

SUPPLEMENTAL MATERIAL

Ambient Air Pollution and Pulmonary Vascular Volume on Computed Tomography:

The MESA Air Pollution and Lung Cohort Studies

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Table E1. Characteristics of population included and not included in the analysis

	Included in analysis (N=3023)	Not included in analysis (N=1897)
Age (mean \pm SD), years	69.3 \pm 9.3	70.6 \pm 9.7
Percent male	47.7	45.0
Race, %		
White	39.0	46.2
Black	27.1	24.4
Hispanic	21.0	21.3
Chinese	12.8	8.1
Education, %		
Incomplete High School	13.7	14.7
Complete High School	17.6	16.9
Some college	28.8	30.5
Complete college	18.5	18.5
Graduate school	21.4	19.4
Height (mean \pm SD), cm	165.5 \pm 10.0	165.0 \pm 10.0
Weight (mean \pm SD), kg	78.5 \pm 17.7	78.1 \pm 18.2
Smoking, %		
Never	43.7	45.8
Former	47.9	46.8
Current	8.5	7.4
Pack-years (mean \pm SD)*	20.5 \pm 25.3	19.3 \pm 22.3
Any exposure to secondhand smoke, % [†]	24.9	19.4
Secondhand smoke, h/week, median (IQR)	2 (1, 8)	3 (1, 9)
Diabetes, %	20.2	18.6
Hypertension, %	59.5	59.0
Estimated GFR (mean \pm SD), ml/min/1.73 m ²	80.6 \pm 20.6	79.9 \pm 22.5
Total cholesterol (mean \pm SD), mg/dL	183.0 \pm 37.6	183.6 \pm 37.6
Study site, %		
Wake Forest	17.3	15.3
Columbia	21.0	13.6
Johns Hopkins	13.5	13.1
Minnesota	13.1	19.8
Northwestern	19.3	15.5
UCLA	15.8	22.7
FEV ₁ (mean \pm SD), L [‡]	2.30 \pm 0.72	2.34 \pm 0.73
FEV ₁ /FVC (mean \pm SD) [‡]	0.74 \pm 0.09	0.74 \pm 0.09
Airflow limitation, % [§]	27.0	26.8
Percent emphysema-950, median (IQR)	1.4	1.4

	(0.6, 3.1)	(0.4, 3.1)
TPVV _{CT} , cm ³	129.3±35.1	126.1±32.6
Percent TPVV _{CT}	2.70±0.27	2.68±0.27
Peripheral TPVV _{CT} , cm ³	79.2±18.2	78.1±17.3
Percent peripheral TPVV _{CT}	2.28±0.28	2.27±0.29
Black carbon (mean ± SD), µg/m ³ ^{**}	0.80±0.37	0.76±0.34
Nitrogen dioxide (mean ± SD), ppb ^{**}	14.6±7.9	13.2±6.4
Oxides of nitrogen (mean ± SD), ppb ^{**}	26.0±16.3	22.7±12.5
PM _{2.5} (mean ± SD), µg/m ³ ^{**}	11.0±1.5	10.8±1.6
Ozone (mean ± SD), ppb ^{††}	23.2±4.7	23.9±4.1

*among 1603 and 1022 ever smokers reporting pack-years

†among 738 and 96 reporting any secondhand smoke exposure

‡among 2690 and 488 with grade A-D spirometry

§pre-bronchodilator FEV₁/FVC < 0.7

||among 3023 and 175 with CT scans performed

**among 895 and 3005 with measures of black carbon, NO₂, NO_x and PM_{2.5}

††among 895 and 3022 with measures of ozone

Table E2. City-specific and overall correlations between air pollution exposures in the study sample

