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Supplemental Material

Cardiopulmonary Effects of Fine Particulate Matter Exposure among Older Adults, during Wildfire and Non-Wildfire Periods, in the United States 2008-2010

Stephanie DeFlorio-Barker, James Crooks, Jeanette Reyes, and Ana G. Rappold

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Smoke days defined as wildfire-specific contribution $>1\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 1\mu\text{g}/\text{m}^3$. Associations are estimated using single lag model for the interaction between $\text{PM}_{2.5}$ ($\text{PM}_{2.5}^{\text{Tot CMAQ}}$, $\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$, or $\text{PM}_{2.5}^{\text{Tot}}$) and SmokeDay adjusting for day of the week, day (natural spline with 6 degrees of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. Using $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ 671 counties, 375 counties, and 684 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. Using the other metrics ($\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$ or $\text{PM}_{2.5}^{\text{Tot}}$) 167 counties, 118 counties, and 173 counties were used in the meta analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axes limits differ between hospitalization types.

Figure S5. Percent difference per $10\mu\text{g}/\text{m}^3$ change in $\text{PM}_{2.5}$ concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, by region Smoke days defined as wildfire-specific contribution $>5\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 5\mu\text{g}/\text{m}^3$. West includes counties from: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Southeast includes counties from: Alabama, Arkansas, Florida, Georgia, North Carolina, and Virginia. Associations are estimated using single lag model for the interaction between $\text{PM}_{2.5}$ ($\text{PM}_{2.5}^{\text{Tot CMAQ}}$, $\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$, or $\text{PM}_{2.5}^{\text{Tot}}$) and SmokeDay adjusting for day of the week, day (natural spline with 18 degrees of freedom), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. For western counties, using $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ 280 counties, 132 counties, and 290 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For western counties, using the other metrics ($\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$ or $\text{PM}_{2.5}^{\text{Tot}}$) 85 counties, 51 counties, and 88 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For southeastern counties, using $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ 155 counties, 129 counties, and 156 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For southeastern counties, using the other metrics ($\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$ or $\text{PM}_{2.5}^{\text{Tot}}$) 33 counties, 32 counties, and 33 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axes limits differ between hospitalization types.

Figure S6. per $10\mu\text{g}/\text{m}^3$ change in $\text{PM}_{2.5}$ concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, cumulative risk Smoke days defined as wildfire-specific contribution $>5\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 5\mu\text{g}/\text{m}^3$. Associations are estimated an unrestricted distributed lag model for the effect of $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ on smoke days and non-smoke days, adjusting for day of the week, day (natural spline with 6 degrees of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. A total of 639 counties, 362 counties, and 652 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axes limits differ between hospitalization types.

Table S1: Percent difference per 10µg/m³ change in PM_{2.5} concentrations (95% Confidence Interval) in hospitalizations during 2008-2010, among U.S. Medicare recipients 65 +

