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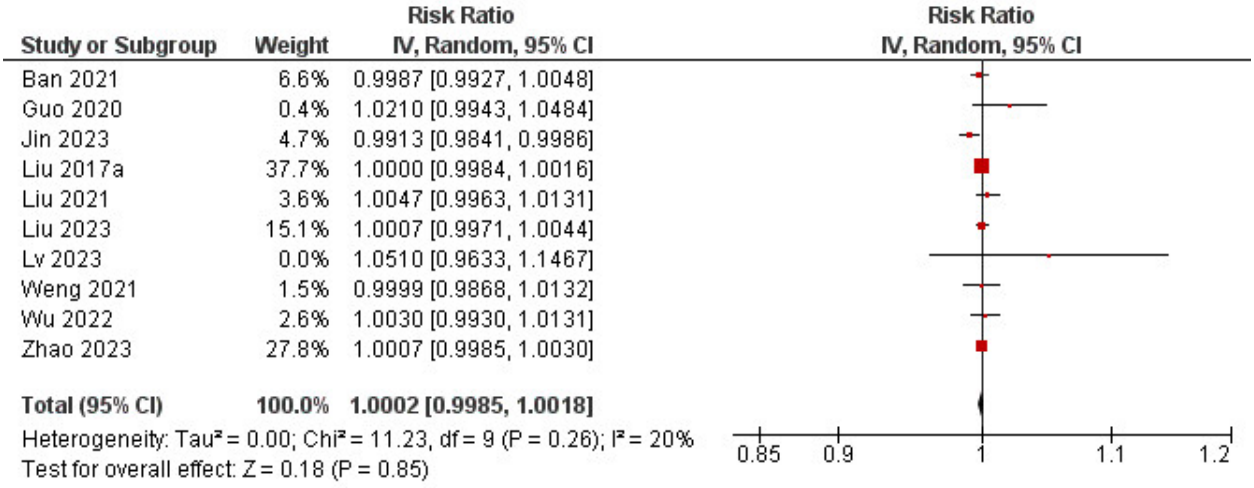
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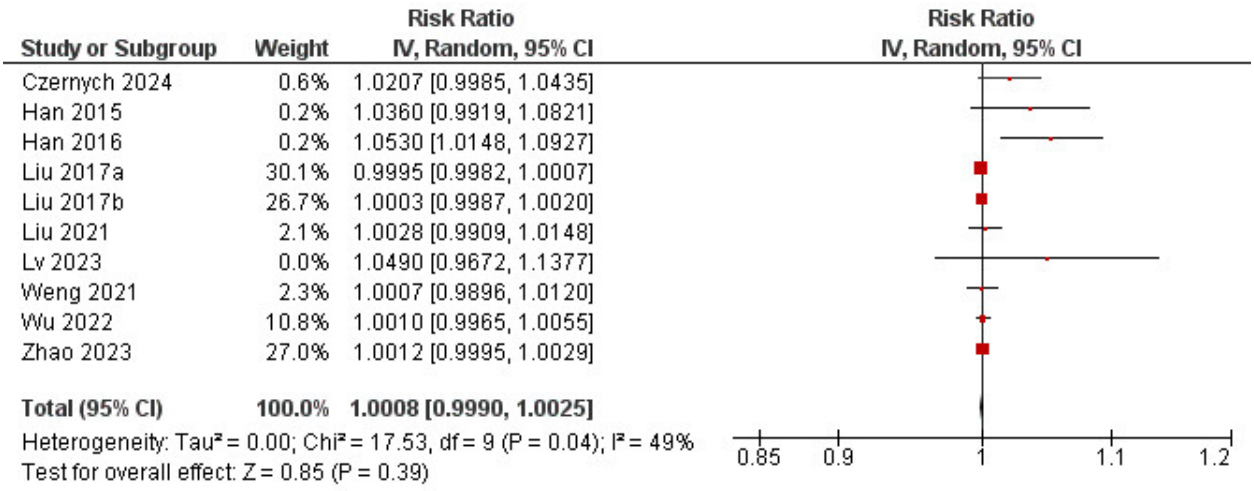
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Supplementary Material

