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Special Report 23

Systematic Review and Meta-analysis of Selected Health Effects of Long-Term Exposure to Traffic-Related Air Pollution

HEI Panel on the Health Effects of Long-Term Exposure to Traffic-Related Air Pollution

Chapter 8: Traffic-Related Air Pollution and Birth Outcomes

These Appendices were reviewed solely for spelling, grammar, and cross-references to the main text. They have not been formatted or fully edited by HEI. This document was part of the HEI Panel's review process.

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Appendices Chapter 8: Additional Figures and Tables

Traffic-Related Air Pollution and Birth Outcomes

Appendix 8A Term low birth weight (TLBW)

Appendix Table 8A-1. Key Study Characteristics of Articles Included in the Systematic Review for TLBW – Pollutants (Exposure Window: **First Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d]	Increment
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.06 (0.94, 1.20)**	10.5 µg/m^3
						NO_x	102.8	**1.06 (0.96, 1.18)**	59.0 µg/m^3
						$PM_{2.5\ abs}$	3.1	**1.17 (0.98, 1.38)**	1.6 1×10^{-5}/m
						PM_{10} mass	39.2	**1.00 (0.82, 1.22)**	5.7 µg/m^3
						PM_{coarse} mass	22.3	0.95 (0.77, 1.18)	3.4 µg/m^3
						$PM_{2.5}$ mass	16.9	**1.07 (0.88, 1.29)**	3.7 µg/m^3
Ghosh 2012	LA County Birth Registry 95/06	Los Angeles County, California, United States	1995–2006	217,686	LUR	NO_2	27.8	**1.02 (0.99, 1.05)**	10 ppb
						NO	32.9	1.00 (0.99, 1.01)	10 ppb
						NO_x	60.4	**1.00 (1.00, 1.01)**	10 ppb
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	10,290	LUR	NO_2	29.2	**0.92 (0.80, 1.06)**	10 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	**1.01 (0.94, 1.09)**	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**0.96 (0.86, 1.08)**	2.5 µg/m^3
Laurent 2014	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	960,945	Surface monitoring	NO_2	26.19	**0.99 (0.98, 1.00)**	9.65 ppb
					Dispersion / CTM	EC	1.2703	**1.01 (1.01, 1.02)**	0.6644 µg/m^3
						$PM_{2.5}$ mass	9.0466	**1.02 (1.01, 1.03)**	4.4031 µg/m^3
						$PM_{2.5}$ diesel	1.8911	1.02 (1.01, 1.03)	1.0071 µg/m^3
						$PM_{2.5}$ gasoline	0.7470	1.02 (1.01, 1.03)	0.3838 µg/m^3
						$PM_{2.5}$ Cu	0.0055	1.01 (1.00, 1.02)	0.0028 µg/m^3
						$PM_{2.5}$ Fe	0.2784	1.02 (1.01, 1.03)	0.1259 µg/m^3
						$PM_{0.1}$	1.1302	1.02 (1.01, 1.03)	0.5945 µg/m^3

Nieuwenhuijsen 2019	HELIX	Multiple cities, Multiple countries	1997–2017	31,458	LUR	NO_2	21.4	1.2 (1.0, 1.4)[e]	0.5 µg/m^3
						$PM_{2.5\ abs}$	1.4	1.1 (0.9, 1.3)[e]	0.5 1×10^{-5}/m
						PM_{10} mass	18.8	1.1 (0.9, 1.3)[e]	0.5 µg/m^3
						$PM_{2.5}$ mass	13.4	1.2 (1, 1.4)[e]	0.4 µg/m^3
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,215	LUR	NO_2	26.2	**1.08 (1.00, 1.17)**	10 µg/m^3
						NO_x	45.5	**1.04 (0.98, 1.11)**	20 µg/m^3
						$PM_{2.5\ abs}$	1.7	**1.16 (1.00, 1.28)**	1 1×10^{-5}/m
						PM_{10} mass	25.4	**1.13 (1.00, 1.28)**	10 µg/m^3
						PM_{coarse} mass	9.1	1.06 (0.94, 1.19)	5 µg/m^3
						$PM_{2.5}$ mass	16.5	**1.12 (1.02, 1.23)**	5 µg/m^3
Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	540,365	Dispersion / CTM	NO_2	40.6	**1.01 (0.98, 1.03)**	10 µg/m^3
						NO_x	72.5	**1.01 (0.99, 1.03)**	20 µg/m^3
						PM_{10} mass	23.1	**1.03 (0.95, 1.11)**	10 µg/m^3
						$PM_{2.5}$ mass	14.4	**1.02 (0.97, 1.07)**	5 µg/m^3
						$PM_{2.5}$ exhaust	0.60	1.07 (0.99, 1.15)	1 µg/m^3
						nontailpipe $PM_{2.5}$	0.70	1.03 (0.96, 1.11)	1 µg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] Estimate was log transformed.

Appendix Table 8A-1. *Continued* (TLBW — **second trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d]	Increment
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.04 (0.91, 1.18)**	19.9 µg/m^3
						NO_x	102.8	**1.06 (0.96, 1.17)**	57.6 µg/m^3
						$PM_{2.5\ abs}$	3.1	**1.14 (0.95, 1.38)**	1.6 1×10^{-5}/m
						PM_{10} mass	39.2	**1.20 (0.96, 1.48)**	5.6 µg/m^3
						PM_{coarse} mass	22.3	1.12 (0.87, 1.43)	3.4 µg/m^3
						$PM_{2.5}$ mass	16.9	**1.19 (0.97, 1.45)**	3.7 µg/m^3
Ghosh 2012	LA County Birth Registry 95/06	Los Angeles County, California, United States	1995–2006	217,308	LUR	NO_2	27.8	**1.03 (1.00, 1.06)**	10 ppb
						NO	32.9	1.01 (1.00, 1.02)	10 ppb
						NO_x	60.4	**1.01 (1.00, 1.02)**	10 ppb
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	10,290	LUR	NO_2	29.2	**0.90 (0.77, 1.05)**	10 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	**1.02 (0.95, 1.09)**	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**1.03 (0.92, 1.16)**	2.5 µg/m^3
Laurent 2014	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	960,945	Surface monitoring	NO_2	26.19	**1.00 (0.99, 1.01)**	9.75 ppb
					Dispersion / CTM	EC	1.2703	**1.01 (1.00, 1.02)**	0.6438 µg/m^3
						$PM_{2.5}$ mass	9.0466	**1.02 (1.01, 1.03)**	4.2143 µg/m^3
						$PM_{2.5}$ diesel	1.8911	1.01 (1.00, 1.02)	0.9764 µg/m^3
						$PM_{2.5}$ gasoline	0.7470	1.02 (1.01, 1.03)	0.3669 µg/m^3
						$PM_{2.5}$ Cu	0.0055	1.01 (1.00, 1.01)	0.0026 µg/m^3
						$PM_{2.5}$ Fe	0.2784	1.01 (1.00, 1.02)	0.1189 µg/m^3
						$PM_{0.1}$	1.1302	1.02 (1.01, 1.03)	0.5692 µg/m^3

Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**0.96 (0.92, 1.00)**	10 ppb
Nieuwenhuijsen 2019	HELIX	Multiple cities, Multiple countries	1997–2017	31,458	LUR	NO_2	21.4	1.2 (1, 1.4)[e]	0.5 μg/m^3
						$PM_{2.5\ abs}$	1.4	1.3 (1.1, 1.5)[e]	0.6 1×10^{-5}/m
						PM_{10} mass	18.8	1.1 (0.9, 1.3)[e]	0.5 μg/m^3
						$PM_{2.5}$ mass	13.4	1.2 (1, 1.4)[e]	0.4 μg/m^3
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,294	LUR	NO_2	26.2	**1.08 (1.00, 1.17)**	10 μg/m^3
						NO_x	45.5	**1.02 (0.96, 1.08)**	20 μg/m^3
						$PM_{2.5\ abs}$	1.7	**1.07 (0.92, 1.24)**	1 1×10^{-5}/m
						PM_{10} mass	25.4	**1.12 (0.97, 1.28)**	10 μg/m^3
						PM_{coarse} mass	9.1	1.00 (0.88, 1.14)	5 μg/m^3
						$PM_{2.5}$ mass	16.5	**1.13 (1.02, 1.26)**	5 μg/m^3
Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	540,365	Dispersion / CTM	NO_2	40.6	**1.03 (1.00, 1.05)**	10 μg/m^3
						NO_x	72.5	**1.02 (1.00, 1.04)**	20 μg/m^3
						PM_{10} mass	23.1	**1.01 (0.94, 1.08)**	10 μg/m^3
						$PM_{2.5}$ mass	14.4	**1.01 (0.96, 1.06)**	5 μg/m^3
						$PM_{2.5}$ exhaust	0.60	1.11 (1.03, 1.19)	1 μg/m^3
						nontailpipe $PM_{2.5}$	0.70	1.07 (1.00, 1.16)	1 μg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] Estimate was log transformed.

Appendix Table 8A-1. *Continued* (TLBW — **Third Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d]	Increment
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.03 (0.90, 1.18)**	18.7 μg/m³
						NO_x	102.8	**1.02 (0.89, 1.17)**	56.8 μg/m³
						$PM_{2.5\ abs}$	3.1	**1.07 (0.85, 1.36)**	1.5 1×10^{-5}/m
						PM_{10} mass	39.2	**1.26 (1.06, 1.51)**	5.2 μg/m³
						PM_{coarse} mass	22.3	1.25 (1.01, 1.54)	3.1 μg/m³
						$PM_{2.5}$ mass	16.9	**1.24 (1.03, 1.49)**	3.6 μg/m³
Ghosh 2012	LA County Birth Registry 95/06	Los Angeles County, California, United States	1995–2006	215,941	LUR	NO_2	27.8	**1.04 (1.00, 1.07)**	10 ppb
						NO	32.9	1.01 (1.00, 1.02)	10 ppb
						NO_x	60.4	**1.01 (1.00, 1.02)**	10 ppb
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	10,290	LUR	NO_2	29.2	**0.95 (0.84, 1.08)**	10 μg/m³
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	**1.01 (0.94, 1.09)**	0.11 μg/m³
						$PM_{2.5}$ mass	9.5	**1.05 (0.96, 1.16)**	2.5 μg/m³
Laurent 2014	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	960,945	Surface monitoring	NO_2	26.19	**1.02 (1.01, 1.03)**	9.64 ppb
					Dispersion / CTM	EC	1.2703	**1.02 (1.01, 1.03)**	0.6550 μg/m³
						$PM_{2.5}$ mass	9.0466	**1.03 (1.02, 1.04)**	4.2936 μg/m³
						$PM_{2.5}$ diesel	1.8911	1.02 (1.01, 1.03)	0.9994 μg/m³
						$PM_{2.5}$ gasoline	0.7470	1.03 (1.02, 1.04)	0.3785 μg/m³
						$PM_{2.5}$ Cu	0.0055	1.01 (1.00, 1.02)	0.0027 μg/m³
						$PM_{2.5}$ Fe	0.2784	1.02 (1.01, 1.03)	0.1235 μg/m³
						$PM_{0.1}$	1.1302	1.03 (1.02, 1.04)	0.5778 μg/m³

Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**0.92 (0.88, 0.96)**	9 ppb
Nieuwenhuijsen 2019	HELIX	Multiple cities, Multiple countries	1997–2017	31,458	LUR	NO_2	21.4	1.2 (1, 1.3)[e]	0.5 μg/m^3
						$PM_{2.5\ abs}$	1.4	1.1 (1, 1.4)[e]	0.6 1×10^{-5}/m
						PM_{10} mass	18.8	1.3 (1.1, 1.5)[e]	0.4 μg/m^3
						$PM_{2.5}$ mass	13.4	1.1 (1, 1.3)[e]	0.4 μg/m^3
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,001	LUR	NO_2	26.2	**1.07 (0.98, 1.16)**	10 μg/m^3
						NO_x	45.5	**1.03 (0.96, 1.10)**	20 μg/m^3
						$PM_{2.5\ abs}$	1.7	**1.07 (0.91, 1.25)**	1 1×10^{-5}/m
						PM_{10} mass	25.4	**1.10 (0.96, 1.27)**	10 μg/m^3
						PM_{coarse} mass	9.1	0.95 (0.84, 1.09)	5 μg/m^3
						$PM_{2.5}$ mass	16.5	**1.15 (1.04, 1.27)**	5 μg/m^3
Ritz 1999	California Birth Registry 89/93	Southern California, United States	1989–1993	125,573	Surface monitoring	CO	2.45	1.22 (1.03, 1.81)	>5.5 vs. <2.2 ppm
								1.04 (0.96, 1.13)	2.2–5.5 vs. <2.2 ppm
Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	540,365	Dispersion / CTM	NO_2	40.6	**1.03 (1.00, 1.05)**	10 μg/m^3
						NO_x	72.5	**1.02 (1.00, 1.04)**	20 μg/m^3
						PM_{10} mass	23.1	**1.04 (0.98, 1.11)**	10 μg/m^3
						$PM_{2.5}$ mass	14.4	**1.05 (1.00, 1.10)**	5 μg/m^3
						$PM_{2.5}$ exhaust	0.60	1.10 (1.02, 1.19)	1 μg/m^3
						nontailpipe $PM_{2.5}$	0.70	1.06 (0.98, 1.14)	1 μg/m^3

Wilhelm 2005	LA County Birth Registry 94/00[f]	Southern California, United States	1994–2000	28,797	Surface monitoring	CO	1.21	1.10 (0.98, 1.23) (Distance ≤1 mile)	1 ppm
				89,126				1.05 (0.99, 1.13) (1 mile < Distance ≤2 miles)	
				300,792				1.06 (1.02, 1.10) (2 miles < Distance ≤4 miles)	

[a] All were cohort studies except Wilhelm et al. 2005.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] Estimate was log transformed.

[f] Case-cohort study.

Appendix Table 8A-2. Noise-Adjusted Analyses in TLBW Studies (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Pollutant	Increment	Single pollutant[a]	Noise adjusted[a]
Dadvand 2014	Barcelona Birth Cohort	Distance	<200 vs. >200 m	1.46 (1.05, 2.04)	1.46 (1.04, 2.05)
		$PM_{2.5}$ mass	3.1 μg/m^3	1.17 (0.98, 1.39)	1.31 (1.07, 1.61)
Gehring 2014	BC 99/02 Birth Cohort	Distance	<50 vs. >50 m	1.49 (1.10, 2.02)	0.97 (0.90, 1.05)
		NO_2	10 μg/m^3	0.97 (0.89, 1.05)	1.01 (0.97, 1.16)
		NO	10 μg/m^3	1.02 (0.96, 1.07)	0.99 (0.93, 1.05)
		$PM_{2.5\ abs}$	1 1×10^{-5}/m	1.03 (0.97, 1.09)	0.97 (0.94, 1.00)
		$PM_{2.5}$ mass	1 μg/m^3	1.02 (0.98, 1.06)	1.04 (0.90, 1.22)
Smith 2017	London Birth Registry 06/10	NO_2	8.6 μg/m^3	1.03 (1.00, 1.06)	1.03 (1.00, 1.06)
		NO_x	23.7 μg/m^3	1.03 (1.01, 1.06)	1.03 (1.00, 1.06)
		PM_{10} mass	3.0 μg/m^3	1.03 (0.99, 1.07)	1.03 (0.99, 1.07)
		$PM_{2.5}$ mass	2.2 μg/m^3	1.06 (1.01, 1.12)	1.06 (1.01, 1.12)
		$PM_{2.5}$ exhaust	0.35 μg/m^3	1.04 (1.01, 1.07)	1.04 (1.01, 1.08)
		nontailpipe $PM_{2.5}$	0.29 μg/m^3	1.02 (1.00, 1.04)	1.02 (1.00, 1.05)

[a] Effect estimates are odds ratios.

Appendix Table 8A-3. Key Study Characteristics of Articles Included in the Systematic Review for TLBW — Indirect Traffic Measures (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Study design	Location	Study period	Sample size[a]	Traffic measure	Effect Estimate (95% CI)[b]	Increment
Brauer 2008	BC 99/02 Birth Cohort	Cohort	Vancouver, British Columbia, Canada	1999–2002	70,249	Distance	0.95 (0.79, 1.13)	<150 m to highway or <50 m to major road vs. higher
Dadvand 2014	Barcelona Birth Cohort	Cohort	Barcelona, Spain	2001–2005	6,438	Distance	1.46 (1.05, 2.04)	<200 vs. >200 m
Gehring 2014	BC 99/02 Birth Cohort	Cohort	Vancouver, British Columbia, Canada	1999–2002	68,238	Distance	1.49 (1.10, 2.02)	<50 vs. >50 m
Habermann 2014	Sao Paulo Birth Registry 06	Case-control	Sao Paulo, Brazil	2006–2006	11,586	Density	0.90 (0.80, 1.01)	764–10,331 vs. <22.5 vehicles/hour
							0.91 (0.82, 1.02)	189–764 vs. <22.5 vehicles/hour
							0.96 (0.86, 1.07)	22.5–189 vs. <22.5 vehicles/hour
						Distance	0.97 (0.87, 1.08)	<150 vs. >150 m
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Cohort	Shizuoka, Japan	1997–2008	4,781	Density	1.00 (0.96, 1.04)	5,000 vehicles/day
Laurent 2013	South Coast Births 97/06	Cohort	Los Angeles and Orange Counties, California, United States	1997–2006	68,303	Density	1.02 (1.00, 1.05)	54 vehicles/day/m
						Distance	0.94 (0.87, 1.01)	253 m
Laurent 2014	LA County Birth Registry 01/08	Cohort	Los Angeles County, California, United States	2001–2008	960,945	Density	1.00 (1.00, 1.01)	5,657 vehicle-m/day
						Distance	1.03 (1.02, 1.05)	<100 vs. >100 m
Laurent 2016b	California Birth Registry 01/08	Case-cohort	California, United States	2001–2008	420,018	Density	1.12 (1.04, 1.21)	10,000 vehicles/m/day
						Distance	1.02 (1.00, 1.04)	<100 vs. >100 m
Nieuwenhuijsen 2019	HELIX	Cohort	Multiple cities, Multiple countries	1997–2017	31,458	Density	1.0 (1.0, 1.1)[c]	2.6 vehicle-m/day
						Distance	0.9 (0.8, 1.1)	<100 vs. >100 m
Padula 2012	SAGE	Cohort	California, United States	2000–2006	237,031	Density	1.08 (1.00, 1.17)	>13,548 vs. <225 vehicles/day
							1.01 (0.93, 1.09)	4,874–13,548 vs. <225 vehicles/day
							1.10 (1.02, 1.19)	225–4,874 vs. <225 vehicles/day

Pedersen 2013	ESCAPE	Cohort	Multiple cities, Multiple countries	1994–2011	60,254	Density	1.01 (0.96, 1.07)	4,000 vehicle-km/day
Wilhelm 2003	LA County Birth Registry 94/96	Case-control	Los Angeles County, California, United States	1994–1996	30,122	Distance	1.02 (0.91, 1.14)	<229 vs. >229 m
Wu 2016	California Birth Registry 01/08	Case-control	California, United States	2001–2008	420,018	Density	1.12 (1.04, 1.21)	10,000 vehicles/day/m
						Distance	1.02 (1.00, 1.04)	<100 vs. >100 m
Yorifuji 2013	Shizuoka Seirei Birth Study 97/10	Cohort	Shizuoka, Japan	1997–2010	14,836	Distance	1.5 (0.7, 3.0)	<50 vs. >200 m
							1.2 (0.9, 1.6)	50–200 vs. >200 m

[a] All studies included male and female participants.

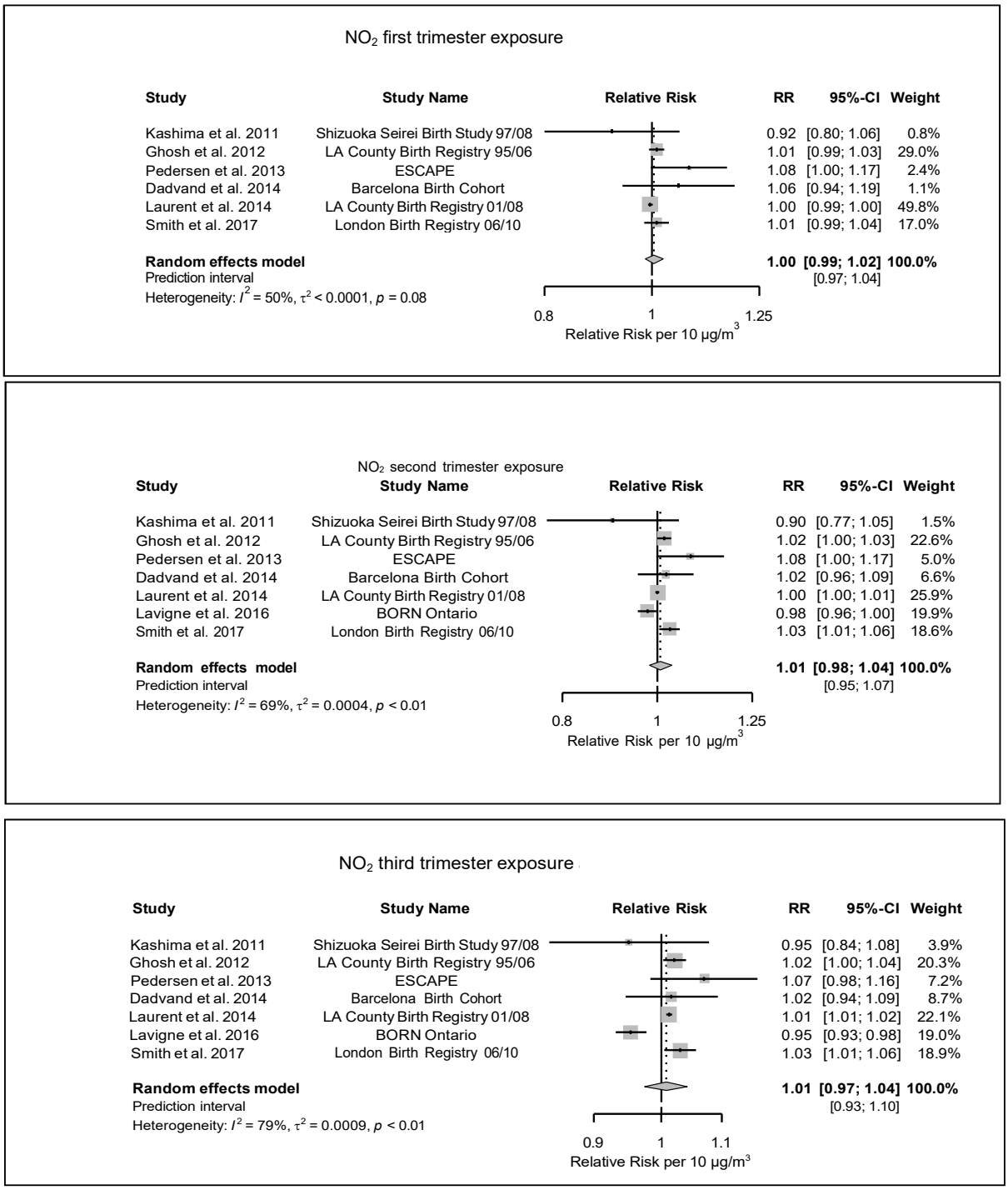
[b] Effect estimates are odds ratios.

[c] Estimate was log transformed.

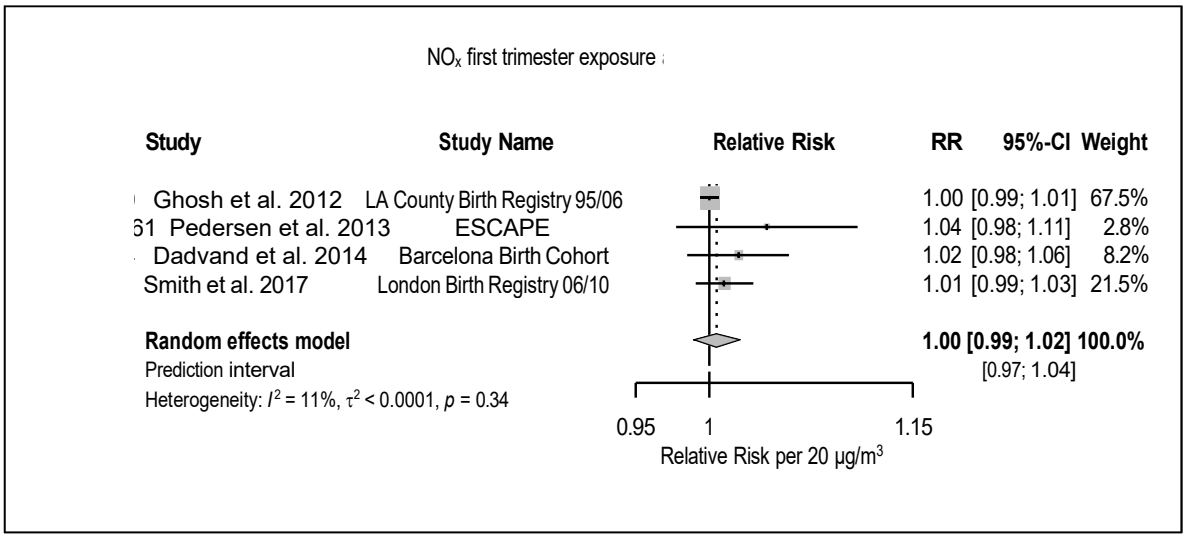
Appendix Table 8A-4. Risk of Bias Assessment for Individual Studies on TLBW (Exposure Window: **Entire Pregnancy**)

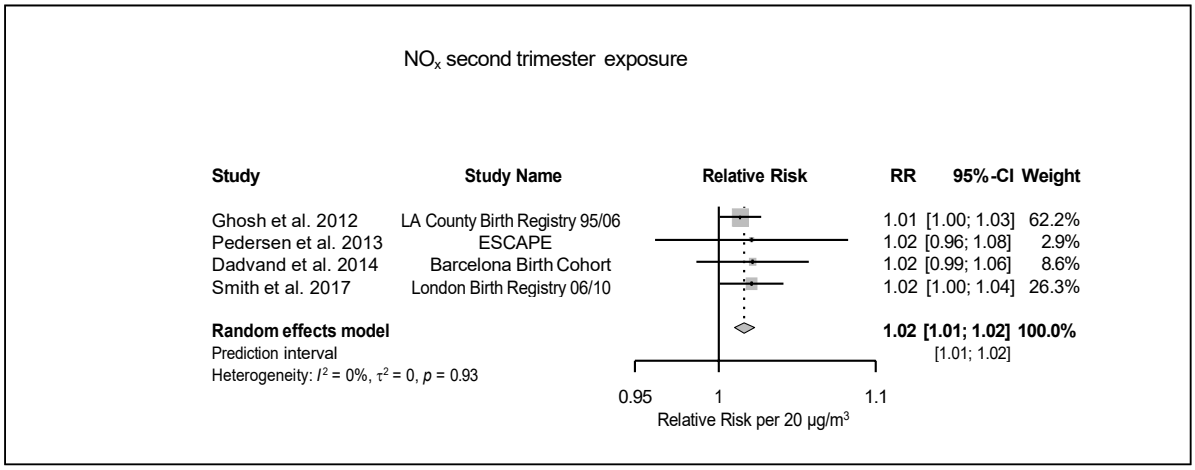
Reference	Study Name	Confounding	Selection Bias	Exposure Assessment	Outcome Measurement	Missing Data	Selective Reporting
Brauer 2008	BC 99/02 Birth Cohort	High	Low	Low	Low	Low	Low
Coker 2015	LA County Birth Registry 95/06	High	Low	High	Low	Low	Low
Dadvand 2014	Barcelona Birth Cohort	Low	Low	Mod	Low	Low	Low
Dedele 2017	Kaunas Birth Outcomes 07/08	Low	Low	Low	Low	Low	Low
Ghosh 2012	LA County Birth Registry 95/06	High	Low	Mod	Low	Low	Low
Hjortebjerg 2016	DNBC	Low	Low	Low	Low	Low	Low
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Low	Low	Low	Low	Low	Low
Kingsley 2017	Rhode Island Birth Outcomes	High	Low	Mod	Low	Low	Low
Laurent 2013	South Coast Births 97/06	High	Low	Mod	Low	Low	Low
Laurent 2014	LA County Birth Registry 01/08	High	Low	Mod	Low	Low	Low
Laurent 2016b	California Birth Registry 01/08	High	Low	Mod	Low	Low	Low
Lavigne 2016	BORN Ontario	High	Low	Low	Low	Low	Low
Pedersen 2013	ESCAPE	Low	Low	Mod	Low	Low	Low
Poirier 2015	Halifax Birth Outcomes	Mod	Low	Mod	Low	Low	Low
Smith 2017	London Birth Registry 06/10	High	Low	Mod	Low	Low	Low
Wilhelm 2003	LA County Birth Registry 94/96	High	Low	Mod	Low	Low	Low

