Measuring Air Quality with Wearable Devices

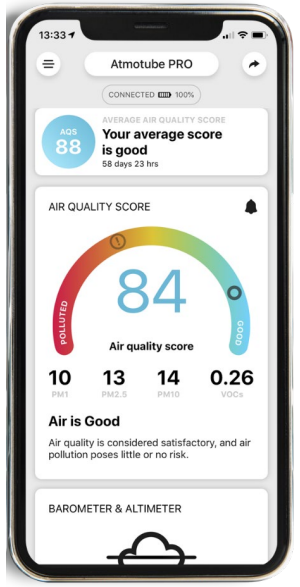
Arie Kapteyn
Center for Economic and Social Research, University of Southern California

Htay-Wah Saw
Center for Economic and Social Research (CESR), University of Southern California &
Michigan Program in Survey and Data Science, University of Michigan-Ann Arbor

Bas Weerman
Center for Economic and Social Research, University of Southern California

Study Background

- The pilot started in June 2021 (transitioning from piloting to scaling up)
- Respondents wear air quality monitor (Atmotube) continuously for one year
- About the device:
  - Bluetooth enabled
  - Communicates with a smartphone app
  - Collect pollution data (PM 1.0, PM 2.5, PM 10.0) and weather data (temperature, pressure, humidity) at 1-minute intervals
  - App uploads pollution data to server
  - Battery lasts for at least a week
- Part of a large study funded by a grant from NIA and SSA (Grant Number: 5U01AG054580)



Overall Goals

- To measure air quality exposure at the individual level
- To achieve a fine-grained and high temporal summary of sources of personal pollution during the day, such as at home, at work, during travel or commuting, or elsewhere
- Long term goal: To assess how air quality impacts health and wellbeing of individuals across the country and in different living environments.

Study Context – Understanding America Study (UAS)

- Probability-based Internet panel
- Established at USC in 2014
- About 13,000 active panel members
- Recruited from a list of all addresses in the United States
- Surveys on economics, psychology, health, government policy…

Study Context – Understanding America Study (UAS)

- Because surveys are conducted online, internet-connected tablets are provided to people who didn't have Internet access before

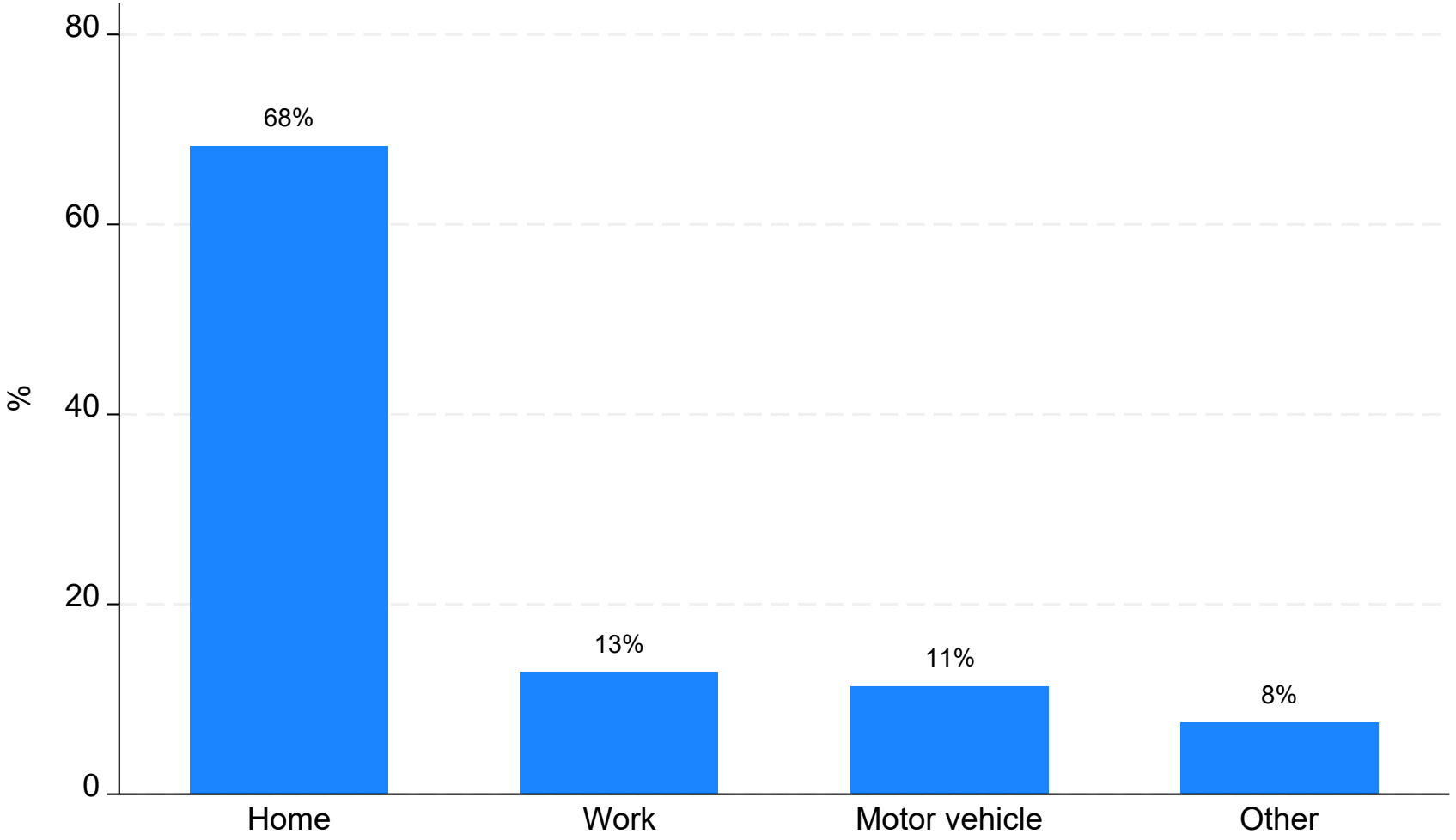
Consent Survey (Fielded: May 2021; N=1,154; Response Rate=83%)

