

Supplementary

**Associations of ambient air pollutants and meteorological factors with
COVID-19 transmission in 31 Chinese provinces: A time series study**

Table A1. Descriptive statistics for daily COVID-19 confirmed new cases, air pollutant concentrations, and meteorological factors in 31 Chinese provinces from January 25 to February 29, 2020.

Variable	Total	Mean	SD	Min	P25	Median	P75	Max	IQR
Daily number of outcomes									
Confirmed new cases, N	77,578	2155	2467	126	658	1836	2692	14,893	2035
Daily air pollutant concentrations									
PM _{2.5} , µg/m ³	-	46.1	13.7	16.1	38.0	46.7	52.7	85.6	14.6
PM ₁₀ , µg/m ³	-	61.9	14.4	32.1	53.9	62.6	71.5	101.7	17.6
SO ₂ , µg/m ³	-	10.7	1.9	7.1	9.7	10.6	11.7	17.3	2.0
NO ₂ , µg/m ³	-	18.0	3.5	9.8	16.0	18.5	20.0	24.9	4.1
O ₃ , µg/m ³	-	80.4	8.4	65.9	73.0	80.9	87.3	98.6	14.3
CO, mg/m ³	-	0.8	0.1	0.5	0.8	0.8	0.9	1.0	0.2
Daily meteorological factors									
Temperature, °C	-	5.7	3.1	1.4	2.9	4.7	8.4	11.6	5.5
Relative humidity, %	-	68.3	7.8	48.7	63.8	69.2	74.6	78.8	10.8
Wind velocity, m/s	-	2.8	0.6	2.1	2.4	2.7	3.0	4.7	0.6

Abbreviations: PM_{2.5}, particulate matter <2.5 µm in aerodynamic diameter; PM₁₀, particulate matter <10 µm in aerodynamic diameter; SO₂, sulfur dioxide; NO₂, nitrogen dioxide; CO, carbon monoxide; O₃, ozone; SD, standardized deviation; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; IQR, interquartile range.

Table A2. Spearman rank correlation coefficients between daily air pollutant concentrations and meteorological factors.

Variable	PM_{2.5}	PM₁₀	SO₂	NO₂	O₃	CO	Temperature	Relative humidity	Wind velocity
PM _{2.5}	1.00	0.80 ^a	0.78 ^a	0.31	0.24	0.89 ^a	-0.13	0.05	-0.41 ^b
PM ₁₀	-	1.00	0.63 ^a	0.62 ^a	0.50 ^b	0.56 ^a	0.23	-0.15	-0.21
SO ₂	-	-	1.00	0.32	0.32	0.76 ^a	-0.20	-0.16	-0.52 ^b
NO ₂	-	-	-	1.00	0.58 ^a	0.18	0.68 ^a	-0.08	-0.33 ^b
O ₃	-	-	-	-	1.00	-0.04	0.30	-0.78 ^a	-0.24
CO	-	-	-	-	-	1.00	-0.15	0.33 ^b	-0.49 ^b
Temperature	-	-	-	-	-	-	1.00	0.12	-0.08
Relative humidity	-	-	-	-	-	-	-	1.00	0.02
Wind velocity	-	-	-	-	-	-	-	-	1.00

^a *P*-value <0.001.

^b *P*-value <0.05.

Table A3. Descriptive statistics for daily COVID-19 confirmed new cases, air pollutant concentrations, and meteorological factors in Heilongjiang, Beijing, Hubei, Guangdong, Hainan and all over China from January 25 to February 29, 2020.

Variable	Total	Mean	SD	Min	P25	Median	P75	Max	IQR
Daily number of outcomes									
Confirmed cases, N									
China	77,578	2155	2467	126	658	1836	2692	14,893	2035
Heilongjiang	474	13	13	0	4	8	21	50	17
Beijing	349	10	10	0	2	7	13	50	11
Hubei	65,788	1827	2435	212	440	1493	2246	14,840	1807
Guangdong	1295	36	34	0	3	26	67	99	64
Hainan	88	2	3	0	0	2	4	14	4
Daily air pollutant concentrations									
PM _{2.5} , µg/m ³									
China	-	46.1	13.7	16.1	38.0	46.7	52.7	85.6	14.6
Heilongjiang	-	43.9	22.7	16.7	28.6	33.6	54.4	93.6	25.8
Beijing	-	72.0	59.7	3.9	27.4	55.4	113.8	208.4	86.4
Hubei	-	45.5	19.7	14.4	33.3	43.3	55.8	92.7	22.4
Guangdong	-	23.0	9.5	3.2	15.0	22.8	29.4	39.5	14.4
Hainan	-	13.6	4.2	7.3	11.0	12.9	17.0	25.1	6.0
PM ₁₀ , µg/m ³									
China	-	61.9	14.4	32.1	53.9	62.6	71.5	101.7	17.6
Heilongjiang	-	56.6	27.0	24.0	37.8	45.3	70.1	119.5	32.3
Beijing	-	65.8	46.1	8.5	33.1	48.8	99.2	157.0	66.1
Hubei	-	55.0	20.7	22.6	37.9	54.1	70.3	104.0	32.4
Guangdong	-	30.6	12.4	6.9	19.2	32.2	40.0	54.4	20.8
Hainan	-	24.6	6.8	10.9	20.0	25.6	29.6	41.1	9.6
SO ₂ , µg/m ³									
China	-	10.7	1.9	7.1	9.7	10.6	11.7	17.3	2.0
Heilongjiang	-	15.8	5.4	10.0	12.3	13.8	18.2	33.6	6.0
Beijing	-	5.0	3.0	2.0	2.5	4.0	7.2	12.8	4.7
Hubei	-	8.0	1.6	5.5	6.5	7.9	9.3	11.0	2.8
Guangdong	-	6.3	0.6	5.5	5.8	6.4	6.8	7.4	1.0
Hainan	-	4.0	0.4	3.5	3.6	3.9	4.1	4.9	0.5
NO ₂ , µg/m ³									
China	-	18.0	3.5	9.8	16.0	18.5	20.0	24.9	4.1
Heilongjiang	-	16.2	5.5	9.0	12.4	14.7	19.9	29.0	7.4
Beijing	-	26.9	12.6	4.4	17.9	26.4	36.4	53.1	18.5
Hubei	-	14.1	3.2	7.2	12.1	13.6	16.3	20.4	4.1
Guangdong	-	14.1	4.9	7.2	9.9	13.4	18.2	22.5	8.3
Hainan	-	4.9	0.8	3.7	4.3	4.8	5.6	6.5	1.3
O ₃ , µg/m ³									
China	-	80.4	8.4	65.9	73.0	80.9	87.3	98.6	14.3

