National Institute for Health and Care Excellence

Final

Maternal and child nutrition

[F] Evidence reviews for healthy and appropriate weight change during pregnancy

NICE guideline NG247

Evidence reviews underpinning recommendations 1.2.6 to 1.2.8, 1.2.11, and 1.2.14 to 1.2.17 in the NICE guideline

January 2025

Final

These evidence reviews were developed by NICE

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ISBN: 978-1-4731-6748-3

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Healthy and appropriate weight change during pregnancy

Review question

What gestational weight change is healthy and appropriate during pregnancy?

Introduction

Weight gain in pregnancy is comprised of the weight of the uterus, fetus and placenta, increased maternal blood volume, amniotic fluid and increased of maternal fat mass. Weight change during pregnancy can be linked with adverse maternal and fetal outcomes, however, the ranges of appropriate weight gain has been uncertain. In recent years extensive effort has been directed towards trying to define appropriate levels of GWG, including evaluation of the safety of adoption of the estimated ranges of appropriate total weight gain during pregnancy for those in the underweight, healthy, overweight and obese BMI categories reported by the USA Institute of Medicine (IOM 2009), now the National Academy of Medicine (NAM). These have been widely implemented globally, but not in the UK. The aim of this review is to determine what gestational weight change is healthy and appropriate during pregnancy.

Summary of the protocol

See Table 1 for a summary of the Population, Presence or absence of a prognostic risk factor, and Outcome (PPO) characteristics of this review.

Table 1: Summary of the protocol (PPO table)

Population	**Inclusion:** • women during a single or multiple pregnancy **Exclusion:** • pregnant women with pre-existing diabetes • women with polycystic ovarian syndrome
Presence or absence of a prognostic risk factor	Gestational weight change, as defined by the study.

Outcome	**Critical**
	• maternal outcomes
	  ○ caesarean birth
	  ○ hypertensive disorders of pregnancy (preeclampsia and gestational hypertension)
	  ○ gestational diabetes
	• fetal/neonatal outcomes:
	  ○ SGA <10th centile
	  ○ LGA >90th centile
	• childhood outcomes (after 2 years)
	  ○ overweight/obesity
	
	Important
	• maternal outcomes:

	○ health related quality of life as measured by a validated tool, for example HRQoL.

HRQoL: health related quality of life; LGA: large for gestational age; SGA: small for gestational age

For further details see the review protocol in appendix A.

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guidelines: the manual. Methods specific to this review question are described in the review protocol in appendix A and the methods document (supplementary document 1).

Declarations of interest were recorded according to NICE's conflicts of interest policy.

Prognostic evidence

Included studies

Thirty-nine studies were included for this review:

- 9 prospective cohort studies (Breckenkamp 2019, Cedergren 2006, Chen CN 2020, Gaillard 2013, Haugen 2014, Lautredou 2022, Morken 2013, Premru-Srsen 2019, and Tanigawa 2022)
- 26 retrospective cohort studies (Beaudrot 2016, Beyerlein 2011, Blomberg 2011, Chen L 2020, Chen-Xu 2022, Chuang 2022, Di Benedetto 2012, Enomoto 2016, Flick 2010, Gante 2015, Gavard 2017, Gawade 2011, Graham 2014, Haile 2019, Harper 2011, Hautier 2022, Hung 2016, Kiefer 2022, Kominiarek 2013, Langford 2011, Liang 2021, McCurdy 2022, Nohr 2008, Park 2011, Simko 2019, and Yee 2013)
- 2 systematic reviews of observational studies (Lipworth 2022 and Whitaker 2022) and
- 2 individual patient data (IPD) meta-analyses (Santos 2019 and Voerman 2019).

The included studies are summarised in Table 2.

Two studies were conducted on twin pregnancies (Lipworth 2022 and Whitaker 2022), all other studies were conducted on single pregnancies.

Twenty-nine studies used the Institute of Medicine (IOM) gestational weight gain guidelines (Beaudrot 2016, Beyerlein 2011, Blomberg 2011, Breckenkamp 2019, Chen CN 2020, Chen-Xu 2022, Di Benedetto 2012, Enomoto 2016, Flick 2010, Gaillard 2013, Gante 2015, Gavard 2017, Haile 2019, Harper 2011, Haugen 2014, Hautier 2022, Hung 2016, Kiefer 2022, Langford 2011, Lautredou 2022, Liang 2021, Lipworth 2022, McCurdy 2022, Park 2011, Santos 2019, Simko 2019, Tanigawa 2022, Voerman 2019, Whitaker 2022), 1 study used a combination of guidelines (Chuang 2022), and 9 studies used independent thresholds (Cedergren 2006, Chen L 2020, Gawade 2011, Graham 2014, Kominiarek 2013, Morken 2013, Nohr 2008, Premru-Srsen 2019, Yee 2013).

Thirty studies assessed the association between gestational weight gain and caesarean birth (Beaudrot 2016, Beyerlein, 2011, Blomberg 2011, Breckenkamp 2019, Cedergren 2006, Chen CN 2020, Chen-Xu 2022, Di Benedetto 2012, Enomoto 2016, Flick 2010, Gaillard 2013, Gante 2015, Gavard 2017, Gawade 2011, Graham 2014, Haile 2019, Harper 2011, Haugen 2014, Hung 2016, Kiefer 2022, Kominiarek 2013, Langford 2011, Lautredou 2022, Lipworth 2022, McCurdy 2022, Morken 2013, Nohr 2008, Simko 2019, Whitaker 2022, Yee 2013). 8 studies assessed the association between gestational weight gain and preeclampsia (Chen CN 2020, Chen L 2020, Chen-Xu 2022, Hung 2016, Lipworth 2022, Premru-Srsen 2019, Santos 2019, Whitaker 2022). 6 studies assessed the association between gestational weight gain and gestational hypertension (Chen CN 2020, Chen-Xu 2022, Enomoto 2016, Lautredou 2022, Santos 2019, Whitaker 2022). 9 studies assessed the association between gestational weight gain and gestational diabetes (Chen CN 2020, Chen-Xu 2022, Chuang 2022, Enomoto 2016, Hung 2016, Lautredou 2022, Lipworth 2022, Santos 2019, Whitaker 2022).

Eight studies assessed the association between gestational weight gain and small for gestational age (Chen-Xu 2022, Enomoto 2016, Hautier 2022, Hung 2016, Lipworth 2022, Park 2011, Santos 2019, Whitaker 2022).10 studies assessed the association between gestational weight gain and large for gestational age (Chen CN 2020, Chen-Xu 2022, Di Benedetto 2012, Enomoto 2016, Hung 2016, Lautredou 2022, Liang 2021, Park 2011, Santos 2019, Whitaker 2022). 2 studies assessed the association between gestational weight gain and childhood overweight or obesity (Tanigawa 2022, Voerman 2019).

All studies adjusted for covariates; however, the committee did not agree on key covariates a priori in the protocol. The adjusted covariates varied across the studies.

All studies used the World Health Organization definition of BMI categories when reporting pre-pregnancy BMI.

The studies used different definitions of gestational weight change (for example, IOM categories of weight change, Swedish categories of weight change) and different methods of weight measurement (for example, self-reported, by healthcare professional at antenatal care appointments). Overall, most studies used the IOM categories for gestational weight change. Studies defined gestational weight change as weight loss, inadequate weight gain, adequate weight gain, or excessive weight gain. Only studies using the same gestational weight change categories and definitions were pooled. Where possible, similarly defined outcomes have been pooled. Since all studies reported results by inadequate or excessive gestational weight change, studies have not been analysed by when gestational weight was measured (for example, gestational weight change at different time points such as 1st, 2nd or 3rd trimester). All studies had a referent population (usually adequate weight gain), but there was some variation in studies (for example, specific weight gain categories such as weight gain of 15-24.9 lbs). Only studies using the same referent population were pooled.

Evidence was identified for all outcomes other than health related quality of life.

See the literature search strategy in appendix B and study selection flow chart in appendix C.

The evidence was stratified by BMI and parity (nulliparous and parous) where possible. No evidence was identified to stratify evidence according to ethnicity and bariatric surgery.

Excluded studies

Studies not included in this review are listed, and reasons for their exclusion are provided in appendix K.

Summary of included studies

Summaries of the studies that were included in this review are presented in Table 2.

Table 2: Summary of included studies.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Beaudrot 2016 Retrospective cohort study USA	N=237717 women Mean (SD) age (years): NR (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: • <15 years: 23.4 (5.0) • 15-17 years: 23.6 (4.9) • 18-19 years: 24.6 (5.7) • 20-34 years: 25.9 (6.4)	Gestational weight change: • lost weight • inadequate weight gain • excessive weight gain. Referent: appropriate weight gain in 20-34 year olds. **Gestational weight change definition:** NR	• maternal race • smoking status • labour induction.	• caesarean birth.

Beyerlein 2011
 	
Retrospective cohort study
 	
Germany
	N=445323 women
	
	Mean (SD) age (years):
	• gestational weight loss (GWL): 30.2 (NR)
	• non-excessive gestational weight gain (NEGWG): 30.6 (NR)
	• excessive gestational weight gain (EGWG): 29.7 (NR)
	
	Maternal pre-pregnancy BMI, kg/m^2, n (%):
	• underweight
	  ○ GWL: 19 (0.54)
	  ○ NEGWG: 26173 (5.92)
	  ○ EGWG: 4328 (1.64)
	• normal weight
	  ○ GWL: 480 (13.63)
		Gestational weight change:
		• weight loss.
		
		Referent: non-excessive weight gain.
		
		Gestational weight change definition:
		Difference between weight prior to birth and at booking.
			• gestational and pre-gestational diabetes
			• smoking in pregnancy
			• offspring's sex
			• parity and maternal age
			• preterm delivery.
				• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
	○ NEGWG: 331439 (75.02) ○ EGWG: 128673 (48.69) • overweight ○ GWL: 808 (22.95) ○ NEGWG: 54512 (12.34) ○ EGWG: 90015 (34.06) • obese class I ○ GWL: 889 (25.25) ○ NEGWG: 18308 (4.14) ○ EGWG: 30043 (11.37) • obese class II ○ GWL: 688 (19.54) ○ NEGWG: 7756 (1.76) ○ EGWG: 8229 (3.11) • obese class III ○ GWL: 637 (18.09) ○ NEGWG: 3614 (0.82) ○ EGWG: 2964 (1.12)			
Blomberg 2011 Retrospective cohort study Sweden	N=46595 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • weight loss • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and at 1st visit.	• maternal age • parity • smoking.	• caesarean birth.
Breckenkamp 2019 Prospective cohort study	N=NR Mean (SD) age (years):	Gestational weight change • inadequate weight gain	• age • parity.	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes

Germany	• non-immigrants: 30.9 (NR)
	• first-generation immigrant women:
	  ○ low and lower middle-income countries: 30.2 (5.6)
	  ○ upper middle-income countries: 29.5 (5.8)
	  ○ high-income countries: 31.0 (5.4)
	• second-generation immigrant women: 27.6 (5.2)
	
	Maternal pre-pregnancy BMI, kg/m^2 (%):
	• BMI <18.5
	  ○ non-immigrants: 3.9
	  ○ first-generation immigrant women:
	    – low and lower middle-income countries: 3.3
	    – upper middle-income countries: 5.1
	    – high-income countries: 3.5
	  ○ second-generation immigrant women: 3.7
	• BMI <25
	  ○ non-immigrants: 64.8
	  ○ first-generation immigrant women
		• excessive weight gain.
		
		Referent: adequate weight gain.
		
		Gestational weight change definition:
		Difference between weight prior to birth and at 1st prenatal check-up.		

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
	– low and lower middle-income countries: 53.0 – upper middle-income countries: 50.8 – high-income countries: 71.8 o second-generation immigrant women: 55.3 • BMI <30 o non-immigrants: 20.7 o first-generation immigrant women – low and lower middle-income countries: 29.9 – upper middle-income countries: 31.9 – high-income countries: 15.5 o second-generation immigrant women: 25.8 • BMI ≥30 o non-immigrants: 10.6 o first-generation immigrant women – low and lower middle-income countries: 13.8 – upper middle-income countries: 12.2 – high-income countries: 9.2 o second-generation immigrant women: 15.3			

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Cedergren 2006 Prospective cohort study Sweden	N=246324 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain **Gestational weight change definition:** Difference between weight prior to birth and at 1st visit.	• maternal age • parity • smoking in early pregnancy • year of birth.	• caesarean birth.
Chen CN 2020 Prospective cohort study Taiwan	N=19052 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 3851 (20.2) • normal: 13333 (70.0) • overweight: 1524 (8.0) • obese: 344 (1.8)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• maternal age • infant sex • parity • maternal education • maternal immigration status • family monthly income • urbanicity of living area • smoking during pregnancy.	• caesarean birth • gestational hypertension • preeclampsia • gestational diabetes • LGA.
Chen L 2020 Retrospective cohort study Taiwan	N=NR Median age (years): • normal pregnancy: 34.0 • preeclampsia: 35.0 Maternal pre-pregnancy BMI, kg/m^2, median (IQR): • normal pregnancy: 22.0 (4.3) • preeclampsia: 24.0 (8.0)	Gestational weight change: • >20kg weight gain. Referent: ≤20kg weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• endocrine parameters • mother's age • age of the male partner • BMI • infertility diagnosis • ovarian stimulation protocol • duration of ovarian stimulation • maximal endometrial thickness • number oocytes retrieved • number of embryos transferred • use of ICSI	• preeclampsia.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
			• use of blastocyst-stage ET • occurrence of multiple pregnancies • pregnancy weight gain.	
Chen-Xu 2022 Retrospective cohort study Portugal	N=13467 women Mean (SD) age (years): 33.3 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: 27.0 (5.8)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth/last appointment before birth and pre-pregnancy body weight.	• maternal age • number of previous abortions/deliveries • first degree family history of diabetes • previous macrosomia • fasting glucose • weeks between diagnosis and first hospital appointment • GD treatment • BMI category • week of delivery.	• caesarean birth • gestational hypertension • preeclampsia • gestational diabetes • SGA • LGA.

Chuang 2022
 	
Retrospective cohort study
 	
Taiwan
	N=5529 women
	
	Mean (SD) age (years): NR (NR)
	
	Maternal pre-pregnancy BMI, kg/m^2, n (%):
	• underweight: 1177 (14.1)
	• normal: 6217 (74.4)
	• overweight/obese: 958 (11.5)
		Gestational weight change:
		• excessive weight gain
		  ○ first trimester
		  ○ second trimester
		  ○ before GDM test.
		
		Referent: NR
		
		Gestational weight change definition:
		First trimester, second trimester, before GDM test.
			• age at delivery (<20, 20–34, and >34 years)
			• primiparity
			• a prior history of assisted or spontaneous abortion
			• preterm delivery
			• stillbirth (>20 weeks of gestation)
			• a family history of type 2 diabetes mellitus (first- and second-degree relatives)
			• conception by assisted reproductive technology (ART)
			• cigarette smoking during pregnancy
			• uterine fibroids
				• gestational diabetes.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
			• maternal diseases such as chronic hypertension, preeclampsia, hypothyroidism, and hyperthyroidism.	
Di Benedetto 2012 Retrospective cohort study Italy	N=2225 women Mean (SD) age (years): • underweight: 28.6 (NR) • normal weight: 29.5 (NR) • overweight: 30.3 (NR) • obese: 30.3 (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 284 (2.7) • normal: 1430 (64.3) • overweight: 336 (15.1) • obese: 175 (7.9)	Gestational weight change: • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• gestation age at delivery • glycaemia.	• caesarean birth • LGA.
Enomoto 2016 Prospective and retrospective cohort study Japan	N=97157 women Mean (SD) age (years): • underweight: 30.88 (NR) • normal weight: 31.95 (NR) • overweight: 32.46 (NR) • obese: 32.04 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: • underweight: 17.59 (0.75) • normal weight: 20.9 (1.63) • overweight: 26.93 (1.39) • obese: 33.65 (3.4)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• maternal age • maternal height • parity.	• caesarean birth • gestational hypertension • gestational diabetes • SGA • LGA.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Flick 2010 Retrospective cohort study USA	N=NR Mean (SD) age (years): • BMI 30-35.9: 28.0 (NR) • BMI 36-39.9: 28.3 (NR) • BMI ≥40: 28.0 (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • weight loss • weight gain of up to 14.9lbs • weight gain of 25lbs. Referent: weight gain of 15 to 24.9lbs. **Gestational weight change definition:** NR	• maternal age • race/ethnicity • trimester at first prenatal visit • previous CD, previous preterm delivery • chronic hypertension • pregestational diabetes.	• caesarean birth.
Gaillard 2013 Prospective cohort study The Netherlands	N=NR Median age, years (90% range): 30.3 (20.4 to 37.9) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: 23.6 (4.4)	Gestational weight change: • excessive weight gain. Referent: adequate/inadequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• educational level • maternal age • ethnicity • parity • folic acid supplement use • smoking habits • alcohol consumption.	• caesarean birth.
Gante 2015 Retrospective cohort study Portugal	N=1806 women Mean (SD) age (years): 33.1 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: 34.7 (4.2)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• age • parity • pre-pregnancy BMI • use of insulin • gestational age at delivery • birthweight.	• caesarean birth.
Gavard 2017 Retrospective cohort study	N=12117 women	Gestational weight change: • inadequate weight gain • excessive weight gain.	• maternal age • race	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
USA	Mean (SD) age (years): NR (SD) Maternal pre-pregnancy BMI: NR	Referent: adequate weight gain. **Gestational weight change definition:** NR	• education • socioeconomic status • smoking • parity • diabetes • adequacy of prenatal care • sex of infant • gestational age at delivery.	
Gawade 2011 Retrospective cohort study USA	N=2495 women Mean (SD) age (years): NR (SD) Maternal pre-pregnancy BMI, kg/m^2, n (%): • <18.5: 77 (3.1) • 18.5-24.9: 1035 (41.5) • 25-29.9: 684 (27.4) • ≥30: 699 (28.0)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• gestational weight gain • maternal age • birthweight • gestational age • pre-pregnancy BMI • parity • bishop score • infant gender.	• caesarean birth.
Graham 2014 Retrospective cohort study USA	N=2157 women Mean (SD) age (years): NR (SD) Maternal pre-pregnancy BMI, kg/m^2, n (%): • <18.5: 255 (12.83) • 18.5–24.9: 1085 (48.78) • 25.0–29.9: 432 (21.00) • ≥30.0: 385 (17.39)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• race/ethnicity • live births • household income • education.	• caesarean birth.
Haile 2019	N=2107 women	Gestational weight change: • inadequate weight gain	• maternal age • education	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Retrospective cohort study USA	Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 1007 (47.8) • normal: 99 (4.7) • overweight: 536 (25.4) • obese: 465 (22.1)	• excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• marital status • pre-pregnancy body mass index • race/ethnicity • poverty-income ratio • gestational age • previous birth experience • gestational diabetes mellitus • macrosomia • type of birth attendant.	
Harper 2011 Retrospective cohort study USA	N=76675 women Mean (SD) age (years): • underweight: 17.49 (NR) • normal weight: 17.55 (NR) • overweight: 17.73 (NR) • obese: 17.96 (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• maternal age • maternal race • tobacco use • alcohol use • a composite maternal medical risk factor (includes chronic hypertension, diabetes, and renal disease), Medicaid, and the Kotel chuck prenatal care index.	• caesarean birth.
Haugen 2014 Prospective cohort study Norway	N=56071 women Mean (SD) age (years): • nulliparous: 28.4 (NR) • parous: 31.8 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: • nulliparous: 23.7 (4.1) • parous: 24.2 (4.2)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight 6 months postpartum and pre-pregnancy body weight.	• maternal age at delivery • maternal height • maternal education level • smoking in pregnancy • gestational length • diabetic conditions.	• caesarean birth.
Hautier 2022	N=340 women	Gestational weight change:	• BMI <18.5 kg/m^2	• SGA.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Retrospective cohort study France	Median (IQR) age, years: • BMI <18.5: 28 (27 to 34) • BMI 18.5-24: 30 (25 to 32) Maternal pre-pregnancy BMI: NR	• inadequate weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• smoking • parity.	
Hung 2016 Retrospective cohort study Taiwan	N=10970 women Age, years, n: • <20: 18 • 20-34: 7086 • >34: 3869 Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• maternal age at delivery • parity • prior fetal death • prior preterm birth • conception methods • genetic amniocentesis • smoking during pregnancy • group B streptococcal colonization at the genitorectal tract • fetal sex • intrapartum epidural analgesia.	• caesarean birth • preeclampsia • gestational diabetes • SGA • LGA.
Kiefer 2022 Retrospective cohort study USA	N=8322 women Mean (SD) age (years): 30.6 (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 161 (1.9) • normal: 2558 (30.7) • overweight: 2188 (26.3) • obesity class I: 1625 (19.5) • obesity class II: 936 (11.3)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and at 1st prenatal check-up.	• age • race • parity • history of caesarean delivery • chronic hypertension • tobacco use • delivery year • gestational age at birth.	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
	• obesity class III: 854 (10.3)			
Kominiarek 2013 Retrospective cohort study USA	N=20950 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • <0kg weight gain • 0 to 4.9kg weight gain • >9kg weight gain. Referent: 5 to 9kg weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• age • race/ethnicity • marital status • insurance • parity • smoking • gestational age.	• caesarean birth.
Langford 2011 Retrospective cohort study USA	N=34143 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• maternal age.	• caesarean birth.
Lautredou 2022 Prospective cohort study France	N=3162 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 247 (6.9) • normal: 1932 (53.7) • overweight: 583 (18.4) • obese: 400 (12.7)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight at last appointment before birth and pre-pregnancy body weight.	• age • parity • geographical origin • tobacco use • gestational age • preexisting diabetes • preexisting chronic hypertension.	• caesarean birth • gestational hypertension • gestational diabetes • LGA.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Liang 2021 Retrospective cohort study Taiwan	N=2210 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 223 (10.1) • normal: 1591 (71.2) • overweight: 305 (13.8) • obese: 91 (4.2)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• age • education • parity • preterm birth • fetal head circumference.	• LGA.
Lipworth 2022 Systematic review USA & Europe	N=13485 women in 14 studies Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n: **Algeri 2018: n=175** • normal weight: 134 • overweight: 30 • obese: 11 **Fox 2010: n=297** • underweight: n=16 • normal weight: n=201 • overweight: n=51 • obese: n=29 **Fox 2011: n=170** • normal weight: 117 • overweight: NR • obese: NR **Gavard 2014: n=831**	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• maternal pre-pregnancy body mass index (BMI) • chronicity • artificial reproductive therapies.	• caesarean birth • preeclampsia • gestational diabetes • SGA.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes

	• obese: n=831
	  o obese I: 405
	  o obese II: 223
	  o obese III: 203
	Gonzalez-Quintero 2012: n=5129
	• normal weight: 2875
	• overweight: 1241
	• obese: 1013
	Kosinska-Kaczynska 2017: n=201
	• normal weight: 201
	Lal 2015: n=2654
	• underweight/normal weight: 1497
	• overweight: 606
	• obese: 551
	Liu 2019: n=252
	• overweight: 162
	• obese: 90
	Liu 2020: n=609
	• normal weight: 609
	Lutsiv 2017: n=741
	• normal weight: 350
	• overweight: 196
	• obese: 195
	Pecheux 2019: n=878
	• normal weight: 621
	• overweight: 168
	• obese: 88
	Pettit 2015: n=489
	• normal weight: 293			

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
	• overweight: 102 • obese: 94 **Pettit 2016: n=489** • normal weight: 247 • overweight: 85 • obese: 69 **Shamshirsaz 2014: n=570** • normal weight: 286 • overweight: 161 • obese: 123			
McCurdy 2022 Retrospective cohort study USA	N=55275 women Mean (SD) age (years): NR (SD) Maternal pre-pregnancy BMI, kg/m^2, n (%): • <18.5: 2440 (4.2) • 18.5-24.9: 27515 (47.6) • 25-29.9: 14151 (24.5) • 30-34.9: 7482 (12.9) • 35-39.9: 3555 (6.1) • ≥40: 2669 (4.6)	Gestational weight change: • <11lbs weight gain • >20lbs weight gain. Referent: 11 to 20lbs weight gain. **Gestational weight change definition:** NR	• age • race • ethnicity • educational level • marital status • household income • live birth order • alcohol use • gestational age • intendedness of pregnancy • infant birth weight • physical activity during pregnancy • comprehensiveness of prenatal care.	• caesarean birth.
Morken 2013 Prospective cohort study Norway	N=50416 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • <8kg weight gain • ≥16kg weight gain. Referent: 8 to 15.9kg weight gain.	• maternal age • smoking • parity • BMI category.	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
		Gestational weight change definition: Difference between weight prior to birth and pre-pregnancy body weight.		
Nohr 2008 Retrospective cohort study Denmark	N=60952 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 2679 (4.4) • normal weight: 41589 (68.3) • overweight: 11874 (19.5) • obese: 4810 (7.9)	Gestational weight change: • <10kg weight gain • 16 to 19kg weight gain • ≥20kg weight gain. Referent: 10 to 15kg weight gain. **Gestational weight change definition:** Difference between weight 6 months postpartum and pre-pregnancy body weight.	• age • parity • height • smoking • alcohol consumption • social status • exercise • gestational age (in days) • birth weight.	• caesarean birth.
Park 2011 Retrospective cohort study USA	N=570672 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** NR	• maternal age • maternal race/ethnicity • parity • gestational age • maternal education attainment • smoking status during pregnancy • WIC program participation • total number of prenatal visits • sex of infant • infant birth year.	• SGA • LGA.
Premru-Srsen 2019 Prospective cohort study Slovakia	N=98604 women Mean (SD) age (years): • women without PE: 30.2 (NR)	Gestational weight change: • 6.7 to 10kg weight gain • <0.5 to 6.9kg weight gain • 13.7 to 29kg weight gain	• maternal age • parity • preventive treatment with low-dose Aspirin	• preeclampsia.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
	• women with PE: 30.3 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: • women without PE: 23.7 (4.5) • women with PE: 26.6 (5.8)	• >24.6 to ≥29.1kg weight gain Referent: adequate weight gain. **Gestational weight change definition:** Difference between last recorded weight before birth and pre-pregnancy body weight.	• smoking • pre-pregnancy diabetes mellitus • pre-pregnancy hypertension • pre-pregnancy BMI.	
Santos 2019 IPD Birth cohorts from Europe, North America, and Oceania	N=265270 women from 39 birth cohorts Median age (years): 30 Maternal pre-pregnancy BMI, kg/m^2, n (%): • underweight: 9065 • normal weight: 148697 • overweight: 42678 • obese I: 13084 • obese II: 3597 • obese III: 1095	Gestational weight change: • low weight gain • medium weight gain • high weight gain. Referent: medium weight gain in women with normal BMI pre-pregnancy. **Gestational weight change definition:** Difference between last recorded weight before birth and pre-pregnancy body weight.	• maternal age • educational level • parity • smoking habits during pregnancy.	• gestational hypertension • preeclampsia • gestational diabetes • SGA • LGA.
Simko 2019 Retrospective cohort study Slovakia	N=7102 women Mean (SD) age (years): • underweight: 17.7 (NR) • normal weight: 21.2 (NR) • overweight: 26.8 (NR) • obese: 34.9 (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• maternal age • gestational age • maternal BMI • smoking.	• caesarean birth.