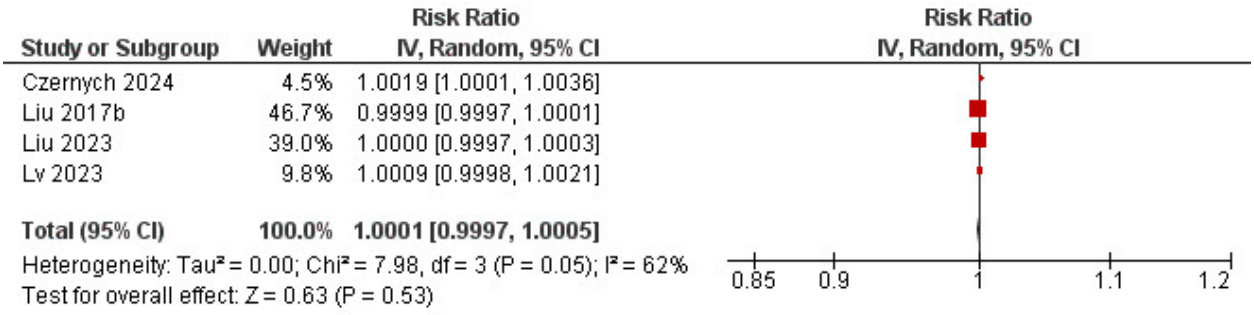
Supplementary Figures



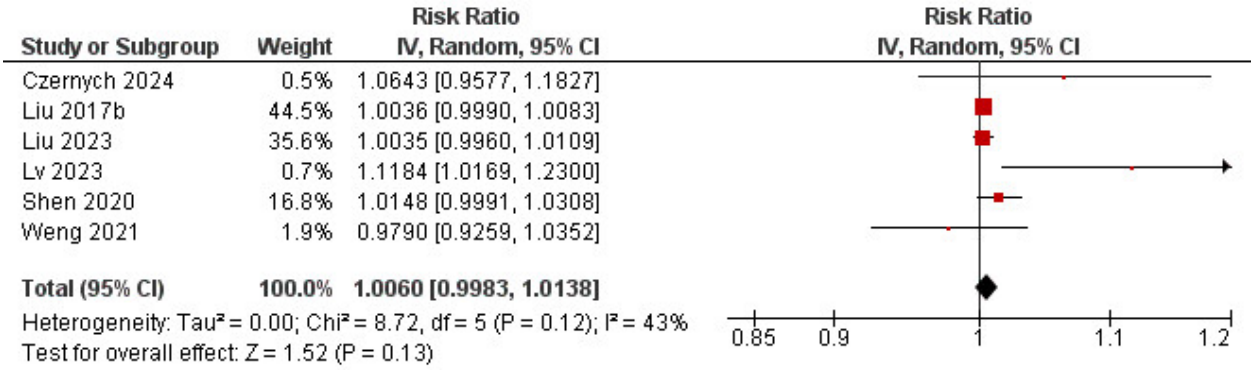
Supplemental Figure S1. Relative risk of hemorrhagic stroke after a 10 μg/m^3 increase in $PM_{2.5}$ exposure.



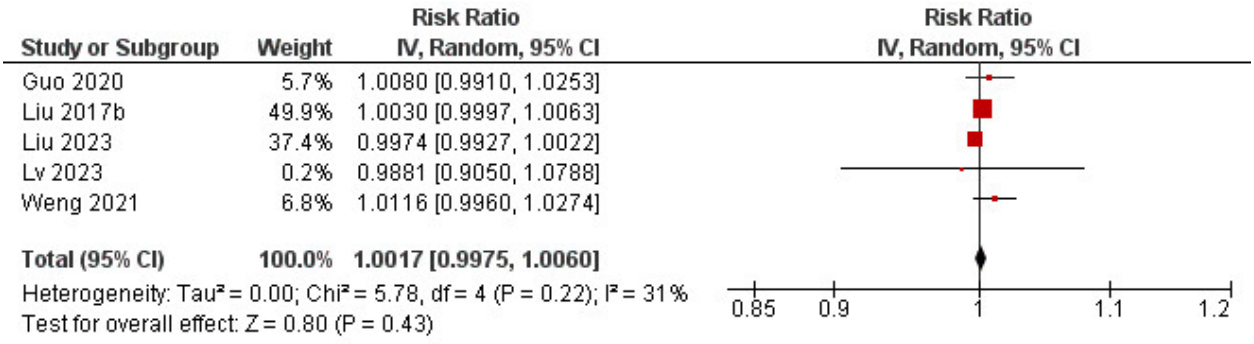
Supplemental Figure S2. Relative risk of hemorrhagic stroke after a 10 μg/m^3 increase in PM_{10} exposure.



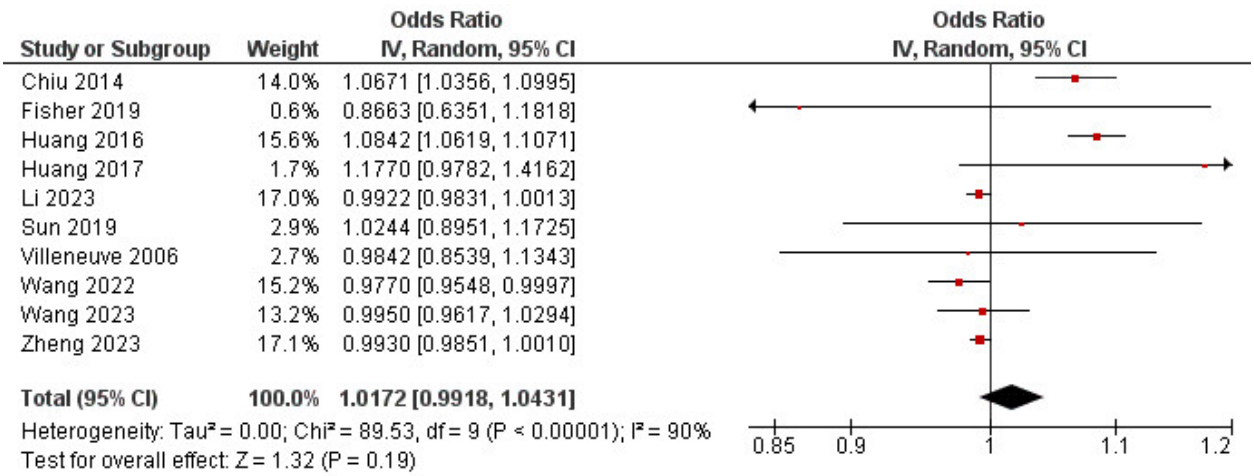
Supplemental Figure S3. Relative risk of hemorrhagic stroke after 10 μg/m^3 increase in CO exposure.



