



Ambient ozone exposure and mental health: a systematic review of epidemiologic studies

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Background:

- Potentially negative impacts of ozone on the immune and nervous system (animal experiments)
- No systematic synthesis yet

Objective:

- Review the studies that assessed the link between ambient ozone exposure and mental health thus far

Methods:

- **PRISMA:** Preferred Reporting Items for Systematic Review and Meta-analysis
- **Database:** PubMed, Web of Science, EMBASE
- **Inclusion criteria:** Ambient ozone exposure and mental or behavioral disorders (ICD-10-WHO, F00-F99)/suicide; Epidemiological research studies; Written in English
- **Assessment:** The Newcastle-Ottawa scale (NOS); the National Toxicology Program's Office of Health Assessment and Translation (OHAT) tool and Navigation Guide

Results:

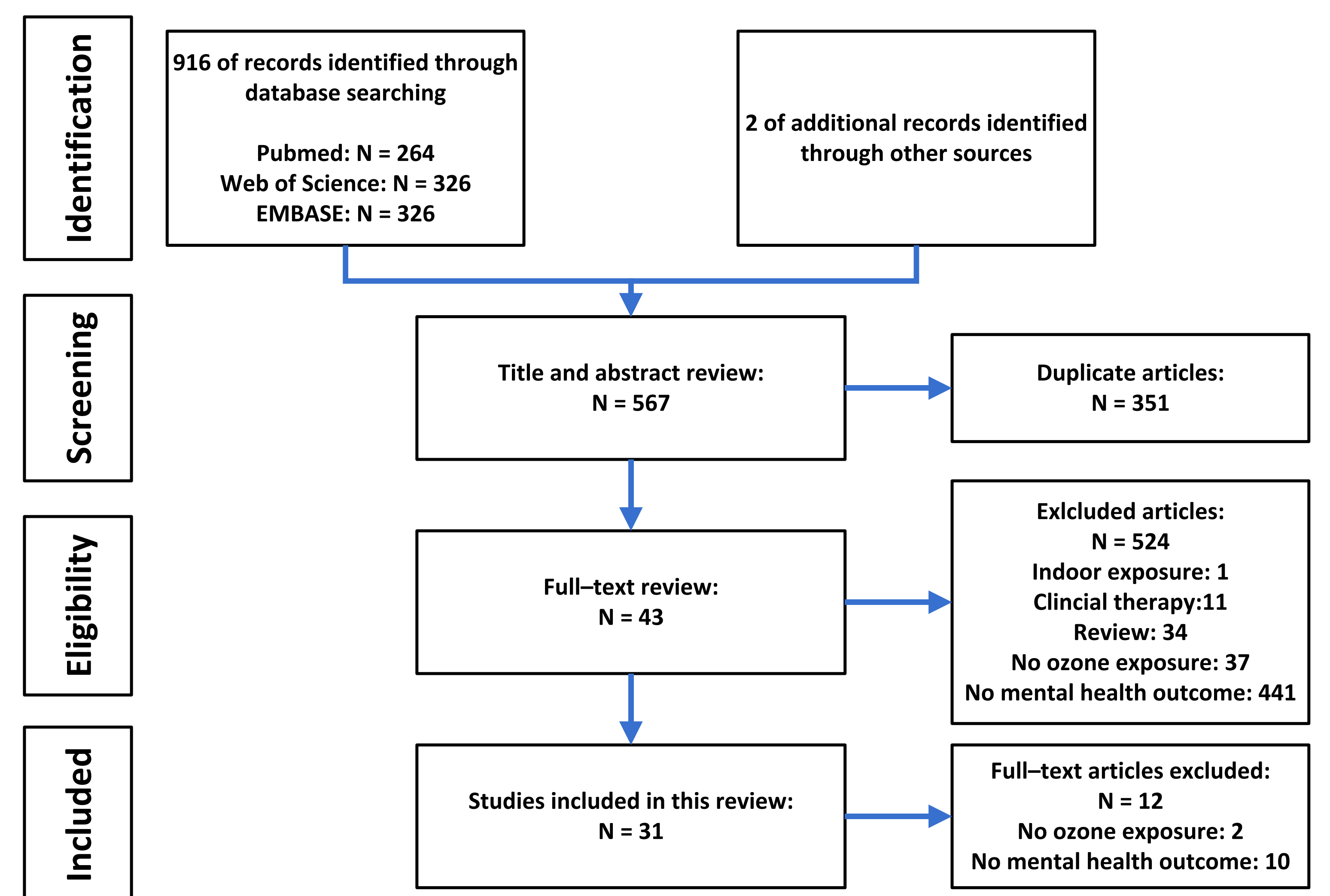


Figure 1. Flow chart for the study selection process

Table 1. Description for the 31 selected studies

Paper	Location	Study design	Association	Quality
Autism spectrum disorder (ASD) or Autism				
1. Becerra et al., Environ Health Perspect, 2013	USA	Case-control	Yes	High
2. Jung et al., PLoS One, 2013	Taiwan, China	Cohort	Yes	High
3. Kim and Volk et al., Autism Res, 2017	USA	Case-control	No	High
4. Volk et al., JAMA Psychiatry, 2013	USA	Case-control	No	High
5. Volk et al., Epidemiology, 2014	USA	Case-control	No	High
6. Goodrich et al., Autism Res, 2017	USA	Case-control	No	High
7. Kerin et al., J Autism Dev Disord, 2017	USA	Ecological	No	-
Cognitive function impairment				
8. Chen et al., NeuroToxicology, 2009	USA	Cross-sectional	Yes	-
9. Gatto et al., NeuroToxicology, 2014	USA	Cross-sectional	Yes	-
Dementia				
10. Calderon-Garcidueñas et al., J Alzheimers Dis, 2015	Mexico	Cross-sectional	Yes	-
11. Wu et al., Alzheimers Dement, 2015	Taiwan, China	Case-Control	Yes	Low
12. Linares et al., Environ Res, 2017	Spain	Time-series	Yes	Low
13. Cleary et al., J Alzheimers Dis, 2018	USA	Cohort	Yes	High
14. Chen et al., Environ Int, 2017	Canada	Cohort	No	High
Depression disorder				
15. Szyszkowicz et al., Int J Occup Med Environ Health, 2007	Canada	Time-series	Yes	Low
16. Lim et al., Environ Health Perspect, 2012	South Korea	Cohort	Yes	High
17. Szyszkowicz et al., Environ Health Insights, 2016	Canada	Case-crossover	Yes	Low
18. Kioumourtzoglou et al., Am J Epidemiol, 2017	USA	Cohort	Yes	High
19. Szyszkowicz et al., Int J Occup Med Environ Health, 2009	Canada	Time-series	No	Low
20. Wang et al Environ Health Perspect, 2014	USA	Cohort	No	High
Suicide				
21. Biermann et al., Med Hypotheses, 2009	Germany	Cross-sectional	Yes	-
22. Yang et al., J Affect Disord, 2011	Taiwan, China	Ecological	Yes.	-
23. Kim et al., PLoS One, 2015	Korea	Time-series	Yes	Medium
24. Casas et al., Eur J Epidemiol, 2017	Belgium	Case-crossover	Yes	Medium
25. Szyszkowicz et al., Environ Health Insights, 2010	Canada	Case-crossover	No	Low
Disorders of sex preference				
26. Rotton, Environ and Behav, 1993	USA	Cross-sectional	Yes	-
Mental disorders				
27. Chen et al., Sci Total Environ, 2018	China	Time-series	No	Medium