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Tanigawa 2022 Prospective cohort study Japan	N=64336 women Mean (SD) age (years): 31.54 (NR) Mean (SD) maternal pre-pregnancy BMI, kg/m^2: 21.12 (NR)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain in women with normal BMI pre-pregnancy. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• maternal age • maternal BMI before pregnancy • maternal education levels • smoking during pregnancy • the frequency of maternal passive smoking during pregnancy • drinking during pregnancy • household income during pregnancy • occupation during pregnancy • marital status during pregnancy • number of children during pregnancy • a history of hypertensive disorder of pregnancy • gestational diabetes • offspring sex • gestational age.	• childhood overweight/ obesity.
Voerman 2019 IPD Cohorts from Europe, North America, and Oceania	N=181678 women from 37 pregnancy and birth cohorts Mean (SD) age (years): NR (NR) Median (95% range) maternal pre-pregnancy BMI, kg/m^2: 22.7 (18.1 to 34.3)	Gestational weight change: • inadequate weight gain • excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between last recorded weight before birth and pre-pregnancy body weight.	• maternal age • maternal educational level • maternal ethnicity • parity • maternal smoking during pregnancy.	• childhood overweight/ obesity.
Whitaker 2022	N=NR	Gestational weight change: • inadequate weight gain	• maternal age • parity	• caesarean birth • gestational hypertension

Study	Population	Risk factor	Covariates adjusted in analysis	Outcomes
Systematic review Japan, USA	Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	• excessive weight gain. Referent: adequate weight gain. **Gestational weight change definition:** Difference between weight prior to birth and pre-pregnancy body weight.	• pre-existing diabetes or hypertension • pre-pregnancy BMI • chronicity • gestational age at delivery • infant sex • race/ethnicity • height • smoking • employment and student status • marital status • insurance • education • fertility treatment • fetal sex of the twin pair • cerclage • prior preterm birth • payer status • diabetes • mode of conception • gestational age.	• preeclampsia • gestational diabetes • SGA • LGA.
Yee 2013 Retrospective cohort study USA	N=26205 women Mean (SD) age (years): NR (NR) Maternal pre-pregnancy BMI: NR	Gestational weight change: • weight loss. Referent: no weight loss. **Gestational weight change definition:** Difference between weight at last visit and at 1st visit.	• maternal age • race/ethnicity • parity • education • primary language.	• caesarean birth.

BMI: body mass index; CD: caesarean delivery; GD: gestational diabetes; GDM: gestational diabetes mellitus; GWL: gestational weight loss; EGWG: excessive gestational weight gain; ET: embryo transfer; ICSI: intracytoplasmic sperm injection; IPD: individual patient data; LGA: large for gestational; NEGWG: non-excessive gestational weight gain; NR: not reported; PE: pre-eclampsia; SD: standard deviation; SGA: small for gestational age; WIC: women, infants, and children.

See the full evidence tables in appendix D and the forest plots in appendix E.

Summary of the evidence

See appendix F for full GRADE tables.

Meta-analysis was performed where possible (for example, if there were at least 2 studies reporting the same risk factor and in populations with the same/similar characteristics) and where there was no significant variation between studies or very serious heterogeneity. Studies adjusting for the same covariates (or matched at baseline) or with an overlap of adjusted covariates were meta-analysed. For those where meta-analysis could not be performed (for example, where there was very serious heterogeneity (I^2 > 80%)), the results for each individual study have been reported in this review. Meta-analysis was possible for 31 studies and for 10 studies risk factors were reported individually.

Association between weight loss, inadequate gestational weight gain, excessive gestational weight gain (IOM gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton and twin pregnancy: all BMI categories, parity and age strata

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
Risk factor: Weight loss										
Singleton births										
Aged <15 years (referent: adequate GWG in 20-34 year olds)	No association (Very low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 15-17 years (referent: adequate GWG in 20-34 year olds)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 18-19 years (referent: adequate GWG in 20-34 year olds)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 20-34 years (referent: adequate GWG in 20-34 year olds)	High risk (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese I (referent: adequate GWG)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese I (referent: adequate GWG)	Low risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese I (referent: adequate GWG)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese II (referent: adequate GWG)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese II (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
Parous, pre-pregnancy BMI obese II (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese III (referent: adequate GWG)	Low/high risk Low to very low quality	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese III (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese III (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Risk factor: Inadequate gestational weight gain										
Singleton pregnancy										
Aged <15 years (referent: adequate GWG in 20-34 year olds)	Low risk (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 15-17 years (referent: adequate GWG in 20-34 year olds)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 18-19 years (referent: adequate GWG in 20-34 year olds)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 20-34 years (referent: adequate GWG in 20-34 year olds)	High risk (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
All pre-pregnancy BMI categories (referent: adequate GWG)	Low risk/no association (Moderate to low quality)	High risk (Low quality)	Low risk (Moderate quality)	Low risk High quality	High risk (Low quality)	Low risk/no association (Very low quality)	NR	Low risk (Moderate quality)	Low risk (High quality)	No association (High quality)

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
Pre-pregnancy BMI underweight (referent: adequate GWG)	High risk (Moderate quality)	High risk (Moderate quality)	Low risk (Low quality)	No association (Low quality)	High risk (Moderate quality)	Low risk (Moderate quality)	Low risk (High quality)	NR	NR	NR
Pre-pregnancy BMI normal weight (referent: adequate GWG)	Low risk/high risk/no association (Very low quality)	High risk (Low quality)	Low risk (Low quality)	No association (Low quality)	NR	Low risk (Moderate quality)	Low risk (Moderate quality)	NR	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	No association (Low quality)	High risk (Moderate quality)	No association (Moderate quality)	NR	High risk (Low quality)	Low risk (Moderate quality)	No association (Moderate quality)	NR	NR	NR
Pre-pregnancy BMI overweight/obese (referent: adequate GWG)	No association (Low quality)	High risk (Moderate quality)	NR	No association (Low quality)	No association (Low quality)	No association (Moderate quality)	NR	NR	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	No association (Very low quality)	High risk (Moderate quality)	No association (Low quality)	NR	High risk (Low quality)	Low risk (Moderate quality)	High risk (High quality)	NR	NR	NR
Pre-pregnancy BMI obese I (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese I (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI	No association	NR	NR	NR	NR	NR	NR	NR	NR	NR

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
obese I (referent: adequate GWG)	(Moderate quality)									
Pre-pregnancy BMI obese II (referent: adequate GWG)	No association (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese II (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese II (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese III (referent: adequate GWG)	Low risk/high risk/no association (Low to very low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese III (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese III (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Twin pregnancy										
All pre-pregnancy BMI categories (referent: adequate GWG)	No association	High risk	Low risk	Low risk	High risk (Low quality)	Low risk	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
	(Low quality)	(Low to very low quality)	(Low to very low quality)	((High quality))		((High quality))				
Pre-pregnancy BMI normal weight (referent: adequate GWG)	No association (Low quality)	No association (Low quality)	NR	Low risk (Moderate quality)	No association (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	NR	No association (Low quality)	NR	No association (Moderate quality)	No association (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	No association (Moderate quality)	No association (Low quality)	NR	Low risk (Moderate quality)	No association (Low quality)	NR	NR	NR	NR	NR
Risk factor: Excessive gestational weight gain										
Singleton pregnancy										
Aged <15 years (referent: adequate GWG in 20-34 year olds)	Low risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 15-17 years (referent: adequate GWG in 20-34 year olds)	Low risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 18-19 years (referent: adequate GWG in 20-34 year olds)	Low risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Aged 20-34 years (referent: adequate GWG in 20-34 year olds)	High risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
All pre-pregnancy BMI categories (referent: adequate GWG)	High risk (Moderate to low quality)	Low risk/high risk/no association (Very low quality)	High risk (Moderate quality)	High risk/no association (Low to very low quality)	Low risk/no association (Low to very low quality)	High risk (Very low quality)	NR	High risk (High quality)	High risk (High quality)	High risk (High quality)
Pre-pregnancy BMI underweight (referent: adequate GWG)	High risk (Low quality)	No association (Very low quality)	High risk (High quality)	No association (Low quality)	No association (Very low quality)	High risk/no association (Low to very low quality)	No association (Low quality)	NR	NR	NR
Nulliparous, pre-pregnancy BMI underweight (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI underweight (referent: adequate GWG)	No association (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI normal weight (referent: adequate GWG)	High risk/no association (Low to very low quality)	High risk/no association (Very low quality)	High risk (High quality)	High risk (High quality)	Low risk (Moderate quality)	High risk (Moderate quality)	High risk (Moderate quality)	NR	NR	NR
Nulliparous, pre-pregnancy BMI normal weight (referent: adequate GWG)	High risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI normal weight (referent: adequate GWG)	High risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
Pre-pregnancy BMI overweight (referent: adequate GWG)	High risk/no association (Low to very low quality)	Low risk (Moderate quality)	High risk (High quality)	NR	No association (Low quality)	High risk (Low quality)	High risk (High quality)	NR	NR	NR
Nulliparous, pre-pregnancy BMI overweight (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI overweight (referent: adequate GWG)	High risk (High quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI overweight/obese (referent: adequate GWG)	No association (Moderate quality)	No association (Very low quality)	NR	No association (Low quality)	No association (High quality)	No association (Moderate quality)	NR	NR	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	High risk (Low quality)	No association (Low quality)	No association (Moderate quality)	NR	No association (Low quality)	High risk (Very low quality)	High risk (High quality)	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese I (referent: adequate GWG)	High risk (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
Nulliparous, pre-pregnancy BMI obese I (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese I (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese II (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese II (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese II (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese III (referent: adequate GWG)	High risk (Low quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nulliparous, pre-pregnancy BMI obese III (referent: adequate GWG)	High risk (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Parous, pre-pregnancy BMI obese III (referent: adequate GWG)	No association (Moderate quality)	NR	NR	NR	NR	NR	NR	NR	NR	NR
Twin pregnancy										
All pre-pregnancy BMI categories	High risk	No association	High risk	High risk	No association	High risk	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age	Childhood overweight			
							3 years of age*	2 to 5 years	5 to 10 years	10 to 18 years
(referent: adequate GWG)	(Moderate quality)	(Low quality)	(High quality)	(High quality)	(Moderate quality)	(Moderate quality)				
Pre-pregnancy BMI underweight (referent: adequate GWG)	NR	NR	NR	NR	No association (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI underweight/normal weight (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI normal weight (referent: adequate GWG)	No association (Low quality)	No association (Low quality)	NR	High risk (High quality)	NR	NR	NR	NR	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	No association (Low quality)	Low risk (High quality)	NR	High risk (Moderate quality)	No association (Moderate quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	No association (Low quality)	No association (Low quality)	High risk (High quality)	High risk (Moderate quality)	No association (Low quality)	NR	NR	NR	NR	NR

*referent for the outcome childhood overweight is adequate GWG in pre-pregnancy BMI normal

BMI: body mass index; GWG: gestational weight gain; IOM: Institute of Medicine; NR: not reported

Association between low, medium, high gestational weight change (study defined category) and maternal/neonatal/fetal outcomes in singleton pregnancy: all BMI categories strata

Outcomes / Population	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
Singleton pregnancy					
Risk factor: Low gestational weight gain					
Pre-pregnancy BMI underweight (referent: medium weight gain in pre-pregnancy BMI normal)	No association	Low risk	Low risk	High risk	Low risk

Outcomes / Population	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
	(Low quality)	(Moderate quality)	(High quality)	(High quality)	(High quality)
Pre-pregnancy BMI normal weight (referent: medium weight gain in pre-pregnancy BMI normal)	No association (Moderate quality)	No association (High quality)	No association (High quality)	High risk (High quality)	Low risk (High quality)
Pre-pregnancy BMI overweight (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	High risk (Moderate quality)	No association (High quality)
Pre-pregnancy BMI obese (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	No association (High quality)	High risk (High quality)
Risk factor: Medium gestational weight gain					
Pre-pregnancy BMI underweight (referent: medium weight gain in pre-pregnancy BMI normal)	Low risk (Moderate quality)	Low risk (Moderate quality)	Low risk (High quality)	High risk (High quality)	Low risk (High quality)
Pre-pregnancy BMI overweight (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	Low risk (Moderate quality)	High risk (High quality)
Pre-pregnancy BMI obese (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	Low risk (Moderate quality)	High risk (High quality)
Risk factor: High gestational weight gain					
Pre-pregnancy BMI underweight (referent: medium weight gain in pre-pregnancy BMI normal)	No association (Low quality)	No association (Low quality)	No association (Moderate quality)	Low risk (Moderate quality)	No association (Low quality)
Pre-pregnancy BMI normal weight (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (Moderate quality)	High risk (High quality)	High risk (Moderate quality)	Low risk (High quality)	High risk (High quality)
Pre-pregnancy BMI overweight (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	Low risk (High quality)	High risk (High quality)
Pre-pregnancy BMI obese (referent: medium weight gain in pre-pregnancy BMI normal)	High risk (High quality)	High risk (High quality)	High risk (High quality)	Low risk (High quality)	High risk (High quality)

BMI: body mass index

Association between low (<8 kg) gestational weight gain and high (>16 kg) gestational weight gain (Independent Swedish gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton pregnancy: all BMI categories strata

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
Singleton pregnancy						
Risk factor: Low (<8 kg) gestational weight gain						
Pre-pregnancy BMI <20 (referent: 8 to 16 kg)	No association (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 20-24.9 (referent: 8 to 16 kg)	No association (Moderate quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 25-29.9 (referent: 8 to 16 kg)	Low risk (Moderate quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 30-34.9 (referent: 8 to 16 kg)	Low risk (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI ≥35 (referent: 8 to 16 kg)	Low risk (Low quality)	NR	NR	NR	NR	NR
Risk factor: (>16 kg) gestational weight gain						
Pre-pregnancy BMI <20 (referent: 8 to 16 kg)	High risk (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 20-24.9 (referent: 8 to 16 kg)	High risk (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 25-29.9 (referent: 8 to 16 kg)	High risk (Low quality)	NR	NR	NR	NR	NR
Pre-pregnancy BMI 30-34.9 (referent: 8 to 16 kg)	High risk (Low quality)	NR	NR	NR	NR	NR

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
Pre-pregnancy BMI ≥35 (referent: 8 to 16 kg)	High risk (Low quality)	NR	NR	NR	NR	NR

BMI: body mass index; GWG: gestational weight gain; IOM: Institute of Medicine; NR: not reported

Association between gestational weight change of <0.5 to 6.9 kg, 6.7 to 10 kg, 13.7 to 29 kg and >24.6 to ≥29.1 kg (Swedish gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton pregnancy: all BMI categories strata

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
Singleton pregnancy						
Risk factor: <0.5 to 6.9 kg gestational weight change						
Pre-pregnancy BMI underweight (referent: adequate GWG)	NR	NR	NR	No association (Low quality)	NR	NR
Pre-pregnancy BMI normal (referent: adequate GWG)	NR	NR	NR	Low risk (Moderate quality)	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	NR	NR	NR	Low risk (Moderate quality)	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	NR	NR	NR	Low risk (High quality)	NR	NR
Risk factor: 6.7 to 10 kg gestational weight change						
Pre-pregnancy BMI normal (referent: adequate GWG)	NR	NR	NR	No association (Moderate quality)	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	NR	NR	NR	Low risk (Moderate quality)	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	NR	NR	NR	Low risk	NR	NR

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
				(High quality)		
Risk factor: 13.7 to 29 kg gestational weight change						
Pre-pregnancy BMI underweight (referent: adequate GWG)	NR	NR	NR	No association (Low quality)	NR	NR
Pre-pregnancy BMI normal (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Risk factor: >24.6 to ≥29.1 kg gestational weight change						
Pre-pregnancy BMI underweight (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Pre-pregnancy BMI normal (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Pre-pregnancy BMI overweight (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR
Pre-pregnancy BMI obese (referent: adequate GWG)	NR	NR	NR	High risk (High quality)	NR	NR

BMI: body mass index; GWG: gestational weight gain; NR: not reported

Association between Weight change (thresholds as reported in the studies) and maternal/neonatal/fetal outcomes in singleton pregnancy

Population \ Outcomes	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
Risk factor: >20 kg gestational weight change						
Singleton pregnancy						
All pre-pregnancy BMI categories (referent: ≤20 kg)	NR	NR	NR	High risk (Moderate quality)	NR	NR
Risk factor: <8 kg gestational weight change						
All pre-pregnancy BMI categories (referent: 8 to 15.9 kg)	No association (Moderate quality)	NR	NR	NR	NR	NR
Risk factor: ≥16 kg gestational weight change						
All pre-pregnancy BMI categories (referent: 8 to 15.9 kg)	High risk (High quality)	NR	NR	NR	NR	NR
Risk factor: <10 kg gestational weight change						
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB before labour	No association (Moderate quality)	NR	NR	NR	NR	NR
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB during labour	Low risk (Moderate quality)	NR	NR	NR	NR	NR
Risk factor: 16 to 19 kg gestational weight change						
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB before labour	No association (High quality)	NR	NR	NR	NR	NR
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB during labour	High risk (Moderate quality)	NR	NR	NR	NR	NR
Risk factor: ≥20 kg gestational weight change						
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB before labour	High risk (Moderate quality)	NR	NR	NR	NR	NR

Outcomes / Population	Caesarean birth	Gestational diabetes	Gestational hypertension	Pre-eclampsia	Small for gestational age	Large for gestational age
All pre-pregnancy BMI categories (referent: 10 to 15 kg) CB during labour	High risk (High quality)	NR	NR	NR	NR	NR
Risk factor: weight loss						
All pre-pregnancy BMI categories (referent: no weight loss) CB before labour	Low risk (Moderate quality)	NR	NR	NR	NR	NR

BMI: body mass index; CB: caesarean birth; NR: not reported

Economic evidence

Included studies

No economic studies were identified which were applicable to this review question. See the literature search strategy in appendix B and economic study selection flow chart in appendix G.

Excluded studies

Economic studies not included in this review are listed, and reasons for their exclusion are provided in appendix J.

Economic model

No economic modelling was undertaken for this review because the committee agreed that other topics were higher priorities for economic evaluation.

The committee's discussion and interpretation of the evidence

The outcomes that matter most

The committee agreed to prioritise the maternal outcomes of caesarean birth, hypertensive disorders of pregnancy, and gestational diabetes; fetal outcomes of SGA and LGA; and childhood outcomes of overweight/obesity as critical outcomes, and health related quality of life as an important outcome. These outcomes are in line with a core outcome set defined in the evidence base.

The quality of the evidence

The quality of the evidence was assessed with an adapted GRADE approach and the overall quality of the evidence ranged from very low to high.

The evidence was downgraded due to methodological limitations in studies (for example, issues with study participation or with prognostic factors measurement), indirectness (for example, outcome indirectness such as, including macrosomia for LGA), and imprecision around the effect estimate. Some evidence was downgraded as a result of serious or very serious heterogeneity that was unexplained by sub-group analysis.

Data were identified for all outcomes except health-related quality of life.

Benefits and harms

Overall, the committee thought that the evidence was difficult to interpret because of the different categories used to define gestational weight change and because weight change was reported as total weight gain in pregnancy instead of trimester specific weight gain in the studies reviewed. This made it difficult to give practical advice about appropriate or inappropriate weight change during different stages of pregnancy.

The committee discussed that weight change in pregnancy is a sensitive and complicated issue. They were aware that many people have negative experiences when being weighed, or when weight or BMI is being discussed in clinical settings. For example, they may feel judged if they have a higher pre-pregnancy BMI, they may experience that their other health concerns are attributed to their weight inappropriately or unnecessarily. Things can be particularly complicated if they have a history of eating disorders. Sometimes - discussions around weight may be more difficult if their partner is present. The committee agreed it was important to handle these discussions with care to avoid stigmatising the individual. The committee referred to the recommendations in the NICE guideline on overweight and obesity management about how to discuss weight in a sensitive manner. Offering to measure height and weight and calculating BMI in the first antenatal (booking) appointment is current practice and helps healthcare providers to plan care and assess for risk factors, as is recommended in the NICE guideline on antenatal care. The committee discussed that unless there are clinical reasons, sharing the weight and BMI with the person at the booking appointment is not always necessary, but if it is it should be shared in a sensitive manner or discreetly, for example so that it is not said out loud but written down instead.

The committee noted that most of the evidence identified reported results according to the IOM (now called the National Academy of Medicine, NAM and referred to as such in the recommendations) categories on gestational weight change during pregnancy, which estimates appropriate weight change ranges according to pre-pregnancy BMI groups (underweight, healthy weight, overweight, obesity). The committee also noted that the categories report total gestational weight change during pregnancy rather than trimester specific gestational weight change, which is important as weight change does not occur equally in each trimester. Although NAM provides some trimester specific guidance, this has not been rigorously validated and therefore its relevance to, and safety for, pregnancy outcomes is unclear.