Phone ownership (more than one answer possible)		
Has an Android Phone	471	41%
Has an Apple iPhone	615	54%
Has a different phone	86	8%
Has no phone	11	1%
Consented when having approriate phone		
Yes	683	64%
No	337	32%
Unsure	45	4%

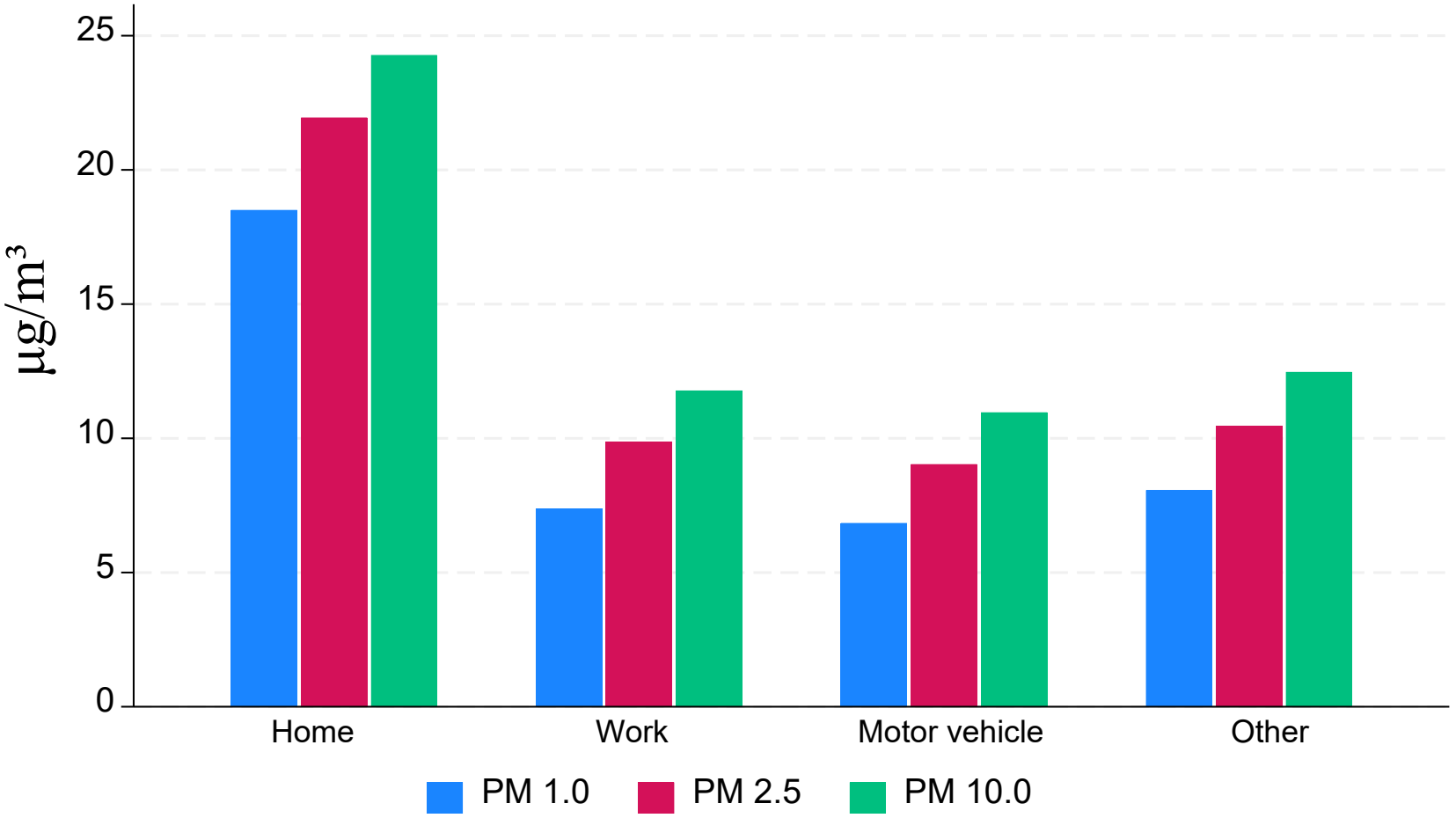
Monthly Survey

- Housing characteristics
- Perceived air quality
- Some items about wear time
- Time diary about yesterday in 30 minute chunks where people were

