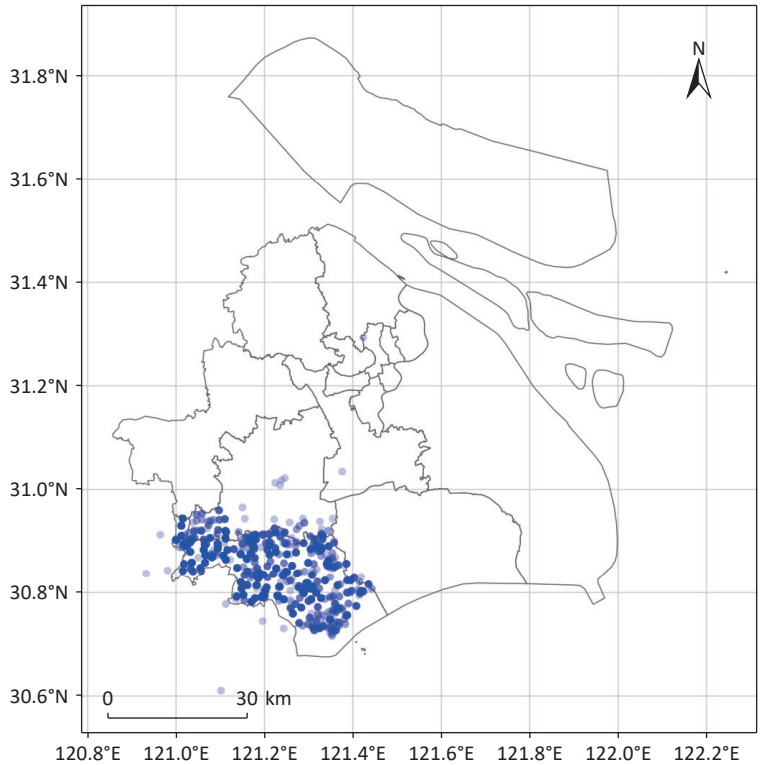
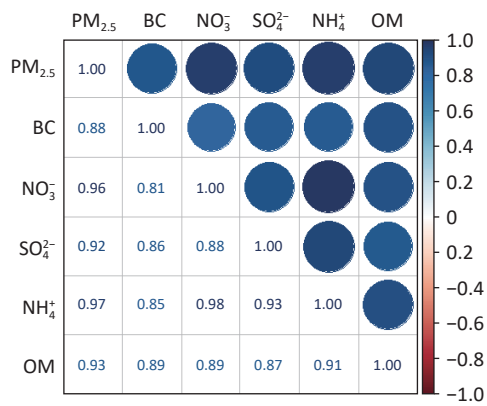
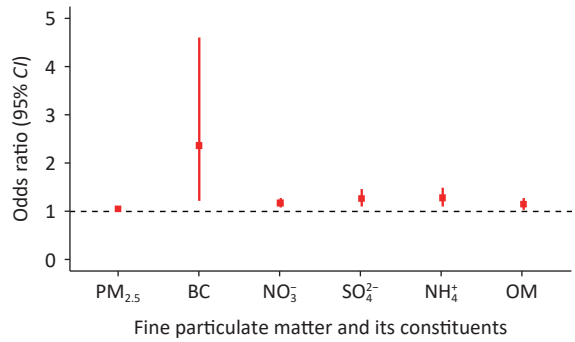


