APPENDIX AVAILABLE ON THE HEI WEB SITE

Research Report 178

National Particle Component Toxicity (NPACT) Initiative Report on Cardiovascular Effects

Sverre Vedal et al.

Section 1: NPACT Epidemiologic Study of Components of Fine Particulate Matter and Cardiovascular Disease in the MESA and WHI-OS Cohorts

Appendix I. WHI Exposure and Health Analysis: Additional Text and Tables

Note: Appendices that are available only on the Web have been assigned letter identifiers that differ from the lettering in the original Investigators' Report. HEI has not changed the content of these documents, only their identifiers.

Appendix I was originally Appendix H

Correspondence may be addressed to Dr. Sverre Vedal, University of Washington, Department of Environmental and Occupational Health Sciences, Box 354695, 4225 Roosevelt Way NE, Suite 100, Seattle, WA 98105-6099; email: *svedal@uw.edu*.

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APPENDIX H: WHI exposure and health analysis: additional text and tables

Including:

- **Details of time-varying exposure analysis**
- **Tables from secondary covariates**
- **Details of WHI city-wide average exposure estimates**
- **Details of secondary WHI analyses: city-wide estimates of $PM_{2.5}$ component exposure**

Details of time-varying exposure analysis

Methods

Instead of using baseline residential location to assign exposure, this approach uses the residential location in the one or two years prior to the event or death (or the corresponding years in subjects who did not have an event) to assign exposure in a time-varying manner. As in the primary analyses of this report, exposure data derive from annual average predictions from the national $PM_{2.5}$ and components models. As the time axis used in survival analysis was time since enrollment, for the purposes of assigning exposure "study years" were defined as one-year periods anchored at the date of enrollment for each participant. Residential history was available throughout the study period, and sometimes prior to enrollment. For each study year, the exposure predicted at the subject residential location was assigned to that study year. In the case of address changes, the location where the subject had lived the longest during each 12-month period was used. As the national model predictions were for a single year, the only changes in the assigned exposure over time could be from changes in residence location. If exposure was missing during the year prior to enrollment, which was true for the majority of cohort, the baseline exposure was assigned to the period one year earlier. Otherwise any study year with missing exposure was not altered.

Two time-varying metrics were used: a one-year average and a two-year average. The "study year" of the event (or death or the corresponding time for women who did not have an event or death in that risk set) was determined for each risk set. Then for the time-varying one-year average exposure, the study year immediately prior to the study year of the risk set (and the exposure assigned to it) was used. For the time-varying two-year average exposure, the average of the exposure assigned to the study year immediately prior to the study year of the risk set and that of the previous year was used as the exposure. If exposure was missing during one of those two years, the two-year average was defined as the exposure during the available year. To facilitate comparisons with analyses of baseline exposure, the analyses of time-varying exposure were restricted to participants who had exposure predictions available at their baseline residence and were eligible for inclusion in primary analyses. As in primary analyses, only exposure predictions at addresses which could be geocoded to street level were used. The survival analysis model was otherwise identical to that used in primary analysis of baseline exposure, except that the exposure was time-varying.

Geocoding results of all addresses

The success of geocoding increased for addresses throughout the subsequent years of the study, compared with baseline address. By the fifth year of the study, the percent of addresses geocoded had surpassed 99%, a rate which was sustained through the end of the study. The percentage of addresses geocoded to the centroid level remained at approximately 7-8% of the total cohort across the years, suggesting the addresses newly geocodable in subsequent study years made a net contribution to an increase in the proportion of participants geocoded at the street level.

Assignment of Exposure model predictions to participant addresses

When considering all years of the study, the number of subjects assigned exposure increases with time, related to a smaller number of addresses that could not be geocoded in subsequent years.

Description of assigned exposures for all study years

Summary statistics of the assigned exposures from all addresses using addresses geocoded to street level and for all study years are given in Appendix Table H.1. In general the distributions are extremely very similar to the baseline distribution (Table 47 in the Section 1 main text). For PM and most components, EC, and OC, when using all study years, very slight increases over baseline were observed in the range and IQR, and very slight decreases in the median and mean. In contrast, for

Silicon the mean and median both decreased slightly, while the range and IQR were both observed to increase slightly. Almost no differences were noted for sulfur. Taken together modestly greater heterogeneity of exposure is observed for all study years compared with baseline alone, in all exposure variables.

Some modest time trends in the exposure assigned to participants were noted (data not shown). Specifically, all annual average study-year-specific pollutant concentrations declined, with the exception of Silicon which increased over time. These trends were most pronounced among the participants having two or more addresses, suggesting that migration patterns of the cohort were the major cause of the observed trends. Amongst the participants who stayed at the same address throughout the study, there remain very modest trends in average exposure over time which in our design can only be explained by participants drop in and dropout, suggesting that those living in higher exposure areas were ever so slightly more likely to either leave the study (whether due to death, illness, or other reason) or to have joined the study later in the rolling four year duration initial enrollment period. As the exposure prediction models were developed for exposure in a single year, the modest time trends noted here are not attributable to actual changes in the concentrations of pollutants at a location over time, but instead to a combination of where the participants lived each year and to who remained in the study during each year of follow-up.

Results of health analyses

The results of survival analysis using time-varying exposure are shown in tables H.2 for cardiovascular events and H.3 for cardiovascular deaths, including the number of events and deaths which were included in the analyses of one-year average and two-year average time-varying exposure. While the number of participants included was the same as in the primary analysis, the number of events and deaths are approximately 2% smaller. This is because for some women who moved, the address in the year or two before the event or death could not be assigned exposure.

For cardiovascular events, the results of the time-varying analysis echo the findings of the primary analysis for both the one-year and the two-year exposure windows. For cardiovascular deaths, the biggest change is the strengthening of the effect of EC compared with baseline exposure analysis (Table 52 in the Section 1 main text). In the two-year average exposure, EC is associated with atherosclerotic cardiac disease death (HR 1.34, 95% CI 1.05, 1.70). As the number of deaths in this analysis specifically was identical to the primary analysis, the larger and now significant Hazard Ratio is not attributable to a difference in the subset of the study population included, but to the change in the exposure metric, or to chance.

In the one-year average analysis, EC is associated with CVD death (HR 1.16, 95% CI 1.03, 1.31) and with atherosclerotic cardiac disease death (HR 1.38, 95% CI 1.09, 1.76). In contrast to results obtained using baseline exposure, these estimates are both significant and Hazard Ratios are 40-45% larger. The effect of $PM_{2.5}$ mass on CVD death has also increased in the one-year average analysis (HR 1.14, 95% CI 0.998, 1.26) while the effect of OC is unchanged and results of Sulfur or Silicon on CVD death remain null.

Discussion

The findings reported in the time-varying section provide additional evidence that EC, as well as OC, are $PM_{2.5}$ components which may contribute to cardiovascular mortality. Yet like the primary analysis, little evidence appears for an association of EC with cerebrovascular death, specifically.

Furthermore, the possibility is suggested that exposure during the one to two years preceding CVD death may have a greater effect than a less proximate baseline exposure, which is often interpreted to represent a generic long-term exposure and was the primary exposure used in WHI for the main analyses of this report. The evidence for this here is small but it is remarkable that it appears for EC, a pollutant which varies on a smaller spatial scale where it may be more important to know the exact residential location to reduce exposure misclassification, assuming the timing of exposure is relevant. It is also noteworthy that this effect is detected among atherosclerotic cardiac disease death, the category with strongest evidence as to an atherosclerotic cause. However chance is also a viable explanation for the stronger association with EC in this analysis. This question should be researched further when time-resolved annual average exposure predictions become available and ideally using extended follow-up of the WHI cohort to increase both the length of follow-up time and residential history, as well as the number of events and deaths available for analysis.