Distribution of Respondents' Locations Yesterday

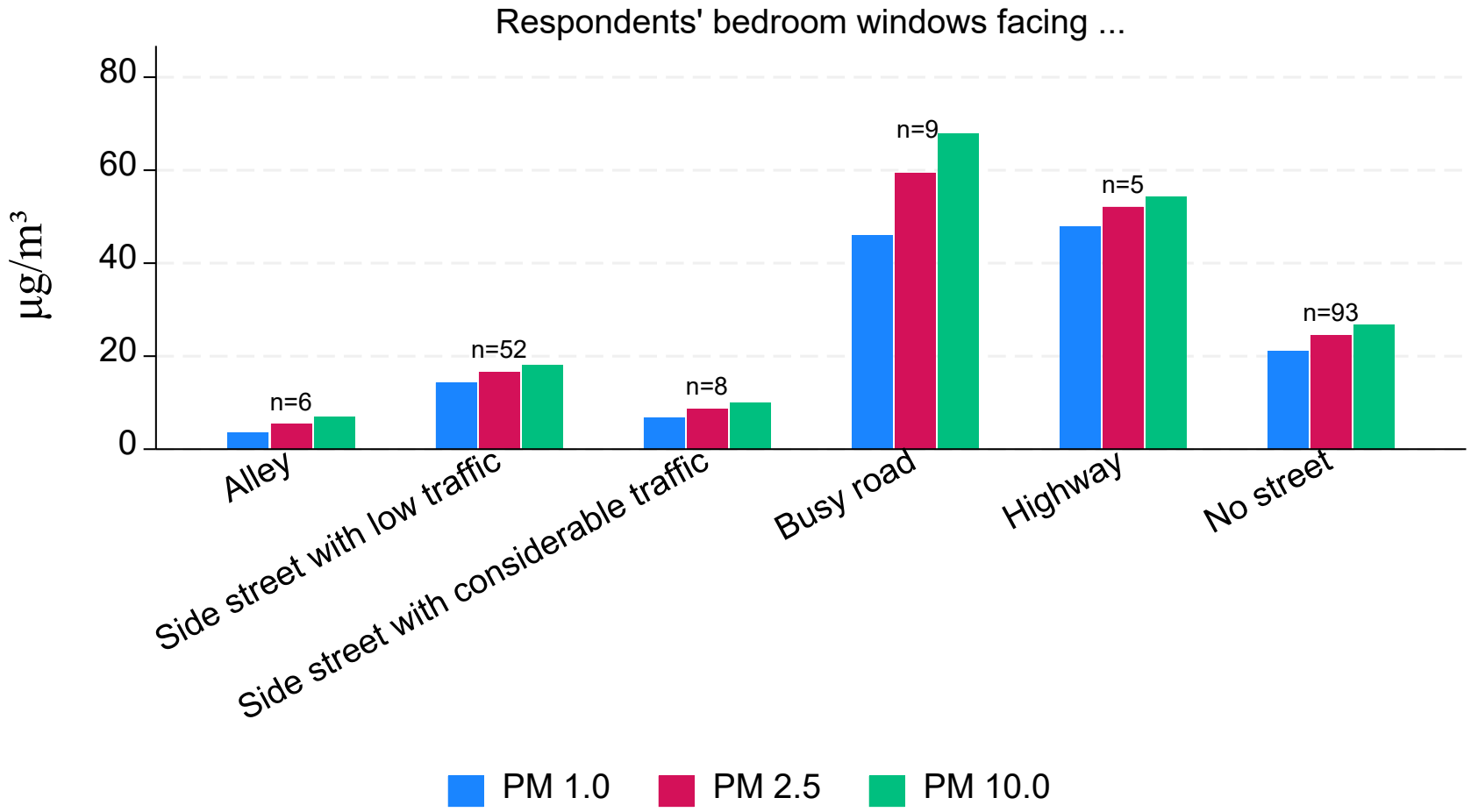


Average Pollution by Respondents' Location Yesterday

