Environ Health Perspect

DOI: 10.1289/EHP2182

Supplemental Material

Estimating Acute Cardiovascular Effects of Ambient $PM_{2.5}$ Metals

Dongni Ye, Mitchel Klein, James A. Mulholland, Armistead G. Russell, Rodney Weber, Eric S. Edgerton, Howard H. Chang, Jeremy A. Sarnat, Paige E. Tolbert, and Stefanie Ebelt Sarnat

Table of Contents

Figure S4. Estimated associations between cardiovascular ED visits and pollutants available during 1998-2013, warm-season analysis including all days with data available for each pollutant.

Figure S5. Estimated associations between cardiovascular ED visits and pollutants available during 1998-2013, cold-season analysis including all days with data available for each pollutant.

Figure S6. Estimated associations between cardiovascular ED visits and pollutants only available during 2008-2013 and water-soluble Fe during 2008-2013, year-round analysis including all days with data available for each pollutant.

Table S1. Limits of detection (LOD) in ng/m^3 of $PM_{2.5}$ trace components measured at the Atlanta Jefferson Street monitoring site, and % of measurements below LOD, during 1998-2008 and 2008-2013.[a]

POLLUTANTS	Measurement Period	Time Period in Health Analysis	LOD 1998-2008	LOD 2008-2013	%<LOD 1998-2008	%<LOD 2008-2013	%<LOD 1998-2013
Na	2008-2013	2008-2013	n/a	4.0	n/a	5	5
Al	1998-2013	2008-2013	6.4	6.0	26	7	19
Si	1998-2013	1998-2013	3.7	5.7	<1	2	1
S	1998-2013	1998-2013	1.0	1.5	0	0	0
K	1998-2013	1998-2013	0.8	0.7	<1	<1	<1
Ca	1998-2013	1998-2013	8.6	3.7	3	1	2
Ti	1998-2013	2008-2013	4.3	0.3	77	2	47
Mn	1998-2013	excluded	0.8	1.2	41	31	37
Fe	1998-2013	1998-2013	4.9	1.4	<1	<1	<1
Cu	1998-2013	2008-2013	1.2	1.6	49	12	34
Zn	1998-2013	1998-2013	0.8	0.7	<1	1	1
Pb	1998-2013	excluded	2.3	1.9	55	38	48
water-soluble V	1998-2013	2008-2013	0.58	0.005	95	<1	77
water-soluble Cr	1998-2013	2008-2013	1.04	0.014	87	1	70
water-soluble Mn	1998-2013	2008-2013	0.29	0.023	65	0	50

POLLUTANTS	Measurement Period	Time Period in Health Analysis	LOD 1998-2008	LOD 2008-2013	%<LOD 1998-2008	%<LOD 2008-2013	%<LOD 1998-2013
water-soluble Ni	1998-2013	2008-2013	1.04	0.046	97	7	79
water-soluble Fe	1998-2013	1998-2013	2.63	0.698	1	<1	1
water-soluble Cu	1998-2013	2008-2013	0.79	0.741	53	12	45
water-soluble Zn	2008-2013	2008-2013	n/a	0.617	n/a	0	0
water-soluble As	2008-2013	2008-2013	n/a	0.026	n/a	<1	<1
water-soluble Se	2008-2013	2008-2013	n/a	0.024	n/a	0	0
water-soluble Cd	2008-2013	2008-2013	n/a	0.004	n/a	<1	<1
water-soluble Ba	2008-2013	2008-2013	n/a	0.118	n/a	0	0
water-soluble La	2008-2013	excluded	n/a	0.007	n/a	51	51
water-soluble Pb	2008-2013	2008-2013	n/a	0.025	n/a	0	0

[a] Total elemental concentrations of $PM_{2.5}$ metals/metalloids, including titanium (Ti), manganese (Mn), iron (Fe), cupper (Cu), zinc (Zn), aluminum (Al), lead (Pb), silicon (Si), calcium (Ca), sodium (Na), and potassium (K), were analyzed from the daily $PM_{2.5}$ filters using X-ray fluorescence. X-ray fluorescence analyses were conducted by Desert Research Institute on filters collected through 3/22/2008, and by Atmospheric Research & Analysis Inc. on filters collected after 3/23/2008; different limits of detection (LOD) were reported before and after the laboratory change for each species. Water-soluble concentrations of $PM_{2.5}$ metals/metalloids, including water-soluble vanadium (WS V), water-soluble chromium (WS Cr), water-soluble manganese (WS Mn), water-soluble iron (WS Fe), water-soluble nickel (WS Ni), and water-soluble cupper (WS Cu), were analyzed using inductive-coupled plasma optical emission

spectrometry (ICP-OES) during 8/14/1998 – 4/6/2008. Starting from 4/7/2008, these water-soluble fractions were analyzed using inductive-coupled plasma mass spectrometry (ICP-MS); again, different LODs were reported before and after the analytical change for these species. Additional water-soluble species, including water-soluble zinc (WS Zn), water-soluble cadmium (WS Cd), water-soluble lead (WS Pb), water-soluble selenium (WS Se), water-soluble arsenic (WS As), water-soluble barium (WS Ba), and water-soluble lanthanum (WS La), were reported starting in 4/7/2008 from ICP-MS analyses. All water-soluble measures were available daily before 2009 and one-in-three day after 2009.

Table S2a. Summary statistics of ambient air pollutants measured at the Atlanta Jefferson Street monitoring site during the warm season (May - October), 1998-2013 and 2008-2013.