Table H.1: Distributions of Predicted $PM_{2.5}$ and Species Concentrations and Distance to Roadways using all Addresses geocoded to Street level and all study years; subjects in main analysis (no prior CVD and nonmissing covariates)

PM Component	N	Min	25^{th}	Median	75^{th}	Max	Mean	Std Dev
Total $PM_{2.5}$ mass	638,042	3.2	10.8	12.65	14.7	30.6	12.8	2.8
EC	637,869	0.10	0.44	0.55	0.65	1.29	0.55	0.16
OC	637,869	0.46	1.59	1.94	2.25	3.58	1.91	0.46
Sulfur	637,869	0.12	0.58	0.70	0.83	1.20	0.69	0.22
Si	637,869	0.04	0.060	0.078	0.132	0.477	0.106	0.072

1 units are expressed in $\mu g/m^3$

Table H.2 Estimated Hazard Ratios for Time to First Cardiovascular Event Associated with an IQR Increase of Time-Varying Exposure using National Model Predictions

	IQR[1]	CVD Event[2,3] HR (95% CI)	Coronary Heart Disease[3,4] HR (95% CI)	Cerebrovascular Disease[3,5] HR (95% CI)	Myocardial Infarction[3] HR (95% CI)	Coronary Revascularization[3] HR (95% CI)	Stroke[3] HR (95% CI)
2-Year Average[6]							
Number of Events		2,506	1,748	852	793	1,276	791
Total $PM_{2.5}$ mass	3.9	1.09 (1.03, 1.15)	1.08 (1.01, 1.15)	1.14 (1.04, 1.25)	1.03 (0.94, 1.14)	1.08 (0.999, 1.16)	1.16 (1.05, 1.27)
EC	0.21	1.00 (0.95, 1.06)	0.99 (0.93, 1.06)	1.05 (0.96, 1.15)	0.95 (0.87, 1.05)	0.96 (0.89, 1.04)	1.05 (0.95, 1.15)
OC	0.64	1.03 (0.97, 1.09)	1.01 (0.94, 1.08)	1.12 (1.01, 1.23)	1.00 (0.91, 1.11)	0.99 (0.91, 1.07)	1.12 (1.01, 1.23)
Sulfur	0.25	1.09 (1.05, 1.14)	1.11 (1.05, 1.17)	1.08 (1.001, 1.17)	1.08 (0.996, 1.17)	1.14 (1.07, 1.22)	1.10 (1.01, 1.19)
Si	0.071	0.97 (0.93, 1.01)	1.00 (0.94, 1.04)	0.93 (0.86, 0.99)	0.93 (0.86, 0.999)	0.98 (0.93, 1.04)	0.93 (0.86, 0.999)
1-Year Average[7]							
Number of Events		2,496	1,740	849	790	1,268	789
Total $PM_{2.5}$ mass	3.9	1.09 (1.04, 1.15)	1.08 (1.01, 1.15)	1.14 (1.04, 1.25)	1.04 (0.95, 1.15)	1.08 (1.01, 1.17)	1.15 (1.05, 1.27)
EC	0.21	1.00 (0.95, 1.06)	0.99 (0.93, 1.06)	1.04 (0.95, 1.15)	0.96 (0.87, 1.06)	0.97 (0.90, 1.04)	1.04 (0.95, 1.15)
OC	0.64	1.03 (0.97, 1.09)	1.01 (0.94, 1.08)	1.11 (1.01, 1.22)	1.00 (0.91, 1.10)	0.99 (0.92, 1.07)	1.12 (1.01, 1.23)
Sulfur	0.25	1.10 (1.05, 1.15)	1.11 (1.06, 1.17)	1.08 (0.999, 1.16)	1.08 (1.00, 1.17)	1.15 (1.08, 1.22)	1.10 (1.01, 1.19)
Si	0.071	0.96 (0.92, 1.00)	0.98 (0.94, 1.03)	0.92 (0.86, 0.99)	0.93 (0.86, 1.01)	0.97 (0.92, 1.03)	0.93 (0.86, 1.00)

1 units are expressed in $\mu g/m^3$
2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.
4 MI, coronary revascularization, atherosclerotic cardiac disease death, and possible CHD death
5 stroke, cerebrovascular death
6 Exposure is average of the last 2 complete study years prior to event
7 Exposure is average of the last complete study year prior to event
Total subjects included =52,539; events through year 2005 included

Table H.3 Estimated Hazard Ratios for Time to Cardiovascular Death Associated with an IQR Increase of Time-Varying Exposure using National Model Predictions

	IQR[1]	CVD Death[3,4] HR (95% CI)	Atherosclerotic Cardiac Disease or Possible CHD Deaths[4] HR (95% CI)	Atherosclerotic Cardiac Disease Death[4] HR (95% CI)	Possible CHD Death[4] HR (95% CI)	Cerebrovascular Death[4] HR (95% CI)
2-Year Average[6] Number of Events		436	250	120	130	186
Total $PM_{2.5}$ mass	3.9	1.11 (0.97, 1.26)	1.19 (1.002, 1.41)	1.22 (0.95, 1.56)	1.16 (0.92, 1.47)	1.00 (0.82, 1.22)
EC	0.21	1.12 (0.98, 1.27)	1.20 (1.02, 1.42)	1.34 (1.05, 1.70)	1.09 (0.87, 1.38)	1.00 (0.82, 1.22)
OC	0.64	1.20 (1.05, 1.37)	1.22 (1.02, 1.46)	1.38 (1.16, 1.63)	1.09 (0.85, 1.39)	1.18 (0.96, 1.45)
Sulfur	0.25	1.03 (0.93, 1.14)	1.06 (0.92, 1.22)	1.22 (0.99, 1.49)	0.94 (0.78, 1.13)	0.99 (0.84, 1.16)
Si	0.071	1.01 (0.92, 1.10)	1.06 (0.94, 1.19)	0.93 (0.77, 1.13)	1.15 (0.99, 1.32)	0.94 (0.81, 1.09)
1-Year Average[7] Number of Events		431	249	119	130	182
Total $PM_{2.5}$ mass	3.9	1.14 (0.998, 1.29)	1.22 (1.03, 1.45)	1.24 (0.96, 1.59)	1.20 (0.95, 1.51)	1.03 (0.84, 1.26)
EC	0.21	1.16 (1.03, 1.31)	1.24 (1.05, 1.46)	1.38 (1.09, 1.76)	1.12 (0.89, 1.40)	1.02 (0.83, 1.24)
OC	0.64	1.23 (1.07, 1.41)	1.26 (1.05, 1.51)	1.39 (1.17, 1.64)	1.12 (0.87, 1.43)	1.19 (0.97, 1.47)
Sulfur	0.25	1.04 (0.93, 1.15)	1.07 (0.93, 1.23)	1.22 (0.99, 1.50)	0.95 (0.79, 1.15)	0.99 (0.84, 1.16)
Si	0.071	0.99 (0.90, 1.09)	1.05 (0.93, 1.17)	0.93 (0.77, 1.13)	1.12 (0.97, 1.30)	0.92 (0.79, 1.07)