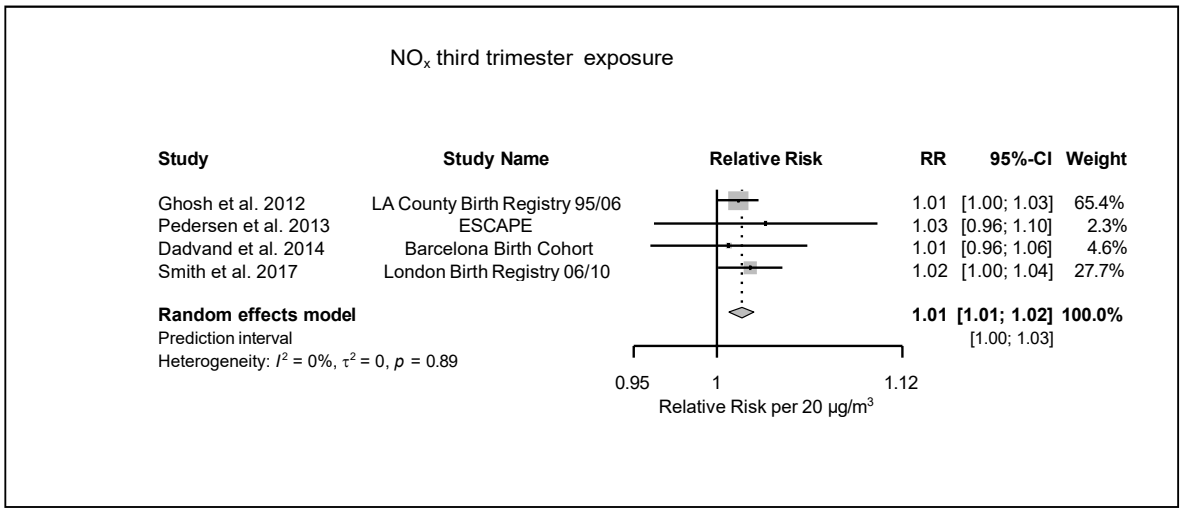
Mod = moderate



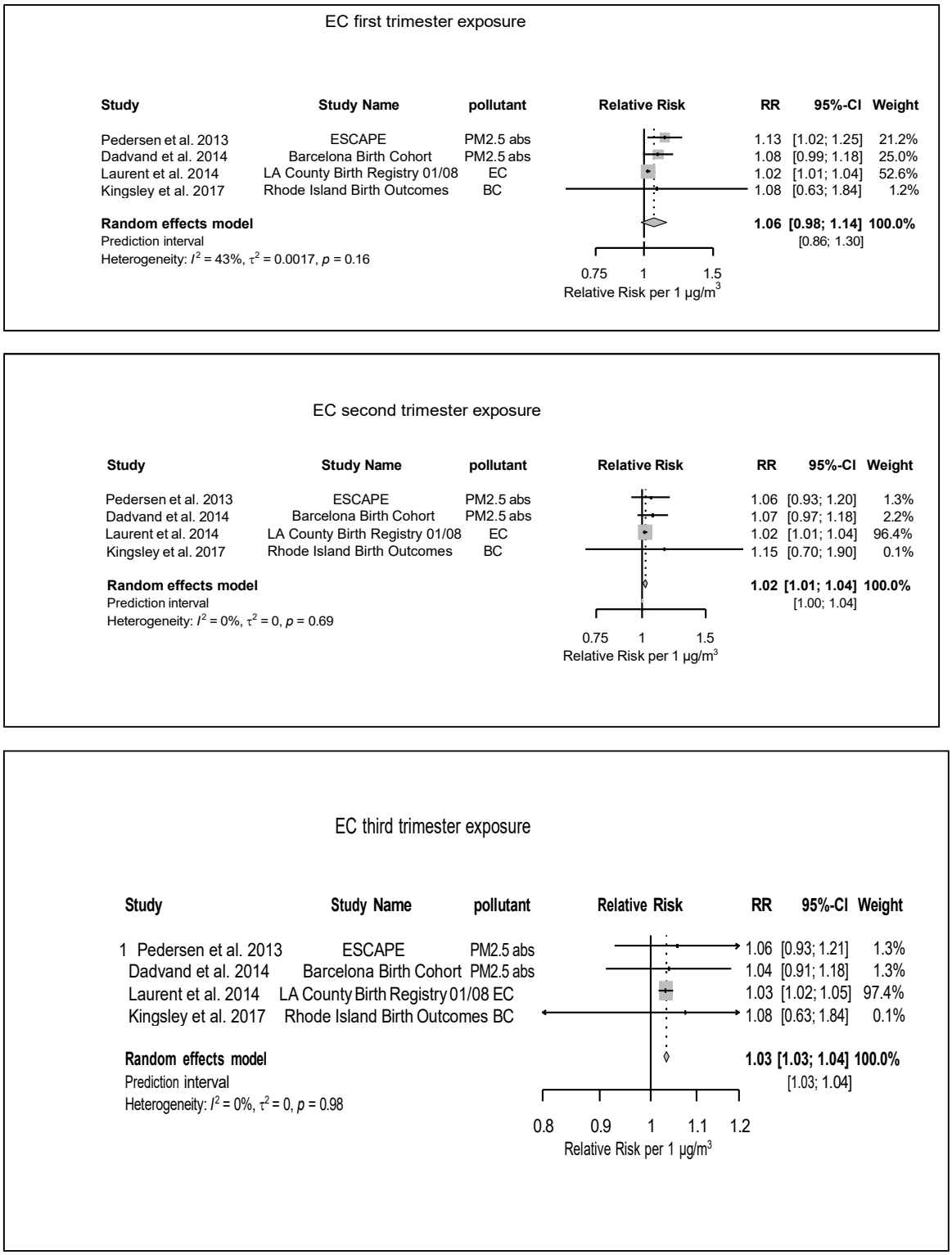
Appendix Figure 8A-1. Associations of NO_2 with TLBW: meta-analysis (exposure window: trimester)



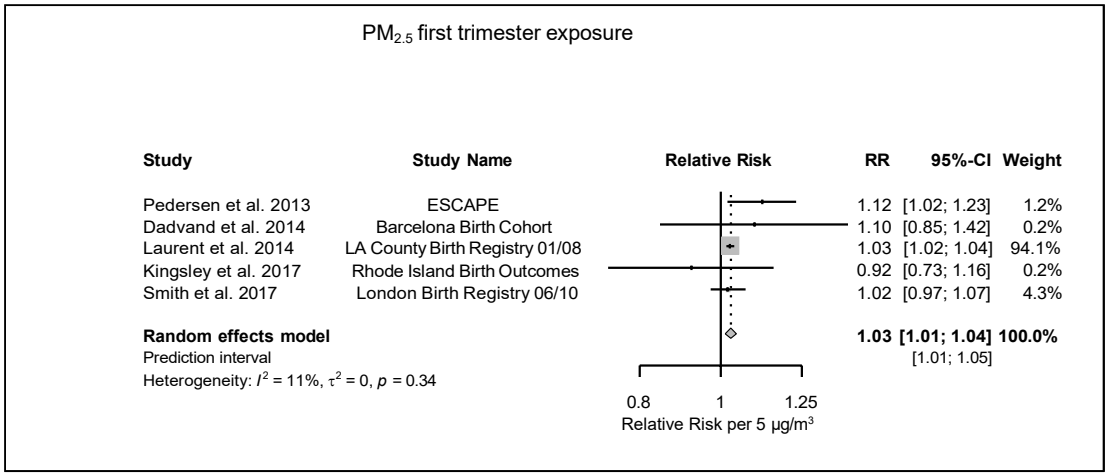


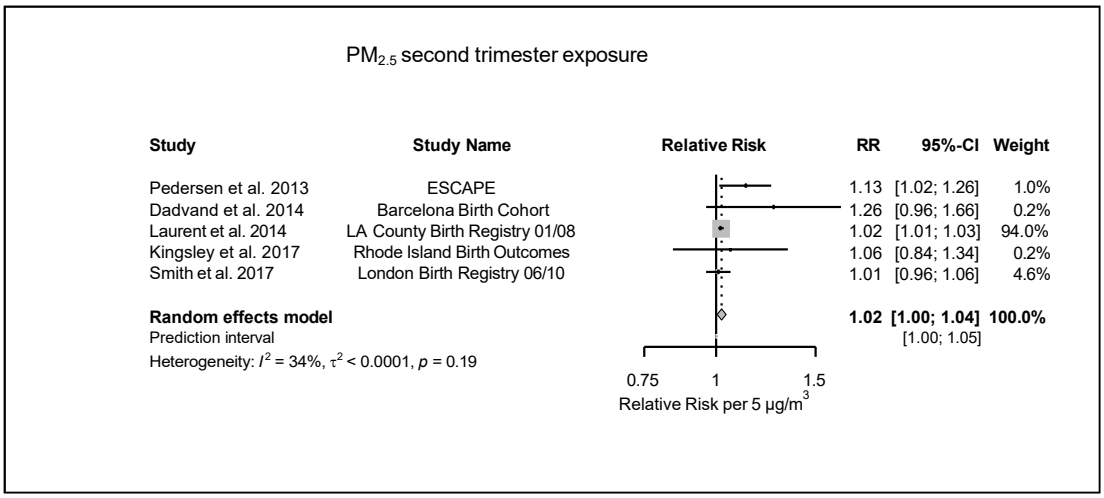


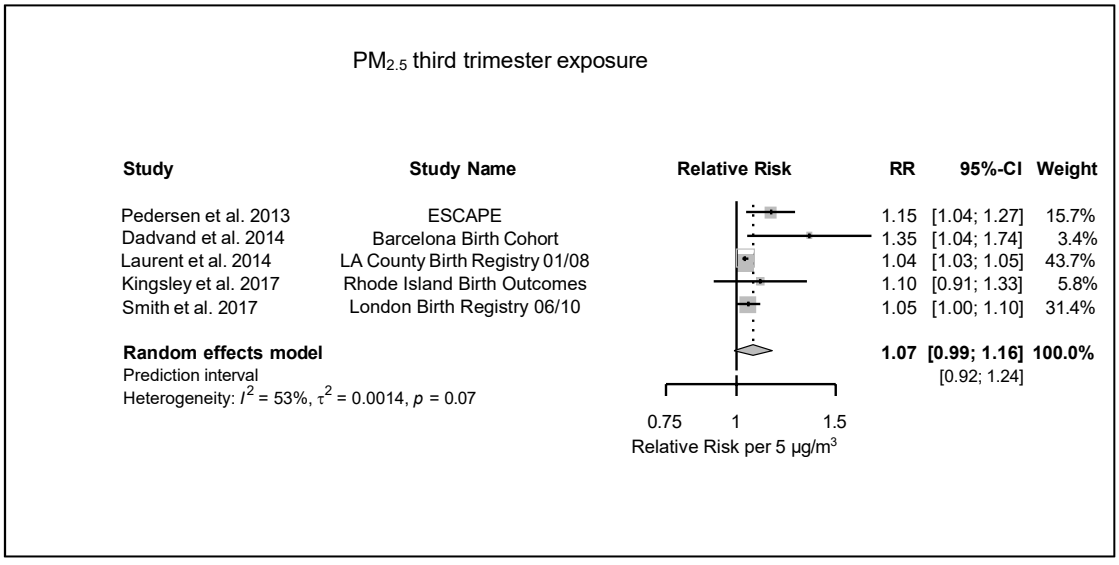
Appendix Figure 8A-2. Associations of NO_X with TLBW: meta-analysis (exposure window: trimester).



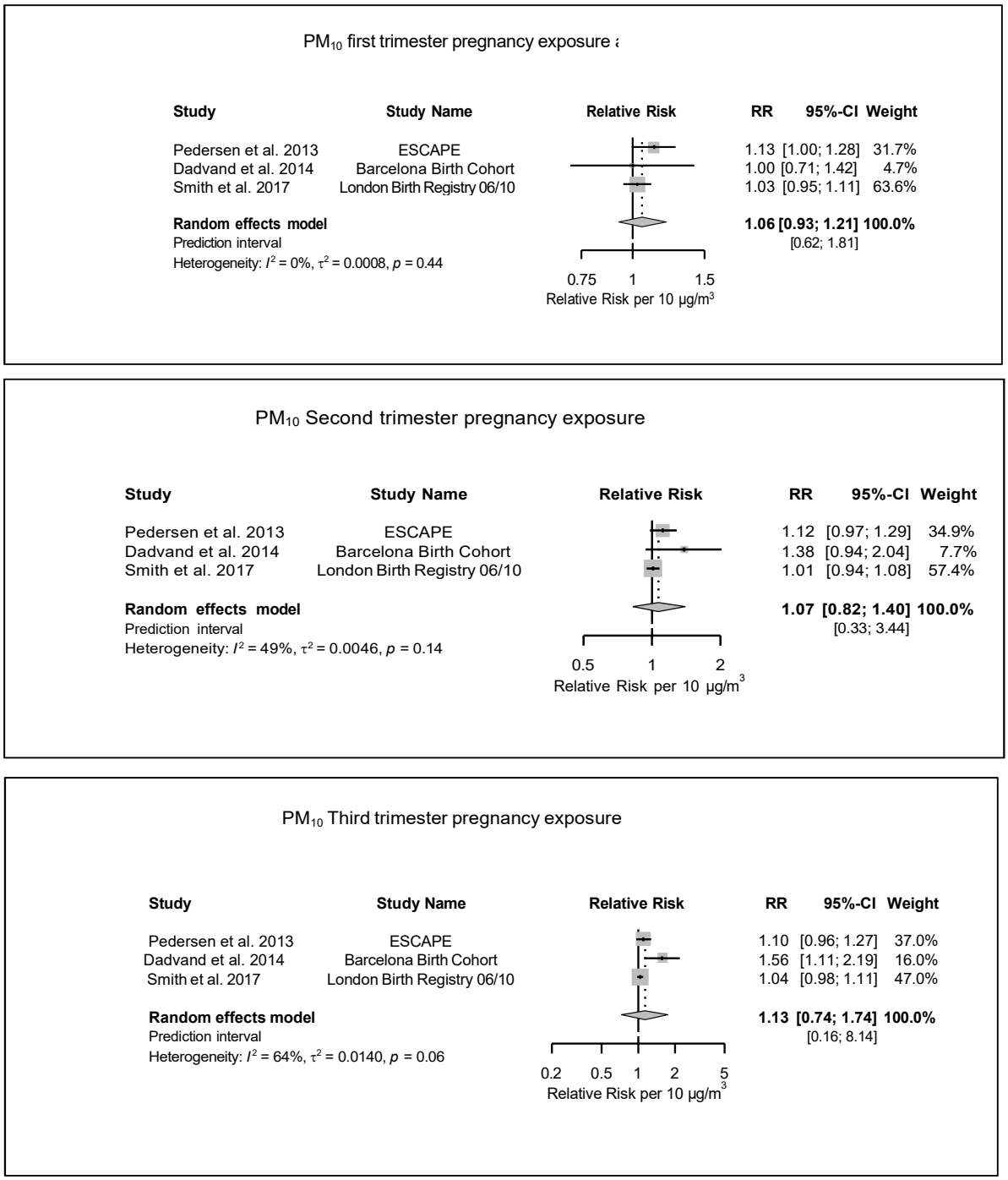
Appendix Figure 8A-3. Associations of EC with TLBW: meta-analysis (exposure window: trimester).



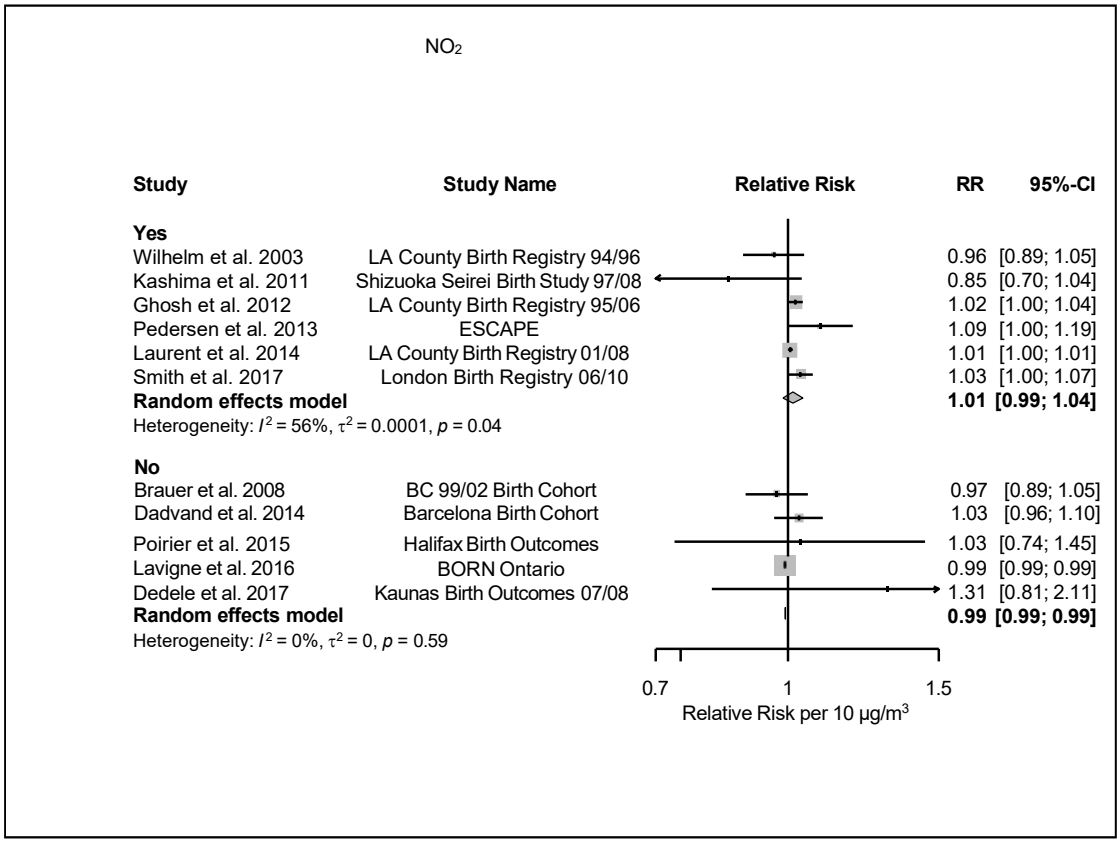


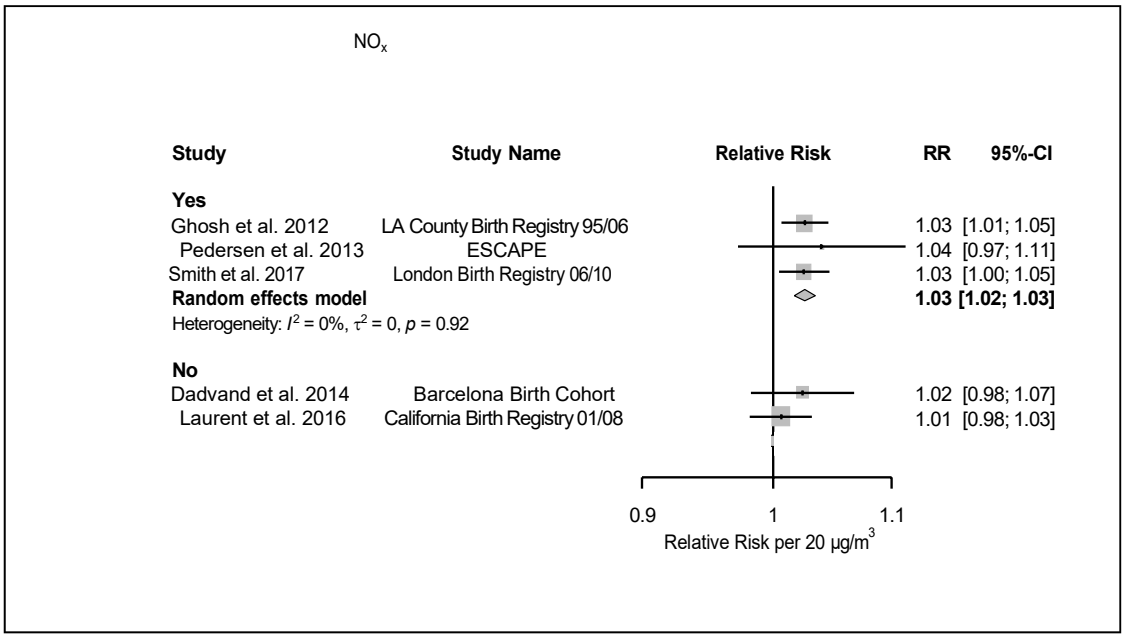


Appendix Figure 8A-4. Associations of $PM_{2.5}$ with TLBW: meta-analysis (exposure window: trimester).

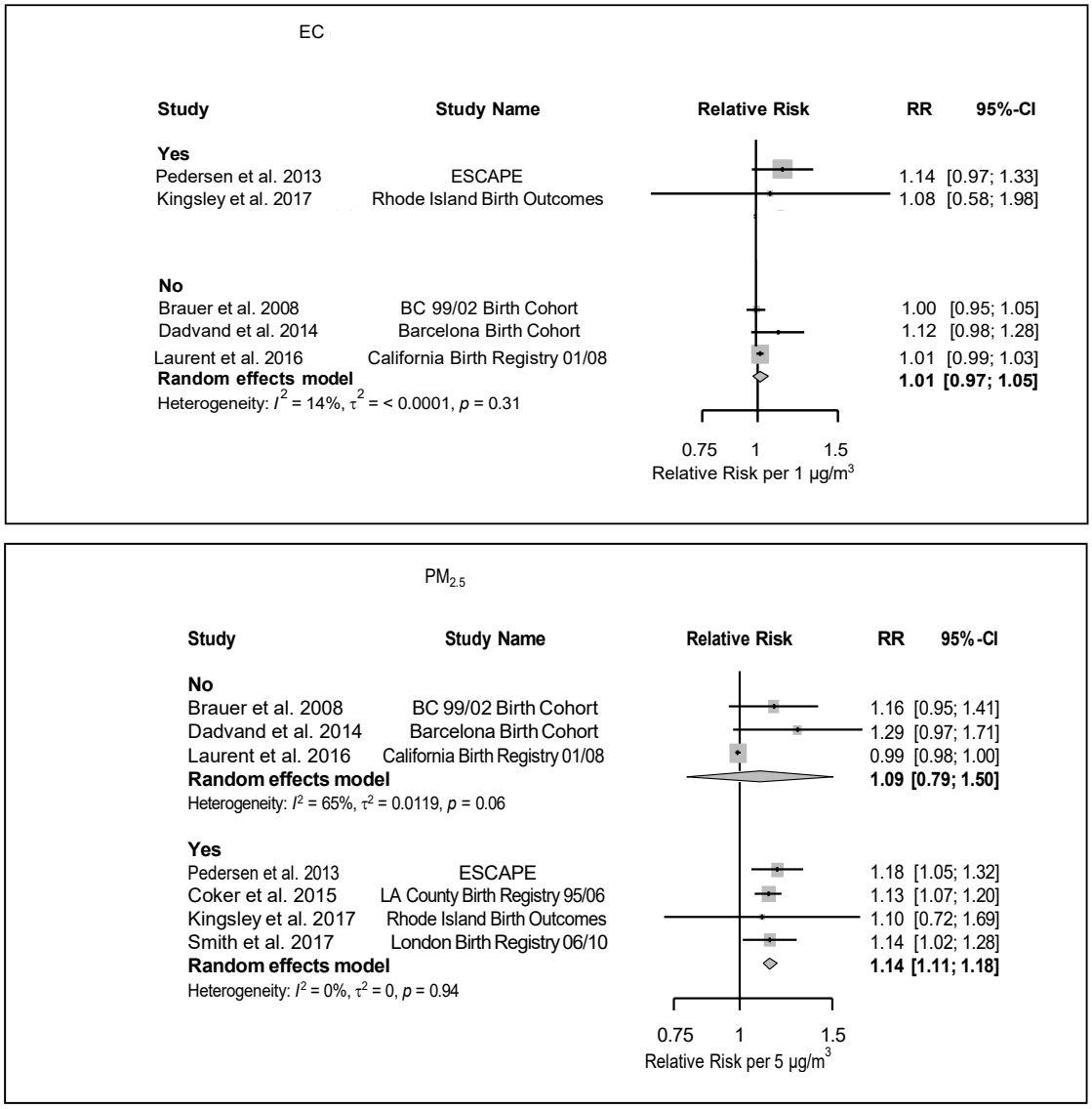


Appendix Figure 8A-5. Associations of PM_{10} with TLBW: meta-analysis (exposure window: trimester).

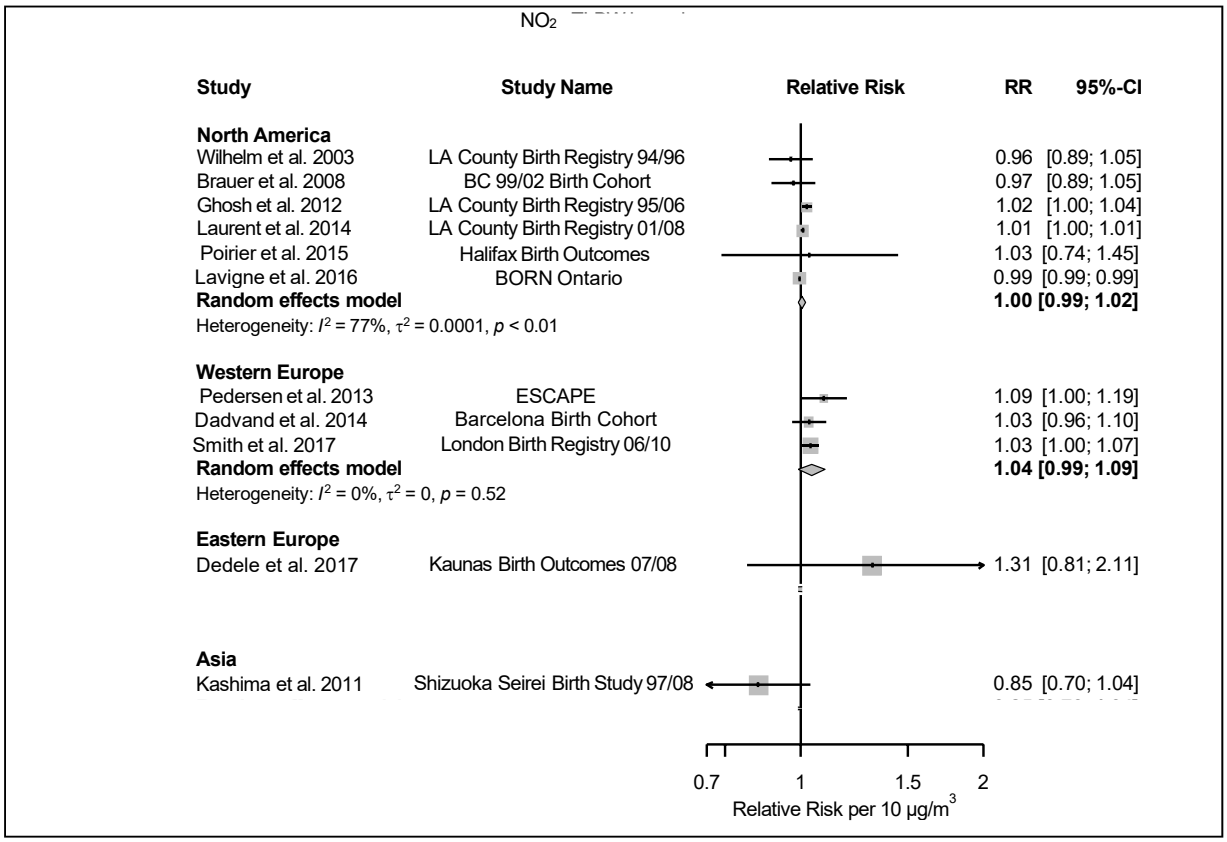


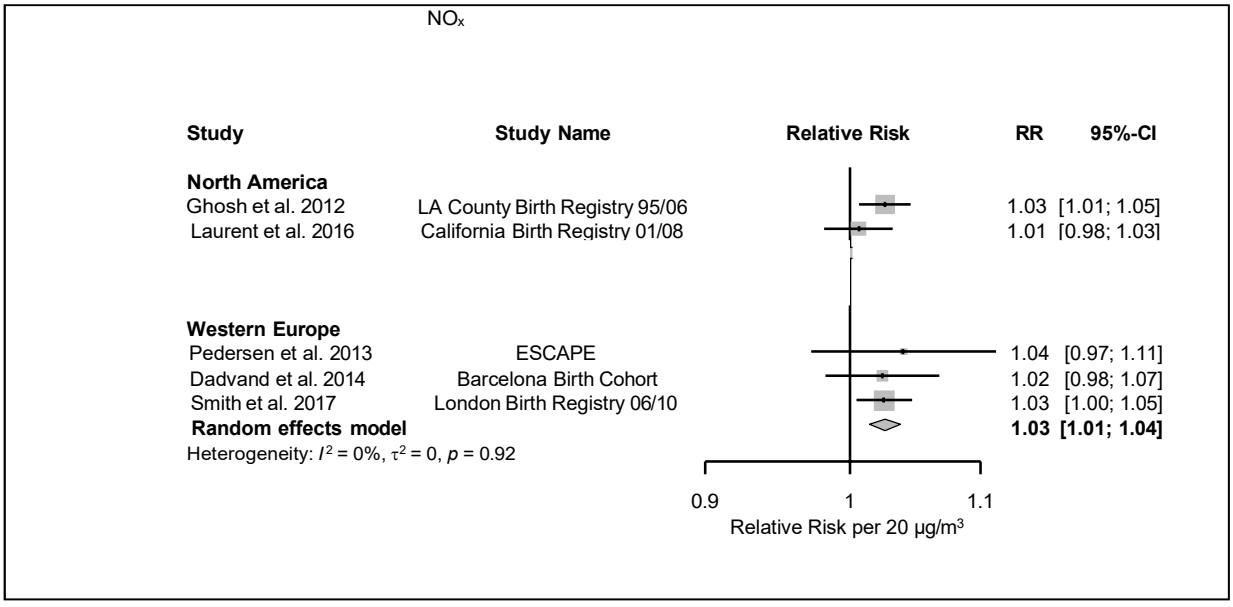


Appendix Figure 8A-6. Associations of NO_2, NO_X, EC, and $PM_{2.5}$ with TLBW: meta-analysis by gestational age adjustment (exposure window: entire pregnancy). *Figure continues next page.*

