

Traffic-Related Air Pollution and LV Mass and Function in MESA

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Air Pollution and Congestive Heart Failure

- CHF is Pump Failure – assoc w/ clinical sx
 - Increasing PH problem
- Two common subtypes (systolic / diastolic)
 - Overlap common, r. f. overlap
 - Likely often stepwise or gradual progression to overt disease, exacerbations
- PM assoc. with CV effects (AMI, CV death)
- Associated with CHF hospitalizations
- Associated with CHF itself?

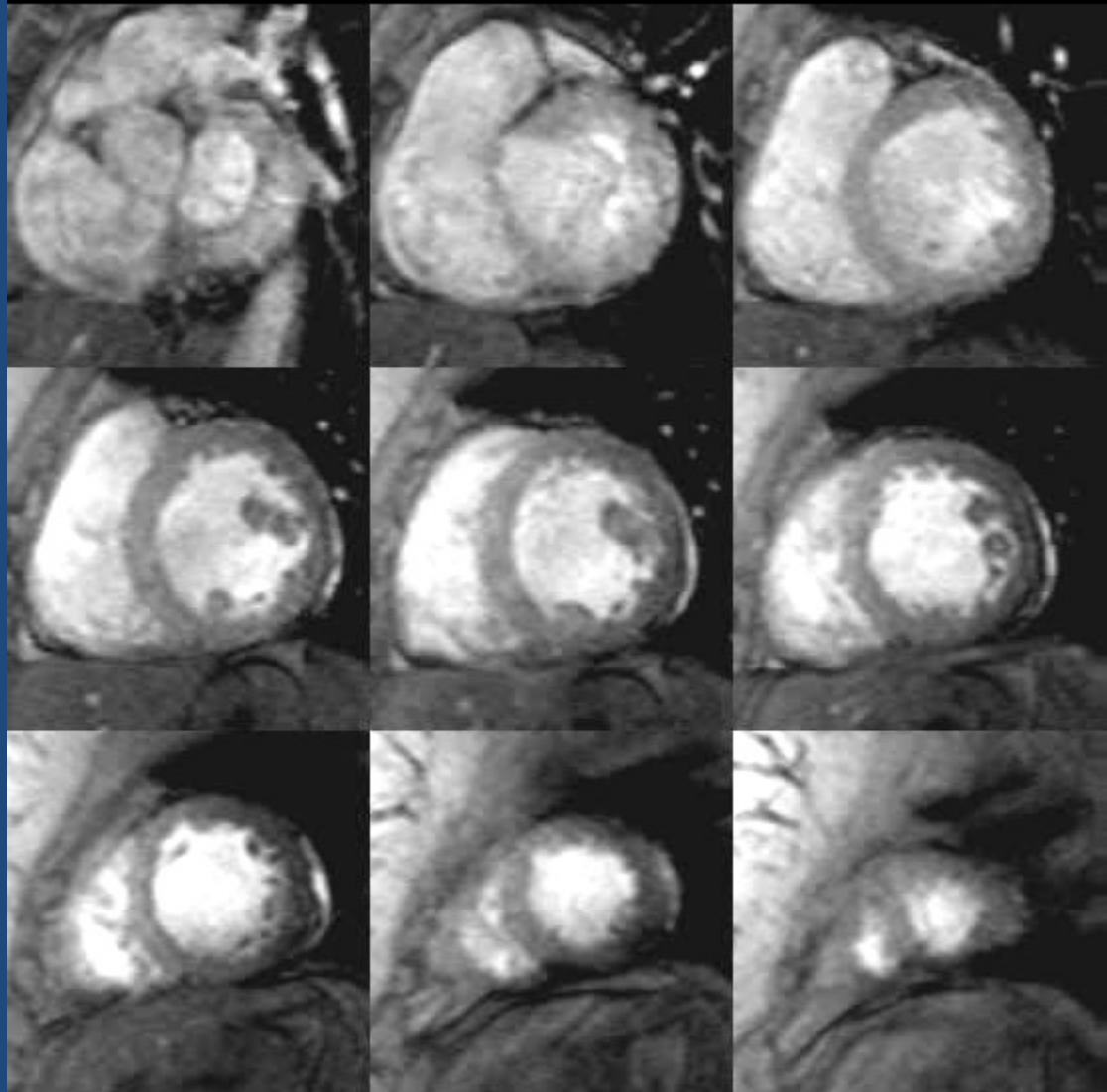
Measuring Cardiac Function

- Clinical CHF Events
- 'Subclinical' changes in function and mass
 - Increases in LVMI predict (clinical) systolic failure (Drazner 2004)
 - Increases in LVMI also associated with (subclinical) diastolic dysfunction (Edvardsen 2006)
 - Increased LVMI independent predictor of CV events (Framingham)
 - Depressed EF without signs could probably be said to represent preclinical systolic CHF