Heilongjiang	-	78.0	8.0	63.7	71.3	77.8	84.0	96.8	12.6
Beijing	-	71.3	14.6	45.0	63.5	69.5	77.5	112.0	14.0
Hubei	-	80.9	17.6	52.9	66.1	83.5	97.7	113.8	31.5
Guangdong	-	81.3	22.4	45.6	61.5	79.6	97.9	127.5	36.4
Hainan	-	79.9	15.0	48.5	68.8	79.0	94.3	105.5	25.5
CO, mg/m ³									
China	-	0.8	0.1	0.5	0.8	0.8	0.9	1.0	0.2
Heilongjiang	-	0.7	0.2	0.5	0.6	0.7	0.8	1.1	0.2
Beijing	-	1.0	0.6	0.2	0.5	0.9	1.3	2.3	0.8
Hubei	-	1.0	0.1	0.7	0.9	1.0	1.1	1.3	0.2
Guangdong	-	0.6	0.1	0.5	0.6	0.6	0.7	0.9	0.1
Hainan	-	0.5	0.1	0.4	0.4	0.4	0.5	1.0	0.1
Daily meteorological factors									
Temperature, °C									
China	-	5.7	3.1	1.4	2.9	4.7	8.4	11.6	5.5
Heilongjiang	-	-12.1	4.8	-20.5	-15.3	-13.0	-8.1	-1.1	7.2
Beijing	-	1.0	3.0	-6.2	-0.9	1.5	3.0	6.4	3.9
Hubei	-	8.0	3.5	2.9	5.5	7.7	10.0	16.4	4.5
Guangdong	-	16.4	3.5	10.7	13.5	16.3	19.3	22.8	5.8
Hainan	-	19.9	3.1	13.1	17.3	20.5	22.3	26.3	5.0
Relative humidity, %									
China	-	68.3	7.8	48.7	63.8	69.2	74.6	78.8	10.8
Heilongjiang	-	63.6	6.7	53.9	57.3	63.0	69.8	75.1	12.5
Beijing	-	56.9	18.2	23.0	42.1	58.6	70.6	91.5	28.5
Hubei	-	77.5	10.6	57.5	69.8	76.6	86.7	95.0	16.9
Guangdong	-	75.4	13.1	46.3	69.2	78.4	84.1	96.4	14.9
Hainan	-	82.3	7.8	64.3	80.3	84.6	86.9	93.1	6.6
Wind velocity, m/s									
China	-	2.8	0.6	2.1	2.4	2.7	3.0	4.7	0.6
Heilongjiang	-	3.1	0.8	1.6	2.6	3.1	3.8	4.7	1.2
Beijing	-	2.5	1.5	0.9	1.5	2.0	3.2	7.8	1.7
Hubei	-	2.7	1.1	1.6	2.0	2.3	2.9	6.6	0.9
Guangdong	-	3.0	0.8	1.9	2.4	2.8	3.4	5.9	1.0
Hainan	-	4.3	0.8	3.0	3.7	4.0	4.9	6.0	1.2

Abbreviations: PM_{2.5}, particulate matter <2.5 μm in aerodynamic diameter; PM₁₀, particulate matter <10 μm in aerodynamic diameter; SO₂, sulfur dioxide; NO₂, nitrogen dioxide; CO, carbon monoxide; O₃, ozone; SD, standardized deviation; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; IQR, interquartile range.