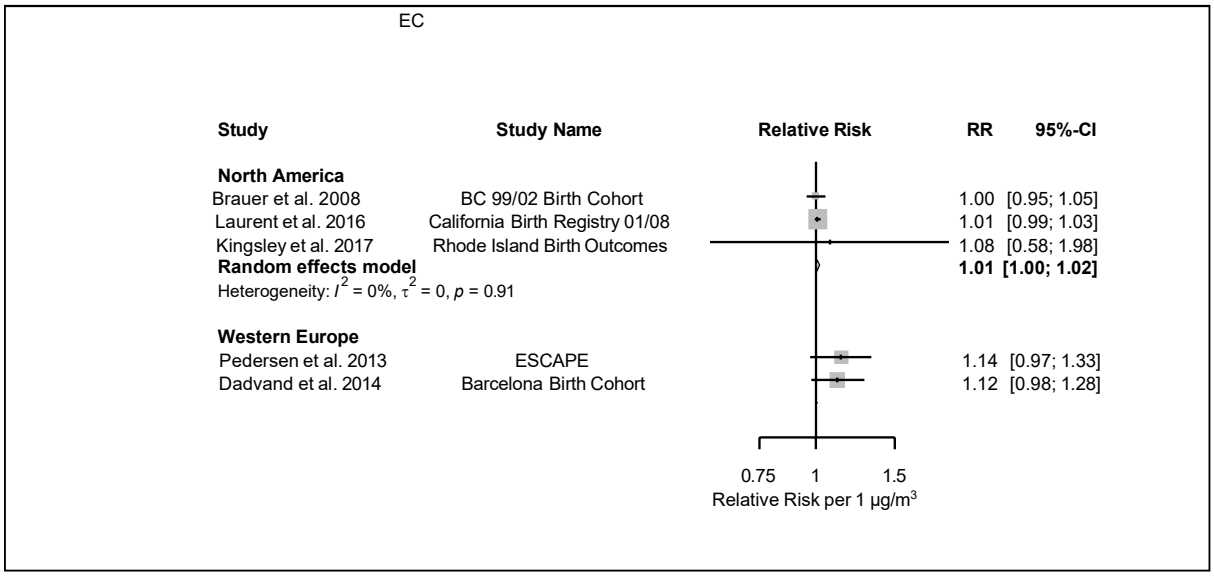


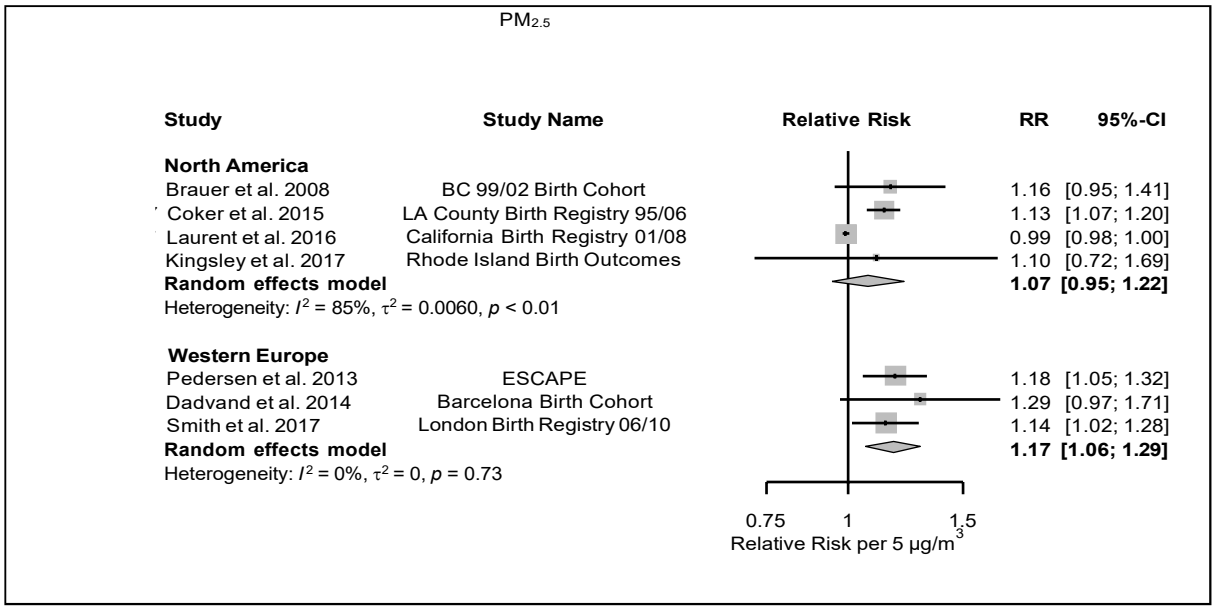
Appendix Figure 8A-6. *(Continued).*



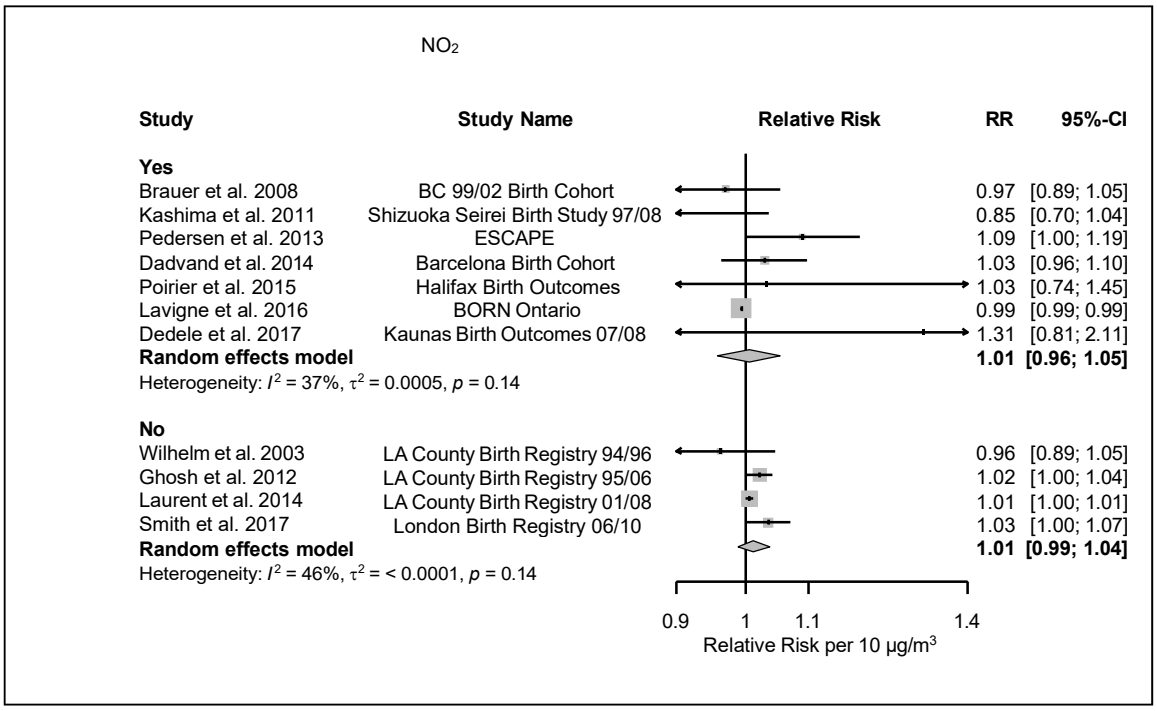


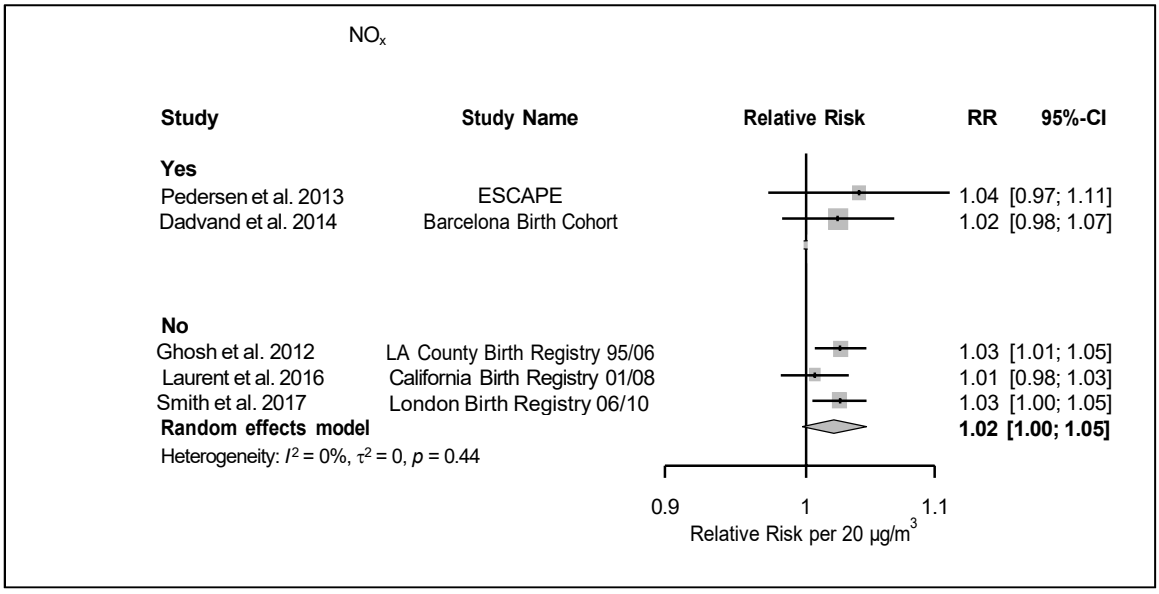
Appendix Figure 8A-7. Associations of NO_2, NO_X, EC, and $PM_{2.5}$ with TLBW: meta-analysis by region (exposure window: entire pregnancy). *Figure continues next page.*



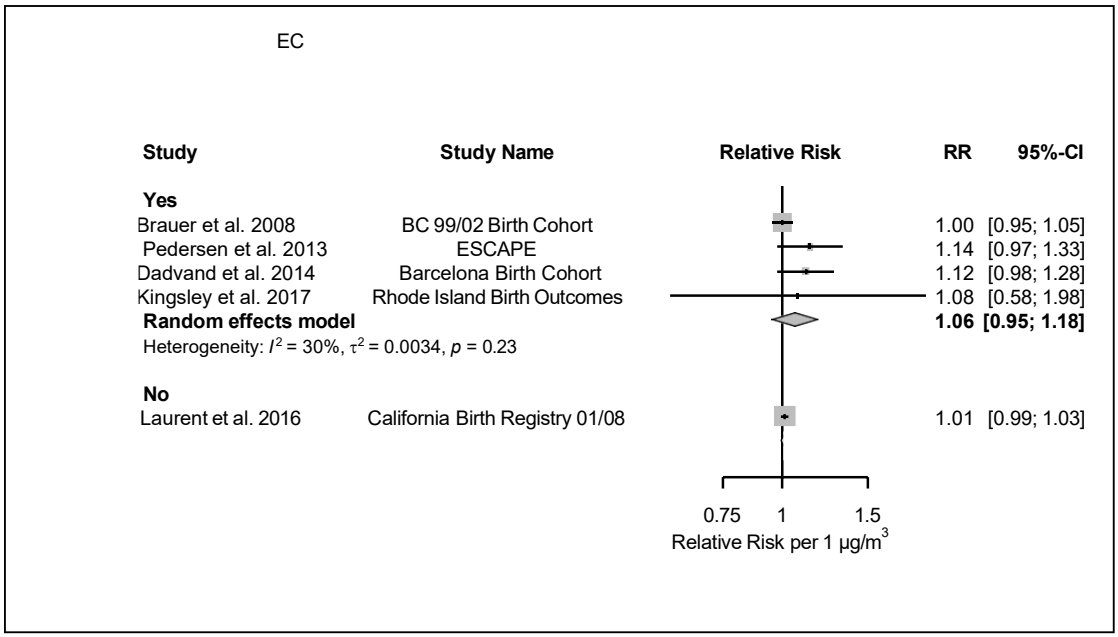


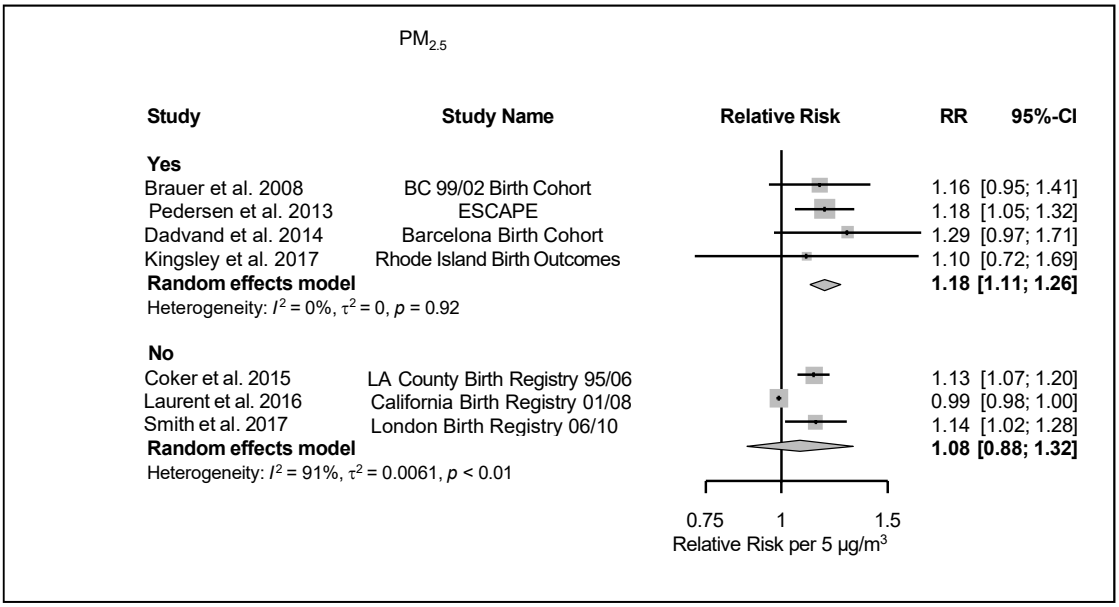
Appendix Figure 8A-7. *(Continued).*



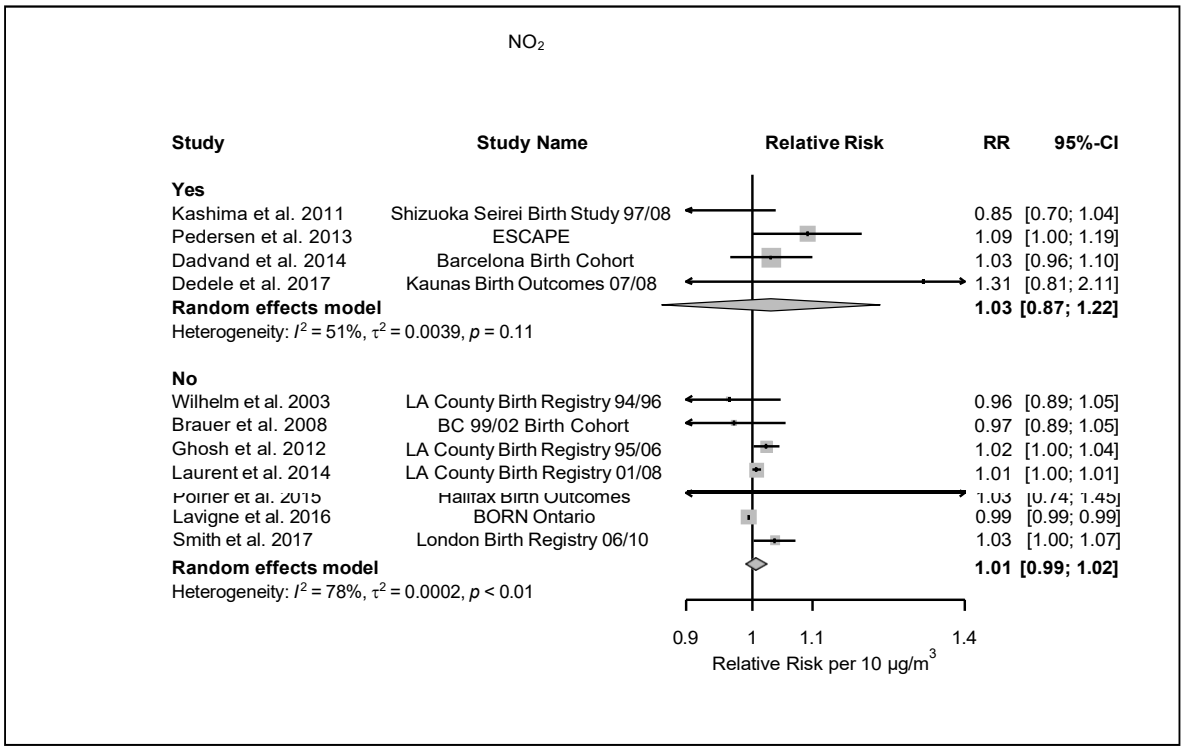


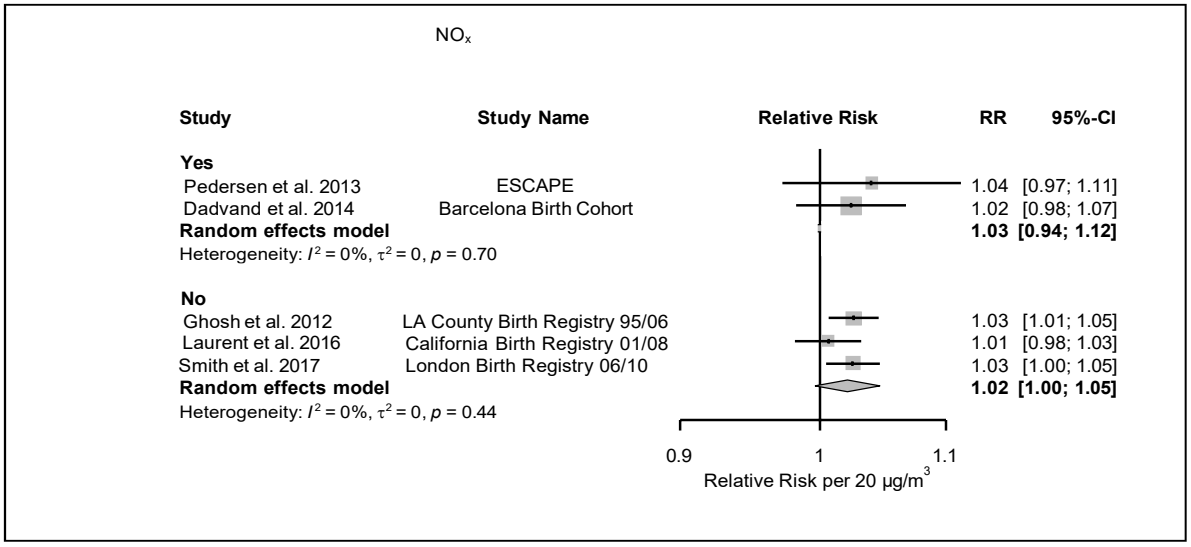
Appendix Figure 8A-8. Associations of NO_2, NO_X, EC, and $PM_{2.5}$ with TLBW: meta-analysis by smoking adjustment (exposure window: entire pregnancy). *Figure continues next page.*



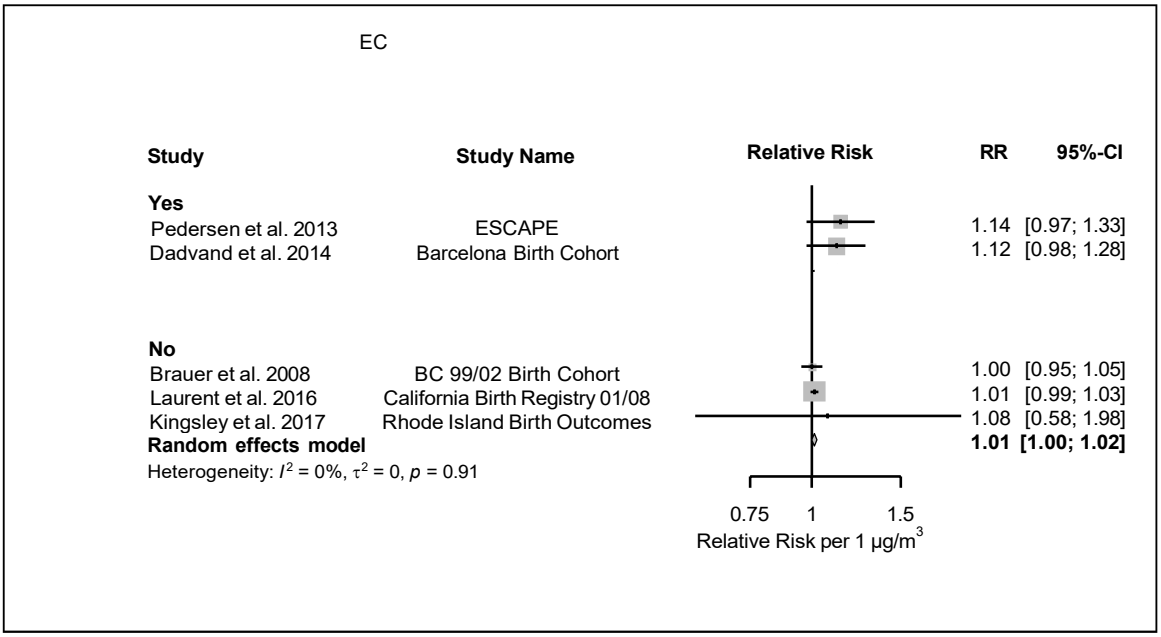


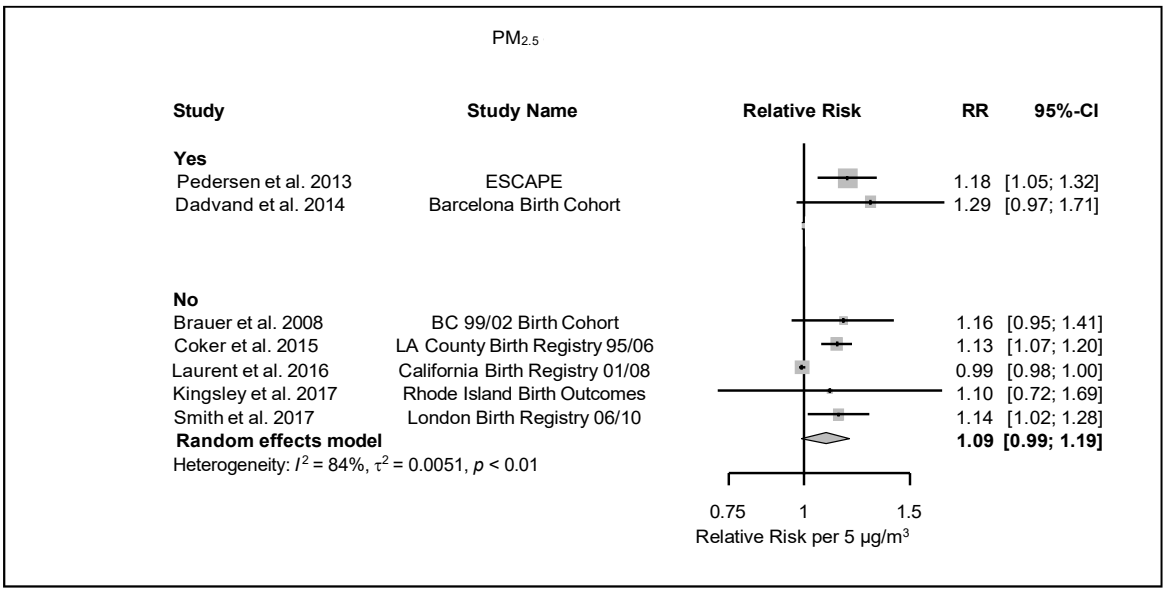
Appendix Figure 8A-8. *(Continued).*





Appendix Figure 8A-9. Associations of NO_2, NO_X, EC, and $PM_{2.5}$ with TLBW: meta-analysis by BMI adjustment (exposure window: entire pregnancy). *Figure continues next page.*





Appendix Figure 8A-9. *(Continued).*

Appendix 8B Term birth weight (TBW)

Appendix Table 8B-1. Key Study Characteristics of Articles Included in the Systematic Review for TBW — Pollutants (Exposure Window: **First Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Mean difference (95% CI) (g)[d]	Increment
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	6,978	LUR	NO_2	38.7	3.9 (−27.9, 35.6)	>51.2 vs. <30.3 μg/m³
								−16.4 (−48.1, 15.3)	45.3–51.2 vs. <30.3 μg/m³
								−14.1 (−45.6, 17.5)	39.1–45.3 vs. <30.3 μg/m³
								25.0 (−6.5, 56.6)	30.3–39.1 vs. <30.3 μg/m³
Gehring 2011b	PIAMA	Multiple cities, The Netherlands	1996–1997	3,408	LUR	NO_2	30.4	**34.3 (9.7, 58.8)**	14.4 μg/m³
						$PM_{2.5\ abs}$	2.75	**20.5 (−3.5, 44.4)**	2.46 1×10^{-5}/m
						$PM_{2.5}$ mass	20.1	**17.5 (−6.8, 41.7)**	7.8 μg/m³
Hjortebjerg 2016	DNBC	Denmark	1996–2002	75,166	Dispersion / CTM	NO_2	11.0	**4.3 (−1.5, 10.0)**	10 μg/m³
						NO_x	not reported	**1.0 (−3.0, 4.9)**	20 μg/m³
Keller 2017	Georgia Birth Registry 02/05	Georgia, United States	2002–2005	180,440	LUR	$PM_{2.5}$ mass	14.2	**−1.5 (−3.2, 0.1)**	1 μg/m³
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	**1.3 (−2.9, 5.5)**	0.11 μg/m³
						$PM_{2.5}$ mass	9.5	**−4.2 (−10.6, 2.3)**	2.5 μg/m³
Li 2016	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	1,203,782	LUR	NO_2	25	**−0.99 (−1.39, −0.59)**	1 ppb
						NO_x	17.32	**−0.54 (−0.80, −0.28)**	1 ppb

Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,215	LUR	NO_2	26.2	**–1 (–5, 3)**	10 µg/m^3
						NO_x	45.5	**–1 (–4, 3)**	20 µg/m^3
						$PM_{2.5\ abs}$	1.7	**–0 (–8, 7)**	1 1×10^{-5}/m
						PM_{10} mass	25.4	–2 (–10, 6)	10 µg/m^3
						PM_{coarse} mass	9.1	1 (–6, 8)	5 µg/m^3
						$PM_{2.5}$ mass	16.5	**–2 (–8, 5)**	5 µg/m^3
Savitz 2014	NYC Birth Registry 08/10	New York City, New York, United States	2008–2010	252,967	LUR	NO_2	25	**–14.2 (SE: 2)**	10 ppb
						$PM_{2.5}$ mass	11	**–18.4 (SE: 4.1)**	10 µg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] **Bold** indicates the effect estimate was included in the meta-analysis.

Appendix Table 8B-1. *Continued* (TBW-**Second Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Mean difference (95% CI) (g)[d]	Increment
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	6,978	LUR	NO_2	38.7	36.4 (4.6, 68.3)	>48.5 vs. <30.6 µg/m^3
								27.6 (–4.3, 59.4)	43.0–48.5 vs. <30.6 µg/m^3
								23.3 (–8.4, 54.9)	37.8–43.0 vs. <30.6 µg/m^3
								19.1 (–12.7, 50.9)	30.6–37.8 vs. <30.6 µg/m^3
Hjortebjerg 2016	DNBC	Denmark	1996–2002	75,166	Dispersion / CTM	NO_2	11.0	**0.5 (–5.5, 6.5)**	10 µg/m^3
						NO_x	not reported	**0.5 (–3.6, 4.5)**	20 µg/m^3
Keller 2017	Georgia Birth Registry 02/05	Georgia, United States	2002–2005	180,440	LUR	$PM_{2.5}$ mass	14.2	**–1.6 (–3.3, 0.0)**	1 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	1.2 (–3, 5.4)	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**–0.3 (–6.8, 6.2)**	2.5 µg/m^3
Li 2016	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	1,203,782	LUR	NO_2	25	**–0.79 (–1.26, –0.32)**	1 ppb
						NO_x	17.32	**–0.52 (–0.78, –0.26)**	1 ppb
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,294	LUR	NO_2	26.2	**0 (–4, 4)**	10 µg/m^3
						NO_x	45.5	**1 (–3, 3)**	20 µg/m^3
						$PM_{2.5\ abs}$	1.7	–0 (–8, 8)	1 1×10^{-5}/m
						PM_{10} mass	25.4	–7 (–15, 2)	10 µg/m^3
						PM_{coarse} mass	9.1	–2 (–9, 5)	5 µg/m^3
						$PM_{2.5}$ mass	16.5	**–5 (–11, 1)**	5 µg/m^3

Savitz 2014	NYC Birth Registry 08/10	New York City, New York, United States	2008–2010	252,967	LUR	NO_2	25	**–15.9 (SE: 2.1)**	10 ppb
						$PM_{2.5}$ mass	11	**–10.5 (SE: 4.5)**	10 µg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] **Bold** indicates the effect estimate was included in the meta-analysis.

Appendix Table 8B-1. *Continued* (TBW-**Third Trimeste**r)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Mean difference (95% CI) (g)[d]	Increment
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,531	LUR	NO_2	38.7	16.5 (−15.6, 48.7)	>45.9 vs. <27.9 µg/m³
								−2.5 (−34.4, 29.4)	39.8–45.9 vs. 27.9 µg/m³
								3.3 (−28.5, 35.1)	33.5–39.8 vs. <27.9 µg/m³
								−15.7 (−47.7, 16.4)	27.9–33.5 vs. <27.9 µg/m³
Hjortebjerg 2016	DNBC	Denmark	1996–2002	75,166	Dispersion / CTM	NO_2	11.0	**3.0 (−3.1, 9.1)**	10 µg/m³
						NO_x	not reported	**1.2 (−3.0, 5.4)**	20 µg/m³
Janssen 2017	ENVIRONAGE	Genk, Belgium	2010–2014	499	Dispersion / CTM	$PM_{2.5}$ mass	16.0	**73 (−18, 164)**	8.2 µg/m³
Keller 2017	Georgia Birth Registry 02/05	Georgia, United States	2002–2005	180,440	LUR	$PM_{2.5}$ mass	14.2	**−2.5 (−4.2, −0.8)**	1 µg/m³
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	−3.6 (−7.8, 0.7)	0.11 µg/m³
						$PM_{2.5}$ mass	9.5	**−5.3 (−11.0, 0.4)**	2.5 µg/m³
Li 2016	LA County Birth Registry 01/08	Los Angeles County, California, United States	2001–2008	1,203,782	LUR	NO_2	25	**−1.27 (−1.72, −0.82)**	1 ppb
						NO_x	17.32	**−0.61 (−0.90, −0.32)**	1 ppb
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,001	LUR	NO_2	26.2	**−3 (−7, 2)**	10 µg/m³
						NO_x	45.5	**−2 (−5, 1)**	20 µg/m³
						$PM_{2.5\ abs}$	1.7	−9 (−17, −1)	1 1×10^{-5}/m
						PM_{10} mass	25.4	**−6 (−15, 2)**	10 µg/m³
						PM_{coarse} mass	9.1	−5 (−12, 3)	5 µg/m³
						$PM_{2.5}$ mass	16.5	**−1 (−9, 7)**	5 µg/m³

Savitz 2014	NYC Birth Registry 08/10	New York City, New York, United States	2008–2010	252,967	LUR	NO_2	25	**–18.0 (SE: 2.2)**	10 ppb
						$PM_{2.5}$ mass	11	**–29.7 (SE: 5.1)**	10 µg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] **Bold** indicates the effect estimate was included in the meta-analysis.

Appendix Table 8B-2. Noise-Adjusted Analyses in TBW Studies (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Pollutant	Increment	Single pollutant[a]	Noise adjusted[a]
Gehring 2014	BC 99/02 Birth Cohort	NO_2	10 µg/m^3	−5.2 (−9.1, −1.4)	−2.1 (−5.9, 1.8)
		NO	10 µg/m^3	−6.5 (−9.1, −3.9)	−1.8 (−4.5, 1.2)
		$PM_{2.5\ abs}$	1 1×10^{-5}/m	−3.4 (−6.2, −0.6)	2.0 (−1.0, 5.0)
		$PM_{2.5}$ mass	1 µg/m^3	−3.1 (−5.1, −1.1)	−1.7 (−3.7, 0.4)
		Distance	<50 vs. >50 m	−13.5 (−32.0, 5.0)	3.4 (−15.3, 22.1)
Hjortebjerg 2016	DNBC	NO_2	10 µg/m^3	0.21 (−5.20, 5.62)	3.26 (−3.19, 9.71)
		NO_x	20 µg/m^3	−0.62 (−4.08, 2.85)	1.15 (−3.07, 5.37)
Smith 2017	London Birth Registry 06/10	NO_2	8.6 µg/m^3	−10.97 (−12.98, −8.96)	−10.43 (−12.64, −8.22)
		NO_x	23.7 µg/m^3	−10.74 (−12.76, −8.73)	−10.07 (−12.26, −7.88)
		PM_{10} mass	3.0 µg/m^3	−7.27 (−9.84, −4.70)	−5.31 (−8.09, −2.52)
		$PM_{2.5}$ mass	2.2 µg/m^3	−12.94 (−16.41, −9.47)	−11.02 (−14.76, −7.37)
		$PM_{2.5}$ exhaust	0.35 µg/m^3	−12.43 (−14.51, −10.35)	−12.54 (−14.92, −10.16)
		nontailpipe $PM_{2.5}$	0.29 µg/m^3	−7.41 (−8.96, −5.86)	−7.27 (−9.14, −5.41)

[a] Effect estimates are mean difference expressed in grams.