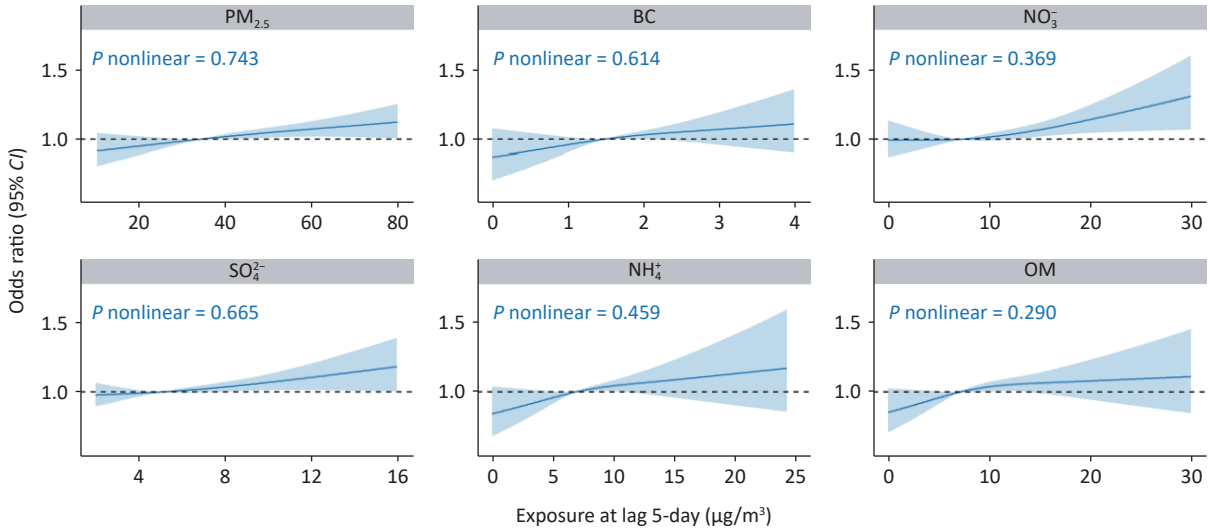
Supplementary Figure S1. Map distribution of acute exacerbations of chronic bronchitis. Map approval number: SH(2020)037.



Supplementary Figure S2. The pairwise coefficients of Spearman correlation between $PM_{2.5}$ and its constituents.



Supplementary Figure S3. The association between $PM_{2.5}$ and its constituents and acute exacerbations of chronic bronchitis in the CHAP data set.



Supplementary Figure S4. Concentration-response curves $PM_{2.5}$ and its constituents associated with acute exacerbations of chronic bronchitis in the CHAP data set.

Supplementary Table S1. Summary distributions of total $PM_{2.5}$, $PM_{2.5}$ constituents on case days and control days, 2018–2022

Variables	Min	Q1 (25%)	Median	Q3 (75%)	Max	Mean	SD	IQR	% of $PM_{2.5}$ mass
On case days (*n* = 2,202)									
$PM_{2.5}$ (μg/m³)	1.00	18.00	27.00	47.00	132.00	34.52	22.85	29.00	100
BC (μg/m³)	0.03	0.79	1.21	1.84	5.26	1.42	0.84	1.05	4.11
NO_3^- (μg/m³)	0.11	3.09	5.73	11.88	40.59	8.20	6.94	8.79	23.75
SO_4^{2-} (μg/m³)	0.18	3.76	5.55	8.46	31.05	6.65	4.13	4.70	19.26
NH_4^+ (μg/m³)	0.09	2.35	4.04	7.66	21.36	5.34	4.03	5.31	15.47
OM (μg/m³)	0.20	3.72	5.83	9.74	32.59	7.47	5.32	6.02	21.64
On control days (*n* = 7,381)									
$PM_{2.5}$ (μg/m³)	1.00	18.00	27.00	47.00	135.00	34.53	22.73	29.00	100
BC (μg/m³)	0.03	0.80	1.23	1.84	4.95	1.41	0.80	1.04	4.08
NO_3^- (μg/m³)	0.10	3.03	5.80	12.13	42.28	8.17	6.75	9.10	23.66
SO_4^{2-} (μg/m³)	0.17	3.73	5.60	8.70	31.20	6.66	4.12	4.97	19.29
NH_4^+ (μg/m³)	0.08	2.32	4.09	7.73	22.12	5.33	3.95	5.41	15.44
OM (μg/m³)	0.17	3.75	5.88	9.75	34.21	7.46	5.22	6.00	21.60

Note. $PM_{2.5}$, fine particulate matter; BC, black carbon; NO_3^-, nitrate; SO_4^{2-}, sulfate; NH_4^+, ammonium; OM, organic matter. Min, minimum; Max, maximum; SD, standard deviation; IQR, interquartile range.