Measuring Cardiac Structure and Function

- Techniques
 - ECG: 7% sensitivity for LVH (Levy 1990)
 - Echocardiography: Poor endocardial definition, acoustic windows, operator dependent, 2-D assumes predefined shape
 - Cardiac MRI:
 - Much better precision, reproducibility than 2-D echo (Myerson 2002)
 - Reduction in needed sample size (Bellenger 2000)

Cardiac MRI: The Cardiac Cycle in 3-D



Questions

- Is PM / traffic-related air pollution associated with increased LVMI, decreased EF?
- Do demographics / r. f. modify these effects?

Methods

- Cross-sectional
- Subjects: MESA participants at Exam 1
 - Consented to use of address information
 - Geocode score >60% (manual review of all <80%)
 - No baseline cardiac dz
 - 5 years in residence
 - At least adequate MRI image quality
- Multiple linear regression -- Adjusted relationship between LVMI, EF and exposure metrics

Participant Characteristics

	N (%)		N (%) or Mean (SD)
Race		Gender	
African American	1,179 (25.4)	Female	2,421 (52.1)
Caucasian	1,851 (39.9)	Age, years	61.3 (10.0)
Chinese	609 (13.1)	Site	
Hispanic	1,006 (21.67)	St. Paul	715 (15.4)
Education		New York	819 (17.6)
Grade 8 or less	430 (9.3)	Los Angeles	939 (20.2)
Grade 9-11	290 (6.2)	Chicago	814 (17.5)
High School / GED	826 (17.8)	Forsyth	623 (13.4)
Some College	1,282 (27.6)	Baltimore	733 (15.8)
Bachelor's Degree	873 (18.8)		
Professional Degree	932 (20.1)	Total	4,645

Participant Characteristics

	N (%)		N (%)
Weekly Alcohol		Household Income	
0 drinks / wk	1,298 (27.9)	<\$12,000	446 (9.6)
1-7 drinks / wk	1,684 (36.3)	\$12,000-\$24,999	857 (18.5)
8-14 drinks / wk	403 (8.9)	\$25,000-\$34,999	585 (12.6)
>14 drinks / wk	297 (6.4)	\$35,000-\$49,999	725 (15.6)
Hypertension		\$50,000-\$74,999	795 (17.1)
Normotensive	2,019 (43.5)	\$75,000-\$99,999	440 (9.5)
Prehypertension	1,513 (32.6)	>=\$100,000	652 (14.0)
Stage 1 HTN	823 (17.7)		
Stage 2 HTN	289 (6.2)		
On HTN Rx	1,617 (34.8)		
		Total	4,645

Participant Characteristics

	N (%)		N (%) or Mean (SD)
Smoking		Diabetes	
Never smoker	2,401 (51.7)	Normal	2,832 (61.0)
Former, <20 pk-yr	1,019 (21.9)	Impaired tolerance	1,234 (26.6)
Former, ≥20 pk-yr	599 (12.9)	Diabetes	568 (12.2)
Current, <20 pk-yr	280 (6.0)	LDL, mg/dl	117.2 (31.0)
Current, ≥20 pk-yr	283 (6.1)	HDL, mg/dl	51.2 (14.9)
2nd-Hand Smoke		On Lipid Rx	741 (16.0)
<1 hr / wk	2,428 (52.3)		
1 hr / wk	578 (12.4)		
2-5 hrs / wk	537 (11.6)		
6-10 hrs / wk	214 (4.6)		
>10 hrs / wk	325 (7.0)	Total	4,645