The committee were aware that the IOM/NAM categories were developed by balancing the risk between small for gestational age (SGA) and large for gestational age (LGA), and the risk of caesarean section and postpartum weight retention. However, gestational diabetes and preeclampsia were not considered in the development of the categories. The committee discussed that because of the way it was developed, the IOM/NAM categories should be applied and interpreted with caution. Furthermore, the committee were aware that currently nearly half of pregnancies worldwide have a gestational weight change during pregnancy that is more than the IOM/NAM recommended weight change categories, potentially reducing relevance to the population today. The committee also noticed that currently the IOM/NAM recommended categories for people with a pre-pregnancy BMI in the obesity range are grouped together rather than by different obesity categories (for example, class I, II, or III). However, the committee agreed there are no better alternatives available at the moment. Based on the evidence and their expertise, the committee agreed that the estimates for optimal total weight change during pregnancy remain uncertain and not well defined for all pre-pregnancy BMI groups, but the IOM/NAM recommendations may provide helpful estimates for total appropriate weight gain in pregnancy and referred to these in the recommendations. However, what is particularly uncertain is what the week by week weight change in each trimester should be.

The committee agreed that the evidence does not support weighing everyone throughout pregnancy and this should only be offered when there is a clinical need (for example, if the person has gestational diabetes or need for thromboprophylaxis, or if there are nutrition concerns due to hyperemesis gravidarum). This is further discussed in evidence review G. Because of the uncertainties around optimal weight change in pregnancy, the committee agreed that the focus during pregnancy should instead be on healthy eating and physical activity which have positive associations with health benefits for the mother and the baby.

The committee discussed that not only are there uncertainties about what is healthy weight change in pregnancy, but the normal physiological changes during pregnancy contributing to the weight change, such as weight of the growing fetus, weight of the placenta, increase in maternal blood volume, breast tissue expansion, and volume of amniotic fluid can vary between individuals across all these contributing factors but especially in relation to the weight of the baby.

However, they acknowledged that some people may want to monitor their weight themselves throughout pregnancy. Quantitative evidence was unable to determine the optimal weight change during pregnancy; however, there are estimates of healthy total weight change in a singleton pregnancy according to the pre pregnancy BMI that healthcare professionals can refer to (Table 1 in the National Academy of Medicine's report on the current understanding of gestational weight gain among women with obesity and the need for future research). But these estimates do not account for trimester specific healthy weight change. The committee noted that there are separate estimates for twin pregnancies, although there is even more uncertainty around these estimates. The committee notes that because of the wide ranges in the NAM/IOM estimates and because they estimate total weight change in the whole of pregnancy, they are not particularly helpful in practice.

The committee recognised that some people who want to monitor their weight might not have access to weighing scales but discussed that these should be available in health care settings or community hubs where people can be advised to go. The committee discussed the difficulties and risks of weight management during pregnancy and agreed that pre-conception weight management should be a priority because weight before pregnancy is potentially a modifiable factor. The committee agreed that pre-pregnancy BMI is a bigger risk factor for adverse maternal and fetal outcomes than gestational weight change during pregnancy. However, weight management before pregnancy is outside the remit of this guideline and is covered in the NICE guideline on overweight and obesity management.

Overall, the meta-analysed data and data from the individual participant data meta-analysis suggested that weight change exceeding the IOM/NAM estimated categories was associated with negative maternal and fetal outcomes. Generally, there was moderate to high quality evidence which suggested an association between excessive gestational weight gain and the outcomes caesarean birth, gestational diabetes, gestational hypertension and large for gestational age for pregnant women with a pre-pregnancy BMI within the healthy, overweight, and obesity ranges. The committee noted that although the relative data suggested these associations for risk, there was no absolute data showing that excessive gestational weight gain in a pre-pregnancy BMI of overweight or obesity ranges leads to more negative outcomes than in those with a lower pre-pregnancy BMI. Despite this, the committee agreed that maintaining a healthy pre-pregnancy BMI would lead to the most optimum outcomes for the mother and the baby.

There was high quality evidence from the individual participant data meta-analysis which showed an association for women with a pre-pregnancy BMI in the obesity range and excessive gestational weight gain for the outcomes of caesarean birth, gestational diabetes, pre-eclampsia and large for gestational age. The committee agreed that this overall trend (weight change exceeding the IOM/NAM estimated categories associated with negative maternal and fetal outcomes) resonated with their clinical and research experience, and therefore these should be discussed. Alongside these risks, it is also important to consider individual level factors that might affect development of these outcomes, for example, comorbidities, family history and obstetric history. The committee noted that there was evidence from 1 study (Enomoto 2016) conducted in Japan where those with pre-pregnancy BMI in the obesity range and who gained excessive gestational weight, showed no association for caesarean birth, gestational diabetes, and gestational hypertension. The committee discussed that because these results were of low quality and were based on Japanese women, they were less applicable to the majority of the population in England and Wales.

Moderate to high quality evidence from the meta-analysis from this review and data from the individual participant data meta-analysis included in this review suggested that weight change exceeding the IOM/NAM estimated categories in people with a healthy pre-pregnancy BMI was associated with gestational diabetes, gestational hypertension, preeclampsia, and baby being large for gestational age. Data from the individual participant data meta-analysis suggested there was a lower risk of small for gestational age babies with excessive gestational weight gain for all pre-pregnancy BMI ranges, when compared to normal gestational weight gain in those with a healthy pre-pregnancy BMI. The committee discussed that pregnant people with a healthy pre-pregnancy BMI who rapidly gain weight during pregnancy is a population that is largely missed and therefore adverse outcomes are likely to be more problematic in this population than in people with a higher pre-pregnancy BMI with excessive gestational weight change in pregnancy, who may be under closer observation. The committee were aware from their knowledge that there is not as much guidance on pregnant people with a healthy pre-pregnancy BMI as it is assumed that this population is at a lower risk of negative maternal and fetal outcomes.

Overall, the committee concluded from the evidence that those with pre-pregnancy BMI in the healthy, overweight and obesity ranges who gain excessive weight during pregnancy are at an increased risk of some obstetric complications, including developing gestational hypertension or gestational diabetes, baby being large for gestational age, or needing a caesarean section. The committee noted that large for gestational age is frequently an indicator for caesarean birth, and therefore this outcome is not independent of caesarean birth.

The committee acknowledged that because the evidence does not justify routine weight monitoring in pregnancy, excess weight gain is also not routinely identified. They agreed that if there are concerns about excessive gestational weight gain during pregnancy raised by the pregnant person, or by a healthcare professional as part of weight monitoring for a clinical reason, this should be explored further, and information about healthy eating and physical activity should be discussed. The committee agreed that there may be various underlying reasons for excessive weight gain during pregnancy, and a holistic exploration of the person's wellbeing is important. Based on the evidence of excessive weight gain being associated with baby being born large for gestational age and with gestational diabetes, the committee recommended that the baby should be monitored for large for gestational age and a test for gestational diabetes should be considered. It should be noted that those with a BMI of 30 or more at the booking appointment should already be offered an oral glucose tolerance test according to the NICE guideline on diabetes in pregnancy, but the committee agreed a referral to the test should be considered regardless of the pre-pregnancy BMI if there are concerns about excessive gestational weight gain.

In terms of too low weight gain during pregnancy, there was high quality evidence from the individual participant data meta-analysis, which showed an increased risk of baby being small for gestational age in those with pre-pregnancy BMI in the underweight and healthy ranges who had low or inadequate weight gain during pregnancy. Moderate quality evidence from other meta-analysed studies also showed an association between inadequate weight gain and baby being small for gestational age among those with pre-pregnancy BMI in the underweight range. Low quality evidence across all pre-pregnancy BMI ranges also showed an association with inadequate weight gain and baby being small for gestational age.

There was low to moderate quality evidence from the individual participant data meta-analysis among those with a pre-pregnancy BMI in the underweight or healthy weight ranges and low gestational weight gain that showed no association of risk for gestational diabetes, however, low to moderate quality evidence from other meta-analysed studies suggested that weight change below the IOM/NAM estimated categories in those with a pre-pregnancy BMI in the underweight or healthy weight ranges was associated with a high risk of gestational diabetes. The committee discussed that this association might be due to participants in this study being diagnosed with gestational diabetes during their second trimester of pregnancy, therefore receiving dietary and exercise advice to control their gestational weight change during the third trimester. It is likely that this would have strongly contributed to the overall gestational weight change as most weight change occurs over this period. The committee noted that the studies reported weight change as the difference between weight prior to birth and pre-pregnancy body weight, and therefore there is uncertainty around how much weight changed by trimester and the causal relationship between low gestational weight change and gestational diabetes.

From their collective experience, the committee agreed that there may be various reasons for low weight gain during pregnancy, for example, nausea and vomiting in pregnancy, mental health issues, or clinical interventions that have been recommended for the person, for example, after a diagnosis of gestational diabetes.

As with excessive gestational weight gain, the committee acknowledged that because the evidence does not justify routine weight monitoring in pregnancy, low weight gain is also not routinely identified. The committee agreed that when there are concerns about low weight gain during pregnancy raised by the pregnant person, or by a healthcare professional as part of weight monitoring for a clinical reason, this should be further explored through individualised discussions about healthy eating and physical activity in pregnancy because advice required for those with low gestational weight gain will likely be different to advice needed for those with excessive gestational weight gain. The committee also agreed that routine monitoring of the growth of the baby (according to the NICE guideline on antenatal care) to check for small for gestational age should be ensured when there are concerns about low weight gain during pregnancy. The committee discussed that for some people, a lifestyle change of healthier eating and increasing physical activity might lead to weight loss. The committee considered it was important to discuss the potential impact of overly restrictive eating and drinking habits.

Overall, the results suggest that gestational weight gain exceeding the IOM/NAM estimated categories is associated with an increased risk of overweight and obesity in childhood. There was high quality evidence from individual participant data meta-analysis for all pre-pregnancy BMI categories and excessive gestational weight gain that showed a high risk of childhood overweight or obesity at 2 to 18 years of age, and with low gestational weight gain showed a low risk of childhood overweight or obesity at 2 to 10 years, and no association at 10 to 18 years. High and moderate quality evidence from 1 study from Japan supported these findings and also found that people within the obesity pre-pregnancy BMI range with low gestational weight gain also had a high risk for childhood overweight or obesity at 3 years. The committee discussed that gestational weight gain is not only associated with maternal outcomes but is also associated with childhood outcomes. The committee agreed that pre-pregnancy BMI is an important modifiable risk factor of childhood weight status, which is currently a significant public health concern. To support people with weight management, the committee referred to the NICE guideline on overweight and obesity management. The committee concluded that supporting healthy eating and drinking, physical activity and weight management in pregnancy can have positive outcomes for the pregnancy and birth but also later on for the child.

Although there was some moderate quality evidence suggesting an association of low risk for weight loss in pre-pregnancy BMI obesity class I and obesity class II for caesarean birth, the committee discussed that they did not want to recommend weight loss during pregnancy, especially in the first trimester, because it was unclear from the evidence whether the weight loss was intentional or unintentional and there was no evidence of benefit or harm identified for other maternal, neonatal, or fetal outcomes. The committee agreed that people may sometimes lose weight during pregnancy unintentionally, for example, if they change their eating or physical activity patterns. However, the committee agreed that intentional weight loss during pregnancy should be advised against because of potential adverse effects for the unborn baby.

The committee noted that most of the evidence included in this review was based on Caucasian populations and there was not enough evidence to stratify according to ethnicity, so the committee agreed there was insufficient evidence to make recommendations for different ethnic groups. Additionally, the evidence stratified participants using the standard BMI classification, which is known to not be appropriate for all populations. NHS and NICE recommend different BMI thresholds for people from South Asian, Chinese, other Asian, Middle Eastern, Black African or African–Caribbean background because their cardiometabolic risk occurs at a lower BMI level.

The committee discussed the limited evidence on twin pregnancies and acknowledged that there are provisional IOM/NAM estimated weight change recommendations for this population. The committee discussed that gestational weight change in twin pregnancies is largely due to the weight of the fetuses. However, the committee were aware from their knowledge that these recommendations have very little evidence base and are seldom used, and therefore, they agreed not to make recommendations on this population.

Cost effectiveness and resource use

Providing personalised advice during routine antenatal appointments to people who are interested in monitoring their weight change during pregnancy, or if there are concerns about low or excessive weight gain during pregnancy may have important resource implications, comprising health professionals' additional time spent to offer this advice; the committee also expressed the view that time pressures may become a barrier to implementation. Offering to measure the person's height and weight and calculate BMI at the first face-to-face antenatal appointment may also have some resource implications regarding health professionals' time, in settings where this is not current practice, although it reflects current advice (existing NICE recommendation). Discussing the option for referral to a specialist obesity service or a specialist practitioner for anyone with a BMI of over 40 at the booking appointment may also have important resource implications. However, the benefits and cost-savings resulting from the above recommendations are expected to offset, at least partially, the costs of implementing them, by reducing the risk of conditions such as gestational diabetes, pregnancy-related hypertension and preeclampsia for the pregnant person, as well as baby being small or large for gestational age, which have negative implications for the health of pregnant people and their babies and, in turn, increase antenatal and postnatal care costs. Considering a test for gestational diabetes following concerns about excessive weight gain during pregnancy, as well as ensuring routine monitoring of the baby to check if they are potentially small or large for their gestational age if there are concerns about low or excess weight gain during pregnancy, respectively, may also have important resource implications, comprising mainly the ultrasound evaluation of the baby's size. However, these are likely to be offset, at least partially, by prevention or more timely management of negative outcomes for the pregnant person (such as gestational diabetes) and the baby (such as being small or large for gestational age) further down the care pathway. Offering testing for gestational diabetes to anyone with a BMI of over 30 at the booking appointment is in line with current clinical recommendations and therefore should not lead to a change in practice and resource implications.

Other factors the committee took into account

For this review question, the population in the evidence was women and no evidence was identified or reviewed for trans men or non-binary people. The protocol and literature searches were not designed to specifically look for evidence on trans men or non-binary people but they were also not excluded. However, there is a small chance evidence on them may not have been captured, if such evidence exists. In discussing the evidence, the committee considered whether the recommendations could apply to a broader population, and used gender inclusive language to promote equity, respect and effective communication with everyone. Healthcare professionals should use their clinical judgement when implementing the recommendations, taking into account each person's circumstances, needs and preferences, and ensuring all people are treated with dignity and respect throughout their care.

Recommendations supported by this evidence review

This evidence review supports recommendations 1.2.6 to 1.2.8, 1.2.11 and 1.2.14 to 1.2.17. Other evidence supporting some of these recommendations can be found in the evidence review G on interventions for helping to achieve healthy and appropriate weight change during pregnancy.

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Whitaker, K.M., Ryan, R., Becker, C. et al. (2022) Gestational Weight Gain in Twin Pregnancies and Maternal and Child Health: An Updated Systematic Review. Journal of Women's Health 31(3): 362-381

Yee 2013

Yee, L.M., Cheng, Y.W., Inturrisi, M. et al. (2013) Gestational weight loss and perinatal outcomes in overweight and obese women subsequent to diagnosis of gestational diabetes mellitus. Obesity 21(12): e770-e774

Other

IOM 2009

Institute of Medicine (IOM). Weight gain during pregnancy: reexamining the guidelines. Washington, DC: National Academies Press; 2009

Wang 2021

Wang H, Chen Y, Lin Y, Abesig J, Wu I X, Tam W et al. The methodological quality of individual participant data meta-analysis on intervention effects: systematic review BMJ 2021; 373

Appendices

Appendix A Review protocols

Review protocol for review question: What gestational weight change is healthy and appropriate during pregnancy?

Table 3: Review protocol

ID	Field	Content
	PROSPERO registration number	CRD42022366188
	Review title	Healthy and appropriate weight change during pregnancy
	Review question	What gestational weight change is healthy and appropriate during pregnancy?
	Objective	To determine what gestational weight change is healthy and appropriate during pregnancy.
	Searches	The following databases will be searched: • Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE • Epistemonikos • CINAHL • CRD HTA • International Health Technology Assessment database Searches will be restricted by: • Date: 1970 (rationale: after 1970 there was an increase in the prevalence of obesity and substantial lifestyle and socio-economic changes) • English language only

ID	Field	Content
		• Human studies only The full search strategies for MEDLINE database will be published in the final review. For each search, the principal database search strategy is quality assured by a second information scientist using an adaptation of the PRESS 2015 Guideline Evidence-Based Checklist. Key papers • Voerman E, Santos S, Patro Golab B, Amiano P, Ballester F, Barros H, Bergström A, Charles MA, Chatzi L, Chevrier C, Chrousos GP. Maternal body mass index, gestational weight gain, and the risk of overweight and obesity across childhood: An individual participant data meta-analysis. PloS medicine. 2019 Feb 11;16(2):e1002744.
	Condition or domain being studied	Gestational weight change during pregnancy
	Population	**Inclusion:** • Women during a single or multiple pregnancy **Exclusion:** • Pregnant women with pre-existing diabetes • Women with polycystic ovarian syndrome
	Risk factor	Gestational weight change, as defined by the study. For example, gestational weight change from the first booking to the third trimester/birth or at different time points such as 1st, 2nd or 3rd trimester. Studies including self-reported weight will be considered for inclusion, but if weight from both self-reported and clinical records is included, priority will be given to the latter.
	Comparator	Gestational weight at a different time point Note: if gestational weight change is not reported by the study, it will be calculated using gestational weight at a different time point
	Types of study to be included	Include published full-text papers: • Observational studies:

ID	Field	Content
		○ Individual patient data (IPD) meta-analysis of observational studies ○ Systematic reviews of observational studies ○ Prospective cohort studies ○ Retrospective cohort studies ○ Historically controlled studies Observational studies will only be included if they adjust for cofounding factors in their analysis. Conference abstracts will not be included because these do not typically have sufficient information to allow full critical appraisal.
	Other exclusion criteria	Setting: • Countries other than high income countries (as defined by the OECD) *If any study or systematic review includes <1/3 of women who received care in the above setting, it will be considered for inclusion but, if included, the evidence will be downgraded for indirectness* Studies: • Studies where multivariate regression analysis was not conducted will be excluded.
	Context	The population of this guideline may overlap with the population of women included in other NICE guidelines (such as postnatal care, antenatal care, intrapartum care, pregnancy and complex social factors or obesity prevention).
	Primary outcomes (critical outcomes)	• **Maternal outcomes** ○ Caesarean birth ○ Hypertensive disorders of pregnancy (preeclampsia and gestational hypertension) ○ Gestational diabetes • **Fetal/neonatal outcomes:** ○ SGA <10^{th} centile ○ LGA >90^{th} centile

ID	Field	Content
		• **Childhood outcomes (after 2 years)** ○ Overweight/obesity
	Secondary outcomes (important outcomes)	• **Maternal outcomes:** ○ Health related quality of life as measured by a validated tool, for example HRQoL.
	Data extraction (selection and coding)	All references identified by the searches and from other sources will be uploaded into EPPI and de-duplicated. Titles and abstracts of the retrieved citations will be screened to identify studies that potentially meet the inclusion criteria outlined in the review protocol. Duplicate screening will not be undertaken for this question. Full versions of the selected studies will be obtained for assessment. Studies that fail to meet the inclusion criteria once the full version has been checked will be excluded at this stage. Each study excluded after checking the full version will be listed, along with the reason for its exclusion. A standardised form will be used to extract data from studies. The following data will be extracted: study details (reference, country where study was carried out, type and dates), participant characteristics, inclusion and exclusion criteria, details of the interventions if relevant, setting and follow-up, relevant outcome data and source of funding. One reviewer will extract relevant data into a standardised form, and this will be quality assessed by a senior reviewer.
	Risk of bias (quality) assessment	Quality assessment of individual studies will be performed using the following checklists: • ROBIS tool for systematic reviews • Wang et al checklist for assessing the methodological quality of IPD meta-analysis https://www.bmj.com/content/bmj/373/bmj.n736.full.pdf • Cochrane ROBINS-I tool for non-randomised (clinical) controlled trials and cohort studies* ***Protocol amendment: the protocol stated that the Cochrane ROBINS-I checklist should be used to assess the quality of the evidence, however, in line with the type of studies included in the evidence review, the Quality in Prognostic studies (QUIPS) tool was used.**

ID	Field	Content
		The quality assessment will be performed by one reviewer and this will be quality assessed by a senior reviewer.
	Strategy for data synthesis	Quantitative findings will be formally summarised in the review. Where multiple studies report on the same outcome for the same comparison, meta-analyses will be conducted using Cochrane Review Manager software. A fixed effect meta-analysis will be conducted and data will be presented as risk ratios if possible or odds ratios when required (for example, if only available in this form in included studies) for dichotomous outcomes, and mean differences or standardised mean differences for continuous outcomes. Heterogeneity in the effect estimates of the individual studies will be assessed using the I^2 statistic. Alongside visual inspection of the point estimates and confidence intervals, I^2 values of greater than 50% and 80% will be considered as significant and very significant heterogeneity, respectively. Heterogeneity will be explored as appropriate using sensitivity analyses and pre-specified subgroup analyses. If heterogeneity cannot be explained through subgroup analysis then a random effects model will be used for meta-analysis, or the data will not be pooled. The confidence in the findings across all available evidence will be evaluated for each outcome using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group: http://www.gradeworkinggroup.org/ **Minimally important differences:** • Caesarean birth, hypertensive disorders of pregnancy, gestational diabetes, SGA, LGA: statistical significance • Validated scales/continuous outcomes: published MIDs where available All other outcomes & where published MIDs are not available: 0.8 and 1.25 for all relative dichotomous outcomes ; +/- 0.5x control group SD for continuous outcomes
	Analysis of subgroups	Evidence will be stratified by: • BMI thresholds on booking: o Underweight range: <18.5 kg/m^2 o Healthy weight range: 18.5 to 24.9 kg/m^2

ID	Field	Content
		○ Overweight range: 25 to 29.99 kg/m² ○ Obesity range 1: 30 to 34.99 kg/m² ○ Obesity range 2: 35 to 39.99 kg/m² ○ Obesity range 3 : >40 kg/m² Follow the [NICE guidance on Obesity: identification and classification of overweight and obesity (update)] for people with a South Asian, Chinese, other Asian, Middle Eastern, Black African or African-Caribbean family background • Ethnicity ○ White/ White British ○ Asian/Asian British ○ Black/African/Caribbean/Black British ○ Mixed/Multiple ethnic group ○ Other ethnic group • Singleton versus multiple pregnancy • Women who had bariatric surgery versus not • Parity (nulliparous versus primiparous/multiparous) Evidence will be sub-grouped by the following only in the event that there is significant heterogeneity in outcomes: • Deprived socioeconomic group • Geographical variation e.g. places without adequate provision of primary care (outside cities). • Religion and cultural considerations Where evidence is stratified or sub-grouped the committee will consider on a case by case basis if separate recommendations should be made for distinct groups. Separate recommendations may be made where there is evidence of a differential effect of

<table>
<tr><th>ID</th><th>Field</th><th>Content</th></tr>
<tr><td></td><td></td><td>interventions in distinct groups. If there is a lack of evidence in one group, the committee will consider, based on their experience, whether it is reasonable to extrapolate and assume the interventions will have similar effects in that group compared with others.</td></tr>
<tr><td></td><td>Type and method of review</td><td>☐ Intervention
☐ Diagnostic
☒ Prognostic
☐ Qualitative
☐ Epidemiologic
☐ Service Delivery
☐ Other (please specify)</td></tr>
<tr><td></td><td>Language</td><td>English</td></tr>
<tr><td></td><td>Country</td><td>England</td></tr>
<tr><td></td><td>Anticipated or actual start date</td><td>29/02/2022</td></tr>
<tr><td></td><td>Anticipated completion date</td><td>22/11/2023</td></tr>
<tr><td></td><td>Stage of review at time of this submission</td><td><table>
<tr><td>Review stage</td><td>Started</td><td>Completed</td></tr>
<tr><td>Preliminary searches</td><td>☐</td><td>☒</td></tr>
<tr><td>Piloting of the study selection process</td><td>☐</td><td>☒</td></tr>
<tr><td>Formal screening of search results against eligibility criteria</td><td>☐</td><td>☒</td></tr>
<tr><td>Data extraction</td><td>☐</td><td>☒</td></tr>
</table></td></tr>
</table>

ID	Field	Content
		<table><tr><td>Risk of bias (quality) assessment</td><td>☐</td><td>☒</td></tr><tr><td>Data analysis</td><td>☐</td><td>☒</td></tr></table>
	Named contact	5a. Named contact National Guideline Alliance 5b. Named contact e-mail mandcnutrition@nice.org.uk 5c. Organisational affiliation of the review National Institute for Health and Care Excellence (NICE)
	Review team members	From the National Institute for Health and Care Excellence (NICE): Senior Systematic Reviewer Systematic Reviewer
	Funding sources/sponsor	This systematic review is being completed by the National Guideline Alliance which receives funding from NICE.
	Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.
	Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline

ID	Field	Content
		committee are available on the NICE website: https://www.nice.org.uk/guidance/indevelopment/gid-ng10191
	Other registration details	None
	URL for published protocol	https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=366188
	Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: notifying registered stakeholders of publication publicising the guideline through NICE's newsletter and alerts issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.
	Keywords	Healthy gestation weight, Body Mass Index (BMI), pregnancy, weight change
	Details of existing review of same topic by same authors	Not applicable
	Current review status	☐ Ongoing ☐ Completed but not published ☒ Completed and published ☐ Completed, published and being updated ☐ Discontinued
	Additional information	None
	Details of final publication	www.nice.org.uk

BMI: body mass index; CDSR: Cochrane Database of Systematic Reviews; CENTRAL: Cochrane Central Register of Controlled Trials; CINAHL: Cumulative Index to Nursing & Allied Health; CRD: Centre for Reviews and Dissemination; DARE: Database of Abstracts of Reviews of Effects; OECD: Organisation for Economic Co-operation and Development; GRADE: Grading of Recommendations Assessment, Development and Evaluation; HRQoL: Health Related Quality of Life; HTA: Health Technology Assessment; IPD: individual patient data; LGA: large for gestational age; MID: minimally important difference; NGA: National Guideline Alliance; NHS: National health service; NICE: National Institute for Health and Care Excellence; PRESS: Peer Review of Electronic Search Strategies; QUIPS: Quality in Prognostic Studies; RCT: randomised controlled trial; RoB: risk of bias; ROBINS-I: Risk Of Bias In Non-randomised Studies – of Interventions; ROBIS: Risk of Bias in Systematic Reviews; SD: standard deviation; SGA: small for gestational age

Appendix B Literature search strategies

Literature search strategies for review question: What gestational weight change is healthy and appropriate during pregnancy?