Supplementary Table S2. Summary distribution of average levels of $PM_{2.5}$ its constituents for the study period 2018–2020

Variable	Min	Q1 (25%)	Median	Q3 (75%)	Max	Mean	SD	IQR
$PM_{2.5}$ (μg/m³)	1.00	18.00	27.00	47.00	135.00	34.52	22.48	29.00
BC (μg/m³)	0.03	0.8	1.22	1.84	5.26	1.41	0.81	1.04
NO_3^- (μg/m³)	0.10	3.04	5.79	12.09	42.28	8.18	6.79	9.05
SO_4^{2-} (μg/m³)	0.17	3.74	5.59	8.61	31.20	6.66	4.12	4.87
NH_4^- (μg/m³)	0.08	2.33	4.07	7.72	22.12	5.33	3.97	5.38
OM (μg/m³)	0.17	3.74	5.86	9.75	34.21	7.46	5.24	6.01

Note. $PM_{2.5}$, fine particulate matter; BC, black carbon; NO_3^-, nitrate; SO_4^{2-}, sulfate; NH_4^+, ammonium; OM, organic matter. Min, minimum; Max, maximum; SD, standard deviation; IQR, interquartile range.

Supplementary Table S3. The estimated odds ratios (95% *CI*) for $PM_{2.5}$ and its constituents for each 10 (μg/m³) increase in AECB risk on different lag days

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
$PM_{2.5}$ (10 μg/m³)	Lag 0-day	1.002 (0.979, 1.025)	0.869
	Lag 1-day	1.006 (0.984, 1.029)	0.598
	Lag 2-day	1.005 (0.983, 1.028)	0.656
	Lag 3-day	1.002 (0.980, 1.025)	0.849
	Lag 4-day	1.020 (0.998, 1.042)	0.081
	Lag 5-day	**1.033 (1.010, 1.055)**	**0.004**
	Lag 6-day	1.003 (0.981, 1.026)	0.785
	Lag 7-day	1.014 (0.992, 1.037)	0.217
	Lag 01-day	1.006 (0.979, 1.033)	0.679
	Lag 02-day	1.008 (0.977, 1.040)	0.606
	Lag 03-day	1.009 (0.975, 1.043)	0.619
	Lag 04-day	1.019 (0.982, 1.056)	0.316
	Lag 05-day	1.034 (0.995, 1.074)	0.088
	Lag 06-day	1.033 (0.993, 1.075)	0.108
	Lag 07-day	1.038 (0.996, 1.083)	0.078
BC (10 μg/m³)	Lag 0-day	1.129 (0.623, 2.046)	0.690
	Lag 1-day	1.343 (0.743, 2.427)	0.329
	Lag 2-day	1.204 (0.664, 2.184)	0.541
	Lag 3-day	0.989 (0.552, 1.771)	0.970
	Lag 4-day	1.559 (0.875, 2.775)	0.132
	Lag 5-day	**1.862 (1.038, 3.342)**	**0.037**
	Lag 6-day	1.218 (0.670, 2.215)	0.518
	Lag 7-day	1.349 (0.736, 2.474)	0.333
	Lag 01-day	1.344 (0.663, 2.724)	0.412
	Lag 02-day	1.443 (0.647, 3.217)	0.371
	Lag 03-day	1.384 (0.573, 3.342)	0.469
	Lag 04-day	1.718 (0.665, 4.440)	0.264