1 units are expressed in $\mu g/m^3$
3 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
4 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.
Exposure is average of the last 2 complete study years prior to event
7 Exposure is average of the last complete study year prior to event
Total subjects included =52,539; events through year 2005 included

Tables from secondary covariates

Table H.4: Multiple Exposure Models: Estimated Hazard Ratios for Time to First Cardiovascular Event Associated with an IQR Increase of Exposure or Living Near Major Roadway[1] at Baseline using National Model Predictions

	CVD Event[2,3] HR (95% CI) N = 2,532	Coronary Heart Disease[3,4] HR (95% CI) N = 1,764	Cerebrovascular Disease[3,5] HR (95% CI) N = 863	Myocardial Infarction[3] HR (95% CI) N = 800	Coronary Revascularization[3] HR (95% CI) N = 1,285	Stroke[3] HR (95% CI) N = 800
Total $PM_{2.5}$ mass	1.09 (1.03, 1.15)	1.07 (1.01, 1.14)	1.14 (1.04, 1.25)	1.03 (0.94, 1.14)	1.08 (0.998, 1.16)	1.16 (1.06, 1.28)
Near Road	1.18 (0.98, 1.42)	1.12 (0.89, 1.41)	1.26 (0.92, 1.71)	0.99 (0.69, 1.43)	1.26 (0.97, 1.63)	1.30 (0.94, 1.78)
Total $PM_{2.5}$ mass	1.09 (1.03, 1.15)	1.07 (1.004, 1.14)	1.14 (1.04, 1.25)	1.03 (0.94, 1.14)	1.07 (0.996, 1.16)	1.16 (1.06, 1.28)
Near Road	1.17 (0.97, 1.41)	1.11 (0.88, 1.40)	1.24 (0.91, 1.69)	0.99 (0.69, 1.42)	1.25 (0.97, 1.62)	1.28 (0.93, 1.76)
EC	0.99 (0.94, 1.05)	0.98 (0.92, 1.05)	1.04 (0.95, 1.14)	0.94 (0.85, 1.03)	0.96 (0.89, 1.03)	1.03 (0.94, 1.14)
OC	1.03 (0.97, 1.09)	1.00 (0.94, 1.07)	1.13 (1.03, 1.24)	0.98 (0.89, 1.09)	0.98 (0.91, 1.06)	1.13 (1.02, 1.24)
S	1.09 (1.05, 1.14)	1.11 (1.05, 1.17)	1.07 (0.995, 1.16)	1.08 (1.001, 1.17)	1.14 (1.07, 1.22)	1.10 (1.01, 1.19)
Si	0.97 (0.93, 1.01)	0.99 (0.94, 1.04)	0.92 (0.86, 0.99)	0.93 (0.86, 1.01)	0.98 (0.92, 1.04)	0.92 (0.85, 0.99)
EC	0.94 (0.87, 1.02)	0.96 (0.87, 1.06)	0.90 (0.78, 1.03)	0.88 (0.76, 1.02)	0.94 (0.83, 1.05)	0.89 (0.77, 1.03)
OC	1.08 (0.99, 1.18)	1.03 (0.93, 1.15)	1.23 (1.06, 1.42)	1.09 (0.94, 1.27)	1.03 (0.92, 1.17)	1.24 (1.06, 1.44)
EC	0.97 (0.92, 1.02)	0.95 (0.89, 1.02)	1.02 (0.93, 1.12)	0.91 (0.83, 1.01)	0.92 (0.85, 0.99)	1.01 (0.91, 1.11)
Sulfur	1.10 (1.05, 1.15)	1.12 (1.06, 1.18)	1.07 (0.99, 1.15)	1.10 (1.02, 1.20)	1.16 (1.09, 1.24)	1.09 (1.01, 1.19)
EC	0.99 (0.94, 1.04)	0.98 (0.92, 1.05)	1.03 (0.94, 1.13)	0.93 (0.84, 1.02)	0.95 (0.89, 1.03)	1.02 (0.93, 1.12)
Si	0.96 (0.92, 1.01)	0.99 (0.94, 1.04)	0.92 (0.86, 0.996	0.93 (0.86, 0.999)	0.97 (0.92, 1.03)	0.92 (0.85, 0.996)
OC	1.02 (0.96, 1.08)	0.99 (0.93, 1.06)	1.13 (1.02, 1.24)	0.98 (0.88, 1.08)	0.96 (0.89, 1.04)	1.12 (1.01, 1.24)
Sulfur	1.09 (1.04, 1.14)	1.11 (1.05, 1.17)	1.07 (0.99, 1.15)	1.08 (1.002, 1.17)	1.15 (1.08, 1.22)	1.09 (1.01, 1.18)
OC	1.02 (0.97, 1.08)	1.00 (0.94, 1.07)	1.12 (1.02, 1.24)	0.98 (0.88, 1.08)	0.97 (0.90, 1.06)	1.12 (1.01, 1.24)
Si	0.97 (0.93, 1.01)	0.99 (0.94, 1.04)	0.93 (0.86, 1.000)	0.93 (0.86, 1.01)	0.98 (0.92, 1.04)	0.92 (0.85, 1.000
Sulfur	1.09 (1.04, 1.14	1.11 (1.05, 1.18)	1.05 (0.98, 1.14)	1.07 (0.98, 1.16)	1.15 (1.08, 1.23)	1.08 (0.99, 1.17)
Si	0.99 (0.94, 1.03)	1.02 (0.97, 1.07)	0.93 (0.86, 1.01)	0.95 (0.87, 1.02)	1.01 (0.95, 1.07)	0.94 (0.86, 1.01)
EC	0.89 (0.82, 0.97)	0.91 (0.82, 1.01)	0.86 (0.74, 0.99)	0.83 (0.71, 0.97)	0.87 (0.77, 0.98)	0.83 (0.71, 0.97)
OC	1.12 (1.02, 1.22)	1.07 (0.96, 1.19)	1.27 (1.10, 1.48)	1.13 (0.96, 1.32)	1.08 (0.95, 1.23)	1.29 (1.10, 1.51)
Sulfur	1.11 (1.06, 1.16)	1.12 (1.06, 1.19)	1.09 (1.01, 1.18)	1.11 (1.03, 1.21)	1.17 (1.10, 1.25)	1.12 (1.03, 1.21)
EC	0.93 (0.86, 1.01)	0.96 (0.87, 1.06)	0.89 (0.77, 1.02)	0.87 (0.75, 1.01)	0.93 (0.83, 1.05)	0.87 (0.75, 1.01)
OC	1.08 (0.99, 1.18)	1.03 (0.93, 1.15)	1.23 (1.07, 1.43)	1.09 (0.94, 1.27)	1.03 (0.92, 1.17)	1.24 (1.07, 1.45)
Si	0.96 (0.92, 1.01)	0.99 (0.94, 1.04)	0.92 (0.85, 0.99)	0.92 (0.85, 0.999)	0.97 (0.92, 1.03)	0.92 (0.84, 0.99)
EC	0.97 (0.92, 1.02)	0.96 (0.90, 1.02)	1.02 (0.93, 1.12)	0.91 (0.82, 1.002)	0.92 (0.85, 0.99)	1.00 (0.91, 1.11)
Sulfur	1.10 (1.05, 1.15)	1.12 (1.06, 1.19)	1.05 (0.97, 1.14)	1.09 (0.998, 1.18)	1.17 (1.09, 1.25)	1.08 (0.99, 1.17)
Si	0.98 (0.94, 1.03)	1.01 (0.96, 1.07)	0.93 (0.87, 1.01)	0.94 (0.87, 1.02)	1.01 (0.95, 1.07)	0.94 (0.86, 1.01)
OC	1.02 (0.96, 1.08)	0.99 (0.93, 1.06)	1.12 (1.02, 1.24)	0.97 (0.88, 1.08)	0.96 (.089, 1.05)	1.12 (1.01, 1.24)
Sulfur	1.09 (1.04, 1.14)	1.11 (1.05, 1.18)	1.05 (0.97, 1.13)	1.07 (0.98, 1.16)	1.15 (1.08, 1.23)	1.07 (0.99, 1.16)
Si	0.97 (0.94, 1.03)	1.02 (0.97, 1.07)	0.94 (0.87, 1.01)	0.94 (0.87, 1.02)	1.01 (0.95, 1.07)	0.94 (0.86, 1.02)
EC	0.89 (0.82, 0.97)	0.91 (0.82, 1.01)	0.85 (0.73, 0.99)	0.83 (0.71, 0.97)	0.87 (0.77, 0.98)	0.83 (0.71, 0.97)
OC	1.12 (1.02, 1.22)	1.07 (0.96, 1.19)	1.27 (1.09, 1.48)	1.13 (0.96, 1.32)	1.08 (0.95, 1.23)	1.29 (1.11, 1.52)
Sulfur	1.11 (1.05, 1.16)	1.13 (1.07, 1.19)	1.07 (0.995, 1.16)	1.10 (1.01, 1.19)	1.17 (1.10, 1.25)	1.10 (1.02, 1.20)

