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Ambient air pollution and adverse birth outcomes: a systematic review and meta-analysis

Key words: Air pollution, Low birth weight, Preterm birth,
Meta-analysis, Adverse birth outcome

Research Summary

Several reviews have assessed the relationship between exposure to ambient air pollution and adverse birth outcomes during pregnancy, but the results remain controversial. The objective of this study was to assess this correlation quantitatively and to explore sources of heterogeneity.

We included all published case-control or cohort studies that evaluated the correlation between ambient air pollution and low birth weight (LBW), preterm birth (PTB), and small for gestational age (SGA). Analytical methods and inclusion criteria were provided on the PROSPERO website (CRD42018085816). We evaluated pooled effects and heterogeneity. Subgroup analyses were also conducted and publication bias was examined. The Risk Of Bias In Systematic Reviews (ROBIS) tool was used to evaluate the overall risk of bias in this review.

Forty studies met the inclusion criteria. We observed pooled odds ratios (ORs) of 1.03-1.21 for LBW and 0.97-1.06 for PTB when mothers were exposed to CO, NO₂, NO_x, O₃, PM_{2.5}, PM₁₀ or SO₂ throughout their pregnancy. For SGA, the pooled estimate was 1.02 in relation to NO₂ concentrations. Subgroup analyses and sensitivity analysis decreased the heterogeneity to some extent, such as the subgroups of continuous measures (OR=0.98 (0.97-0.99), I²=0.0%) and NOS>7 (OR=0.98 (0.97-0.99), I²=0.0%) in evaluating the association between PTB and NO₂.

This review was completed with a low risk of bias. High concentrations of air pollution were significantly related to the higher risk of adverse birth outcomes. However, the sources of heterogeneity among studies should be further explored.

Results

Table 1 Characteristics of primary studies

Table 2 Pooled odds ratios (ORs) between air pollutants and adverse birth outcomes during the entire pregnancy

Table 3 Pooled associations between PM₁₀ exposure, NO₂ exposure and LBW in different subgroups

Table 4 Pooled associations between PM₁₀ exposure, NO₂ exposure and PTB in different subgroups

Table 5 Summary of population bias

Table 6 Risk of bias in this meta-analysis according to the ROBIS

Fig. 1 Flow diagram of study search and selection

Fig. 2 Forest plot for LBW per 20 ug/m³ PM₁₀ in different trimesters of pregnancy

Fig. 3 Forest plot for LBW per 20 pbb NO₂ in different trimesters of pregnancy

Fig. 4 Forest plot for PTB per 20 ug/m³ PM₁₀ in different trimesters of pregnancy

Fig. 5 Forest plot for PTB per 20 pbb NO₂ in different trimesters of pregnancy

Fig. 6 Sensitivity analyses for adverse birth outcomes per 20 pbb NO₂, by exposure period. (a) LBW. (b) PTB

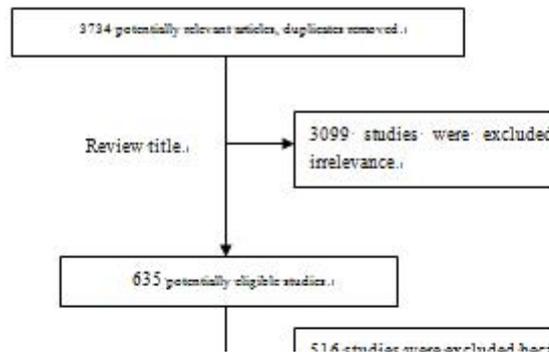


Table 2. Pooled odds ratios (ORs) between air pollutants and adverse birth outcomes during the entire pregnancy.

	CO ₁ (1 ppm)	NO ₂ (20 ppb)	NO _x (20 ppb)	O ₃ (20 ppb)	PM _{2.5} (10 µg/m ³)	PM ₁₀ (20 µg/m ³)	SO ₂ (5 ppb)
Odds ratio for LBW	0.95	1.02	1.03	1.06	1.00	1.06	1.21
(95% CI)	0.88-1.01	1.00-1.04	1.01-1.05	0.95-1.19	0.98-1.03	1.02-1.09	1.08-1.35
<i>n</i>	4	11	3	4	6	11	5
<i>P</i> (%)	84.9	32.3	58.6	21.1	73.3	73.3	98.4
Odds ratio for PTB	1.06	0.98	1.02	1.04	1.00	1.05	0.97
(95% CI)	1.04-1.08	0.97-0.99	1.01-1.03	1.00-1.07	0.98-1.01	1.02-1.07	0.96-0.99
<i>n</i>	7	8	5	3	13	8	2
<i>P</i> (%)	89.9	69.8	88.8	0.0	99.7	81.3	0.0
	1.02	—	—	—	1.01	1.01	1.01
	1.01-1.03	—	—	—	1.00-1.03	0.98-1.04	0.99-1.03
	5	0	0	5	4	2	—
	87.3	—	—	51.5	58.3	0.0	—