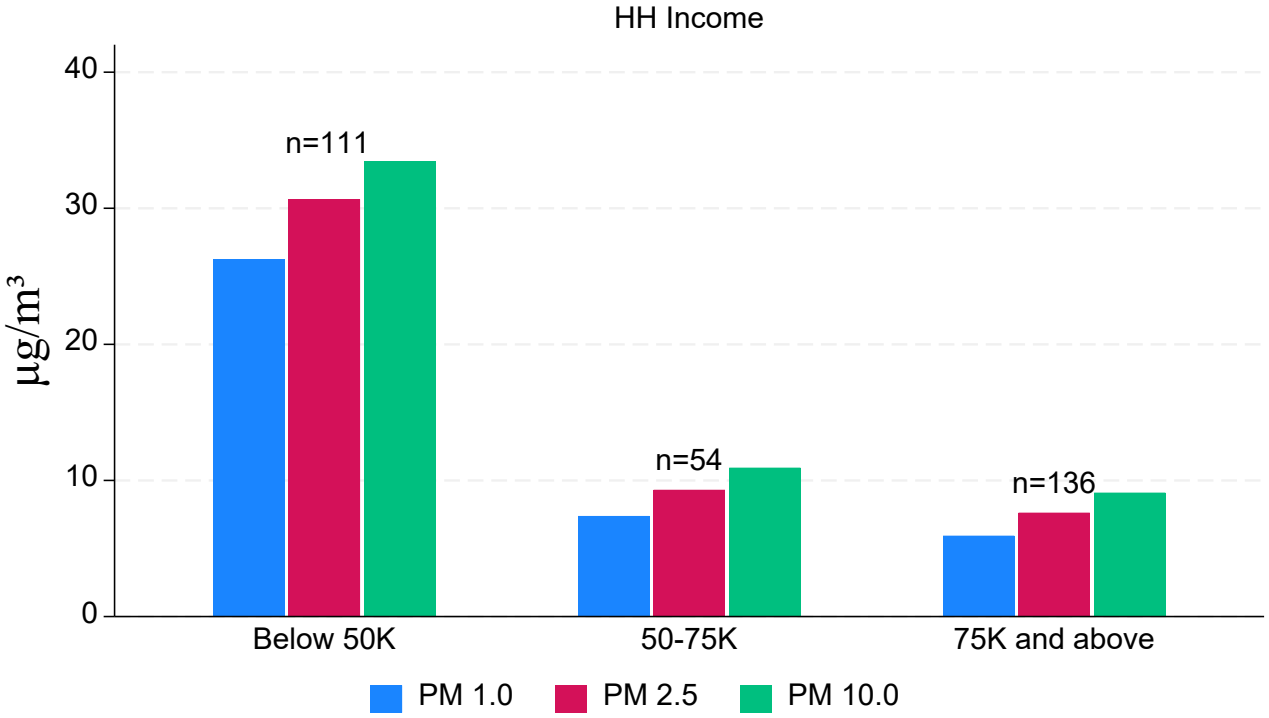


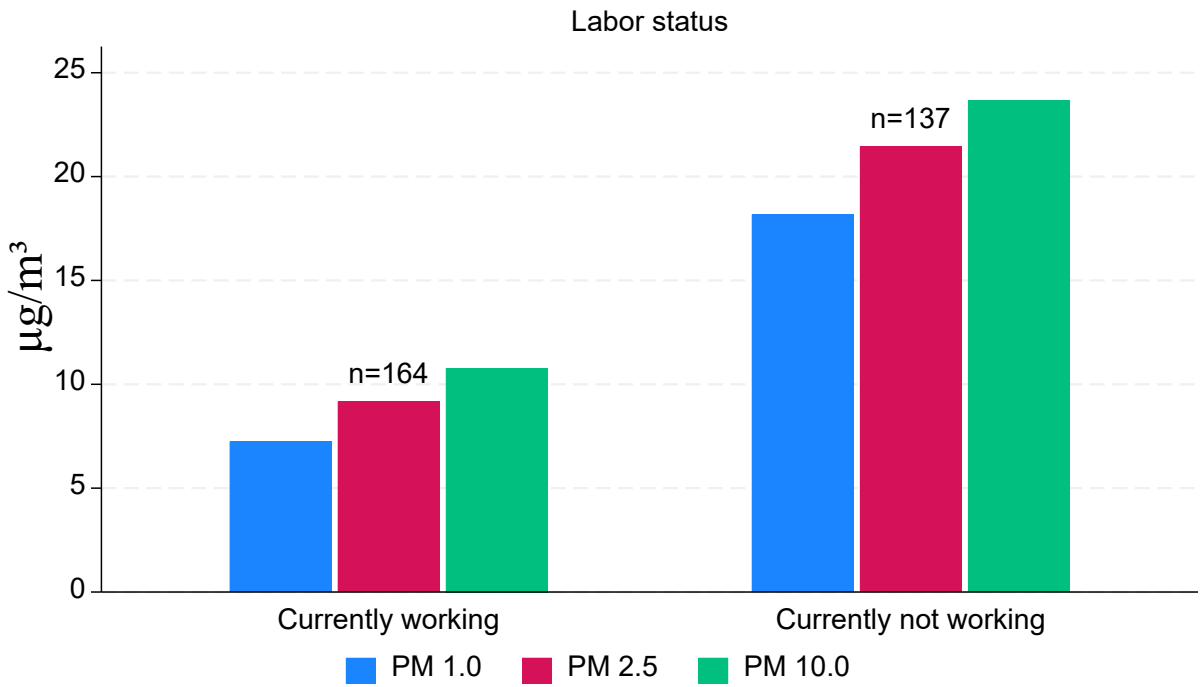
Average pollution by respondents' housing characteristics