Si	0.98 (0.94, 1.03)	1.01 (0.96, 1.07)	0.93 (0.86, 1.01)	0.94 (0.87, 1.02)	1.01 (0.95, 1.07)	0.93 (0.86, 1.02)
EC	0.88 (0.81, 0.96)	0.90 (0.81, 1.00)	0.84 (0.72, 0.98)	0.83 (0.71, 0.97)	0.86 (0.76, 0.97)	0.82 (0.70, 0.96)
OC	1.12 (1.03, 1.23)	1.08 (0.97, 1.20)	1.28 (1.10, 1.49)	1.13 (0.96, 1.32)	1.09 (0.96, 1.24)	1.31 (1.11, 1.53)
Sulfur	1.11 (1.05, 1.16)	1.13 (1.07, 1.19)	1.08 (0.995, 1.16)	1.10 (1.01, 1.19)	1.17 (1.10, 1.25)	1.10 (1.02, 1.20)
Si	0.99 (0.94, 1.03)	1.02 (0.97, 1.07)	0.94 (0.87, 1.01)	0.94 (0.87, 1.02)	1.01 (0.95, 1.07)	0.94 (0.86, 1.02)
Near Road	1.19 (0.98, 1.44)	1.13 (0.90, 1.43)	1.25 (0.92, 1.72)	1.01 (0.71, 1.46)	1.29 (0.99, 1.68)	1.30 (0.94, 1.80)

1 A1 or A2 <100 m

2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death

3 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.

4 MI, coronary revascularization, atherosclerotic cardiac disease death, and possible CHD death

5 stroke, cerebrovascular death

Total subjects included =52,539, events through year 2005 included

Table H.5: Multiple Exposure Models: Estimated Hazard Ratios for Time to Cardiovascular Death Associated with an IQR Increase of Exposure or Living Near Major Roadway[1] at Baseline using National Model Predictions

	CVD Death[3,4] HR (95% CI) N = 445	Atherosclerotic Cardiac Disease or Possible CHD Deaths[4] HR (95% CI) N = 254	Atherosclerotic Cardiac Disease Death[4] HR (95% CI) N = 120	Possible CHD Death[4] HR (95% CI) N = 134	Cerebrovascular Death[4] HR (95% CI) N = 191
Total $PM_{2.5}$ mass	1.11 (0.98, 1.26)	1.18 (0.996, 1.40)	1.20 (0.94, 1.55)	1.16 (0.92, 1.46)	1.02 (0.84, 1.24)
Near Road	1.06 (0.68, 1.67)	0.80 (0.41, 1.57)	1.20 (0.52, 2.76)	0.49 (0.15, 1.54)	1.45 (0.78, 2.68)
Total $PM_{2.5}$ mass	1.11 (0.98, 1.26)	1.18 (0.999, 1.40)	1.20 (0.93, 1.55)	1.17 (0.93, 1.47)	1.02 (0.83, 1.24)
Near Road	1.05 (0.67, 1.64)	0.78 (0.40, 1.53)	1.17 (0.51, 2.69)	0.48 (0.15, 1.50)	1.45 (0.78, 2.68)
EC	1.11 (0.98, 1.26)	1.17 (0.99, 1.38)	1.27 (0.99, 1.61)	1.08 (0.86, 1.36)	1.03 (0.85, 1.26)
OC	1.23 (1.07, 1.41)	1.21 (1.01, 1.46)	1.34 (1.02, 1.75)	1.12 (0.88, 1.43)	1.25 (1.01, 1.53)
S	1.01 (0.92, 1.12)	1.05 (0.91, 1.20)	1.23 (0.999, 1.51)	0.91 (0.76, 1.09)	0.97 (0.83, 1.14)
Si	1.03 (0.94, 1.12)	1.08 (0.97, 1.21)	0.92 (0.76, 1.13)	1.18 (1.03, 1.35)	0.96 (0.83, 1.11)
EC	0.93 (0.77, 1.12)	1.05 (0.83, 1.34)	1.10 (0.77, 1.56)	1.01 (0.72, 1.41)	0.76 (0.56, 1.02)
OC	1.30 (1.07, 1.58)	1.17 (0.90, 1.52)	1.25 (0.85, 1.82)	1.11 (0.78, 1.59)	1.53 (1.13, 2.07)
EC	1.11 (0.98, 1.27)	1.16 (0.98, 1.37)	1.21 (0.94, 1.55)	1.12 (0.89, 1.42)	1.04 (0.86, 1.28)
Sulfur	0.99 (0.89, 1.10)	1.02 (0.88, 1.17)	1.18 (0.96, 1.47)	0.89 (0.73, 1.08)	0.96 (0.82, 1.13)
EC	1.12 (0.99, 1.27)	1.19 (1.01, 1.41)	1.25 (098, 1.60)	1.16 (0.92, 1.46)	1.02 (0.84, 1.25)
Si	1.04 (0.95, 1.14)	1.11 (0.99, 1.25)	0.94 (0.77, 1.16)	1.22 (1.05, 1.41)	0.96 (0.83, 1.11)
OC	1.23 (1.07, 1.41)	1.21 (1.01, 1.45)	1.32 (1.004, 1.75)	1.12 (0.88, 1.43)	1.25 (1.01, 1.53)
Sulfur	1.01 (0.91, 1.11)	1.04 (0.91, 1.19)	1.20 (0.98, 1.47)	0.91 (0.76, 1.09)	0.97 (0.83, 1.13)
OC	1.24 (1.08, 1.42)	1.24 (1.04, 1.48)	1.33 (1.02, 1.75)	1.20 (0.94, 1.53)	1.24 (1.01, 1.53)
Si	1.05 (0.95, 1.16)	1.11 (0.99, 1.26)	0.93 (0.75, 1.15)	1.23 (1.06, 1.43)	0.97 (0.83, 1.13)
Sulfur	1.03 (0.92, 1.14)	1.08 (0.94, 1.25)	1.22 (0.98, 1.51)	0.97 (0.80, 1.19)	0.96 (0.81, 1.13)
Si	1.03 (0.94, 1.14)	1.10 (0.98, 1.25)	0.97 (0.78, 1.20)	1.18 (1.02, 1.37)	0.95 (0.81, 1.10)
EC	0.91 (0.75, 1.12)	1.03 (0.80, 1.33)	1.00 (0.69, 1.45)	1.07 (0.76, 1.52)	0.75 (0.55, 1.03)
OC	1.31 (1.07, 1.61	1.18 (0.91, 1.54)	1.32 (0.89, 1.97)	1.07 (0.75, 1.52)	1.55 (1.13, 2.12)
Sulfur	1.02 (0.92, 1.14)	1.03 (0.90, 1.19)	1.20 (0.98, 1.48)	0.90 (0.74, 1.09)	1.02 (0.87, 1.19)
EC	0.93 (0.77, 1.13)	1.07 (0.84, 1.36)	1.08 (0.76, 1.54)	1.05 (0.75, 1.47)	0.75 (0.56, 1.02)
OC	1.30 (1.07, 1.58)	1.18 (0.91, 1.52)	1.26 (0.86, 1.85)	1.16 (0.82, 1.65)	1.54 (1.13, 2.08)
Si	1.05 (0.95, 1.15)	1.12 (0.99, 1.26)	0.93 (0.75, 1.16)	1.23 (1.06, 1.43)	0.96 (0.81, 1.12)
EC	1.12 (0.98, 1.27)	1.18 (0.995, 1.40)	1.20 (0.94, 1.55)	1.17 (0.93, 1.48)	1.04 (0.85, 1.27)
Sulfur	1.01 (0.90, 1.12)	1.05 (0.91, 1.22)	1.18 (0.95, 1.47)	0.95 (0.78, 1.16)	0.95 (0.80, 1.12)
Si	1.04 (0.95, 1.15)	1.12 (0.99, 1.27)	0.98 (0.79, 1.21)	1.20 (1.03, 1.40)	0.95 (0.81, 1.10)
OC	1.24 (1.08, 1.42)	1.24 (1.03, 1.48)	1.33 (1.004, 1.75)	1.20 (0.94, 1.53)	1.24 (1.01, 1.52)
Sulfur	1.02 (0.92, 1.13)	1.07 (0.93, 1.23)	1.20 (0.97, 1.47)	0.97 (0.80, 1.18)	0.96 (0.82, 1.12)
Si	1.06 (0.96, 1.17)	1.13 (0.998, 1.29)	0.97 (0.77, 1.21)	1.22 (1.04, 1.43)	0.96 (0.82, 1.13)
EC	0.92 (0.75, 1.12)	1.04 (0.81, 1.34)	1.00 (0.69, 1.45)	1.07 (0.75, 1.51)	0.75 (0.54, 4.03)
OC	1.32 (1.08, 1.62)	1.20 (0.92, 1.57)	1.33 (0.89, 1.98)	1.14 (0.80, 1.64)	1.54 (1.12, 2.11)
Sulfur	1.04 (0.93, 1.15)	1.07 (0.92, 1.23)	1.20 (0.97, 1.48)	0.96 (0.79, 1.18)	1.01 (0.85, 1.19)
Si	1.06 (0.96, 1.22)	1.13 (0.999, 1.29)	0.97 (0.77, 1.21)	1.22 (1.04, 1.42)	0.96 (0.81, 1.13)