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
		8/14/1998 – 12/15/2013		
Criteria gases				
CO	ppm	2755	0.74 (0.66)	0.53 (0.35, 0.88)
NO_2	ppb	2738	36.5 (15.9)	34.6 (25.3, 45.9)
SO_2	ppb	2771	11.7 (13.3)	6.6 (2.6, 16.2)
O_3	ppb	2786	52.0 (19.7)	51.5 (37.9, 64.6)
$PM_{2.5}$				
$PM_{2.5}$	$\mu g/m^3$	2839	16.11 (8.24)	14.64 (10.00, 20.56)
OC	$\mu g/m^3$	2820	3.63 (1.79)	3.28 (2.42, 4.39)
EC	$\mu g/m^3$	2811	1.27 (0.92)	1.01 (0.66, 1.59)
NH_4	$\mu g/m^3$	2831	1.69 (1.18)	1.37 (0.83, 2.22)
NO_3	$\mu g/m^3$	2831	0.47 (0.36)	0.36 (0.24, 0.58)
SO_4	$\mu g/m^3$	2835	5.03 (3.47)	4.10 (2.48, 6.56)

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
Si	ng/m^3	2564	116.76 (135.99)	82.15 (50.50, 132.36)
K	ng/m^3	2564	62.44 (101.37)	47.38 (34.34, 68.10)
Ca	ng/m^3	2564	39.29 (31.78)	31.57 (20.45, 48.24)
Fe	ng/m^3	2556	82.46 (59.67)	67.29 (45.54, 99.69)
Zn	ng/m^3	2525	9.76 (8.66)	7.87 (5.07, 11.64)
water-soluble Fe	ng/m^3	2104	31.72 (23.64)	25.83 (16.36, 40.63)
		4/7/2008 – 12/15/2013		
Na	ng/m^3	1050	36.34 (32.06)	26.76 (15.58, 45.38)
Al	ng/m^3	1051	57.44 (73.83)	39.46 (22.42, 65.77)
Ti	ng/m^3	1051	5.25 (4.59)	4.12 (2.82, 6.20)
Cu	ng/m^3	1045	5.04 (5.50)	3.96 (2.68, 5.67)
water-soluble V	ng/m^3	463	0.20 (0.17)	0.15 (0.09, 0.28)
water-soluble Cr	ng/m^3	463	0.15 (0.21)	0.11 (0.07, 0.16)
water-soluble Mn	ng/m^3	463	1.31 (0.92)	1.08 (0.66, 1.70)

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
water-soluble Ni	ng/m^3	463	0.34 (0.69)	0.17 (0.11, 0.27)
water-soluble Cu	ng/m^3	457	2.83 (3.27)	2.04 (1.31, 3.22)
water-soluble Zn	ng/m^3	368	8.73 (5.90)	7.14 (4.59, 11.16)
water-soluble As	ng/m^3	463	0.62 (0.40)	0.54 (0.37, 0.74)
water-soluble Se	ng/m^3	463	0.75 (0.61)	0.60 (0.39, 0.94)
water-soluble Cd	ng/m^3	463	0.06 (0.05)	0.05 (0.03, 0.07)
water-soluble Ba	ng/m^3	463	3.24 (3.37)	2.61 (1.60, 4.34)
water-soluble Pb	ng/m^3	462	1.22 (1.25)	0.89 (0.59, 1.39)

Table S2b. Summary statistics of ambient air pollutants measured at the Atlanta Jefferson Street monitoring site during the cold season (November - April), 1998-2013 and 2008-2013.

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
		8/14/1998 – 12/15/2013		
Criteria gases				
CO	ppm	2703	0.97 (0.97)	0.61 (0.37, 1.19)
NO_2	ppb	2583	37.9 (14.4)	37.4 (27.7, 46.9)
SO_2	ppb	2694	15.2 (15.8)	9.9 (4.0, 21.0)
O_3	ppb	2704	31.9 (14.0)	30.4 (22.0, 40.6)
$PM_{2.5}$				
$PM_{2.5}$	$\mu g/m^3$	2749	12.77 (6.67)	11.39 (8.14, 15.93)
OC	$\mu g/m^3$	2726	3.72 (2.34)	3.15 (2.18, 4.57)
EC	$\mu g/m^3$	2704	1.26 (1.03)	0.96 (0.59, 1.56)
NH_4	$\mu g/m^3$	2732	1.07 (0.62)	0.93 (0.64, 1.34)
NO_3	$\mu g/m^3$	2738	1.17 (0.90)	0.93 (0.52, 1.57)
SO_4	$\mu g/m^3$	2737	2.68 (1.60)	2.3 (1.58, 3.35)

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
Si	ng/m^3	2368	70.42 (71.86)	54.17 (32.42, 88.58)
K	ng/m^3	2368	65.22 (59.40)	55.67 (36.69, 82.00)
Ca	ng/m^3	2368	33.32 (26.96)	26.77 (16.55, 41.08)
Fe	ng/m^3	2365	70.07 (58.41)	52.65 (34.40, 87.60)
Zn	ng/m^3	2355	13.06 (13.13)	10.11 (6.58, 15.33)
water-soluble Fe	ng/m^3	1981	16.25 (12.68)	13.31 (8.02, 20.29)
		4/7/2008 – 12/15/2013		
Na	ng/m^3	880	41.85 (46.32)	25.27 (13.98, 49.00)
Al	ng/m^3	880	32.25 (30.23)	24.85 (12.98, 45.46)
Ti	ng/m^3	880	3.54 (2.61)	3.05 (1.91, 4.45)
Cu	ng/m^3	871	5.65 (14.20)	3.51 (2.23, 5.68)
water-soluble V	ng/m^3	342	0.19 (0.21)	0.11 (0.06, 0.25)
water-soluble Cr	ng/m^3	342	0.11 (0.10)	0.08 (0.05, 0.14)
water-soluble Mn	ng/m^3	333	1.04 (1.03)	0.76 (0.47, 1.29)

POLLUTANTS	UNIT	N	MEAN (SD)	50^{th} (25^{th}, 75^{th}) PERCENTILES
water-soluble Ni	ng/m^3	342	0.25 (0.67)	0.13 (0.07, 0.22)
water-soluble Cu	ng/m^3	333	2.83 (5.89)	1.49 (0.85, 2.85)
water-soluble Zn	ng/m^3	314	9.30 (6.40)	7.60 (4.96, 11.15)
water-soluble As	ng/m^3	342	0.76 (0.65)	0.60 (0.34, 0.93)
water-soluble Se	ng/m^3	342	0.66 (0.55)	0.47 (0.29, 0.85)
water-soluble Cd	ng/m^3	342	0.10 (0.10)	0.08 (0.05, 0.12)
water-soluble Ba	ng/m^3	342	3.00 (3.00)	2.12 (1.12, 3.83)
water-soluble Pb	ng/m^3	341	1.62 (4.33)	0.84 (0.54, 1.45)

Table S3. Year-round Pearson correlations among pollutants, 1998-2013 and 2008-2013.