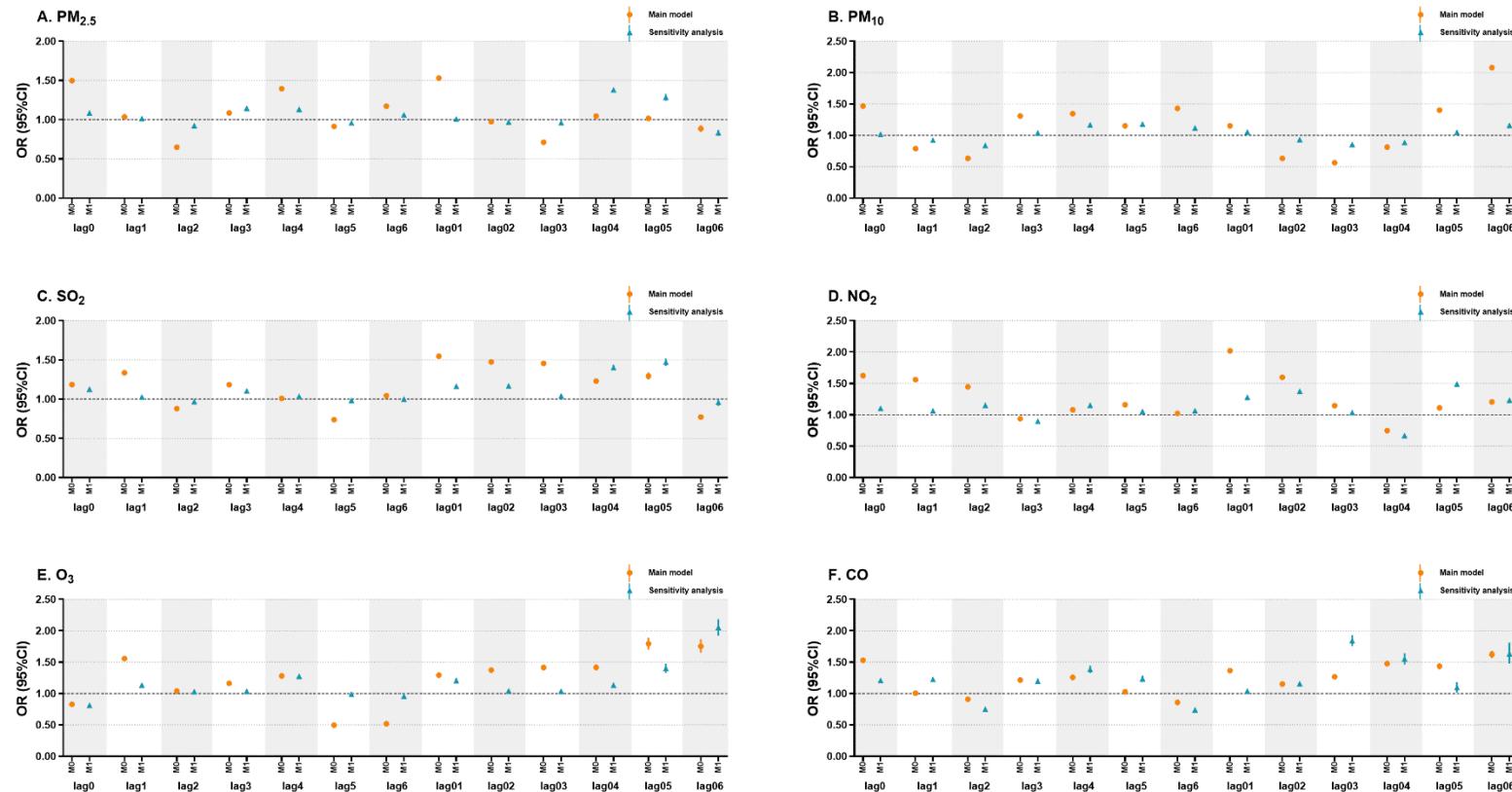


Figure A1. Odds ratios and 95% confidence intervals per an interquartile range increase in the concentrations of air pollutants with and without the counts on 13 February.

Note: M0: main model, including the counts on 13 February. M1: excluding the counts on 13 February.

