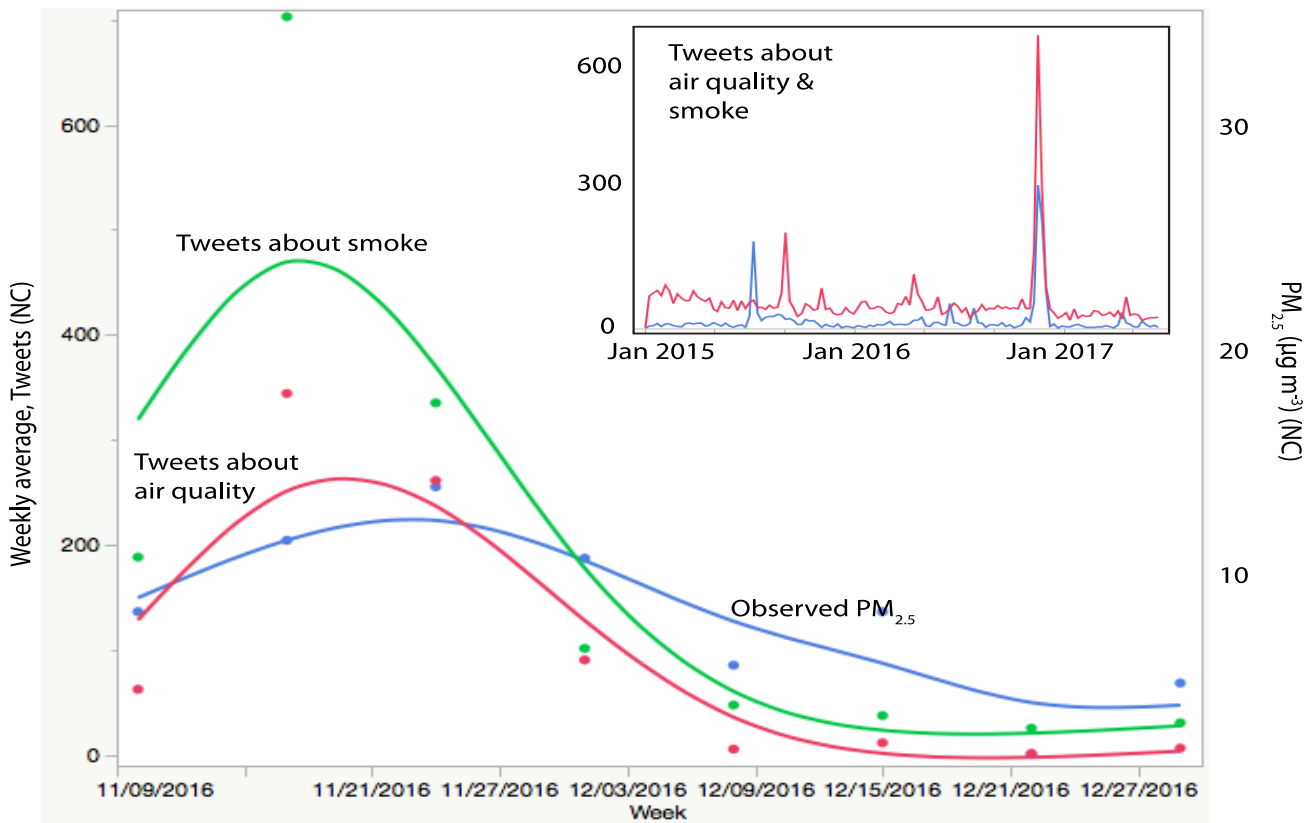
N = 43

Due to personnel and instrumentation, this crossover study design was **implemented in four batches**