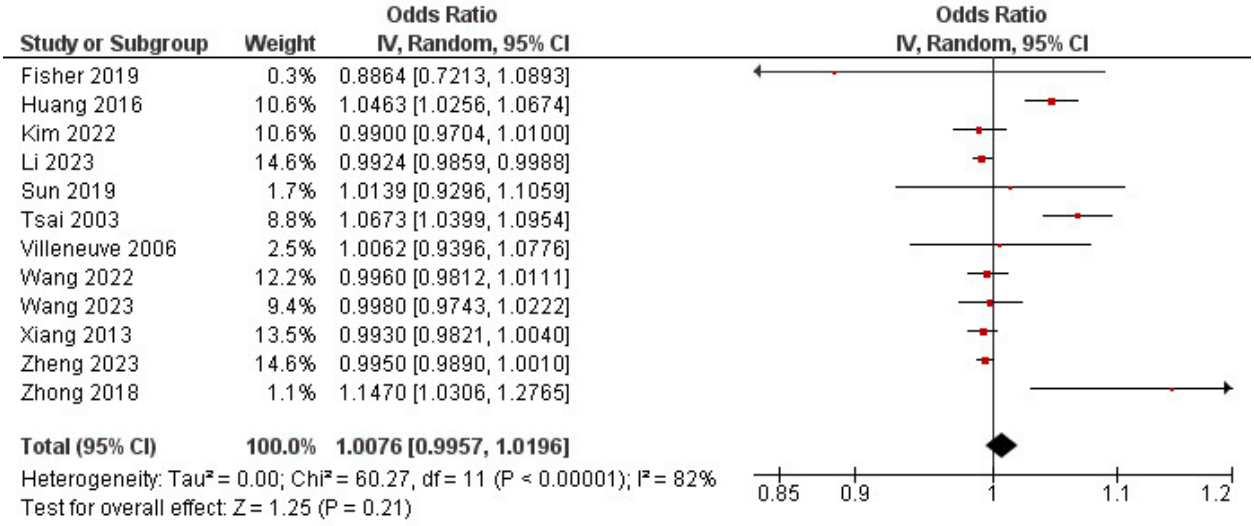
Supplemental Figure S4. Relative risk of hemorrhagic stroke after 10 μg/m^3 increase in SO_2 exposure.



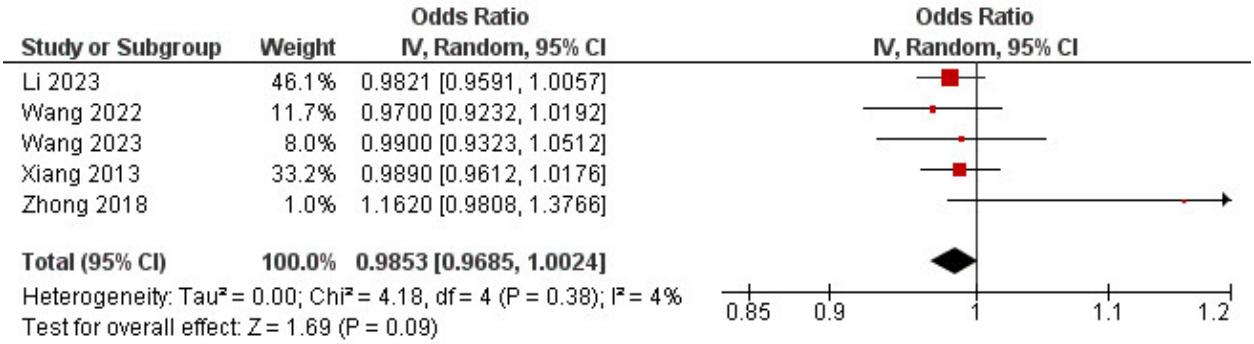
Supplemental Figure S5. Relative risk of hemorrhagic stroke after a 10 μg/m^3 increase in O_3 exposure.