EC	0.91 (0.75, 1.12)	1.05 (0.81, 1.36)	0.99 (0.68, 1.45)	1.10 (0.77, 1.56)	0.73 (0.53, 1.01)
OC	1.32 (1.08, 1.62)	1.20 (0.92, 1.56)	1.33 (0.89, 1.99)	1.13 (0.79, 1.61)	1.56 (1.14, 2.14)
Sulfur	1.04 (0.93, 1.15)	1.07 (0.92, 1.23)	1.20 (0.97, 1.48)	0.96 (0.79, 1.18	1.01 (0.85, 1.18)
Si	1.06 (0.96, 1.16)	1.13 (0.996, 1.28)	0.97 (0.77, 1.21)	1.21 (1.03, 1.41)	0.96 (0.82, 1.13)
Near Road	1.08 (0.68, 1.70)	0.79 (0.40, 1.55)	1.11 (0.48, 2.58)	0.50 (0.16, 1.59)	1.52 (0.81, 2.83)

1 A1 or A2 <100 m

3 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death

4 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.

Total subjects included =52,539, events through year 2005 included

Details of WHI city-wide average exposure estimates

Exposure data were obtained from US EPA for speciation monitors from the Speciation Trends Network (STN) or special speciation monitoring, in WHI “cities” for years 2002 to 2004, using monitors located in these same Metropolitan Statistical Areas (MSA) or Consolidated Metropolitan Statistical Areas (CMSA). Data were downloaded from http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm on October 27, 2009 (for all available cities) and www.epa.cgi-bin/htmSQL/mxplorer/query_spe.hsql on July 7, 2010 (for Houston, TX). Analyses used year 2004 due to greatest data availability, compared to earlier years. Monitors with data for minimum fifty percent of intended observations in each quarter of year 2004 were included. For each monitor, the annual average concentration was computed, using the average of the arithmetic mean of all observations in each quarter. The annual average concentrations from all monitors in a city were averaged to obtain the city-wide annual average and this exposure metric assigned to all study participants from a given city. Fine particulate matter and its components were considered as follows: total fine particulate mass ($PM_{2.5}$), elemental carbon (EC), organic carbon (OC), Sulfate, Silicon (Si), and Nickel (Ni).

Annual average exposure for each city was estimated as described and number of monitors per city was recorded. Descriptive statistics (mean, standard deviation, minimum, 25th percentile, median, 75th percentile, maximum, inter-quartile range) were computed for annual average exposure concentrations. The pairwise correlation coefficients comparing $PM_{2.5}$ mass and all components were computed.

The annual average exposure for each city and number of monitors per city are given in Appendix Table H.6; 30 cities had at least one speciation monitor that met our criteria. For $PM_{2.5}$

there were between 1 and 7 monitors per city with sufficient data, while for all $PM_{2.5}$ components the range was 1 to 8 monitors per city. The minimum annual average concentration for $PM_{2.5}$ was found in Honolulu (4.7 µg/m^3) and maximum in Los Angeles-Riverside-Orange County (19.7 µg/m^3). The minimum annual average concentration for EC was in Honolulu (0.25 µg/m^3) and maximum in Miami-Fort Lauderdale (1.34 µg/m^3). The minimum annual average concentration for sulfate was in Reno (0.6 µg/m^3) and maximum in Washington-Baltimore (5.2 µg/m^3). The minimum annual average concentration for Si was in Honolulu (0.02 µg/m^3) and maximum in Tucson (0.24 µg/m^3). The minimum annual average concentration for Ni was in Des Moines (0.0002 µg/m^3) and maximum in New York-Northern New Jersey-Long Island (0.0097 µg/m^3).