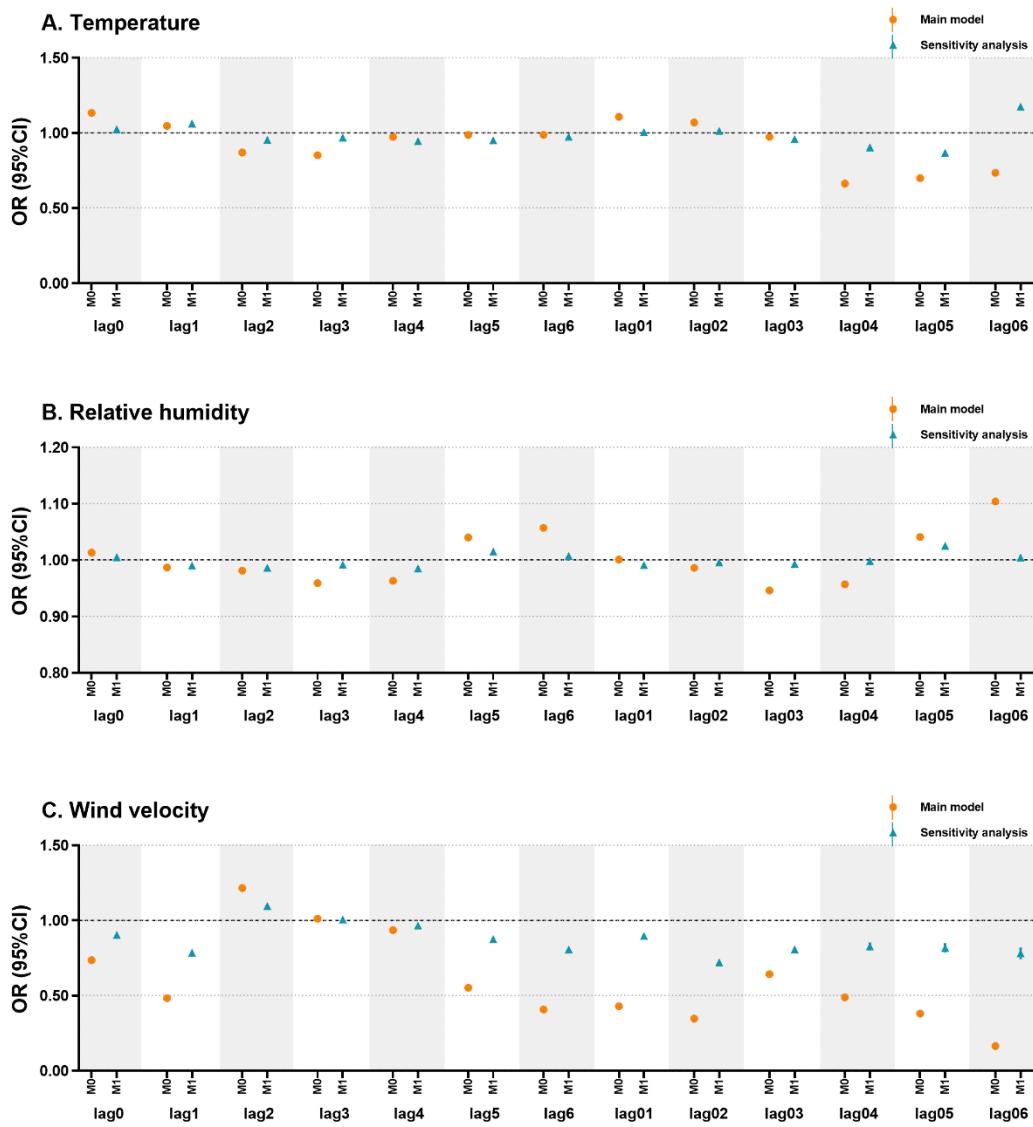


Figure A2. Odds ratios and 95% confidence intervals per 1°C, 1% and 1 m/s increase in temperature, relative humidity and wind velocity with and without the counts on 13 February.

Note: M0: main model, including the counts on 13 February. M1: excluding the counts on 13 February.