Appendix Table 8B-3. Key Study Characteristics of Articles Included in the Systematic Review for TBW — Indirect Traffic Measures (Exposure Window: **Entire Pregnancy**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Traffic measure	Mean difference (95% CI) (g)	Increment
Gehring 2014	BC 99/02 Birth Cohort	Vancouver, British Columbia, Canada	1999–2002	68,238	Distance	−13.5 (−32.0, 5.0)	<50 vs. >50 m
Kingsley 2016	RICHS	Providence, Rhode Island, United States	2009–2013	471	Distance	−175.9 (−318.9, −32.9)	<50 m from A3 or <150 m from A1/A2 road vs. higher
Laurent 2013	South Coast Births 97/06	Los Angeles and Orange Counties, California, United States	1997–2006	68,303	Density	−0.51 (−2.00, 0.97)	54 vehicles/day/m
					Distance	−1.95 (−5.42, 1.51)	253 m
Pedersen 2013	ESCAPE	Multiple cities, Multiple countries	1994–2011	60,254	Density	−1.0 (−4.0, 2.0)	4,000 vehicle-km/day

[a] All were cohort studies.

[b] All studies included male and female participants.

Appendix Table 8B-4. Risk of Bias Assessment for Individual Studies on TBW (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Confounding	Selection Bias	Exposure Assessment	Outcome Measurement	Missing Data	Selective Reporting
Gehring 2011b	PIAMA	High	Low	Mod	Mod	Low	Low
Gehring 2014	BC 99/02 Birth Cohort	High	Low	Low	Low	Low	Low
Hjortebjerg 2016	DNBC	Low	Low	Low	Low	Low	Low
Kingsley 2017	Rhode Island Birth Outcomes	High	Low	Mod	Low	Low	Low
Laurent 2013	South Coast Births 97/06	High	Low	Mod	Low	Low	Low
Li 2016	LA County Birth Registry 01/08	High	Low	Mod	Low	Low	Low
Pedersen 2013	ESCAPE	Low	Low	Mod	Low	Low	Low
Savitz 2014	NYC Birth Registry 08/10	High	Low	Mod	Low	Low	Low
Smith 2017	London Birth Registry 06/10	High	Low	Mod	Low	Low	Low

Mod = moderate

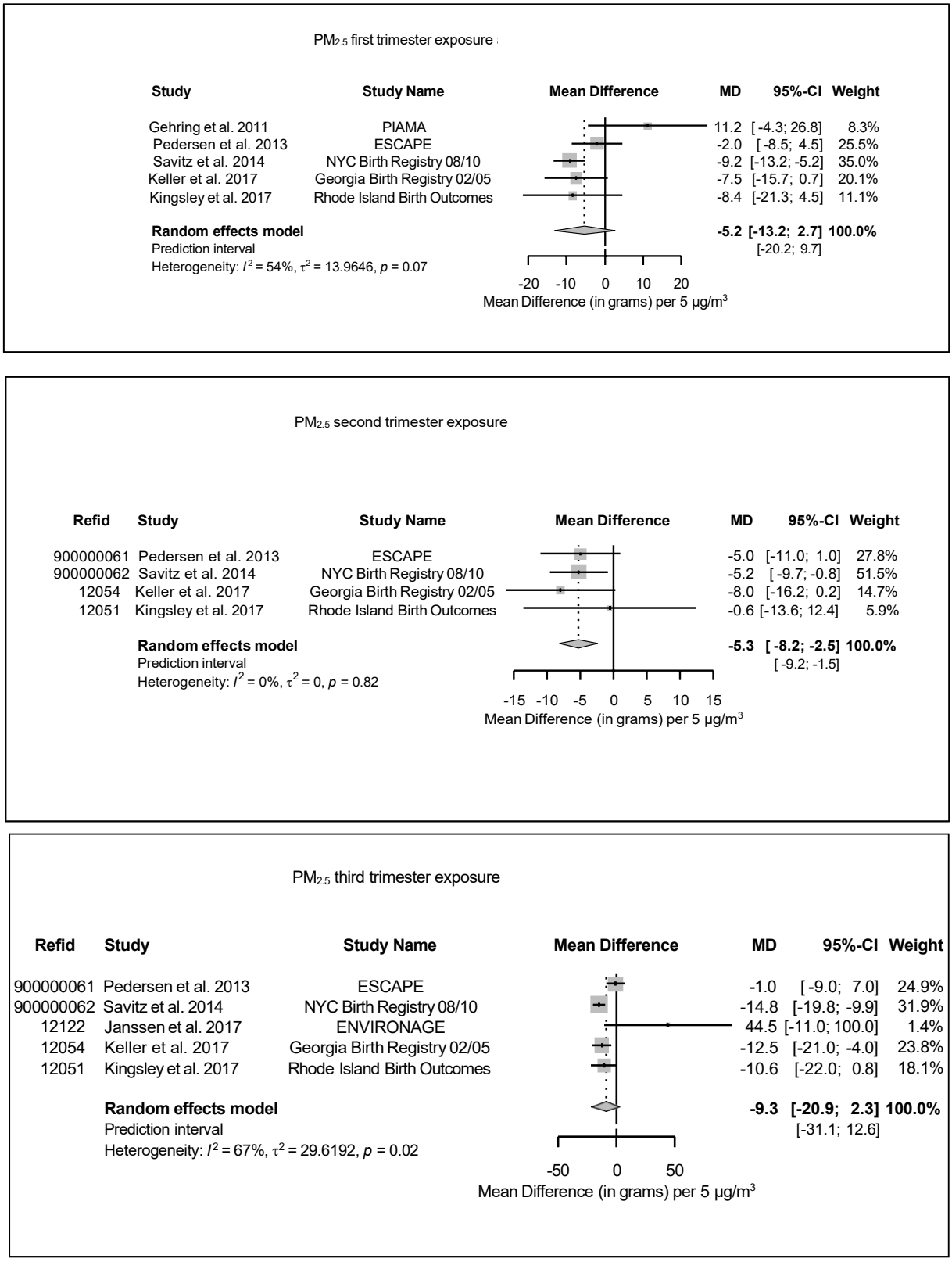


Figure 8B-1. Association of $PM_{2.5}$ with TBW: meta-analysis (exposure window: trimester).

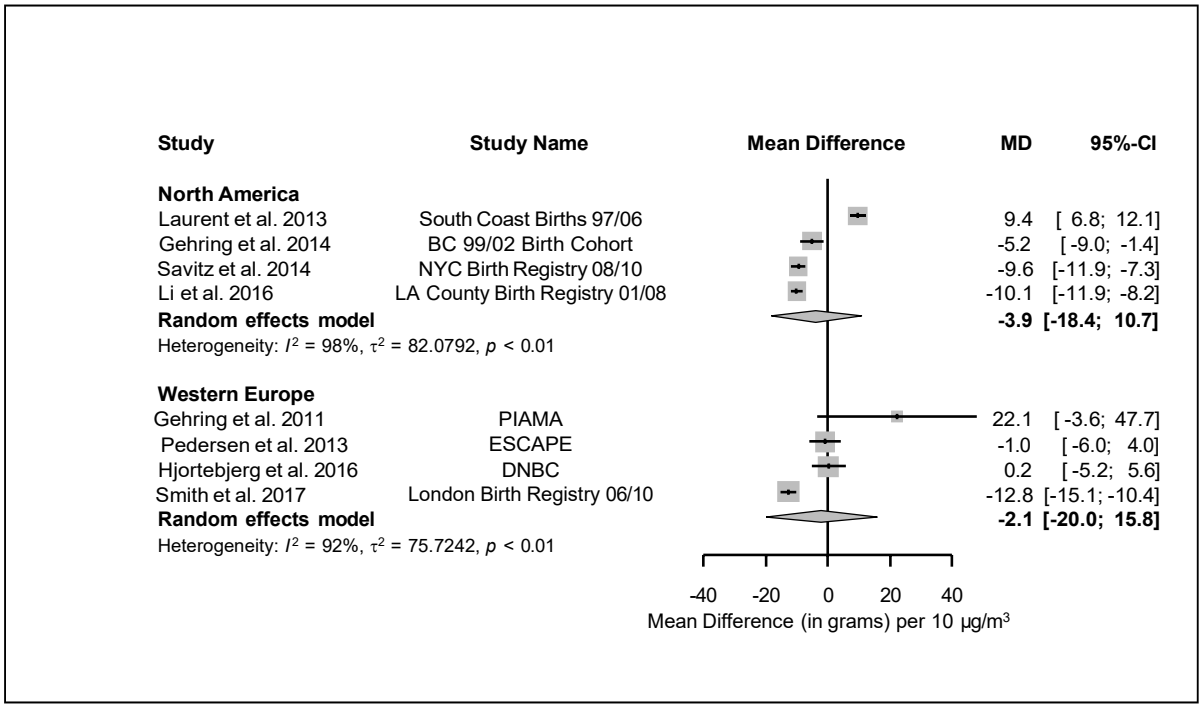
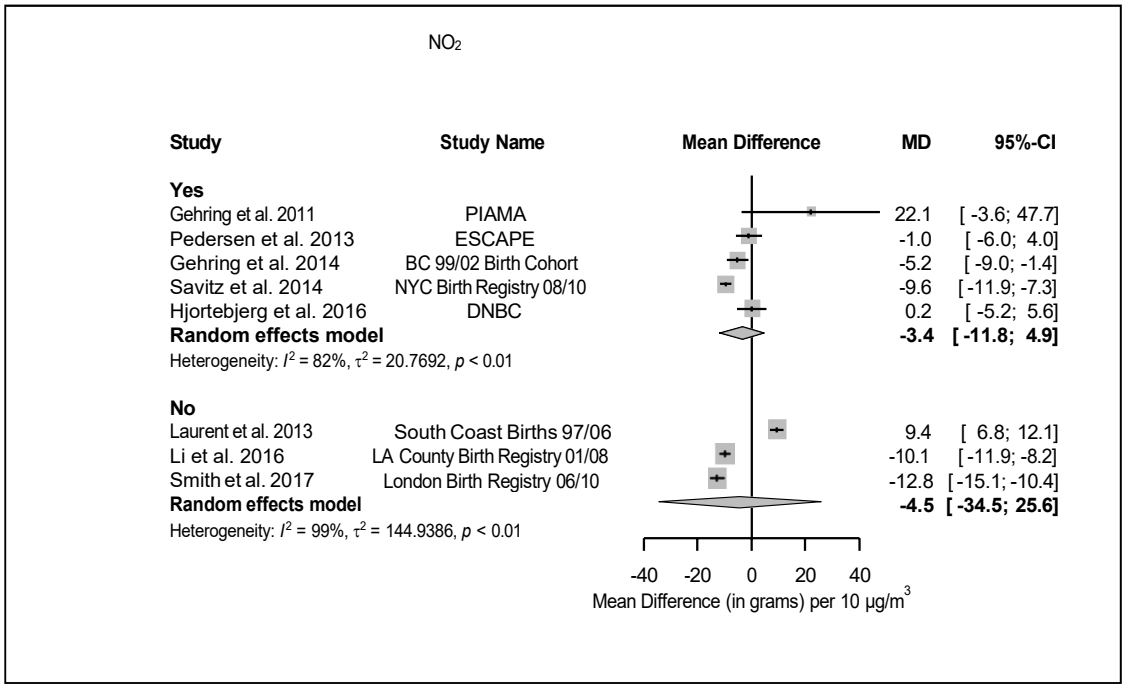


Figure 8B-2. Association of NO_2 with TBW: meta-analysis by region (exposure window: entire pregnancy).



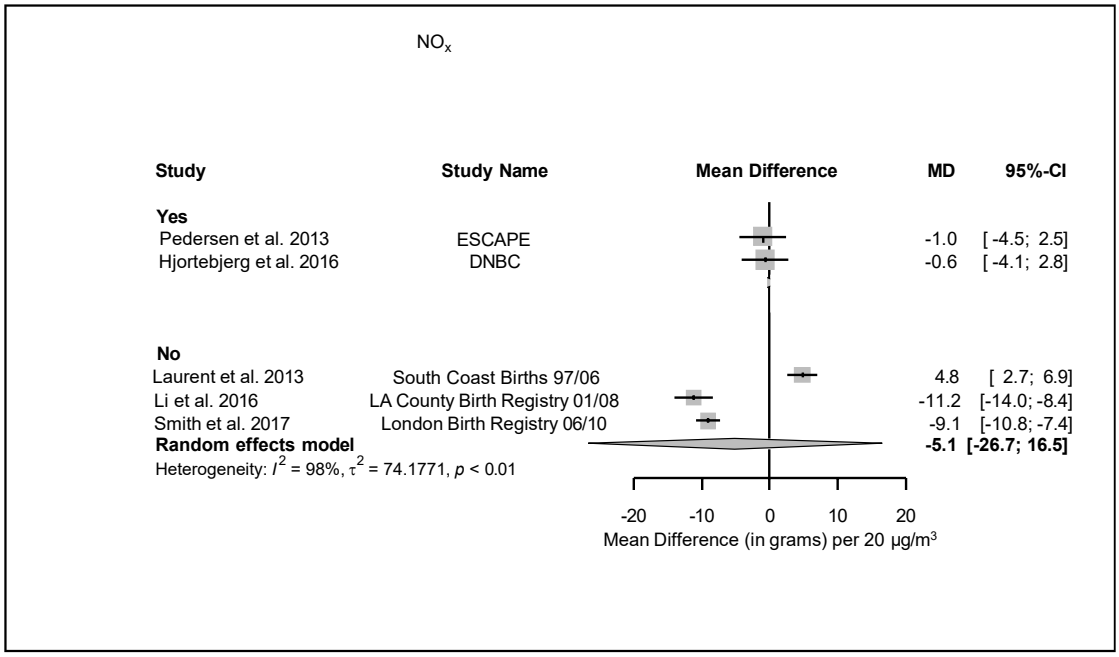


Figure 8B-3. Associations of NO_2, NO_x, and $PM_{2.5}$ with TBW: meta-analysis by smoking adjustment (exposure window: entire pregnancy). *Figure continues next page.*

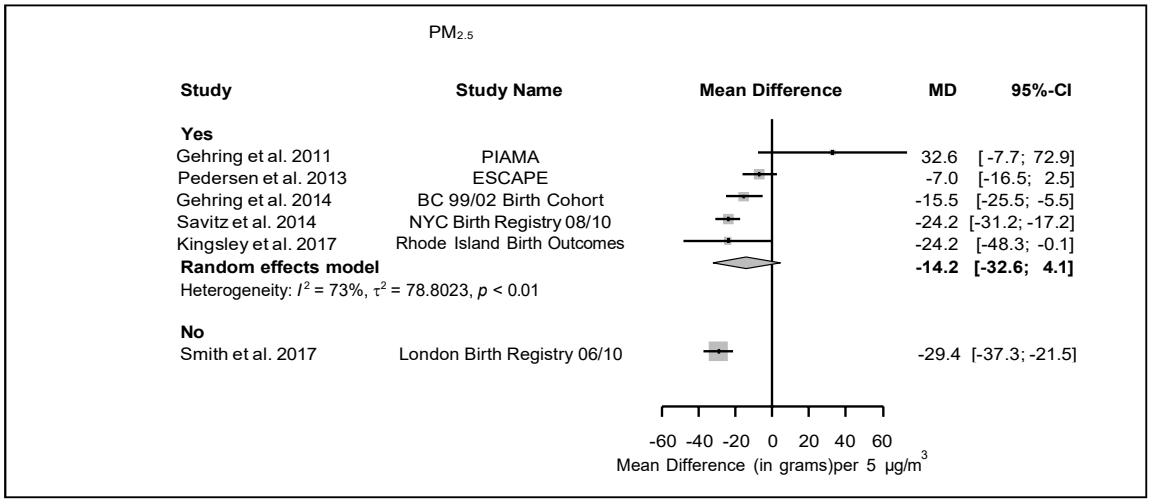
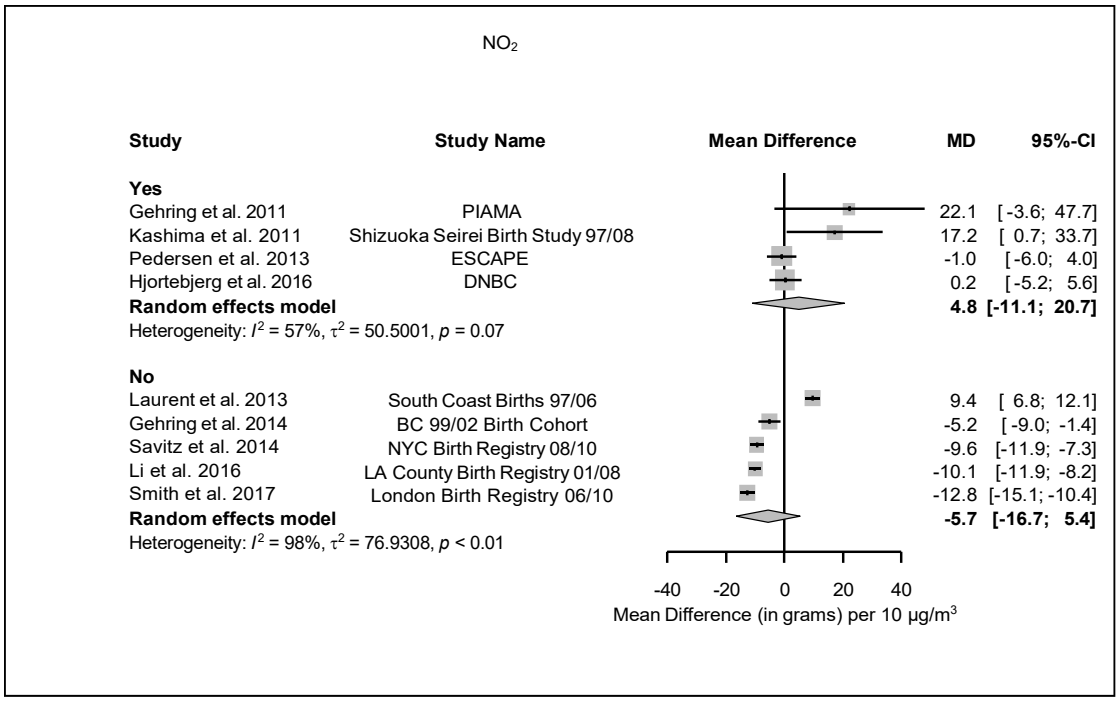


Figure 8B-3. *(Continued).*



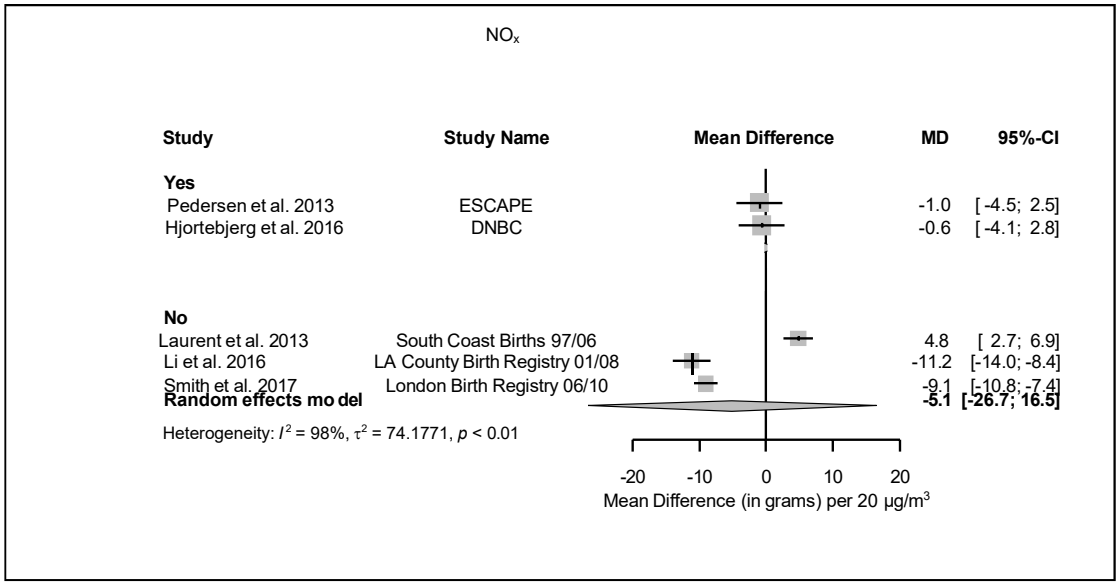


Figure 8B-4. Associations of NO_2, NO_x, EC, and $PM_{2.5}$ with TBW: meta-analysis by BMI adjustment (exposure window: entire pregnancy). *Figure continues next page.*

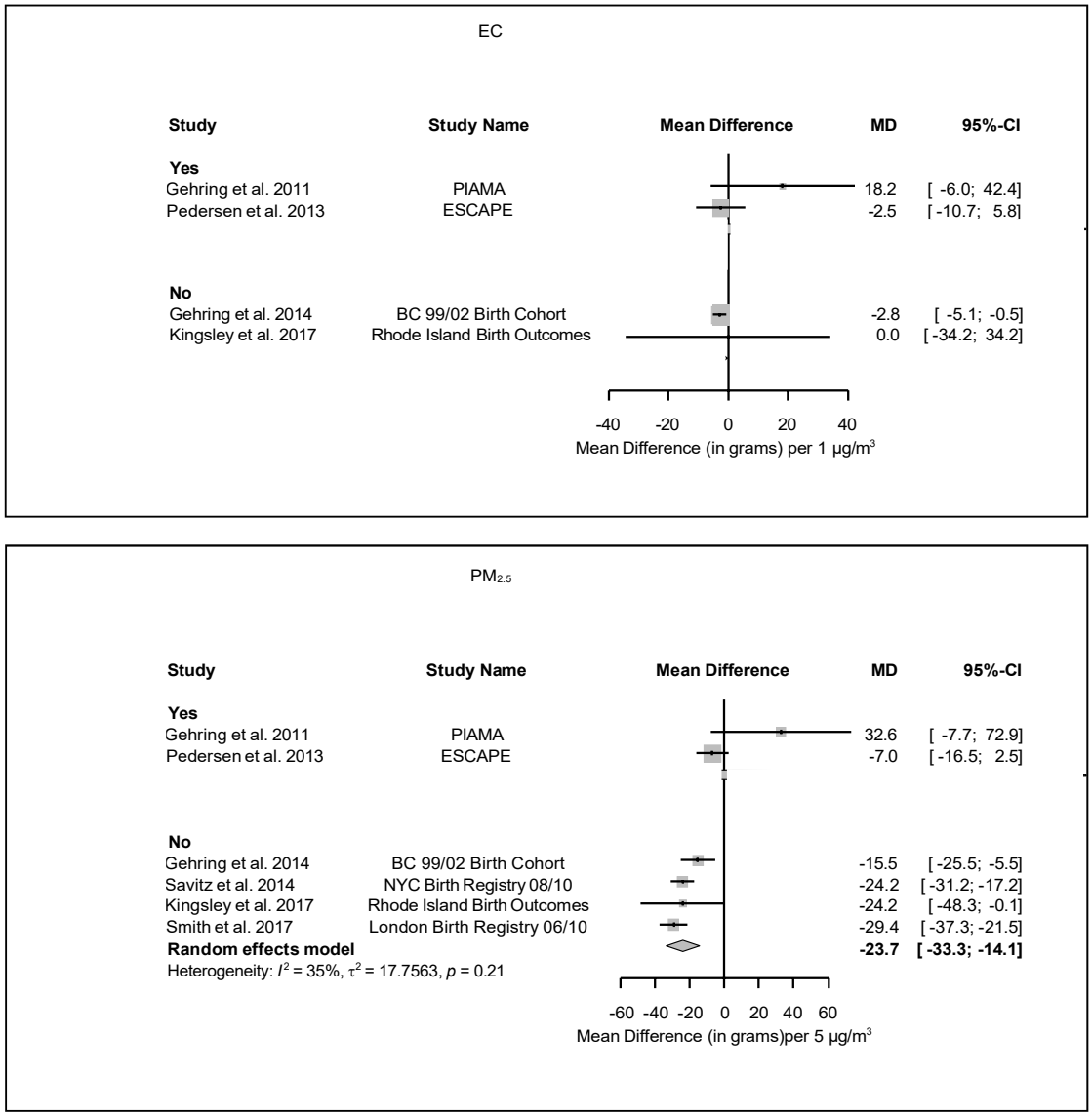
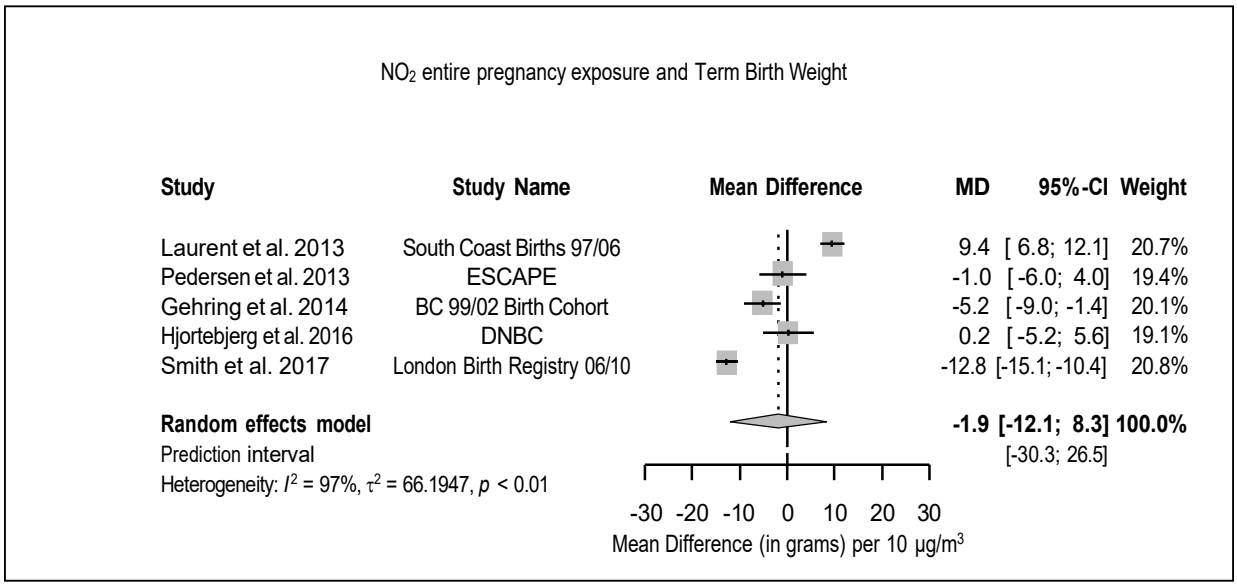


Figure 8B-4. *(Continued).*



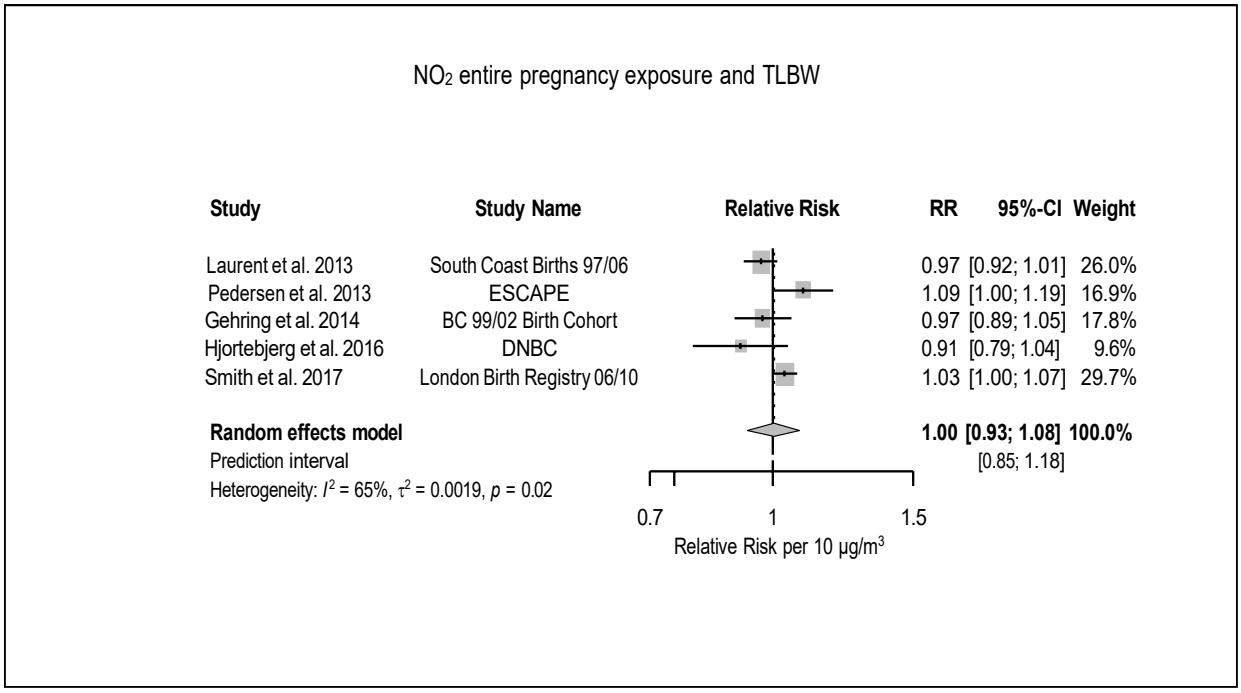
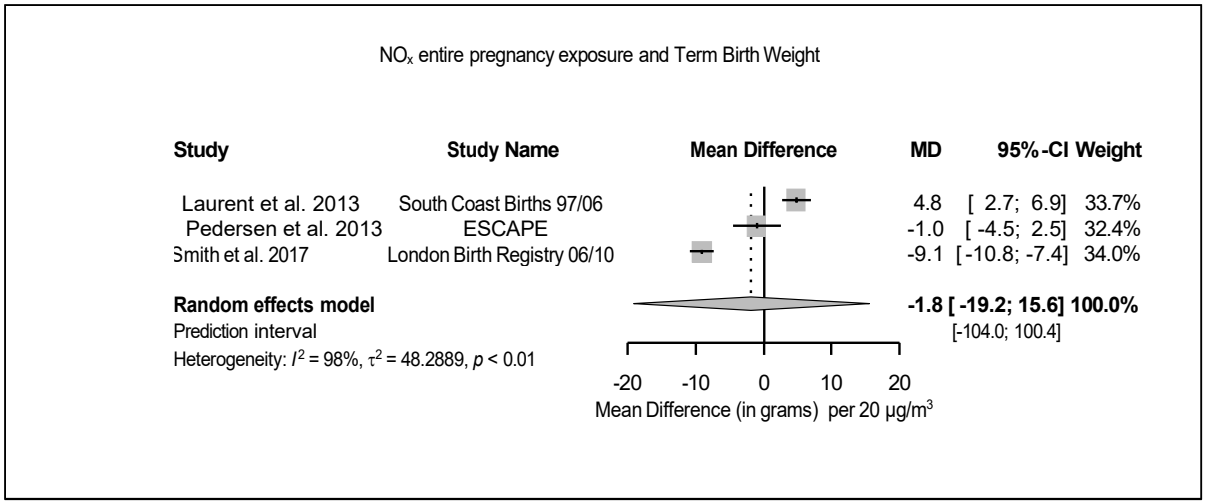