1998-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
CO	1.00														
NO_2	0.55	1.00													
SO_2	0.32	0.30	1.00												
O_3	0.01	0.33	-0.04	1.00											
$PM_{2.5}$	0.47	0.50	0.24	0.44	1.00										
OC	0.64	0.53	0.21	0.22	0.74	1.00									
EC	0.73	0.58	0.28	0.12	0.67	0.79	1.00								
NO_3	0.26	0.18	0.21	-0.37	0.24	0.26	0.27	1.00							
SO_4	0.14	0.30	0.16	0.55	0.80	0.34	0.34	0.01	1.00						
Si	0.12	0.15	0.08	0.22	0.23	0.17	0.19	-0.11	0.13	1.00					
K	0.17	0.15	0.03	0.09	0.25	0.28	0.20	0.07	0.08	0.21	1.00				
Ca	0.38	0.43	0.28	0.27	0.44	0.38	0.47	0.08	0.28	0.62	0.20	1.00			
Fe	0.48	0.43	0.17	0.21	0.47	0.49	0.58	0.07	0.19	0.69	0.26	0.66	1.00		
Zn	0.49	0.33	0.20	-0.03	0.38	0.45	0.50	0.28	0.10	0.11	0.18	0.34	0.42	1.00	
WS Fe	0.27	0.37	0.13	0.46	0.65	0.39	0.48	-0.05	0.61	0.48	0.18	0.47	0.64	0.16	1.00

2008-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
Na	-0.03	-0.06	-0.12	-0.06	0.08	0.11	0.02	-0.09	-0.01	0.20	0.15	0.16	0.10	0.06	0.01
Al	-0.03	-0.02	-0.05	0.15	0.17	0.07	0.05	-0.16	0.06	0.94	0.26	0.59	0.53	-0.02	0.31
Ti	0.15	0.17	0.10	0.22	0.32	0.24	0.27	-0.10	0.16	0.87	0.28	0.70	0.70	0.18	0.43
Cu	0.26	0.24	0.07	0.07	0.21	0.25	0.27	0.06	0.05	0.09	0.23	0.21	0.26	0.21	0.23
WS V	-0.10	-0.11	-0.05	-0.01	0.21	0.10	-0.03	-0.09	0.25	0.23	0.15	0.14	0.07	0.00	0.17
WS Cr	0.21	0.17	0.02	0.16	0.26	0.21	0.25	-0.02	0.16	0.12	0.19	0.18	0.24	0.21	0.34
WS Mn	0.33	0.35	0.12	0.26	0.45	0.36	0.49	-0.05	0.28	0.31	0.31	0.41	0.60	0.39	0.52
WS Ni	0.01	-0.01	0.04	0.09	0.02	0.03	0.06	-0.08	0.02	0.04	0.07	0.01	0.06	0.03	0.07
WS Cu	0.27	0.26	0.07	0.10	0.24	0.27	0.30	0.01	0.09	0.06	0.24	0.15	0.26	0.22	0.27
WS Zn	0.51	0.45	0.13	0.07	0.44	0.45	0.58	0.18	0.24	0.05	0.19	0.27	0.39	0.80	0.37
WS As	0.50	0.30	0.07	-0.05	0.28	0.40	0.47	0.23	0.01	0.00	0.12	0.11	0.29	0.29	0.20
WS Se	0.16	0.24	0.42	0.13	0.46	0.27	0.26	0.14	0.46	0.07	0.08	0.26	0.20	0.18	0.41
WS Cd	0.48	0.34	0.16	-0.08	0.31	0.45	0.47	0.30	0.04	0.00	0.16	0.18	0.32	0.47	0.21
WS Ba	0.42	0.39	0.16	0.23	0.36	0.38	0.50	0.05	0.18	0.17	0.72	0.30	0.49	0.33	0.39
WS Pb	0.25	0.17	0.06	0.04	0.19	0.23	0.19	0.07	0.06	0.00	0.12	0.07	0.10	0.22	0.13

2008-2013	Na	Al	Ti	Cu	WS V	WS Cr	WS Mn	WS Ni	WS Cu	WS Zn	WS As	WS Se	WS Cd	WS Ba	WS Pb
Na	1.00														
Al	0.21	1.00													
Ti	0.19	0.83	1.00												
Cu	0.00	0.06	0.17	1.00											
WS V	0.48	0.21	0.21	-0.03	1.00										
WS Cr	0.04	0.11	0.15	0.17	0.09	1.00									
WS Mn	0.11	0.28	0.43	0.20	0.08	0.25	1.00								
WS Ni	0.13	0.05	0.08	0.04	0.09	0.04	0.16	1.00							
WS Cu	-0.03	0.05	0.12	0.92	-0.01	0.22	0.21	0.09	1.00						
WS Zn	-0.05	0.01	0.16	0.28	-0.02	0.29	0.40	0.00	0.28	1.00					
WS As	-0.07	-0.01	0.04	0.24	-0.07	0.17	0.13	-0.09	0.21	0.42	1.00				
WS Se	-0.01	0.01	0.10	0.10	0.15	0.18	0.11	-0.02	0.13	0.25	0.29	1.00			
WS Cd	0.02	-0.02	0.06	0.41	-0.04	0.14	0.19	-0.05	0.36	0.52	0.52	0.38	1.00		
WS Ba	0.02	0.19	0.31	0.34	-0.08	0.22	0.56	0.15	0.34	0.36	0.21	0.12	0.24	1.00	
WS Pb	-0.02	0.01	0.04	0.71	0.02	0.10	0.05	-0.01	0.73	0.26	0.27	0.18	0.39	0.15	1.00

Table S4a. Pearson correlations among pollutants during the warm season (May - October), 1998-2013 and 2008-2013.