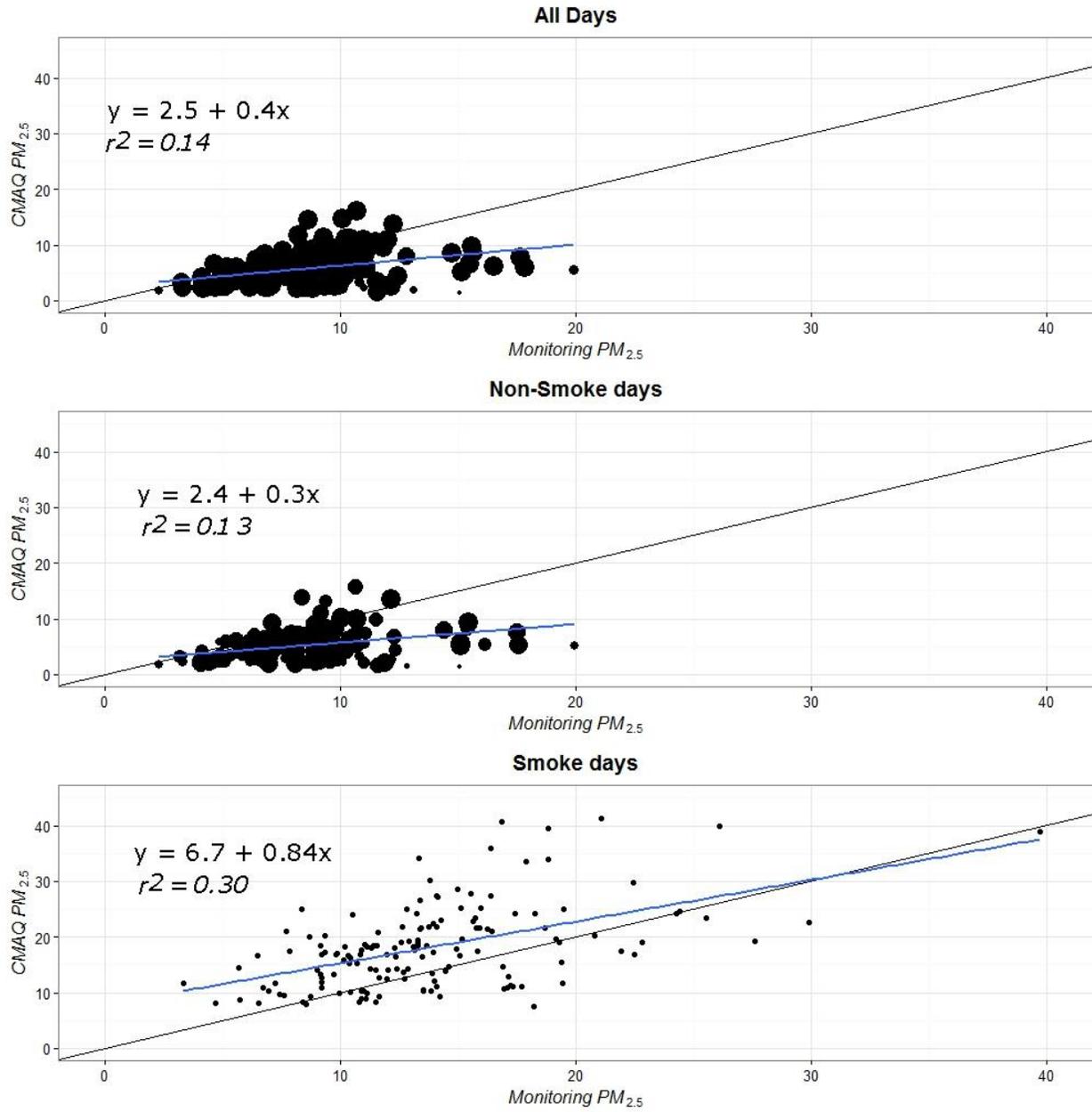
Outcome	Lag	PM _{2.5} ^{Tot} CMAQ			PM _{2.5} ^{Tot} CMAQ-M			PM _{2.5} ^{Tot}		
		Smoke Days	Non-smoke Days	Interaction ρ -value	Smoke Days	Non-smoke Days	Interaction ρ -value	Smoke Days	Non-smoke Days	Interaction ρ -value
RSP	0	1.1(0.31,1.89)	0.96(0.25,1.67)	0.74	2.22(0.66,3.78)	1.22(0.02,2.42)	0.36	1.89(-0.59,4.37)	0.05(-0.57,0.67)	0.17
ABW	0	5.78(2.85,8.71)	1.55(-0.73,3.85)	0.07	7.44(0.62,14.3)	1.58(-1.37,4.54)	0.88	7.03(-1,15.13)	-0.85(-3.28,1.59)	0.19
CVD	0	0.43(-0.06,0.92)	1.47(1.01,1.93)	0.14	0.88(-0.33,2.09)	1.43(0.75,2.11)	0.34	1.34(0.08,2.62)	0.63(0.02,1.23)	0.46
RSP	1	1.08(0.28,1.89)	0.67(-0.09,1.44)	0.66	1.48(-0.28,3.24)	1.44(0.04,2.85)	0.82	-2(-4.66,0.66)	0.83(-0.1,1.76)	0.02
ABW	1	6.9(3.71,10.11)	1.34(-1.1,3.77)	0.09	6.14(-0.36,12.68)	2.05(-1.5,12)	0.73	0.36(-8.15,8.95)	1.43(-0.67,3.52)	0.33
CVD	1	0.61(0.09,1.14)	0.69(0.19,1.2)	0.91	0.71(-0.36,1.79)	0.99(0.33,1.66)	0.88	0.04(-1.42,1.49)	0.27(-0.5,1.04)	0.93
RSP	2	1.36(0.55,2.17)	0.59(-0.23,1.41)	0.53	2.03(0.33,3.73)	1.34(0.28,2.4)	0.73	1.68(-0.97,4.33)	0.35(-0.42,1.13)	0.5
ABW	2	5.01(2.09,7.95)	1.97(-0.46,4.4)	0.05	4.22(-2.22,10.7)	2.31(-0.75,5.38)	0.43	6.57(-1.3,14.49)	1.67(-0.41,3.74)	0.34
CVD	2	0.4(-0.11,0.91)	0.44(-0.22,1.09)	0.4	1.47(0.44,2.5)	0.74(-0.04,1.52)	0.56	1.5(0.16,2.85)	0.33(-0.17,0.83)	0.22
RSP	3	0.3(-0.53,1.13)	-0.47(-1.24,0.3)	0.35	0.77(-0.89,2.44)	0.36(-0.73,1.46)	0.9	0.69(-1.72,3.11)	0.01(-0.6,0.61)	0.86
ABW	3	6.12(3.32,8.94)	1.11(-1.35,3.58)	0.1	3.47(-2.35,9.31)	2.47(-1.11,6.07)	0.15	7.52(-0.09,15.17)	0.82(-1.26,2.9)	0.02
CVD	3	0.25(-0.3,0.79)	0.22(-0.23,0.68)	0.73	0.58(-0.69,1.86)	0.66(0.02,1.31)	0.69	0.5(-1.02,2.03)	0.3(-0.16,0.75)	0.65
RSP	4	0.47(-0.34,1.28)	-0.46(-1.2,0.29)	0.33	1.09(-0.59,2.78)	-0.07(-1.03,0.9)	0.53	0.36(-2.31,3.03)	-0.33(-0.94,0.29)	0.77
ABW	4	5.55(2.64,8.48)	1.5(-0.68,3.69)	0.03	3.26(-2.42,8.97)	1.66(-1.18,4.51)	0.06	4.94(-2.85,12.8)	1.08(-1.06,3.22)	0.27
CVD	4	0.3(-0.22,0.81)	0.2(-0.24,0.64)	0.26	-0.29(-1.47,0.89)	0.41(-0.22,1.03)	0.38	-0.49(-1.97,0.98)	0.37(-0.1,0.83)	0.26
RSP	5	1.14(0.35,1.94)	-0.29(-0.95,0.37)	0.12	0.69(-0.95,2.34)	0.02(-0.87,0.92)	0.76	0.79(-1.68,3.27)	0.02(-0.66,0.69)	0.98
ABW	5	3.09(0.13,6.06)	0(-2.55,2.56)	0.34	-5.03(-11.51,1.49)	2.58(-1.82,6.99)	0.12	-3.75(-13.86,6.47)	-0.35(-2.44,1.73)	0.09
CVD	5	0.43(-0.07,0.93)	0.54(0.07,1.01)	0.3	0.8(-0.26,1.87)	0.53(-0.13,1.18)	0.75	-0.07(-1.38,1.24)	0.52(0.04,1)	0.15
RSP	6	0.79(0.01,1.58)	-0.37(-1.21,0.48)	0.31	-0.54(-2.14,1.07)	0(-1.09,1.08)	0.49	-1.2(-3.45,1.05)	-0.03(-0.75,0.7)	0.47
ABW	6	4.19(1.32,7.07)	0.21(-1.99,2.41)	0.34	1.87(-4.7,8.48)	-1.14(-4.19,1.91)	0.1	-1.13(-9.89,7.7)	-1.63(-3.51,0.25)	0.32
CVD	6	0.53(0.04,1.01)	0.16(-0.31,0.64)	0.97	0.71(-0.29,1.71)	0.56(-0.05,1.17)	0.62	0.2(-1.06,1.47)	0.49(0.09,0.89)	0.73