Study city	Black carbon	Nitrogen dioxide	Oxides of nitrogen	PM _{2.5}
Forsyth County, NC				
Nitrogen dioxide	0.90			
Oxides of nitrogen	0.86	0.96		
PM _{2.5}	0.21	0.22	0.17	
Ozone	-0.37	-0.40	-0.44	0.06*
New York, NY				
Nitrogen dioxide	0.80			
Oxides of nitrogen	0.81	0.92		
PM _{2.5}	0.75	0.83	0.81	
Ozone	-0.79	-0.91	-0.89	-0.91
Baltimore, MD				
Nitrogen dioxide	0.91			
Oxides of nitrogen	0.94	0.97		
PM _{2.5}	0.79	0.84	0.84	
Ozone	-0.77	-0.77	-0.81	-0.57
St. Paul, MN				
Nitrogen dioxide	0.84			
Oxides of nitrogen	0.85	0.98		
PM _{2.5}	0.51	0.69	0.64	
Ozone	-0.74	-0.92	-0.89	-0.80
Chicago, IL				
Nitrogen dioxide	0.62			
Oxides of nitrogen	0.57	0.80		
PM _{2.5}	0.46	0.68	0.70	
Ozone	0.12	0.18	0.22	0.39
Los Angeles, CA				
Nitrogen dioxide	0.69			
Oxides of nitrogen	0.72	0.88		
PM _{2.5}	0.38	0.59	0.60	
Ozone	-0.28	-0.59	-0.51	-0.38
Overall				
Nitrogen dioxide	0.90			
Oxides of nitrogen	0.87	0.95		
PM _{2.5}	0.69	0.75	0.72	
Ozone	-0.79	-0.85	-0.84	-0.55

All p-values < 0.01 unless noted otherwise. *P-value = 0.16.

Table E3. Mean differences in peripheral pulmonary vascular volume associated with an increase in 5-year mean for NO₂, NO_x, and PM_{2.5} exposure

	Mean difference in peripheral TPVV _{CT} (95% CI)	P-value
Nitrogen dioxide, per 4 ppb (N=2991)		
Age, sex, race and height adjusted	0.28 (0.04, 0.53)	0.025
Full model	0.28 (0.03, 0.53)	0.029
Full model + city	0.41 (-0.05, 0.88)	0.08
Oxides of nitrogen, per 8 ppb (N=2991)		
Age, sex, race and height adjusted	0.22 (0.003, 0.44)	0.047
Full model	0.20 (-0.03, 0.42)	0.08
Full model + city	0.27 (-0.13, 0.68)	0.19
PM_{2.5}, per 1.3 µg/m³ (N=2991)		
Age, sex, race and height adjusted	0.54 (0.18, 0.91)	0.004
Full model	0.49 (0.11, 0.86)	0.011
Full model + city	0.26 (-0.25, 0.77)	0.32

Full model adjusts for age, sex, race/ethnicity, height, weight, education, neighborhood SES index, smoking status, pack-years, second hand smoke exposure, estimated glomerular filtration rate and scanner manufacturer

Table E4. Multi-pollutant models showing mean difference in peripheral pulmonary vascular volume associated with an increase in 1-year mean air pollutant exposure (N=3005)

	Mean difference in peripheral TPVV _{CT} , cm ³ (95% CI)	P-value
Single pollutant models		
Black carbon, per 0.15 µg/m ³	0.41 (0.03, 0.80)	0.036
Nitrogen dioxide, per 4 ppb	0.41 (-0.06, 0.88)	0.09
PM _{2.5} , per 1.3 µg/m ³	0.22 (-0.29, 0.72)	0.40
Multi-pollutant models		
Black carbon, per 0.15 µg/m ³	0.36 (-0.21, 0.94)	0.22
Nitrogen dioxide, per 4 ppb	0.08 (-0.64, 0.79)	0.83
Black carbon, per 0.15 µg/m ³	0.52 (0.02, 1.02)	0.044
PM _{2.5} , per 1.3 µg/m ³	-0.22 (-0.88, 0.44)	0.52
Black carbon, per 0.15 µg/m ³	0.42 (-0.17, 1.01)	0.17
Nitrogen dioxide, per 4 ppb	0.27 (-0.56, 1.09)	0.53
PM _{2.5} , per 1.3 µg/m ³	-0.34 (-1.11, 0.42)	0.38

Model adjusts for age, sex, race/ethnicity, height, weight, education, neighborhood SES index, smoking status, pack-years, second hand smoke exposure, estimated glomerular filtration rate, scanner manufacturer and city

Table E5. Mean differences in *percent* total and peripheral pulmonary vascular volume associated with an increase in 1-year mean air pollutant exposure