1998-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
CO	1.00														
NO_2	0.60	1.00													
SO_2	0.28	0.29	1.00												
O_3	0.18	0.52	0.14	1.00											
$PM_{2.5}$	0.45	0.57	0.31	0.59	1.00										
OC	0.55	0.58	0.21	0.48	0.74	1.00									
EC	0.72	0.63	0.31	0.30	0.64	0.71	1.00								
NO_3	0.48	0.41	0.17	0.09	0.48	0.46	0.55	1.00							
SO_4	0.26	0.43	0.30	0.54	0.88	0.49	0.45	0.40	1.00						
Si	0.09	0.10	0.10	0.06	0.14	0.11	0.14	0.04	0.03	1.00					
K	0.09	0.10	0.02	0.11	0.16	0.16	0.09	0.09	0.07	0.19	1.00				
Ca	0.40	0.44	0.28	0.29	0.43	0.38	0.49	0.31	0.29	0.59	0.17	1.00			
Fe	0.44	0.40	0.20	0.22	0.38	0.39	0.54	0.26	0.18	0.76	0.20	0.70	1.00		
Zn	0.46	0.37	0.22	0.17	0.39	0.39	0.51	0.34	0.24	0.10	0.13	0.40	0.39	1.00	
WS Fe	0.36	0.44	0.24	0.39	0.64	0.48	0.58	0.28	0.56	0.45	0.18	0.50	0.66	0.27	1.00

2008-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
Na	-0.12	-0.12	-0.11	-0.14	-0.02	-0.04	-0.09	-0.06	-0.06	0.32	0.13	0.20	0.17	-0.03	0.05
Al	-0.08	-0.07	-0.04	-0.02	0.11	0.01	-0.01	-0.02	-0.03	0.96	0.25	0.60	0.68	-0.03	0.30
Ti	0.07	0.11	0.07	0.10	0.25	0.15	0.18	0.07	0.09	0.90	0.26	0.71	0.79	0.13	0.39
Cu	0.30	0.28	0.04	0.20	0.26	0.29	0.31	0.18	0.14	0.09	0.50	0.28	0.27	0.19	0.30
WS V	-0.13	-0.12	-0.01	-0.09	0.21	0.08	-0.07	-0.01	0.21	0.33	0.12	0.20	0.19	0.01	0.22
WS Cr	0.25	0.18	0.00	0.12	0.21	0.16	0.21	0.17	0.11	0.09	0.17	0.15	0.20	0.17	0.26
WS Mn	0.31	0.40	0.12	0.29	0.46	0.38	0.43	0.21	0.31	0.36	0.33	0.53	0.58	0.38	0.53
WS Ni	0.01	-0.01	0.08	0.07	0.00	0.02	0.03	0.01	0.01	0.04	0.07	0.00	0.02	0.02	0.02
WS Cu	0.32	0.32	0.07	0.19	0.25	0.22	0.32	0.19	0.14	0.09	0.39	0.23	0.30	0.15	0.34
WS Zn	0.40	0.43	0.11	0.17	0.41	0.31	0.49	0.32	0.38	0.03	0.11	0.32	0.31	0.77	0.39
WS As	0.39	0.20	0.01	-0.01	0.18	0.21	0.40	0.27	0.05	-0.03	0.01	0.04	0.18	0.08	0.19
WS Se	0.20	0.27	0.43	0.19	0.47	0.25	0.27	0.21	0.48	0.05	0.05	0.26	0.18	0.14	0.40
WS Cd	0.48	0.41	0.09	0.07	0.28	0.30	0.45	0.36	0.16	0.02	0.12	0.24	0.31	0.34	0.26
WS Ba	0.35	0.33	0.09	0.30	0.33	0.37	0.42	0.28	0.20	0.18	0.83	0.33	0.38	0.21	0.34
WS Pb	0.31	0.32	0.09	0.19	0.27	0.15	0.24	0.24	0.21	0.01	0.17	0.19	0.21	0.18	0.32

2008-2013	Na	Al	Ti	Cu	WS V	WS Cr	WS Mn	WS Ni	WS Cu	WS Zn	WS As	WS Se	WS Cd	WS Ba	WS Pb
Na	1.00														
Al	0.32	1.00													
Ti	0.30	0.87	1.00												
Cu	0.02	0.09	0.16	1.00											
WS V	0.50	0.30	0.32	-0.02	1.00										
WS Cr	0.02	0.08	0.10	0.29	0.06	1.00									
WS Mn	0.09	0.32	0.43	0.30	0.09	0.22	1.00								
WS Ni	0.14	0.05	0.07	-0.01	0.08	0.02	0.12	1.00							
WS Cu	0.00	0.08	0.14	0.83	0.03	0.38	0.30	0.08	1.00						
WS Zn	-0.09	-0.01	0.10	0.24	-0.06	0.26	0.45	0.00	0.34	1.00					
WS As	-0.20	-0.02	0.00	0.10	-0.15	0.18	0.05	-0.15	0.07	0.20	1.00				
WS Se	-0.07	0.00	0.08	0.03	0.17	0.15	0.13	-0.03	0.08	0.20	0.36	1.00			
WS Cd	-0.12	-0.01	0.06	0.21	-0.07	0.20	0.31	-0.04	0.22	0.48	0.56	0.47	1.00		
WS Ba	0.07	0.22	0.28	0.50	-0.06	0.18	0.47	0.14	0.47	0.30	0.13	0.09	0.25	1.00	
WS Pb	-0.06	-0.01	0.08	0.60	0.02	0.23	0.21	0.03	0.64	0.24	0.17	0.21	0.37	0.25	1.00

Table S4b. Pearson correlations among pollutants during the cold season (November - April), 1998-2013 and 2008-2013.