Clinical evidence searches

Database: Medline

Date of last search: 17/10/2022

#	Searches
1	exp Pregnancy/ or Pregnant Women/ or Prenatal Care/
2	body weight changes/ or weight gain/ or weight loss/ or body mass index/ or obesity/
3	waist circumference/ or waist-hip ratio/ or Waist-Height Ratio/
4	2 or 3
5	1 and 4
6	((pregnan* or gestation*) adj2 (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference* or (waist adj2 hip ratio*) or (waist adj2 height ratio*) or (weight adj2 height ratio*))).ti,ab.
7	((pregnan* or gestation*) adj2 weight* adj3 (gain* or increas* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)).ti,ab.
8	Gestational Weight Gain/ or obesity, maternal/ or GWG.ti,ab.
9	or/5-8
10	risk factors/ or Risk Assessment/
11	(risk* adj2 (factor* or assess* or stratif* or increas* or decreas*)).ti,ab.
12	or/10-11
13	9 and 12
14	animals/ not humans/
15	exp Animals, Laboratory/
16	exp Animal Experimentation/
17	exp Models, Animal/
18	exp Rodentia/
19	(rat or rats or rodent* or mouse or mice).ti.
20	or/14-19
21	13 not 20
22	limit 21 to English language
23	predict.ti.
24	(validat* or rule*).ti,ab.
25	(predict* and (outcome* or risk* or model*)).ti,ab.
26	((history or variable* or criteria or scor* or characteristic* or finding* or factor*) and (predict* or model* or decision* or identif* or prognos*)).ti,ab.
27	decision*.ti,ab. and Logistic models/
28	(decision* and (model* or clinical*)).ti,ab.
29	(prognostic and (history or variable* or criteria or scor* or characteristic* or finding* or factor* or model*)).ti,ab.
30	(stratification or discrimination or discriminate or c statistic or "area under the curve" or AUC or calibration or indices or algorithm or multivariable).ti,ab.
31	ROC curve/
32	or/23-31
33	Observational Studies as Topic/
34	Observational Study/
35	Epidemiologic Studies/
36	exp Case-Control Studies/
37	exp Cohort Studies/

#	Searches
38	Cross-Sectional Studies/
39	Controlled Before-After Studies/
40	Historically Controlled Study/
41	Interrupted Time Series Analysis/
42	Comparative Study.pt.
43	case control$.tw.
44	case series.tw.
45	(cohort adj (study or studies)).tw.
46	cohort analy$.tw.
47	(follow up adj (study or studies)).tw.
48	(observational adj (study or studies)).tw.
49	longitudinal.tw.
50	prospective.tw.
51	retrospective.tw.
52	cross sectional.tw.
53	or/33-52
54	22 and (32 or 53)
55	afghanistan/ or africa/ or africa, northern/ or africa, central/ or africa, eastern/ or "africa south of the sahara"/ or africa, southern/ or africa, western/ or albania/ or algeria/ or andorra/ or angola/ or "antigua and barbuda"/ or argentina/ or armenia/ or azerbaijan/ or bahamas/ or bahrain/ or bangladesh/ or barbados/ or belize/ or benin/ or bhutan/ or bolivia/ or borneo/ or "bosnia and herzegovina"/ or botswana/ or brazil/ or brunei/ or bulgaria/ or burkina faso/ or burundi/ or cabo verde/ or cambodia/ or cameroon/ or central african republic/ or chad/ or exp china/ or comoros/ or congo/ or cote d'ivoire/ or croatia/ or cuba/ or "democratic republic of the congo"/ or cyprus/ or djibouti/ or dominica/ or dominican republic/ or ecuador/ or egypt/ or el salvador/ or equatorial guinea/ or eritrea/ or eswatini/ or ethiopia/ or fiji/ or gabon/ or gambia/ or "georgia (republic)"/ or ghana/ or grenada/ or guatemala/ or guinea/ or guinea-bissau/ or guyana/ or haiti/ or honduras/ or independent state of samoa/ or exp india/ or indian ocean islands/ or indochina/ or indonesia/ or iran/ or iraq/ or jamaica/ or jordan/ or kazakhstan/ or kenya/ or kosovo/ or kuwait/ or kyrgyzstan/ or laos/ or lebanon/ or liechtenstein/ or lesotho/ or liberia/ or libya/ or madagascar/ or malaysia/ or malawi/ or mali/ or malta/ or mauritania/ or mauritius/ or mekong valley/ or melanesia/ or micronesia/ or monaco/ or mongolia/ or montenegro/ or morocco/ or mozambique/ or myanmar/ or namibia/ or nepal/ or nicaragua/ or niger/ or nigeria/ or oman/ or pakistan/ or palau/ or exp panama/ or papua new guinea/ or paraguay/ or peru/ or philippines/ or qatar/ or "republic of belarus"/ or "republic of north macedonia"/ or romania/ or exp russia/ or rwanda/ or "saint kitts and nevis"/ or saint lucia/ or "saint vincent and the grenadines"/ or "sao tome and principe"/ or saudi arabia/ or serbia/ or sierra leone/ or senegal/ or seychelles/ or singapore/ or somalia/ or south africa/ or south sudan/ or sri lanka/ or sudan/ or suriname/ or syria/ or taiwan/ or tajikistan/ or tanzania/ or thailand/ or timor-leste/ or togo/ or tonga/ or "trinidad and tobago"/ or tunisia/ or turkmenistan/ or uganda/ or ukraine/ or united arab emirates/ or uruguay/ or uzbekistan/ or vanuatu/ or venezuela/ or vietnam/ or west indies/ or yemen/ or zambia/ or zimbabwe/
56	"organisation for economic co-operation and development"/
57	australasia/ or exp australia/ or austria/ or baltic states/ or belgium/ or exp canada/ or chile/ or colombia/ or costa rica/ or czech republic/ or exp denmark/ or estonia/ or europe/ or finland/ or exp france/ or exp germany/ or greece/ or hungary/ or iceland/ or ireland/ or israel/ or exp italy/ or exp japan/ or korea/ or latvia/ or lithuania/ or luxembourg/ or mexico/ or netherlands/ or new zealand/ or north america/ or exp norway/ or poland/ or portugal/ or exp "republic of korea"/ or "scandinavian and nordic countries"/ or slovakia/ or slovenia/ or spain/ or sweden/ or switzerland/ or turkey/ or exp united kingdom/ or exp united states/
58	european union/
59	developed countries/
60	or/56-59
61	55 not 60
62	54 not 61
63	limit 62 to ed=19700101-20221031
64	limit 62 to dt=19700101-20221031
65	63 or 64

Database: Embase

Date of last search: 17/10/2022

#	Searches
1	exp pregnancy/ or pregnant woman/ or prenatal care/ or prenatal period/

#	Searches
2	exp *body weight change/ or *obesity/ or *body mass/
3	*waist circumference/ or *waist-hip ratio/ or *Waist-Height Ratio/
4	2 or 3
5	1 and 4
6	((pregnan* or gestation*) adj2 (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference* or (waist adj2 hip ratio*) or (waist adj2 height ratio*) or (weight adj2 height ratio*))).ti,ab.
7	((pregnan* or gestation*) adj2 weight* adj3 (gain* or increas* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)).ti,ab.
8	*gestational weight gain/ or *maternal obesity/ or GWG.ti,ab.
9	or/5-8
10	*risk factor/ or *risk assessment/
11	(risk* adj2 (factor* or assess* or stratif* or increas* or decreas*)).ti,ab.
12	or/10-11
13	9 and 12
14	animal/ not human/
15	nonhuman/
16	exp Animal Experiment/
17	exp Experimental Animal/
18	animal model/
19	exp Rodent/
20	(rat or rats or rodent* or mouse or mice).ti.
21	or/14-20
22	13 not 21
23	limit 22 to English language
24	(conference abstract* or conference review or conference paper or conference proceeding).db,pt,su.
25	23 not 24
26	predict.ti.
27	(validat* or rule*).ti,ab.
28	(predict* and (outcome* or risk* or model*)).ti,ab.
29	((history or variable* or criteria or scor* or characteristic* or finding* or factor*) and (predict* or model* or decision* or identif* or prognos*)).ti,ab.
30	decision*.ti,ab. and Statistical model/
31	(decision* and (model* or clinical*)).ti,ab.
32	(prognostic and (history or variable* or criteria or scor* or characteristic* or finding* or factor* or model*)).ti,ab.
33	(stratification or discrimination or discriminate or c statistic or "area under the curve" or AUC or calibration or indices or algorithm or multivariable).ti,ab.
34	Receiver operating characteristic/
35	or/26-34
36	Clinical study/
37	Case control study/
38	Family study/
39	Longitudinal study/
40	Retrospective study/
41	comparative study/
42	Prospective study/
43	Randomized controlled trials/
44	42 not 43
45	Cohort analysis/
46	cohort analy$.tw.
47	(Cohort adj (study or studies)).tw.
48	(Case control$ adj (study or studies)).tw.

#	Searches
49	(follow up adj (study or studies)).tw.
50	(observational adj (study or studies)).tw.
51	(epidemiologic$ adj (study or studies)).tw.
52	(cross sectional adj (study or studies)).tw.
53	case series.tw.
54	prospective.tw.
55	retrospective.tw.
56	or/36-41,44-55
57	25 and (35 or 56)
58	afghanistan/ or africa/ or "africa south of the sahara"/ or albania/ or algeria/ or andorra/ or angola/ or argentina/ or "antigua and barbuda"/ or armenia/ or exp azerbaijan/ or bahamas/ or bahrain/ or bangladesh/ or barbados/ or belarus/ or belize/ or benin/ or bhutan/ or bolivia/ or borneo/ or exp "bosnia and herzegovina"/ or botswana/ or exp brazil/ or brunei darussalam/ or bulgaria/ or burkina faso/ or burundi/ or cambodia/ or cameroon/ or cape verde/ or central africa/ or central african republic/ or chad/ or exp china/ or comoros/ or congo/ or cook islands/ or cote d'ivoire/ or croatia/ or cuba/ or cyprus/ or democratic republic congo/ or djibouti/ or dominica/ or dominican republic/ or ecuador/ or el salvador/ or egypt/ or equatorial guinea/ or eritrea/ or eswatini/ or ethiopia/ or exp "federated states of micronesia"/ or fiji/ or gabon/ or gambia/ or exp "georgia (republic)"/ or ghana/ or grenada/ or guatemala/ or guinea/ or guinea-bissau/ or guyana/ or haiti/ or honduras/ or exp india/ or exp indonesia/ or iran/ or exp iraq/ or jamaica/ or jordan/ or kazakhstan/ or kenya/ or kiribati/ or kosovo/ or kuwait/ or kyrgyzstan/ or laos/ or lebanon/ or liechtenstein/ or lesotho/ or liberia/ or libyan arab jamahiriya/ or madagascar/ or malawi/ or exp malaysia/ or maldives/ or mali/ or malta/ or mauritania/ or mauritius/ or melanesia/ or moldova/ or monaco/ or mongolia/ or "montenegro (republic)"/ or morocco/ or mozambique/ or myanmar/ or namibia/ or nauru/ or nepal/ or nicaragua/ or niger/ or nigeria/ or niue/ or north africa/ or oman/ or exp pakistan/ or palau/ or palestine/ or panama/ or papua new guinea/ or paraguay/ or peru/ or philippines/ or polynesia/ or qatar/ or "republic of north macedonia"/ or romania/ or exp russian federation/ or rwanda/ or sahel/ or "saint kitts and nevis"/ or "saint lucia"/ or "saint vincent and the grenadines"/ or saudi arabia/ or senegal/ or exp serbia/ or seychelles/ or sierra leone/ or singapore/ or "sao tome and principe"/ or solomon islands/ or exp somalia/ or south africa/ or south asia/ or south sudan/ or exp southeast asia/ or sri lanka/ or sudan/ or suriname/ or syrian arab republic/ or taiwan/ or tajikistan/ or tanzania/ or thailand/ or timor-leste/ or togo/ or tonga/ or "trinidad and tobago"/ or tunisia/ or turkmenistan/ or tuvalu/ or uganda/ or exp ukraine/ or exp united arab emirates/ or uruguay/ or exp uzbekistan/ or vanuatu/ or venezuela/ or viet nam/ or western sahara/ or yemen/ or zambia/ or zimbabwe/
59	exp "organisation for economic co-operation and development"/
60	exp australia/ or "australia and new zealand"/ or austria/ or baltic states/ or exp belgium/ or exp canada/ or chile/ or colombia/ or costa rica/ or czech republic/ or denmark/ or estonia/ or europe/ or exp finland/ or exp france/ or exp germany/ or greece/ or hungary/ or iceland/ or ireland/ or israel/ or exp italy/ or japan/ or korea/ or latvia/ or lithuania/ or luxembourg/ or exp mexico/ or netherlands/ or new zealand/ or north america/ or exp norway/ or poland/ or exp portugal/ or scandinavia/ or sweden/ or slovakia/ or slovenia/ or south korea/ or exp spain/ or switzerland/ or "Turkey (republic)"/ or exp united kingdom/ or exp united states/ or western europe/
61	european union/
62	developed country/
63	or/59-62
64	58 not 63
65	57 not 64
66	limit 65 to dc=19700101-20221031

Database: Cochrane Database of Systematic Reviews Issue 10 of 12, October 2022 and Cochrane Central Register of Controlled Trials Issue 10 of 12, October 2022

Date of last search: 17/10/2022

#	Searches
#1	MeSH descriptor: [Pregnancy] explode all trees
#2	MeSH descriptor: [Pregnant Women] this term only
#3	MeSH descriptor: [Prenatal Care] this term only
#4	{OR #1-#3}
#5	MeSH descriptor: [Body Weight Changes] this term only
#6	MeSH descriptor: [Weight Gain] this term only
#7	MeSH descriptor: [Weight Loss] this term only
#8	MeSH descriptor: [Body Mass Index] this term only
#9	MeSH descriptor: [Obesity] this term only
#10	MeSH descriptor: [Waist Circumference] this term only

#	Searches
#11	MeSH descriptor: [Waist-Hip Ratio] this term only
#12	MeSH descriptor: [Waist-Height Ratio] this term only
#13	{OR #5-#12}
#14	#4 AND #13
#15	((pregnan* or gestation*) NEAR/2 (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference* or (waist adj2 hip ratio*) or (waist adj2 height ratio*) or (weight adj2 height ratio*))):ti,ab
#16	((pregnan* or gestation*) NEAR/2 weight* NEAR/3 (gain* or increas* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)):ti,ab
#17	MeSH descriptor: [Gestational Weight Gain] this term only
#18	MeSH descriptor: [Obesity, Maternal] this term only
#19	GWG:ti,ab,kw
#20	{OR #14-#19}
#21	MeSH descriptor: [Risk Factors] this term only
#22	MeSH descriptor: [Risk Assessment] this term only
#23	(risk* NEAR/2 (factor* or assess* or stratif* or increas* or decreas*)):ti,ab
#24	{OR #21-#23}
#25	#20 AND #24
#26	conference:pt or (clinicaltrials or trialsearch):so
#27	#25 NOT #26 with Cochrane Library publication date Between Jan 1970 and Oct 2022

Database: CINAHL

Date of last search: 17/10/2022

#	Searches
1	(MH "Pregnancy+")
2	(MH "Expectant Mothers")
3	(MH "Prenatal Care")
4	(MH "Body Weight Changes")
5	(MH "Weight Gain")
6	(MH "Weight Loss")
7	(MH "Body Mass Index")
8	(MH "Obesity")
9	(MH "Waist Circumference") OR (MH "Waist-Hip Ratio")
10	S1 OR S2 OR S3
11	S4 OR S5 OR S6 OR S7 OR S8 OR S9
12	S10 AND S11
13	TI (((pregnan* OR gestation*) N2 (body mass index OR BMI OR quetelet index OR anthropometr* OR obes* OR overweight OR over weight OR corpulen* OR heavy OR heavier OR fat OR adipos* OR underweight OR under weight OR waist circumference* OR (waist N2 hip ratio*) or (waist N2 height ratio*) or (weight N2 height ratio*))) OR AB (((pregnan* OR gestation*) N2 (body mass index OR BMI OR quetelet index OR anthropometr* OR obes* OR overweight OR over weight OR corpulen* OR heavy OR heavier OR fat OR adipos* OR underweight OR under weight OR waist circumference* OR (waist N2 hip ratio*) or (waist N2 height ratio*) or (weight N2 height ratio*)))
14	TI (((pregnan* OR gestation*) N2 weight* N3 (gain* OR increas* OR accelerat* OR excess* OR decreas* OR retention OR retain* OR alter* OR chang* OR loss OR lost OR lose OR losing OR reduc* OR status OR manag* OR maintain* OR control* OR health* OR ideal* OR optimal* OR optimum OR appropriate OR recommend*))) OR AB (((pregnan* OR gestation*) N2 weight* N3 (gain* OR increas* OR accelerat* OR excess* OR decreas* OR retention OR retain* OR alter* OR chang* OR loss OR lost OR lose OR losing OR reduc* OR status OR manag* OR maintain* OR control* OR health* OR ideal* OR optimal* OR optimum OR appropriate OR recommend*)))
15	(MH "Gestational Weight Gain")
16	(MH "Obesity, Maternal")
17	TI GWG OR AB GWG
18	S12 OR S13 OR S14 OR S15 OR S16 OR S17
19	(MH "Risk Factors")
20	(MH "Risk Assessment")

#	Searches
21	TI ((risk* N2 (factor* OR assess* OR stratif* OR increas* OR decreas*))) OR AB ((risk* N2 (factor* OR assess* OR stratif* OR increas* OR decreas*)))
22	S19 OR S20 OR S21
23	S18 AND S22
24	Limiters - Published Date: 19700101-20221031; English Language; Human; Geographic Subset: Australia & New Zealand, Canada, Continental Europe, Europe, UK & Ireland, USA

Database: Epistemonikos

Date of last search: 17/10/2022

#	Searches
1	advanced_title_en:(((pregnan* OR gestation*) AND weight* AND (gain* OR increas* OR accelerat* OR excess* OR decreas* OR retention OR retain* OR alter* OR chang* OR loss OR lost OR lose OR losing OR reduc* OR status OR manag* OR maintain* OR control* OR health* OR ideal* OR optimal* OR optimum OR appropriate OR recommend*)))
2	(advanced_title_en:((risk* AND (factor* OR assess* OR stratif* OR increas* OR decreas*))) OR advanced_abstract_en:((risk* AND (factor* OR assess* OR stratif* OR increas* OR decreas*))))
3	1 AND 2
4	[Filters: protocol=no, min_year=1970, max_year=2022]

Economic searches

Database: Medline

Date of last search: 17/10/2022

#	Searches
1	exp Pregnancy/ or Pregnant Women/ or Prenatal Care/
2	body weight changes/ or weight gain/ or weight loss/ or body mass index/ or obesity/
3	waist circumference/ or waist-hip ratio/ or Waist-Height Ratio/
4	2 or 3
5	1 and 4
6	((pregnan* or gestation*) adj2 (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference* or (waist adj2 hip ratio*) or (waist adj2 height ratio*) or (weight adj2 height ratio*))).ti,ab.
7	((pregnan* or gestation*) adj2 weight* adj3 (gain* or 70aesarea* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)).ti,ab.
8	Gestational Weight Gain/ or obesity, maternal/ or GWG.ti,ab.
9	or/5-8
10	risk factors/ or Risk Assessment/
11	(risk* adj2 (factor* or assess* or stratif* or 70aesarea* or decreas*)).ti,ab.
12	or/10-11
13	9 and 12
14	animals/ not humans/
15	exp Animals, Laboratory/
16	exp Animal Experimentation/
17	exp Models, Animal/
18	exp Rodentia/
19	(rat or rats or rodent* or mouse or mice).ti.
20	or/14-19
21	13 not 20
22	limit 21 to English language
23	Economics/
24	Value of life/

#	Searches
25	exp “Costs and Cost Analysis”/
26	exp Economics, Hospital/
27	exp Economics, Medical/
28	exp Resource Allocation/
29	Economics, Nursing/
30	Economics, Pharmaceutical/
31	exp “Fees and Charges”/
32	exp Budgets/
33	budget*.ti,ab.
34	cost*.ti,ab.
35	(economic* or pharmaco?economic*).ti,ab.
36	(price* or pricing*).ti,ab.
37	(71aesare* or fee or fees or expenditure* or saving*).ti,ab.
38	(value adj2 (money or monetary)).ti,ab.
39	71aesarea* 71aesarea*.ti,ab.
40	(fund or funds or funding* or funded).ti,ab.
41	(ration or rations or rationing* or rationed).ti,ab.
42	ec.fs.
43	or/23-42
44	exp models, economic/
45	*Models, Theoretical/
46	*Models, Organizational/
47	71aesar chains/
48	monte carlo method/
49	exp Decision Theory/
50	(71aesar* or monte carlo).ti,ab.
51	econom* model*.ti,ab.
52	(decision* adj2 (tree* or analy* or model*)).ti,ab.
53	or/44-52
54	quality-adjusted life years/
55	sickness impact profile/
56	(quality adj2 (wellbeing or well being)).ti,ab.
57	sickness impact profile.ti,ab.
58	disability adjusted life.ti,ab.
59	(qal* or qtime* or qwb* or daly*).ti,ab.
60	(euroqol* or eq5d* or eq 5*).ti,ab.
61	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
62	(health utility* or utility score* or 71aesarean71* or utility value*).ti,ab.
63	(hui or hui1 or hui2 or hui3).ti,ab.
64	(health* year* equivalent* or hye or hyes).ti,ab.
65	discrete choice*.ti,ab.
66	rosser.ti,ab.
67	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
68	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
69	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
70	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
71	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
72	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
73	or/54-72
74	22 and (43 or 53 or 73)
75	limit 74 to ed=19700101-20221031