	Mean difference in percent TPVV _{CT} (95% CI)	P-value	Mean difference in percent peripheral TPVV _{CT} (95% CI)	P-value
Black carbon, per 0.15 µg/m³ (N=3005)				
Age, sex, race and height adjusted	0.016 (0.012, 0.020)	<0.001	0.016 (0.012, 0.020)	<0.001
Full model	0.014 (0.010, 0.019)	<0.001	0.015 (0.010, 0.019)	<0.001
Full model + city	0.015 (0.007, 0.023)	<0.001	0.014 (0.006, 0.023)	<0.001
Nitrogen dioxide, per 4 ppb (N=3005)				
Age, sex, race and height adjusted	0.020 (0.014, 0.025)	<0.001	0.020 (0.015, 0.025)	<0.001
Full model	0.018 (0.013, 0.024)	<0.001	0.019 (0.014, 0.024)	<0.001
Full model + city	0.014 (0.004, 0.024)	0.004	0.014 (0.004, 0.024)	0.007
Oxides of nitrogen, per 8 ppb (N=3005)				
Age, sex, race and height adjusted	0.020 (0.015, 0.025)	<0.001	0.020 (0.015, 0.026)	<0.001
Full model	0.019 (0.014, 0.024)	<0.001	0.019 (0.013, 0.024)	<0.001
Full model + city	0.014 (0.005, 0.024)	0.002	0.013 (0.004, 0.023)	0.006
PM_{2.5}, per 1.3 µg/m³ (N=3005)				
Age, sex, race and height adjusted	0.021 (0.013, 0.029)	<0.001	0.021 (0.013, 0.030)	<0.001
Full model	0.018 (0.010, 0.027)	<0.001	0.019 (0.010, 0.028)	<0.001
Full model + city	0.010 (0.0002, 0.021)	0.046	0.009 (-0.001, 0.020)	0.09
Ozone, per 3 ppb (N=3022)				
Age, sex, race and height adjusted	-0.028 (-0.034, -0.021)	<0.001	-0.027 (-0.034, -0.020)	<0.001
Full model	-0.026 (-0.033, -0.019)	<0.001	-0.025 (-0.032, -0.018)	<0.001
Full model + city	-0.018 (-0.030, -0.007)	0.002	-0.015 (-0.027, -0.003)	0.015

Full model adjusts for age, sex, race/ethnicity, height, weight, education, neighborhood SES index, smoking status, pack-years, second hand smoke exposure, estimated glomerular filtration rate and scanner manufacturer

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graph TD
    A[6814 enrolled into MESA at Baseline (2000-02)] --> B[5161 selected for MESA Lung (2004)]
    A --> C[1653 not selected for MESA Lung  
87 died or lost to follow-up  
196 without genetic consent  
610 without endothelial function measured  
760 not selected at random]
    B --> D[3965 enrolled into MESA Lung (2004-06)]
    B --> E[1196 ineligible/did not enroll in MESA Lung]
    D --> F[4920 overall attended MESA Exam 5]
    D --> G[1543 attended MESA Exam 5 (2010-12)]
    E --> G
    F --> H[3173 attended MESA Exam 5 (2010-12)]
    F --> I[204 attended MESA Exam 5 (2010-12)]
    I --> J[157 ineligible or did not enroll in MESA Lung]
    I --> K[119 not selected for full-lung CT scan  
18 full lung-CT scans not performed]
    K --> L[67 underwent full-lung CT scan]
    H --> M[2727 underwent full-lung CT scan]
    H --> N[0 not selected for full-lung CT scan  
446 full lung-CT scans not performed]
    N --> M
    G --> O[409 underwent full-lung CT scan]
    G --> P[692 not selected for full-lung CT scan  
442 full lung-CT scans not performed]
    P --> O
    L --> Q[3203 total underwent full-lung CT scan (2010-12)]
    M --> Q
    O --> Q
    Q --> R[3023 included in study sample]
    Q --> S[180 not included  
175 without air pollution estimates  
5 CT scans technically inadequate]
  