Continued

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
	Lag 05-day	2.249 (0.823, 6.144)	0.114
	Lag 06-day	2.389 (0.823, 6.938)	0.109
	Lag 07-day	2.681 (0.866, 8.299)	0.087
NO_3^- (10 μg/m³)	Lag 0-day	1.006 (0.931, 1.088)	0.871
	Lag 1-day	1.020 (0.944, 1.101)	0.623
	Lag 2-day	1.020 (0.944, 1.102)	0.617
	Lag 3-day	1.019 (0.945, 1.099)	0.620
	Lag 4-day	**1.078 (1.000, 1.162)**	**0.049**
	Lag 5-day	**1.129 (1.049, 1.216)**	**0.001**
	Lag 6-day	1.030 (0.955, 1.112)	0.439
	Lag 7-day	1.064 (0.986, 1.149)	0.109
	Lag 01-day	1.018 (0.929, 1.116)	0.699
	Lag 02-day	1.027 (0.927, 1.139)	0.608
	Lag 03-day	1.035 (0.925, 1.158)	0.546
	Lag 04-day	1.072 (0.951, 1.208)	0.254
	Lag 05-day	1.131 (0.997, 1.283)	0.055
	Lag 06-day	1.140 (0.998, 1.301)	0.054
	Lag 07-day	1.165 (1.013, 1.340)	0.032
SO_4^{2-} (10 μg/m³)	Lag 0-day	0.986 (0.874, 1.112)	0.818
	Lag 1-day	0.985 (0.873, 1.110)	0.801
	Lag 2-day	0.992 (0.879, 1.119)	0.898
	Lag 3-day	0.985 (0.876, 1.108)	0.806
	Lag 4-day	1.079 (0.962, 1.212)	0.195
	Lag 5-day	**1.145 (1.021, 1.284)**	**0.020**
	Lag 6-day	0.996 (0.885, 1.122)	0.953
	Lag 7-day	1.056 (0.937, 1.191)	0.371
	Lag 01-day	0.978 (0.846, 1.132)	0.770
	Lag 02-day	0.976 (0.824, 1.155)	0.775
	Lag 03-day	0.968 (0.801, 1.169)	0.735
	Lag 04-day	1.017 (0.828, 1.249)	0.872
	Lag 05-day	1.103 (0.885, 1.375)	0.381
	Lag 06-day	1.099 (0.868, 1.391)	0.432
	Lag 07-day	1.132 (0.880, 1.457)	0.333
NH_4^+ (10 μg/m³)	Lag 0-day	1.008 (0.886, 1.148)	0.903
	Lag 1-day	1.035 (0.910, 1.177)	0.602
	Lag 2-day	1.048 (0.921, 1.193)	0.475
	Lag 3-day	1.027 (0.905, 1.164)	0.682
	Lag 4-day	1.127 (0.995, 1.276)	0.061
	Lag 5-day	**1.190 (1.051, 1.346)**	**0.006**
	Lag 6-day	1.046 (0.921, 1.188)	0.490

Continued

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
	Lag 7-day	1.109 (0.976, 1.260)	0.114
	Lag 01-day	1.030 (0.884, 1.200)	0.704
	Lag 02-day	1.055 (0.887, 1.254)	0.544
	Lag 03-day	1.065 (0.881, 1.287)	0.514
	Lag 04-day	1.129 (0.921, 1.384)	0.242
	Lag 05-day	1.222 (0.985, 1.515)	0.068
	Lag 06-day	1.237 (0.985, 1.553)	0.068
	Lag 07-day	1.288 (1.013, 1.639)	0.039
OM (10 μg/m³)	Lag 0-day	1.005 (0.914, 1.106)	0.910
	Lag 1-day	1.046 (0.953, 1.149)	0.342
	Lag 2-day	1.019 (0.928, 1.119)	0.689
	Lag 3-day	1.022 (0.933, 1.119)	0.637
	Lag 4-day	1.079 (0.986, 1.180)	0.096
	Lag 5-day	**1.105 (1.009, 1.209)**	**0.031**
	Lag 6-day	1.004 (0.915, 1.101)	0.935
	Lag 7-day	1.097 (0.998, 1.205)	0.055
	Lag 01-day	1.037 (0.927, 1.160)	0.525
	Lag 02-day	1.045 (0.919, 1.187)	0.505
	Lag 03-day	1.054 (0.915, 1.214)	0.462
	Lag 04-day	1.097 (0.942, 1.276)	0.234
	Lag 05-day	1.145 (0.977, 1.342)	0.095
	Lag 06-day	1.138 (0.963, 1.344)	0.128
	Lag 07-day	1.178 (0.989, 1.403)	0.066

Note. *P*-values of regression coefficient hypothesis test; the bold indicates correlation is significant at the 0.5 level.