#	Searches
76	limit 74 to dt=19700101-20221031
77	75 or 76

Database: Embase

Date of last search: 17/10/2022

#	Searches
1	exp pregnancy/ or pregnant woman/ or prenatal care/ or prenatal period/
2	exp *body weight change/ or *obesity/ or *body mass/
3	*waist circumference/ or *waist-hip ratio/ or *Waist-Height Ratio/
4	2 or 3
5	1 and 4
6	((pregnan* or gestation*) adj2 (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference* or (waist adj2 hip ratio*) or (waist adj2 height ratio*) or (weight adj2 height ratio*))).ti,ab.
7	((pregnan* or gestation*) adj2 weight* adj3 (gain* or 72aesarea* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)).ti,ab.
8	*gestational weight gain/ or *maternal obesity/ or GWG.ti,ab.
9	or/5-8
10	*risk factor/ or *risk assessment/
11	(risk* adj2 (factor* or assess* or stratif* or 72aesarea* or decreas*)).ti,ab.
12	or/10-11
13	9 and 12
14	animal/ not human/
15	nonhuman/
16	exp Animal Experiment/
17	exp Experimental Animal/
18	animal model/
19	exp Rodent/
20	(rat or rats or rodent* or mouse or mice).ti.
21	or/14-20
22	13 not 21
23	limit 22 to English language
24	(conference abstract* or conference review or conference paper or conference proceeding).db,pt,su.
25	23 not 24
26	health economics/
27	exp economic evaluation/
28	exp health care cost/
29	exp fee/
30	budget/
31	funding/
32	resource allocation/
33	budget*.ti,ab.
34	cost*.ti,ab.
35	(economic* or pharmaco?economic*).ti,ab.
36	(price* or pricing*).ti,ab.
37	(72aesare* or fee or fees or expenditure* or saving*).ti,ab.
38	(value adj2 (money or monetary)).ti,ab.
39	72aesarea* 72aesarea*.ti,ab.
40	(fund or funds or funding* or funded).ti,ab.
41	(ration or rations or rationing* or rationed).ti,ab.
42	or/26-41

#	Searches
43	statistical model/
44	exp economic aspect/
45	43 and 44
46	*theoretical model/
47	*nonbiological model/
48	stochastic model/
49	decision theory/
50	decision tree/
51	monte carlo method/
52	(73aesar* or monte carlo).ti,ab.
53	econom* model*.ti,ab.
54	(decision* adj2 (tree* or analy* or model*)).ti,ab.
55	or/45-54
56	quality adjusted life year/
57	“quality of life index”/
58	short form 12/ or short form 20/ or short form 36/ or short form 8/
59	sickness impact profile/
60	(quality adj2 (wellbeing or well being)).ti,ab.
61	sickness impact profile.ti,ab.
62	disability adjusted life.ti,ab.
63	(qal* or qtime* or qwb* or daly*).ti,ab.
64	(qal* or qtime* or qwb* or daly*).ti,ab.
65	(qol* or hql* or hqol* or h qol* or hrqol* or hr qol*).ti,ab.
66	(health utility* or utility score* or 73aesarean73* or utility value*).ti,ab.
67	(hui or hui1 or hui2 or hui3).ti,ab.
68	(health* year* equivalent* or hye or hyes).ti,ab.
69	discrete choice*.ti,ab.
70	rosser.ti,ab.
71	(willingness to pay or time tradeoff or time trade off or tto or standard gamble*).ti,ab.
72	(sf36* or sf 36* or short form 36* or shortform 36* or shortform36*).ti,ab.
73	(sf20 or sf 20 or short form 20 or shortform 20 or shortform20).ti,ab.
74	(sf12* or sf 12* or short form 12* or shortform 12* or shortform12*).ti,ab.
75	(sf8* or sf 8* or short form 8* or shortform 8* or shortform8*).ti,ab.
76	(sf6* or sf 6* or short form 6* or shortform 6* or shortform6*).ti,ab.
77	or/56-76
78	25 and (42 or 55 or 77)
79	limit 78 to dc=19700101-20221031

Database: INAHTA

Date of last search: 17/10/2022

#	Searches
1	“Pregnancy”[mhe]
2	“Pregnant Women”[mh]
3	“Prenatal Care”[mh]
4	#3 OR #2 OR #1
5	“Body Weight Changes”[mh]
6	“Weight Gain”[mh]
7	“Weight Loss”[mh]
8	“Body Mass Index”[mh]
9	“Obesity”[mh]
10	“Waist Circumference”[mh]

#	Searches
11	"Waist-Hip Ratio"[mh]
12	"Waist-Height Ratio"[mh]
13	#12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5
14	#13 AND #4
15	(((pregnan* or gestation*) AND (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference*)))[Title] OR (((pregnan* or gestation*) AND (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference*)))[abs]
16	(((pregnan* or gestation*) AND (waist AND hip ratio*) or (waist AND height ratio*) or (weight AND height ratio*)))[Title] OR (((pregnan* or gestation*) AND (waist AND hip ratio*) or (waist AND height ratio*) or (weight AND height ratio*)))[abs]
17	(((pregnan* or gestation*) AND weight* AND (gain* or 74aesarea* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)))[Title] OR (((pregnan* or gestation*) AND weight* AND (gain* or 74aesarea* or accelerat* or excess* or decreas* or retention or retain* or alter* or chang* or loss or lost or lose or losing or reduc* or status or manag* or maintain* or control* or health* or ideal* or optimal* or optimum or appropriate or recommend*)))[abs]
18	"Gestational Weight Gain"[mh]
19	"Obesity, Maternal"[mh]
20	(GWG)[Title] OR (GWG)[abs]
21	#20 OR #19 OR #18 OR #17 OR #16 OR #15 OR #14
22	"Risk Factors"[mh]
23	"Risk Assessment"[mh]
24	((risk* AND (factor* or assess* or stratif* or 74aesarea* or decreas*)))[Title] OR ((risk* AND (factor* or assess* or stratif* or 74aesarea* or decreas*)))[abs]
25	#24 OR #23 OR #22
26	#25 AND #21

Database: CRD HTA

Date of last search: 17/10/2022

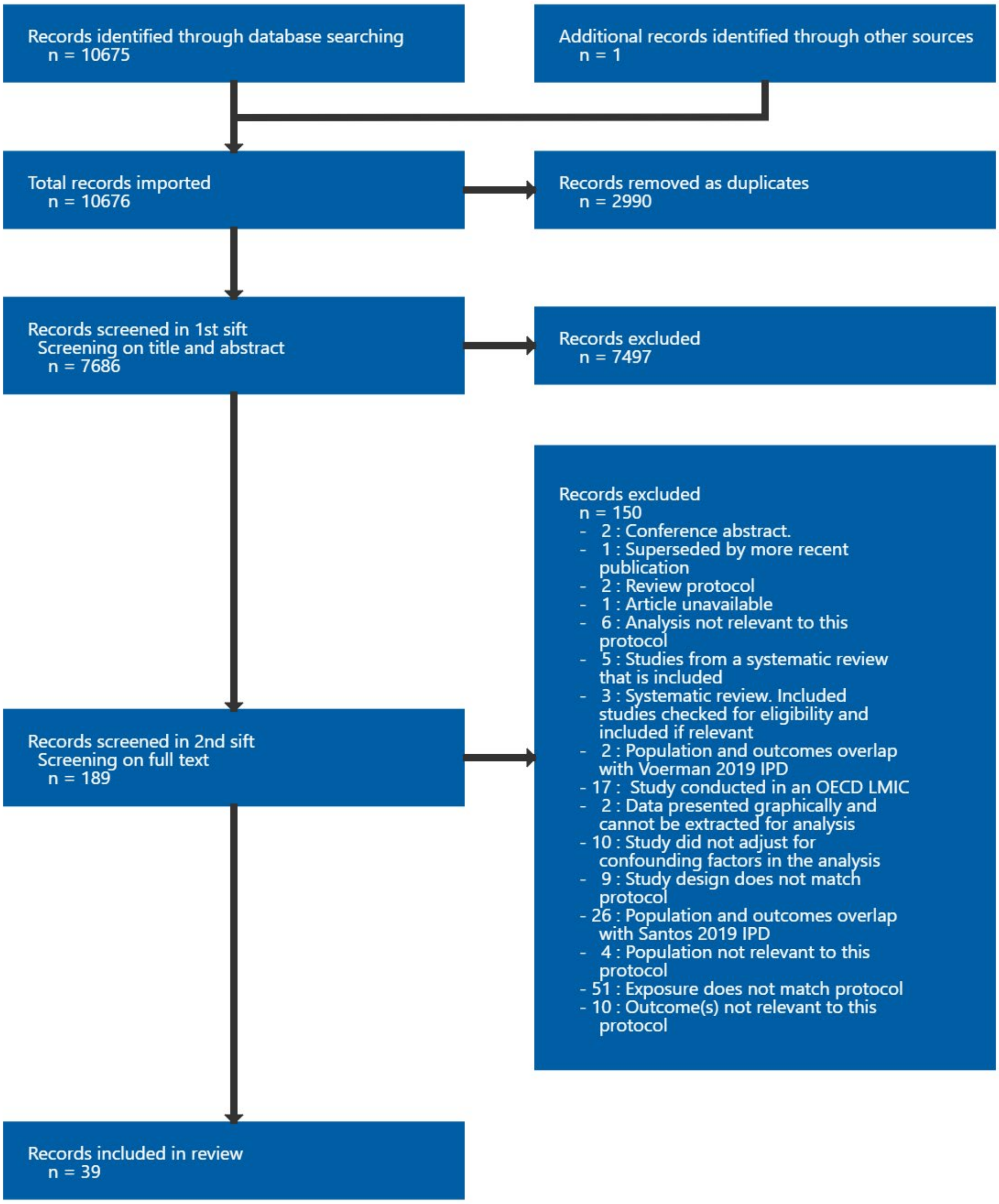
#	Searches
1	MeSH DESCRIPTOR Pregnancy EXPLODE ALL TREES IN HTA
2	MeSH DESCRIPTOR Pregnant Women IN HTA
3	MeSH DESCRIPTOR Prenatal Care IN HTA
4	#1 OR #2 OR #3
5	MeSH DESCRIPTOR Body Weight Changes IN HTA
6	MeSH DESCRIPTOR Weight Gain IN HTA
7	MeSH DESCRIPTOR Weight Loss IN HTA
8	MeSH DESCRIPTOR Body Mass Index IN HTA
9	MeSH DESCRIPTOR Obesity IN HTA
10	MeSH DESCRIPTOR Waist Circumference IN HTA
11	MeSH DESCRIPTOR Waist-Hip Ratio IN HTA
12	MeSH DESCRIPTOR Waist-Height Ratio IN HTA
13	#5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12
14	#4 AND #13
15	(((pregnan* or gestation*) AND (body mass index or BMI or quetelet index or anthropometr* or obes* or overweight or over weight or corpulen* or heavy or heavier or fat or adipos* or underweight or under weight or waist circumference*))) IN HTA
16	(((pregnan* or gestation*) AND (waist AND hip ratio*) or (waist AND height ratio*) or (weight AND height ratio*))) IN HTA
17	MeSH DESCRIPTOR Gestational Weight Gain IN HTA
18	MeSH DESCRIPTOR Obesity, Maternal IN HTA
19	(GWG) IN HTA
20	#14 OR #15 OR #16 OR #17 OR #18 OR #19

#	Searches
21	MeSH DESCRIPTOR Risk Factors IN HTA
22	MeSH DESCRIPTOR Risk Assessment IN HTA
23	((risk* AND (factor* or assess* or stratif* or 75aesarea* or decreas*))) IN HTA
24	#21 OR #22 OR #23
25	#20 AND #24

Appendix C Prognostic evidence study selection

Study selection for review question: What gestational weight change is healthy and appropriate during pregnancy?

Figure 1: Study selection flow chart



Appendix D Evidence tables

Evidence tables for review question: What gestational weight change is healthy and appropriate during pregnancy?

Table 4: Evidence tables

All outcome data were adjusted estimates.

Beaudrot, 2016

Bibliographic Reference	Beaudrot, M.E.; Elchert, J.A.; DeFranco, E.A.; Influence of gestational weight gain and BMI on cesarean delivery risk in adolescent pregnancies; Journal of Perinatology; 2016; vol. 36 (no. 8); 612-617

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2006-2012
Inclusion criteria	• singleton live births • primiparous women • 37 to 42 gestational weeks
Exclusion criteria	• nonvertex presentation births • births with missing gestational age data

Patient characteristics	**Mean (SD) maternal age, years** NR (NR) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** <15 years: 23.4 (5.0) 15-17 years: 23.6 (4.9) 18-19 years: 24.6 (5.7) 20-34 years: 25.9 (6.4) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain (definition not reported) Institute of Medicine (IOM) categories used: • underweight: 28 to 40 pounds (12.7 to 18.15 kg) • normal: 25 to 35 pounds (11.34 to 15.88 kg) • overweight: 15 to 25 pounds (6.8 to 11.34 kg) • obese: 11 to 20 pounds (4.99 to 9.07 kg)
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal race • smoking status • labour induction

Duration of follow-up	Until birth
Setting	Department of Health
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Weight loss (N = 3635)

Inadequate gestational weight gain (N = 31283)

Adequate gestational weight gain (N = 53933)

Excessive gestational weight gain (N = 148866)

Outcomes

Outcome	Weight loss, N = 3635	Inadequate gestational weight gain, N = 31283	Adequate gestational weight gain, N = 53933	Excessive gestational weight gain, N = 148866
Caesarean birth aOR (95% CI)	-	-	-	-
<15 years old (n=534)	0.75 (0.78 to 7.22)	0.48 (0.25 to 0.93)	0.53 (0.30 to 0.92)	0.62 (0.47 to 0.81)

Outcome	Weight loss, N = 3635	Inadequate gestational weight gain, N = 31283	Adequate gestational weight gain, N = 53933	Excessive gestational weight gain, N = 148866
aOR (95% CI)				
15-17 years old (n=14730) aOR (95% CI)	0.43 (0.29 to 0.63)	0.57 (0.51 to 0.65)	0.56 (0.51 to 0.63)	0.61 (0.57 to 0.64)
18-19 years old (n=34148) aOR (95% CI)	0.59 (0.47 to 0.75)	0.62 (0.57 to 0.67)	0.65 (0.61 to 0.70)	0.68 (0.66 to 0.70)
20-34 years old (n=188305) aOR (95% CI)	1.22 (1.03 to 1.43)	1.20 (1.13 to 1.28)	referent	1.14 (1.11 to 1.17)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal race, smoking status, labour induction

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome.)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome.)
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome.)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results.)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Beyerlein, 2011

Bibliographic Reference	Beyerlein, A.; Schiessl, B.; Lack, N.; Von Kries, R.; Associations of gestational weight loss with birth-related outcome: A retrospective cohort study; BJOG: An International Journal of Obstetrics and Gynaecology; 2011; vol. 118 (no. 1); 55-61

Study details

Country/ies where study was carried out	Germany
Study type	Retrospective cohort study Multivariate analysis
Study dates	2000-2007
Inclusion criteria	• singleton deliveries
Exclusion criteria	• missing values for weight at booking • implausible data points • booking at <4 weeks before delivery or unknown date of booking • women with excessive GWG

Patient characteristics	**Mean (SD) maternal age, years**
	• gestational weight loss (GWL): 30.2 (5.5)
	• non-excessive gestational weight gain (NEGWG): 30.6 (5.4)
	• excessive gestational weight gain (EGWG): 29.7 (5.2)
	Maternal pre-pregnancy BMI, n (%)
	• underweight
	  ○ GWL: 19 (0.54)
	  ○ NEGWG: 26173 (5.92)
	  ○ EGWG: 4328 (1.64)
	• normal weight

	- GWL: 480 (13.63) - NEGWG: 331439 (75.02) - EGWG: 128673 (48.69) - overweight - GWL: 808 (22.95) - NEGWG: 54512 (12.34) - EGWG: 90015 (34.06) - obese class I - GWL: 889 (25.25) - NEGWG: 18308 (4.14) - EGWG: 30043 (11.37) - obese class II - GWL: 688 (19.54) - NEGWG: 7756 (1.76) - EGWG: 8229 (3.11) - obese class III - GWL: 637 (18.09) - NEGWG: 3614 (0.82) - EGWG: 2964 (1.12) **Ethnicity, n:** NR

Risk factor(s) of interest	Gestational weight gain
	-difference between maternal weight at last measurement prior to delivery and maternal weight at booking
	Institute of Medicine (IOM) categories used:
	• excessive gestational weight gain:
	    ○ >18.0 kg for underweight
	    ○ >16.0 kg for normal-weight
	    ○ >11.5 kg for overweight
	    ○ >9.0 kg for obese

Confounding factor(s) of interest	Covariates adjusted in analysis: • gestational and pre-gestational diabetes • smoking in pregnancy • offspring's sex • parity • maternal age • preterm delivery
Duration of follow-up	Until birth
Setting	Obstetric units
Sources of funding	Not industry funded

BMI: body mass index; GWG: gestational weight gain; NR: not reported; SD: standard deviation

Study arms

Non-excessive gestational weight gain (N = 441802)

Weight loss (N = 3521)

Outcomes

Outcome	Non-excessive gestational weight gain, N = 441802	Weight loss, N = 3521
Caesarean birth Non-elective aOR (95% CI)	-	-
Normal weight aOR (95% CI)	referent	1.13 (0.84 to1.52)
Overweight aOR (95% CI)	referent	0.74 (0.58 to 0.95)
Obese class I aOR (95% CI)	referent	0.65 (0.51 to 0.83)
Obese class II aOR (95% CI)	referent	0.80 (0.62 to 1.02)
Obese class III aOR (95% CI)	referent	0.76 (0.60 to 0.98)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: gestational and pre-gestational diabetes, smoking in pregnancy, offspring’s sex, parity, maternal age, preterm delivery

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome.)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome.)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias.)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome.)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results.)*
Overall risk of bias and directness	Risk of Bias	Low

Section	Question	Answer
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Blomberg, 2011

Bibliographic Reference	Blomberg, M.; Maternal and neonatal outcomes among obese women with weight gain below the new institute of medicine recommendations; Obstetrics and Gynecology; 2011; vol. 117 (no. 5); 1065-1070

Study details

Country/ies where study was carried out	Sweden
Study type	Retrospective cohort study Multivariate analysis
Study dates	1993 to 2008
Inclusion criteria	• BMI ≥30
Exclusion criteria	NR
Patient characteristics	**Maternal age, years, n (%)** • BMI 30 to 34.9 ○ 15 to 19: 495 (1.5) ○ 20 to 24: 5126 (15.5)

	○ 25 to 29: 10747 (32.6) ○ 30 to 34: 10512 (31.9) ○ 35 to 39: 5050 (15.3) ○ ≥40: 1061 (3.2) • BMI 35 to 39.9 ○ 15 to 19: 114 (1.1) ○ 20 to 24: 1602 (15.9) ○ 25 to 29: 3311 (32.9) ○ 30 to 34: 3176 (31.5) ○ 35 to 39: 1516 (15.1) ○ ≥40: 349 (3.5) • BMI 40 or higher ○ 15 to 19: 33 (0.9) ○ 20 to 24: 529 (15.0) ○ 25 to 29: 1148 (32.5) ○ 30 to 34: 1166 (33.0) ○ 35 to 39: 561 (15.9) ○ ≥40: 99 (2.8) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** NR (NR) **Ethnicity, n**

	NR
Risk factor(s) of interest	Gestational weight gain -the difference between maternal weight measured at the delivery unit and maternal pre-pregnancy weight recorded at the first visit Institute of Medicine (IOM) categories used: • less than 0 kg for weight loss • 0 to 4.9 kg low weight gain • 5 to 9 kg recommended weight gain • >9 kg excessive weight gain
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • parity • smoking
Duration of follow-up	Until birth
Setting	Maternity healthcare centres
Sources of funding	NR

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Weight loss (N = 2656)

Inadequate gestational weight gain (N = 5187)

Adequate gestational weight gain (N = 12736)

Excessive gestational weight gain (N = 26016)

Outcomes

Outcome	Weight loss, N = 2656	Inadequate gestational weight gain, N = 5187	Adequate gestational weight gain, N = 12736	Excessive gestational weight gain, N = 26016
Caesarean birth aOR (95% CI)	-	-	-	-
BMI 30-34.9 aOR (95% CI)	0.76 (0.65 to 0.89)	0.89 (0.80 to 0.99)	referent	1.23 (1.16 to 1.31)
BMI 35-39.9 aOR (95% CI)	0.66 (0.54 to 0.82)	0.87 (0.74 to 1.01)	referent	1.17 (1.05 to 1.31)
BMI 40 or more aOR (95% CI)	0.77 (0.60 to 0.99)	0.82 (0.65 to 1.04)	referent	1.12 (0.94 to 1.35)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, parity, smoking

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome.)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome.)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias.)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome.)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results.)*
Overall risk of bias and directness	Risk of Bias	Low

Section	Question	Answer
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Breckenkamp, 2019

Bibliographic Reference	Breckenkamp, J.; Razum, O.; Henrich, W.; Borde, T.; David, M.; Effects of maternal obesity, excessive gestational weight gain and fetal macrosomia on the frequency of cesarean deliveries among migrant and non-migrant women-a prospective study; Journal of Perinatal Medicine; 2019; vol. 47 (no. 4); 402-408

Study details

Country/ies where study was carried out	Germany
Study type	Prospective cohort study Multivariate analysis
Study dates	2011-2012
Inclusion criteria	NR
Exclusion criteria	• <18 years • not residents of Germany • women terminating a pregnancy • women with miscarriages and stillbirths

Patient characteristics	**Mean (SD) maternal age, years**
	• non-immigrants: 30.9 (5.6)
	• first-generation immigrant women
	  ○ low and lower middle-income countries: 30.2 (5.6)
	  ○ upper middle-income countries: 29.5 (5.8)
	  ○ high-income countries: 31.0 (5.4)
	• second-generation immigrant women: 27.6 (5.2)
	Maternal pre-pregnancy BMI, kg/m^2, %
	• BMI <18.5
	  ○ non-immigrants: 3.9
	  ○ first-generation immigrant women
	    ▪ low and lower middle-income countries: 3.3
	    ▪ upper middle-income countries: 5.1
	    ▪ high-income countries: 3.5
	  ○ second-generation immigrant women: 3.7
	• BMI <25
	  ○ non-immigrants: 64.8
	  ○ first-generation immigrant women
	    ▪ low and lower middle-income countries: 53.0
	    ▪ upper middle-income countries: 50.8
	    ▪ high-income countries: 71.8

<table>
<tr><td></td><td>

second-generation immigrant women: 55.3
BMI <30

non-immigrants: 20.7
first-generation immigrant women

low and lower middle-income countries: 29.9
upper middle-income countries: 31.9
high-income countries: 15.5

second-generation immigrant women: 25.8

BMI ≥30

non-immigrants: 10.6
first-generation immigrant women

low and lower middle-income countries: 13.8
upper middle-income countries: 12.2
high-income countries: 9.2

second-generation immigrant women: 15.3

Ethnicity, n
NR
</td></tr>
<tr><td>Risk factor(s) of interest</td><td>
Gestational weight gain
-difference between weight at delivery and weight at first prenatal check-up
Institute of Medicine (IOM) categories used:

12.5 to 18 kg for underweight

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	• 11.5 to 16 kg for normal weight • 7 to 15 kg for overweight • 5 to 9 kg for obese
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • parity
Duration of follow-up	Until birth
Setting	Maternity hospitals
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = NR)

Inadequate gestational weight gain (N = NR)

Excessive gestational weight gain (N = NR)

Outcomes

Outcome	Adequate gestational weight gain, N = NR	Inadequate gestational weight gain, N = NR	Excessive gestational weight gain, N = NR
Caesarean birth Elective and emergency aOR (95%CI)	referent	1.13 (0.94 to 1.35)	1.35 (1.16 to 1.57)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, parity

