Maternal pre-pregnancy body mass index, gestational weight gain, and risk of childhood asthma/wheeze: A systematic review and meta-analysis of cohort studies

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Abstract

Introduction: The goal of this study was to evaluate the association between maternal pre-pregnancy body mass index (BMI), gestational weight gain (GWG) and risk of childhood asthma/wheeze by conducting a meta-analysis of cohort studies. Methods: A systematic literature search of several databases was conducted through January 2020 to identify relevant studies. The exposure of interest was maternal pre-pregnancy BMI (e.g., underweight, overweight, obesity, and continuous BMI) and GWG (e.g., inadequate GWG, excessive GWG, GWG < 9 kg, GWG > 15 kg, and continuous GWG). Random-effects models were used to calculate the pooled odds ratios (ORs) and their 95% confidence intervals (CIs). Results: Twenty-one cohort studies were included (N = 150,198 mother-child pairs). Age of children was 3 months to 16 years. Maternal overweight (OR = 1.13; 95% CI: 1.07 - 1.19) and obesity (OR = 1.39; 95% CI: 1.23 - 1.58) were associated with higher odds of childhood asthma/wheeze; each 1-kg/m2 increase in maternal pre-pregnancy BMI was associated with a 4% increase in the odds of childhood asthma/wheeze. GWG < 9 kg (OR = 1.08; 95% CI, 1.01 - 1.14) was slightly associated with higher odds of childhood asthma/wheeze. Subgroup analyses have identified several variables associated with the between-study heterogeneity. Conclusions: Maternal overweight and obesity are associated with an elevated risk of childhood asthma/wheeze, suggesting that maternal pre-pregnancy BMI need to be considered in studies on the early origins of asthma. Further studies are needed to confirm the association between GWG and risk of childhood asthma/wheeze.

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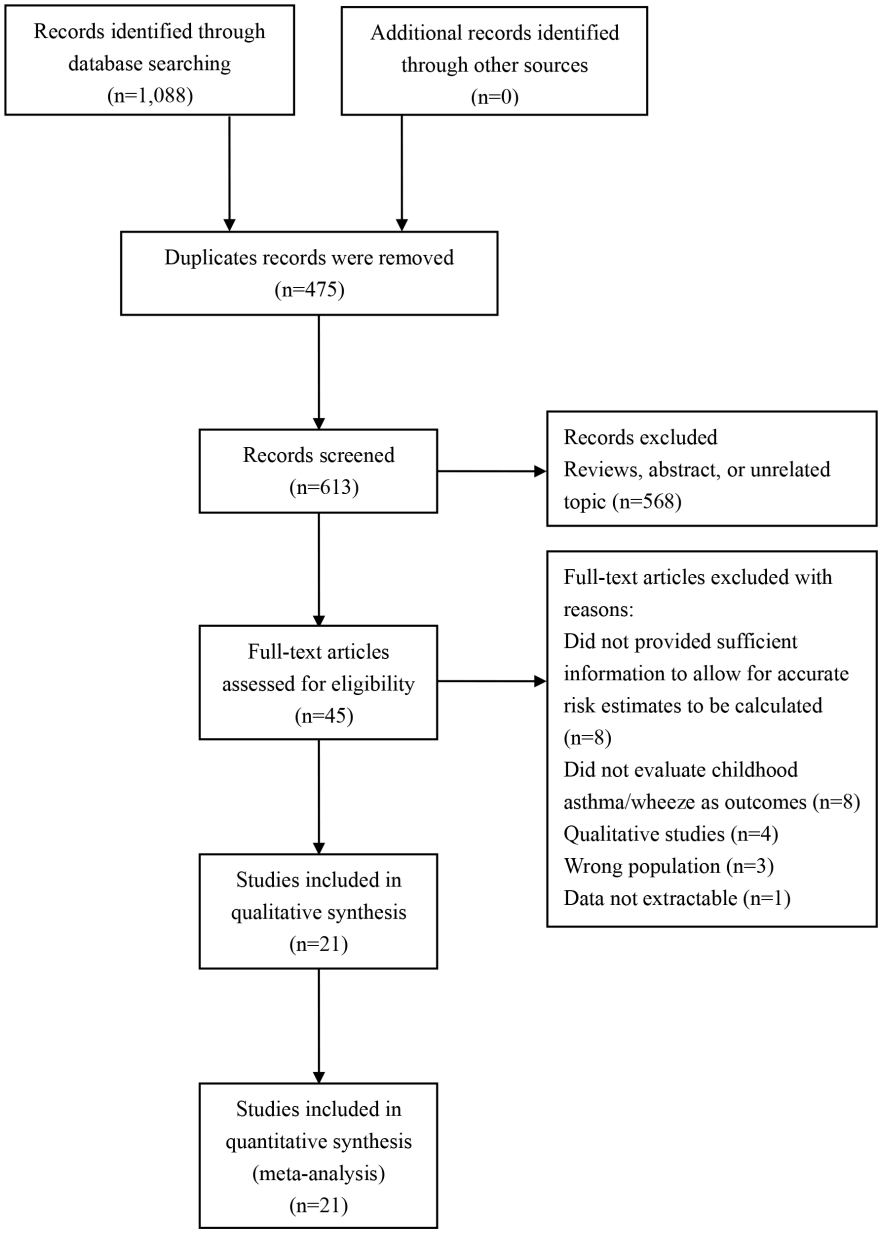
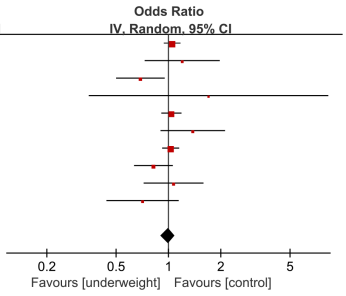