Supplementary Table S4. The estimated odds ratios (95% confidence intervals) for $PM_{2.5}$ mass and its constituents for each 10 (μg/m³) increase in AECB risk on different lag days (Elimination of the COVID-19 pandemic: Populations after December 2019)

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
$PM_{2.5}$ (10 μg/m³)	Lag 0-day	0.995 (0.969, 1.022)	0.730
	Lag 1-day	1.003 (0.977, 1.029)	0.842
	Lag 2-day	0.996 (0.971, 1.023)	0.775
	Lag 3-day	1.000 (0.975, 1.025)	0.988
	Lag 4-day	1.004 (0.979, 1.030)	0.731
	Lag 5-day	1.017 (0.992, 1.043)	0.187
	Lag 6-day	1.008 (0.982, 1.034)	0.553
	Lag 7-day	1.035 (1.009, 1.061)	0.009
	Lag 01-day	0.999 (0.968, 1.03)	0.933
	Lag 02-day	0.997 (0.962, 1.032)	0.848
	Lag 03-day	0.997 (0.959, 1.036)	0.871
	Lag 04-day	0.999 (0.959, 1.041)	0.978
	Lag 05-day	1.008 (0.965, 1.052)	0.727
	Lag 06-day	1.011 (0.966, 1.058)	0.642
	Lag 07-day	1.025 (0.978, 1.075)	0.300
BC (10 μg/m³)	Lag 0-day	0.869 (0.436, 1.729)	0.688
	Lag 1-day	1.137 (0.576, 2.247)	0.711
	Lag 2-day	0.972 (0.493, 1.917)	0.934
	Lag 3-day	0.882 (0.456, 1.706)	0.708
	Lag 4-day	1.082 (0.557, 2.103)	0.815
	Lag 5-day	1.232 (0.630, 2.407)	0.542
	Lag 6-day	1.364 (0.689, 2.699)	0.373
	Lag 7-day	2.227 (1.116, 4.444)	0.023
	Lag 01-day	0.993 (0.441, 2.237)	0.987
	Lag 02-day	0.977 (0.393, 2.432)	0.961
	Lag 03-day	0.912 (0.338, 2.466)	0.856
	Lag 04-day	0.957 (0.328, 2.790)	0.936
	Lag 05-day	1.059 (0.342, 3.284)	0.920
	Lag 06-day	1.212 (0.365, 4.029)	0.753
	Lag 07-day	1.691 (0.474, 6.026)	0.418
NO_3^- (10 μg/m³)	Lag 0-day	0.998 (0.911, 1.093)	0.958
	Lag 1-day	1.017 (0.930, 1.112)	0.717
	Lag 2-day	0.989 (0.904, 1.082)	0.806
	Lag 3-day	0.998 (0.915, 1.089)	0.962
	Lag 4-day	1.023 (0.936, 1.117)	0.617
	Lag 5-day	1.073 (0.984, 1.171)	0.110
	Lag 6-day	1.046 (0.958, 1.143)	0.318
	Lag 7-day	1.15 (1.054, 1.255)	0.002