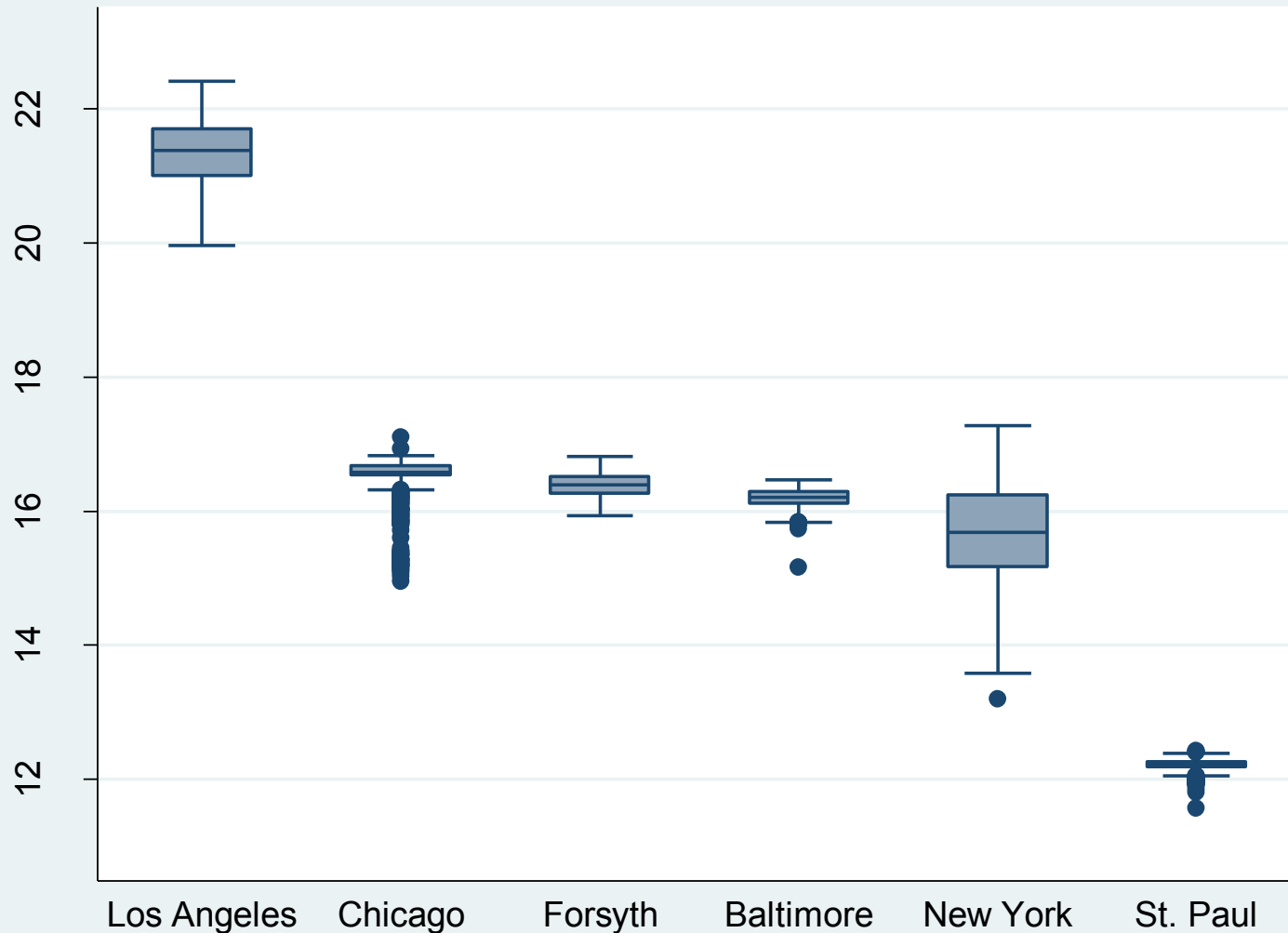
Participant Characteristics

	N (%)		N (%) or Mean (SD)
Years in Neighbhd		Geocoded	4,478 (96.4)
>1	4,562 (98.2)	LVMl (g/m²)	77.81 (16.14)
>5	3,885 (83.6)	EF (%)	69.05 (7.29)
>10	3,181 (68.5)		
MRI Image Quality			
Good / adequate	3,971 (85.5)		
Minimally adequate	640 (13.8)		
Inadequate	34 (0.7)		
		Total	4,645