1998-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
CO	1.00														
NO2	0.54	1.00													
SO2	0.33	0.31	1.00												
O3	0.01	0.24	-0.12	1.00											
PM25	0.61	0.47	0.24	0.04	1.00										
OC	0.70	0.50	0.21	0.06	0.82	1.00									
EC	0.75	0.54	0.27	-0.06	0.75	0.86	1.00								
NO3	0.16	0.12	0.19	-0.40	0.42	0.24	0.24	1.00							
SO4	0.24	0.22	0.18	0.16	0.65	0.34	0.30	0.24	1.00						
Si	0.30	0.33	0.12	0.35	0.35	0.32	0.33	-0.08	0.17	1.00					
K	0.32	0.26	0.04	0.10	0.49	0.49	0.40	0.09	0.18	0.31	1.00				
Ca	0.42	0.44	0.31	0.17	0.43	0.40	0.45	0.07	0.21	0.74	0.28	1.00			
Fe	0.57	0.49	0.16	0.14	0.57	0.59	0.63	0.09	0.15	0.61	0.42	0.60	1.00		
Zn	0.49	0.32	0.18	-0.07	0.50	0.50	0.53	0.21	0.15	0.25	0.30	0.36	0.50	1.00	
WS Fe	0.44	0.39	0.14	0.18	0.60	0.49	0.52	0.11	0.47	0.44	0.29	0.40	0.67	0.28	1.00

2008-2013	CO	NO_2	SO_2	O_3	$PM_{2.5}$	OC	EC	NO_3	SO_4	Si	K	Ca	Fe	Zn	WS Fe
Na	-0.01	-0.03	-0.13	0.09	0.21	0.21	0.10	-0.17	0.14	0.14	0.34	0.15	0.06	0.10	0.05
Al	0.16	0.22	-0.10	0.41	0.25	0.22	0.19	-0.16	0.07	0.86	0.42	0.71	0.44	0.12	0.16
Ti	0.41	0.44	0.17	0.27	0.43	0.42	0.47	-0.01	0.13	0.72	0.50	0.76	0.71	0.43	0.40
Cu	0.26	0.25	0.10	0.06	0.24	0.26	0.28	0.04	0.04	0.15	0.19	0.21	0.27	0.23	0.23
WS V	-0.08	-0.10	-0.10	0.07	0.23	0.11	0.00	-0.12	0.40	0.07	0.26	0.07	-0.06	0.00	0.11
WS Cr	0.34	0.22	0.04	0.10	0.38	0.38	0.40	0.03	0.20	0.13	0.36	0.22	0.37	0.45	0.56
WS Mn	0.42	0.32	0.12	0.11	0.40	0.35	0.55	-0.03	0.16	0.18	0.38	0.25	0.62	0.44	0.48
WS Ni	0.03	0.01	-0.04	0.05	0.03	0.03	0.09	-0.09	-0.03	0.01	0.08	0.01	0.09	0.05	0.11
WS Cu	0.26	0.24	0.07	0.06	0.28	0.30	0.29	-0.01	0.08	0.03	0.16	0.11	0.24	0.29	0.27
WS Zn	0.59	0.48	0.17	0.01	0.53	0.56	0.67	0.19	0.13	0.12	0.47	0.23	0.50	0.83	0.43
WS As	0.54	0.39	0.15	0.04	0.49	0.52	0.52	0.20	0.09	0.12	0.43	0.22	0.41	0.44	0.35
WS Se	0.17	0.22	0.40	-0.04	0.43	0.32	0.27	0.28	0.47	0.05	0.19	0.24	0.21	0.28	0.40
WS Cd	0.45	0.31	0.26	0.01	0.53	0.55	0.53	0.21	0.18	0.11	0.38	0.24	0.40	0.56	0.41
WS Ba	0.56	0.51	0.28	0.07	0.41	0.42	0.62	0.08	0.09	0.11	0.48	0.24	0.64	0.51	0.48
WS Pb	0.23	0.15	0.07	0.05	0.24	0.27	0.19	0.03	0.07	0.02	0.21	0.06	0.10	0.27	0.14

2008-2013	Na	Al	Ti	Cu	WS V	WS Cr	WS Mn	WS Ni	WS Cu	WS Zn	WS As	WS Se	WS Cd	WS Ba	WS Pb
Na	1.00														
Al	0.20	1.00													
Ti	0.13	0.62	1.00												
Cu	-0.01	0.12	0.30	1.00											
WS V	0.49	0.08	0.04	-0.04	1.00										
WS Cr	0.15	0.11	0.26	0.08	0.17	1.00									
WS Mn	0.15	0.17	0.46	0.14	0.06	0.37	1.00								
WS Ni	0.14	0.01	0.07	0.07	0.11	0.06	0.20	1.00							
WS Cu	-0.04	0.04	0.13	0.95	-0.03	0.11	0.16	0.10	1.00						
WS Zn	-0.03	0.11	0.34	0.32	0.01	0.46	0.36	0.00	0.27	1.00					
WS As	-0.02	0.13	0.21	0.31	-0.02	0.30	0.23	-0.04	0.27	0.57	1.00				
WS Se	0.07	-0.03	0.10	0.17	0.13	0.28	0.07	0.00	0.20	0.32	0.29	1.00			
WS Cd	0.04	0.14	0.25	0.51	-0.01	0.27	0.20	-0.04	0.43	0.58	0.49	0.43	1.00		
WS Ba	-0.02	0.11	0.40	0.25	-0.11	0.35	0.67	0.18	0.27	0.46	0.33	0.15	0.31	1.00	
WS Pb	-0.02	0.09	0.08	0.76	0.03	0.11	0.01	-0.01	0.78	0.31	0.30	0.23	0.40	0.15	1.00

Figure S1. Estimated associations between cardiovascular ED visits and tomorrow's pollutant levels, 1998-2013 year-round analysis (3303 days).