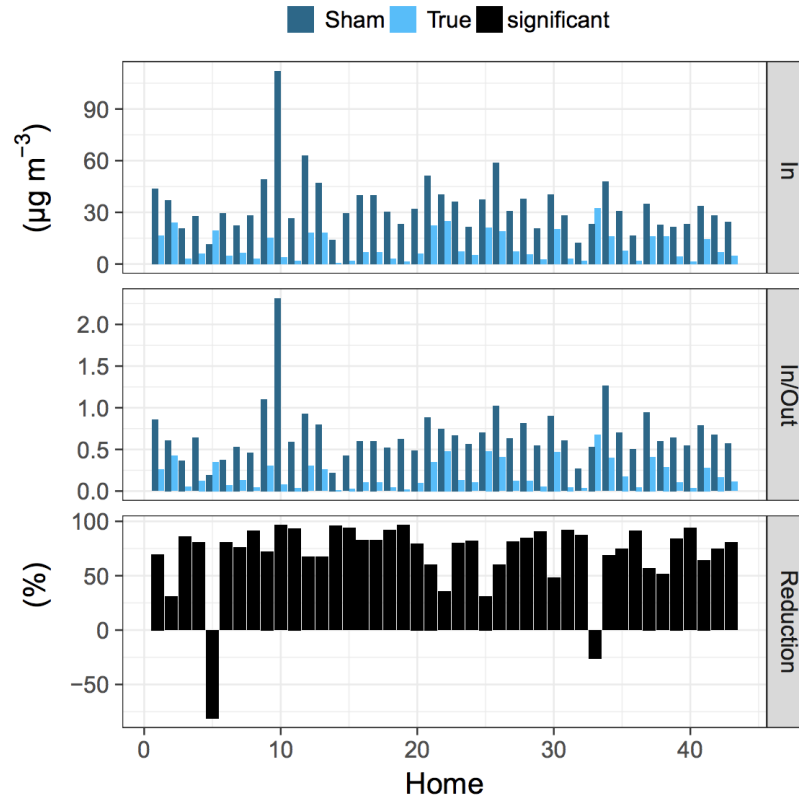
# Shanghai: Filter-based PM<sub>2.5</sub>



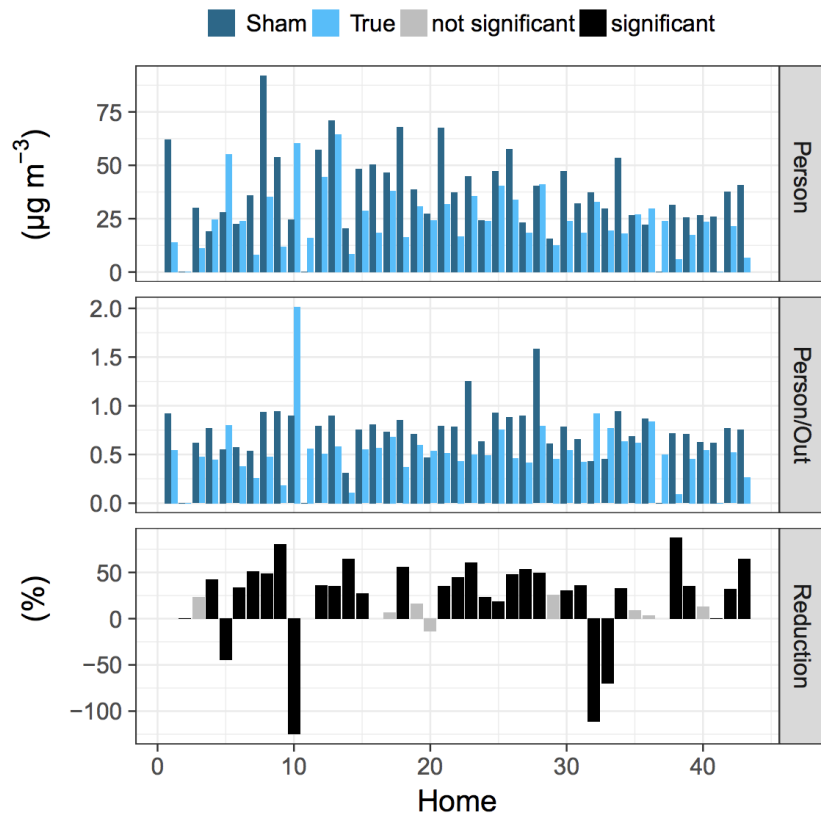
# Wild Fire Influence on Air Pollution (PM<sub>2.5</sub>) and Related Tweets