Continued

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
	Lag 01-day	1.01 (0.908, 1.124)	0.854
	Lag 02-day	1.002 (0.889, 1.128)	0.977
	Lag 03-day	1.000 (0.879, 1.139)	0.995
	Lag 04-day	1.012 (0.881, 1.162)	0.871
	Lag 05-day	1.045 (0.903, 1.21)	0.554
	Lag 06-day	1.064 (0.911, 1.243)	0.432
	Lag 07-day	1.129 (0.958, 1.331)	0.146
SO_4^{2-} (10 μg/m³)	Lag 0-day	0.962 (0.841, 1.102)	0.577
	Lag 1-day	0.962 (0.841, 1.100)	0.570
	Lag 2-day	0.961 (0.840, 1.100)	0.564
	Lag 3-day	0.987 (0.866, 1.124)	0.841
	Lag 4-day	0.995 (0.873, 1.134)	0.941
	Lag 5-day	1.054 (0.927, 1.199)	0.419
	Lag 6-day	0.992 (0.869, 1.133)	0.908
	Lag 7-day	1.120 (0.981, 1.279)	0.094
	Lag 01-day	0.946 (0.804, 1.112)	0.498
	Lag 02-day	0.928 (0.770, 1.118)	0.433
	Lag 03-day	0.926 (0.753, 1.138)	0.464
	Lag 04-day	0.926 (0.739, 1.161)	0.506
	Lag 05-day	0.958 (0.753, 1.220)	0.731
	Lag 06-day	0.955 (0.738, 1.237)	0.728
	Lag 07-day	1.015 (0.770, 1.337)	0.918
NH_4^+ (10 μg/m³)	Lag 0-day	1.000 (0.862, 1.160)	0.997
	Lag 1-day	1.027 (0.887, 1.189)	0.720
	Lag 2-day	1.001 (0.864, 1.160)	0.987
	Lag 3-day	1.004 (0.871, 1.158)	0.954
	Lag 4-day	1.033 (0.895, 1.192)	0.662
	Lag 5-day	1.089 (0.945, 1.256)	0.240
	Lag 6-day	1.077 (0.932, 1.246)	0.316
	Lag 7-day	1.236 (1.071, 1.427)	0.004
	Lag 01-day	1.019 (0.857, 1.212)	0.833
	Lag 02-day	1.017 (0.836, 1.235)	0.869
	Lag 03-day	1.017 (0.822, 1.259)	0.876
	Lag 04-day	1.033 (0.821, 1.299)	0.783
	Lag 05-day	1.074 (0.842, 1.371)	0.564
	Lag 06-day	1.108 (0.856, 1.435)	0.436
	Lag 07-day	1.216 (0.925, 1.599)	0.161
OM (10 μg/m³)	Lag 0-day	0.989 (0.888, 1.101)	0.841
	Lag 1-day	1.049 (0.945, 1.165)	0.367
	Lag 2-day	0.995 (0.895, 1.106)	0.921

Continued

Exposure	Lag structures	*OR* (95% *CI*)	*P*-values
	Lag 3-day	1.012 (0.915, 1.120)	0.815
	Lag 4-day	1.025 (0.925, 1.135)	0.637
	Lag 5-day	1.053 (0.951, 1.165)	0.324
	Lag 6-day	1.018 (0.918, 1.130)	0.732
	Lag 7-day	1.183 (1.066, 1.312)	0.002
	Lag 01-day	1.028 (0.906, 1.166)	0.670
	Lag 02-day	1.021 (0.884, 1.179)	0.781
	Lag 03-day	1.026 (0.876, 1.201)	0.749
	Lag 04-day	1.038 (0.876, 1.229)	0.667
	Lag 05-day	1.061 (0.889, 1.267)	0.509
	Lag 06-day	1.066 (0.886, 1.284)	0.497
	Lag 07-day	1.143 (0.942, 1.388)	0.176

Note. *P*-values of regression coefficient hypothesis test; the bold indicates correlation is significant at the 0.5 level.