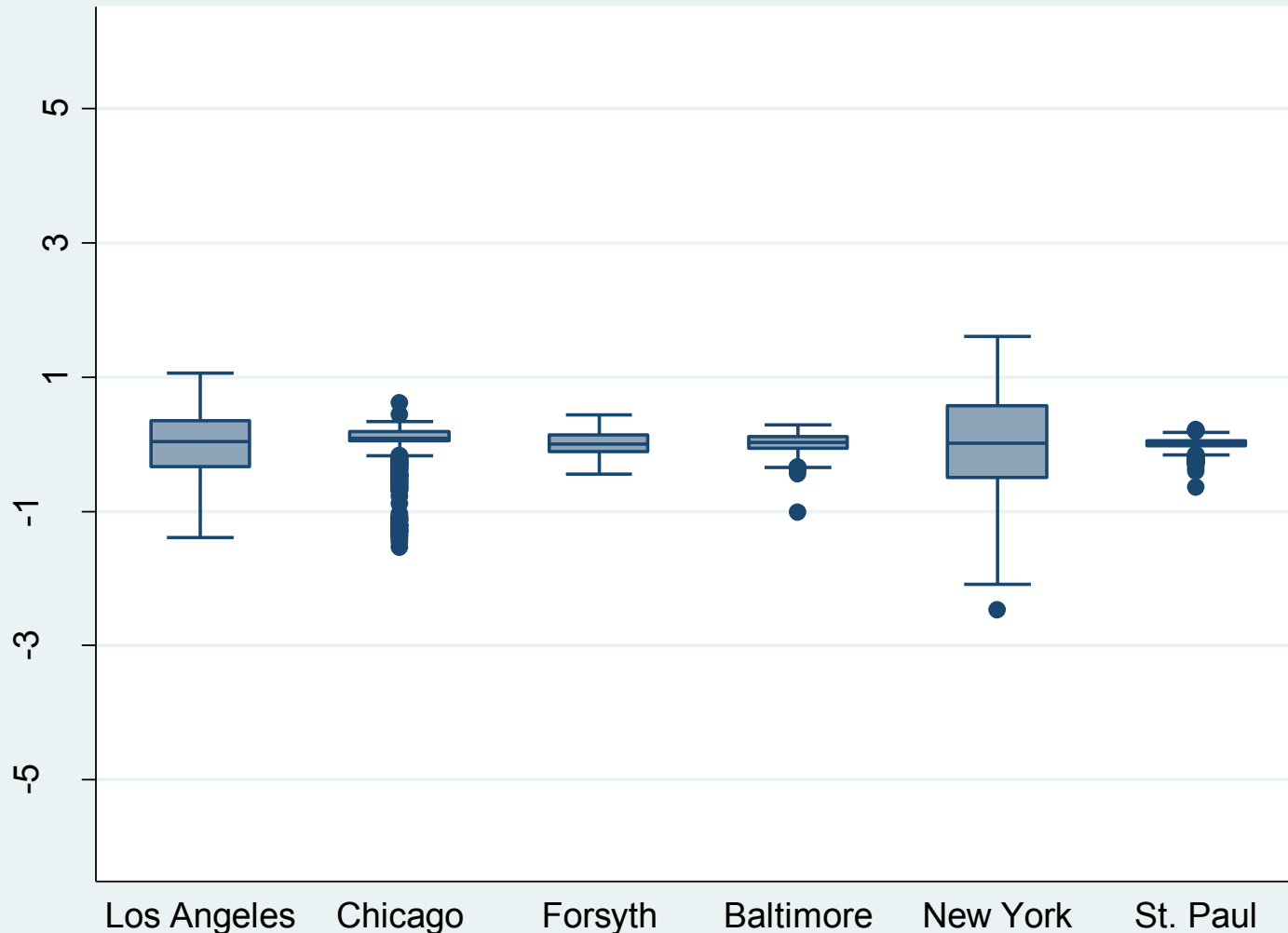
Measuring Exposures

- After geocoding:
- **Kriged average $PM_{2.5}$ in 2000 (AIRS database), interpolated to home residence**
 - Between-city >> within-city effects
 - After site adjustment, not enough within-city variability to conduct this portion of the analysis
- Proximity to major roadway (CFCC A1*-A3*)
 - Within 50m
 - Within 100m
 - Within 150m
 - Within-city effects

Total Variability in Kriged PM_{2.5} (Variance 8.0, Range 10.8)