# PM<sub>2.5</sub> Reductions by Household



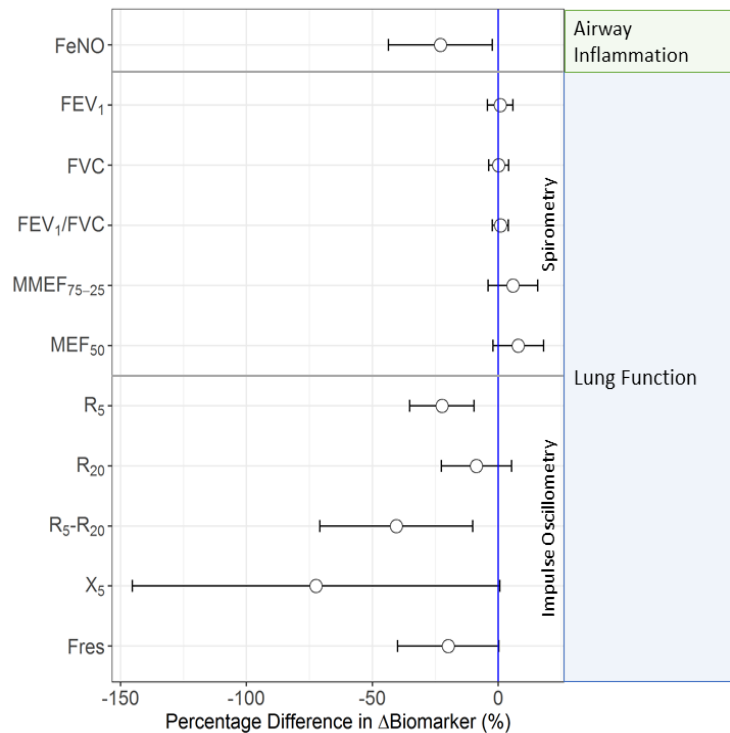
# PM<sub>2.5</sub> Reductions by Household for Personal Exposure



# Health Indicators

	Measurement	Method	Indicators
<b>Airway inflammation</b>	Fractional Exhaled Nitric Oxide (FeNO)	NIOX machine	Airway inflammation
<b>Symptom</b>	C-ACT questionnaire	Self-reported questionnaire	Overall, exercise, cough, wake up at night, daytime symptom, wheeze
<b>Airway Mechanics</b>	Spirometry	Best results of 3 exhalations	FEV <sub>1</sub> , FVC FEV <sub>1</sub> /FVC: lung obstruction
	Impulse Oscillometry	Normal breathing sound wave	Sensitive detection of early changes of small airway function
	Peak Expiratory Flow (PEF)	Self-administrated daily	Maximum speed of expiration, indicates airway obstruction

# Shanghai: Health Effects - Results

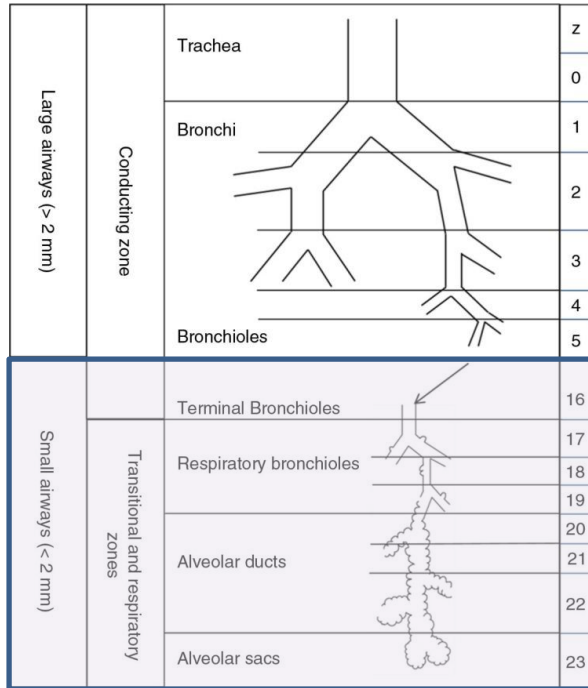


Two-weeks of indoor air filtration:

- Decreased respiratory inflammation
  - ↓ FeNO by 23%
- Improved the small airway mechanics
  - ↓ Z<sub>5</sub> by 14.7%
  - ↓ R<sub>5</sub> by 22.4%
  - ↓ R<sub>5</sub> - R<sub>20</sub> by 40.6%

Cui et al. *Unpublished*

# Shanghai: Health Effects – Significance of Results



Small airways are of pathophysiological significance for asthma

- The major site of airflow limitation and airway inflammation
- Early changes of lung function

Zainudin et al 1990. *Thorax*; Usmani et al 2005. *Am J Respir Crit Care Med*; Heyder et al 2004. *Proc Am Thorac Soc* ; Lavorini et al 2014. *Respiration* ; Lipworth et al 2014. *Lancet Respir Med*



# Summary

- Under proper conditions indoor filtration can substantially reduce indoor concentrations
- Personal exposure reductions are less apparent for indoor filtration due to varied activity and related exposures
- There are health benefits to indoor filtration for asthmatic children, but it is not a clear slam dunk