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Moderate risk of bias *(The study sample represents the population of interest on some key characteristics. There is possibly some bias of the observed relationship between PF and outcome.)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome.)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome .)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results.)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Moderate risk of selection bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Cedergren, 2006

Bibliographic Reference	Cedergren, M.; Effects of gestational weight gain and body mass index on obstetric outcome in Sweden; International Journal of Gynecology and Obstetrics; 2006; vol. 93 (no. 3); 269-274

Study details

Country/ies where study was carried out	Sweden
Study type	Prospective cohort study Multivariate analysis

Study dates	1994 to 2002
Inclusion criteria	NR
Exclusion criteria	NR

Patient characteristics	**Maternal age, years, n (%)**
	• BMI <20
	    ○ 15 to 19: 1013 (3.8)
	    ○ 20 to 24: 6200 (23.0)
	    ○ 25 to 29: 10,398 (38.7)
	    ○ 30 to 34: 6913 (25.7)
	    ○ 35 to 39: 2007 (7.7)
	    ○ 40+: 298 (1.1)
	• BMI 20 to 24.9
	    ○ 15 to 19: 2648 (1.9)
	    ○ 20 to 24: 22009 (15.9)
	    ○ 25 to 29: 52097 (37.7)
	    ○ 30 to 34: 43006 (31.1)
	    ○ 35 to 39: 15642 (11.3)
	    ○ 40+: 2612 (1.9)
	• BMI 25 to 29.9
	    ○ 15 to 19: 884 (1.5)

	○ 20 to 24: 9142 (15.7) ○ 25 to 29: 20976 (36.1) ○ 30 to 34: 18157 (31.2) ○ 35 to 39: 7518 (12.9) ○ 40+: 1473 (2.5) • BMI 30 to 34.9 ○ 15 to 19: 246 (1.5) ○ 20 to 24: 2866 (17.4) ○ 25 to 29: 5858 (35.6) ○ 30-34: 4940 (30.0) ○ 35 to 39: 2145 (13.0) ○ 40+: 399 (2.4) • BMI ≥35 ○ 15 to 19: 67 (1.1) ○ 20 to 24: 1029 (17.3) ○ 25 to 29: 2254 (38.0) ○ 30 to 34: 1757 (29.6) ○ 35 to 39: 695 (11.7) ○ 40+: 135(2.3) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** NR

	Ethnicity, n NR
Risk factor(s) of interest	Gestational weight gain -the difference between the maternal weights measured when the woman attended the delivery unit and the maternal weight recorded at the first visit Independent categories used: • 8 kg (low weight gain) • 8 to 16 kg (referent) • >16 kg (high weight gain)
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • parity • smoking in early pregnancy • year of birth
Duration of follow-up	Until birth
Setting	Maternity health care centre
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Low gestational weight gain (N = 30127)

Adequate gestational weight gain (N = 145008)

High gestational weight gain (N = 71189)

Outcomes

Outcome	Low gestational weight gain, N = 30127	Adequate gestational weight gain, N = 145008	High gestational weight gain, N = 71189
Caesarean birth aOR (95% CI)	-	-	-
BMI <20 aOR (95% CI)	1.07 (0.89 to 1.29)	referent	1.29 (1.17 to 1.43)
BMI 20 to 24.9 aOR (95% CI)	0.98 (0.92 to 1.05)	referent	1.24 (1.19 to 1.29)
BMI 25 to 29.9 aOR (95% CI)	0.88 (0.82 to 0.95)	referent	1.23 (1.17 to 1.30)
BMI 30 to 34.9 aOR (95% CI)	0.81 (0.73 to 0.90)	referent	1.22 (1.10 to 1.35)
BMI >=35	0.75 (0.66 to 0.87)	referent	1.27 (1.05 to 1.52)

Outcome	Low gestational weight gain, N = 30127	Adequate gestational weight gain, N = 145008	High gestational weight gain, N = 71189
aOR (95% CI)			

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, parity, smoking in early pregnancy, year of birth

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(Although there is some missing information, it is likely that PF is adequately measured in study participants to sufficiently limit potential bias)*
Study Attrition	Study Attrition Summary	Low risk of bias *(The relationship between the prognostic factor and outcome is unlikely to be different for completing and non-completing participants.)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(Prognostic factor is measured similarly for all participants, and a valid and reliable measurement is used.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome.)*

Section	Question	Answer
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Chen, 2020

Bibliographic Reference	Chen, CN; Chen, HS; Hsu, HC; Maternal Prepregnancy Body Mass Index, Gestational Weight Gain, and Risk of Adverse Perinatal Outcomes in Taiwan: A Population-Based Birth Cohort Study.; International journal of environmental research and public health; 2020; vol. 17 (no. 4)

Study details

Country/ies where study was carried out	Taiwan
Study type	Prospective cohort study Multivariate analysis
Study dates	2005 to 2006
Inclusion criteria	• mother-infant dyads born between January 2005 and 31 December 2005

	• live born children in 2005
Exclusion criteria	• participants with missing or invalid data • mothers with a major medical illness • previous chronic hypertension • type 1 diabetes • multiple births
Patient characteristics	**Maternal age, years, n (%)** <25: 4323 (22.7) 25 to 29: 7211 (37.9) 30 to 34: 5527 (29) ≥35: 1991 (10.4) **Maternal pre-pregnancy BMI, kg/m^2, n (%)** <18.5: 3851 (20.2) 18.5 to 24.9: 13333 (70.0) 25 to 29.9: 1524 (8.0) ≥30: 344 (1.8) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -the difference between the final body weight before delivery and the pre-pregnancy body weight

	Institute of Medicine (IOM) categories used:
	• adequate:
	  ○ 12.5 to 18 kg for underweight
	  ○ 11.5 to 16 kg for normal weight
	  ○ 7 to 11.5 kg for overweight
	  ○ 5 to 9 kg for obese
	• insufficient: when the values were below the intervals for each category
	• excessive: when the values were above the intervals for each category

Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • infant sex • parity • maternal education • maternal immigration status • family monthly income • urbanicity of living area • smoking during pregnancy
Duration of follow-up	Until birth
Setting	Population-based

Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 7994)

Inadequate gestational weight gain (N = 5433)

Excessive gestational weight gain (N = 5625)

Outcomes

Outcome	Adequate gestational weight gain, N = 7994	Inadequate gestational weight gain, N = 5433	Excessive gestational weight gain, N = 5625
Gestational diabetes aOR (95% CI)	referent	1.1 (0.85 to 1.41)	1.27 (0.99 to 1.62)
Gestational hypertension aOR (95% CI)	referent	0.69 (0.47 to 0.99)	2.51 (1.94 to 3.25)
Preeclampsia aOR (95% CI)	referent	0.59 (0.29 to 1.18)	3.17 (2.04 to 4.93)
Caesarean birth aOR (95% CI)	referent	0.95 (0.87 to 1.02)	1.53 (1.42 to 1.65)

Outcome	Adequate gestational weight gain, N = 7994	Inadequate gestational weight gain, N = 5433	Excessive gestational weight gain, N = 5625
Large for gestational age (macrosomia) aOR (95% CI)	referent	0.59 (0.42 to 0.83)	2.66 (2.11 to 3.36)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, infant sex, parity, maternal education, maternal immigration status, family monthly income, urbanicity of living area, smoking during pregnancy

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Chen, 2020

Bibliographic Reference	Chen, Y.-C.; Lai, Y.-J.; Su, Y.-T.; Tsai, N.-C.; Lan, K.-C.; Higher gestational weight gain and lower serum estradiol levels are associated with increased risk of preeclampsia after in vitro fertilization; Pregnancy Hypertension; 2020; vol. 22; 126-131

Study details

Country/ies where study was carried out	Taiwan
Study type	Retrospective cohort study Multivariate analysis

Study dates	2001 to 2018
Inclusion criteria	• women who had live births after fresh in vitro fertilization (IVF)/intracytoplasmic sperm injection embryo transfer (ICSI-ET)
Exclusion criteria	• women using donor oocytes
Patient characteristics	**Median (IQR) maternal age, years** Normal pregnancy: 34.0 (5.4) Preeclampsia: 35.0 (4.8) **Median (IQR) maternal pre-pregnancy BMI, kg/m^2** Normal pregnancy: 22.0 (4.3) Preeclampsia: 24.0 (8.0) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -the difference between body weight at delivery and the pre-pregnancy body weight
Confounding factor(s) of interest	Covariates adjusted in analysis: • endocrine parameters • mother's age • age of the male partner • BMI • infertility diagnosis

	• ovarian stimulation protocol • duration of ovarian stimulation • maximal endometrial thickness • number oocytes retrieved • number of embryos transferred • use of ICSI • use of blastocyst-stage ET • occurrence of multiple pregnancies • pregnancy weight gain
Duration of follow-up	18 years
Setting	Hospital-based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

<=20 kg gestational weight gain (N = NR)

>20 kg gestational weight gain (N = NR)

Outcomes

Outcome	<=20 kg gestational weight gain, N = NR	>20 kg gestational weight gain, N = NR
Preeclampsia aOR (95% CI)	referent	13.601 (3.784 to 48.880)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: endocrine parameters, mother's age, age of the male partner, BMI, infertility diagnosis, ovarian stimulation protocol, duration of ovarian stimulation, maximal endometrial thickness, number oocytes retrieved, number of embryos transferred, use of ICSI, use of blastocyst-stage ET, occurrence of multiple pregnancies, pregnancy weight gain

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Moderate risk of measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Chen-Xu, 2022

Bibliographic Reference	Chen-Xu, J.; Coelho, A.; Association between Body Mass Index and Gestational Weight Gain with Obstetric and Neonatal Complications in Pregnant Women with Gestational Diabetes; Acta Medica Portuguesa; 2022; vol. 35 (no. 13)

Study details

Country/ies where study was carried out	Portugal
Study type	Retrospective cohort study Multivariate analysis

Study dates	2014 to 2018
Inclusion criteria	• pregnant women with gestational diabetes
Exclusion criteria	• <18 years • missing data on BMI and GWG • history/current diagnosis of diabetes mellitus • multifetal pregnancy • GWG above 28.3 kg • GWG below 7.1 kg
Patient characteristics	**Mean (SD) maternal age, years** 33.3 (5.3) **Mean maternal pre-pregnancy BMI, kg/m^2** 27.0 (5.8) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -weight at birth or last appointment before birth and pre-pregnancy weight Institute of Medicine (IOM) categories used: • adequate: ○ 12.5 to 18 kg for underweight

	○ 11.5 to 16 kg for normal weight ○ 7 to 11.5 kg overweight ○ 5 to 9 kg for obese • insufficient: when the values were below the intervals for each category • excessive: when the values were above the intervals for each category
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • number of previous abortions/deliveries • first degree family history of diabetes • previous macrosomia • fasting glucose • weeks between diagnosis and first hospital appointment • GD treatment • BMI category • week of delivery
Duration of follow-up	Until birth
Setting	Public healthcare institutions
Sources of funding	Not industry funded

BMI: body mass index; GWG: gestational weight gain; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 4372)

Inadequate gestational weight gain (N = 5245)

Excessive gestational weight (N = 3850)

Outcomes

Outcome	Adequate gestational weight gain, N = 4372	Inadequate gestational weight gain, N = 5245	Excessive gestational weight, N = 3850
Gestational hypertension aOR (95% CI)	referent	0.69 (0.48 to 0.98)	1.53 (1.11 to 2.12)
Preeclampsia aOR (95% CI)	referent	0.44 (0.28 to 0.68)	1.26 (0.86 to 1.85)
Caesarean birth aOR (95% CI)	referent	0.81 (0.69 to 0.96)	1.15 (0.96 to 1.37)
Large for gestational age Fenton charts aOR (95% CI)	referent	0.74 (0.49 to 1.11)	1.94 (1.35 to 2.78)

Outcome	Adequate gestational weight gain, N = 4372	Inadequate gestational weight gain, N = 5245	Excessive gestational weight, N = 3850
Small for gestational age aOR (95% CI)	referent	1.40 (1.09 to 1.79)	0.97 (0.72 to 1.31)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, number of previous abortions/deliveries, first degree family history of diabetes, previous macrosomia, fasting glucose, weeks between diagnosis and first hospital appointment, GD treatment, BMI category, week of delivery

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Chuang, 2022

Bibliographic Reference	Chuang, Y.-C.; Huang, L.; Lee, W.-Y.; Shaw, S.W.; Chu, F.-L.; Hung, T.-H.; The association between weight gain at different stages of pregnancy and risk of gestational diabetes mellitus; Journal of Diabetes Investigation; 2022; vol. 13 (no. 2); 359-366

Study details

Country/ies where study was carried out	Taiwan
Study type	Retrospective cohort study Multivariate analysis

Study dates	2012 to 2016
Inclusion criteria	• gestational diabetes mellitus (GDM) screening tests • delivered after 28 weeks of complete gestation at Taipei Chang Gung Memorial Hospital between January 1st 2012 and December 31st 2016
Exclusion criteria	• pregnancies complicated by multiple gestation • fetal death • chromosomal or structural abnormalities • women with overt diabetes mellitus diagnosed before pregnancy • at their first antenatal visit before 13 weeks of gestation
Patient characteristics	**Maternal age, years, n (%)** <20: 11 (0.13) 20 to 34: 5208 (62.4) >34: 3133 (37.5) **Maternal pre-pregnancy BMI, kg/m^2, n (%)** <18.5: 1177 (14.1) 18.5 to 24.9: 6217 (74.4) >25: 958 (11.5) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain (GWG)

	• at different time points:
	  ◦ first trimester GWG (increase in weight from before pregnancy to 12–14 weeks of gestation)
	  ◦ second trimester GWG (weight change between 12 to 14 weeks and 26 to 28 weeks of gestation)
	  ◦ GWG before GDM screening (weight at the GDM screening test minus pre-pregnancy weight)
	  ◦ GWG after GDM screening (weight at delivery minus weight at the GDM screening)
	  ◦ total GWG (weight at delivery minus pre-pregnancy weight)
	Definitions of excessive GWG:
	• percentile of study population defined as weight gain above the 90th percentile of all women with the same pre-pregnancy BMI category and gestation
	• Institute of Medicine (IOM) guidelines
	  ◦ highest recommended GWG in the first trimester: 2kg for all pregnant women
	  ◦ highest recommended rate of GWG in the second trimester, according to pre-pregnancy BMI and gestation:
	    ▪ 0.58 kg/week for underweight
	    ▪ 0.50 kg/week for normal weight
	    ▪ 0.33 kg/week for overweight women

Confounding factor(s) of interest	Covariates adjusted in analysis: • age at delivery • primiparity • a prior history of assisted or spontaneous abortion • preterm delivery • stillbirth (>20 weeks of gestation)

	• a family history of type 2 diabetes mellitus (first- and second-degree relatives) • conception by assisted reproductive technology • cigarette smoking during pregnancy • uterine fibroids • maternal diseases such as chronic hypertension, preeclampsia, hypothyroidism, and hyperthyroidism
Duration of follow-up	Until birth
Setting	Hospital-based
Sources of funding	Not industry funded

BMI: body mass index; GWG: gestational weight gain; NR: not reported

Study arms

Excessive gestational weight gain before GDM test (IOM) (N = 1953)

Outcomes

Outcome	Excessive gestational weight gain before GDM test (IOM), N = 1953
Gestational diabetes aOR (95% CI)	-
Normal weight	1.11 (0.92 to 1.35)

Outcome	Excessive gestational weight gain before GDM test (IOM), N = 1953
aOR (95% CI)	
Underweight aOR (95% CI)	1.01 (0.52 to 1.98)
Overweight/obese aOR (95% CI)	0.97 (0.61 to 1.53)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age at delivery, primiparity, prior history of assisted or spontaneous abortion, preterm delivery, stillbirth (>20 weeks of gestation), family history of type 2 diabetes mellitus (first- and second-degree relatives), conception by assisted reproductive technology, cigarette smoking during pregnancy, uterine fibroids, maternal diseases

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Di Benedetto, 2012

Bibliographic Reference	Di Benedetto, A; D'anna, R; Cannata, M L; Giordano, D; Interdonato, M L; Corrado, F; Effects of prepregnancy body mass index and weight gain during pregnancy on perinatal outcome in glucose-tolerant women.; Diabetes & metabolism; 2012; vol. 38 (no. 1); 63-7

Study details

Country/ies where study was carried out	Italy

Study type	Retrospective cohort study Multivariate analysis
Study dates	2004 to 2009
Inclusion criteria	• Caucasian patients who had undergone a glucose challenge test (GCT) at the University of Messina hospital between January 2004 and December 2009
Exclusion criteria	• twin pregnancies • preterm delivery (less than 37 weeks gestation) • diagnosed glucose intolerance in pregnancy (gestational diabetes mellitus or one abnormal value) • missing information regarding delivery
Patient characteristics	**Mean (SD) maternal age, years** Underweight: 28.6 (4.4) Normal weight: 29.5 (4.7) Overweight: 30.3 (5.1) Obese: 30.3 (5.1) **Maternal pre-pregnancy BMI, kg/m²** <19.8: 284 (2.7) 19.8 to 26: 1430 (64.3) >26 to 29.9: 336 (15.1) ≥30: 175 (7.9) **Ethnicity, n**

	NR
Risk factor(s) of interest	Gestational weight gain -the difference between the final body weight before delivery and the pre-pregnancy body weight Institute of Medicine (IOM) categories used: • normal or excess weight gain (throughout the whole of pregnancy)
Confounding factor(s) of interest	Covariates adjusted in analysis: • gestation age at delivery • glycaemia
Duration of follow-up	Until birth
Setting	Hospital-based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 1209)

Excessive gestational weight gain (N = 1016)

Outcomes

Outcome	Adequate gestational weight gain, N = 1209	Excessive gestational weight gain, N = 1016
Large for gestational age (macrosomia, birthweight more than 4000gm) aOR (95% CI)	-	-
Normal weight aOR (95% CI)	referent	2.2 (0.5 to 9.3)
Underweight aOR (95% CI)	referent	1
Overweight aOR (95% CI)	referent	2.9 (1.2 to 6.8)
Obese aOR (95% CI)	referent	8.3 (2.4 to 28.7)
Caesarean birth aOR (95% CI)	-	-
Normal weight aOR (95% CI)	referent	1
Underweight aOR (95% CI)	referent	1.1 (0.8 to 1.3)
Overweight	referent	1

Outcome	Adequate gestational weight gain, N = 1209	Excessive gestational weight gain, N = 1016
aOR (95% CI)		
Obese aOR (95% CI)	referent	1.4 (0.7 to 2.6)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: gestation age at delivery, glycaemia

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Enomoto, 2016

Bibliographic Reference	Enomoto, Kimiko; Aoki, Shigeru; Toma, Rie; Fujiwara, Kana; Sakamaki, Kentaro; Hirahara, Fumiki; Pregnancy Outcomes Based on Pre-Pregnancy Body Mass Index in Japanese Women.; PloS one; 2016; vol. 11 (no. 6); e0157081

Study details

Country/ies where study was carried out	Japan
Study type	Retrospective cohort study Multivariate analysis

Study dates	2013
Inclusion criteria	NR
Exclusion criteria	• women with concomitant hypertension or diabetes as the underlying disease • a history of cervical conization • delivered a newborn with congenital anomalies • data were unknown
Patient characteristics	**Mean (SD) maternal age, years** Underweight: 30.88 (5.40) Normal weight: 31.95 (5.37) Overweight: 32.46 (5.51) Obese: 32.04 (5.32) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** Underweight: 17.59 (0.75) Normal weight: 20.9 (1.63) Overweight: 26.93 (1.39) Obese: 33.65 (3.4) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -definition not reported

	Institute of Medicine (IOM) categories used:
	• for normal weight:
	    o below <11.5 kg
	    o within 11.5 to 16 kg
	    o above <16kg

Confounding factor(s) of interest	• maternal age • maternal height • parity
Duration of follow-up	Until birth
Setting	Hospital based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 62005)

Adequate gestational weight gain (N = 28281)

Excessive gestational weight gain (N = 6871)

Outcomes

Outcome	Inadequate gestational weight gain, N = 62005	Adequate gestational weight gain, N = 28281	Excessive gestational weight gain, N = 6871
Gestational hypertension aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	0.726 (0.594 to 0.887)	referent	2.380 (1.635 to 3.464)
Prepregnancy BMI- Normal weight aOR (95% CI)	0.904 (0.833 to 0.980)	referent	1.852 (1.589 to 2.157)
Prepregnancy BMI- Overweight aOR (95% CI)	0.972 (0.821 to 1.150)	referent	1.542 (1.277 to 1.864)
Prepregnancy BMI- Obese aOR (95% CI)	0.982 (0.778 to 1.240)	referent	1.147 (0.852 to 1.545)
Gestational diabetes aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	1.703 (1.275 to 2.274)	referent	1.030 (0.476 to 2.229)

Outcome	Inadequate gestational weight gain, N = 62005	Adequate gestational weight gain, N = 28281	Excessive gestational weight gain, N = 6871
Prepregnancy BMI- Normal weight aOR (95% CI)	1.814 (1.633 to 1.770)	referent	1.477 (1.233 to 1.770)
Prepregnancy BMI- Overweight aOR (95% CI)	1.749 (1.472 to 2.078)	referent	0.711 (0.561 to 0.901)
Prepregnancy BMI- Obese aOR (95% CI)	1.703 (1.323 to 2.193)	referent	1.030 (0.765 to 1.386)
Small for gestational age aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	2.142 (1.849 to 2.482)	referent	0.774 (0.516 to 1.161)
Prepregnancy BMI- Normal weight aOR (95% CI)	1.764 (1.647 to 1.889)	referent	0.659 (0.554 to 0.784)
Prepregnancy BMI- Overweight aOR (95% CI)	1.489 (1.212 to 1.829)	referent	0.863 (0.663 to 1.123)

Outcome	Inadequate gestational weight gain, N = 62005	Adequate gestational weight gain, N = 28281	Excessive gestational weight gain, N = 6871
Prepregnancy BMI- Obese aOR (95% CI)	1.628 (1.085 to 2.444)	referent	1.108 (0.714 to 1.720)
Large for gestational age aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	0.352 (0.310 to 0.399)	referent	1.443 (1.067 to 1.950)
Prepregnancy BMI- Normal weight aOR (95% CI)	0.544 (0.517 to 0.572)	referent	1.734 (1.592 to 1.888)
Prepregnancy BMI- Overweight aOR (95% CI)	0.653 (0.560 to 0.761)	referent	1.655 (1.433 to 1.912)
Prepregnancy BMI- Obese aOR (95% CI)	0.595 (0.476 to 0.742)	referent	1.470 (1.162 to 1.860)
Caesarean birth aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight	1.138 (1.037 to 1.247)	referent	1.205 (0.915 to 1.587)

Outcome	Inadequate gestational weight gain, N = 62005	Adequate gestational weight gain, N = 28281	Excessive gestational weight gain, N = 6871
aOR (95% CI)			
Prepregnancy BMI- Normal weight aOR (95% CI)	1.117(1.071 to 1.166)	referent	1.358 (1.252 to 1.474)
Prepregnancy BMI- Overweight aOR (95% CI)	1.101 (0.987 to 1.229)	referent	1.176 (1.041 to 1.328)
Prepregnancy BMI- Obese aOR (95% CI)	0.934 (0.790 to 1.104)	referent	1.171 (0.937 to 1.462)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, maternal height, parity

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome.)
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias.)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Some risk of measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Flick, 2010

Bibliographic Reference	Flick, Amy A; Brookfield, Kathleen F; de la Torre, Lesley; Tudela, Carmen Maria; Duthely, Lunthita; Gonzalez-Quintero, Victor Hugo; Excessive weight gain among obese women and pregnancy outcomes.; American journal of perinatology; 2010; vol. 27 (no. 4); 333-8

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2000 to 2005
Inclusion criteria	• singleton pregnancies • obese women
Exclusion criteria	• multiple gestations • missing data on weight gain • pregnancies complicated by fetal lethal anomalies
Patient characteristics	**Mean (SD) maternal age, years** BMI 30 to 35.9: 28.0 (6.6) BMI 36 to 39.9: 28.3 (6.6) BMI ≥40: 28.0 (6.5) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n** NR