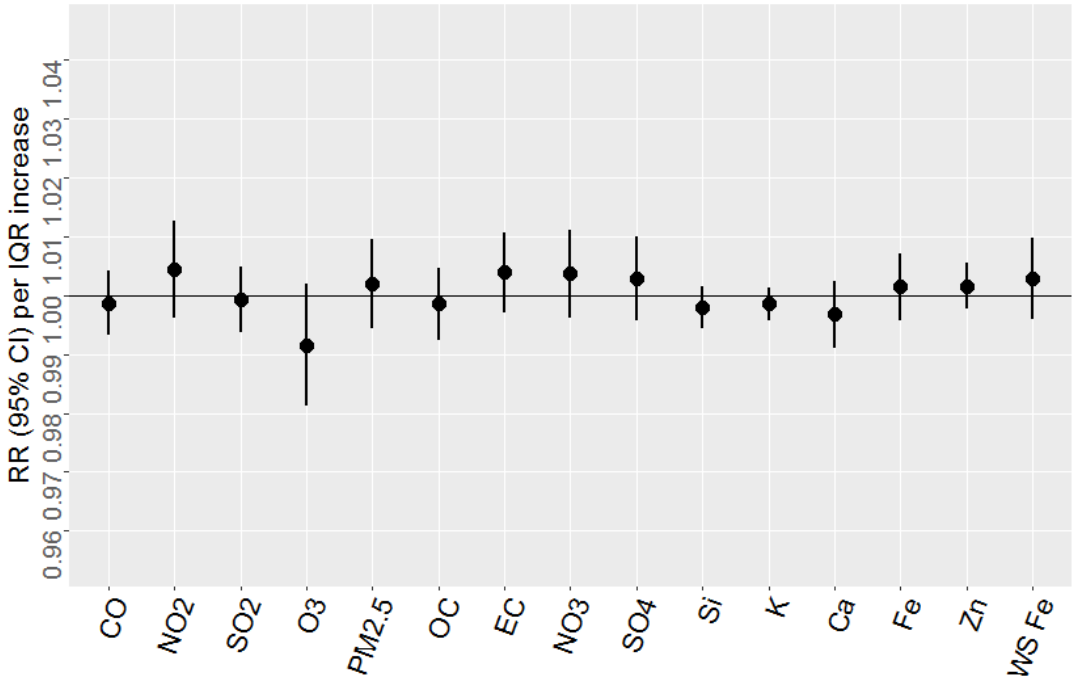


Figure S2. Estimated associations between cardiovascular ED visits and tomorrow's pollutant levels, 2008-2013 year-round analysis (628 days).

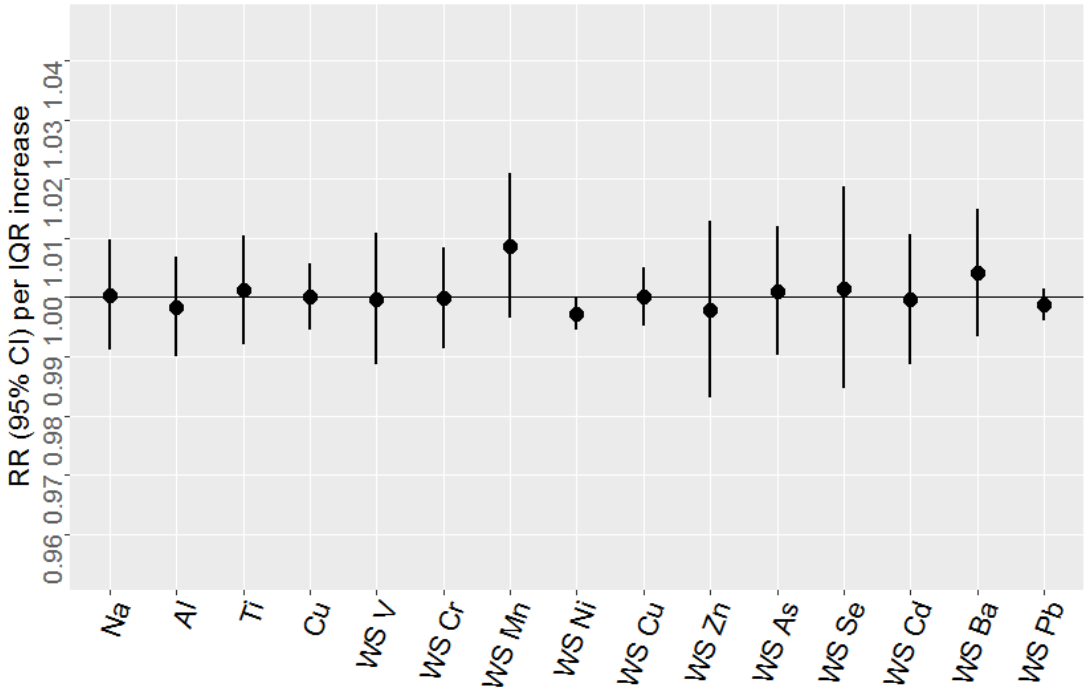
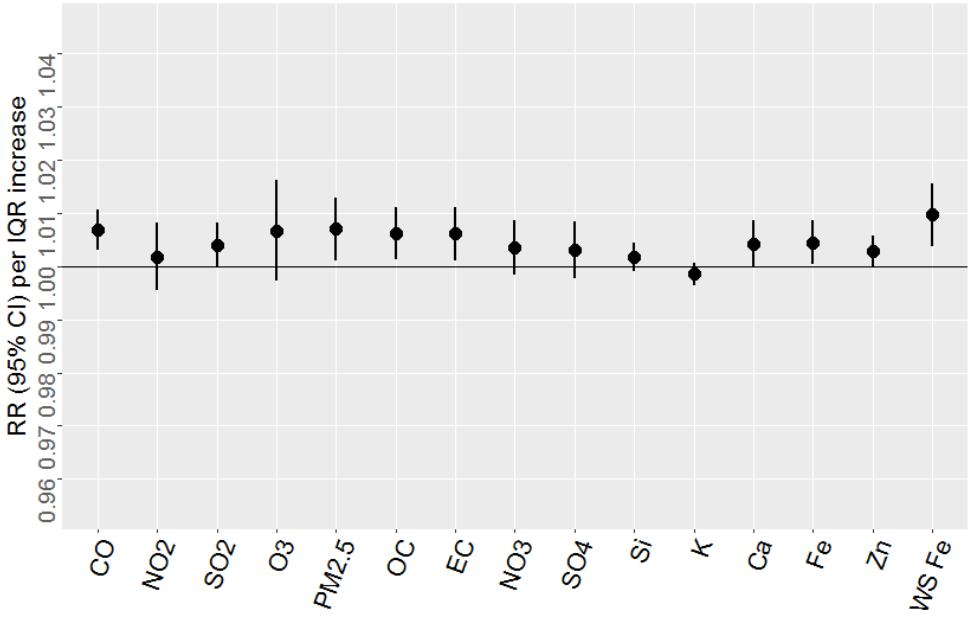


Figure S3. Estimated associations between cardiovascular ED visits and pollutants available during 1998-2013, year-round analysis including all days with data available for each pollutant.

a) Results from single-pollutant models



b) Results from two-pollutant models: water-soluble Fe controlling for each of the other pollutants