- Living next to a busy road may be least healthy
- A graph for living room windows shows similar results

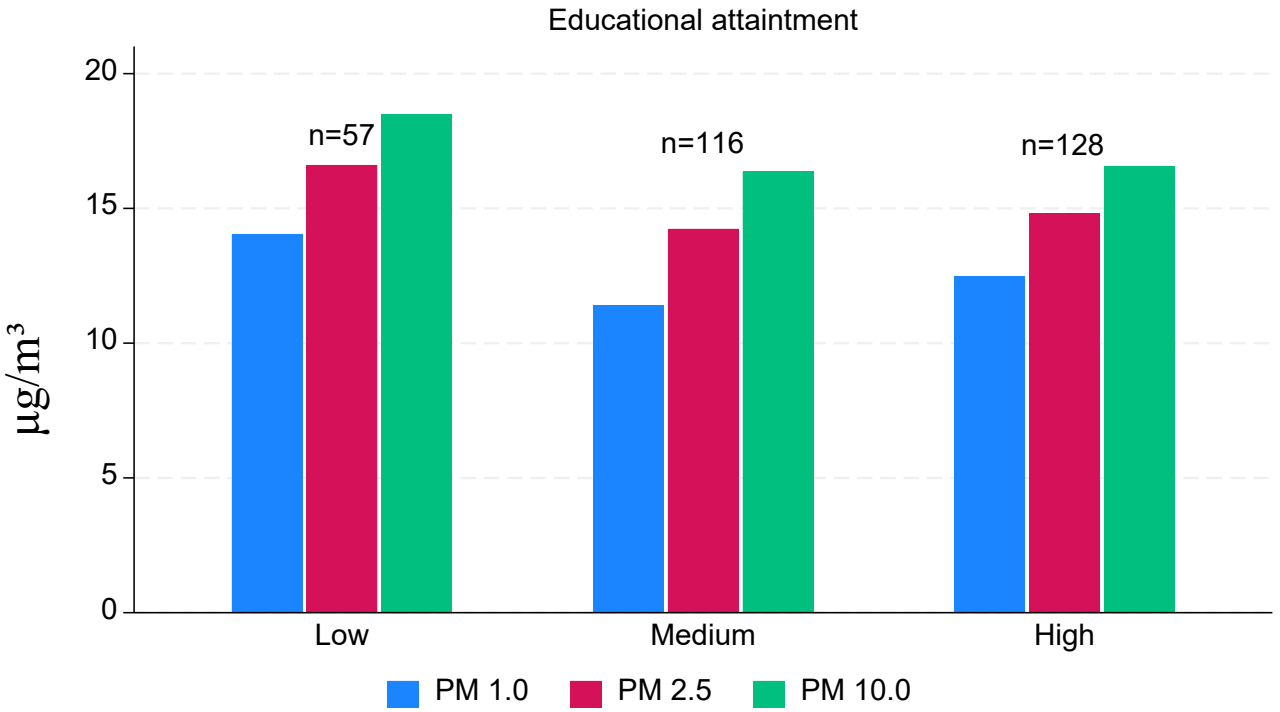


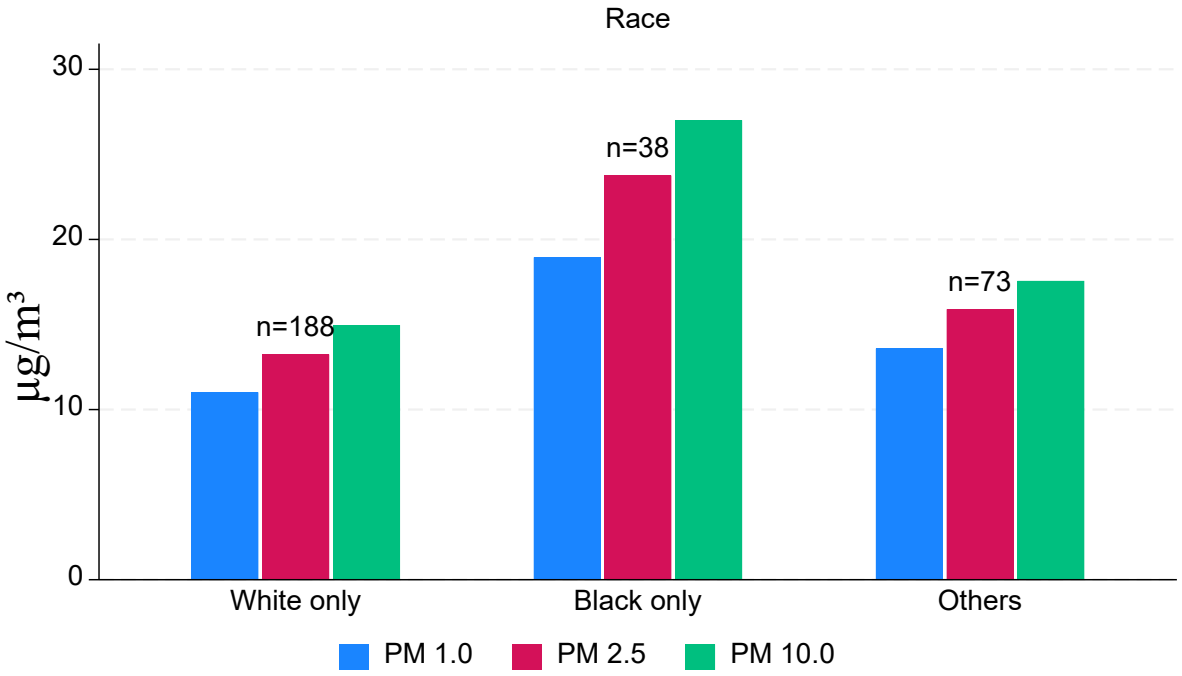
Average pollution by household income and employment status



