

Supplemental Material for

Neurodegenerative hospital admissions and long-term exposure to ambient fine particle air pollution

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Supplemental Table S1. Fifteen most common comorbidities (ICD-9 codes) for primary hospital admissions for primary diagnosis of selected neurological diseases, by study site, 2005-2016

	Albany		Buffalo		Rochester		Bronx		Manhattan		Queens	
	N	%	N	%	N	%	N	%	N	%	N	%
Essential hypertension (401)	1,031	49.8	2,042	51.3	1,314	49.0	8,808	50.3	10,299	51.3	8,907	52.5
Persistent mental disorders (294)	1,151	55.6	1,984	49.9	1,204	44.9	8,032	45.9	8,597	42.8	7,914	46.7
Disorders of lipoid metabolism (272)	678	32.8	1,193	30.0	837	31.2	4,118	23.5	4,686	23.3	4,183	24.7
Diabetes mellitus (250)	370	17.9	740	18.6	546	20.4	3,975	22.7	4,433	22.1	3,619	21.3
Ischemic heart disease, other (414)	373	18.0	860	21.6	528	19.7	2,704	15.4	3,937	19.6	3,249	19.2
Disorders of fluid, electrolyte, and acid-based balance (276)	595	28.8	911	22.9	588	21.9	2,862	16.3	3,335	16.6	2,924	17.2
General symptoms (780)	312	15.1	737	18.5	358	13.4	2,398	13.7	2,535	12.6	2,481	14.6
Personal history presenting hazards to health, other (V15)	362	17.5	910	22.9	606	22.6	2,000	11.4	2,355	11.7	2,204	13.0
Cardiac dysrhythmias (427)	361	17.5	627	15.8	452	16.9	1,757	10.0	2,356	11.7	2,190	12.9
Post procedural states, other (V45)	259	12.5	582	14.6	407	15.2	1,752	10.0	2,306	11.5	2,427	14.3
Disorders of urethra and urinary tract (599)	316	15.3	604	15.2	355	13.2	1,938	11.1	2,207	11.0	1,873	11.0
Acquired hypothyroidism (244)	284	13.7	619	15.6	425	15.9	1,535	8.8	2,011	10.0	1,950	11.5

Symptoms involving nervous and musculoskeletal systems (781)	247	11.9	451	11.3	233	8.7	1,690	9.7	2,025	10.1	1,568	9.2
Personal history of certain other diseases (V12)	204	9.9	499	12.5	335	12.5	1,652	9.4	1,793	8.9	1,728	10.2
Depressive disorder, not elsewhere classified (311)	349	16.9	569	14.3	401	15.0	1,590	9.1	1,652	8.2	1,521	9.0

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Supplemental Table S2a. Correlation coefficients (p values) between PM_{2.5} and PM_{2.5} source concentration, lag 0-29, 2005-2016

	PM2.5	AS	AN	GAS	DIE	RD	BB	OP
	1.000	0.666	0.343	0.076	0.279	0.304	0.205	0.496
PM2.5	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		1.000	0.111	-0.145	0.205	0.182	0.041	0.372
AS		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			1.000	-0.385	-0.085	-0.120	0.376	-0.065
AN			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
				1.000	-0.019	0.115	-0.028	-0.018
GAS				(0.000)	(0.003)	(0.000)	(0.000)	(0.025)
					1.000	0.347	-0.153	0.082
DIE					(0.000)	(0.000)	(0.000)	(0.000)
						1.000	-0.268	0.240
RD						(0.000)	(0.000)	(0.000)
							1.000	-0.051
BB							(0.000)	(0.000)
								1.000
OP								(0.000)

Supplemental Table S2b. Correlation coefficients (p values) between PM_{2.5} and PM_{2.5} source concentration, lag 0-179, 2005-2016

	PM2.5	AS	AN	GAS	DIE	RD	BB	OP
	1.000	0.754	0.343	-0.194	0.526	0.509	0.021	0.522
PM2.5	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
		1.000	0.128	-0.290	0.353	0.243	0.031	0.422
AS		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			1.000	-0.450	-0.008	-0.127	0.450	-0.081
AN			(0.000)	(0.000)	(0.220)	(0.000)	(0.000)	(0.000)
				1.000	-0.085	0.039	-0.150	-0.175
GAS				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
					1.000	0.440	-0.108	0.105
DIE					(0.000)	(0.000)	(0.000)	(0.000)
						1.000	-0.408	0.428
RD						(0.000)	(0.000)	(0.000)
							1.000	-0.191
BB							(0.000)	(0.000)

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Supplemental Table S2c. Correlation coefficients (p values) between PM_{2.5} and PM_{2.5} source concentration, lag 0-364, 2005-2016