1) Maternal underweight

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Dumas 2016	0.0488	0.0565	23.8%	1.05 [0.94, 1.17]
Ekström 2015	0.1823	0.2536	3.2%	1.20 [0.73, 1.97]
Goudarzi 2018	-0.3711	0.1643	6.7%	0.69 [0.50, 0.95]
Guerra 2013	0.5306	0.809	0.3%	1.70 [0.35, 8.30]
Harpsøe 2013	0.0392	0.0681	20.6%	1.04 [0.91, 1.19]
Harskamp-van Ginkel 2015	0.3221	0.2181	4.2%	1.38 [0.90, 2.12]
Leermakers 2013	0.0296	0.0576	23.5%	1.03 [0.92, 1.15]
Patel 2012	-0.1985	0.131	9.6%	0.82 [0.63, 1.06]
Polinski 2017	0.0677	0.2021	4.8%	1.07 [0.72, 1.59]
Rajappan 2017	-0.3425	0.2441	3.4%	0.71 [0.44, 1.15]
Total (95% CI)			**100.0%**	**1.00 [0.91, 1.09]**

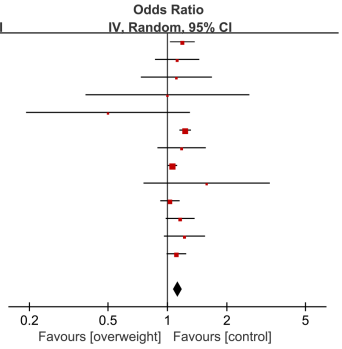
Heterogeneity: Tau² = 0.01; Chi² = 13.76, df = 9 (P = 0.13); I² = 35%
Test for overall effect: Z = 0.10 (P = 0.92)



2) Maternal overweight

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Dumas 2016	0.174	0.0737	9.6%	1.19 [1.03, 1.37]
Ekström 2015	0.1133	0.1318	3.9%	1.12 [0.87, 1.45]
Goudarzi 2018	0.1044	0.2114	1.6%	1.11 [0.73, 1.68]
Guerra 2013	0	0.4875	0.3%	1.00 [0.38, 2.60]
Halonen 2013	-0.6931	0.4875	0.3%	0.50 [0.19, 1.30]
Harpsøe 2013	0.207	0.0343	20.2%	1.23 [1.15, 1.32]
Harskamp-van Ginkel 2015	0.1655	0.1439	3.3%	1.18 [0.89, 1.56]
Håberg 2009	0.0583	0.0281	22.4%	1.06 [1.00, 1.12]
Kumar 2010	0.4574	0.3758	0.5%	1.58 [0.76, 3.30]
Leermakers 2013	0.0296	0.0576	13.0%	1.03 [0.92, 1.15]
Patel 2012	0.1484	0.086	7.7%	1.16 [0.98, 1.37]
Polinski 2017	0.1989	0.1223	4.4%	1.22 [0.96, 1.55]
Rajappan 2017	0.1044	0.0584	12.8%	1.11 [0.99, 1.24]
Total (95% CI)			**100.0%**	**1.13 [1.07, 1.19]**