Risk factor(s) of interest	Gestational weight gain -definition not reported Institute of Medicine (IOM) categories used: • weight loss • weight gain of up to 14.9 pounds • weight gain of 15 to 24.9 pounds • weight gain of 25 or more pounds
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • race/ethnicity • trimester at first prenatal visit • previous CD • previous preterm delivery • chronic hypertension • pregestational diabetes
Duration of follow-up	Until birth
Setting	Jackson Memorial Hospital/University of Miami
Sources of funding	NR

BMI: body mass index; CD: caesarean delivery; NR: not reported; SD: standard deviation

Study arms

Gestational weight loss (N = NR)

Gestation weight gain of up to 14.9 pounds (N = NR)

Gestational weight gain of 15 to 24.9 pounds (N = NR)

Gestational weight gain of 25 or more pounds (N = NR)

Outcomes

Outcome	Gestational weight loss, N = NR	Gestation weight gain of up to 14.9 pounds, N = NR	Gestational weight gain of 15 to 24.9 pounds, N = NR	Gestational weight gain of 25 or more pounds, N = NR
Caesarean birth aOR (95% CI)	-	-	-	-
BMI 30-35.9 aOR (95% CI)	1.02 (0.08 to 1.26)	0.97 (0.81 to 1.16)	referent	1.46 (1.31 to 1.63)
BMI 36-39.9 aOR (95% CI)	0.78 (0.50 to 1.23)	1.06 (0.74 to 1.51)	referent	0.99 (0.70 to 1.41)
BMI ≥40 aOR (95% CI)	1.46 (1.31 to 1.63)	1.54 (1.33 to 1.94)	referent	1.58 (1.21 to 2.05)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, race/ethnicity, trimester at first prenatal visit, previous CD, previous preterm delivery, chronic hypertension, pregestational diabetes

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	**Question**	**Answer**
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias.)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*

Section	Question	Answer
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Gaillard, 2013

Bibliographic Reference	Gaillard, R.; Durmus, B.; Hofman, A.; MacKenbach, J.P.; Steegers, E.A.P.; Jaddoe, V.W.V.; Risk factors and outcomes of maternal obesity and excessive weight gain during pregnancy; Obesity; 2013; vol. 21 (no. 5); 1046-1055

Study details

Country/ies where study was carried out	The Netherlands
Study type	Prospective cohort study Multivariate analysis
Study dates	2001 to 2005
Inclusion criteria	• information about pre-pregnancy BMI available
Exclusion criteria	• pregnancies not leading to singleton live births
Patient characteristics	**Median (90% range) maternal age, years**

	30.3 (20.4 to 37.9) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** 23.6 (4.4) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -difference between pre-pregnancy weight and weight at birth Institute of Medicine (IOM) categories used: • >16 kg for underweight and normal weight • >11.5 kg for overweight • >9 kg for obese
Confounding factor(s) of interest	Covariates adjusted in analysis: • educational level • maternal age • ethnicity • parity • folic acid supplement use • smoking habits • alcohol consumption
Duration of follow-up	Two months after birth

Setting	Medical Centres
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Excessive gestational weight gain (N = 1474)

Recommended or less than recommended gestational weight gain (N = NR)

Outcomes

Outcome	Excessive gestational weight gain, N = 1474	Recommended or less than recommended gestational weight gain, N = NR
Caesarean birth aOR (95% CI)	1.26 (1.00 to 1.57)	referent

CI: confidence interval; OR: odds ratio

Covariates adjusted for: educational level, maternal age, ethnicity, parity, folic acid supplement use, smoking habits, alcohol consumption

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Moderate risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome. There is a risk of recall bias because pre- and post-pregnancy weight was taken from questionnaire data.)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Moderate risk of study confounding)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Gante, 2015

Bibliographic Reference	Gante, I.; Amaral, N.; Dores, J.; Almeida, M.C.; Impact of gestational weight gain on obstetric and neonatal outcomes in obese diabetic women; BMC Pregnancy and Childbirth; 2015; vol. 15 (no. 1); 249

Study details

Country/ies where study was carried out	Portugal
Study type	Retrospective cohort study Multivariate analysis
Study dates	2008 to 2012
Inclusion criteria	• pre-pregnancy obesity
Exclusion criteria	• missing GWG values • twin pregnancies
Patient characteristics	**Mean (SD) maternal age, years** 33.1 (5.0) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** 34.7 (4.2) **Ethnicity, n** NR

Risk factor(s) of interest	Gestational weight gain -measurement of gestational weight gain not reported Institute of Medicine (IOM) categories used: • gained <5 kg • gained within 5 to 9 kg • gained above >9 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • parity • pre-pregnancy BMI • use of insulin • gestational age at delivery • birthweight
Duration of follow-up	Until birth
Setting	25 Portuguese health institutions
Sources of funding	NR

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 502)

Adequate gestational weight gain (N = 634)

Excessive gestational weight gain (N = 670)

Outcomes

Outcome	Inadequate gestational weight gain, N = 502	Adequate gestational weight gain, N = 634	Excessive gestational weight gain, N = 670
Caesarean birth aOR (95% CI)	0.67 (0.54 to 0.85)	referent	1.31 (1.07 to 1.61)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, parity, pre-pregnancy BMI, use of insulin, gestational age at delivery, birthweight

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*

Section	Question	Answer
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Gavard, 2017

Bibliographic Reference	Gavard, Jeffrey; Gestational Weight Gain and Maternal and Neonatal Outcomes in Underweight Pregnant Women: A Population-Based Historical Cohort Study.; Maternal & Child Health Journal; 2017; vol. 21 (no. 5); 1203-1210

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2002 to 2008
Inclusion criteria	• underweight women (pre-pregnancy BMI <18.5 kg/m^2) • singleton, live, term (≥37 weeks) infants
Exclusion criteria	• congenital malformations
Patient characteristics	**Maternal age, years, n (%)** ≤25 years: • <28 lb weight gain during pregnancy: 3133 (59.0) • 28-40 lb weight gain during pregnancy: 6178 (61.5) • >40 lb weight gain during pregnancy: 4648 (73.5) 26-35 years: • <28 lb weight gain during pregnancy: 1910 (36.0) • 28-40 lb weight gain during pregnancy: 3457 (34.4) • >40 lb weight gain during pregnancy: 1534 (24.3) >35 years: • <28 lb weight gain during pregnancy: 263 (5.0) • 28-40 lb weight gain during pregnancy: 409 (4.1)

- >40 lb weight gain during pregnancy: 142 (2.2)

Mean (SD) maternal pre-pregnancy BMI, kg/m^2

NR

Ethnicity, n

White (non-Hispanic):

- <28 lb weight gain during pregnancy: 3972 (77.7)
- 28-40 lb weight gain during pregnancy: 8052 (82.2)
- >40 lb weight gain during pregnancy: 5220 (83.8)

Black

- <28 lb weight gain during pregnancy: 680 (13.3)
- 28-40 lb weight gain during pregnancy: 1019 (10.4)
- >40 lb weight gain during pregnancy: 660 (10.6)

Hispanic

- <28 lb weight gain during pregnancy: 206 (4.0)
- 28-40 lb weight gain during pregnancy: 304 (3.1)
- >40 lb weight gain during pregnancy: 188 (3.0)

Other

- <28 lb weight gain during pregnancy: 255 (5.0)
- 28-40 lb weight gain during pregnancy: 422 (4.3)
- >40 lb weight gain during pregnancy: 158 (2.5)

Risk factor(s) of interest	Gestational weight gain -measurement of GWG not reported Institute of Medicine (IOM) categories used: • <28 lbs: inadequate weight gain • 28-40 lbs: recommended weight gain • >40 lbs: excessive weight gain
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • race • education • socioeconomic status • smoking • parity • diabetes • adequacy of prenatal care • sex of infant • gestational age at delivery
Duration of follow-up	Until birth
Setting	Missouri Department of Health

Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 857)

Adequate gestational weight gain (N = 10043)

Excessive gestational weight gain (N = 1217)

Outcomes

Outcome	Inadequate gestational weight gain, N = 857	Adequate gestational weight gain, N = 1566	Excessive gestational weight gain, N = 1217
Caesarean birth aOR (95%CI)	1.04 (0.94 to 1.14)	referent	1.40 (1.28 to 1.53)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, race, education, socioeconomic status, smoking, parity, diabetes, adequacy of prenatal care, sex of infant, gestational age at delivery

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Gawade, 2011

Bibliographic Reference	Gawade, P.; Markenson, G.; Bsat, F.; Healy, A.; Pekow, P.; Plevyak, M.; Association of gestational weight gain with cesarean delivery rate after labor induction; Journal of Reproductive Medicine; 2011; vol. 56 (no. 3); 95-102

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2005 to 2008
Inclusion criteria	• women undergoing labour induction between 37 and 42 completed weeks of gestation
Exclusion criteria	• breech presentation • multiple gestation • previous caesarean delivery • missing information on pre-pregnancy weight, weight at delivery or height
Patient characteristics	**Maternal age, years, n (%)** ≤20: 455 (18.2) 21 to 25: 529 (21.2) 26 to 30: 691 (27.7) 31 to 35: 545 (21.8)

	36 to 40: 236 (9.5) >40: 39 (1.6) **Maternal pre-pregnancy BMI, kg/m^2, n (%)** <18.5: 77 (3.1) 18.5 to 24.9: 1035 (41.5) 25 to 29.9: 684 (27.4) ≥30: 699 (28.0) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -the difference between weight at delivery and pre-pregnancy weight Institute of Medicine (IOM) categories used: • 12.5 to 18 kg for underweight • 11.5 to 16 kg for normal weight • 7 to 11.5 kg for overweight • 5 to 9 kg for obese
Confounding factor(s) of interest	Covariates adjusted in analysis: • gestational weight gain • maternal age

	• birthweight • gestational age • pre-pregnancy BMI • parity • bishop score • infant gender
Duration of follow-up	Until birth
Setting	Baystate Medical Centre
Sources of funding	NR

BMI: body mass index; NR: not reported

Study arms

Inadequate gestational weight gain (N = 1328)

Adequate gestational weight gain (N = 679)

Excessive gestational weight gain (N = 488)

Outcomes

Outcome	Inadequate gestational weight gain, N = 1328	Adequate gestational weight gain, N = 679	Excessive gestational weight gain, N = 488
Caesarean birth aOR (95% CI)	NR	referent	1.13 (1.05 to 1.23)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: gestational weight gain, maternal age, birthweight, gestational age, pre-pregnancy BMI, parity, bishop score, infant gender

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Graham, 2014

Bibliographic Reference	Graham, Lauren E; Brunner Huber, Larissa R; Thompson, Michael E; Ersek, Jennifer L; Does amount of weight gain during pregnancy modify the association between obesity and cesarean section delivery?.; Birth (Berkeley, Calif.); 2014; vol. 41 (no. 1); 93-9

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis

Study dates	2008 to 2009
Inclusion criteria	NR
Exclusion criteria	• <18 years old • >45 years old • prior cesarean delivery
Patient characteristics	**Maternal age, years, n (%)** 18 to 24: 723 25 to 34: 1153 ≥35: 301 **Maternal pre-pregnancy BMI, kg/m², n (%)** <18.5: 255 (12.83) 18.5 to 24.9: 1085 (48.78) 25.0 to 29.9: 432 (21.00) ≥30.0: 385 (17.39)
Risk factor(s) of interest	Gestational weight gain -definition of gestational weight gain not reported Institute of Medicine (IOM) categories used but thresholds not reported
Confounding factor(s) of interest	Covariates adjusted in analysis: • race/ethnicity • live births

	• household income • education
Duration of follow-up	Until birth
Setting	NR
Sources of funding	NR

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 664)

Adequate gestational weight gain (N = 696)

Excessive gestational weight gain (N = 797)

Outcomes

Outcome	Inadequate gestational weight gain, N = 664	Adequate gestational weight gain, N = 696	Excessive gestational weight gain, N = 797
Caesarean birth aOR (95% CI)	-	-	-

Outcome	Inadequate gestational weight gain, N = 664	Adequate gestational weight gain, N = 696	Excessive gestational weight gain, N = 797
BMI <18.5 aOR (95% CI)	0.75 (0.34 to 1.48)	1.24 (0.71 to 1.98)	1.42 (0.68 to 2.53)
BMI 18.5-24.9 aOR (95% CI)	referent	referent	referent
BMI 25.0-29.9 aOR (95% CI)	0.73 (0.27 to 1.69)	1.05 (0.65 to 1.63)	1.07 (0.74 to 1.51)
BMI >30 aOR (95% CI)	2.58 (1.71 to 3.47)	1.71 (1.10 to 2.47)	1.64 (1.15 to 2.23)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: race/ethnicity, live births, household income, education

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Some risk of measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Haile, 2019

Bibliographic Reference	Haile, Z.T.; Chavan, B.; Teweldeberhan, A.K.; Chertok, I.R.A.; Francescon, J.; Gestational weight gain and unplanned or emergency cesarean delivery in the United States; Women and Birth; 2019; vol. 32 (no. 3); 263-269

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2005 to 2007
Inclusion criteria	• 18 years or older • delivered a singleton (at least 35 gestational weeks) • newborn weighing at least 5 pounds • no admission to intensive care for more than 3 days • both the mother and infant were free of any medical condition preventing breastfeeding
Exclusion criteria	• planned caesarean delivery • missing data on mode of delivery, GWG, or any of the covariates adjusted in the multivariable model
Patient characteristics	**Maternal age, years, n (%)** 18 to 24: 474 (22.5) 25to 34: 1326 (62.9) ≥35: 307 (14.6) **Maternal pre-pregnancy BMI, kg/m^2, n (%)** Underweight: 1007 (47.8) Normal: 99 (4.7)

	Overweight: 536 (25.4) Obese: 465 (22.1) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -difference between pre-pregnancy BMI and weight gain during pregnancy Institute of Medicine (IOM) categories used: • BMI <18.5: recommended weight gain 12.5 to 18 kg • BMI 18.5 to 24.9: recommended weight gain 11.5 to 16 kg • BMI 25.0 to 29.9: recommended weight gain 7 to 11.5 kg • BMI≥30: recommended weight gain 5 to 9 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • education • marital status • pre-pregnancy body mass index • race/ethnicity • poverty-income ratio • gestational age • previous birth experience

	• gestational diabetes mellitus • macrosomia • type of birth attendant
Duration of follow-up	Until birth
Setting	NR
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported

Study arms

Adequate gestational weight gain (N = 418)

Inadequate gestational weight gain (N = 651)

Excessive gestational weight gain (N = 1038)

Outcomes

Outcome	Adequate gestational weight gain, N = 418	Inadequate gestational weight gain, N = 651	Excessive gestational weight gain, N = 1038
Caesarean birth	referent	1.01 (0.61 to 1.65)	1.56 (1.07 to 2.27)

Outcome	Adequate gestational weight gain, N = 418	Inadequate gestational weight gain, N = 651	Excessive gestational weight gain, N = 1038
aOR (95% CI)			

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, education, marital status, pre-pregnancy body mass index, race/ethnicity, poverty-income ratio, gestational age, previous birth experience, gestational diabetes mellitus, macrosomia, type of birth attendant

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*

Section	Question	Answer
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Harper, 2011

Bibliographic Reference	Harper, Lorie M; Chang, Jen Jen; Macones, George A; Adolescent pregnancy and gestational weight gain: do the Institute of Medicine recommendations apply?.; American journal of obstetrics and gynecology; 2011; vol. 205 (no. 2); 140e1-8

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	1989 to 2005
Inclusion criteria	• primiparous

	• singleton gestations • <20 years • delivered 24 to 44 weeks gestation
Exclusion criteria	• pregnancies complicated by major fetal anomalies • breech presentation • multifetal gestations
Patient characteristics	**Mean (SD) maternal age, years** BMI <18.5: 17.49 (1.30) BMI 18.5 to 24.9: 17.55 (1.31) BMI 25.0 to 29.9: 17.73 (1.28) BMI ≥30: 17.96 (1.16) **Mean maternal pre-pregnancy BMI, kg/m²** NR **Ethnicity** NR
Risk factor(s) of interest	Gestational weight gain -Gestational weight gain definition not reported Institute of Medicine (IOM) categories used: • Gain less than IOM: <28 lbs • Within IOM: 28 to 40 lbs

	• Gain more than IOM: >40 lbs
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • maternal race • tobacco use • alcohol use • composite maternal medical risk factor (includes chronic hypertension, diabetes, and renal disease), Medicaid, and the Kotel chuck prenatal care index
Duration of follow-up	Until birth
Setting	NR
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 14795)

Adequate gestational weight gain (N = 24201)

Excessive gestational weight gain (N = 37679)

Outcomes

Outcome	Inadequate gestational weight gain, N = 14795	Adequate gestational weight gain, N = 24201	Excessive gestational weight gain, N = 37679
Caesarean birth aOR (95% CI)	-	-	-
BMI <18.5 aOR (95% CI)	1.02 (0.87 to 1.20)	referent	1.15 (0.99 to 1.34)
BMI 18.5-24.9 aOR (95% CI)	1.00 (0.92 to 1.08)	referent	1.35 (1.27 to 1.44)
BMI 25.0-29.9 aOR (95% CI)	0.94 (0.77 to 1.15)	referent	1.27 (1.13 to 1.43)
BMI >30 aOR (95% CI)	0.69 (0.54 to 0.88)	referent	1.12 (0.96 to 1.31)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, maternal race, tobacco use, alcohol use, composite maternal medical risk factor

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Moderate *(Some risk of measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Haugen, 2014

Bibliographic Reference	Haugen, M.; Brantsaeter, A.L.; Winkvist, A.; Lissner, L.; Alexander, J.; Oftedal, B.; Magnus, P.; Meltzer, H.M.; Associations of pre-pregnancy body mass index and gestational weight gain with pregnancy outcome and postpartum weight retention: A prospective observational cohort study; BMC Pregnancy and Childbirth; 2014; vol. 14 (no. 1); 201

Study details

Country/ies where study was carried out	Norway
Study type	Prospective cohort study Multivariate analysis
Study dates	1999 to 2008
Inclusion criteria	• singleton delivery
Exclusion criteria	• pregnancy duration <37 weeks or >42 weeks • GWG less than 30 kg or higher than 50 kg • <18 years of age • women with a second or third participation in the Norwegian Mother and Child Cohort Study (MoBa)
Patient characteristics	**Mean (SD) maternal age, years** Nulliparous: 28.4 (4.3) Parous: 31.8 (4.1) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** Nulliparous: 23.7 (4.1)

	Parous: 24.2 (4.2) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -difference between self-reported weight at delivery and registered 6 months after birth. Institute of Medicine (IOM) categories used: • BMI <18.5: 12.5 to 18 kg • BMI 18.5 to 24.9: 11.5 to 16 kg • BMI 25 to 29.9: 7 to 11.5 kg • BMI >30.0: 5 to 9 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age at delivery • maternal height • maternal education level • smoking in pregnancy • gestational length • diabetic conditions
Duration of follow-up	Until birth
Setting	Norwegian Institute of Public Health

Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 19201)

Excessive gestational weight gain (N = 26697)

Outcomes

Outcome	Adequate gestational weight gain, N = 19201	Excessive gestational weight gain, N = 26697
Caesarean birth aOR (95% CI)	-	-
Caesarean birth Nulliparous, BMI Underweight aOR (95% CI)	referent	1.71 (0.85 to 3.43)
Caesarean birth Nulliparous, BMI Normal weight aOR (95% CI)	referent	1.44 (1.28 to 1.62)
Caesarean birth Nulliparous, BMI Overweight aOR (95% CI)	referent	1.42 (1.14 to 1.77)

Outcome	Adequate gestational weight gain, N = 19201	Excessive gestational weight gain, N = 26697
Caesarean birth Nulliparous, BMI Obese aOR (95% CI)	referent	1.39 (1.04 to 1.84)
Caesarean birth Parous, BMI Underweight aOR (95% CI)	referent	1.25 (0.40 to 3.91)
Caesarean birth Parous, BMI Normal weight aOR (95% CI)	referent	1.48 (1.23 to 1.78)
Caesarean birth Parous, BMI Overweight aOR (95% CI)	referent	1.95 (1.41 to 2.69)
Caesarean birth Parous, BMI Obese aOR (95% CI)	referent	1.21 (0.85 to 1.73)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age at delivery, maternal height, maternal education level, smoking in pregnancy, gestational length, diabetic conditions

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Hautier, 2022

Bibliographic Reference	Hautier, S.; Capmas, P.; Houllier, M.; Evaluation of the impact of body mass index < 18,5 kg/m^2 in early pregnancy on obstetric and neonatal outcomes; Journal of Gynecology Obstetrics and Human Reproduction; 2022; vol. 51 (no. 8); 102438

Study details

Country/ies where study was carried out	France
Study type	Retrospective cohort study Multivariate analysis
Study dates	2017 to 2019
Inclusion criteria	• birth after 15 weeks of gestation • singleton pregnancy • BMI <18.5 kg/m^2 in early pregnancy
Exclusion criteria	• birth before 37 weeks of gestation
Patient characteristics	**Median (IQR) maternal age, years** BMI <18.5: 28 (27 to 34) BMI 18.5 to 24: 30 (25 to 32) **Mean maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n**

	NR

Risk factor(s) of interest	Gestational weight gain
	-weight recorded during the last consultation on the day of delivery and the pre-pregnancy self-reported weight
	French guidelines based on Institute of Medicine (IOM) categories:
	• adequate:
	  ○ 12.5 to 18 kg for underweight
	  ○ 11.5 to 16 kg for normal weight
	  ○ 7 to 11.5 kg for overweight
	  ○ 5 to 9 kg for obese
	• under or greater than recommendations

Confounding factor(s) of interest	Covariates adjusted in analysis: • BMI <18.5 kg/m^2 • smoking • parity
Duration of follow-up	Until birth
Setting	Hospital-based
Sources of funding	NR

BMI: body mass index; IQR: interquartile range; NR: not reported

Study arms

Adequate gestational weight gain (N = 201)

Inadequate gestational weight gain (N = 139)

Outcomes

Outcome	Adequate gestational weight gain, N = 201	Inadequate gestational weight gain, N = 139
Small for gestational age (below 10th percentile of birthweight) aOR (95% CI)	referent	2.41 (1.5 to 3.87)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: BMI <18.5 kg/m^2, smoking, parity

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Hung, 2016

Bibliographic Reference	Hung, T.-H.; Hsieh, T.-T.; Pregestational body mass index, gestational weight gain, and risks for adverse pregnancy outcomes among Taiwanese women: A retrospective cohort study; Taiwanese Journal of Obstetrics and Gynecology; 2016; vol. 55 (no. 4); 575-581

Study details

Country/ies where study was carried out	Taiwan
Study type	Retrospective cohort study Multivariate analysis
Study dates	2009 to 2015
Inclusion criteria	• deliveries after 37 0/7 weeks of gestation
Exclusion criteria	• multiple gestations • fetal chromosomal or structural anomalies • fetal demise • pregestational diabetes mellitus • chronic hypertension
Patient characteristics	**Maternal age, years, n** <20: 18 20-34: 7086 >34: 3869 **Mean maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity** NR

Risk factor(s) of interest	Gestational weight gain - difference between pre-pregnancy weight and weight at delivery Institute of Medicine (IOM) categories used: • underweight: 12.5 to 18 kg • normal weight: 11.5 to 16 kg • overweight: 7 to 11.5 kg • obese: 5 to 9 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age at delivery • parity • prior fetal death • prior preterm birth • conception methods • genetic amniocentesis • smoking during pregnancy • group B streptococcal colonization at the genitorectal tract • fetal sex • intrapartum epidural analgesia
Duration of follow-up	Until birth
Setting	Hospital based

Sources of funding	Not industry funded

BMI: body mass index; NR: not reported

Study arms

Adequate gestational weight gain (N = 4945)

Inadequate gestational weight gain (N = 3156)

Excessive gestational weight gain (N = 2869)