	PM2.5	AS	AN	GAS	DIE	RD	BB	OP
	1.000	0.818	0.394	-0.295	0.580	0.575	-0.078	0.554
PM2.5	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
		1.000	0.476	-0.513	0.417	0.279	0.124	0.416
AS		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
			1.000	-0.343	0.151	-0.181	0.466	-0.075
AN			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
				1.000	-0.222	-0.014	-0.132	-0.256
GAS				(0.000)	(0.000)	(0.038)	(0.000)	(0.000)
					1.000	0.460	-0.054	0.078
DIE					(0.000)	(0.000)	(0.000)	(0.000)
						1.000	-0.505	0.494
RD						(0.000)	(0.000)	(0.000)
							0.416	0.185
RS							(0.000)	(0.000)
							1.000	-0.315
BB							(0.000)	(0.000)
								1.000
OP								(0.000)

Supplemental Table S3. Rate ratio (95% confidence interval (CI)) of total and cause-specific neurological disease hospital admissions associated with each interquartile range (IQR) increase in PM_{2.5} concentration, by lag time and outcome, 2005-2016

Outcome/Lag	Albany	Bronx	Buffalo	Manhattan	Queens	Rochester
Total						
0	1.01 (0.95, 1.07)	1.01 (0.99, 1.03)	0.98 (0.94, 1.02)	0.99 (0.97, 1.01)	1.01 (0.99, 1.03)	1.02 (0.96, 1.07)
0-13	1.08 (0.98, 1.19)	1.01 (0.98, 1.05)	1.05 (0.98, 1.12)	1.01 (0.97, 1.04)	1.03 (1.00, 1.07)	0.99 (0.91, 1.08)
0-29	1.07 (0.94, 1.21)	1.00 (0.95, 1.05)	1.08 (0.98, 1.18)	1.04 (1.00, 1.09)	1.05 (1.00, 1.10)	0.98 (0.88, 1.10)
0-179	1.22 (0.73, 2.05)	0.88 (0.66, 1.16)	1.37 (0.98, 1.92)	0.97 (0.78, 1.21)	1.12 (0.91, 1.37)	1.27 (0.79, 2.04)
0-364	1.94 (0.73, 5.16)	1.05 (0.58, 1.90)	1.66 (0.90, 3.04)	1.16 (0.75, 1.81)	0.77 (0.49, 1.23)	1.13 (0.52, 2.48)
Alzheimer's disease						
0	0.98 (0.91, 1.06)	1.00 (0.97, 1.03)	0.99 (0.94, 1.05)	0.99 (0.96, 1.02)	1.01 (0.98, 1.03)	1.05 (0.98, 1.13)
0-13	1.11 (0.98, 1.25)	1.00 (0.95, 1.04)	1.10 (1.01, 1.20)	1.00 (0.95, 1.05)	1.01 (0.97, 1.06)	1.00 (0.90, 1.13)
0-29	1.13 (0.97, 1.33)	0.99 (0.93, 1.06)	1.13 (1.01, 1.27)	1.02 (0.96, 1.09)	1.01 (0.94, 1.08)	1.06 (0.91, 1.24)
0-179	1.17 (0.62, 2.19)	0.85 (0.59, 1.22)	1.40 (0.92, 2.13)	0.86 (0.65, 1.13)	1.13 (0.87, 1.46)	1.44 (0.75, 2.75)
0-364	1.66 (0.49, 5.56)	1.80 (0.82, 3.96)	2.00 (0.95, 4.23)	0.97 (0.54, 1.71)	0.83 (0.45, 1.52)	1.41 (0.48, 4.13)
Dementia						
0	1.04 (0.88, 1.23)	1.01 (0.97, 1.05)	0.98 (0.88, 1.10)	0.99 (0.95, 1.03)	1.01 (0.97, 1.06)	1.06 (0.96, 1.17)
0-13	1.00 (0.76, 1.33)	1.03 (0.97, 1.11)	0.96 (0.80, 1.15)	1.01 (0.95, 1.08)	1.01 (0.95, 1.08)	1.01 (0.86, 1.18)
0-29	0.88 (0.61, 1.28)	1.00 (0.91, 1.10)	0.97 (0.77, 1.24)	1.06 (0.97, 1.15)	1.03 (0.93, 1.13)	0.90 (0.73, 1.11)
0-179	2.78 (0.54, 14.23)	0.96 (0.55, 1.67)	1.26 (0.52, 3.07)	1.41 (0.92, 2.14)	0.97 (0.63, 1.49)	1.32 (0.54, 3.20)
0-364	5.04 (0.25, 100.64)	0.55 (0.18, 1.72)	1.92 (0.36, 10.21)	2.28 (0.98, 5.32)	0.41 (0.16, 1.07)	2.11 (0.49, 9.11)
Parkinson' disease						
0	1.07 (0.94, 1.22)	1.04 (0.99, 1.10)	0.91 (0.83, 1.01)	0.97 (0.92, 1.03)	1.03 (0.98, 1.08)	0.86 (0.75, 0.99)
0-13	1.03 (0.82, 1.28)	1.02 (0.93, 1.11)	0.95 (0.81, 1.11)	1.03 (0.95, 1.12)	1.12 (1.04, 1.21)	0.94 (0.77, 1.15)
0-29	0.96 (0.72, 1.29)	0.99 (0.88, 1.11)	0.99 (0.80, 1.22)	1.07 (0.96, 1.20)	1.21 (1.09, 1.35)	0.89 (0.69, 1.16)
0-179	0.90 (0.28, 2.85)	0.80 (0.40, 1.61)	1.22 (0.56, 2.68)	0.78 (0.46, 1.33)	1.26 (0.79, 2.00)	0.78 (0.26, 2.37)
0-364	1.72 (0.21, 14.07)	0.53 (0.12, 2.24)	0.74 (0.18, 3.02)	0.82 (0.28, 2.37)	1.39 (0.47, 4.04)	0.33 (0.05, 2.09)