Supplementary Table S5. In subgroup analyses, the odds ratio (95% *CI*) for AECB was associated with each 10μg/m³ increase in exposure to $PM_{2.5}$ and its constituents

Subgroup	$PM_{2.5}$			BC			NO_3^-		
	OR (95% *CI*)	*P*-values	*P*.int	*OR* (95% *CI*)	*P*-values	*P*.int	*OR* (95% *CI*)	*P*-values	*P*.int
Sex									
Men	**1.046 (1.017, 1.076)**	**0.002**	0.165	**2.352 (1.104, 5.009)**	**0.027**	0.341	**1.168 (1.062, 1.285)**	**0.001**	0.271
Women	1.013 (0.979, 1.049)	0.455		1.317 (0.522, 3.32)	0.559		1.074 (0.956, 1.207)	0.231	
Age									
< 80 years	**1.034 (1.002, 1.067)**	**0.035**	0.888	1.549 (0.669, 3.586)	0.307	0.548	**1.132 (1.019, 1.258)**	**0.021**	0.951
80+ years	1.031 (1.000, 1.063)	0.048		2.218 (0.981, 5.013)	0.056		**1.127 (1.017, 1.249)**	**0.023**	
Season at happen									
Cold	**1.034 (1.009, 1.059)**	**0.008**	0.882	**2.391 (1.223, 4.674)**	**0.011**	0.138	**1.125 (1.037, 1.221)**	**0.005**	0.835
Warm	1.029 (0.980, 1.081)	0.252		0.840 (0.251, 2.813)	0.778		1.148 (0.969, 1.36)	0.110	
Subgroup	SO_4^{2-}			NH_4^+			OM		
	OR (95% *CI*)	*P*-values	*P*.int	*OR* (95% *CI*)	*P*-values	*P*.int	*OR* (95% *CI*)	*P*-values	*P*.int
Sex									
Men	**1.235 (1.065, 1.432)**	**0.005**	0.119	**1.265 (1.077, 1.485)**	**0.004**	0.24	**1.145 (1.018, 1.287)**	**0.023**	0.394
Women	1.025 (0.855, 1.229)	0.789		1.087 (0.894, 1.321)	0.404		1.048 (0.909, 1.209)	0.515	
Age									
< 80 years	1.172 (0.996, 1.38)	0.056	0.391	**1.207 (1.011, 1.441)**	**0.037**	0.818	1.116 (0.982, 1.269)	0.094	0.826
80+ years	1.119 (0.953, 1.315)	0.170		1.173 (0.986, 1.395)	0.072		1.094 (0.963, 1.242)	0.166	
Season									
Cold	**1.171 (1.020, 1.344)**	**0.025**	0.569	**1.191 (1.035, 1.37)**	**0.015**	0.972	**1.111 (1.005, 1.228)**	**0.039**	0.793
Warm	1.089 (0.884, 1.341)	0.423		1.184 (0.909, 1.544)	0.210		1.077 (0.876, 1.325)	0.480	

Note. $^*P < 0.05$; *P*.int: *P*-value of regression coefficient hypothesis test. *P*-values of regression coefficient hypothesis test.

Supplementary Table S6. Sensitivity analysis of odds ratios (95% *CI*) for each 10 μg/m³-associated increase in exposure to air pollutants in AECB

Exposure	Model adjustments	*OR* (95% *CI*)	*P*-values *a*	*P*.int
$PM_{2.5}$	Main model	**1.033 (1.01, 1.055)**	**0.004**	–
	and O^3	**1.029 (1.005, 1.052)**	**0.016**	0.656
BC	Main model	**1.862 (1.038, 3.342)**	**0.037**	–
	and O^3	1.642 (0.890, 3.027)	0.112	0.209
NO_3^-	Main model	**1.129 (1.049, 1.216)**	**0.001**	–
	and O^3	**1.116 (1.033, 1.206)**	**0.005**	0.754
SO_4^{2-}	Main model	**1.145 (1.021, 1.284)**	**0.02**	–
	and O^3	1.122 (0.997, 1.262)	0.056	0.769
NH_4^+	Main model	**1.190 (1.051, 1.346)**	**0.006**	–
	and O^3	**1.162 (1.020, 1.324)**	**0.024**	0.657
OM	Main model	**1.105 (1.009, 1.209)**	**0.031**	–
	and O^3	1.082 (0.984, 1.191)	0.105	0.595

Note. *df*: degrees of freedom; *P*.int: *P*-value of regression coefficient hypothesis test. *P*-values of regression coefficient hypothesis test.