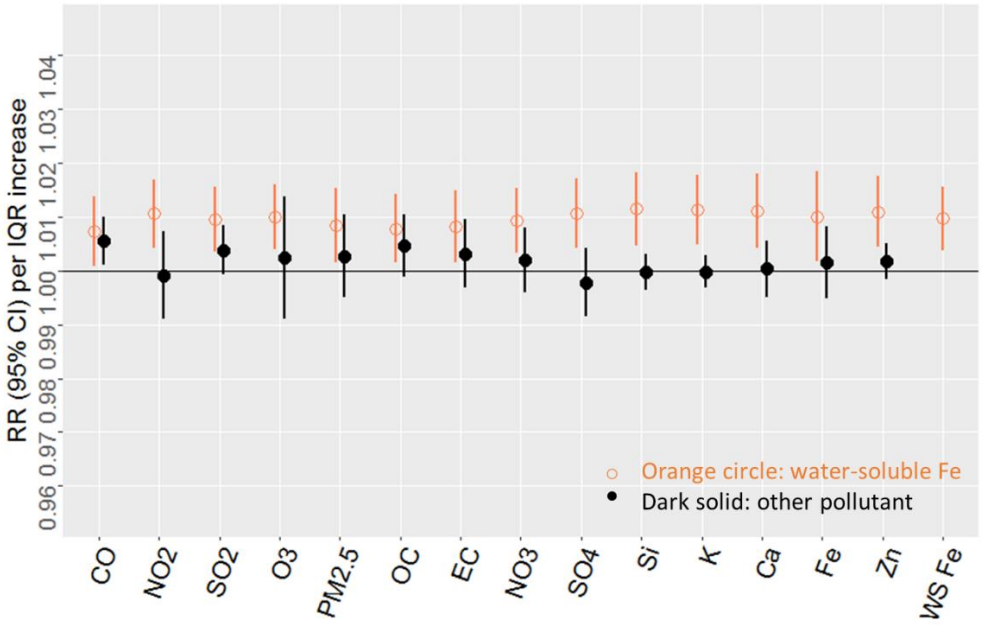
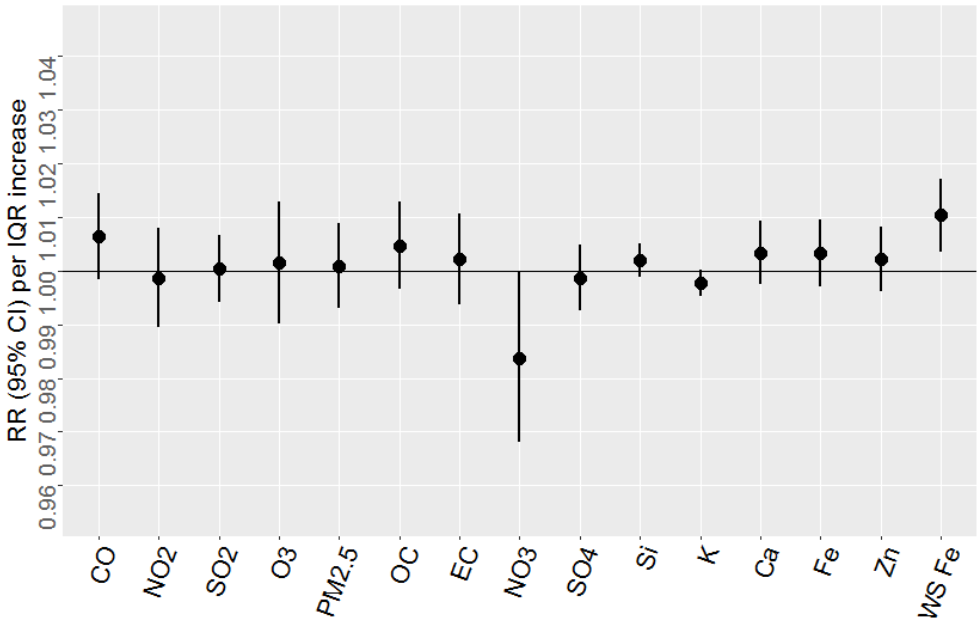


Figure S4. Estimated associations between cardiovascular ED visits and pollutants available during 1998-2013, warm-season analysis including all days with data available for each pollutant.

a) Results from single-pollutant models



b) Results from two-pollutant models: water-soluble Fe controlling for each of the other pollutants

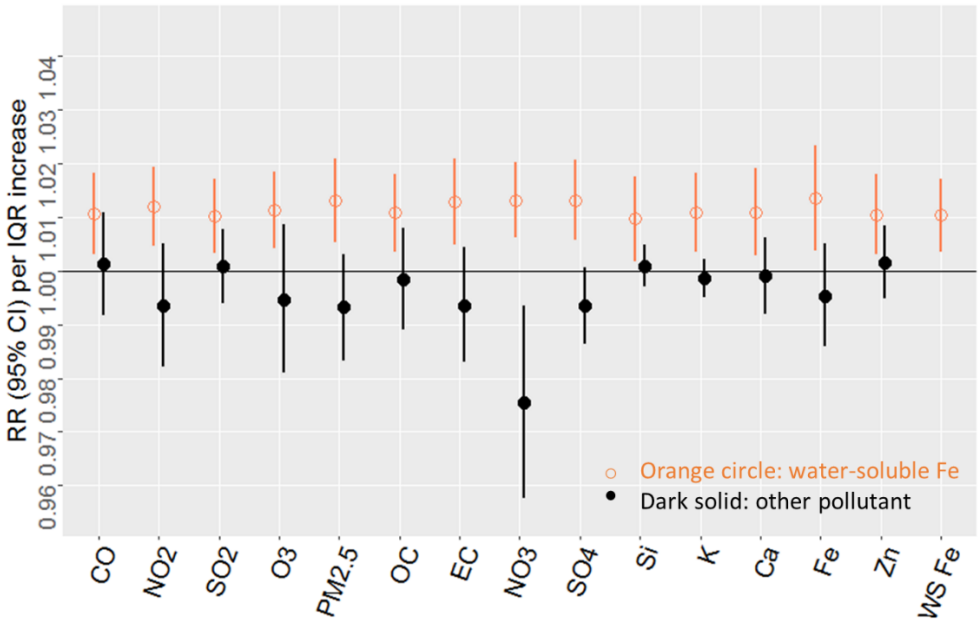
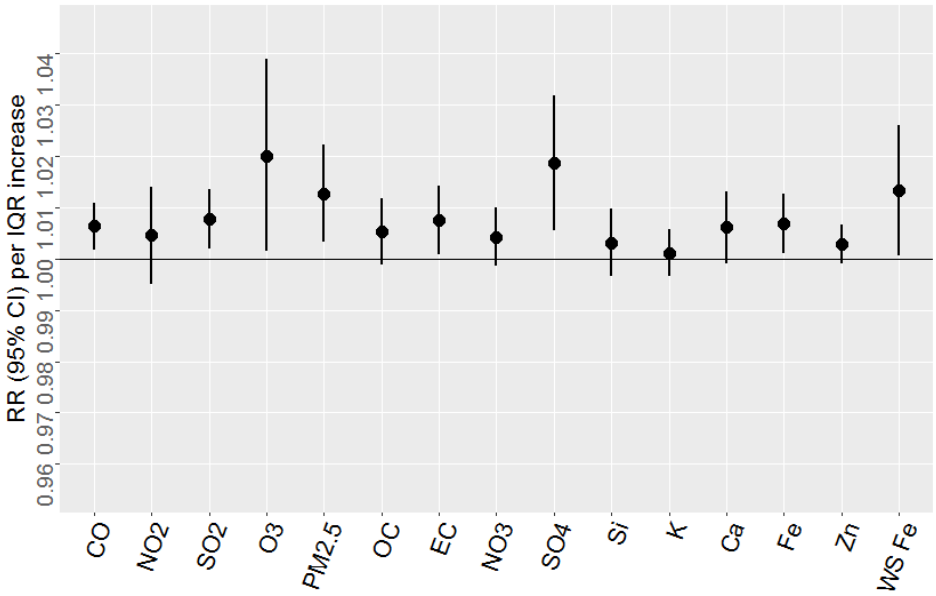