Figure 8B-5. Associations of NO_2, NO_x, EC, and $PM_{2.5}$: meta-analysis of studies that report both TBW and TLBW Estimates for (exposure window: entire pregnancy). *Figure continues next page.*



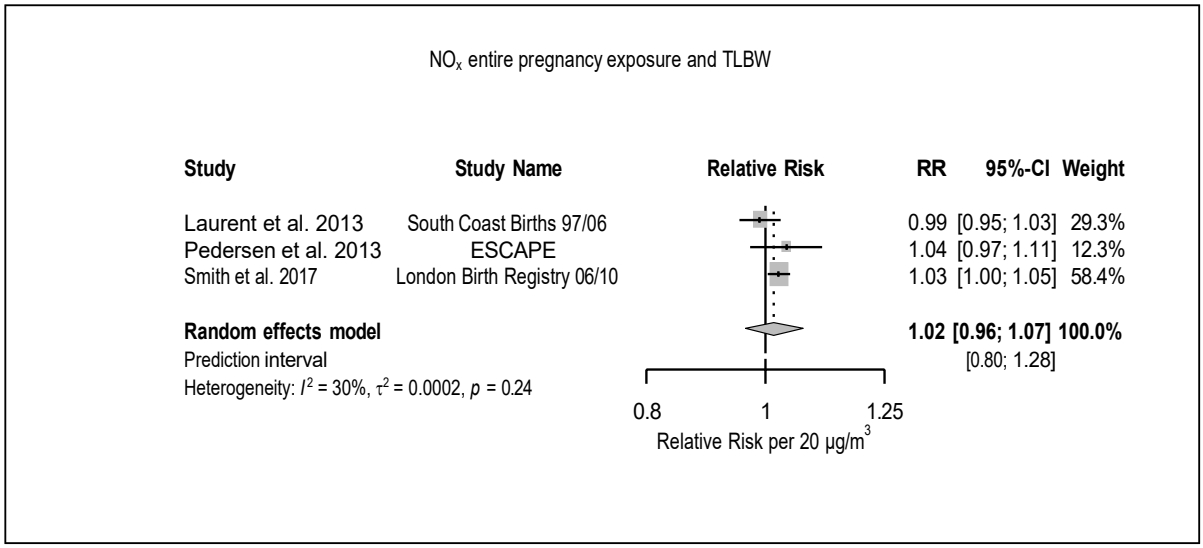
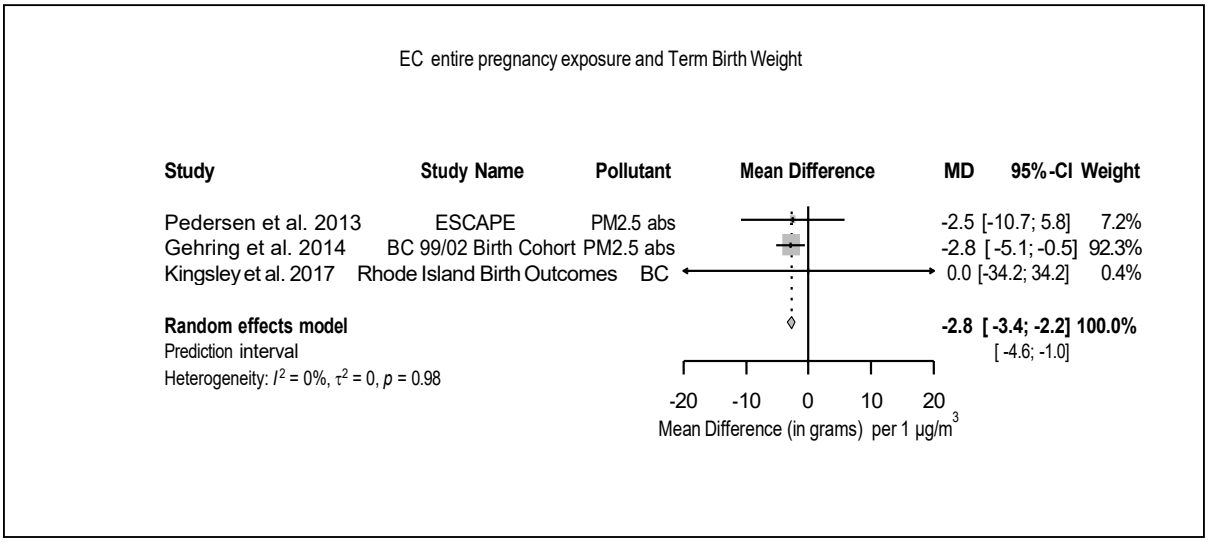


Figure 8B-5. *(Continued).*



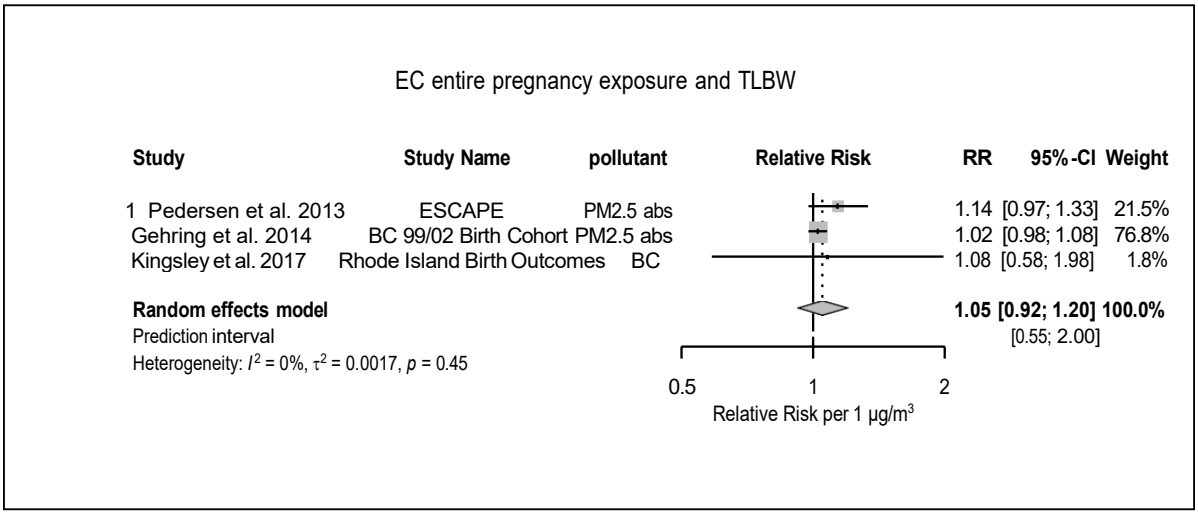
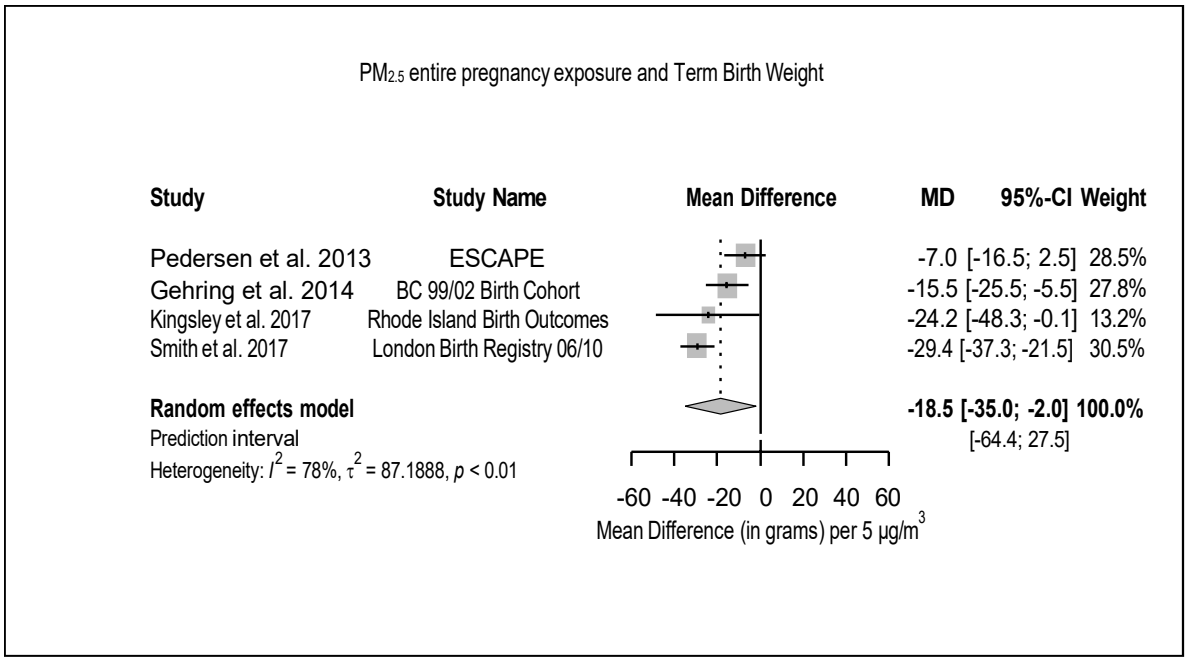


Figure 8B-5. *(Continued).*



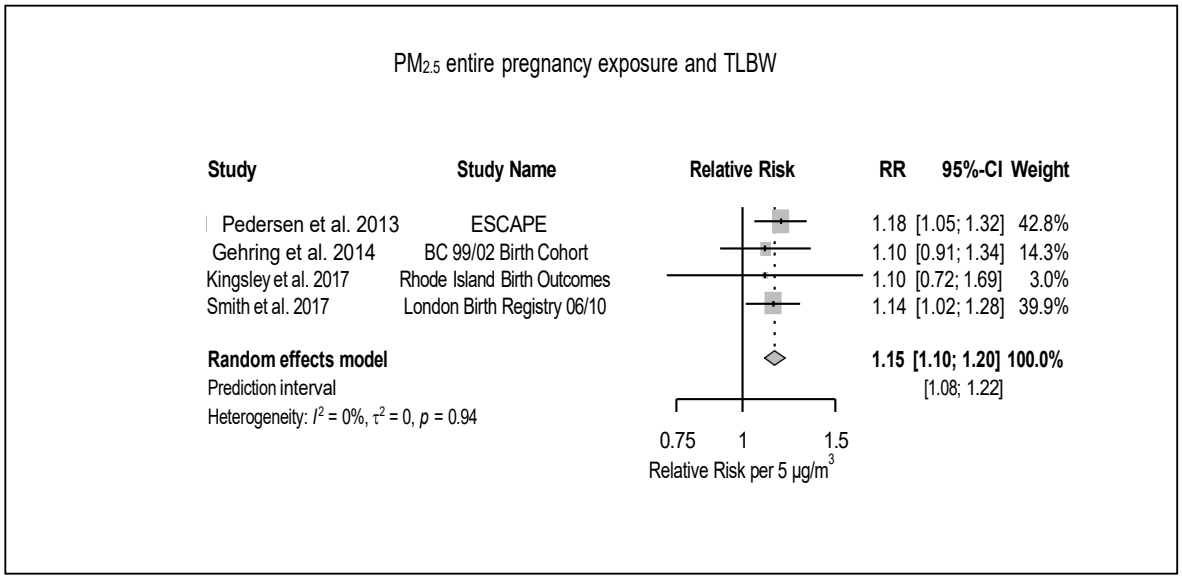
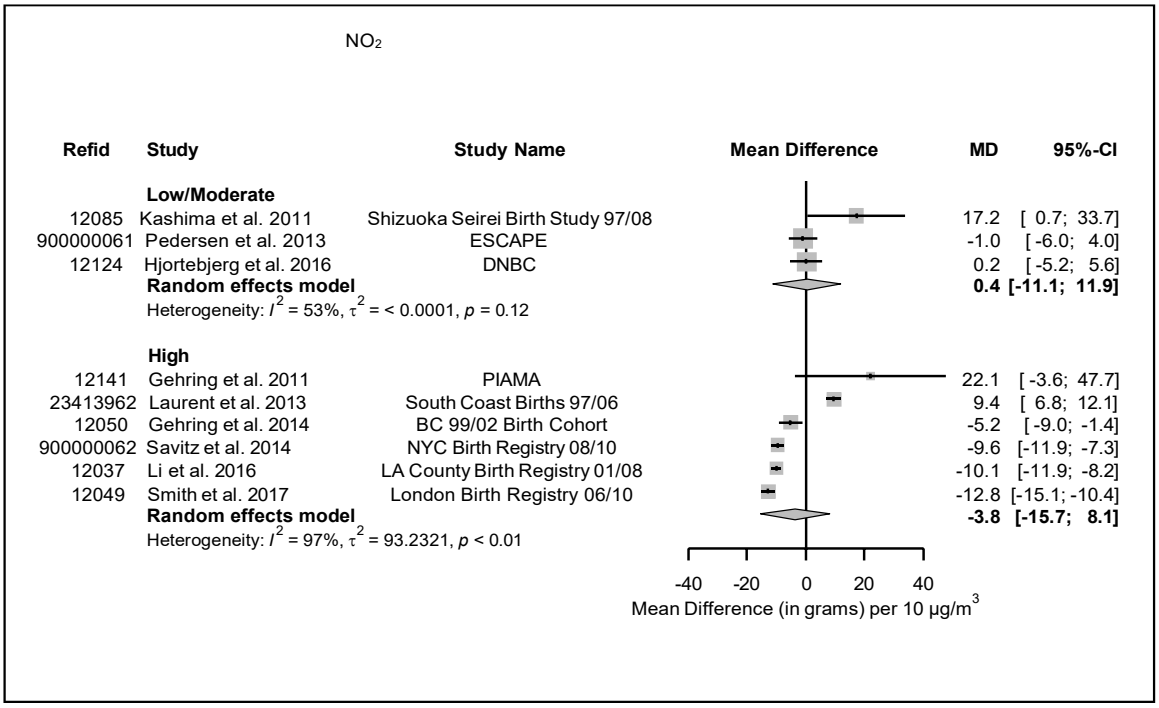


Figure 8B-5. *(Continued).*



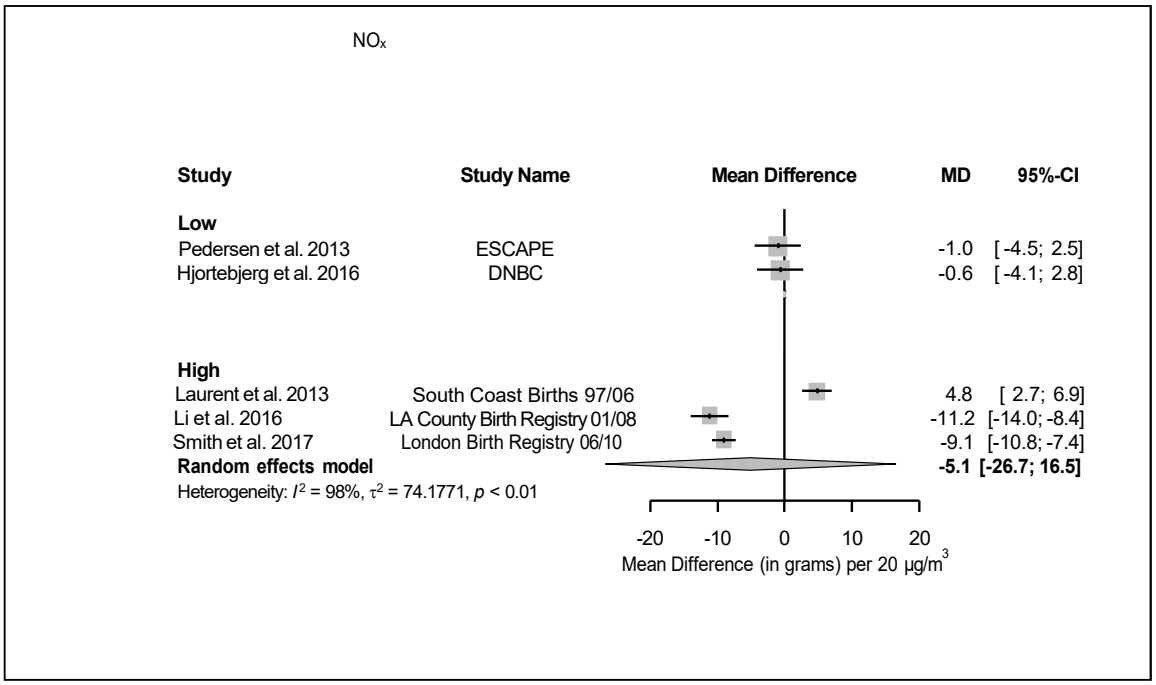
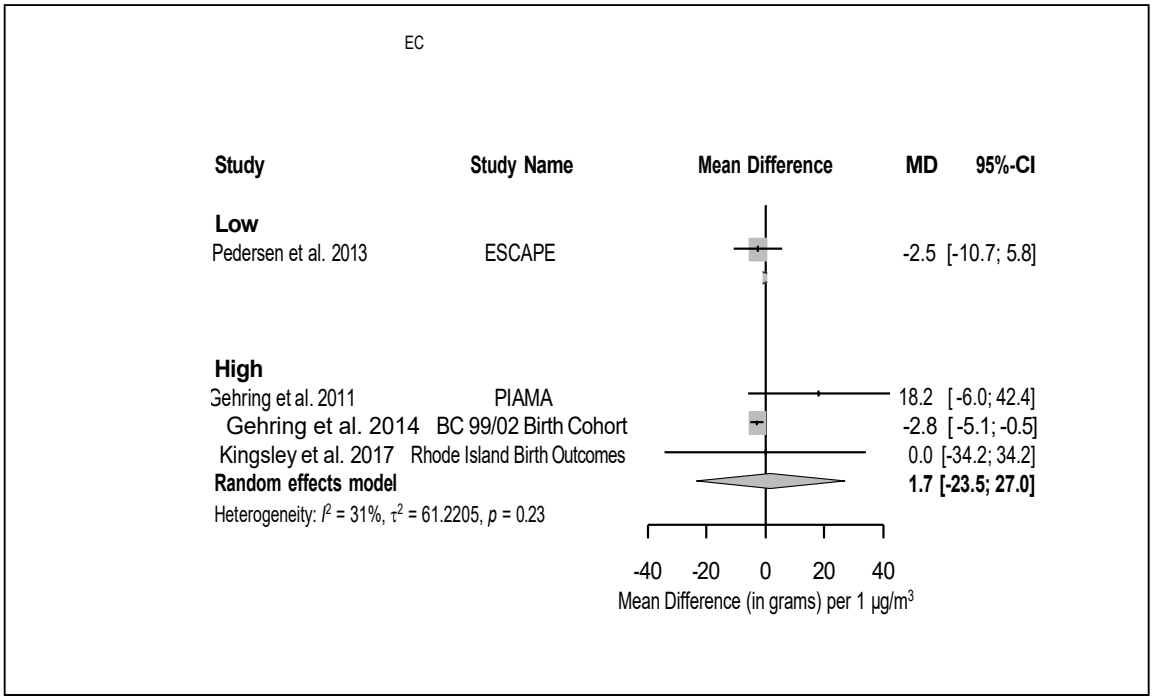


Figure 8B-6. Associations of NO_2, NO_x, EC, and $PM_{2.5}$ with TBW: meta-analysis by risk of bias assessment on confounding (entire pregnancy). *Figure continues next page.*



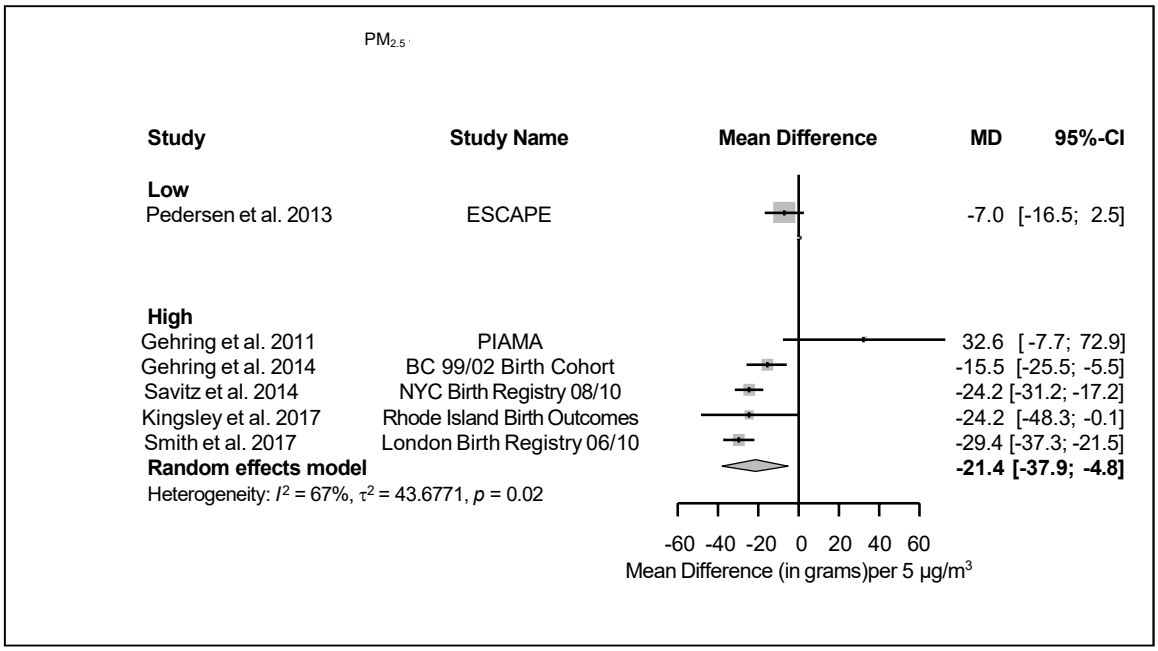


Figure 8B-6. *(Continued).*

Appendix 8C Small for gestational age (SGA)

Appendix Table 8C-1. Key Study Characteristics of Articles Included in the Systematic Review for SGA — Pollutants (Exposure Window**: First Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d,e]	Increment
Ballester 2010	INMA Valencia	Valencia, Spain	2003–2006	785	LUR	NO_2	36.9	**1.18 (0.89, 1.56)**	10 µg/m^3
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.04 (0.97, 1.11)**	20.5 µg/m^3
						NO_x	102.8	1.04 (0.98, 1.11)	59.0 µg/m^3
						$PM_{2.5\ abs}$	3.1	1.07 (0.95, 1.21)	1.6 1×10^{-5}/m
						PM_{10} mass	39.2	**1.00 (0.90, 1.11)**	5.7 µg/m^3
						PM_{coarse} mass	22.3	1.04 (0.93, 1.16)	3.4 µg/m^3
						$PM_{2.5}$ mass	16.9	**1.06 (0.96, 1.17)**	3.7 µg/m^3
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,541	LUR	NO_2	38.7	0.91 (0.71, 1.17)	>51.2 vs. <30.3 µg/m^3
								1.00 (0.79, 1.27)	45.3–51.2 vs. <30.3 µg/m^3
								1.00 (0.79, 1.26)	39.1–45.3 vs. <30.3 µg/m^3
								0.84 (0.65, 1.07)	30.3–39.1 vs. <30.3 µg/m^3
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	11,348	LUR	NO_2	29.2	**0.97 (0.88, 1.07)**	10 µg/m^3
						BC	0.52	1.03 (0.99, 1.06)	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**1.00 (0.95, 1.06)**	2.5 µg/m^3
Mannes 2005	Sydney Birth Study 98/00	Sydney, Australia	1998–2000	51,460	Surface monitoring	NO_2	23.2	**1.06 (0.99, 1.14)**	1 ppb
				22,684		CO	0.8	0.99 (0.86, 1.14)	1 ppm
Mariet 2018	PRECEE	Dijon and Besancon, France	2005–2009	249	Dispersion / CTM	NO_2	23.1	**0.78 (0.55, 1.12)**	10 µg/m^3

Olsson 2015	Stockholm Birth Outcomes	Stockholm, Sweden	1997–2006	74,991	Dispersion / CTM	NO_x	15.1	1.14 (1.06, 1.23)	Q4 vs. Q1 µg/m^3
								1.08 (1.00, 1.17)	Q3 vs. Q1 µg/m^3
								1.12 (1.05, 1.20)	Q2 vs. Q1 µg/m^3
Pereira 2012	Perth Birth Cohort	Perth, Australia	2000–2006	23,452	LUR	NO_2	23.04	**1.04 (0.88, 1.24)**	5.63 ppb
Sathyanarayana 2013	Puget Sound Birth Registry	Puget Sound, United States	1997–2005	367,046	LUR	NO_2	13.7	1.08 (1.04, 1.12)	15.2–34.7 vs. 8.7–12.2 ppb
								1.06 (1.03, 1.10)	13.6–15.2 vs. 8.7–12.2 ppb
								1.01 (0.97, 1.04)	12.2–13.6 vs. 8.7–12.2 ppb
Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	471,489	Dispersion / CTM	NO_2	40.6	**1.01 (1.00, 1.03)**	10 µg/m^3
						NO_x	72.5	1.01 (1.00, 1.02)	20 µg/m^3
						PM_{10} mass	23.1	**1.04 (0.99, 1.08)**	10 µg/m^3
						$PM_{2.5}$ mass	14.4	**1.03 (1.00, 1.06)**	5 µg/m^3
						$PM_{2.5}$ exhaust	0.60	1.05 (1.01, 1.10)	1 µg/m^3
						nontailpipe $PM_{2.5}$	0.70	1.03 (0.98, 1.07)	1 µg/m^3
Winckelmans 2015	Flanders Birth Study 99/09	Flanders, Belgium	1999–2009	494,653	Dispersion / CTM	PM_{10} mass	31.24	**1.06 (1.04, 1.08)** (>36 weeks)	10 µg/m^3
								1.16 (1.06, 1.27) (32–36 weeks)	
								0.98 (0.74, 1.29) (<32 weeks)	

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] None of the estimates were log transformed.

Appendix Table 8C-1. *Continued* (SGA – **Second Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d,e]	Increment
Ballester 2010	INMA Valencia	Valencia, Spain	2003–2006	785	LUR	NO_2	36.9	**1.37 (1.01, 1.85)**	10 µg/m^3
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.04 (0.97, 1.11)**	19.9 µg/m^3
						NO_x	102.8	1.03 (0.97, 1.09)	57.6 µg/m^3
						$PM_{2.5\ abs}$	3.1	1.07 (0.97, 1.18)	1.6 1×10^{-5}/m
						PM_{10} mass	39.2	**1.03 (0.92, 1.16)**	5.6 µg/m^3
						PM_{coarse} mass	22.3	1.08 (0.95, 1.22)	3.4 µg/m^3
						$PM_{2.5}$ mass	16.9	**1.08 (0.97, 1.20)**	3.7 µg/m^3
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,541	LUR	NO_2	38.7	0.91 (0.71, 1.17)	>48.5 vs. <30.6 µg/m^3
								1.05 (0.83, 1.34)	43.0–48.5 vs. <30.6 µg/m^3
								1.00 (0.79, 1.26)	37.8–43.0 vs. <30.6 µg/m^3
								0.94 (0.74, 1.20)	30.6–37.8 vs. <30.6 µg/m^3
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	11,348	LUR	NO_2	29.2	**0.96 (0.86, 1.06)**	10 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	1.03 (0.99, 1.07)	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**1.04 (0.99, 1.10)**	2.5 µg/m^3
Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**0.90 (0.88, 0.91)**	10 ppb
Mannes 2005	Sydney Birth Study 98/00	Sydney, Australia	1998–2000	51,460	Surface monitoring	NO_2	23.2	**1.14 (1.07, 1.22)**	1 ppb
				22,684	Surface monitoring	CO	0.8	1.06 (0.90, 1.25)	1 ppm
Mariet 2018	PRECEE	Dijon and Besancon, France	2005–2009	249	Dispersion / CTM	NO_2	23.1	**0.83 (0.58, 1.19)**	10 µg/m^3
Pereira 2012	Perth Birth Cohort	Perth, Australia	2000–2006	23,452	LUR	NO_2	23.04	**1.17 (0.98, 1.39)**	5.63 ppb

Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	471,489	Dispersion / CTM	NO_2	40.6	**1.01 (1.00, 1.03)**	10 μg/m³
						NO_x	72.5	1.01 (1.00, 1.02)	20 μg/m³
						PM_{10} mass	23.1	**1.00 (0.96, 1.04)**	10 μg/m³
						$PM_{2.5}$ mass	14.4	**1.01 (0.98, 1.04)**	5 μg/m³
						$PM_{2.5}$ exhaust	0.60	1.05 (1.01, 1.10)	1 μg/m³
						nontailpipe $PM_{2.5}$	0.70	1.03 (0.98, 1.07)	1 μg/m³
Winckelmans 2015	Flanders Birth Study 99/09	Flanders, Belgium	1999–2009	494,653	Dispersion / CTM	PM_{10} mass	31.24	**1.07 (1.05, 1.10)** (>36 weeks)	10 μg/m³
								1.13 (1.03, 1.24) (32–36 weeks)	10 μg/m³
								0.94 (0.70, 1.24) (<32 weeks)	10 μg/m³

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] None of the estimates were log transformed.