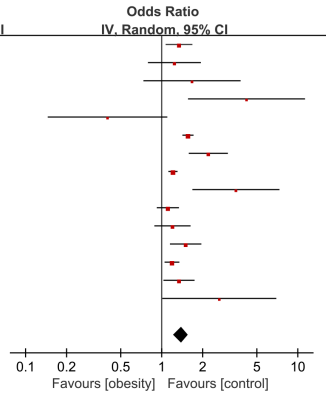
Heterogeneity: Tau² = 0.00; Chi² = 18.52, df = 12 (P = 0.10); I² = 35%
Test for overall effect: Z = 4.33 (P < 0.0001)



3) Maternal obesity

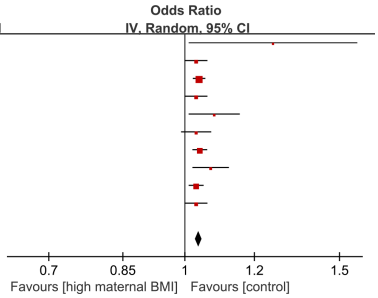
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Dumas 2016	0.2927	0.1154	9.2%	1.34 [1.07, 1.68]
Ekström 2015	0.2151	0.2284	4.8%	1.24 [0.79, 1.94]
Goudarzi 2018	0.5128	0.4195	1.9%	1.67 [0.73, 3.80]
Guerra 2013	1.4351	0.505	1.4%	4.20 [1.56, 11.30]
Halonen 2013	-0.9163	0.5161	1.3%	0.40 [0.15, 1.10]
Harpsøe 2013	0.4447	0.048	12.4%	1.56 [1.42, 1.71]
Harskamp-van Ginkel 2015	0.7885	0.1689	6.8%	2.20 [1.58, 3.06]
Håberg 2009	0.1906	0.0394	12.7%	1.21 [1.12, 1.31]
Kumar 2010	1.2556	0.3759	2.3%	3.51 [1.68, 7.33]
Leermakers 2013	0.1044	0.0958	10.2%	1.11 [0.92, 1.34]
Patel 2012	0.1823	0.1563	7.3%	1.20 [0.88, 1.63]
Polinski 2017	0.4055	0.1356	8.2%	1.50 [1.15, 1.96]
Rajappan 2017	0.174	0.0639	11.8%	1.19 [1.05, 1.35]
Reichman 2008	0.2927	0.1342	8.3%	1.34 [1.03, 1.74]
Wright 2013	0.9746	0.4922	1.4%	2.65 [1.01, 6.95]
Total (95% CI)			**100.0%**	**1.39 [1.23, 1.58]**

Heterogeneity: Tau² = 0.03; Chi² = 53.09, df = 14 (P < 0.00001); I² = 74%
Test for overall effect: Z = 5.32 (P < 0.00001)



Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Caudri 2013	0.2311	0.1128	0.1%	1.26 [1.01, 1.57]
de Vries 2014	0.0296	0.0151	8.3%	1.03 [1.00, 1.06]
Eising 2015	0.0373	0.0084	26.9%	1.04 [1.02, 1.06]
Goudarzi 2018	0.0296	0.0151	8.3%	1.03 [1.00, 1.06]
Guerra 2013	0.077	0.0342	1.6%	1.08 [1.01, 1.15]
Leermakers 2013	0.0296	0.0202	4.7%	1.03 [0.99, 1.07]
Patel 2012	0.0392	0.0099	19.4%	1.04 [1.02, 1.06]
Pike 2013	0.0677	0.0244	3.2%	1.07 [1.02, 1.12]
Polinski 2017	0.0296	0.01	19.0%	1.03 [1.01, 1.05]
Scholtens 2010	0.0296	0.0151	8.3%	1.03 [1.00, 1.06]
Total (95% CI)			**100.0%**	**1.04 [1.03, 1.05]**