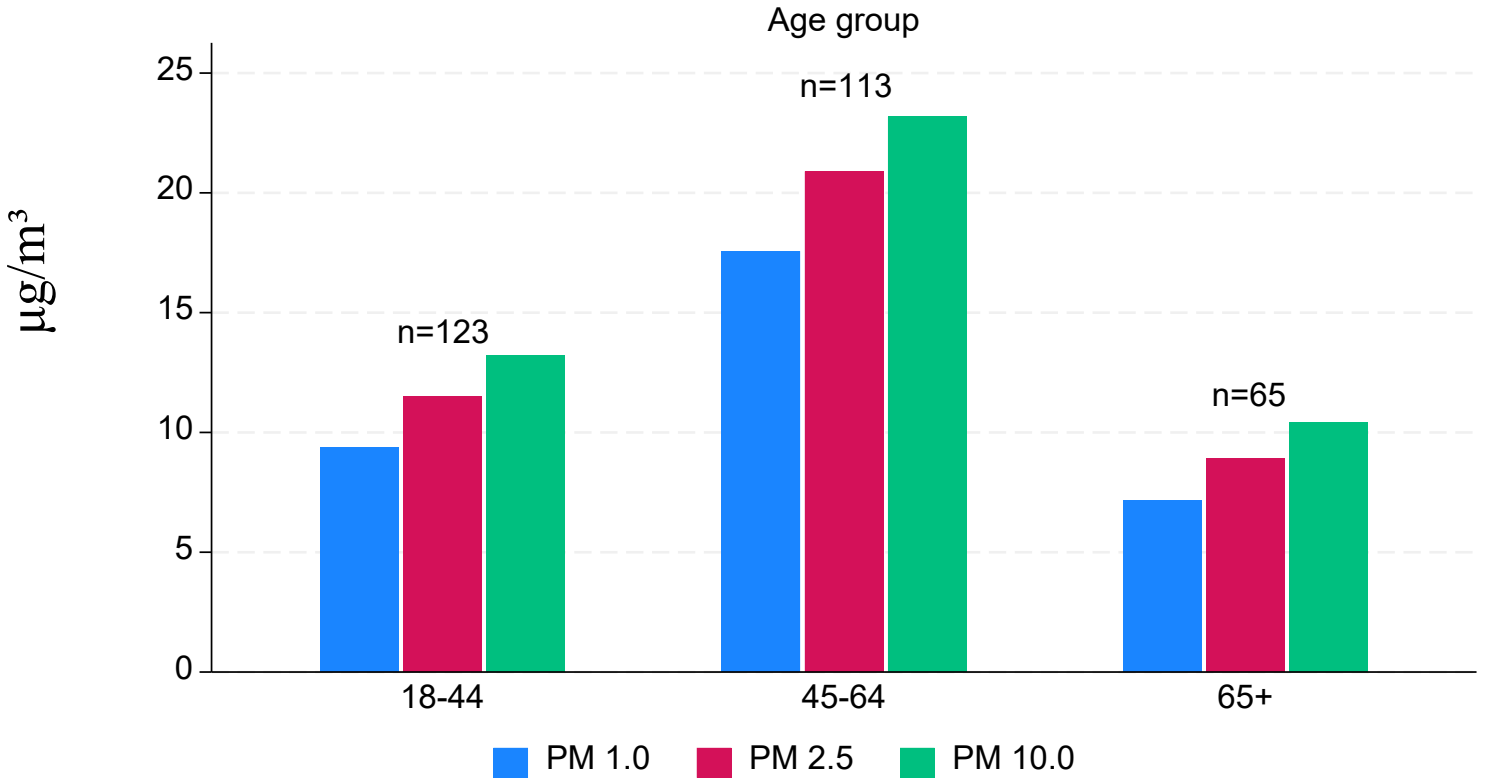


Average pollution by education and race/ethnicity

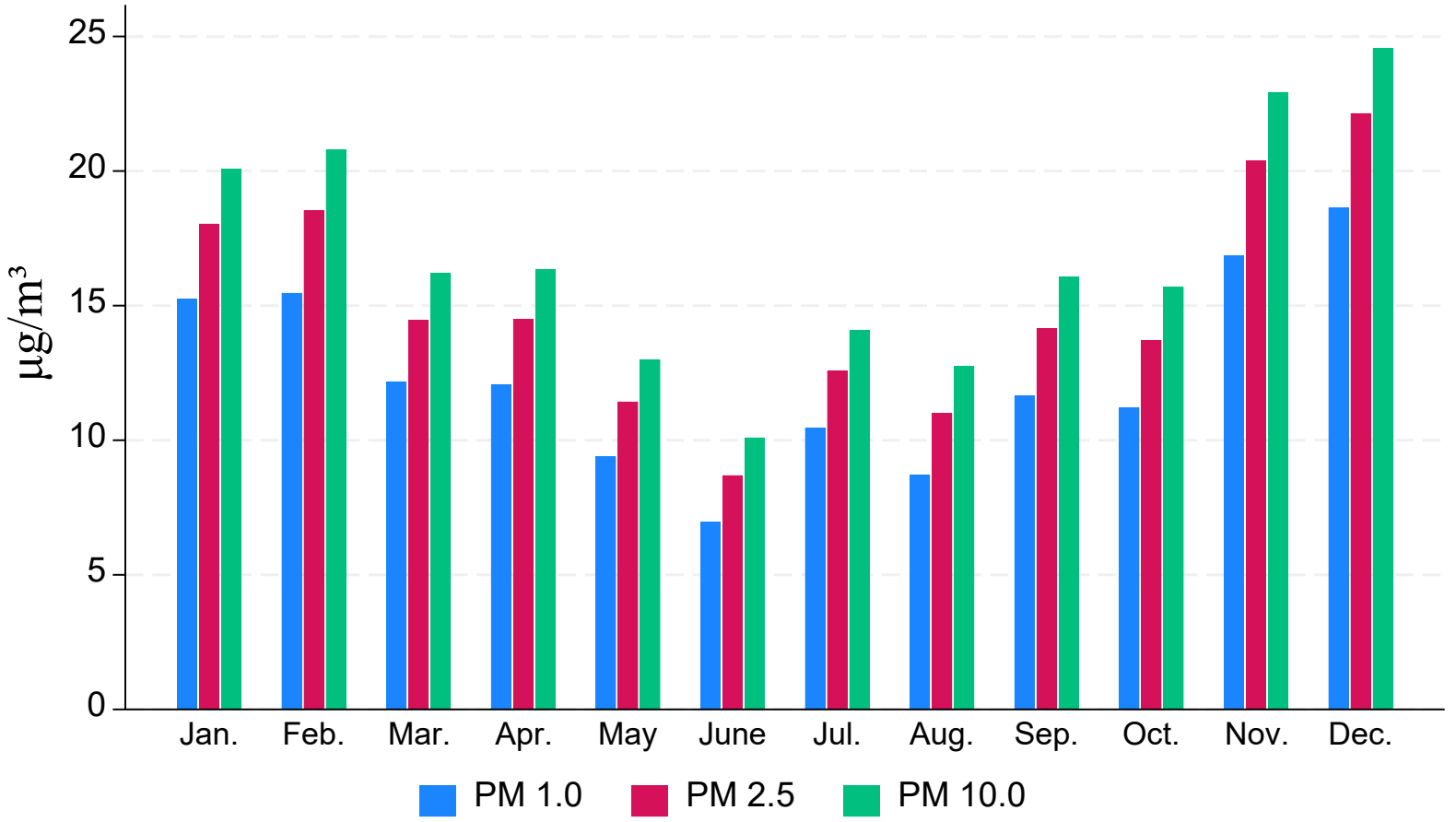




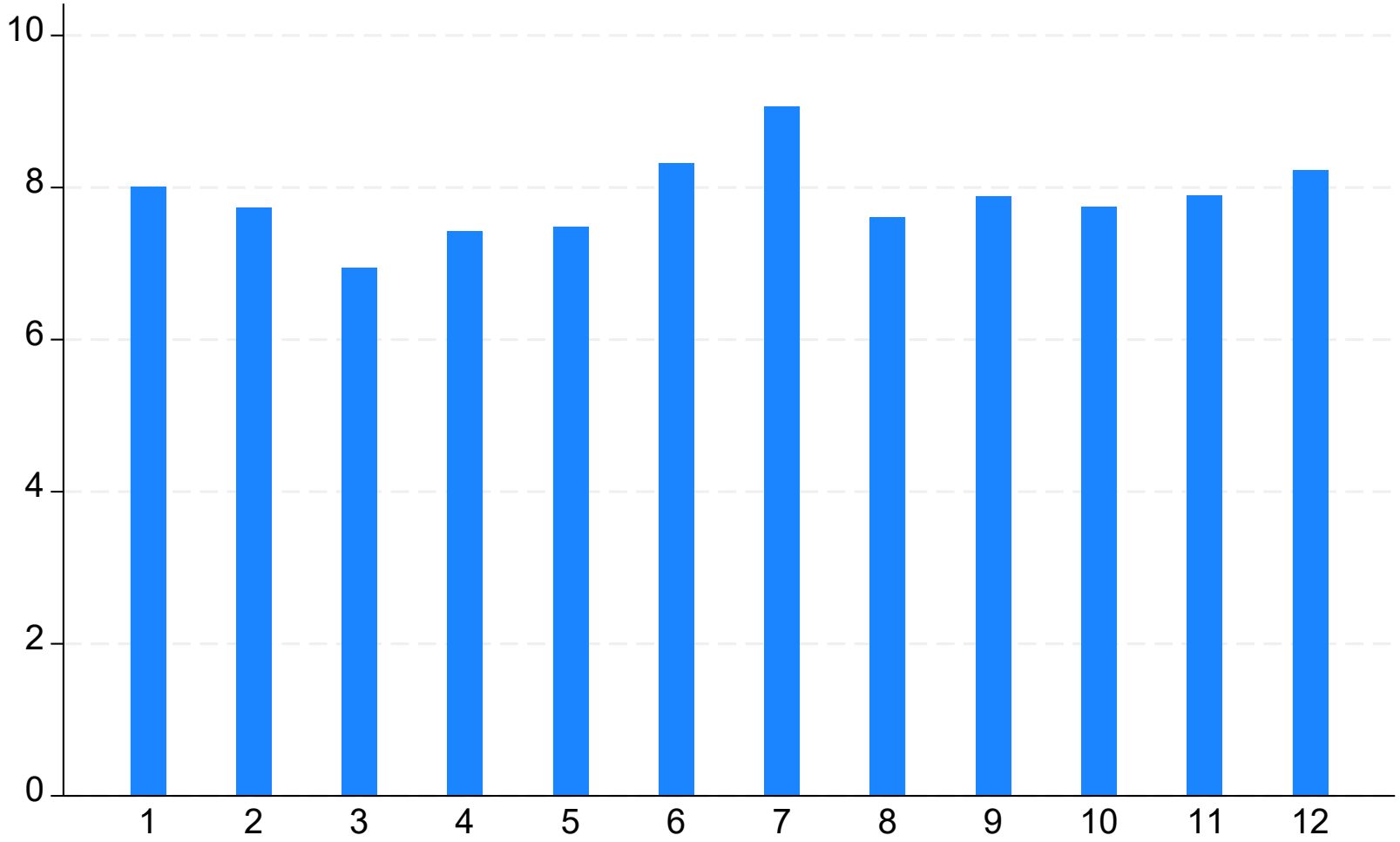
Average pollution by age



Average pollution by month of the year (Atmotube)



Average pollution by month of year (EPA monitors)



Regression Analysis (month dummies included)

		OLS		Random Effects (RE)	
	Atmo PM 2.5	Atmo PM 2.5	EPA PM 2.5	Atmo PM 2.5	EPA PM 2.5
EPA PM 2.5	2.004	1.752		0.39	
	[0.051]*	[0.082]*		[0.624]	
Race/Ethnicity (Ref: White only)					
Black only		6.955	-0.123	7.461	0.143
		[0.298]	[0.625]	[0.488]	[0.719]
Others		4.057	-0.1	-4.204	-0.139
		[0.527]	[0.679]	[0.627]	[0.668]
Age (Ref: 18-44)					
45-64		16.105	-0.068	7.743	-0.079
		[0.004]***	[0.750]	[0.362]	[0.805]
65 or older		-22.143	-0.198	-24.574	-0.256