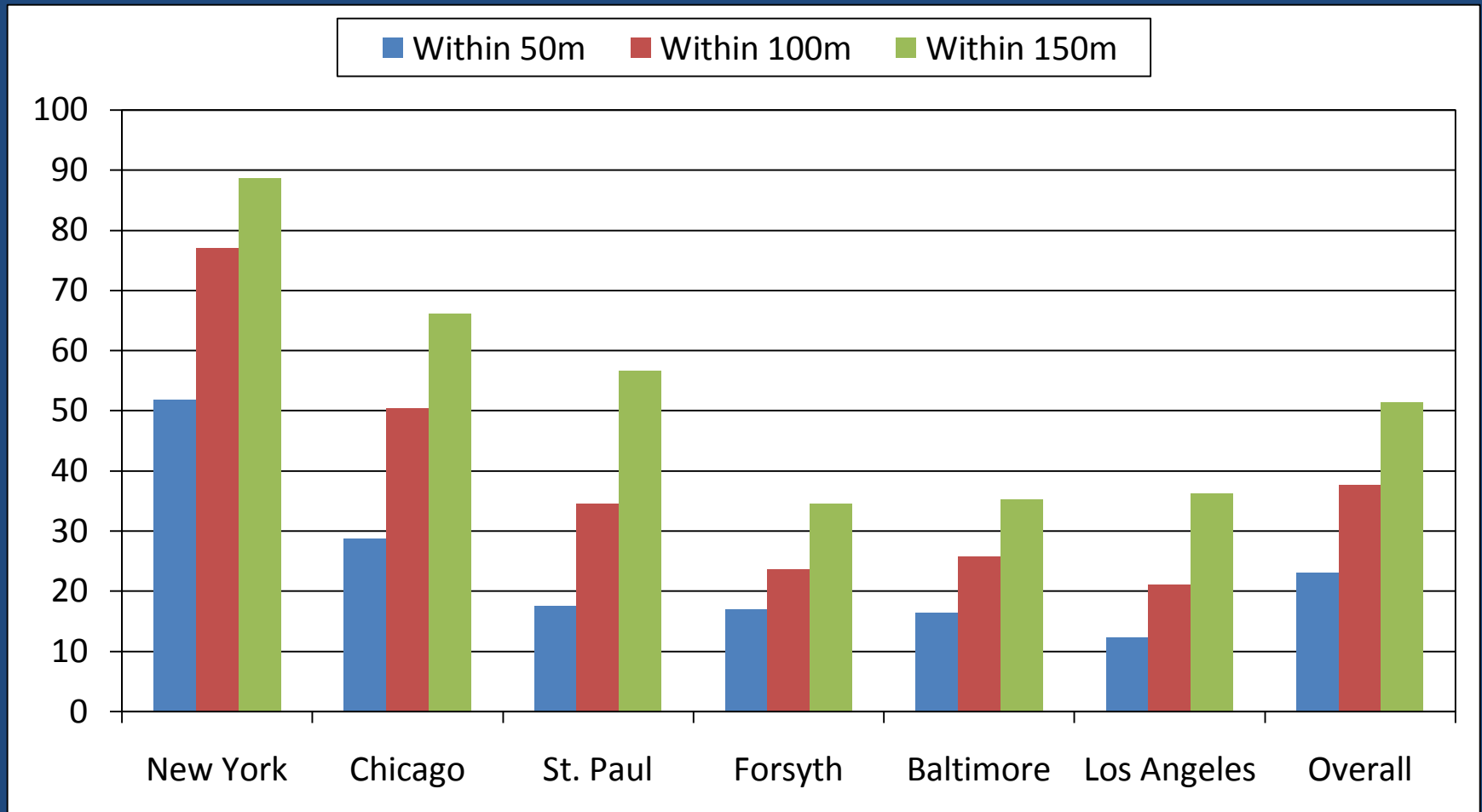
Within-City Variability (Variance 0.2, Range 4.1)