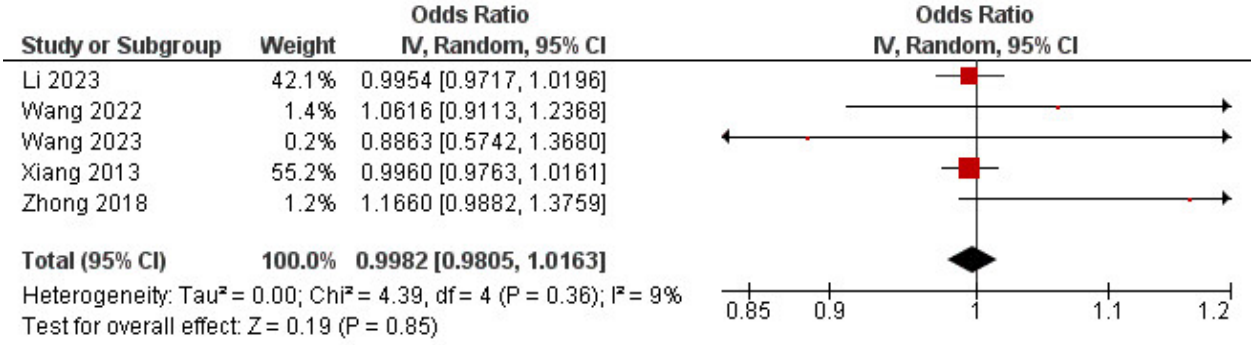
Supplemental Figure S6. Odds ratio of hemorrhagic stroke after a 10 μg/m^3 increase in $PM_{2.5}$ exposure.



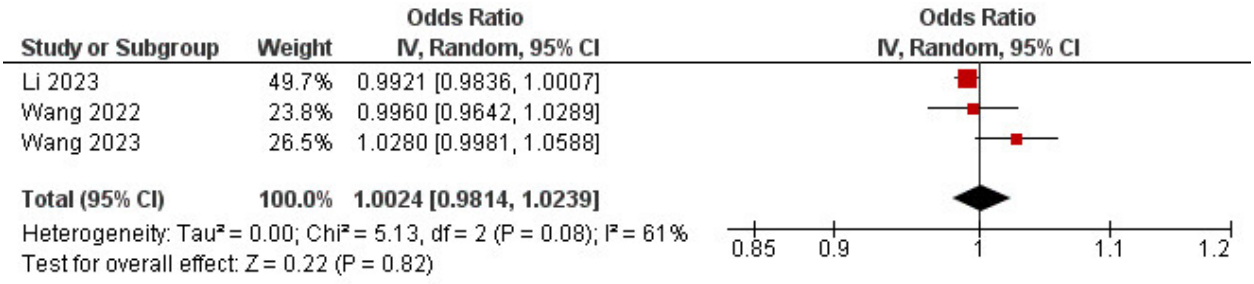
Supplemental Figure S7. Odds ratio of hemorrhagic stroke after a 10 μg/m^3 increase in PM_{10} exposure.



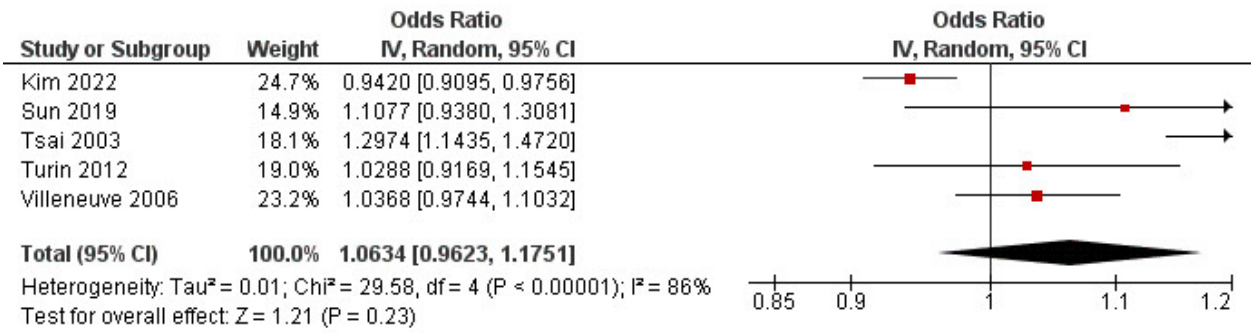
Supplemental Figure S8. Odds ratio of hemorrhagic stroke after a 10 μg/m^3 increase in NO_2 exposure.