* Models adjusted for temperature (4df) and relative humidity using natural splines (3df)

* P values in bold indicate statistically significant associations at $\alpha=0.05$

Supplemental Table S4. Rate ratio (95% confidence interval (CI)) of total and cause-specific neurological disease hospital admissions associated with each interquartile range (IQR) increase in PM_{2.5} source concentration, by lag time and outcome, 2005-2016

PM _{2.5} or PM _{2.5} Source	IQR * (µg/m ³)	Total			Alzheimer's Disease			Dementia			Parkinson's Disease		
		N	Rate Ratio* (95% CI)	P*	N	Rate Ratio* (95% CI)	P*	N	Rate Ratio* (95% CI)	P*	N	Rate Ratio* (95% CI)	P*
PM_{2.5}													
0	6.3	27532	1.01 (0.99, 1.02)	0.45	15328	1.00 (0.98, 1.02)	0.95	7425	1.01 (0.98, 1.04)	0.39	4779	1.01 (0.98, 1.05)	0.52
0-13	4.9	55248	1.02 (1.00, 1.03)	0.01	31035	1.02 (1.00, 1.03)	0.11	14531	1.01 (0.98, 1.04)	0.42	9682	1.03 (1.00, 1.07)	0.041
Road Dust (RD)													
0	6.1	27001	0.98 (0.80, 1.20)	0.84	15026	0.97 (0.74, 1.28)	0.84	7286	1.13 (0.78, 1.65)	0.51	4689	0.73 (0.45, 1.20)	0.21
0-13	5.0	55072	0.99 (0.80, 1.23)	0.94	30935	0.92 (0.69, 1.22)	0.56	14495	1.20 (0.80, 1.79)	0.38	9642	0.95 (0.58, 1.56)	0.84
Secondary Sulfate (AS)													
0	6.1	27001	1.01 (0.99, 1.04)	0.32	15026	1.01 (0.98, 1.05)	0.46	7286	1.01 (0.96, 1.06)	0.81	4689	1.03 (0.97, 1.10)	0.35
0-13	5.0	55072	1.03 (1.00, 1.05)	0.018	30935	1.03 (1.00, 1.06)	0.045	14495	1.00 (0.95, 1.05)	0.90	9642	1.06 (1.00, 1.12)	0.037
Secondary Nitrate (AN)													
0	6.1	27001	1.01 (0.98, 1.05)	0.48	15026	0.99 (0.94, 1.04)	0.58	7286	1.05 (0.97, 1.13)	0.21	4689	1.06 (0.96, 1.16)	0.26
0-13	5.0	55072	0.98 (0.94, 1.02)	0.29	30935	0.97 (0.92, 1.02)	0.27	14495	0.99 (0.91, 1.07)	0.74	9642	1.00 (0.91, 1.11)	0.94
Diesel (DIE)													
0	6.1	27001	0.97 (0.87, 1.08)	0.53	15026	0.89 (0.78, 1.03)	0.13	7286	1.20 (0.98, 1.47)	0.075	4689	0.88 (0.67, 1.14)	0.32
0-13	5.0	55072	0.98 (0.88, 1.08)	0.66	30935	0.97 (0.85, 1.11)	0.70	14495	0.92 (0.75, 1.14)	0.45	9642	1.09 (0.86, 1.40)	0.47
Spark-Ignition Emissions (GAS)													
0	6.1	27001	0.97 (0.92, 1.03)	0.37	15026	0.97 (0.90, 1.05)	0.49	7286	1.00 (0.89, 1.11)	0.96	4689	0.94 (0.83, 1.08)	0.38
0-13	5.0	55072	1.03 (0.97, 1.09)	0.39	30935	1.01 (0.94, 1.09)	0.74	14495	1.07 (0.96, 1.19)	0.25	9642	1.01 (0.88, 1.15)	0.91
Biomass burning (BB)													
0	6.1	27001	0.85 (0.71, 1.03)	0.091	15026	0.87 (0.69, 1.10)	0.25	7286	0.78 (0.53, 1.15)	0.21	4689	0.95 (0.62, 1.45)	0.80
0-13	5.0	55072	0.99 (0.85, 1.15)	0.86	30935	1.02 (0.84, 1.23)	0.86	14495	0.88 (0.63, 1.22)	0.43	9642	1.05 (0.73, 1.50)	0.79
Pyrolyzed Organic Rich (OP)													
0	5.6	18449	0.99 (0.94, 1.06)	0.84	10027	1.00 (0.92, 1.08)	0.96	5049	0.98 (0.87, 1.11)	0.76	3373	0.97 (0.84, 1.12)	0.68
0-13	4.5	37791	1.02 (0.96, 1.09)	0.44	20845	1.03 (0.96, 1.12)	0.40	10130	1.07 (0.95, 1.19)	0.28	6816	0.92 (0.79, 1.06)	0.24