Measuring Exposures

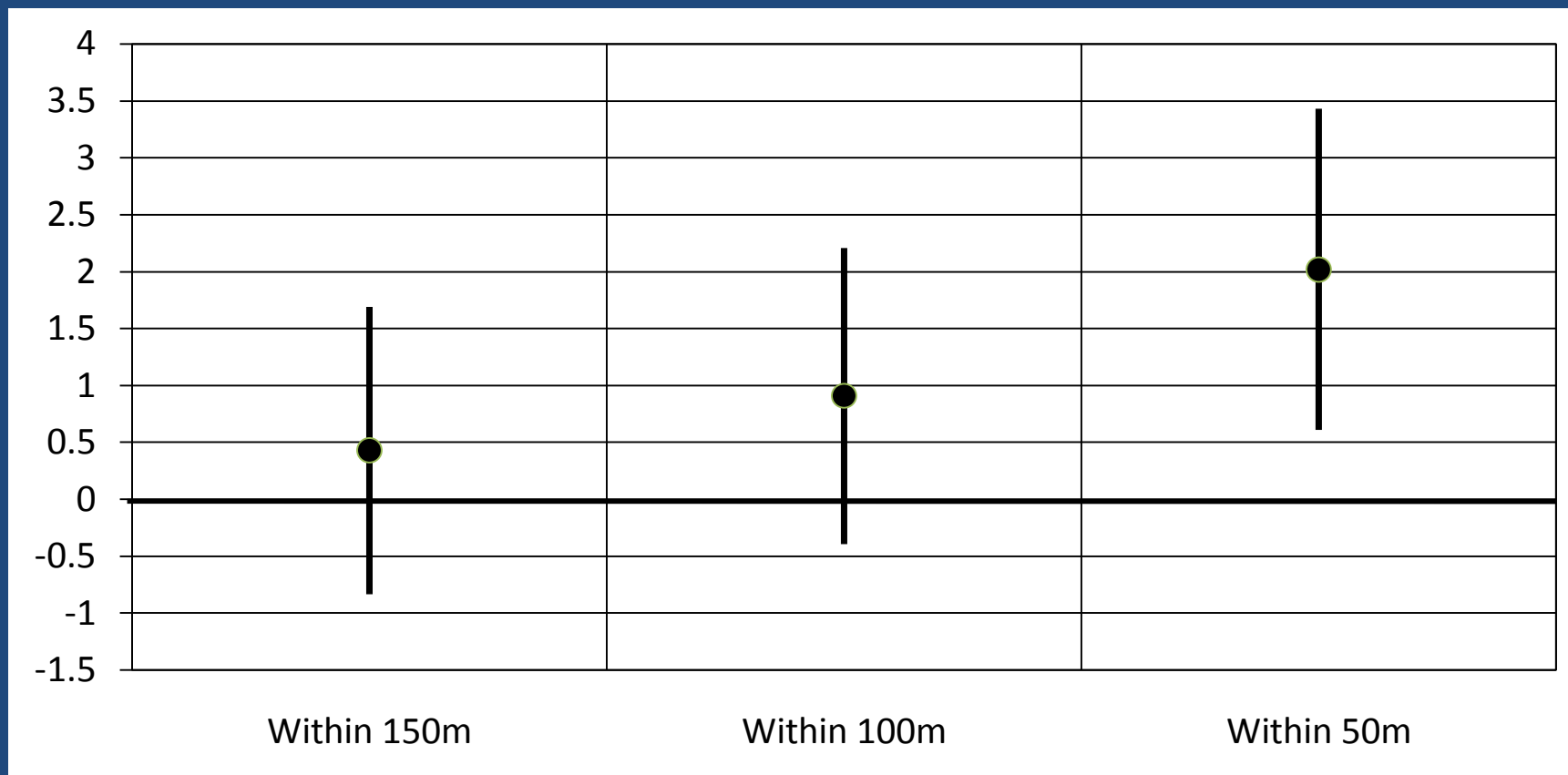
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Participants Near Major Roadways (%), by City and Overall



RESULTS

Change in LVMI (g/m², 95% CI bars) Assoc. w/ Proximity to Major Roads*



*Adjusted for gender, age, race, SBP, DBP, fasting glucose, education, income, smoking and pack-years smoking history, second-hand smoke exposure, weekly alcohol intake, LDL cholesterol, anti-hypertensive Rx, lipid-lowering Rx, diabetes Rx, and site.
p=0.004 for 'within 50m' association.

Change in EF Associated with Proximity to Major Roads*

Distance to Major Roadway	Change in EF % (95% CI)
Within 150 meters	-0.01 (-0.63, 0.61) p=0.98
Within 100 meters	0.16 (-0.48, 0.79) p=0.63
Within 50 meters	-0.10 (-0.79, 0.59) p=0.78

*Adjusted for gender, age, race, SBP, DBP, fasting glucose, education, income, smoking and pack-years smoking history, second-hand smoke exposure, weekly alcohol intake, LDL cholesterol, anti-hypertensive Rx, lipid-lowering Rx, diabetes Rx, and site.

Sensitivity Analyses

- Without adjustment for BP, very little change in proximity to roadway effects
- The confounder with largest effect on proximity coefficient was site
- Improving model fit, using different outcome measures (log LVM / SV adjusted for height, weight) had little to no effect on results
- Cross-sectional effects larger (but more imprecise) with longer duration of residence

Conclusion

- Increasing proximity to major roadway independently associated with increasing LVMI
 - Effects small but significant (2 g/m² change in LVMI is same as the effect of a 9.5 mmHg increase in SBP in this data)
 - Corresponds well with traffic-related pollution gradient
 - No significant evidence of EM by gender, age, DM, HTN, site, race, or smoking
- Proximity to major roadway not associated with EF

Discussion

- After site adjustment, not enough variability in $PM_{2.5}$ within sites to analyze kriged $PM_{2.5}$ effects (in this study)
- Components of traffic-related pollutants responsible? Ultrafine a possibility.
- Mechanisms? Vascular reactivity or another pollutant effect.