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The flowchart details the selection process for the study sample. It begins with 6814 individuals enrolled into MESA at Baseline (2000-02). From this group, 5161 were selected for MESA Lung (2004), while 1653 were not selected for various reasons (87 died or lost to follow-up, 196 without genetic consent, 610 without endothelial function measured, and 760 not selected at random). The 5161 selected for MESA Lung (2004) were further divided into 3965 enrolled into MESA Lung (2004-06) and 1196 ineligible/did not enroll in MESA Lung. The 3965 enrolled into MESA Lung (2004-06) were then divided into 4920 overall attended MESA Exam 5 and 1543 attended MESA Exam 5 (2010-12). The 4920 overall attended MESA Exam 5 were further divided into 3173 attended MESA Exam 5 (2010-12) and 204 attended MESA Exam 5 (2010-12). The 204 attended MESA Exam 5 (2010-12) were further divided into 157 ineligible or did not enroll in MESA Lung and 119 not selected for full-lung CT scan (18 full lung-CT scans not performed). The 119 not selected for full-lung CT scan (18 full lung-CT scans not performed) were further divided into 67 underwent full-lung CT scan and 0 not selected for full-lung CT scan (446 full lung-CT scans not performed). The 67 underwent full-lung CT scan were further divided into 3203 total underwent full-lung CT scan (2010-12) and 180 not included (175 without air pollution estimates, 5 CT scans technically inadequate). The 3203 total underwent full-lung CT scan (2010-12) were further divided into 3023 included in study sample and 180 not included (175 without air pollution estimates, 5 CT scans technically inadequate).

3023 had 1 or more air pollution measure. 3022 with ozone, 3005 with black carbon, NO₂, NO_x and PM_{2.5}

