The Association Between Fine Particulate Matter Chemical Components And Atherosclerosis In The Multi-Ethnic Study Of Atherosclerosis

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RATIONALE: The association between long-term fine particulate matter ($PM_{2.5}$) air pollution and subclinical outcomes of atherosclerosis has been reported in previous studies including a study based on the Multi-Ethnic Study of Atherosclerosis (MESA) cohort. There has been increasing interest in identifying $PM_{2.5}$ chemical components that underlie this association. We examined whether specific $PM_{2.5}$ chemical components are associated with the extent of common carotid intima-media thickness (CIMT) in the MESA cohort.
METHODS: We assessed the association between predicted long-term concentrations of $PM_{2.5}$ chemical components and right far wall mean thickness of CIMT measured in 5,501 MESA participants residing in six metropolitan U.S. cities (Los Angeles, Chicago, St. Paul, Baltimore, New York, and Winston-Salem) between 2000 to 2002. Long-term $PM_{2.5}$ component concentrations were predicted at participant homes using a spatio-temporal model based on speciated $PM_{2.5}$ monitoring data obtained from a dedicated cohort-specific monitoring campaign. We chose four $PM_{2.5}$ components of particular interest: elemental and organic carbon (EC, OC), sulfur, and silicon as indicators of combustion-generated $PM_{2.5}$, secondary inorganic aerosol, and crustal dust, respectively. We performed cross-sectional analyses using multiple linear regression to adjust for potential confounders including study city. Our primary model, constructed using a variable selection approach based on previous scientific findings, included age, gender, race/ethnicity, income, education, waist circumstance, body surface area, body mass index, diastolic blood pressure, hypertension, and statin use.
RESULTS: Means of predicted long-term concentrations at subject residences of EC, OC, sulfur, and silicon over six cites were 1.43, 2.08, 1.28, and 0.12 $\mu g/m^3$, respectively. Study participants had a mean age of 62 years, included 52 % females, and were racially diverse. The average CIMT was 0.68 mm. Interquartile increases of 0.65, 0.53, and 0.03 $\mu g/m^3$ in OC, sulfur, and silicon predictions from the spatio-temporal model were associated with 2.0 % (95% CI=1.2-2.7), 2.5 % (95% CI=1.6-3.4), and 0.6 % (95% CI=0.1-1.1) increases in CIMT, respectively (Table 1). A 0.79 $\mu g/m^3$ increase in EC was marginally associated with CIMT (0.6 %, 95% CI=0.0-1.3). The associations remained after adjustment for an extended set of covariates, but, with the exception of sulfur, were sensitive to adjustment for study city.
CONCLUSIONS: Extent of CIMT was associated with long-term concentrations of OC, silicon and sulfur, and marginally with EC. Our findings suggest that $PM_{2.5}$ air pollution resulting from some combustion-related sources, secondary inorganic aerosol, and possibly crustal dust may be more likely than $PM_{2.5}$ from other sources to contribute to atherosclerosis.

Table 1. Mean differences in CIMT associated with IQR increments in long-term concentrations of four $PM_{2.5}$ components predicted from the spatio-temporal model in MESA participants (primary model in bold)

Component	Model*	B+	95% CI+	
EC	**1**	**0.006**	**0.000**	**0.013**
	2	0.005	-0.002	0.012
	3	0.004	-0.005	0.013
OC	**1**	**0.020**	**0.012**	**0.027**
	2	0.015	0.007	0.023
	3	0.001	-0.008	0.010
Sulfate	**1**	**0.025**	**0.016**	**0.034**
	2	0.022	0.013	0.032
	3	0.040	0.004	0.075
Silicon	**1**	**0.006**	**0.001**	**0.011**
	2	0.003	-0.002	0.009
	3	0.000	-0.008	0.008

*3 models adjusted for a progressively larger set of risk factor covariates
Model 1 (Primary model): $PM_{2.5}$ component + age + gender + race/ethnicity + income + education + waist circumstance + body surface area + BMI + BMI^2 + diastolic blood pressure + hypertension + statin use
Model 2 (Fully-specified model): Model 1 + height + weight + systolic blood pressure + diabetes+ low density lipoprotein + high density lipoprotein + triglyceride + creatinine + hypertension medication + gum disease + alcohol use + smoking status
Model 3(City adjustment): Model 1 + city
+ Coefficients and 95% CIs per IQR increments increase: 0.79, 0.65, 0.53, and 0.03 $\mu g/m^3$ for EC, OC, sulfur, and silicon predictions, respectively

This abstract is funded by: Health Effects Institute, National Institutes of Health, and Environmental Protection Agency