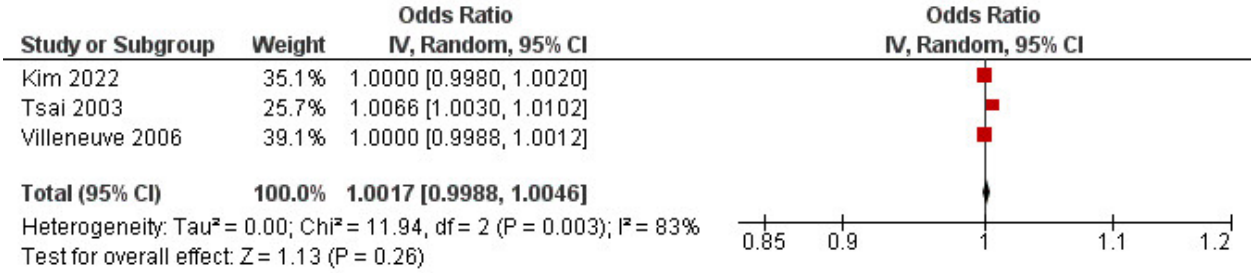
Supplemental Figure S9. Odds ratio of hemorrhagic stroke after a 10 μg/m^3 increase in SO_2 exposure.



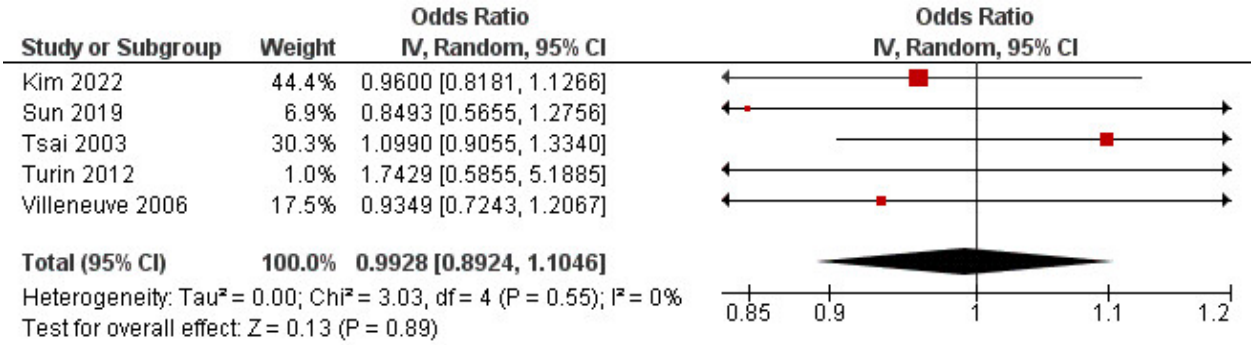
Supplemental Figure S10. Odds ratio of hemorrhagic stroke after a 10 μg/m^3 increase in O_3 exposure.



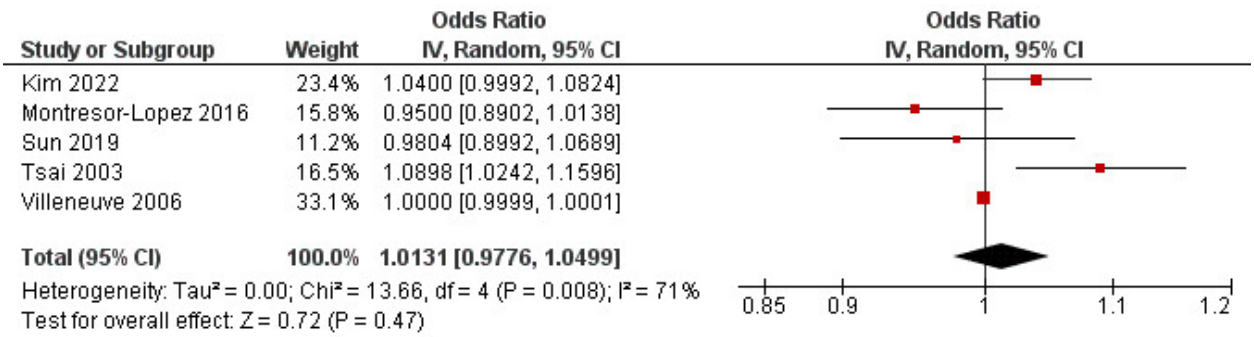
Supplemental Figure S11. Odds ratio of hemorrhagic stroke after a 10 ppb increase in NO_2 exposure.



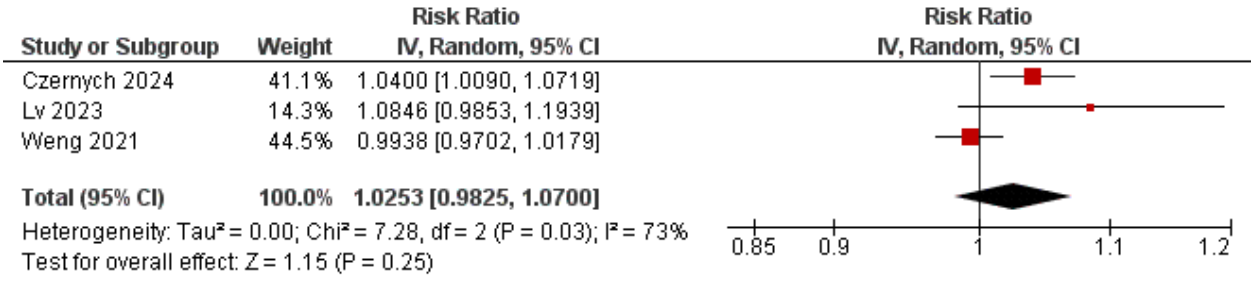
Supplemental Figure S12. Odds ratio of hemorrhagic stroke after a 10 ppb increase in CO exposure.