RSP: All-cause respiratory hospitalizations, ABW: Asthma, bronchitis, and wheezing hospitalizations, CVD: All-cause cardiovascular hospitalizations
 PM_{2.5}^{Tot} CMAQ: CMAQ estimated PM_{2.5} concentrations on all days and in all counties, PM_{2.5}^{Tot} CMAQ-M: CMAQ estimated PM_{2.5} concentrations on days and in counties with corresponding monitored data, PM_{2.5}^{Tot}: Monitored data alone. Smoke days defined as wildfire-specific contribution >5µg/m³ and on-smoke days defined as wildfire-specific contribution ≤ 5µg/m³
 Associations are estimated using single lag model for the interaction between PM_{2.5} (PM_{2.5}^{Tot} CMAQ, PM_{2.5}^{Tot} CMAQ-M, or PM_{2.5}^{Tot}) and SmokeDay adjusting for day of the week, day (natural spline with 6 degrees of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. Using PM_{2.5}^{Tot} CMAQ 595 counties, 341 counties, and 607 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. Using the other metrics (PM_{2.5}^{Tot} CMAQ-M or PM_{2.5}^{Tot}) 134 counties, 92 counties, and 137 counties were used in the meta-analyses for respiratory, RSP, ABW, and CVD hospitalizations, respectively.