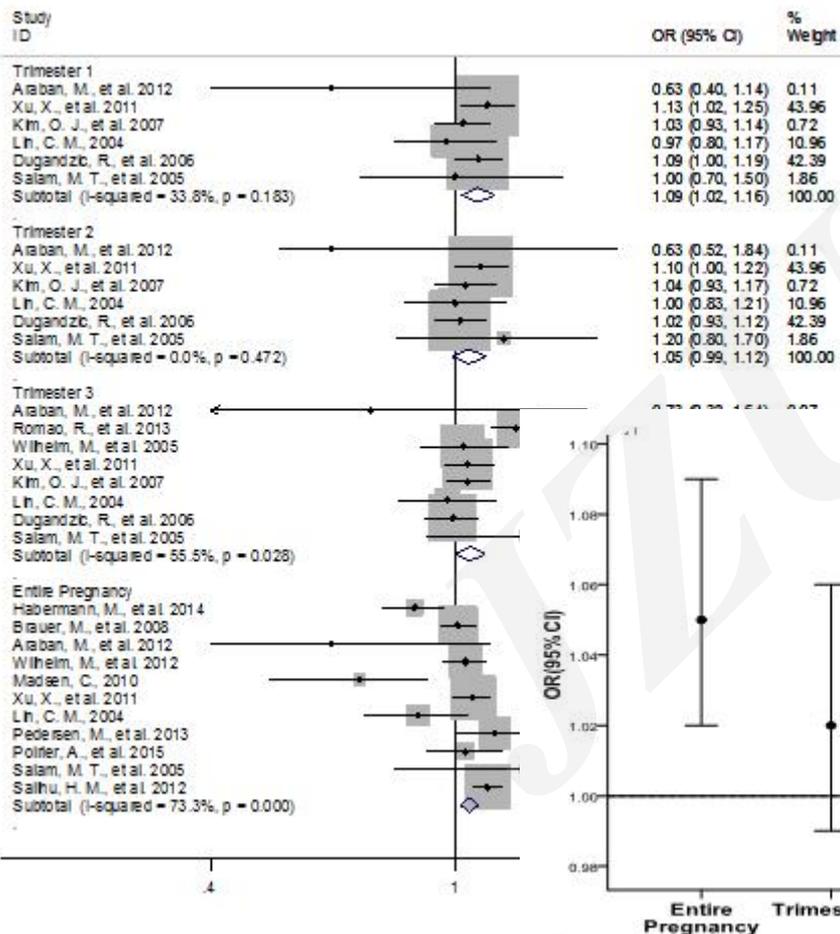


Table 3. Risk of bias in this meta-analysis according to the ROBIS.

Phase	Question	Answer	Judgment
Phase 1			
Study eligibility criteria			
Q1.1	YES	LOW	
Q1.2	YES		
Q1.3	YES		
Q1.4	YES		
Q1.5	PROBABLY YES		
Phase 2			
Identification and selection of studies			
Q2.1	PROBABLY YES	HIGH	
Q2.2	NO		
Q2.3	PROBABLY YES		
Q2.4	YES		
Q2.5	YES		
Phase 3			
Data collection and study appraisal			
Q3.1	YES	LOW	
Q3.2	PROBABLY YES		
Q3.3	PROBABLY YES		
Q3.4	YES		
Q3.5	YES		

(a)

Innovation points

Our review covered a larger number of high-quality studies.

We reported associations between three adverse birth outcomes and seven pollutants. A series of subgroup and sensitivity analyses were conducted to identify possible exposure-response relationships and explore sources of heterogeneity.

The role of meteorological factors was taken into account, which was not covered in previous meta-analyses.

In addition, to our knowledge, this is the first time that the ROBIS tool has been used in a review of air pollution and birth outcomes.

Hence, these results demonstrate that more studies on associations between ambient air pollution and adverse birth outcomes are needed.

Future large cohort studies with sufficient data and detailed information during pregnancy as well as reliable exposure data are required for a better understanding of the associations.

In addition, future meta-analyses should take into account the interactions between various pollutants. By exploring the nature of interactions, we can better explore the sources of heterogeneity and better understand the effect of pollutants on birth outcomes.