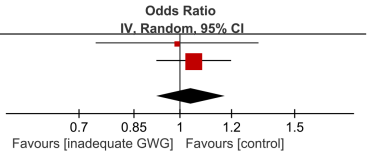
Heterogeneity: Tau² = 0.00; Chi² = 7.29, df = 9 (P = 0.61); I² = 0%
Test for overall effect: Z = 8.22 (P < 0.00001)



1) Inadequate GWG

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Polinski 2017	-0.0101	0.1468	17.4%	0.99 [0.74, 1.32]
Rajappan 2017	0.0488	0.0674	82.6%	1.05 [0.92, 1.20]
Total (95% CI)			**100.0%**	**1.04 [0.92, 1.17]**

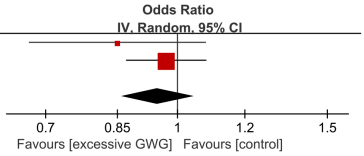
Heterogeneity: Tau² = 0.00; Chi² = 0.13, df = 1 (P = 0.72); I² = 0%
Test for overall effect: Z = 0.63 (P = 0.53)



2) Excessive GWG

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Polinski 2017	-0.1625	0.1222	17.1%	0.85 [0.67, 1.08]
Rajappan 2017	-0.0305	0.0555	82.9%	0.97 [0.87, 1.08]
Total (95% CI)			**100.0%**	**0.95 [0.86, 1.05]**

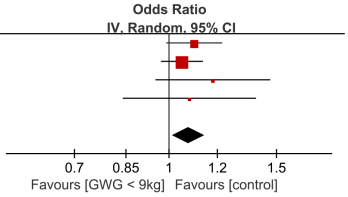
Heterogeneity: Tau² = 0.00; Chi² = 0.97, df = 1 (P = 0.33); I² = 0%
Test for overall effect: Z = 1.05 (P = 0.29)



3) GWG < 9kg

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Dumas 2016	0.0953	0.0538	31.4%	1.10 [0.99, 1.22]
Harpsøe 2013	0.0488	0.0404	55.7%	1.05 [0.97, 1.14]
Polinski 2017	0.1655	0.1106	7.4%	1.18 [0.95, 1.47]
Rusconi 2007	0.077	0.1282	5.5%	1.08 [0.84, 1.39]
Total (95% CI)			**100.0%**	**1.08 [1.01, 1.14]**

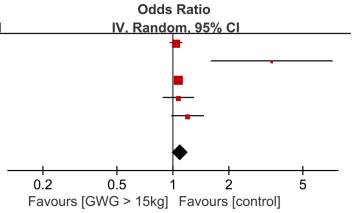
Heterogeneity: Tau² = 0.00; Chi² = 1.23, df = 3 (P = 0.75); I² = 0%
Test for overall effect: Z = 2.44 (P = 0.01)



4) GWG > 15kg

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Dumas 2016	0.0392	0.0408	31.9%	1.04 [0.96, 1.13]
Halonen 2013	1.2238	0.3846	1.5%	3.40 [1.60, 7.23]
Harpsøe 2013	0.0677	0.0244	37.3%	1.07 [1.02, 1.12]
Polinski 2017	0.0677	0.0997	15.0%	1.07 [0.88, 1.30]
Rusconi 2007	0.1823	0.1033	14.3%	1.20 [0.98, 1.47]
Total (95% CI)			**100.0%**	**1.10 [1.00, 1.21]**

Heterogeneity: Tau² = 0.01; Chi² = 10.75, df = 4 (P = 0.03); I² = 63%
Test for overall effect: Z = 1.92 (P = 0.06)



5) Continuous GWG

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Leermakers 2013	0.0953	0.0286	46.1%	1.10 [1.04, 1.16]
Polinski 2017	0	0.0103	53.9%	1.00 [0.98, 1.02]
Total (95% CI)			**100.0%**	**1.04 [0.95, 1.15]**

Heterogeneity: Tau² = 0.00; Chi² = 9.83, df = 1 (P = 0.002); I² = 90%
Test for overall effect: Z = 0.92 (P = 0.36)