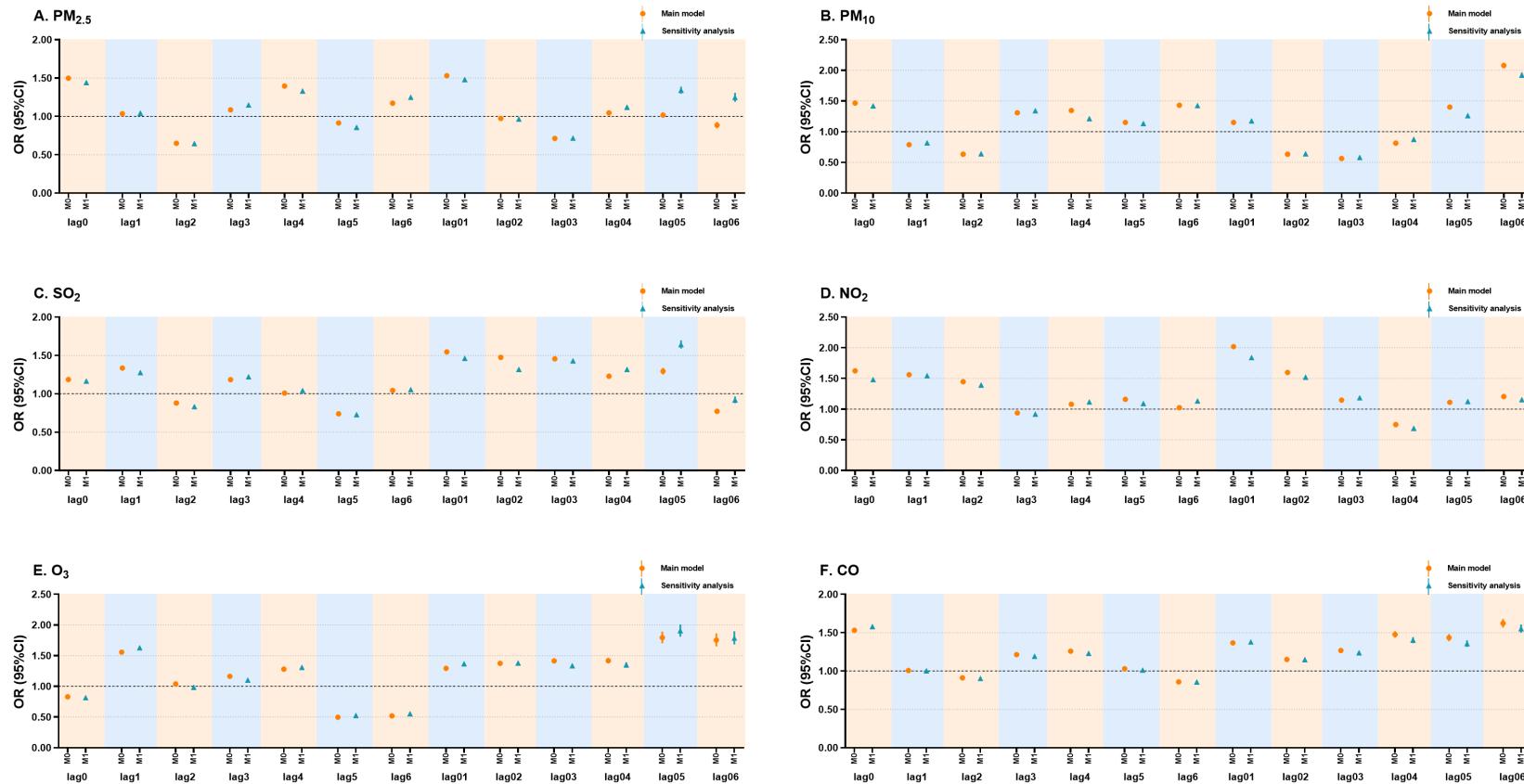


Figure A3. Odds ratios and 95% confidence intervals per an interquartile range increase in the concentrations of air pollutants using different lag structures for models with different degrees of freedom (df) in meteorological factors.

Note: M0: main model, temperature df=3, relative humidity df=3, wind velocity df=3, time df=7. M1: changing df in meteorological factors, temperature df=4, relative humidity df=4, wind velocity df=4, time df=7.

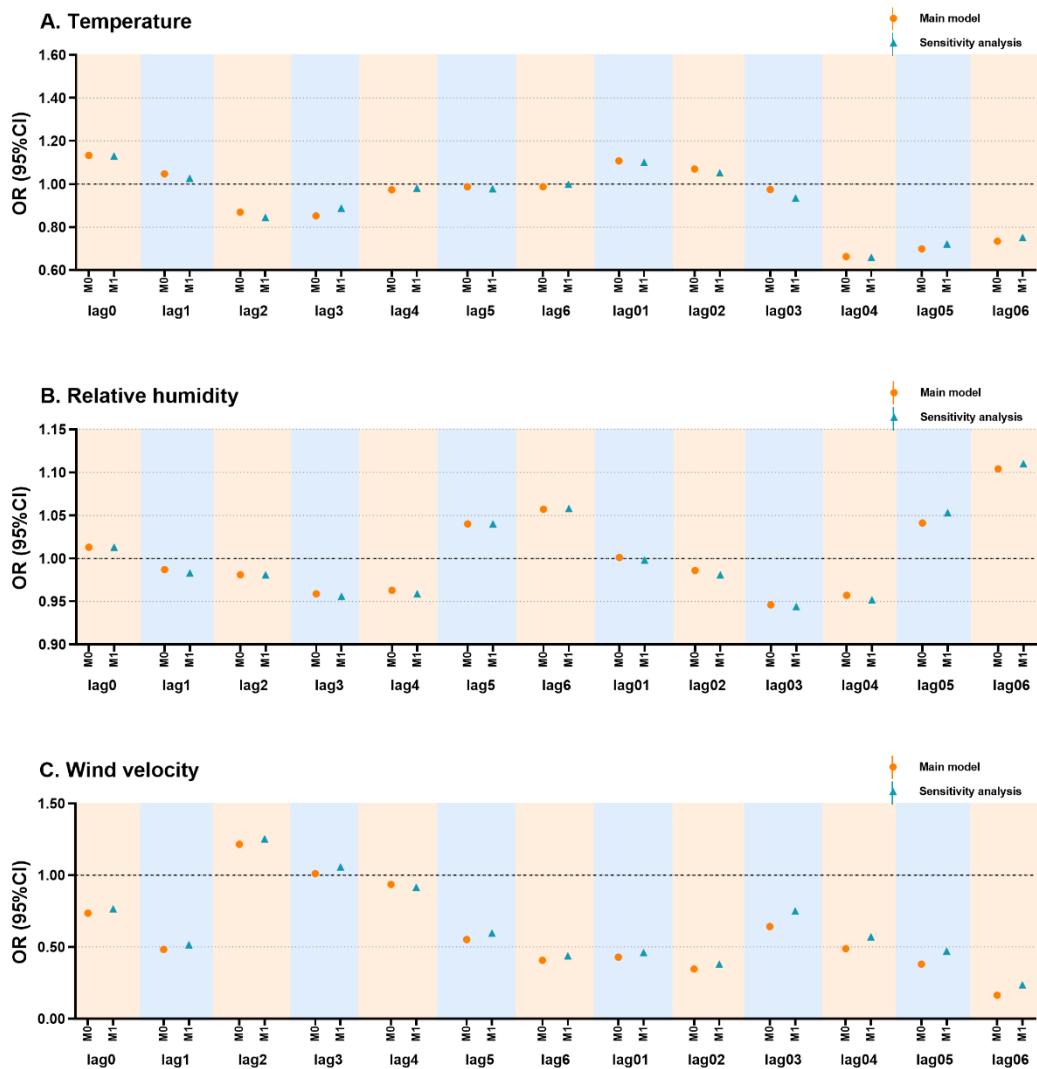


Figure A4. Odds ratios and 95% confidence intervals per 1°C, 1% and 1 m/s increase in temperature, relative humidity and wind velocity using different lag structures for models with different degrees of freedom (df) in meteorological factors.

Note: M0: main model, adjusted meteorological factors df=3, time df=7. M1: changing df in adjusted meteorological factors, adjusted meteorological factors df=4, time df=7.