Table S2: Summary of PM_{2.5} concentrations (µg/m³), overall and by smoke and non-smoke days

Exposure Metric	Mean	Min	25 th Percentile	Median	75 th percentile	Max	<i>n</i> county-days
<i>All days</i>							
PM _{2.5} ^{Tot CMAQ}	5.3	0.01	2.3	3.9	6.5	274.6	758,432
PM _{2.5} ^{Tot CMAQ-M}	6.1	0.07	2.7	4.6	7.7	212.5	79,298
PM _{2.5} ^{Tot}	9.1	0	4.7	7.2	11.0	212.1	79,298
<i>Smoke Days</i>							
PM _{2.5} ^{Tot CMAQ}	20.5	5.4	12.0	16.2	22.9	274.6	28,118
PM _{2.5} ^{Tot CMAQ-M}	20.9	6.0	12.0	16.5	23.2	212.5	2,908
PM _{2.5} ^{Tot}	15.2	0	8.7	12.2	17.2	200.2	2,908
<i>Non-smoke days</i>							
PM _{2.5} ^{Tot CMAQ}	4.7	0.01	2.2	3.7	6.1	59.6	730,314
PM _{2.5} ^{Tot CMAQ-M}	5.6	0.07	2.7	4.4	7.2	56.0	76,390
PM _{2.5} ^{Tot}	8.8	0	4.6	7.0	10.7	212.1	76,390

PM_{2.5}^{Tot CMAQ}: CMAQ estimated PM_{2.5} concentrations on all days and in all counties, PM_{2.5}^{Tot CMAQ-M}: CMAQ estimated PM_{2.5} concentrations on days and in counties with corresponding monitored data, PM_{2.5}^{Tot}: Monitored data alone. Smoke days defined as wildfire-specific contribution >5µg/m³ and on-smoke days defined as wildfire-specific contribution ≤ 5µg/m³



County-days

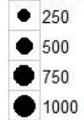
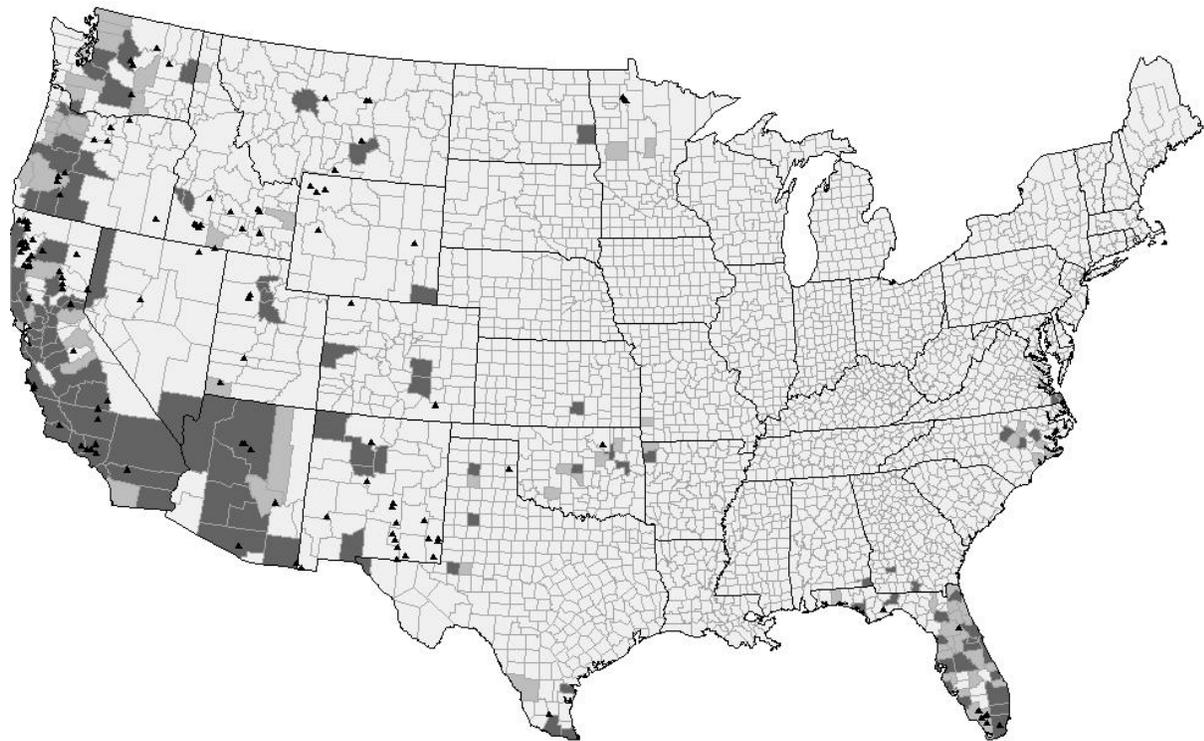