Descriptive statistics for city-wide annual average exposures are given in Appendix Table H.7. The mean annual average concentration was 12.7 µg/m^3 (std dev 3.2) for $PM_{2.5}$ with interquartile range (IQR) 4.0. In order from largest to smallest, the mean annual average concentration (std dev, IQR) for the components were: OC 4.0 µg/m^3 (1.0, 1.5), Sulfate 2.9 µg/m^3 (1.4, 2.0), EC 0.7 µg/m^3 (0.3, 0.4), Si 0.11 µg/m^3 (0.06, 0.09), Ni 0.0018 µg/m^3 (0.002, 0.0012). The pairwise correlation coefficients are shown in Appendix Table H.8. The strongest correlations were between OC and total $PM_{2.5}$ mass (.64), EC and OC (.58), EC and $PM_{2.5}$ (.57), and sulfate and $PM_{2.5}$ (.56). Modest correlations were observed between Si and OC (.36), Si and sulfate (-.30), Si and Ni (-.27), Si and EC (.26), and Ni and EC (.25). Little to no correlation existed between EC and sulfate (.14), Si and $PM_{2.5}$ (.12), OC and sulfate (-.07), Ni and $PM_{2.5}$ (-.03), Ni and OC (-.02), or Ni and sulfate (-.02).

Table H.6: Annual Average $PM_{2.5}$ and Species Concentrations and Number of Monitors per City for Year 2004, Using CSN Monitoring Data Measurements

	$PM_{2.5}$[1]	N	EC[1]	N	OC[1]	N	Sulfate[1]	N	Silicon[1]	N	Nickel[1]	N
Atlanta, GA MSA	16.0	1	1.01	1	4.9	1	4.8	1	0.11	1	0.0003	1
Birmingham, AL MSA	17.7	2	1.02	2	5.2	2	4.4	2	0.16	2	0.0017	2
Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA	10.3	4	0.60	4	3.5	4	2.9	4	0.06	4	0.0026	4
Buffalo-Niagara Falls, NY MSA	13.2	1	0.50	1	3.0	1	3.8	1	0.08	1	0.0005	1
Chicago-Gary-Kenosha, IL-IN-WI CMSA	13.3	7	0.79	7	3.7	7	2.7	7	0.08	7	0.0007	7
Cincinnati-Hamilton, OH-KY-IN CMSA	14.4	3	0.62	3	3.5	3	4.3	3	0.07	3	0.0011	3
Columbus, OH MSA	13.5	1	0.58	1	3.7	1	3.9	1	0.05	1	0.0010	1
Davenport-Moline-Rock Island, IA-IL MSA	12.0	1	0.33	1	3.0	1	2.7	1	0.09	1	0.0005	1
Des Moines, IA MSA	9.9	1	0.26	1	2.5	1	1.9	1	0.09	1	0.0002	1
Detroit-Ann Arbor-Flint, MI CMSA	14.3	4	0.67	4	3.7	4	3.3	4	0.10	4	0.0011	4
Greensboro--Winston-Salem--High Point, NC MSA	16.7	3	0.58	3	4.6	3	5.1	3	0.07	3	0.0008	3
Honolulu, HI MSA	4.7	1	0.25	1	1.5	1	0.9	1	0.02	1	0.0023	1
Houston-Galveston-Brazoria, TX CMSA	11.8	5	0.43	7	2.8	7	3.2	5	0.23	5	0.0014	5
Los Angeles-Riverside-Orange County, CA CMSA	19.7	4	1.13	4	5.6	4	2.9	4	0.16	4	0.0023	4
Memphis, TN-AR-MS MSA	13.7	1	0.95	1	4.5	1	3.6	1	0.13	1	0.0003	1
Miami-Fort Lauderdale, FL CMSA	11.7	1	1.34	1	3.4	1	2.6	1	0.21	1	0.0020	1
Milwaukee-Racine, WI CMSA	12.5	2	0.55	2	3.8	2	2.3	2	0.13	2	0.0015	2
Minneapolis-St. Paul, MN-WI MSA	10.4	2	0.46	2	3.3	2	1.9	2	0.08	2	0.0013	2
New York-Northern New Jersey-Long Island, NY-NJ-CT-PA CMSA	13.3	7	0.94	8	3.6	8	3.9	8	0.06	8	0.0097	8
Phoenix-Mesa, AZ MSA	9.5	1	0.86	1	5.2	1	1.0	1	0.24	1	0.0013	1
Pittsburgh, PA MSA	16.2	3	1.27	3	4.2	3	5.0	3	0.09	3	0.0014	3
Providence-Fall River-Warwick, RI-MA MSA	9.9	1	0.55	1	3.3	1	3.3	1	0.07	1	0.0038	1
Raleigh-Durham-Chapel Hill, NC MSA	14.4	1	0.53	1	4.6	1	4.5	1	0.07	1	0.0012	1
Reno, NV MSA	8.6	1	0.85	1	4.8	1	0.6	1	0.16	1	0.0008	1
Sacramento-Yolo, CA CMSA	12.6	2	0.74	1	5.6	2	1.1	2	0.16	1	0.0013	1
San Diego, CA MSA	14.4	2	0.75	1	5.6	2	2.6	2	0.09	1	0.0020	1
San Francisco-Oakland-San Jose, CA CMSA	13.7	1	0.79	1	5.3	1	1.4	1	0.11	1	0.0071	1
Seattle-Tacoma-Bremerton, WA CMSA	11.2	3	1.08	4	4.3	4	1.4	4	0.05	4	0.0021	4
Tucson, AZ MSA	6.6	1	0.46	1	3.2	1	1.0	1	0.24	1	0.0010	1
Washington-Baltimore, DC-MD-VA-WV CMSA	15.1	1	0.61	1	3.8	1	5.2	1	0.08	1	0.0011	1

1 units are expressed in $\mu g/m^3$

Table H.7: Distributions of Fine Particulate Matter Air Pollution and its Components across the WHI cities, Using CSN Monitoring Data Measurements

PM Component	Mean[1]	Std Dev[1]	Min[1]	25th[1]	Median[1]	75th[1]	Max[1]	IQR[1]
Total $PM_{2.5}$ mass	12.7	3.2	4.7	10.4	13.2	14.4	19.7	4.0
Components EC	0.7	0.3	0.3	0.5	0.6	0.9	1.3	0.4
OC	4.0	1.0	1.5	3.3	3.8	4.8	5.6	1.5
SO_4	2.9	1.4	0.6	1.9	2.9	3.9	5.2	2.0
Si	0.11	0.06	0.02	0.07	0.09	0.16	0.24	0.09
Ni	0.0018	0.0020	0.0002	0.0008	0.0013	0.0020	0.0097	0.0012

1 units are expressed in $\mu g/m^3$

Table H.8: Correlation of Components of Fine Particulate Matter Air Pollution across the WHI Cities, Using CSN Monitoring Data Measurements

	Total $PM_{2.5}$ mass	EC	OC	SO_4	Si	Ni
Total $PM_{2.5}$ mass						
EC	.57					
OC	.64	.58				
SO_4	.56	.14	-.07			
Si	.12	.26	.36	-.30		
Ni	-.03	.25	-.02	-.02	-.27	

Details of secondary WHI analyses: city-wide estimates of $PM_{2.5}$ component exposure

The total number of eligible women and the number of women experiencing study outcomes, including incident CVD events and CVD mortality and all their subcategories, were enumerated. Cox proportional hazards regression was used to estimate hazard ratios (HR) and 95% confidence intervals (CI) for time to first cardiovascular event or time to cardiovascular mortality associated with an interquartile range (IQR) difference in $PM_{2.5}$, EC, OC, Sulfate, Si, or Ni. Factors hypothesized *a priori* to potentially confound the relationship between air pollution and cardiovascular disease were included in all models; these included age, body mass index (BMI), smoking status, cigarettes per day and years smoked, systolic blood pressure, history of hypertension, hypercholesterolemia, history of diabetes, education and household income levels, and race; models were stratified (i.e. separate baseline hazards) by baseline diabetes status, age, and BMI. Components found to be significantly associated with outcomes studied in single-exposure-variable models were included in models with two or three components (i.e. two or three exposure variables). Sensitivity analyses examined associations with the categories Other CVD death and Unknown CVD death, where there was less evidence for an atherosclerotic cause. Data were analyzed using the statistical package SAS v9.2 (Cary, NC).