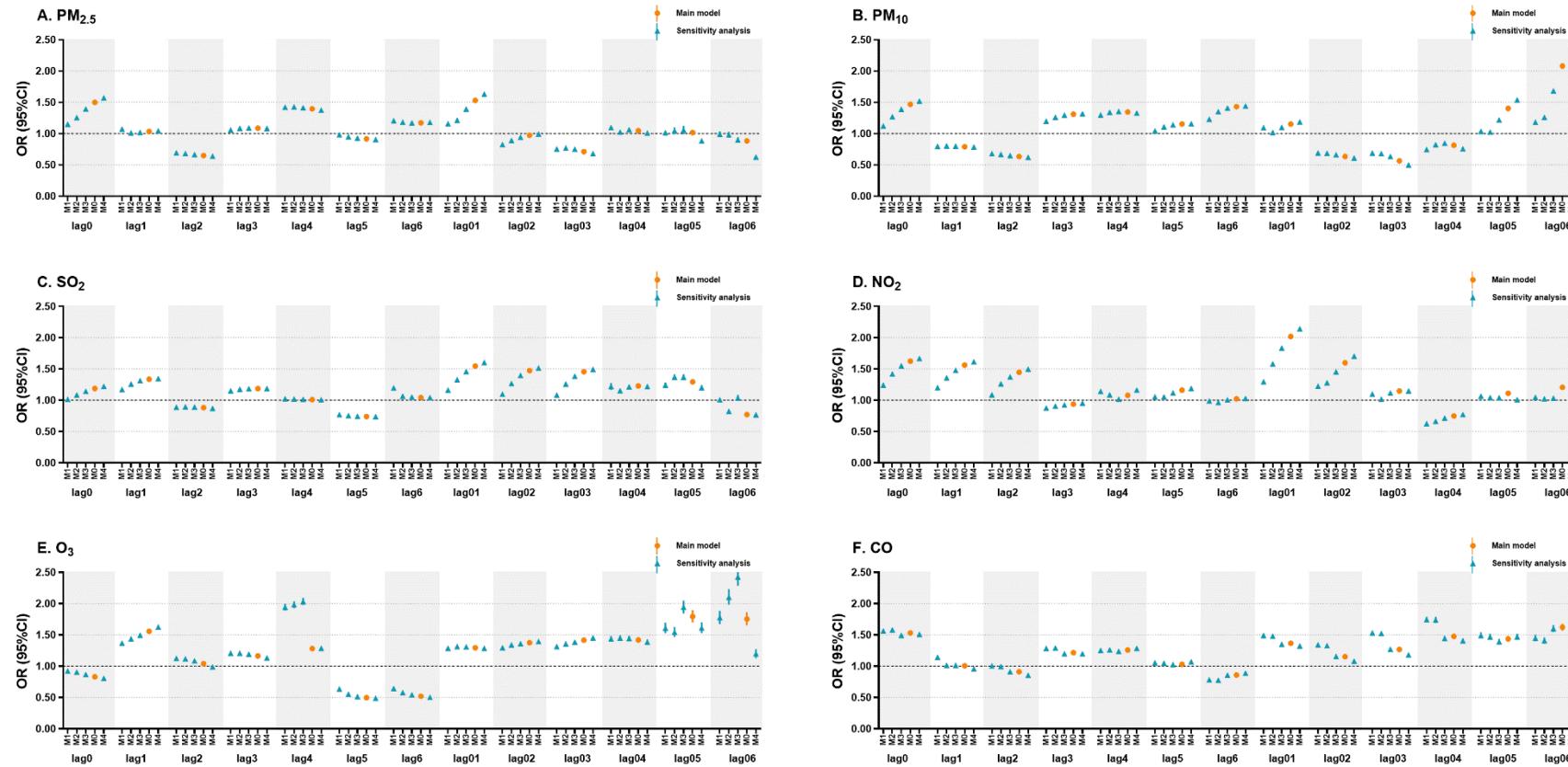


Figure A5. Odds ratios and 95% confidence intervals per an interquartile range increase in the concentrations of air pollutants using different lag structures for models with different degrees of freedom (df) in time trend.

Note: M0: main model, temperature df=3, relative humidity df=3, wind velocity df=3, time df=7. M1-M4: changing df included in the cubic thin plate spline function used to capture time trend, temperature df=3, relative humidity df=3, wind velocity df=3, time df=4, 5, 6, and 8.