Figure S1: Average $PM_{2.5}$ concentrations for CMAQ ($PM_{2.5}^{Tot\ CMAQ-M}$) and monitors ($PM_{2.5}^{Tot}$)



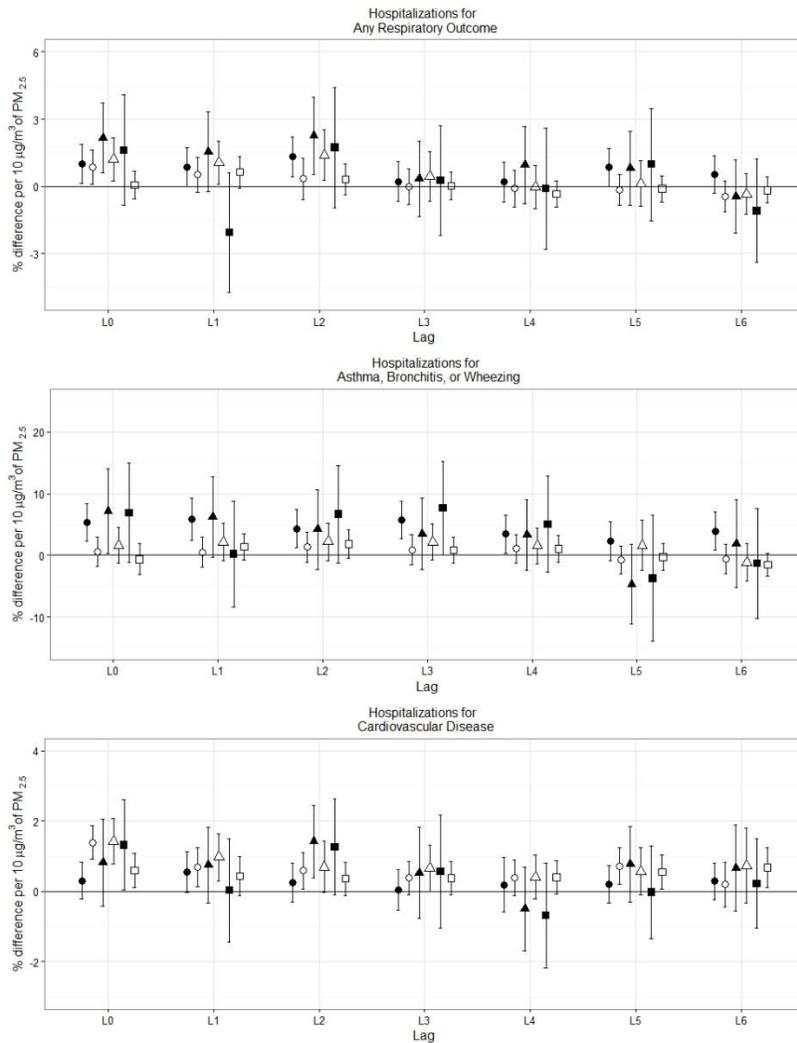
▲ Fire Point of Origin

Counties not included

Counties in study area

Counties in study area with monitoring sites

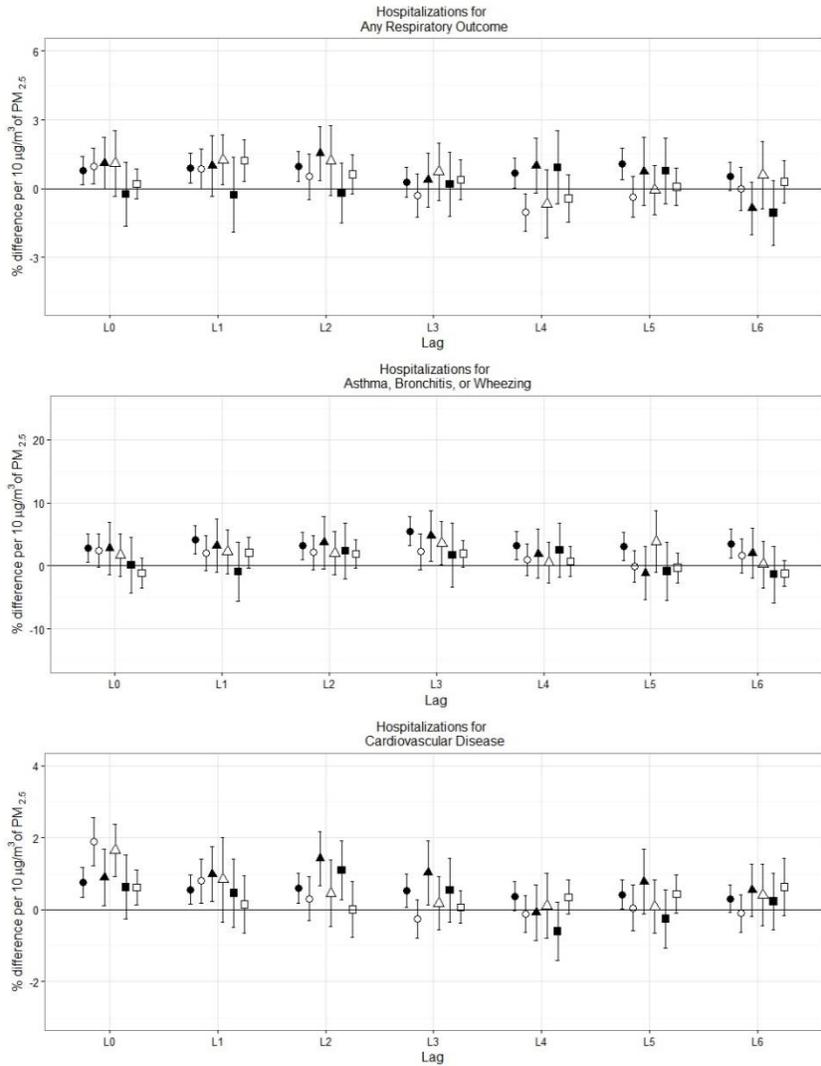
Figure S2: 185 Counties included in analysis with $\geq 10,000$ of those 65+, 2008-2010, 120 counties had monitoring sites