Figure E2. Estimated mean black carbon exposure in 2006-2008 by city

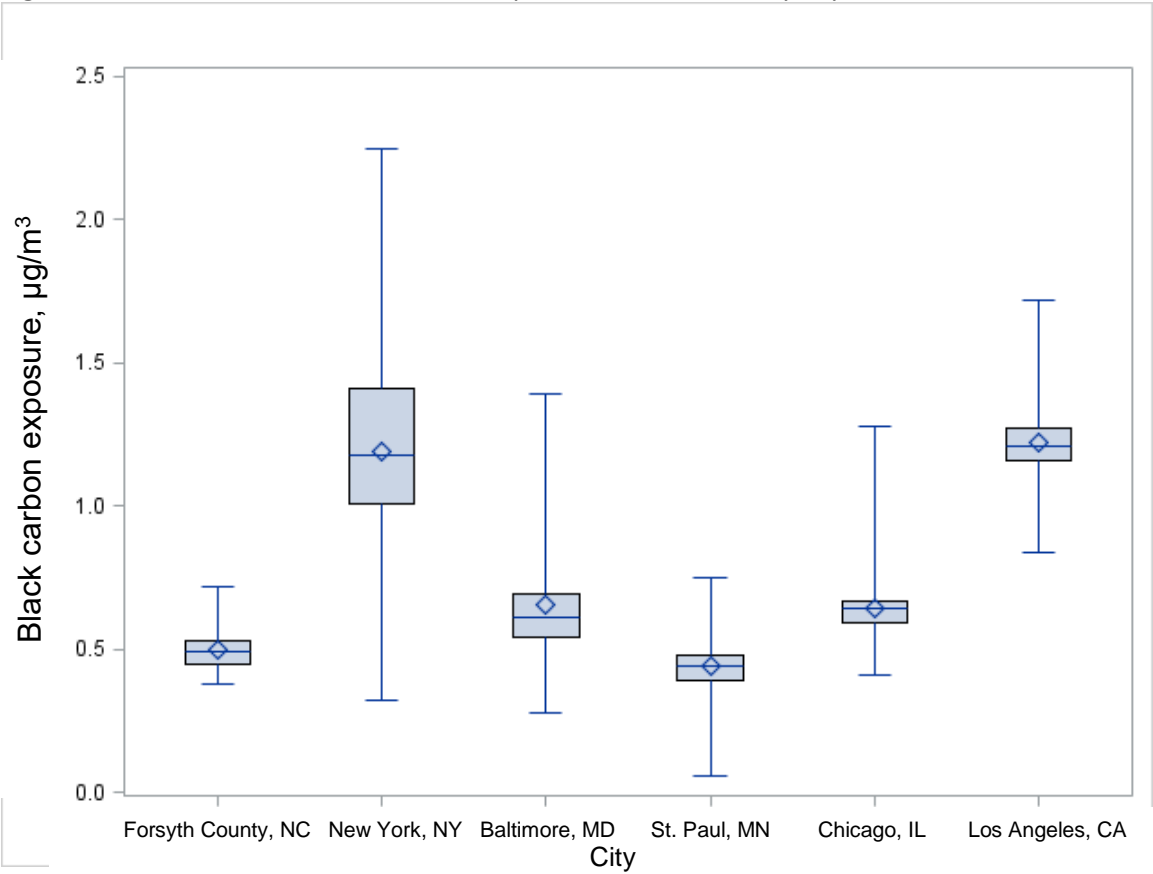
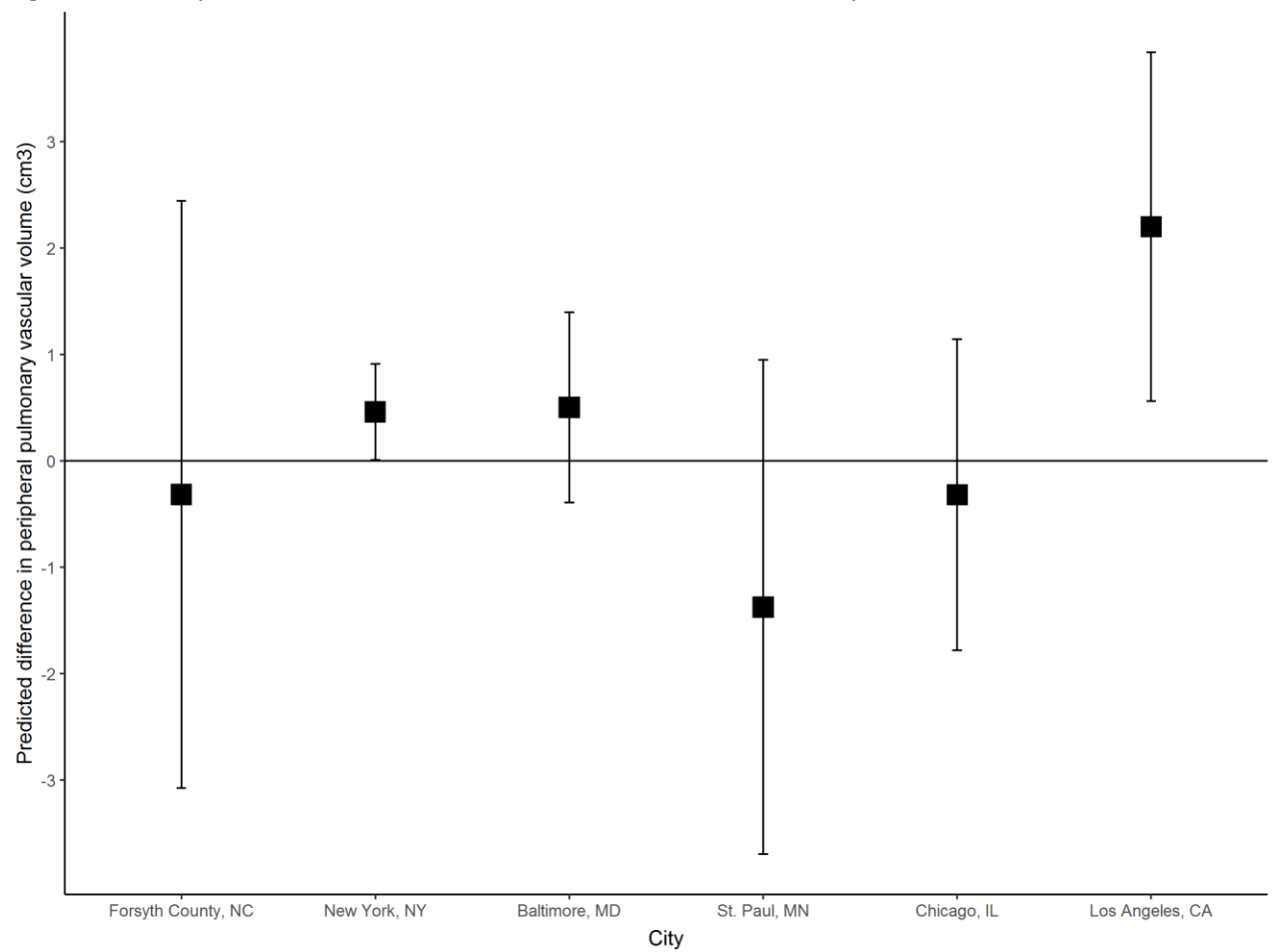


Figure E3. Site-specific estimates for an IQR increase in black carbon exposure



Model adjusts for age, sex, race/ethnicity, height, weight, education, smoking status, pack years, secondhand smoke and scanner manufacturer.