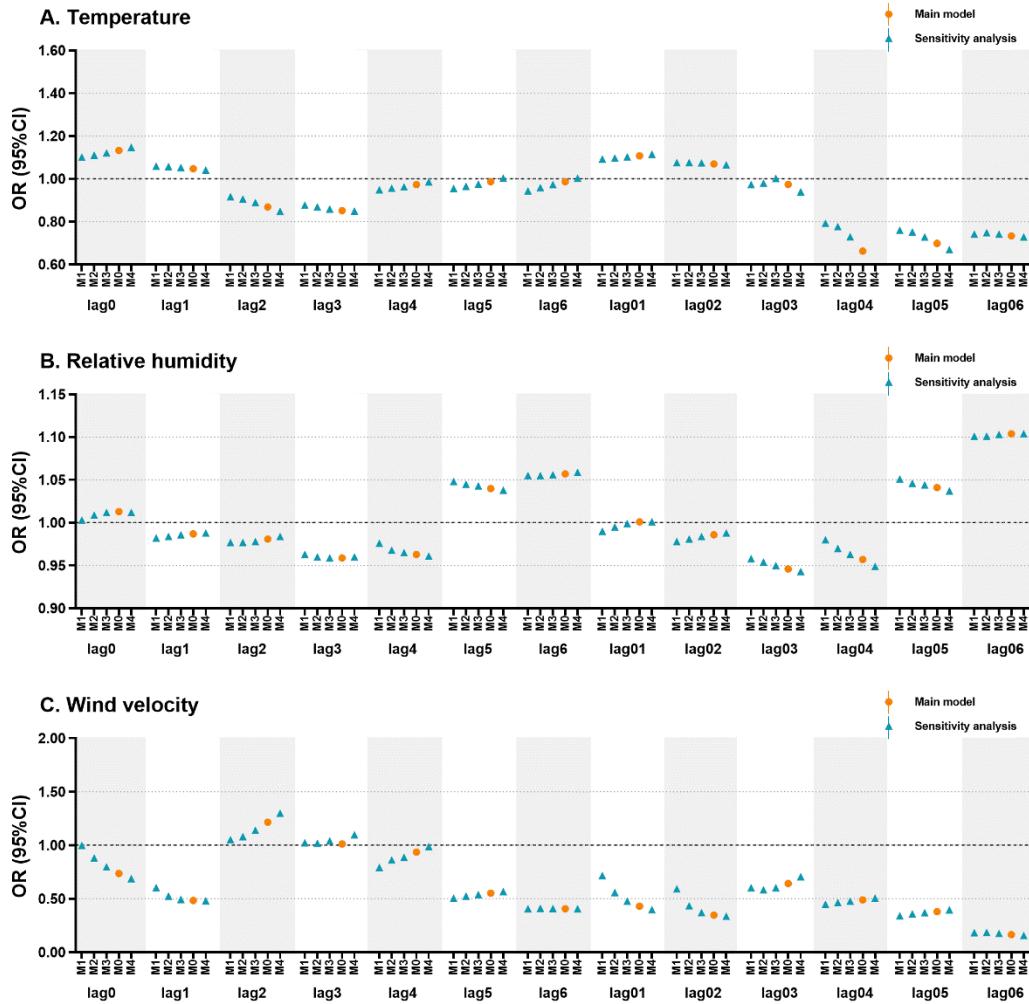


Figure A6. Odds ratios and 95% confidence intervals per 1°C , 1% and 1 m/s increase in temperature, relative humidity and wind velocity using different lag structures for models with different degrees of freedom (df) in time trend.

Note: M0: main model, adjusted meteorological factors df=3, time df=7. M1-M4: changing df included in the cubic thin plate spline function used to capture time trend, adjusted meteorological factors df=3, time df=4, 5, 6, and 8.