Of the 97,676 subjects, 72,569 had no cardiovascular disease at enrollment. Those women who had returned a follow-up questionnaire, met our residence criteria, and lived by a city with a speciation monitor were included in analysis. The number of cardiovascular events and deaths are given in Appendix Table H.9; between 1994 and 2005 there were a total of 2627 cardiovascular events of which 469 were deaths. Nearly two-thirds of the events and deaths included in the categories “CVD event” and “CVD death” were related to atherosclerotic cardiac or coronary heart disease, and the remainder had cerebrovascular causes.

The estimated hazard ratios for time to first cardiovascular event and cardiovascular death associated with an IQR increase of exposure are presented in Appendix Table H.10. An IQR increase in total $PM_{2.5}$ mass was associated with first cardiovascular event (hazard ratio 1.07; 95% CI 1.02 to 1.13) and with cardiovascular death (hazard ratio 1.20; 95% CI 1.06 to 1.35). Sulfate was associated with first cardiovascular event (hazard ratio 1.10; 95% CI 1.04 to 1.17), but not with cardiovascular death. Conversely, not associated with first cardiovascular event, but associated with cardiovascular death were: EC (hazard ratio 1.17; 95% CI 1.01 to 1.23), OC (hazard ratio 1.19; 95% CI 1.03 to 1.37), and silicon (hazard ratio 1.21; 95% CI 1.04 to 1.41). Nickel was not associated with either first cardiovascular event or cardiovascular death.

Appendix Table H.11 gives estimated hazard ratios for time to subtypes of cardiovascular death associated with an IQR Increase of exposure. An IQR increase in total $PM_{2.5}$ mass was associated with death from Atherosclerotic Cardiac Disease (hazard ratio 1.29; 95% CI 1.01 to 1.64) and with death from possible CHD (hazard ratio 1.22; 95% CI 1.02 to 1.47), but not with Cerebrovascular Disease death. The largest association was found between EC and death from Atherosclerotic Cardiac Disease (hazard ratio 1.48; 95% CI 1.10 to 1.99), yet EC was not associated with either possible CHD or Cerebrovascular deaths. While OC was not significantly associated with any of the three death subtypes individually, the magnitudes of the hazard ratios remained similar across categories. Silicon was associated with Cerebrovascular death (hazard ratio 1.43; 95% CI 1.12 to 1.83), and with the combined grouping of Atherosclerotic Cardiac Disease or Possible CVD deaths (hazard ratio 1.28; 95% CI 1.05 to 1.55). There was little evidence for an association of either sulfate or nickel with any of the cardiovascular death subtypes. For the categories Other CVD death and Unknown CVD death examined in sensitivity analyses, no associations were observed with $PM_{2.5}$ nor with any of its components (results shown in Appendix Table H.12).

Results of analyses using groupings by disease subtype are displayed in Appendix Table H.13, $PM_{2.5}$ was associated with Cerebrovascular Disease Events (hazard ratio 1.11; 95% CI 1.02 to 1.21), but did not cross the significance threshold for Coronary Heart Disease Events (hazard ratio 1.06; 95% CI 0.995 to 1.13). Sulfate was associated with Coronary Heart Disease Events (hazard ratio 1.12; 95% CI 1.04 to 1.21) including Coronary Revascularization (hazard ratio 1.14; 95% CI 1.05 to 1.25), but not with Cerebrovascular Disease (hazard ratio 1.06; 95% CI 0.96 to 1.18). Negative associations were observed between Si and Myocardial Infarction (hazard ratio 0.86; 95% CI 0.76 to 0.98); and Ni and Cerebrovascular Disease (hazard ratio 0.96; 95% CI 0.93 to 0.99), Coronary Revascularization (hazard ratio 0.97; 95% CI 0.95 to 0.995), and Stroke (hazard ratio 0.95; 95% CI 0.92 to 0.98). No significant associations were observed for either EC or OC with any disease subtype.

Findings of analyses involving multi-pollutant models including multiple $PM_{2.5}$ components are found in Appendix Table H.14. The association of EC with Atherosclerotic Cardiac Disease death was robust to adjustment for OC (hazard ratio 1.50; 95% CI 1.07 to 2.09), or for both OC and Si (hazard ratio 1.50; 95% CI 1.07 to 2.09). For cardiovascular death, inclusion of OC rendered the association with EC non-significant, but addition of Si revealed an association with Si when controlling for both EC and OC (hazard ratio 1.18; 95% CI 1.00 to 1.38). The same pattern was observed with a Si only effect while adjusting for EC and OC, for the combined grouping of Atherosclerotic Cardiac Disease or possible CVD deaths (hazard ratio 1.24; 95% CI 1.003 to 1.52); and for Cerebrovascular Deaths (hazard ratio 1.40; 95% CI 1.08 to 1.82). The association of sulfate with cardiovascular events was robust to adjustment for EC (hazard ratio 1.10; 95% CI 1.03 to 1.17).

Table H.9. Number of Outcomes Occurring during Study Period for City-wide Mean Exposure Estimates, Using CSN Monitoring Data Measurements

CVD Event[2]	2627[6]
Coronary Heart Disease[4]	1822
Myocardial Infarction	816
Coronary Revascularization	1328
Atherosclerotic Cardiac Disease Death	123
Possible CHD death	151
Cerebrovascular Disease[5]	901
Stroke	824
Cerebrovascular death	195
CVD Death[3]	469
Atherosclerotic Cardiac Disease Death	123
Possible CHD death	151
Cerebrovascular death	195
other CVD Death	121
unknown CVD Death	38

2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
4 MI, coronary revascularization, atherosclerotic cardiac disease death, and possible CHD death
5 Stroke, cerebrovascular death
6 The sum of events from all categories may be greater than the total number of events as some women had more than one type of event

Table H.10. Estimated Hazard Ratios for Time to First Cardiovascular Event and Cardiovascular Death Associated with an IQR Increase of City-wide Mean Exposure, Using CSN Monitoring Data Measurements

Component	IQR[1]	CVD Event[2,4] HR (95% CI)	CVD Death[3,4] HR (95% CI)
Total $PM_{2.5}$ mass	4.0	1.07 (1.02, 1.13)	1.20 (1.06, 1.35)
Components			
EC	0.4	1.02 (0.96, 1.09)	1.17 (1.01, 1.23)
OC	1.5	1.01 (0.95, 1.07)	1.19 (1.03, 1.37)
SO_4	2.0	1.10 (1.04, 1.17)	1.02 (0.88, 1.18)
Si	0.09	0.99 (0.92, 1.05)	1.21 (1.04, 1.41)
Ni	0.0012	0.98 (0.96, .996)	1.01 (0.97, 1.05

1 units are expressed in $\mu g/m^3$
2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
4 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia

Table H.11. Estimated Hazard Ratios for Time to Cardiovascular Death Subtype Associated with an IQR Increase of City-wide Mean Exposure, Using CSN Monitoring Data Measurements