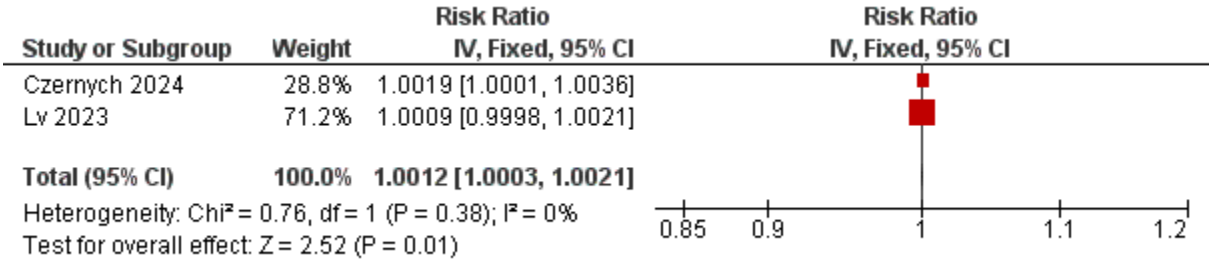
Supplemental Figure S13. Odds ratio of hemorrhagic stroke after a 10 ppb increase in SO_2 exposure.



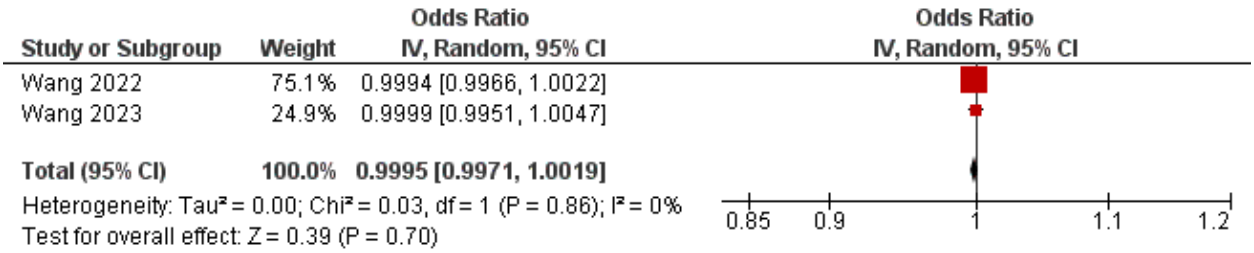
Supplemental Figure S14. Odds ratio of hemorrhagic stroke after a 10 ppb increase in O_3 exposure.



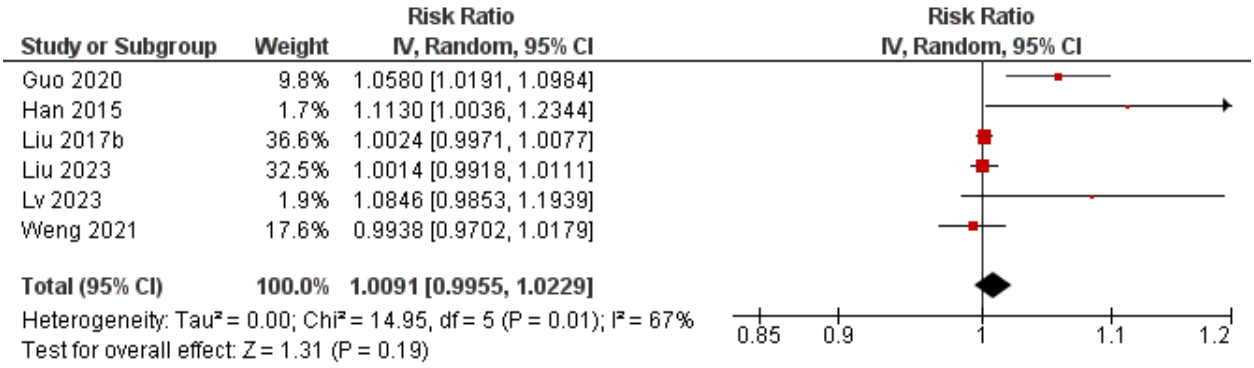
Supplemental Figure S15. Sensitivity analysis for lag0 relative risk outcomes of hemorrhagic stroke after a 10 $\mu g/m^3$ increase in NO_2 exposure.