Appendix Table 8C-1. *Continued* (SGA — **Third Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d,e]	Increment
Ballester 2010	INMA Valencia	Valencia, Spain	2003–2006	785	LUR	NO_2	36.9	**1.19 (0.91, 1.55)**	10 µg/m^3
Dadvand 2014	Barcelona Birth Cohort	Barcelona, Spain	2001–2005	6,438	LUR	NO_2	55.5	**1.03 (0.97, 1.10)**	18.7 µg/m^3
						NO_x	102.8	1.01 (0.94, 1.08)	56.8 µg/m^3
						$PM_{2.5\ abs}$	3.1	1.05 (0.93, 1.18)	1.5 1×10^{-5}/m
						PM_{10} mass	39.2	**1.02 (0.93, 1.13)**	5.2 µg/m^3
						PM_{coarse} mass	22.3	1.06 (0.95, 1.18)	3.1 µg/m^3
						$PM_{2.5}$ mass	16.9	**1.07 (0.97, 1.18)**	3.6 µg/m^3
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,531	LUR	NO_2	38.7	0.85 (0.66, 1.10)	>45.9 vs. <27.9 µg/m^3
								1.04 (0.81, 1.32)	39.8–45.9 vs. <27.9 µg/m^3
								1.05 (0.83, 1.34)	33.5–39.8 vs. <27.9 µg/m^3
								1.16 (0.91, 1.47)	27.9–33.5 vs. <27.9 µg/m^3
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	11,348	LUR	NO_2	29.2	**0.93 (0.86, 1.02)**	10 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	1.03 (0.99, 1.07)	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**1.02 (0.97, 1.08)**	2.5 µg/m^3
Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**0.88 (0.86, 0.90)**	9 ppb
Malmqvist 2011	Scania Birth Cohort 99/05	Scania, Sweden	1999–2005	81,110	Dispersion / CTM	NO_x	16.4	0.99 (0.92, 1.06)	9.0–14.1 vs. 2.5–8.9 µg/m^3
								1.00 (0.94, 1.08)	14.2–22.6 vs. 2.5–8.9 µg/m^3
								1.07 (0.99, 1.15)	>22.7 vs. 2.5–8.9 µg/m^3

Mannes 2005	Sydney Birth Study 98/00	Sydney, Australia	1998–2000	51,460	Surface monitoring	NO_2	23.2	**1.13 (1.05, 1.21)**	1 ppb
				22,684		CO	0.8	1.05 (0.90, 1.23)	1 ppm
Mariet 2018	PRECEE	Dijon and Besancon, France	2005–2009	249	Dispersion / CTM	NO_2	23.1	**0.88 (0.62, 1.25)**	10 μg/m^3
Pereira 2012	Perth Birth Cohort	Perth, Australia	2000–2006	23,452	LUR	NO_2	23.04	**1.00 (0.83, 1.19)**	5.63 ppb
Sathyanarayana 2013	Puget Sound Birth Registry	Puget Sound, United States	1997–2005	367,046	LUR	NO_2	13.7	1.07 (1.03, 1.11)	15.0–35.7 vs. 6.3–12.0 ppb
								1.05 (1.02, 1.09)	13.4–15.0 vs. 6.3–12.0 ppb
								1.04 (1.00, 1.07)	12.0–13.4 vs. 6.3–12.0 ppb
Smith 2017	London Birth Registry 06/10	London, United Kingdom	2006–2010	471,489	Dispersion / CTM	NO_2	40.6	**1.00 (0.99, 1.02)**	10 μg/m^3
						NO_x	72.5	1.00 (0.99, 1.01)	20 μg/m^3
						PM_{10} mass	23.1	**0.98 (0.94, 1.02)**	10 μg/m^3
						$PM_{2.5}$ mass	14.4	**0.99 (0.97, 1.02)**	5 μg/m^3
						$PM_{2.5}$ exhaust	0.60	1.02 (0.98, 1.07)	1 μg/m^3
						nontailpipe $PM_{2.5}$	0.70	1.00 (0.95, 1.04)	1 μg/m^3
Winckelmans 2015	Flanders Birth Study 99/09	Flanders, Belgium	1999–2009	494,653	Dispersion / CTM	PM_{10} mass	31.24	**1.04 (1.02, 1.06)** (>36 weeks)	10 μg/m^3
								1.04 (0.97, 1.12) (32–36 weeks)	

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] None of the estimates were log transformed.

Appendix Table 8C-2. Key Study Characteristics of Articles Included in the Systematic Review (**Z-score**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Exposure Window	Effect measure	Effect Estimate (95% CI)[d]	Increment
Fleisch 2015	VIVA	Boston, Massachusetts, United States	1999–2002	2,114	LUR	BC	0.7	Third trimester	mean difference	−0.17 (−0.29, −0.05)	0.76–1.01 vs. <0.4 μg/m^3
										0.03 (−0.09, 0.14)	0.6–0.76 vs. <0.4 μg/m^3
										−0.03 (−0.15, 0.08)	0.4–0.6 vs. <0.4 μg/m^3
Lakshmanan 2015	ACCESS	Boston, Massachusetts, United States	2002–2009	670	LUR	BC	0.36	Entire pregnancy	beta	−0.07 (SE: 0.07)	0.21 μg/m^3
						$PM_{2.5}$ mass	11	Entire pregnancy	beta	−0.05 (SE: 0.08)	1.64 μg/m^3
Malmqvist 2017	MAPSS	Scania, Sweden	1999–2009	48,743	Dispersion / CTM	NO_x	17.3	Third trimester	mean difference	−0.7 (−0.9, −0.5)	10 μg/m^3
Rokoff 2018	VIVA	Massachusetts, United States	1999–2003	1,597	LUR	BC	0.8	First trimester	mean difference	−0.08 (−0.15, −0.01)	0.36 μg/m^3
Rosa 2017	ACCESS, PROGRESS, PRISM	Boston, Massachusetts, United States and Mexico City, Mexico	2002–2012	1,966	LUR	$PM_{2.5}$ mass	16.27	Third trimester	beta	−0.01 (−0.02, −0.01)	1 μg/m^3
Wang 2019	Nanning Birth Cohort	Nanjing, China	2014–2015	433	LUR	$PM_{2.5}$ mass	60.82	First trimester	beta	−0.01 (−0.01, −0.01)	1 μg/m^3

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] None of the estimates were log transformed.

Appendix Table 8C-3. Noise-Adjusted Analyses in SGA studies (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Pollutant	Increment	Single pollutant[a]	Noise adjusted[a]
Gehring 2014	BC 99/02 Birth Cohort	NO_2	10 µg/m^3	0.98 (0.96, 1.01)	1.00 (0.98, 1.01)
		NO	10 µg/m^3	1.02 (1.00, 1.04)	0.99 (0.97, 1.01)
		$PM_{2.5\ abs}$	1 1×10^{-5}/m	1.02 (1.00, 1.04)	0.99 (0.97, 1.00)
		$PM_{2.5}$ mass	1 µg/m^3	1.01 (0.99, 1.02)	1.00 (0.95, 1.06)
		Distance	<50 vs. >50 m	1.10 (0.97, 1.26)	0.99 (0.96, 1.02)
Smith 2017	London Birth Registry 06/10	NO_2	8.6 µg/m^3	1.01 (1.00, 1.03)	1.01 (0.99, 1.03)
		NO_x	23.7 µg/m^3	1.01 (1.00, 1.03)	1.01 (0.99, 1.03)
		PM_{10} mass	3.0 µg/m^3	1.01 (0.99, 1.03)	1.00 (0.98, 1.03)
		$PM_{2.5}$ mass	2.2 µg/m^3	1.03 (1.00, 1.06)	1.03 (1.00, 1.06)
		$PM_{2.5}$ exhaust	0.35 µg/m^3	1.02 (1.01, 1.04)	1.02 (1.00, 1.04)
		nontailpipe $PM_{2.5}$	0.29 µg/m^3	1.01 (1.00, 1.02)	1.01 (0.99, 1.02)
van den Hooven 2012	Generation R	NO_2	1 µg/m^3	1.03 (0.99, 1.06)[b]	1.03 (0.99, 1.06)[b]
		PM_{10} mass	1 µg/m^3	1.03 (0.99, 1.07)[b]	1.03 (0.99, 1.07)[b]

[a] Effect estimates are odds ratios.

[b] The single pollutant results also corrected for noise, thus the two columns are similar.

Appendix Table 8C-4. Key Study Characteristics of Articles Included in the Systematic Review for SGA — Indirect Traffic Measures (Exposure Window: **Entire Pregnancy**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Traffic measure	Effect Estimate (95% CI)	Increment
Brauer 2008	BC 99/02 Birth Cohort	Vancouver, British Columbia, Canada	1999–2002	70,249	Distance	0.99 (0.92, 1.06)	<150 m to highway or <50 m to major road vs. higher
Gehring 2014	BC 99/02 Birth Cohort	Vancouver, British Columbia, Canada	1999–2002	68,238	Distance	1.10 (0.97, 1.26)	<50 vs. >50 m
Genereux 2008	Montreal Birth Outcome Study	Montreal, Quebec, Canada	1997–2001	99,087	Distance	1.06 (0.96, 1.17)	<200 vs. >200 m
Hannam 2013	NWPSU	Multiple cities, United Kingdom	2004–2008	35,488	Distance	1.02 (0.92, 1.12)	<100 vs. >100 m
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Shizuoka, Japan	1997–2008	5,369	Density	0.98 (0.96, 1.01)	5,000 vehicles/day
Malmqvist 2011	Scania Birth Cohort 99/05	Scania, Sweden	1999–2005	81,110	Density	1.04 (0.93, 1.15)	>10 cars/minute vs. no road within 100 m
						0.98 (0.89, 1.08)	6–10 cars/minute vs. no road within 100 m
						1.03 (0.96, 1.10)	2–5 cars/minute vs. no road within 100 m
						0.98 (0.92, 1.04)	<2 cars/minute vs. no road within 100 m
Miranda 2013	North Carolina Birth Registry 04/08	North Carolina, United States	2004–2008	468,517	Distance	1.01 (0.98, 1.05)	<250 vs. 250–500 m
						1.01 (0.99, 1.04)	<250 vs. >500 m
Olsson 2015	Stockholm Birth Outcomes	Stockholm, Sweden	1997–2006	76,185	Density	1.00 (0.99, 1.01)	3,000 vehicles/day
Sathyanarayana 2013	Puget Sound Birth Registry	Puget Sound, United States	1997–2005	364,757	Distance	1.11 (1.00, 1.23)	<50 vs. >50 m to highway
						1.01 (0.98, 1.04)	<50 vs. >50 m to major road
van den Hooven 2009	Generation R	Rotterdam, The Netherlands	2002–2006	7,278	Density	1.12 (0.78, 1.59)	>1,235 vs. <158 vehicle-km/day
						0.99 (0.69, 1.43)	547–1,235 vs. <158 vehicle-km/day
						0.94 (0.65, 1.36)	158–547 vs. <158 vehicle-km/day
					Distance	1.14 (0.77, 1.68)	<50 vs. >200 m
						1.12 (0.78, 1.62)	50–100 vs. >200 m
						1.01 (0.69, 1.48)	100–150 vs. >200 m
						1.00 (0.67, 1.49)	150–200 vs. >200 m

Wesselink 2017	Cape Cod Family Health	Cape Cod, Massachusetts, United States	2002–2003	3,290	Distance	0.91 (0.63, 1.31)	<100 vs. >200 m
						0.81 (0.55, 1.19)	100–199 vs. >200 m
Zeka 2008	Eastern Massachusetts Birth Outcomes	Massachusetts, United States	1996–2002	425,751	Density	1.02 (1.01, 1.04)[c]	1 SD
					Distance	0.98 (0.97, 0.99)[c]	1 SD

[a] All were cohort studies.

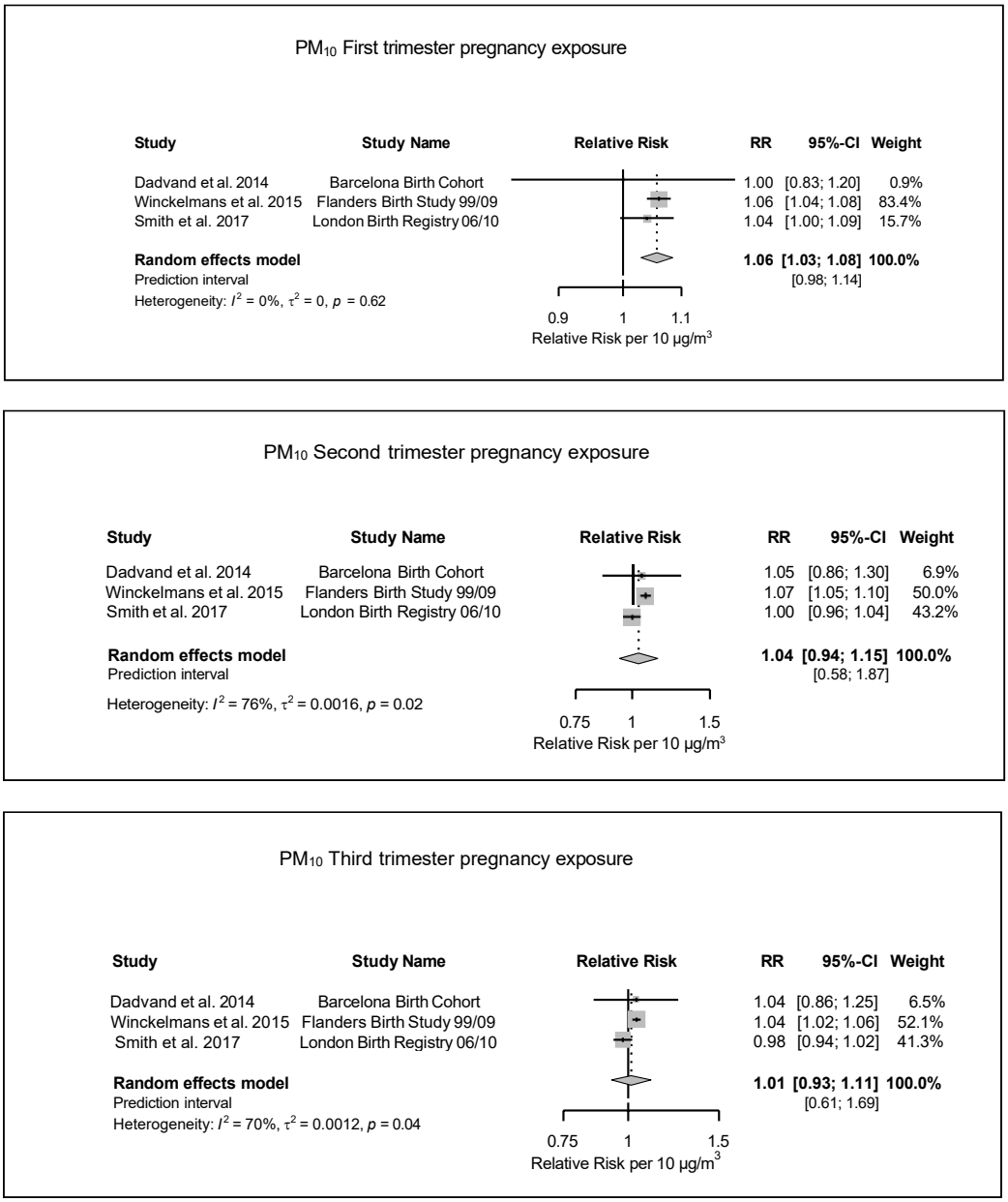
[b] All studies included male and female participants.

[c] Estimate was log transformed.

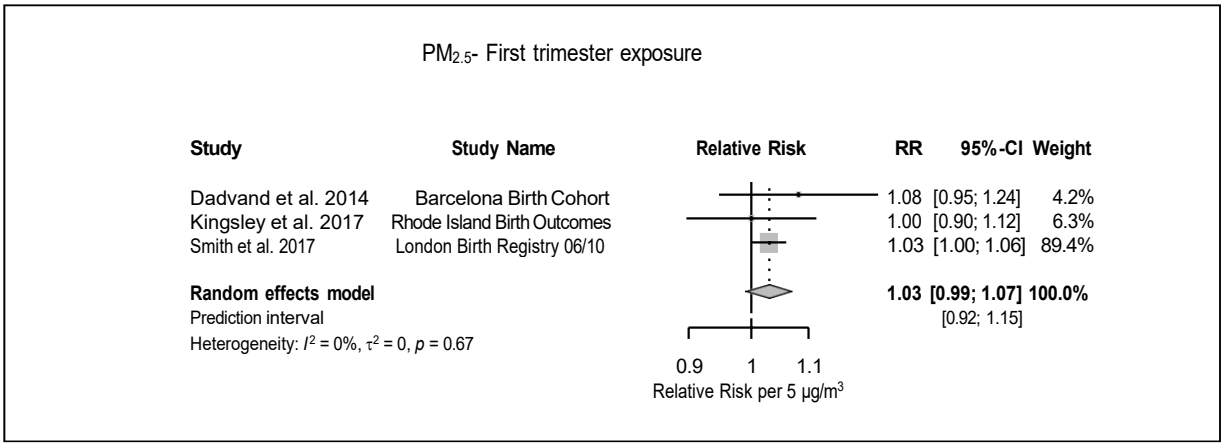
Appendix Table 8C-5. Risk of Bias Assessment for Individual Studies on SGA (Exposure Window: **Entire Pregnancy**)

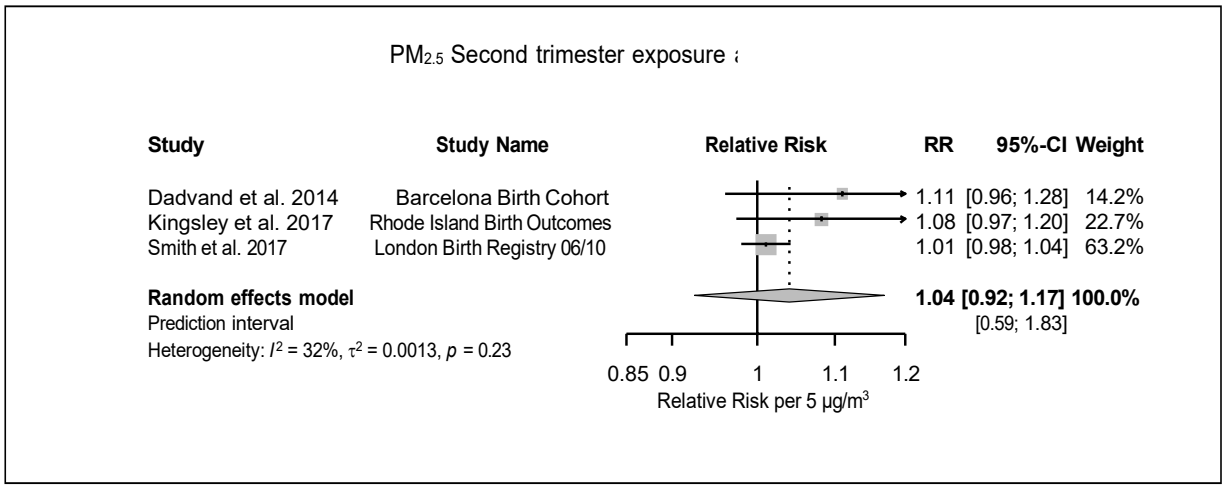
Reference	Study Name	Confounding	Selection Bias	Exposure Assessment	Outcome Measurement	Missing Data	Selective Reporting
Ballester 2010	INMA Valencia	Low	Low	Low	Low	Low	Low
Brauer 2008	BC 99/02 Birth Cohort	High	Low	Low	Low	Low	Low
Dadvand 2014	Barcelona Birth Cohort	Low	Low	Mod	Low	Low	Low
Dedele 2017	Kaunas Birth Outcomes 07/08	Low	Low	Low	Low	Low	Low
Kashima 2011	Shizuoka Seirei Birth Study 97/08	Low	Low	Low	Low	Low	Low
Kingsley 2017	Rhode Island Birth Outcomes	High	Low	Mod	Low	Low	Low
Lavigne 2016	BORN Ontario	High	Low	Low	Low	Low	Low
Mariet 2018	PRECEE	High	Low	Mod	Low	Low	Low
Pereira 2012	Perth Birth Cohort	High	Low	Low	Low	Low	Low
Poirier 2015	Halifax Birth Outcomes	Mod	Low	Mod	Low	Low	Low
Smith 2017	London Birth Registry 06/10	High	Low	Mod	Low	Low	Low
van den Hooven 2012	Generation R	Low	Low	Low	Low	Low	Low
Winckelmans 2015	Flanders Birth Study 99/09	High	Low	Low	Low	Low	Low

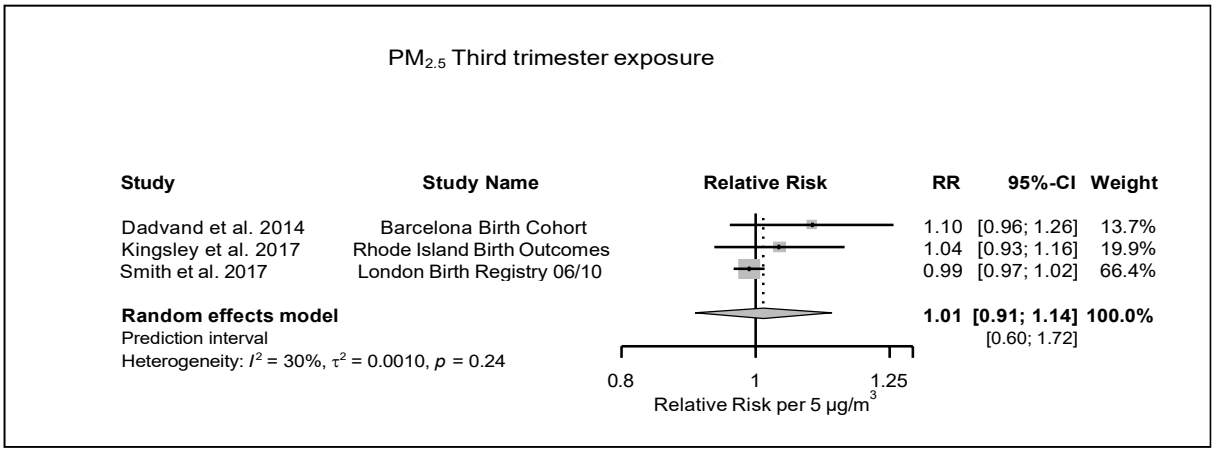
Mod = moderate



Appendix Figure 8C-1. Associations of PM_{10} and $PM_{2.5}$ with SGA: meta-analysis (exposure window: trimester). *Figure continues next page.*







Appendix Figure 8C-1. ***(Continued).***

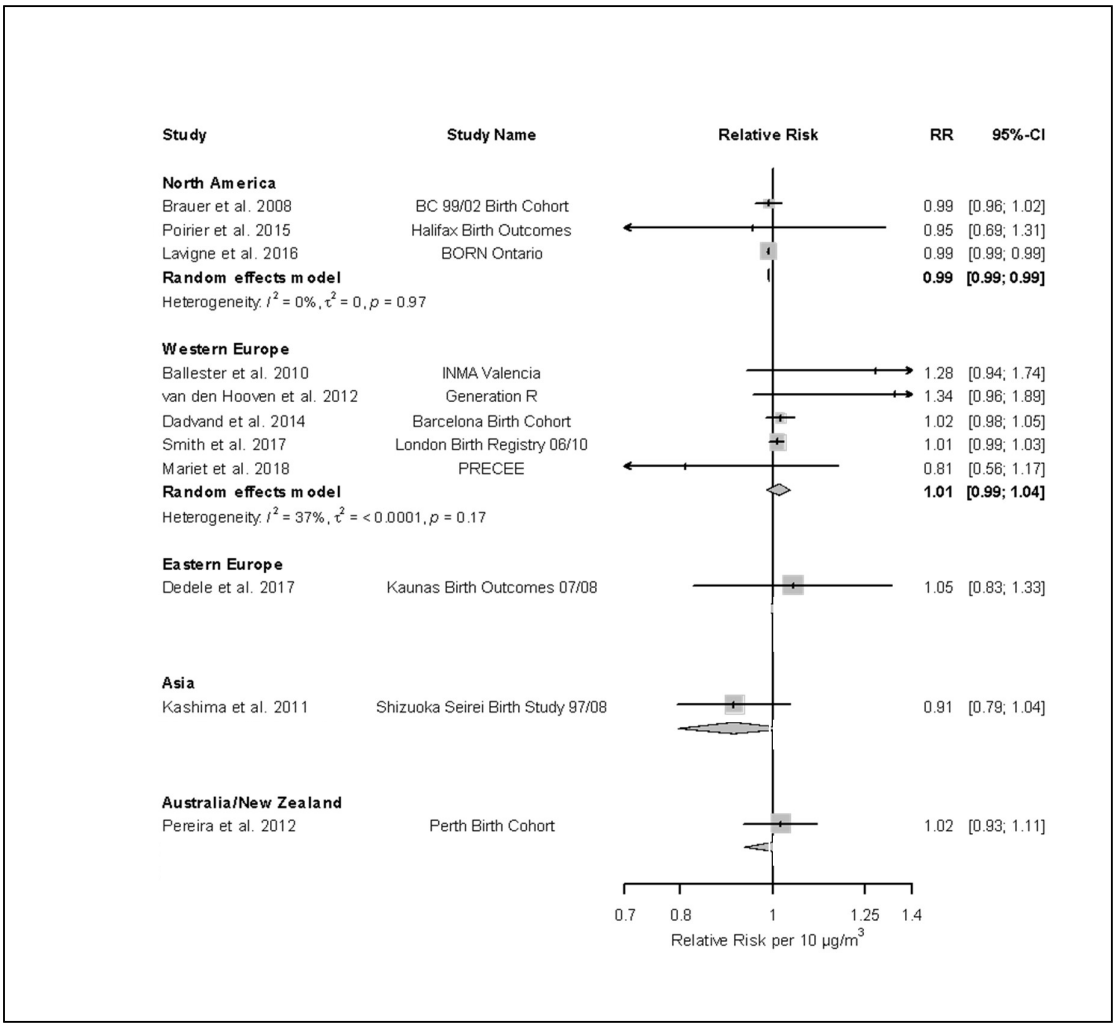
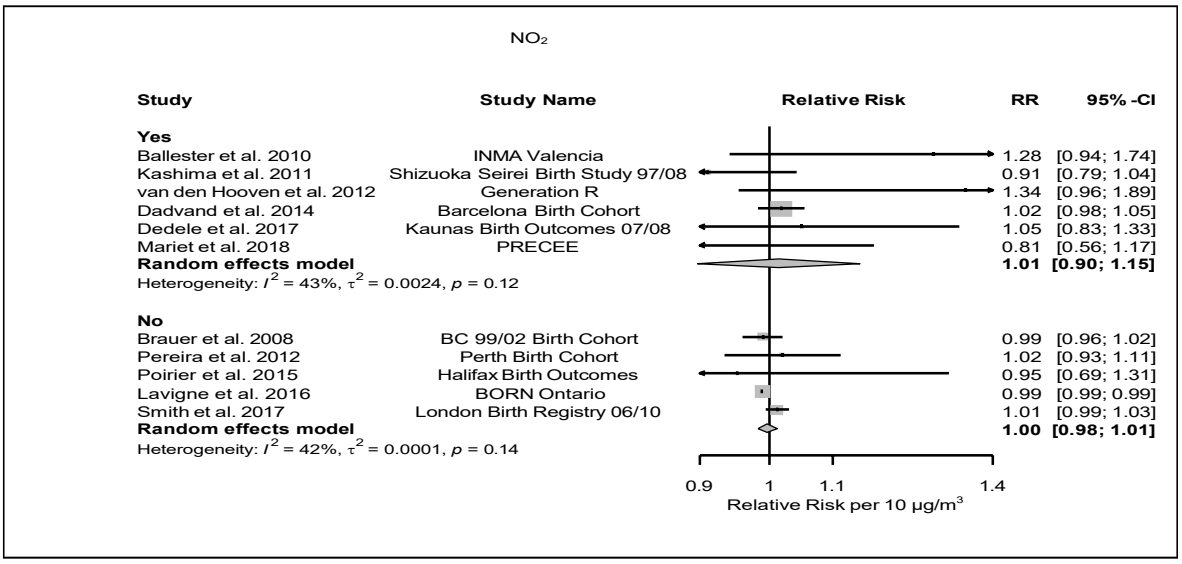
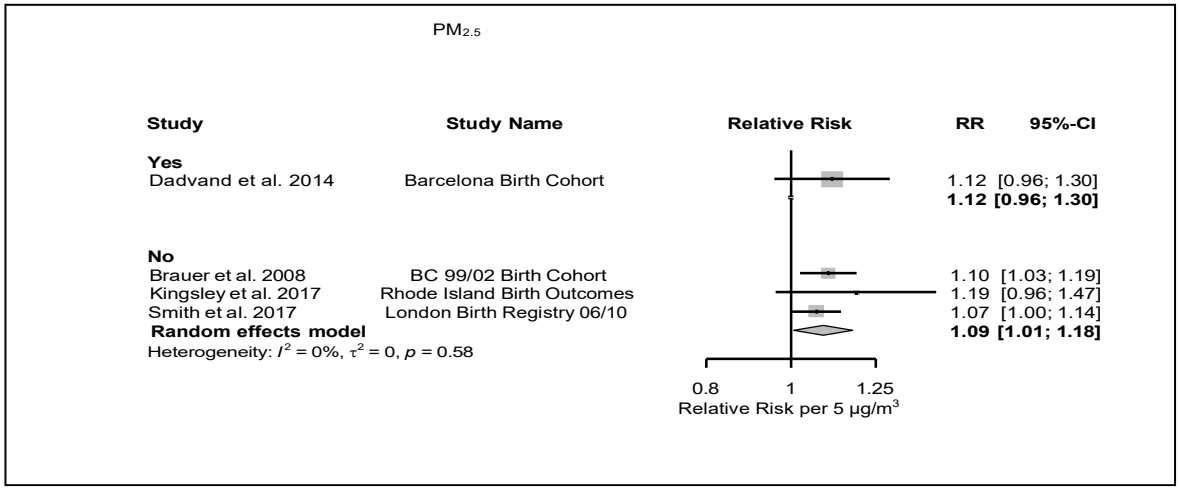
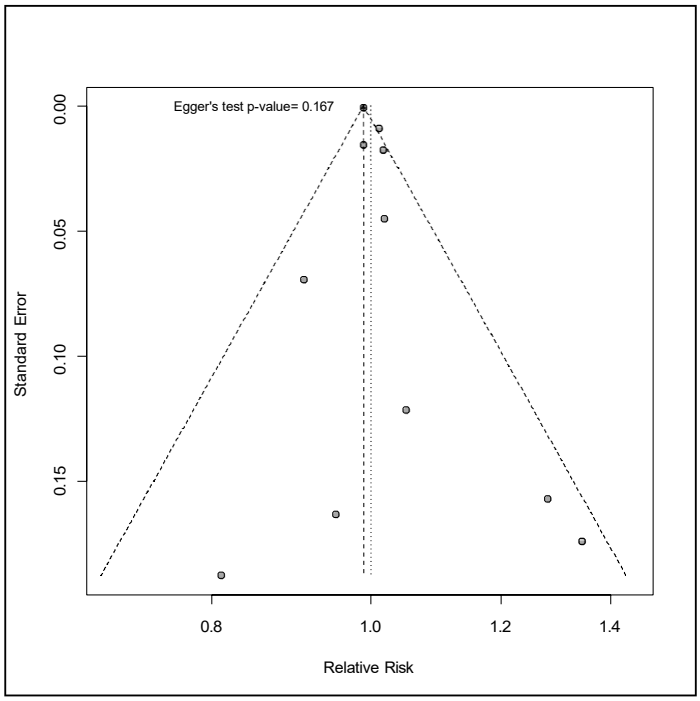


Figure 8C-2. Association of NO_2 with SGA: meta-analysis by region (exposure window: entire pregnancy).





Appendix Figure 8C-3. Associations of NO_2 and $PM_{2.5}$ with SGA: meta-analysis by BMI adjustment (exposure window: entire pregnancy).



Appendix Figure 8C-4. Funnel plot for NO_2 and SGA (exposure window: entire pregnancy). The vertical lines in the funnel plots represent the pooled fixed and random effect estimates. The vertical dashed line in the middle of the funnel shows the fixed effect estimate. As the Panel applied a random-effects model, the funnel plot also presents the random-effects estimate with the dotted line.