Component	IQR[1]	CVD Death[2,3] HR (95% CI)	Atherosclerotic Cardiac Disease or Possible CHD Deaths[3,4] HR (95% CI)	Atherosclerotic Cardiac Disease Death[3] HR (95% CI)	Possible CHD Death[3] HR (95% CI)	Cerebrovascular Death[3] HR (95% CI)
Total $PM_{2.5}$ mass	4.0	1.20 (1.06, 1.35)	1.18(1.004, 1.37)	1.29(1.01, 1.64)	1.22(1.02, 1.47)	1.10(0.90, 1.35)
Components EC	0.4	1.17 (1.01, 1.23)	1.29(1.06, 1.57)	1.48(1.10, 1.99)	1.02(0.81, 1.29)	1.16(0.89, 1.51)
OC	1.5	1.19 (1.03, 1.37)	1.20(0.996, 1.44)	1.19(0.89, 1.58)	1.18(0.95, 1.46)	1.20(0.95, 1.53)
SO_4	2.0	1.02 (0.88, 1.18)	0.99(0.82, 1.19)	1.14(0.86, 1.53)	1.07(0.85, 1.33)	0.88(0.69, 1.13)
Si	0.09	1.21 (1.04, 1.41)	1.28(1.05, 1.55)	1.08(0.80, 1.47)	1.16(0.92, 1.46)	1.43(1.12, 1.83)
Ni	0.001	1.01 (0.97, 1.05)	1.04(0.99, 1.09)	1.06(0.99, 1.13)	0.95(0.89, 1.02)	1.03(0.97, 1.10)

1 units are expressed in $\mu g/m^3$
2 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.
4 atherosclerotic cardiac disease death and possible CHD death

Table H.12: Estimated Hazard Ratios for Time to Fatal CVD Events Associated with an IQR Increase in City-wide Mean Concentrations: Other death subtypes, Using CSN Monitoring Data Measurements

Component	IQR[1]	Fatal Events[2,3] HR (95% CI)	Other or Unknown CVD Death[3] HR (95% CI)	Other CVD Death[3] HR (95% CI)	Unknown CVD Death[3] HR (95% CI)
Total $PM_{2.5}$ mass	4.0	1.17 (1.05, 1.29)	1.09 (0.88, 1.34)	1.13 (0.89, 1.44)	0.98 (0.65, 1.48)
Components EC	0.4	1.15 (1.02, 1.30)	1.08 (0.84, 1.40)	1.08 (0.80, 1.46)	1.05 (0.63, 1.75)
OC	1.5	1.15 (1.02, 1.30)	1.04 (0.82, 1.34)	1.20 (0.90, 1.59)	0.67 (0.40, 1.11)
SO_4	2.0	1.01 (0.90, 1.15)	1.00 (0.78, 1.28)	0.91 (0.69, 1.21)	1.40 (0.84, 2.34)
Si	0.09	1.20 (1.05, 1.36)	1.12 (0.86, 1.46)	1.13 (0.84, 1.52)	1.07 (0.62,1.87)
Ni	0.001	1.02 (0.99, 1.05)	1.05 (0.98, 1.11)	1.05 (0.98, 1.13)	1.04 (0.90, 1.19)

1 units are expressed in $\mu g/m^3$

2 Includes atherosclerotic cardiac disease death, possible CHD death, cerebrovascular death, other or unknown CVD death

3 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.

Table H.13. Estimated Hazard Ratios for Time to Cardiovascular Event Associated with an IQR Increase of City-wide Mean Exposure: Cardiovascular event subtypes, Using CSN Monitoring Data Measurements

Component	IQR[1]	CVD Event [2,3] HR (95% CI)	Coronary Heart Disease[3,4] HR (95% CI)	Cerebrovascular Disease[3,5] HR (95% CI)	Myocardial Infarction[3] HR (95% CI)	Coronary Revascularization[3] HR (95% CI)
Total $PM_{2.5}$ mass	4.0	1.07 (1.02, 1.13)	1.06 (0.995, 1.13)	1.11 (1.02, 1.21)	1.01(0.92, 1.10)	1.05 (0.98, 1.13)
Components EC	0.4	1.02 (0.96, 1.09)	1.04 (0.98, 1.18)	1.02 (0.91, 1.13)	0.98 (0.87, 1.10)	1.00 (0.92, 1.10)
OC	1.5	1.01 (0.95, 1.07)	0.99 (0.92, 1.06)	1.09 (0.98, 1.20)	0.99 (0.89, 1.11)	0.96 (0.88, 1.04)
SO_4	2.0	1.10 (1.04, 1.17)	1.12 (1.04, 1.21)	1.06 (0.96, 1.18)	1.10 (0.98, 1.22)	1.14 (1.05, 1.25)
Si	0.09	0.99 (0.92, 1.05)	0.97 (0.90, 1.06)	1.00 (0.90, 1.12)	0.86 (0.76, 0.98)	0.95 (0.87, 1.05)
Ni	0.001	0.98 (0.96, .996)	0.99 (0.97, 1.01)	0.96 (0.93, 0.99)	0.99 (0.96, 1.02)	0.97 (0.95, 0.995)

1 units are expressed in $\mu g/m^3$
2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.
4 MI, coronary revascularization, atherosclerotic cardiac disease death, and possible CHD death
5 stroke, cerebrovascular death

Table H.14. Multi-Pollutant Models for Estimated Hazard Ratios for Time to First Cardiovascular Event and Cardiovascular Death Associated with an IQR Increase of City-wide Mean Exposure, Using CSN Monitoring Data Measurements

Component	IQR[1]	CVD Event[2,4,5] HR (95% CI)	CVD Death[3,4,6] HR (95% CI)	Atherosclerotic Cardiac Disease Death[4,6] HR (95% CI)	Possible CHD Death[4,6] HR (95% CI)	Atherosclerotic Cardiac Disease Death or Possible CHD Death[4,6] HR (95% CI)	Cerebrovascular Death[4,6] HR (95% CI)	CVD Death[3,4,7] HR (95% CI)	Atherosclerotic Cardiac Disease Death[4,7] HR (95% CI)
EC	0.4	1.01 (0.94, 1.07)	1.08 (0.90, 1.30)	1.50 (1.07, 2.09)	0.88 (0.65, 1.18)	1.24 (0.98, 1.56)	1.05 (0.76, 1.45)	1.09 (0.91, 1.30)	1.50 (1.07, 2.09)
OC	1.5	--	1.14 (0.96, 1.35)	0.98 (0.70, 1.36)	1.26 (0.97, 1.64)	1.07 (0.86, 1.34)	1.17 (0.88, 1.57)	1.08 (0.91, 1.29)	0.97 (0.68, 1.39)
SO_4	2.0	1.10 (1.03, 1.17)	--	--	--	--	--	--	--
Si	0.09	--	--	--	--	--	--	1.18 (1.00, 1.38)	1.02 (0.72, 1.43)

1 units are expressed in $\mu g/m^3$
2 MI, coronary revascularization, stroke, atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
3 Atherosclerotic cardiac disease death, possible CHD death, and cerebrovascular death
4 All estimates adjusted for age, ethnicity, education, household income, smoking, diabetes, hypertension, systolic blood pressure, BMI, and hypercholesterolemia.
5 Model includes EC and Sulfate
6 Model includes EC and OC
7 Model includes EC, OC, and Silicon