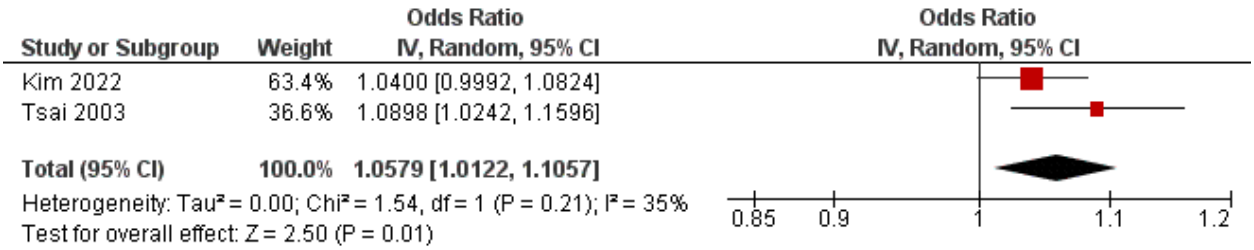
Supplemental Figure S16. Sensitivity analysis for lag0 relative risk outcomes of hemorrhagic stroke after a 10 $\mu g/m^3$ increase in CO exposure.



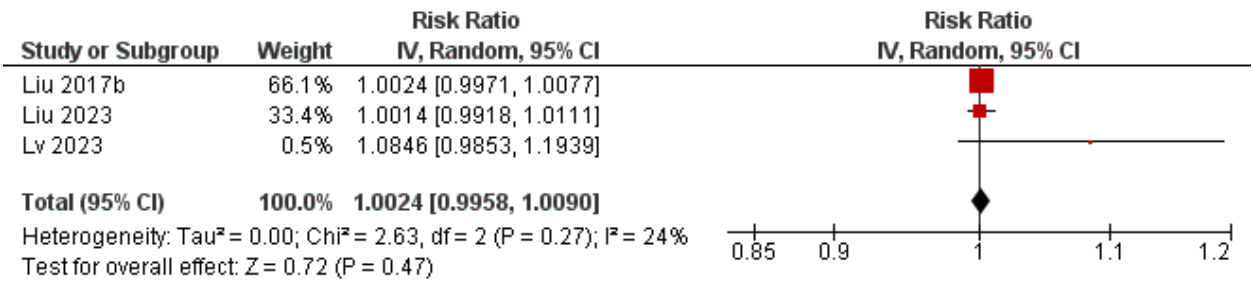
Supplemental Figure S17. Sensitivity analysis for lag0 odds ratio outcomes of hemorrhagic stroke after a 10 μg/m^3 increase in CO exposure.



Supplemental Figure S18. Sensitivity analysis from Asian region studies that reported odds ratio outcomes of hemorrhagic stroke after a 10 μg/m^3 increase in NO_2 exposure.



Supplemental Figure S19. Sensitivity analysis from Asian region studies that reported odds ratio outcomes of hemorrhagic stroke after a 10 ppb increase in O_3 exposure.



Supplemental Figure S20. Sensitivity analysis from case-crossover studies that reported odds ratio outcomes of hemorrhagic stroke after a 10 $\mu g/m^3$ increase in NO_2 exposure.

Supplementary Tables

Supplemental Table S1. Search strategy.

#	Search Terms	Embase	OVID Medline	Web of Science	PubMed
1	"air pollution"	131,278	74,573	195,056	110,378
2	"particulate matter"	88,603	41,641	108,278	101,365
3	"pm10"	7,013	9,117	27,731	12,014
4	"pm2.5"	13,464	18,862	52,829	10,368
5	"pm1"	2,634	1,502	4,522	2,436
6	"pm0.1"	59	123	334	61
7	"carbon monoxide"	68,537	36,314	105,737	43,484
8	"sulphur dioxide"	2,507	1,091	37,982	12,142
9	"sulfur dioxide"	21,211	8,004	38,095	12,142
10	"so2"	5,698	9,671	62,047	15,516
11	"nitrogen dioxide"	22,418	9,961	59,342	24,502
12	"no2"	11,168	16,920	78,839	26,017
13	"ozone"	48,473	25,364	118,941	33,989
14	"o3"	12,257	16,245	34,857	58,098
15	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14	309,407	171,726	630,502	313,611
16	"hemorrhagic stroke"	13,166	6,311	18,069	15,462
17	"intracerebral hemorrhage"	26,984	14,675	31,782	79,886
18	"subarachnoid hemorrhage"	64,479	31,907	40,804	39,092
19	#16 OR #17 OR #18	98,275	49,947	81,546	107,677
20	#15 AND #19	393	199	393	343

Supplemental Table S2. Methodological risk of bias assessment.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Score
Ban 2021	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Chiu 2014	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Czernych 2024	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Fisher 2019	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Guo 2020	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Han 2015	O	O	O	O	O	O	O	O	O	O	O	NA	O	O	Good
Han 2016	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Huang 2016	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Huang 2017	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Jin 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Kim 2022	O	O	O	O	O	O	O	O	O	O	O	NA	O	O	Good
Li 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Liu 2017a	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Liu 2017b	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Liu 2021	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Liu 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Lv 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good