* Models adjusted for day of the week, public holidays, time trend (4df/year), temperature (4df) and relative humidity using natural splines (3df);

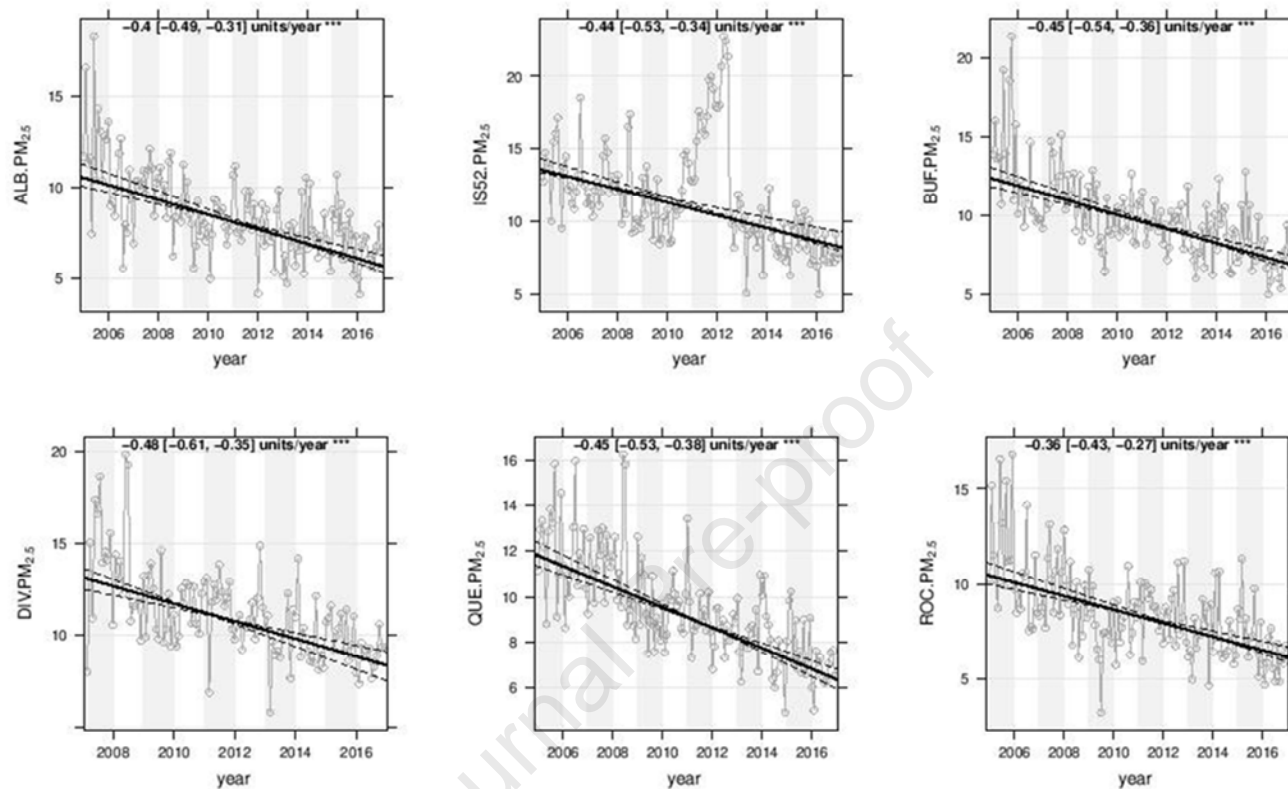


Figure S1. Time series of $PM_{2.5}$ concentrations at the 6 NYS urban sites.