Appendix 8D Preterm birth (PTB)

Appendix Table 8D-1. Key Study Characteristics of Articles Included in the Systematic Review for PTB — Pollutants (Exposure Window: **First Trimester**)

Reference	Study Name	Study Design	Location	Study period	Sample size[a]	Exposure Assessment	Pollutant	Mean or median exposure[b]	Effect Estimate (95% CI)[c,d]	Increment
Dedele 2017	Kaunas Birth Outcomes 07/08	Cohort	Kaunas, Lithuania	2007–2008	3,013	Dispersion / CTM	NO_2	16.8–24.2	**1.11 (0.91, 1.35)**	10 μg/m^3
Estarlich 2016	INMA	Cohort	Multiple cities, Spain	2004–2008	2,409	LUR	NO_2	28.8	**1.02 (0.61, 1.71)**	10 μg/m^3
							Benzene	1.3	1.13 (0.64, 2.01)	1 μg/m^3
Gehring 2011a	ABCD	Cohort	Amsterdam, The Netherlands	2003–2004	7,541	LUR	NO_2	38.7	1.04 (0.74, 1.45)	>51.2 vs. <30.3 μg/m^3
									1.24 (0.90, 1.72)	45.3–51.2 vs. <30.3 μg/m^3
									1.09 (0.78, 1.51)	39.1–45.3 vs. <30.3 μg/m^3
									1.15 (0.83, 1.59)	30.3–39.1 vs. <30.3 μg/m^3
Gehring 2011b	PIAMA	Cohort	Multiple cities, The Netherlands	1996–1997	3,853	LUR	NO_2	30.4	**0.97 (0.73, 1.27)**	14.4 μg/m^3
							$PM_{2.5\ abs}$	2.75	**0.94 (0.72, 1.23)**	2.46 1×10^{-5}/m
							$PM_{2.5}$ mass	20.1	**0.98 (0.75, 1.29)**	7.8 μg/m^3
Giorgis-Allemand 2017	ESCAPE	Cohort	Multiple cities, Multiple countries	1994–2011	71,493	LUR	NO_2	25	**0.97 (0.92, 1.02)**	10 μg/m^3
							NO_x	not reported	0.97 (0.93, 1.01)	20 μg/m^3
							$PM_{2.5\ abs}$	not reported	**0.95 (0.87, 1.05)**	1 1×10^{-5}/m
							PM_{10} mass	25	0.98 (0.90, 1.07)	10 μg/m^3
							PM_{coarse} mass	not reported	0.99 (0.91, 1.07)	5 μg/m^3
							$PM_{2.5}$ mass	15	**0.98 (0.91, 1.05)**	5 μg/m^3
Jalaludin 2007	Sydney Birth Study 98/00	Cohort	Sydney, Australia	1998–2000	123,840	Surface monitoring	NO_2	23.4	**1.05 (0.74, 1.49)**	1 ppb
							CO	0.9	1.25 (0.81, 1.92)	1 ppm

Ji 2019	Shanghai PTB Study	Cohort	Shanghai, China	2014–2015	25,493	LUR	NO_2	48.2	**1.00 (0.95, 1.07)**	10 μg/m³
Johnson 2016	NYC Birth Registry 08/10	Cohort	New York City, New York, United States	2008–2010	258,294	LUR	NO_2	27.1	**0.92 (0.87, 0.98)**	20 ppb
							$PM_{2.5}$ mass	11.5	**0.97 (0.90, 1.05)**	10 μg/m³
Kingsley 2017	Rhode Island Birth Outcomes	Cohort	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	**0.99 (0.96, 1.03)**	0.11 μg/m³
							$PM_{2.5}$ mass	9.5	**0.93 (0.88, 0.98)**	2.5 μg/m³
Leem 2006	Incheon PTB	Cohort	Incheon, South Korea	2001–2002	52,113	Surface monitoring	NO_2	43.1	1.24 (1.09, 1.41)	56.22–80.58 vs. 10.41–29.67 μg/m³
									1.07 (0.94, 1.21)	43.12–56.21 vs. 10.41–29.67 μg/m³
									1.13 (0.99, 1.27)	29.68–43.11 vs. 10.41–29.67 μg/m³
							CO	0.74	1.26 (1.11, 1.44)	0.91–1.27 vs. 0.47–0.63 mg/m³
									1.14 (1.01, 1.29)	0.78–0.90 vs. 0.47–0.63 mg/m³
									0.92 (0.81, 1.05)	0.64–0.77 vs. 0.47–0.63 mg/m³
Llop 2010	INMA Valencia	Cohort	Valencia, Spain	2003–2005	738	LUR	NO_2	36.9	0.96 (0.88, 1.05) [> 46.2 μg/m³]	1 μg/m³
									1.03 (0.98, 1.08) [< 46.2 μg/m³]	
							Benzene	2.2	0.84 (0.41, 1.71) [>2.7 μg/m³]	1 μg/m³
									1.39 (0.67, 2.88) [<2.7 μg/m³]	
Maroziene 2002	Kaunas Birth Outcomes 98	Cohort	Kaunas, Lithuania	1998–1998	3,988	Surface monitoring	NO_2	11.69	**1.67 (1.28, 2.18)**	10 μg/m³
Olsson 2015	Stockholm Birth Outcomes	Cohort	Stockholm, Sweden	1997–2006	74,991	Dispersion / CTM	NO_x	15.1	1.05 (0.98, 1.13)	10 μg/m³

Padula 2014b	SAGE	Cohort	Fresno, California, United States	2001–2006	42,904	LUR	PAH	3.55	0.92 (0.84, 1.00) [34–36 weeks gestation]	Q4 vs. Q1–Q3 ng/m^3
									0.87 (0.72, 1.05) [32–33 weeks gestation]	
									0.56 (0.44, 0.71) [28–31 weeks gestation]	
									0.42 (0.31, 0.58) [20–27 weeks gestation]	
Ritz 2007	Los Angeles Birth Cohort	Case-control	Los Angeles County, California, United States	2003–2003	58,316	Surface monitoring	NO_2	3.13	1.09 (1.00, 1.19)	>3.64 vs. <2.61 pphm
									1.09 (1.00, 1.19)	3.13–3.64 vs. <2.61 pphm
									1.22 (1.13, 1.31)	2.62–3.12 vs. <2.61 pphm
							CO	0.92	1.25 (1.12, 1.38)	>1.25 vs. <0.58 ppm
									1.15 (1.05, 1.26)	0.92–1.25 vs. <0.58 ppm
									1.17 (1.08, 1.26)	0.59–0.91 vs. <0.58 ppm
Wilhelm 2005	LA County Birth Registry 94/00	Case-cohort	Southern California, United States	1994–2000	24,004	Surface monitoring	CO	1.21	1.06 (1.00, 1.12) [Distance ≤1 mile]	1 ppm
					74,762				1.06 (1.03, 1.10) [1 mile < Distance ≤2 miles]	
					254,308				1.08 (1.06, 1.09) [2 miles < Distance ≤4 miles]	

[a] All studies included male and female participants.

[b] Units are in the increment column.

[c] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[d] None of the estimates were log transformed.

Appendix Table 8D-1. *Continued* (PTB – **Second Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d,e]	Increment
Dedele 2017	Kaunas Birth Outcomes 07/08	Kaunas, Lithuania	2007–2008	3,013	Dispersion / CTM	NO_2	16.8–24.2	**1.15 (0.96, 1.39)**	10 µg/m^3
Estarlich 2016	INMA	Multiple cities, Spain	2004–2008	2,409	LUR	NO_2	28.8	**1.06 (0.86, 1.32)**	10 µg/m^3
						Benzene	1.3	1.14 (0.86, 1.51)	1 µg/m^3
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,541	LUR	NO_2	38.7	0.87 (0.62, 1.20)	>48.5 vs. <30.6 µg/m^3
								1.03 (0.75, 1.41)	43.0–48.5 vs. <30.6 µg/m^3
								0.82 (0.59, 1.14)	37.8–43.0 vs. <30.6 µg/m^3
								1.02 (0.74, 1.40)	30.6–37.8 vs. <30.6 µg/m^3
Giorgis-Allemand 2017	ESCAPE	Multiple cities, Multiple countries	1994–2011	71,493	LUR	NO_2	25	**0.96 (0.92, 1.01)**	10 µg/m^3
						NO_x	not reported	0.97 (0.93, 1.00)	20 µg/m^3
						$PM_{2.5\ abs}$	not reported	0.97 (0.88, 1.07)	1 1×10^{-5}/m
						PM_{10} mass	25	0.98 (0.90, 1.06)	10 µg/m^3
						PM_{coarse} mass	not reported	1.00 (0.92, 1.08)	5 µg/m^3
						$PM_{2.5}$ mass	15	**0.96 (0.90, 1.03)**	5 µg/m^3
Ji 2019	Shanghai PTB Study	Shanghai, China	2014–2015	25,493	LUR	NO_2	48.2	**1.01 (0.95, 1.07)**	10 µg/m^3
Johnson 2016	NYC Birth Registry 08/10	New York City, New York, United States	2008–2010	258,294	LUR	NO_2	27.1	**0.89 (0.83, 0.95)**	20 ppb
						$PM_{2.5}$ mass	11.5	**0.95 (0.88, 1.03)**	10 µg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	56,633	LUR	BC	0.52	0.99 (0.95, 1.02)	0.11 µg/m^3
						$PM_{2.5}$ mass	9.5	**1.03 (0.98, 1.09)**	2.5 µg/m^3
Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**1.07 (1.05, 1.10)**	10 ppb

Llop 2010	INMA Valencia	Valencia, Spain	2003–2005	738	LUR	NO_2	36.9	1.11 (1.03, 1.21) [> 46.2 µg/m^3]	1 µg/m^3
								0.97 (0.92, 1.02) [< 46.2 µg/m^3]	
						Benzene	2.2	1.16 (0.59, 2.27) [>2.7 µg/m^3]	1 µg/m^3
								1.14 (0.51, 2.53) [<2.7 µg/m^3]	
Maroziene 2002	Kaunas Birth Outcomes 98	Kaunas, Lithuania	1998–1998	3,988	Surface monitoring	NO_2	11.69	**1.13 (0.90, 1.40)**	10 µg/m^3
Padula 2014b	SAGE	Fresno, California, United States	2001–2006	42,904	LUR	PAH	3.55	0.98 (0.89, 1.07) [34–36 weeks gestation]	Q4 vs. Q1–Q3 ng/m^3
								1.03 (0.85, 1.24) [32–33 weeks gestation]	
								1.02 (0.83, 1.25) [28–31 weeks gestation]	
								1.10 (0.81, 1.49) [20–27 weeks gestation]	

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] None of the estimates were log transformed.

Appendix Table 8D-1. *Continued* (PTB – **Third Trimester**)

Reference	Study Name[a]	Location	Study period	Sample size[b]	Exposure Assessment	Pollutant	Mean or median exposure[c]	Effect Estimate (95% CI)[d,e]	Increment
Dedele 2017	Kaunas Birth Outcomes 07/08	Kaunas, Lithuania	2007–2008	3,013	Dispersion / CTM	NO_2	16.8–24.2	**1.09 (0.90, 1.31)**	10 μg/m^3
Estarlich 2016	INMA	Multiple cities, Spain	2004–2008	2,409	LUR	NO_2	28.8	**1.02 (0.81, 1.27)**	10 μg/m^3
						Benzene	1.3	1.12 (0.63, 2.01)	1 μg/m^3
Gehring 2011a	ABCD	Amsterdam, The Netherlands	2003–2004	7,531	LUR	NO_2	38.7	0.83 (0.61, 1.13)	>45.9 vs. <27.9 μg/m^3
								0.73 (0.53, 1.01)	39.8–45.9 vs. <27.9 μg/m^3
								0.66 (0.48, 0.92)	33.5–39.8 vs. <27.9 μg/m^3
								0.82 (0.60, 1.12)	27.9–33.5 vs. <27.9 μg/m^3
Jalaludin 2007	Sydney Birth Study 98/00	Sydney, Australia	1998–2000	123,840	Surface monitoring	NO_2	23.4	**1.05 (0.91, 1.21)**	1 ppb
						CO	0.9	1.11 (0.94, 1.31)	1 ppm
Ji 2019	Shanghai PTB Study	Shanghai, China	2014–2015	25,493	LUR	NO_2	48.2	**1.07 (1.03, 1.13)**	10 μg/m^3
Kingsley 2017	Rhode Island Birth Outcomes	Providence, Rhode Island, United States	2002–2012	61,640	LUR	BC	0.52	0.99 (0.95, 1.02)	0.11 μg/m^3
						$PM_{2.5}$ mass	9.5	1.02 (0.97, 1.07)	2.5 μg/m^3
Lavigne 2016	BORN Ontario	Ontario, Canada	2005–2012	818,400	LUR	NO_2	15.89	**1.06 (1.05, 1.09)**	9 ppb
Leem 2006	Incheon PTB	Incheon, South Korea	2001–2002	52,113	Surface monitoring	NO_2	43.1	1.21 (1.07, 1.37)	57.67–76.12 vs. 11.92–29.93 μg/m^3
								1.14 (1.01, 1.29)	46.92–57.66 vs. 11.92–29.93 μg/m^3
								1.06 (0.93, 1.20)	29.94–46.91 vs. 11.92–29.93 μg/m^3
						CO	0.74	1.16 (1.01, 1.34)	0.88–1.16 vs. 0.49–0.63 mg/m^3
								1.07 (0.94, 1.22)	0.75–0.87 vs. 0.49–0.63 mg/m^3
								1.07 (0.95, 1.21)	0.64–0.74 vs. 0.49–0.63 mg/m^3

Llop 2010	INMA Valencia	Valencia, Spain	2003–2005	738	LUR	NO_2	36.9	1.10 (1.00, 1.21) [> 46.2 µg/m^3]	1 µg/m^3
								0.99 (0.95, 1.04) [< 46.2 µg/m^3]	
						Benzene	2.2	0.78 (0.37, 1.67) [>2.7 µg/m^3]	1 µg/m^3
								1.85 (0.79, 4.32) [<2.7 µg/m^3]	
Malmqvist 2011	Scania Birth Cohort 99/05	Scania, Sweden	1999–2005	81,110	Dispersion / CTM	NO_x	16.4	0.85 (0.77, 0.94)	>22.7 vs. 2.5–8.9 µg/m^3
								0.87 (0.80, 0.96)	14.2–22.6 vs. 2.5–8.9 µg/m^3
								0.89 (0.81, 0.97)	9.0–14.1 vs. 2.5–8.9 µg/m^3
Maroziene 2002	Kaunas Birth Outcomes 98	Kaunas, Lithuania	1998–1998	3,988	Surface monitoring	NO_2	11.69	**1.19 (0.96, 1.47)**	10 µg/m^3
Padula 2014b	SAGE	Fresno, California, United States	2001–2006	42,904	LUR	PAH	3.55	1.00 (0.92, 1.09) [34–36 weeks gestation]	Q4 vs. Q1–Q3 ng/m^3
								0.99 (0.81, 1.19) [32–33 weeks gestation]	
								1.00 (0.81, 1.23) [28–31 weeks gestation]	

[a] All were cohort studies.

[b] All studies included male and female participants.

[c] Units are in the increment column.

[d] Effect estimates are odds ratios. **Bold** indicates the effect estimate was included in the meta-analysis.

[e] None of the estimates were log transformed.

Appendix Table 8D-2. Noise-Adjusted Analyses in PTB Studies (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Pollutant	Increment	Single pollutant[a]	Noise adjusted[a]
van den Hooven 2012	Generation R	NO_2	1 μg/m^3	1.01 (0.98, 1.04)[b]	1.01 (0.98, 1.04)[b]
		PM_{10} mass	1 μg/m^3	1.03 (1.00, 1.07)[b]	1.03 (1.00, 1.07)[b]

[a] Effect estimates are odds ratios.

[b] The single pollutant results also corrected for noise, thus the two columns are the same.

Appendix Table 8D-3. Key Study Characteristics of Articles Included in the Systematic Review for PTB — Indirect Traffic Measures (Exposure Window: **Entire Pregnancy**)

Reference	Study Name	Study Design	Location	Study period	Sample size[a]	Traffic measure	Effect Estimate (95% CI)[b]	Increment
Gehring 2014	BC 99/02 Birth Cohort	Cohort	Vancouver, British Columbia, Canada	1999–2002	68,238	Distance	1.07 (0.89, 1.29) [30 – <37 weeks gestation]	<50 vs. >50 m
							1.29 (0.68, 2.43) [<30 weeks gestation]	<50 vs. >50 m
Genereux 2008	Montreal Birth Outcome Study	Cohort	Montreal, Quebec, Canada	1997–2001	99,178	Distance	1.14 (1.02, 1.27)	<200 vs. >200 m
Giorgis-Allemand 2017	ESCAPE	Cohort	Multiple cities, Multiple countries	1994–2011	71,493	Density	0.96 (0.89, 1.03)	4,000 vehicle-km/day
Hannam 2013	NWPSU	Cohort	Multiple cities, United Kingdom	2004–2008	35,005	Distance	1.05 (0.93, 1.18)	<100 vs. >100 m
Laurent 2016a	California Birth Registry 01/08	Case-control	California, United States	2001–2008	1,257,633	Density	0.97 (0.94, 1.00)	10,000 vehicles/day/m
						Distance	0.99 (0.98, 1.00)	<100 vs. >100 m
Malmqvist 2011	Scania Birth Cohort 99/05	Cohort	Scania, Sweden	1999–2005	81,110	Density	0.88 (0.76, 1.02)	>10 cars/minute vs. no road within 100 m
							0.94 (0.82, 1.07)	6–10 cars/minute vs. no road within 100 m
							0.97 (0.88, 1.06)	2–5 cars/minute vs. no road within 100 m
							1.01 (0.94, 1.10)	<2 cars/minute vs. no road within 100 m
Miranda 2013	North Carolina Birth Registry 04/08	Cohort	North Carolina, United States	2004–2008	468,517	Distance	1.04 (1.01, 1.08)	<250 vs. 250–500 m
							1.04 (1.01, 1.07)	<250 vs. >500 m
Olsson 2015	Stockholm Birth Outcomes	Cohort	Stockholm, Sweden	1997–2006	75,599	Density	1.00 (0.99, 1.02)	3,000 vehicles/day

Padula 2014a	San Joaquin Valley Birth Study	Cohort	San Joaquin Valley, California, United States	2000–2006	247,487	Density	1.25 (1.00, 1.56) [Gestational week 20–23]	>13,561 vs. <13,561 vehicles/day
							1.13 (0.96, 1.33) [Gestational week 24–27]	
							1.05 (0.95, 1.15) [Gestational week 28–31]	
							1.10 (1.01, 1.19) [Gestational week 32–33]	
							1.04 (1.00, 1.07) [Gestational week 34–36]	
van den Hooven 2009	Generation R	Cohort	Rotterdam, The Netherlands	2002–2006	7,337	Density	1.18 (0.87, 1.59)	>1,235 vs. <158 vehicle-km/day
							1.33 (0.98, 1.79)	547–1,235 vs. <158 vehicle-km/day
							1.37 (1.02, 1.84)	158–547 vs. <158 vehicle-km/day
						Distance	1.15 (0.84, 1.58)	<50 vs. >200 m
							1.08 (0.80, 1.45)	50–100 vs. >200 m
							1.13 (0.84, 1.52)	100–150 vs. >200 m
							1.09 (0.79, 1.50)	150–200 vs. >200 m
Wilhelm 2003	LA County Birth Registry 94/96	Case-control	Los Angeles County, California, United States	1994–1996	34,588	Distance	0.96 (0.89, 1.02)	<229 vs. >229 m
Wu 2011	South Coast Births 97/06 LA	Case-control	Los Angeles County, California, United States	1997–2006	38,709	Density	1.02 (1.00, 1.04)	76.6 vehicles/day/m
	South Coast Births 97/06 OC				42,477		1.00 (0.98, 1.03)	76.6 vehicles/day/m
Wu 2016	California Birth Registry 01/08	Case-control	California, United States	2001–2008	1,142,853	Density	1.00 (0.99, 1.00)	10,000 vehicles/day/m
						Distance	1.00 (0.99, 1.01)	<100 vs. >100 m
Yang 2003	Taiwan Birth Registry Study	Cohort	Kaohsiung, Taiwan	1992–1997	6,251	Distance	1.30 (1.03, 1.65)	<500 vs. 500–1500 m
Yorifuji 2011	Shizuoka Seirei Birth Study 97/08	Cohort	Shizuoka, Japan	1997–2008	14,266	Distance	1.5 (1.2, 1.8)	<200 vs. >200 m
Yorifuji 2013	Shizuoka Seirei Birth Study 97/10	Cohort	Shizuoka, Japan	1997–2010	16,615	Distance	1.7 (1.0, 2.9)	<50 vs. >200 m
							1.5 (1.2, 1.8)	50–200 vs. >200 m
Yorifuji 2015	Shizuoka Seirei Birth Study 97/12	Cohort	Shizuoka, Japan	1997–2012	19,077	Distance	1.4 (1.2, 1.7)	<200 vs. >200 m

Zeka[c] 2008	Eastern Massachusetts Birth Outcomes	Cohort	Massachusetts, United States	1996–2002	425,751	Density	1.00 (0.98, 1.01)	1 SD
						Distance	1.00 (0.99, 1.02)	1 SD

[a] All studies included male and female participants.

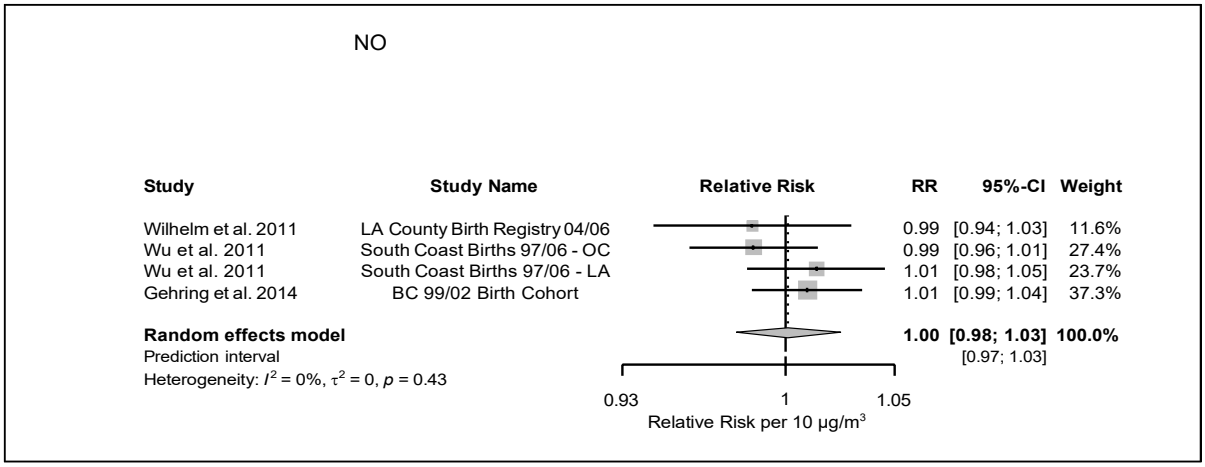
[b] Effect estimates are odds ratios.

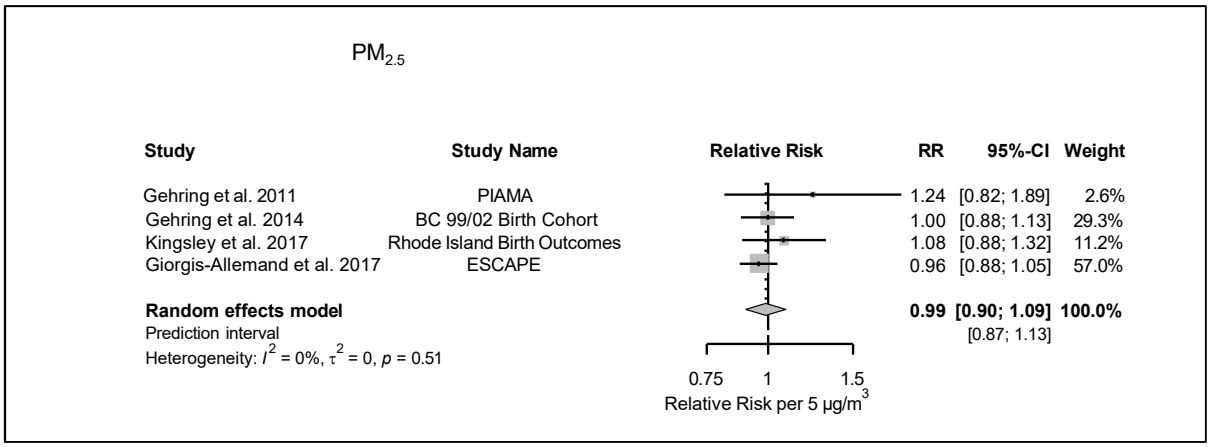
[c] Estimate was log transformed.

Appendix Table 8D-4. Risk of Bias Assessment for Individual Studies on PTB (Exposure Window: **Entire Pregnancy**)

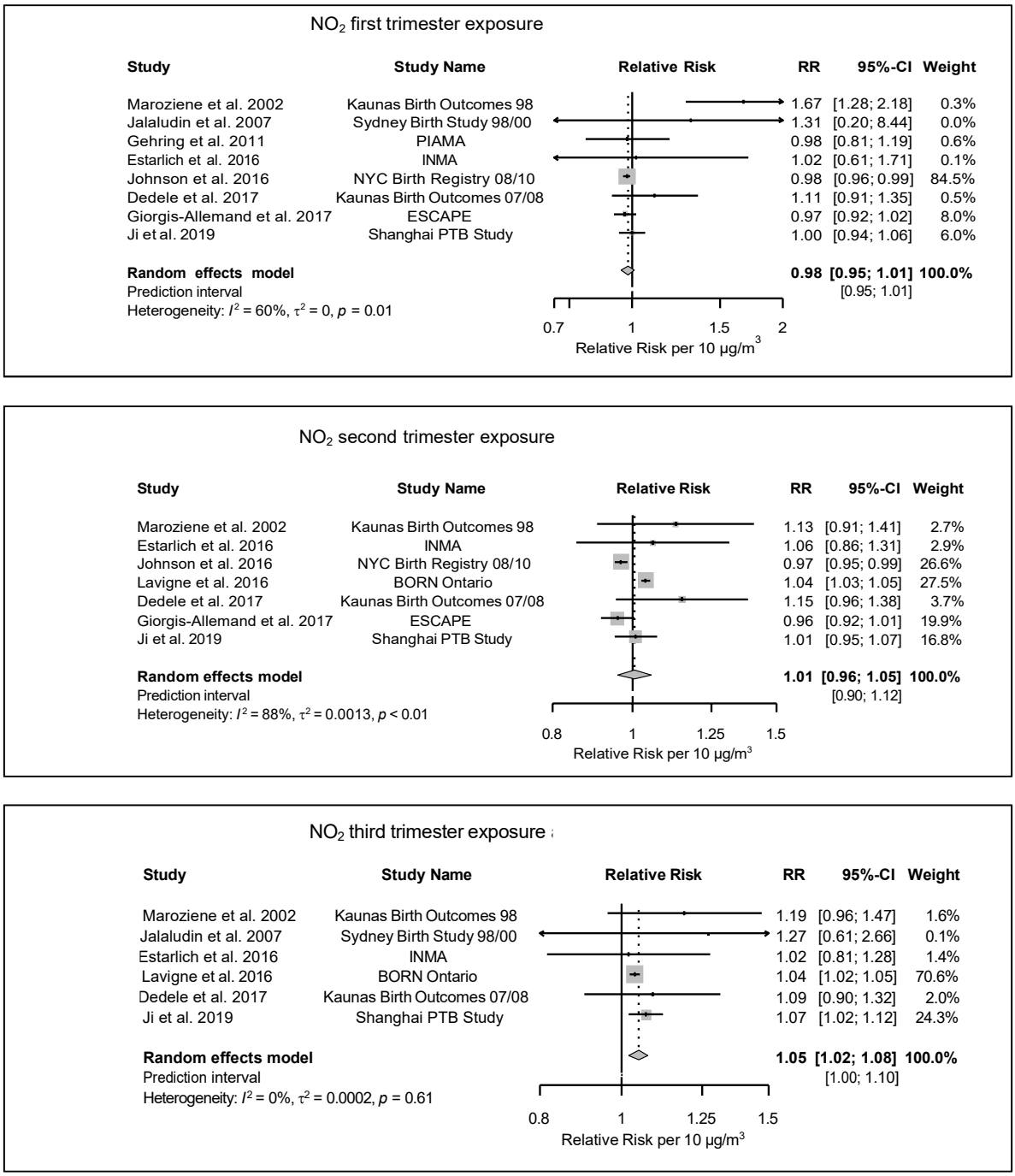
Reference	Study Name	Confounding	Selection Bias	Exposure Assessment	Outcome Measurement	Missing Data	Selective Reporting
Dedele 2017	Kaunas Birth Outcomes 07/08	Low	Low	Low	Low	Low	Low
Estarlich 2016	INMA	High	Low	Low	Low	Low	Low
Gehring 2011b	PIAMA	High	Low	Mod	Mod	Low	Low
Gehring 2014	BC 99/02 Birth Cohort	High	Low	Low	Low	Low	Low
Giorgis-Allemand 2017	ESCAPE	Low	Low	Mod	Low	Low	Low
Ji 2019	Shanghai PTB Study	Low	Low	Mod	Low	Low	Low
Kingsley 2017	Rhode Island Birth Outcomes	High	Low	Mod	Low	Low	Low
Laurent 2016a	California Birth Registry 01/08	High	Low	Mod	Low	Low	Low
Lavigne 2016	BORN Ontario	High	Low	Low	Low	Low	Low
Maroziene 2002	Kaunas Birth Outcomes 98	High	Low	Mod	Low	Low	Low
Olsson 2015	Stockholm Birth Outcomes	Mod	Low	Low	Low	Low	Low
Poirier 2015	Halifax Birth Outcomes	Mod	Low	Mod	Low	Low	Low
van den Hooven 2012	Generation R	Low	Low	Low	Low	Low	Low
Wilhelm 2003	LA County Birth Registry 94/96	High	Low	Mod	Low	Low	Low
Wilhelm 2011	LA County Birth Registry 04/06	High	Low	Mod	Low	Low	Low
Wu 2011	South Coast Births 97/06 LA	High	Low	Mod	Low	Low	Low
Wu 2011	South Coast Births 97/06 OC	High	Low	Mod	Low	Low	Low

Mod = moderate

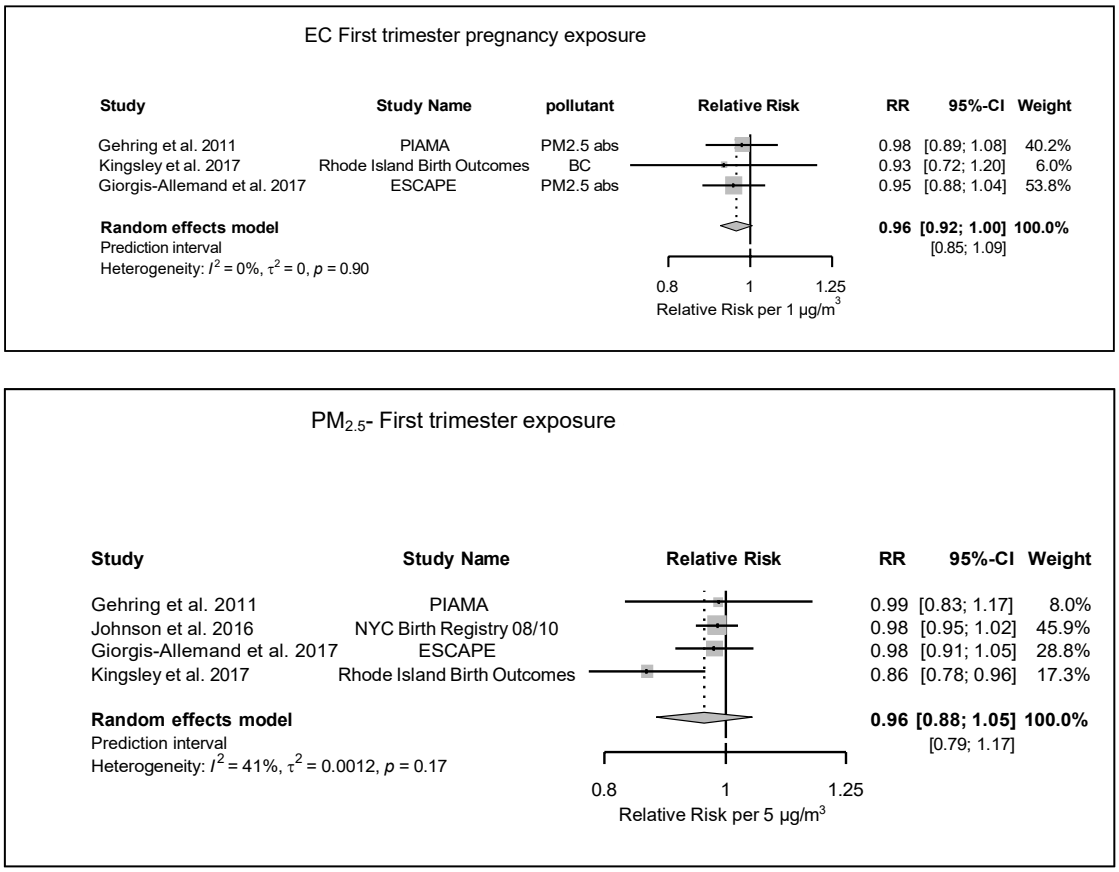




Appendix Figure 8D-1. Associations of NO and $PM_{2.5}$ with PTB: primary meta-analysis (exposure window: entire pregnancy).