Exposure Metric

- Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)
- Non-Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)
- ▲ Smoke Days, $PM_{2.5}^{TOT\ CMAQ-M}$ (CMAQ estimated concentrations on days and in counties with corresponding monitored data)
- △ Non-Smoke Days, $PM_{2.5}^{TOT\ CMAQ-M}$ (CMAQ estimated concentrations on days and in counties with corresponding monitored data)
- Smoke Days, $PM_{2.5}^{TOT}$ (Monitored data alone)
- Non-Smoke Days, $PM_{2.5}^{TOT}$ (Monitored data alone)

Figure S3: Percent difference per $10\mu\text{g}/\text{m}^3$ change in $PM_{2.5}$ concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, population $\geq 10,000$ of those 65+
 Smoke days defined as wildfire-specific contribution $>5\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 5\mu\text{g}/\text{m}^3$. Associations are estimated using single lag model for the interaction between $PM_{2.5}$ ($PM_{2.5}^{TOT\ CMAQ}$, $PM_{2.5}^{TOT\ CMAQ-M}$, or $PM_{2.5}^{TOT}$) and SmokeDay adjusting for day of the week, day (natural spline with 6 of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. Using $PM_{2.5}^{TOT\ CMAQ}$ 170 counties, 168 counties, and 170 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. Using the other metrics ($PM_{2.5}^{TOT\ CMAQ-M}$ or $PM_{2.5}^{TOT}$) 97 counties, 85 counties, and 97 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axes limits differ between hospitalization types.



Exposure Metric

- Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)
- Non-Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)
- ▲ Smoke Days, $PM_{2.5}^{TOT\ CMAQ-M}$ (CMAQ estimated concentrations on days and in counties with corresponding monitored data)
- △ Non-Smoke Days, $PM_{2.5}^{TOT\ CMAQ-M}$ (CMAQ estimated concentrations on days and in counties with corresponding monitored data)
- Smoke Days, $PM_{2.5}^{TOT}$ (Monitored data alone)
- Non-Smoke Days, $PM_{2.5}^{TOT}$ (Monitored data alone)

Figure S4: Percent difference per $10\mu\text{g}/\text{m}^3$ change in $PM_{2.5}$ concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, lower threshold

Smoke days defined as wildfire-specific contribution $>1\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 1\mu\text{g}/\text{m}^3$. Associations are estimated using single lag model for the interaction between $PM_{2.5}$ ($PM_{2.5}^{Tot\ CMAQ}$, $PM_{2.5}^{Tot\ CMAQ-M}$, or $PM_{2.5}^{Tot}$) and SmokeDay adjusting for day of the week, day (natural spline with 6 degrees of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. Using $PM_{2.5}^{Tot\ CMAQ}$ 671 counties, 375 counties, and 684 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. Using the other metrics ($PM_{2.5}^{Tot\ CMAQ-M}$ or $PM_{2.5}^{Tot}$) 167 counties, 118 counties, and 173 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axis limits differ between hospitalization types.