Montresor-Lopez 2016	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Shen 2020	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Sun 2019	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Tsai 2003	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Turin 2012	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Villeneuve 2006	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Wang 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Wang 2022	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Weng 2021	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Wu 2022	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Xiang 2013	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Zhao 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Zheng 2023	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good
Zhong 2018	O	O	O	O	O	O	O	O	O	O	O	NA	NA	O	Good

–, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S3. GRADE assessment for relative risk - $PM_{2.5}$ (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	10 Good 0 Fair	I^2 = 20%	Already screened for	1.0002 (0.9985, 1.0018). CI limits do not cross the 25th percentile.	10 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S4. GRADE assessment for relative risk - PM_{10} (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	-1	O	O	O	Very Low
Reason	10 Good 0 Fair	I^2 = 49%	Already screened for	1.0008 (0.9990, 1.0025) CI limits do not cross the 25th percentile.	10 studies Asymmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S5. GRADE assessment for relative risk - NO_2 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	7 Good 0 Fair	I^2 = 71%	Already screened for	1.0142 (1.0000, 1.0286) CI limits do not cross the 25th percentile.	7 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S6. GRADE assessment for relative risk - CO (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	4 Good 0 Fair	I^2 = 62%	Already screened for	1.0001 (0.9997, 1.0005) CI limits do not cross the 25th percentile.	< 5 studies	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S7. GRADE assessment for relative risk - SO_2 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	6 Good 0 Fair	I^2 = 43%	Already screened for	1.0060 (0.9983, 1.0138) CI limits do not cross the 25th percentile.	6 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S8. GRADE assessment for relative risk - O_3 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	5 Good 0 Fair	I^2 = 31%	Already screened for	1.0017 (0.9975, 1.0060) CI limits do not cross the 25th percentile.	5 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S9. GRADE assessment for odds ratio - $PM_{2.5}$ (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	-1	O	O	O	O	O	O	Very Low
Reason	10 Good 0 Fair	I^2 = 90%	Already screened for	1.0172 (0.9918, 1.0431) CI limits do not cross the 25th percentile.	10 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S10. GRADE assessment for odds ratio - PM_{10} (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	-1	O	O	O	O	O	O	Very Low
Reason	12 Good 0 Fair	I^2 = 82%	Already screened for	1.0076 (0.9957, 1.0196) CI limits do not cross the 25th percentile.	12 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S11. GRADE assessment for odds ratio - NO_2 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	5 Good 0 Fair	$I^2 = 4\%$	Already screened for	0.9853 (0.9685, 1.0024) CI limits do not cross the 25th percentile.	5 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S12. GRADE assessment for odds ratio - CO (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	3 Good 0 Fair	$I^2 = 0\%$	Already screened for	1.0008 (1.0000, 1.0016) CI limits do not cross the 25th percentile.	< 5 studies	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S13. GRADE assessment for odds ratio - SO_2 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	5 Good 0 Fair	I^2 = 9%	Already screened for	0.9982 (0.9805, 1.0163) CI limits do not cross the 25th percentile.	5 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S14. GRADE assessment for odds ratio - O_3 (10 μg/m^3 increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	3 Good 0 Fair	I^2 = 61%	Already screened for	1.0024 (0.9814, 1.0239) CI limits do not cross the 25th percentile.	< 5 studies	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S15. GRADE assessment for odds ratio - NO_2 (10 ppb increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	-1	O	O	-1	O	O	O	Very Low
Reason	5 Good 0 Fair	$I^2 = 86\%$	Already screened for	1.0634 (0.9623, 1.1751) CI limits do not cross the 25th percentile.	5 studies Asymmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S16. GRADE assessment for odds ratio - CO (10 ppb increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	-1	O	O	O	O	O	O	Very Low
Reason	3 Good 0 Fair	$I^2 = 83\%$	Already screened for	1.0017 (0.9988, 1.0046) CI limits do not cross the 25th percentile.	< 5 studies	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S17. GRADE assessment for odds ratio - SO_2 (10 ppb increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	-1	O	O	O	Very Low
Reason	5 Good 0 Fair	$I^2 = 0\%$	Already screened for	0.9928 (0.8924, 1.1046) CI limits do not cross the 25th percentile.	5 studies Asymmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.

Supplemental Table S18. GRADE assessment for odds ratio - O_3 (10 ppb increment).

GRADE Criteria	**RoB**	**Inconsistency**	**Indirectness**	**Imprecision**	**Publication Bias**	**Large magnitude of effect**	**Dose-response gradient**	**Residual Confounding**	**Quality**
Result	O	O	O	O	O	O	O	O	Low
Reason	5 Good 0 Fair	$I^2 = 71\%$	Already screened for	1.0131 (0.9776, 1.0499) CI limits do not cross the 25th percentile.	5 studies Symmetrical funnel plot	NA	NA	NA	

-1, Criteria unsatisfied; NA, Not applicable; O, Criteria satisfied.