Appendix Figure 8D-2. Associations of NO_2, EC, and $PM_{2.5}$ with PTB: primary meta-analysis (exposure window: trimester). *Figure continues next page.*



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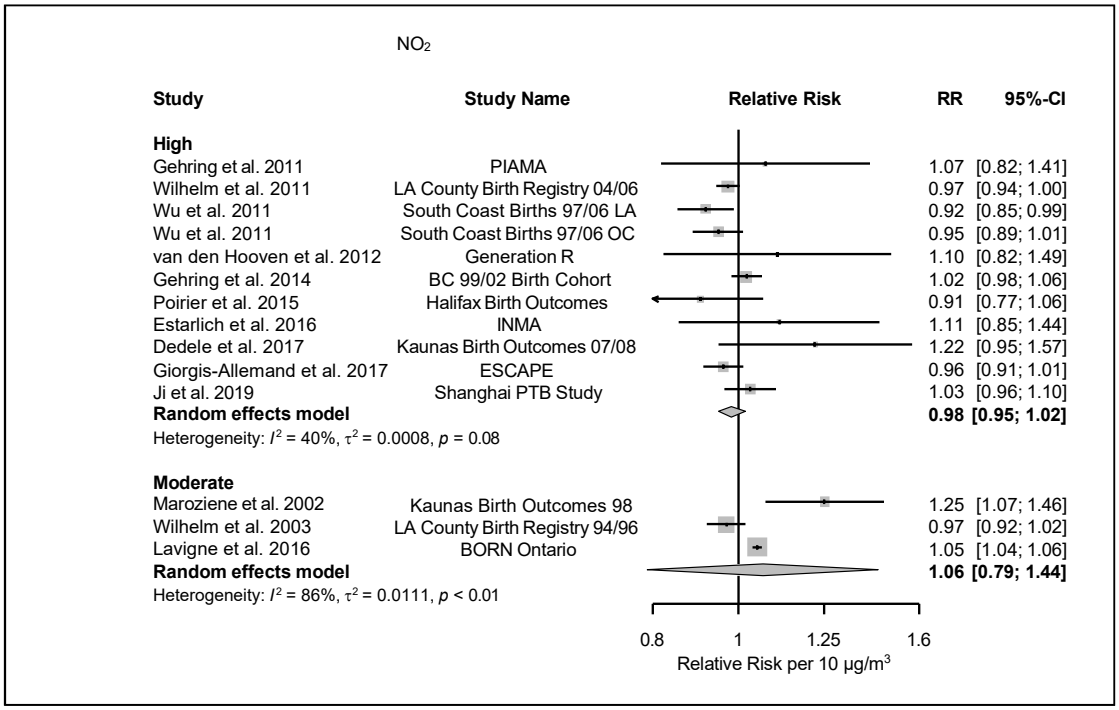
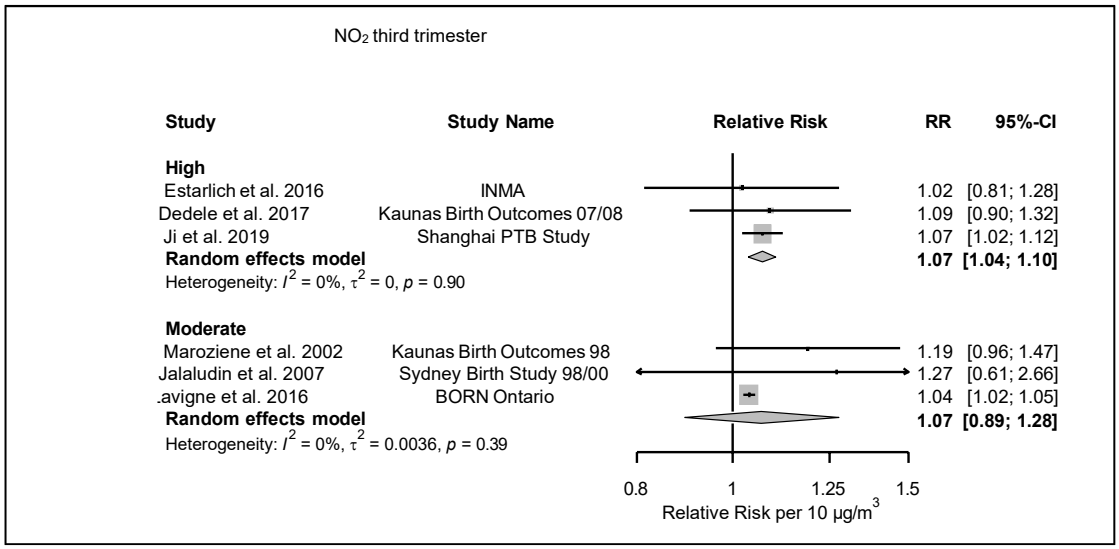
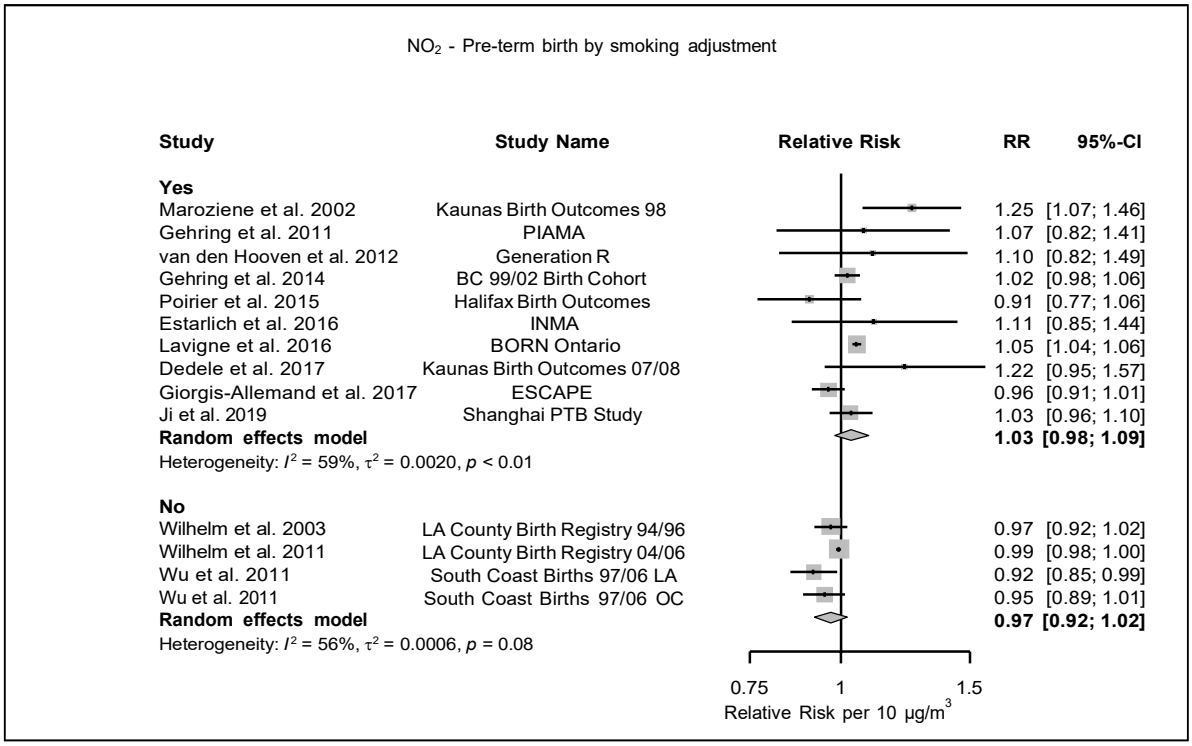
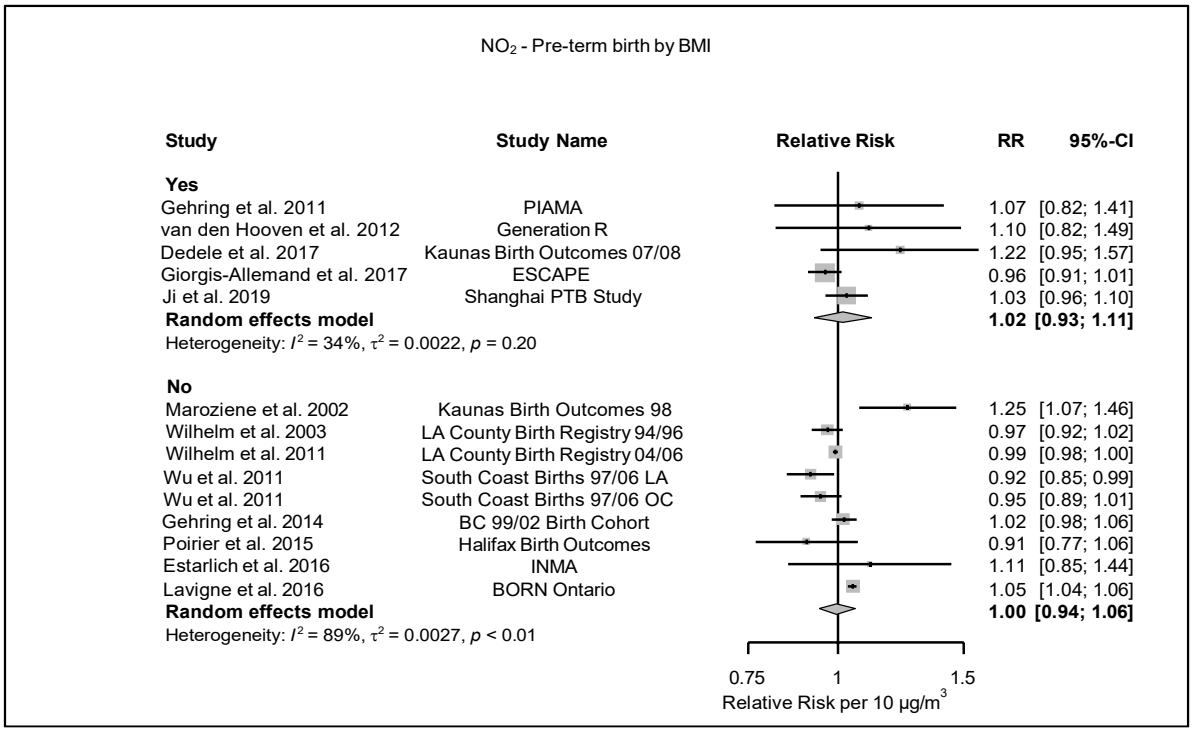


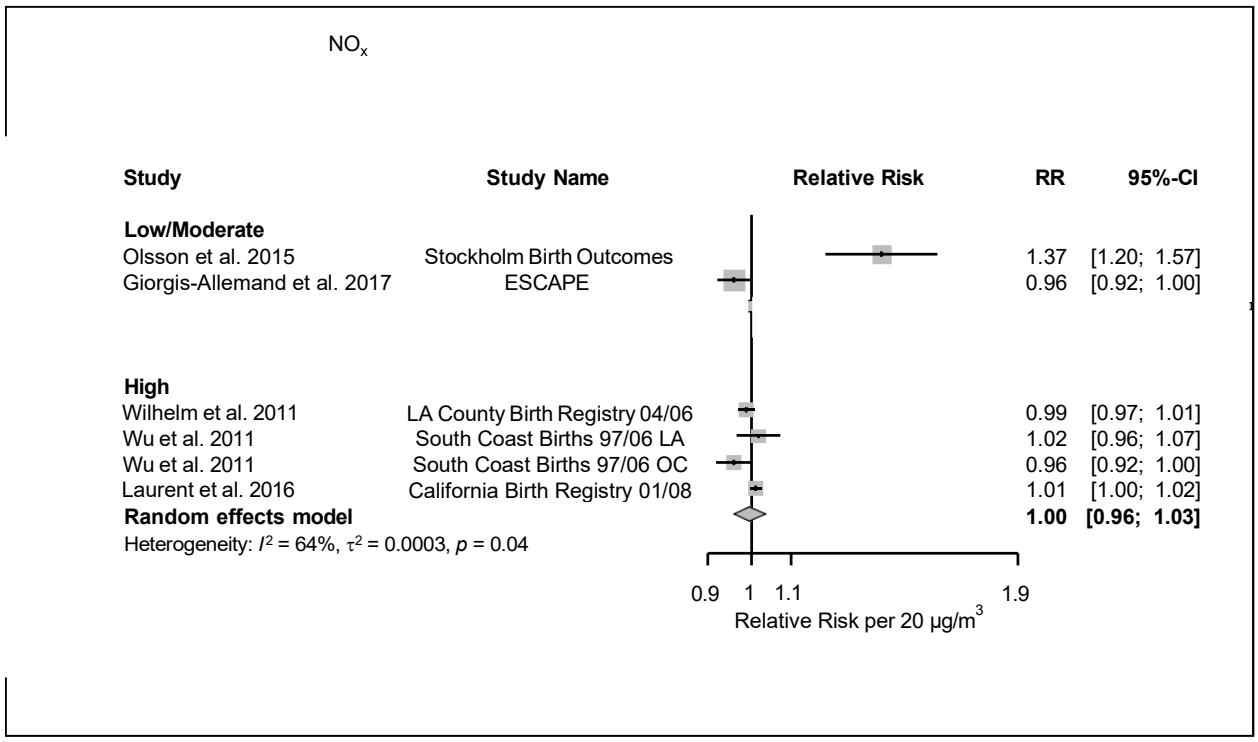


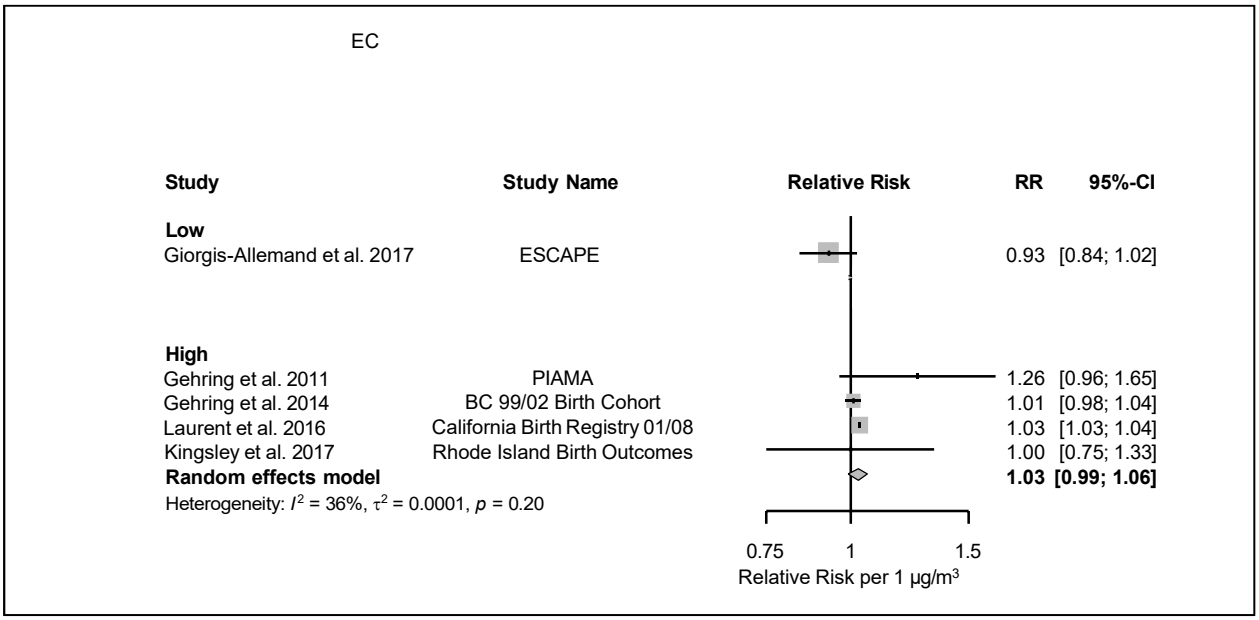
Appendix Figure 8D-3. Association of NO_2 with PTB: meta-analysis by traffic specificity (exposure window: entire pregnancy and by trimester).



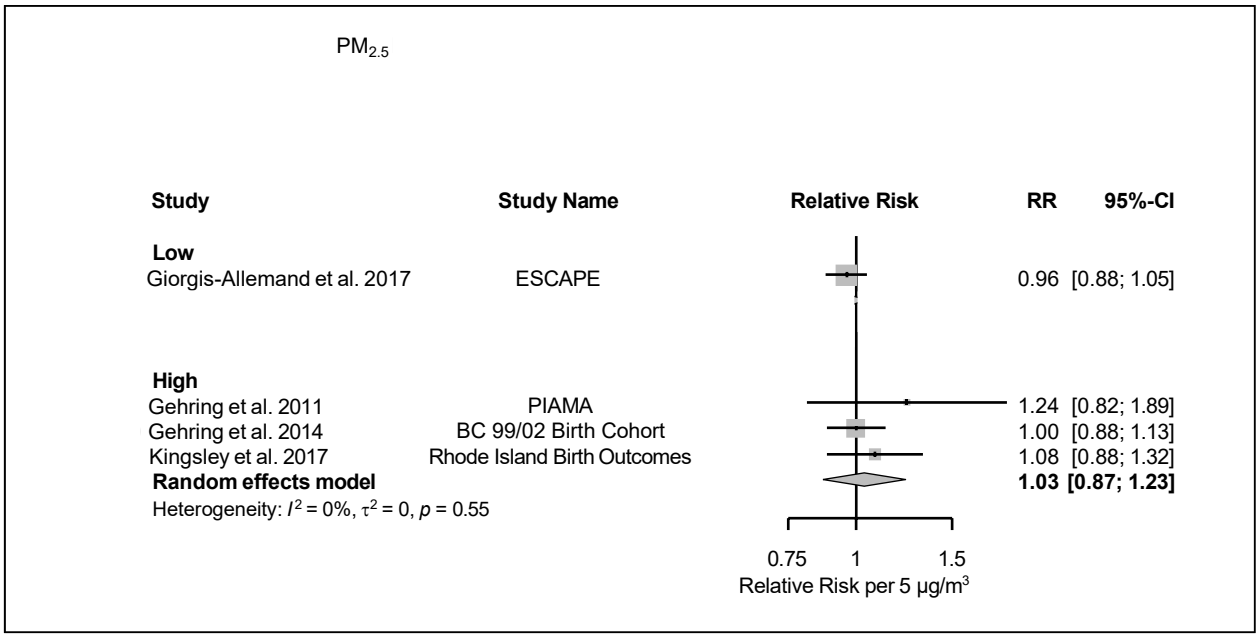


Appendix Figure 8D-4. Association of NO_2 with PTB: meta-analysis by smoking and BMI adjustment (exposure window: entire pregnancy).





Appendix Figure 8D-5. Associations of NO_x, EC, and $PM_{2.5}$ with PTB: meta-analysis by risk of bias assessment on confounding (exposure window: entire pregnancy). *Figure continues next page.*



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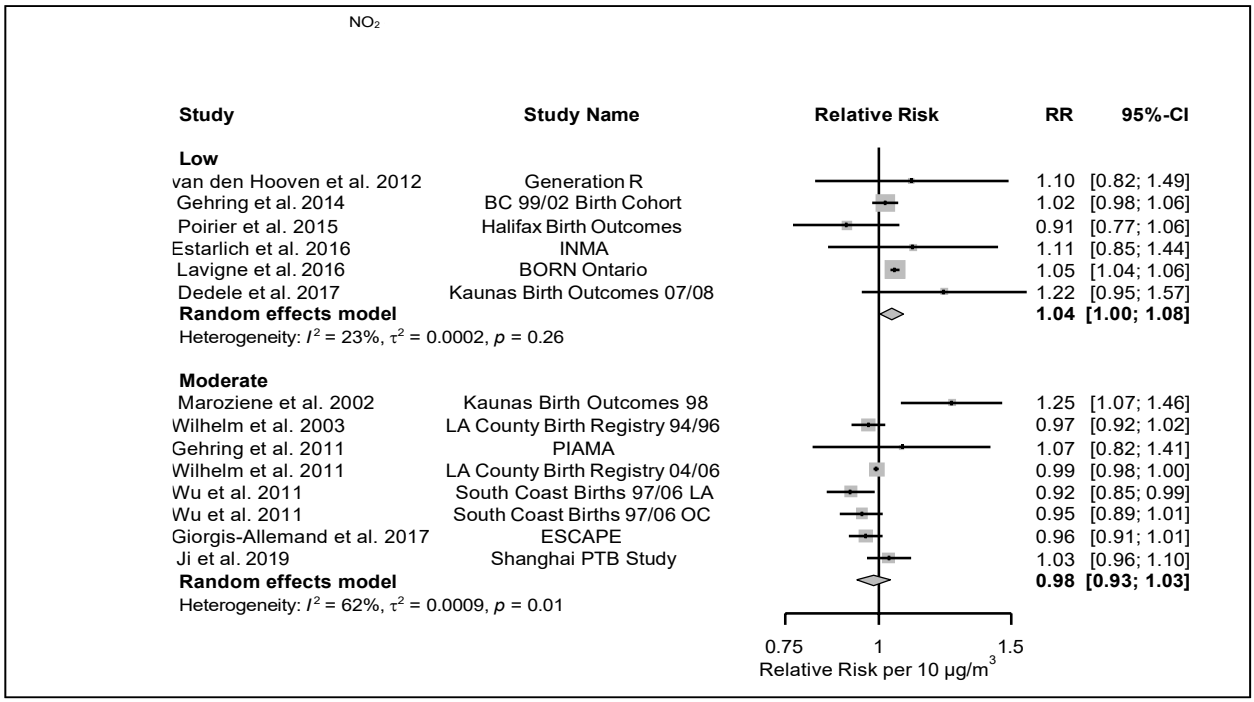
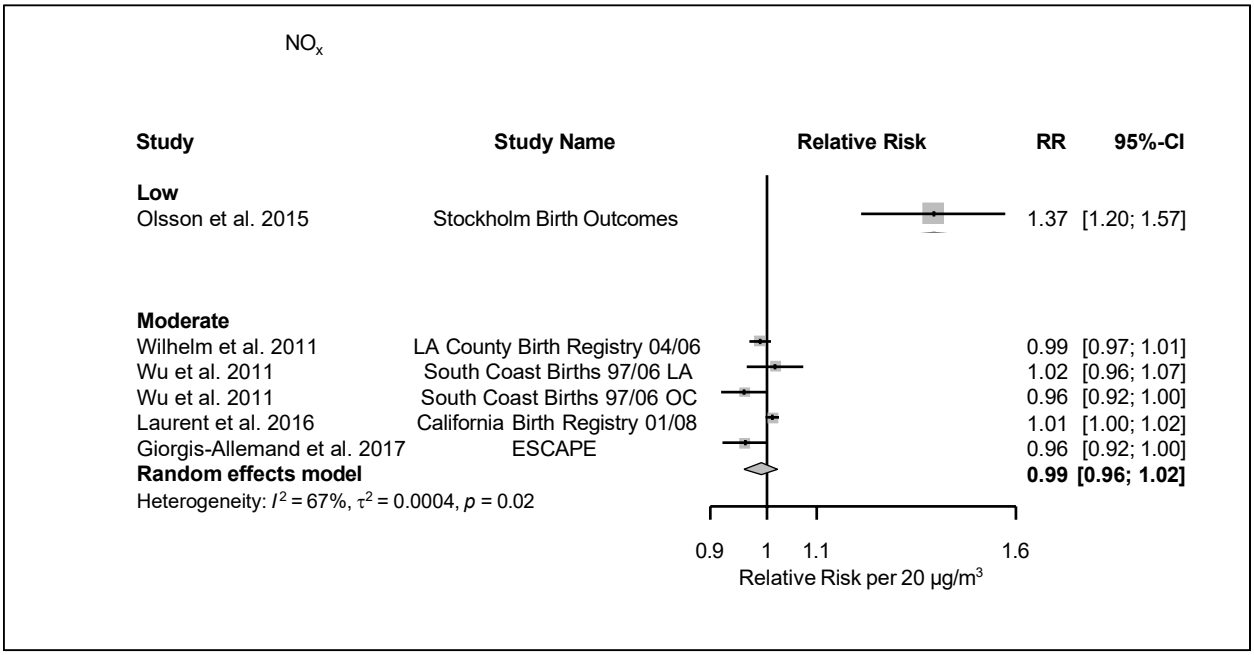
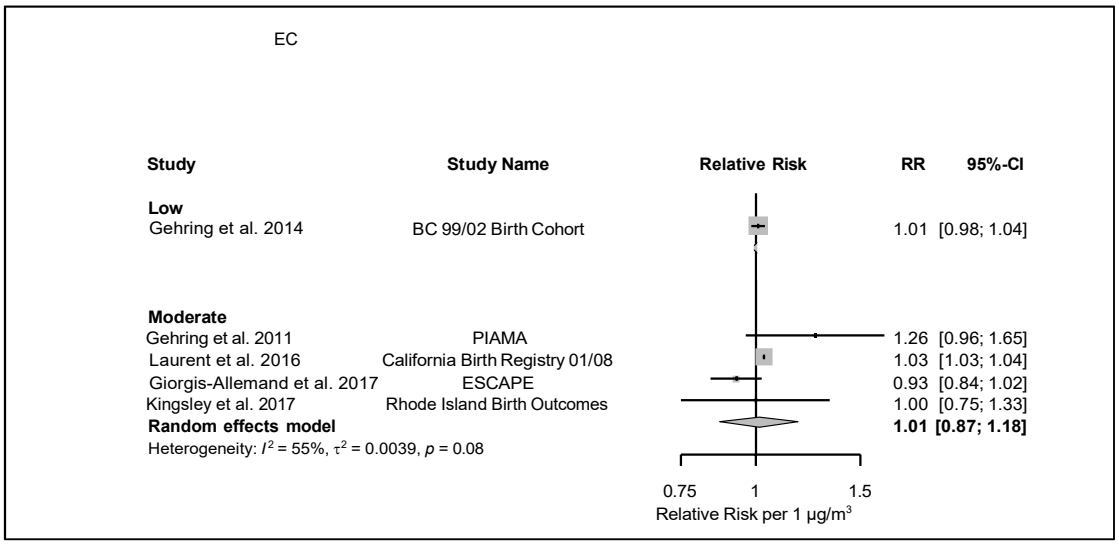




Appendix Figure 8D-6. Associations of NO_2, NO_x and EC with PTB: meta-analysis by risk of bias assessment on exposure assessment (exposure window: entire pregnancy). *Figure continues next page.*



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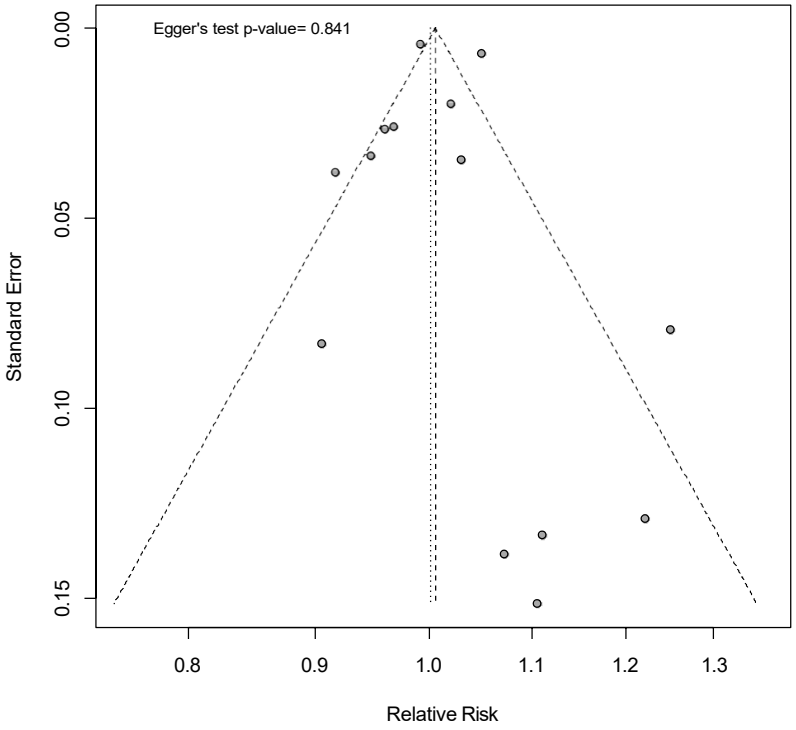

Appendix Figure 8D-7. Funnel plot for NO_2 and PTB (exposure window: entire pregnancy). The vertical lines in the funnel plots represent the pooled fixed and random effect estimates. The vertical dashed line in the middle of the funnel shows the fixed effect estimate. As the Panel applied a random-effects model, the funnel plot also presents the random-effects estimate with the dotted line.

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