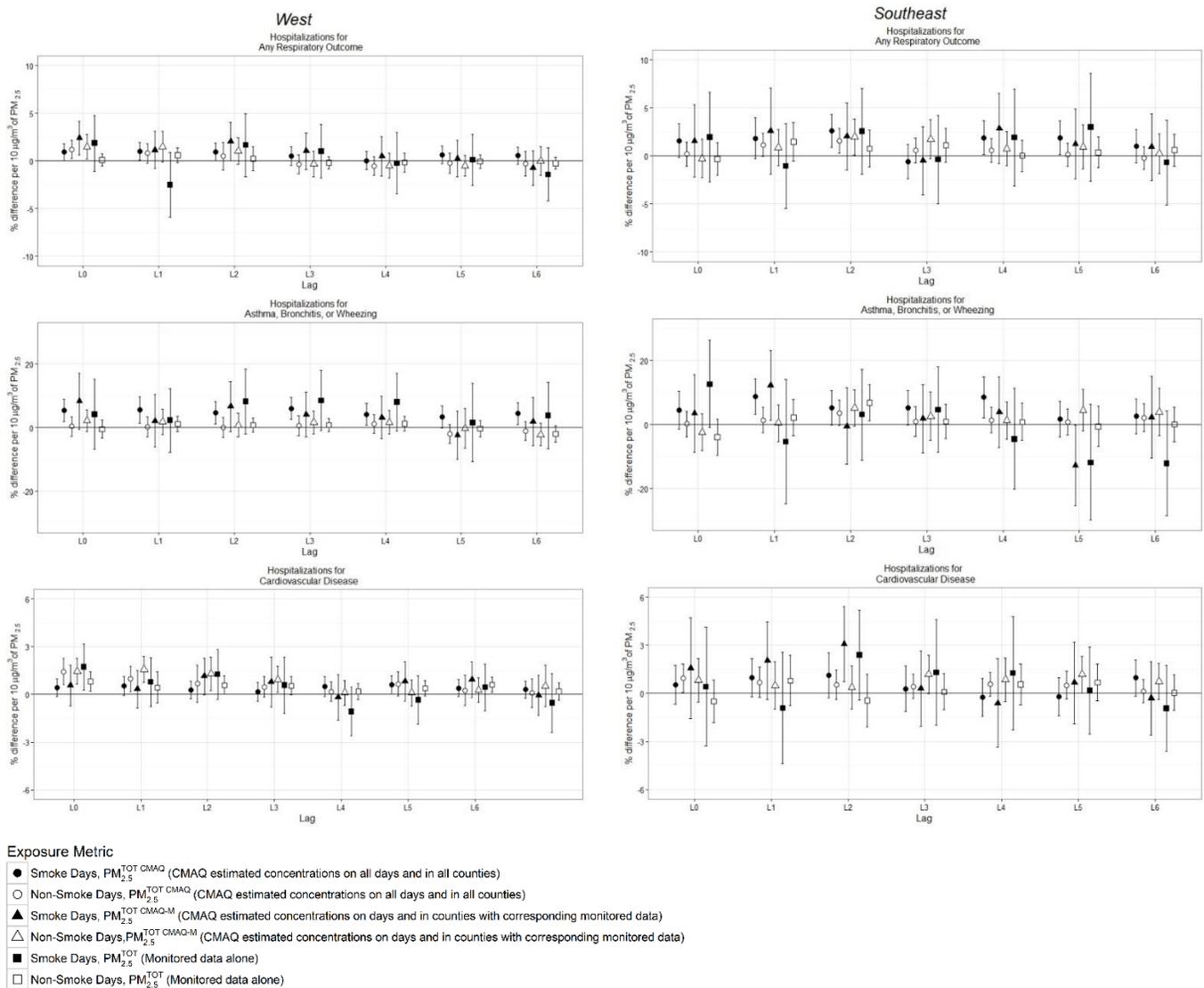
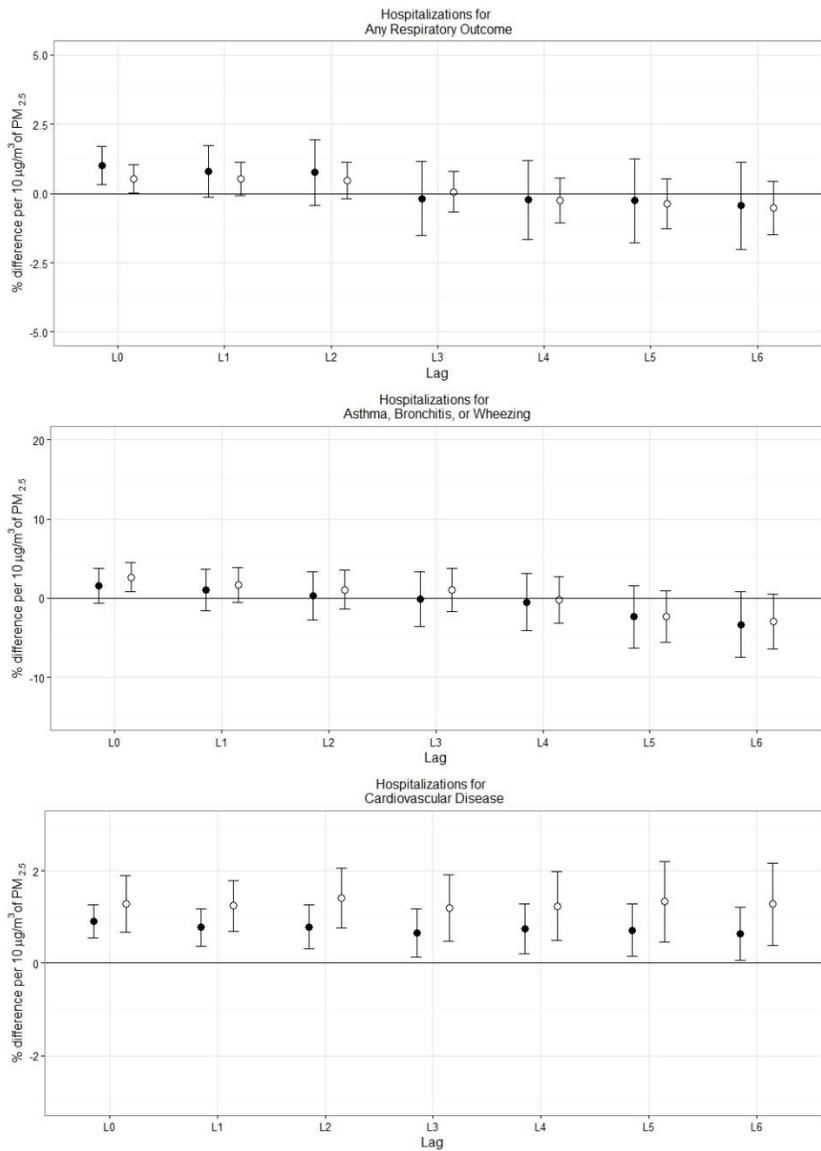