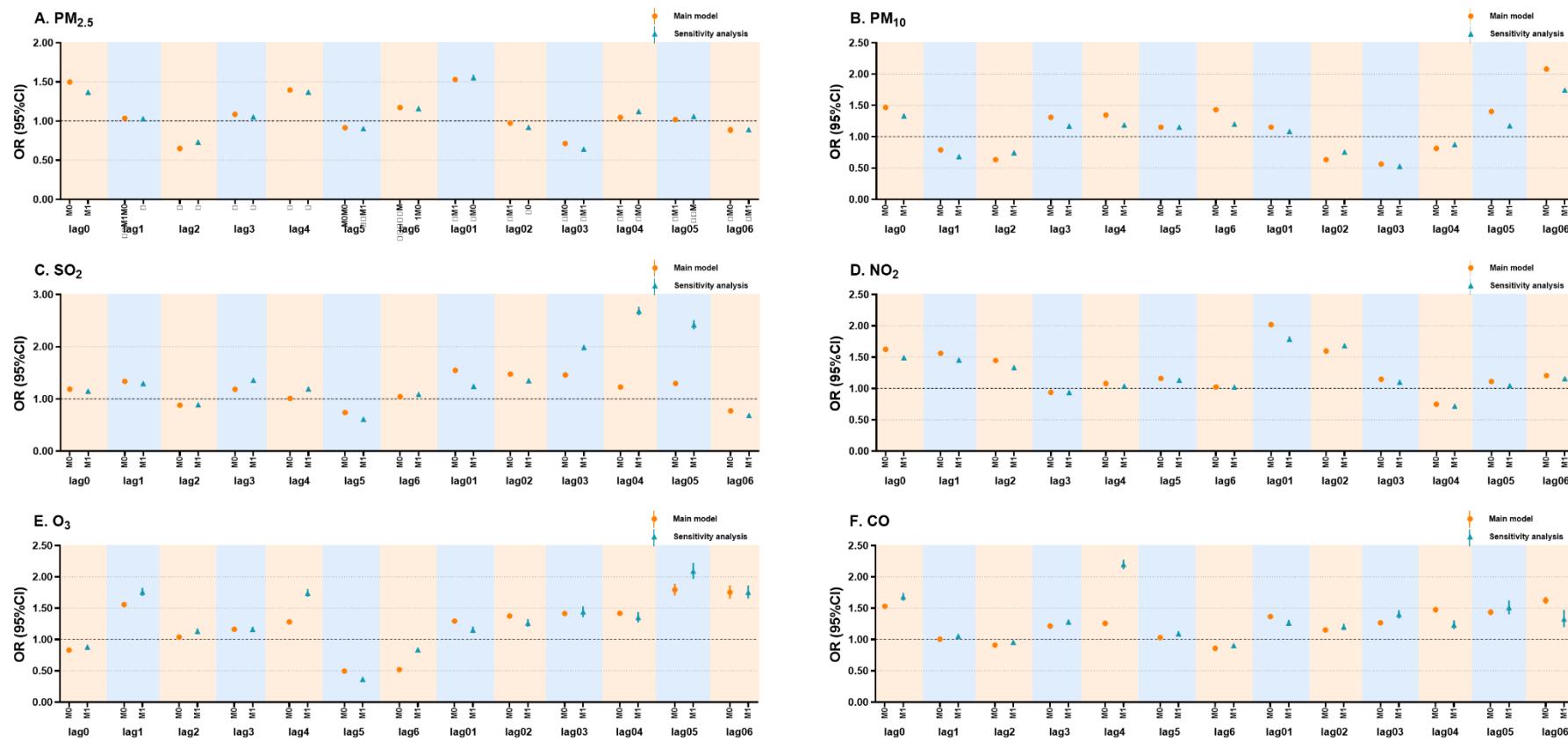


Figure A7. Odds ratios and 95% confidence intervals per an interquartile range increase in the concentrations of air pollutants using different lag structures for different models.

Note: M0: main model, GAMMs. M1: conditional Poisson model.

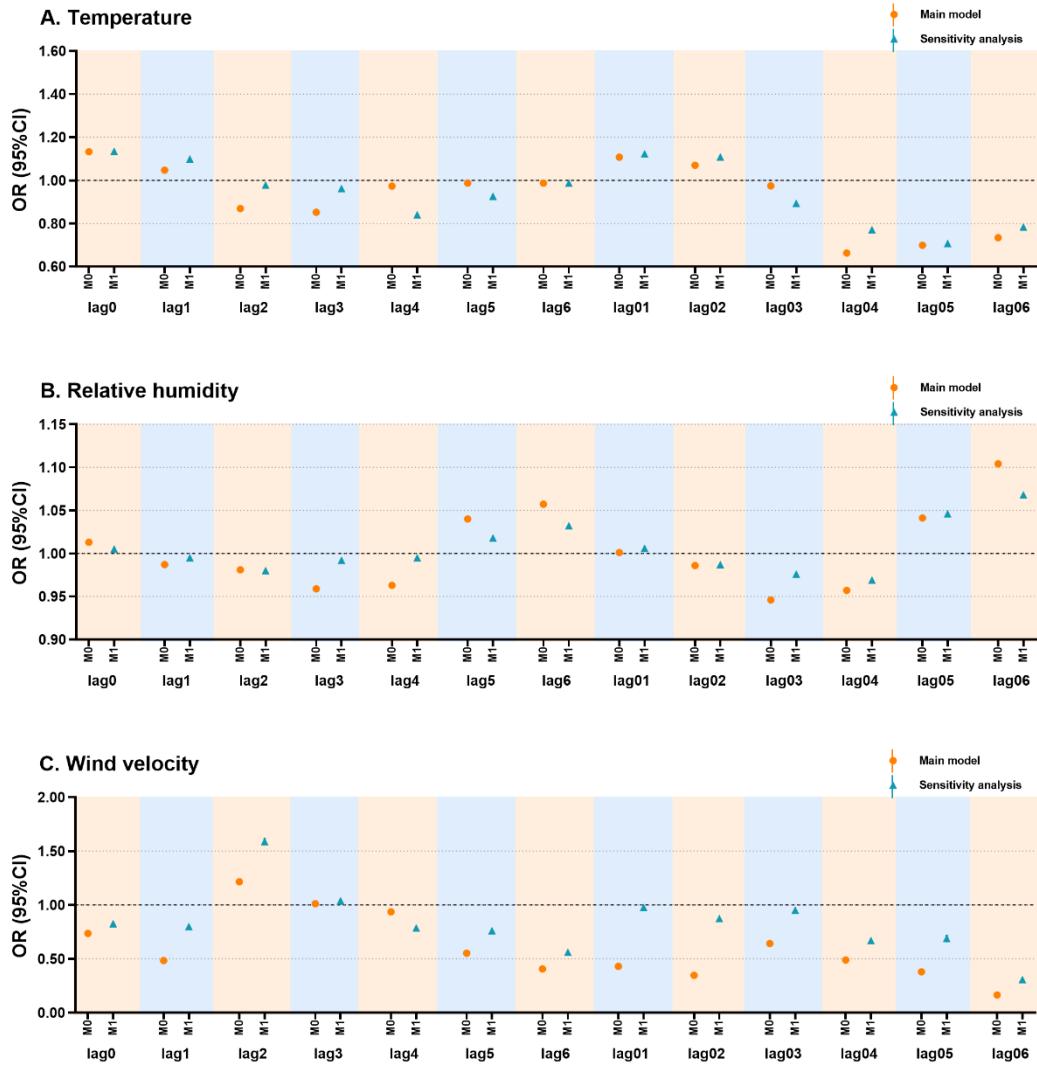


Figure A8. Odds ratios and 95% confidence intervals per 1°C, 1% and 1 m/s increase in temperature, relative humidity and wind velocity using different lag structures for different models.

Note: M0: main model, GAMMs. M1: conditional Poisson model.