Neurobehavioral disorder				
28. Lin et al., Int J Environ Res Public Health, 2014	Taiwan, China	Cross-sectional	No	-
Panic attacks				
29. Cho et al., J Psychiatr Res, 2015	South Korea	Time-series	Yes	Medium
Psychiatric emergency				
30. Oudin et al., Environ Health, 2018)	Sweden	Case-cross over	No	Low
Sexual dysfunction				
31. Tallon et al., Environ Health, 2017	USA	Cohort	No	High

Quality assessment: According to the NOS and Mustafic's study

Study	Key Criteria				Other Criteria			
	Exposure	Outcome	Confounding	Selection	Attrition/exclusion	Selective reporting	Interest conflict	Other biases
1. Becerra et al., 2013	Green	Green	Green	Green	Green	Green	Green	Green
2. Jung et al., 2013	Green	Green	Green	Green	Green	Green	Green	Green
3. Kim and Volk et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
4. Volk et al., 2013	Green	Green	Green	Green	Green	Green	Green	Green
5. Volk et al., 2014	Green	Green	Green	Green	Green	Green	Green	Green
6. Goodrich et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
7. Kerin et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
8. Chen et al., 2009	Green	Green	Green	Green	Green	Green	Green	Green
9. Gatto et al., 2014	Green	Green	Green	Green	Green	Green	Green	Green
10. Calderon-Garcidueñas et al., 2015	Green	Green	Green	Green	Green	Green	Green	Green
11. Wu et al., 2015	Green	Green	Green	Green	Green	Green	Green	Green
12. Linares et al., 2017	Green	Green	Red	Green	Green	Green	Green	Green
13. Cleary et al., 2018	Green	Green	Green	Green	Green	Green	Green	Green
14. Chen et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
15. Szyszkowicz et al., 2007	Green	Green	Green	Green	Green	Green	Green	Green
16. Lim et al., 2012	Green	Green	Green	Green	Green	Green	Green	Green
17. Szyszkowicz et al., 2016	Green	Green	Red	Green	Green	Green	Green	Green
18. Kioumourtzoglou et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
19. Szyszkowicz et al., 2007	Green	Green	Green	Green	Green	Green	Green	Green
20. Wang et al., 2014	Green	Green	Green	Green	Green	Green	Green	Green
21. Biermann et al., 2008	Green	Green	Red	Green	Green	Green	Green	Green
22. Yang et al., 2010	Green	Green	Green	Green	Green	Green	Green	Green
23. Kim et al., 2015	Green	Green	Green	Green	Green	Green	Green	Green
24. Casas et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
25. Szyszkowicz et al., 2010	Green	Green	Green	Green	Green	Green	Green	Green
26. Rotton, 1993	Green	Green	Green	Green	Green	Green	Green	Green
27. Chen et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
28. Lin et al., 2014	Green	Green	Green	Green	Green	Green	Green	Green
29. Cho et al., 2015	Green	Green	Green	Green	Green	Green	Green	Green
30. Oudin et al., 2018	Green	Green	Red	Green	Green	Green	Green	Green
31. Tallon et al., 2017	Green	Green	Green	Green	Green	Green	Green	Green
Risk of bias rating	Low	Low	Probably low	Probably high	Probably high	High	High	High

Summary:

- Large heterogeneity in published studies
- Indication for an association between ambient ozone exposure and mental health
- Overall findings are inconclusive

Conclusions:

- Further studies (with accurate exposure assessment and holistic covariates) are needed