Figure S5: Percent difference per $10\mu\text{g}/\text{m}^3$ change in $PM_{2.5}$ concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, by region

Smoke days defined as wildfire-specific contribution $>5\mu\text{g}/\text{m}^3$ and non-smoke days defined as wildfire-specific contribution $\leq 5\mu\text{g}/\text{m}$. West includes counties from: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Southeast includes counties from: Alabama, Arkansas, Florida, Georgia, North Carolina, and Virginia.

Associations are estimated using single lag model for the interaction between PM_{2.5} ($\text{PM}_{2.5}^{\text{Tot CMAQ}}$, $\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$, or $\text{PM}_{2.5}^{\text{Tot}}$) and SmokeDay adjusting for day of the week, day (natural spline with 18 degrees of freedom), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. For western counties, using $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ 280 counties, 132 counties, and 290 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For western counties, using the other metrics ($\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$ or $\text{PM}_{2.5}^{\text{Tot}}$) 85 counties, 51 counties, and 88 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For southeastern counties, using $\text{PM}_{2.5}^{\text{Tot CMAQ}}$ 155 counties, 129 counties, and 156 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. For southeastern counties, using the other metrics ($\text{PM}_{2.5}^{\text{Tot CMAQ-M}}$ or $\text{PM}_{2.5}^{\text{Tot}}$) 33 counties, 32 counties, and 33 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axis limits differ between hospitalization types.



Exposure Metric

- Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)
- Non-Smoke Days, $PM_{2.5}^{TOT\ CMAQ}$ (CMAQ estimated concentrations on all days and in all counties)

Figure S6: per 10µg/m³ change in PM_{2.5} concentrations in hospitalizations during 2008-2010, among U.S. Medicare recipients 65+, cumulative risk

Smoke days defined as wildfire-specific contribution >5µg/m³ and non-smoke days defined as wildfire-specific contribution ≤ 5µg/m³. Associations are estimated an unrestricted distributed lag model for the effect of $PM_{2.5}^{TOT\ CMAQ}$ on smoke days and non-smoke days, adjusting for day of the week, day (natural spline with 6 degrees of freedom per year), temperature (natural spline with 3 degrees of freedom), and relative humidity (natural spline with 3 degrees of freedom) for each county, followed by a meta-analysis. A total of 639 counties, 362 counties, and 652 counties were used in the meta-analyses for RSP, ABW, and CVD hospitalizations, respectively. The y-axes limits differ between hospitalization types.