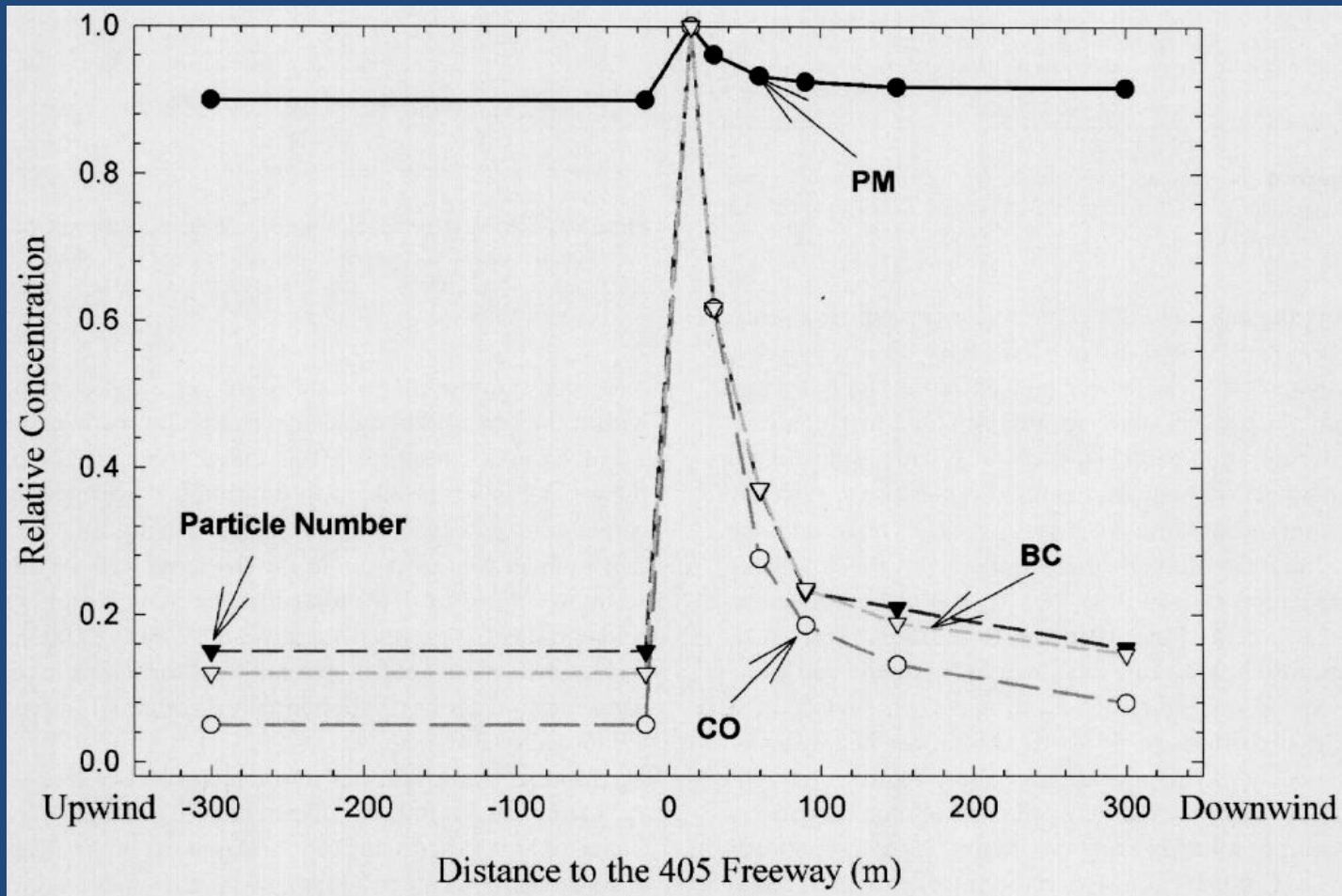
Future Directions

- Longitudinal approach
- Better exposure modeling (traffic, spatio-temporal model)
- CHF events