		[0.001]***	[0.425]	[0.024]**	[0.520]

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Regression Analysis (continued)

		OLS		Random Effects (RE)	
	Atmo PM 2.5	Atmo PM 2.5	EPA PM 2.5	Atmo PM 2.5	EPA PM 2.5
Medium Education		15.277	0.365	9.733	0.291
		[0.042]**	[0.199]	[0.391]	[0.494]
High Education		8.637	-0.103	1.911	-0.076
		[0.252]	[0.718]	[0.864]	[0.856]
HH Income (Ref: < $50K)					
50-75K		-18.413	-0.143	-15.773	-0.17
		[0.010]***	[0.594]	[0.144]	[0.672]
75K and above		-27.665	0.09	-25.152	-0.323
		[0.000]***	[0.683]	[0.004]***	[0.322]
Employment Status (Ref: Currently working)					
Currently not working		23.657	0.224	25.19	-0.051
		[0.000]***	[0.276]	[0.002]***	[0.868]
Constant	2.941	-0.276	7.932	18.229	8.205
	[0.720]	[0.984]	[0.000]***	[0.209]	[0.000]***
Observations	719	713	713	713	713
R-squared	0.005	0.134	0.058		

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First impression

- Not much correlation between individually worn monitors and the EPA monitors
- The EPA monitors don't seem to be very informative about invidual exposure to bad air
- Caveat: We still have to model the air quality by Census Tract

Next Steps

- Recruit up to 1000 respondents, and collect their pollution data up to one year
- Model daily air quality measures by Census Tract based on EPA ground station measures.
- Substantive analysis:
  - relate exposure to air pollution to health and cognitive outcomes, racial and socioeconomic differences in exposure to air pollution

Thank You!

Email: kapteyn@usc.edu

UAS Web Site: https://uasdata.usc.edu/index.php