Figure S5. Estimated associations between cardiovascular ED visits and pollutants available during 1998-2013, cold-season analysis including all days with data available for each pollutant.

a) Results from single-pollutant models



b) Results from two-pollutant models: water-soluble Fe controlling for each of the other pollutants

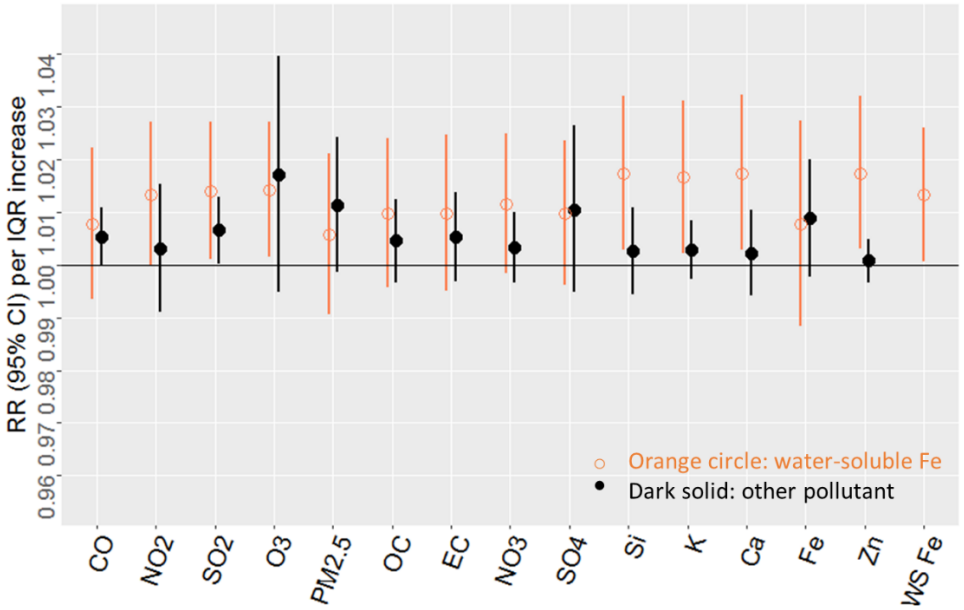
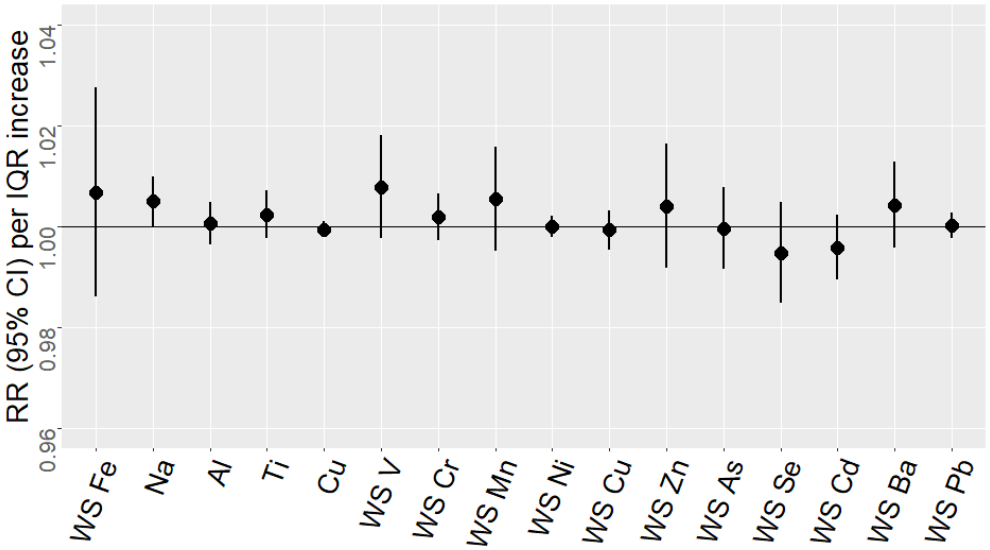


Figure S6. Estimated associations between cardiovascular ED visits and pollutants only available during 2008-2013 and water-soluble Fe during 2008-2013, year-round analysis including all days with data available for each pollutant.

a) Results from single-pollutant models



b) Results from two-pollutant models: water-soluble Fe controlling for each of the other pollutants