Acknowledgements

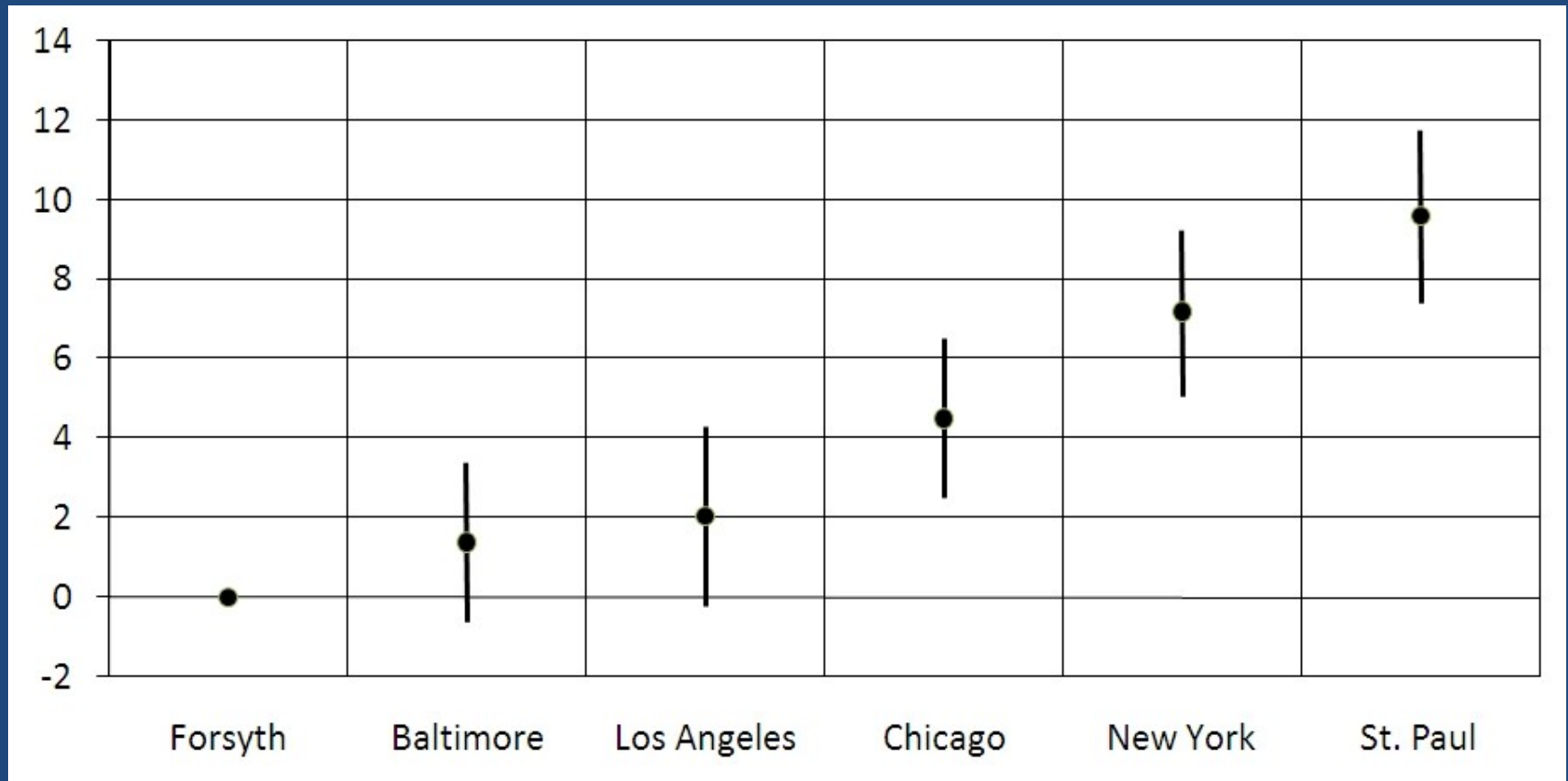
- My writing group
- Seattle weather

Ultrafine Particle Distribution Near Major Highways



Zhu, et al. Concentration and Size Distribution of Ultrafine Particles Near a Major Highway. JAWMA Sept 2002; 52:1032-1042.

Adjusted* Differences in LVMI by City (g/m², 95% CI bars); Forsyth Referent



*Adjusted for gender, age, race, hypertension, diabetes, education, income, smoking and pack-years smoking history, second-hand smoke exposure, weekly alcohol intake, LDL cholesterol, anti-hypertensive Rx, and lipid-lowering Rx.