Outcomes

Outcome	Adequate gestational weight gain, N = 4945	Inadequate gestational weight gain, N = 3156	Excessive gestational weight gain, N = 2869
Gestational diabetes aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	referent	1.66 (1.07 to 2.56)	0.36 (0.11 to 1.19)
Prepregnancy BMI- Normal weight aOR (95% CI)	referent	1.49 (1.25 to 1.78)	0.89 (0.72 to 1.10)

Outcome	Adequate gestational weight gain, N = 4945	Inadequate gestational weight gain, N = 3156	Excessive gestational weight gain, N = 2869
Prepregnancy BMI- Overweight/Obese aOR (95% CI)	referent	1.75 (1.15 to 2.68)	0.61 (0.43 to 0.87)
Preeclampsia aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	referent	1.72 (0.28 to 10.48)	4.58 (0.62 to 34.14)
Prepregnancy BMI- Normal weight aOR (95% CI)	referent	1.13 (0.58 to 2.22)	3.65 (2.18 to 6.10)
Prepregnancy BMI- Overweight/Obese aOR (95% CI)	referent	0.76 (0.27 to 2.16)	1.24 (0.64 to 2.41)
Caesarean birth aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	referent	0.94 (0.68 to 1.29)	2.32 (1.45 to 3.72)

Outcome	Adequate gestational weight gain, N = 4945	Inadequate gestational weight gain, N = 3156	Excessive gestational weight gain, N = 2869
Prepregnancy BMI- Normal weight aOR (95% CI)	referent	0.76 (0.65 to 0.89)	1.35 (1.16 to 1.56)
Prepregnancy BMI- Overweight/Obese aOR (95% CI)	referent	0.95 (0.55 to 1.64)	1.32 (0.92 to 1.90)
Small for gestational age aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	referent	2.17 (1.56 to 3.02)	0.73 (0.36 to 1.47)
Prepregnancy BMI- Normal weight aOR (95% CI)	referent	1.55 (1.27 to 1.89)	0.65 (0.50 to 0.83)
Prepregnancy BMI- Overweight/Obese aOR (95% CI)	referent	1.30 (0.62 to 2.72)	0.64 (0.35 to 1.16)
Large for gestational age aOR (95% CI)	-	-	-

Outcome	Adequate gestational weight gain, N = 4945	Inadequate gestational weight gain, N = 3156	Excessive gestational weight gain, N = 2869
Prepregnancy BMI- Underweight aOR (95% CI)	referent	0.22 (0.10 to 0.49)	2.58 (1.38 to 4.81)
Prepregnancy BMI- Normal weight aOR (95% CI)	referent	0.52 (0.41 to 0.65)	1.80 (1.51 to 2.15)
Prepregnancy BMI- Overweight/Obese aOR (95% CI)	referent	0.66 (0.37 to 1.16)	1.30 (0.91 to 1.86)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age at delivery, parity, prior fetal death, prior preterm birth, conception methods, genetic amniocentesis, smoking during pregnancy, group B streptococcal colonization at the genitorectal tract, fetal sex, intrapartum epidural analgesia

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Kiefer, 2022

Bibliographic Reference	Kiefer, M.K.; Adebayo, A.; Cleary, E.; Klebanoff, M.; Costantine, M.M.; Landon, M.B.; Gabbe, S.; Frey, H.; Venkatesh, K.K.; Gestational Weight Gain and Adverse Maternal and Neonatal Outcomes for Pregnancies Complicated by Pregestational and Gestational Diabetes; American Journal of Perinatology; 2022; vol. 39 (no. 7); 691-698

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2002-2008
Inclusion criteria	• deliveries >23 gestational weeks of nonanomalous singletons • pregestational or gestational diabetes
Exclusion criteria	• implausible weight gain or weight loss (defined as a weight gain of ≥36.4 kg or 80 lbs or weight loss of ≥18.2 kg or 40 lbs)
Patient characteristics	**Mean (SD) maternal age, years** 30.6 (5.97) **Maternal pre-pregnancy BMI category, n (%)** Underweight: 161 (1.9) Normal: 2558 (30.7) Overweight: 2188 (26.3) Obesity class I: 1625 (19.5) Obesity class II: 936 (11.3) Obesity class III: 854 (10.3) **Ethnicity, n**

	NR
Risk factor(s) of interest	Gestational weight gain -difference between weight on admission to delivery and pre-pregnancy weight at the first prenatal visit Institute of Medicine (IOM) categories used: • gestational weight gain categories not reported
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • race • parity • history of caesarean delivery • chronic hypertension • tobacco use • delivery year • gestational age at birth
Duration of follow-up	Until birth
Setting	19 hospitals across the United States
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Gestational weight gain- Inadequate (N = 2199)

Gestational weight gain- Adequate (N = 2267)

Gestational weight gain- Excessive (N = 3856)

Outcomes

Outcome	Gestational weight gain- Inadequate, N = 2199	Gestational weight gain- Adequate, N = 2267	Gestational weight gain- Excessive, N = 3856
Caesarean birth aOR (95% CI)	0.79 (0.69 to 0.92)	referent	1.60 (1.41 to 1.82)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, race, parity, history of caesarean delivery, chronic hypertension, tobacco use, delivery year, gestational age at birth

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key*

Section	Question	Answer
		characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Kominiarek, 2013

Bibliographic Reference	Kominiarek, MA; Seligman, NS; Dolin, C; Gao, W; Berghella, V; Hoffman, M; Hibbard, JU; Gestational weight gain and obesity: is 20 pounds too much?; American journal of obstetrics and gynecology; 2013; vol. 209 (no. 3); 214.e1-11

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2005 to 2007
Inclusion criteria	• pre-pregnancy BMI ≥30 kg/m^2 • known gestational weight change • singleton, term (≥37.0 weeks), live-born gestation
Exclusion criteria	• stillbirths • missing data
Patient characteristics	**Mean (SD) maternal age, years** • weight change, loss: 28.1 (5.7) • weight change, low: 28.8 (5.7) • weight change, normal: 28.7 (5.8) • weight change, high: 27.7 (5.9) **Mean maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n** NR

Risk factor(s) of interest	Gestational weight gain -the difference between the self-reported pre-pregnancy weight and delivery weight Categories used: • loss: <0 kg • low: 0 to 4.9 kg • normal: 5 to 9 kg • high: >9 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • race/ethnicity • marital status • insurance • parity • smoking • gestational age
Duration of follow-up	NR
Setting	Hospital based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Weight loss (N = 1182)

Low gestational weight gain (N = 3028)

Normal gestational weight gain (N = 3613)

High gestational weight gain (N = 13127)

Outcomes

Outcome	Weight loss, N = 1182	Low gestational weight gain, N = 3028	Normal gestational weight gain, N = 3613	High gestational weight gain, N = 13127
Caesarean birth Nulliparous aOR (95% CI)	-	-	-	-
Class I obese aOR (95% CI)	0.21 (0.11 to 0.42)	0.85 (0.62 to 1.2)	referent	1.2 (1.0 to 1.5)
Class II obese aOR (95% CI)	0.81 (0.48 to 1.4)	1.1 (0.74 to 1.6)	referent	1.5 (1.1 to 2.0)
Class III obese aOR (95% CI)	0.79 (0.49 to 1.3)	1.1 (0.71 to 1.7)	referent	1.7 (1.2 to 2.4)

Outcome	Weight loss, N = 1182	Low gestational weight gain, N = 3028	Normal gestational weight gain, N = 3613	High gestational weight gain, N = 13127
Caesarean birth Parous aOR (95% CI)	-	-	-	-
Class I obese aOR (95% CI)	0.61 (0.44 to 0.83)	0.88 (0.74 to 1.1)	referent	1.3 (1.1 to 1.4)
Class II obese aOR (95% CI)	0.82 (0.60 to 1.1)	0.82 (0.66 to 1.0)	referent	1.1 (0.93 to 1.3)
Class III obese aOR (95% CI)	0.76 (0.56 to 1.0)	0.77 (0.59 to 0.99)	referent	1.1 (0.94 to 1.5)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, race/ethnicity, marital status, insurance, parity, smoking, gestational age

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*

Section	Question	Answer
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Langford, 2011

Bibliographic Reference	Langford, Aisha; Joshu, Corinne; Chang, Jen Jen; Myles, Thomas; Leet, Terry; Does gestational weight gain affect the risk of adverse maternal and infant outcomes in overweight women?.; Maternal and child health journal; 2011; vol. 15 (no. 7); 860-5

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	1990 to 2004
Inclusion criteria	• nulliparous women who delivered a full-term (≥37 weeks) singleton infant • 18–35 years of age at time of delivery
Exclusion criteria	NR

Patient characteristics	**Maternal age, years, %**
	• Below IOM recommendations
	  ○ 18 to 24: 57.1
	  ○ 25 to 30: 30.8
	  ○ 31 to 35: 12.1
	• Within IOM recommendations
	  ○ 18 to 24: 52.5
	  ○ 25 to 30: 34.7
	  ○ 31 to 35: 12.8
	• Above IOM recommendations

	18 to 24: 53.8 25 to 30: 34.5 31 to 35: 11.7 **Mean maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -Gestational weight gain definition not reported Institute of Medicine (IOM) categories used: - below recommendations: <15 lbs - within recommendations: 15 to 25 lbs - above recommendations: >25 lbs
Confounding factor(s) of interest	Covariates adjusted in analysis: maternal age
Duration of follow-up	Until birth
Setting	NR
Sources of funding	NR

BMI: body mass index; IOM: Institute of Medicine; NR: not reported

Study arms

Inadequate gestational weight gain (N = 1787)

Adequate gestational weight gain (N = 7205)

Excessive gestational weight gain (N = 25151)

Outcomes

Outcome	Inadequate gestational weight gain, N = 1787	Adequate gestational weight gain, N = 7205	Excessive gestational weight gain, N = 25151
Caesarean birth aRR (95% CI)	0.92 (0.83 to 1.01)	referent	1.30 (1.24 to 1.36)

CI: confidence interval; RR: risk ratio

Covariates adjusted for: maternal age

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Moderate risk of bias *(The study sample represents the population of interest on some key characteristics. There is possibly some bias of the observed relationship between PF and outcome)*

Section	Question	Answer
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	High *(Moderate risk of selection and measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Lautredou, 2022

Bibliographic Reference	Lautredou, M.; Pan-Petesch, B.; Dupre, P.-F.; Drugmanne, G.; Nowak, E.; Anouilh, F.; Briend, D.; Salomon, C.; Gourhant, L.; Le Moigne, E.; Merviel, P.; Lacut, K.; Robin, S.; Tremouilhac, C.; de Moreuil, C.; Excessive gestational weight gain is an independent risk factor for gestational diabetes mellitus in singleton pregnancies: Results from a French cohort study; European Journal of Obstetrics and Gynecology and Reproductive Biology; 2022; vol. 275; 31-36

Study details

Country/ies where study was carried out	France
Study type	Prospective cohort study Multivariate analysis
Study dates	2013 to 2015
Inclusion criteria	• women admitted for delivery in the maternity ward of Brest University Hospital between April 1st and May 29th 2013 • singleton pregnancies • delivery after 24 weeks of gestation
Exclusion criteria	• declined to participate • missing medical files • gemellar pregnancies • deliveries before 24 weeks gestation • missing pre-pregnancy BMI or GWG values in medical files
Patient characteristics	**Mean maternal age, years** NR

	Maternal pre-pregnancy BMI, kg/m^2, n (%) <18.5: 247 (6.9) 18.5 to 24.9: 1932 (53.7) 25 to 29.9: 583 (18.4) ≥30: 400 (12.7) **Ethnicity, n** NR

Risk factor(s) of interest	Gestational weight gain
	-the difference between the body weight at last pregnancy visit (maximum one month before birth) and the body weight at first visit
	Institute of Medicine (IOM) categories used:
	• adequate
	  ○ 12.5 to 18 kg for underweight
	  ○ 11.5 to 16 kg for normal weight
	  ○ 7 to 11.5 kg for overweight
	  ○ 5 to 9 kg for obese
	• inadequate: when the values were below the intervals for each category
	• excessive: when the values were above the intervals for each category

Confounding factor(s) of interest	Covariates adjusted in analysis: • age • parity

	• geographical origin • tobacco use • gestational age • preexisting diabetes • preexisting chronic hypertension
Duration of follow-up	Until birth
Setting	Hospital-based
Sources of funding	Not industry funded

BMI: body mass index

Study arms

Adequate gestational weight gain (N = 1038)

Inadequate gestational weight gain (N = 968)

Excessive gestational weight gain (N = 1156)

Outcomes

Outcome	Adequate gestational weight gain, N = 1038	Inadequate gestational weight gain, N = 968	Excessive gestational weight gain, N = 1156
Gestational diabetes aOR (95% CI)	referent	1.59 (1.19 to 2.13)	1.55 (1.17 to 2.06)
Gestational hypertension aOR (95% CI)	referent	0.85 (0.27 to 2.75)	1.99 (0.73 to 5.41)
Caesarean birth aOR (95% CI)	referent	0.94 (0.73 to 1.21)	1.46 (1.16 to 1.83)
Normal pre-pregnancy BMI aOR (95% CI)	referent	1.55 (0.94 to 2.53)	1.59 (0.95 to 2.66)
Large for gestational age (macrosomia ≥ 4000 g) aOR (95% CI)	referent	0.53 (0.33 to 0.84)	2.09 (1.50 to 2.91)
Normal pre-pregnancy BMI aOR (95% CI)	referent	0.47 (0.27 to 0.84)	1.87 (1.22 to 2.87)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, parity, geographical origin, tobacco use, gestational age, preexisting diabetes, preexisting chronic hypertension

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Liang, 2021

Bibliographic Reference	Liang, Ching-Chung; Chao, Minston; Chang, Shuenn-Dhy; Chiu, Sherry Yueh-Hsia; Pregnancy weight gain may affect perinatal outcomes, quality of life during pregnancy, and child-bearing expenses: an observational cohort study.; Archives of gynecology and obstetrics; 2021; vol. 304 (no. 3); 599-608

Study details

Country/ies where study was carried out	Taiwan
Study type	Retrospective cohort study Multivariate analysis
Study dates	2014 to 2015
Inclusion criteria	• singleton pregnancies who delivered at Chang Gung Memorial Hospital, Linkou between 2014 and 2015
Exclusion criteria	• multiple pregnancies • fetal anomalies • diabetes • chronic hypertension • delivery before 28 gestational weeks • incomplete data for other variables of interest
Patient characteristics	**Maternal age, years, n (%)** 20 to 24: 80 (3.6) 25 to 29: 456 (20.7)

	30 to 34: 947 (42.9) 35 to 39: 633 (28.6) ≥40: 94 (4.3) **Maternal BMI, kg/m^2, n (%)** <18.5: 223 (10.1) 18.5 to 24.9: 1591 (71.2) 25 to 29.9: 305 (13.8) ≥30: 91 (4.2) **Ethnicity, n** NR

Risk factor(s) of interest	Gestational weight gain
	-the difference between the final body weight before delivery and the pre-pregnancy body weight
	Institute of Medicine (IOM) categories used:
	• within IOM
	  ○ 12.7 to 18.1 kg for underweight
	  ○ 11.3 to 15.9 kg for normal weight
	  ○ 6.8 to 11.3 kg for overweight
	  ○ 5.0 to 9.1 kg for obese
	• below IOM: when the values were below the intervals for each category
	• above IOM: when the values were above the intervals for each category

Confounding factor(s) of interest	Covariates adjusted in analysis: • age • education • parity • preterm birth • fetal head circumference
Duration of follow-up	NR
Setting	Private hospital-based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 931)

Inadequate gestational weight gain (N = 914)

Excessive gestational weight gain (N = 365)

Outcomes

Outcome	Adequate gestational weight gain, N = 931	Inadequate gestational weight gain, N = 914	Excessive gestational weight gain, N = 365
Large for gestational age (macrosomia ≥ 4000 g) aOR (95% CI)	referent	0.02 (0.003 to 0.09)	17.69 (5.43 to 57.62)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, education, parity, preterm birth, fetal head circumference

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*

Section	Question	Answer
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome .)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious result)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Lipworth, 2022

Bibliographic Reference	Lipworth, H.; Barrett, J.F.R.; Murphy, K.E.; Redelmeier, D.; Melamed, N.; Gestational weight gain in twin gestations and pregnancy outcomes: a systematic review and meta-analysis; BJOG: An International Journal of Obstetrics and Gynaecology; 2022; vol. 129 (no. 6); 868-879

Study details

Country/ies where study was carried out	Canada: n=1 China: n=3 France: n=1 Italy: n=1

	Poland: n=1 USA: n=12 *Note: data from studies conducted in China were not analysed
Study type	Systematic review Prospective and retrospective cohort studies Multivariate analysis
Study dates	1991 to 2017
Inclusion criteria	• spontaneous labour ≥28 weeks • term birth • BMI obese • BMI normal weight • birth ≥22 weeks
Exclusion criteria	• monochorionic monoamniotic • intrauterine fetal demise • malformations • twin-to-twin transfusion syndrome • BMI underweight • BMI normal weight • birth ≥39 weeks • birth <24 weeks

	• birth <23 weeks • birth <20 weeks • uterine malformation • birthweight <500g • GWG above IOM guidelines
Patient characteristics	N=19 studies, with a total of 36023 twin pregnancies **Maternal age, years** NR **Maternal pre-pregnancy BMI, kg/m^2, n** Underweight: 963 Underweight/normal weight: 1497 Normal weight: 18886 Overweight: 9588 Obese: 10099 Obese class I: 4009 Obese class II: 2080 Obese class III: 1589 **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain

	-difference between pre-pregnancy weight and last measured weight in pregnancy Institute of Medicine (IOM) categories for twin gestation used: • 6.8 to 24.5 kg for underweight or normal weight women • 14.1 to 22.7 kg for overweight women • 11.3 to 19.1 kg for obese women
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal pre-pregnancy body mass index (BMI) • chronicity • artificial reproductive therapies
Duration of follow-up	Until birth
Setting	NR
Sources of funding	Systematic review was not industry funded. Sources of funding for individual studies is not reported.
Other information	Categories of BMI were defined based on the WHO recommendations: • underweight: <18.5 kg/m^2 • normal weight: 18.5 to 24.9 kg/m^2 • overweight: 25 to 29.9 kg/m^2 • obese: ≥30 kg/m^2

BMI: body mass index; GWG: gestational weight gain; IOM: Institute of Medicine; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 12834)

Adequate gestational weight gain (N = 21852)

N value calculated by TT at NICE

Excessive gestational weight gain (N = 6621)

Outcomes

Outcome	Inadequate gestational weight gain, N = 12834	Adequate gestational weight gain, N = 21852	Excessive gestational weight gain, N = 6621
Preeclampsia aOR (95% CI)	-	-	-
BMI normal weight aOR (95% CI)	0.68 (0.48 to 0.97)	referent	2.04 (1.43 to 2.89)
BMI overweight aOR (95% CI)	0.58 (0.32 to 1.06)	referent	1.82 (1.15 to 2.87)
BMI obese aOR (95% CI)	0.49 (0.21 to 1.11)	referent	1.43 (1.02 to 2.01)
BMI- all categories aOR (95% CI)	0.47 (0.31 to 0.71)	referent	2.72 (1.73 to 4.28)

Outcome	Inadequate gestational weight gain, N = 12834	Adequate gestational weight gain, N = 21852	Excessive gestational weight gain, N = 6621
Gestational diabetes aOR (95% CI)	-	-	-
BMI normal weight aOR (95% CI)	0.89 (0.52 to 1.52)	referent	0.75 (0.42 to 1.32)
BMI overweight aOR (95% CI)	0.82 (0.38 to 1.78)	referent	0.18 (0.06 to 0.54)
BMI obese aOR (95% CI)	1.09 (0.49 to 2.44)	referent	1.37 (0.67 to 2.79)
BMI- all categories aOR (95% CI)	1.37 (1.06 to 1.77)	referent	0.94 (0.52 to 1.72)
Caesarean birth aOR (95% CI)	-	-	-
BMI normal weight aOR (95% CI)	0.75 (0.30 to 1.91)	referent	0.83 (0.50 to 1.38)
BMI overweight aOR (95% CI)	NR	referent	0.51 (0.20 to 1.33)
BMI obese	0.76 (0.54 to 1.08)	referent	1.07 (0.76 to 1.52)

Outcome	Inadequate gestational weight gain, N = 12834	Adequate gestational weight gain, N = 21852	Excessive gestational weight gain, N = 6621
aOR (95% CI)			
BMI- all categories aOR (95% CI)	0.95 (0.71 to 1.27)	referent	1.04 (0.82 to 1.34)
SGA Birthweight <10th centile aOR (95% CI)	-	-	-
BMI normal weight aOR (95% CI)	1.06 (0.53 to 2.14)	referent	0.84 (0.54 to 1.30)
BMI overweight aOR (95% CI)	1.09 (0.63 to 1.88)	referent	0.51 (0.23 to 1.11)
BMI obese aOR (95% CI)	1.22 (0.63 to 2.37)	referent	0.91 (0.41 to 1.98)
BMI- all categories aOR (95% CI)	1.29 (1.04 to 1.61)	referent	0.66 (0.43 to 1.01)

CI: confidence interval; OR: odds ratio; SGA: small for gestational age

Covariates adjusted for: maternal pre-pregnancy body mass index, chronicity, artificial reproductive therapies

Critical appraisal - NGA Critical appraisal - ROBIS checklist

Section	Question	Answer
Study eligibility criteria	Concerns regarding specification of study eligibility criteria	Low *(Study eligibility criteria clearly described, with appropriate restrictions on eligibility, justified where appropriate. SR protocol registered in PROSPERO, demonstrating that objectives and eligibility criteria were pre-specified. These pre-specified objectives and eligibility criteria were reported in the study.)*
Identification and selection of studies	Concerns regarding methods used to identify and/or select studies	Low *(The search included an appropriate range of sources to identify relevant published and unpublished reports and the terms and structure of the search strategy were comprehensive. Search restrictions applied were appropriate and justified. Two independent reviewers conducted data extraction to minimise error.)*
Data collection and study appraisal	Concerns regarding methods used to collect data and appraise studies	Low *(Methods of data collection clearly described, with sufficient data extracted from studies and presented clearly. Risk of bias was assessed by independent reviewers using the Newcastle-Ottawa risk of bias scale for cohort studies.)*
Synthesis and findings	Concerns regarding the synthesis and findings	Low *(The synthesis included all relevant studies and adhered to pre-defined analyses (or departures were clearly explained). Heterogeneity was addressed in the synthesis and explored where high. The reported findings were robust, as demonstrated through a funnel plot. The biases in primary studies were addressed.)*
Overall study ratings	Overall risk of bias	Low
Overall study ratings	Applicability as a source of data	Fully applicable

SR: systematic review

McCurdy, 2022

Bibliographic Reference	McCurdy, R.J.; Delgado, D.J.; Baxter, J.K.; Berghella, V.; Influence of weight gain on risk for cesarean delivery in obese pregnant women by class of obesity: pregnancy risk assessment monitoring system (PRAMS); Journal of Maternal-Fetal and Neonatal Medicine; 2022; vol. 35 (no. 14); 2781-2787

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2013 to 2014
Inclusion criteria	NR
Exclusion criteria	NR
Patient characteristics	**Maternal age, years, n (%)** <17 to 19: 4362 (7.2) 20 to 34: 46998 (77.7) ≥35: 9134 (15.1) **Maternal BMI, kg/m^2, n (%)** <18.5: 2440 (4.2) 18.5 to 24.9: 27515 (47.6) 25 to 29.9: 14151 (24.5)

	30 to 34.9: 7482 (12.9) 35 to 39.9: 3555 (6.1) ≥40: 2669 (4.6) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -definition not reported National Academy of Medicine (ACOG approved) guidelines used for obese people: • adequate GWG: 11 to 20 lbs • insufficient GWG: <11 lbs • excessive GWG: >20 lbs
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • race • ethnicity • educational level • marital status • household income • live birth order • alcohol use

	• gestational age • intendedness of pregnancy • infant birth weight • physical activity during pregnancy • comprehensiveness of prenatal care
Duration of follow-up	Until birth
Setting	Hospital based
Sources of funding	NR

BMI: body mass index; GWG: gestational weight gain; NR: not reported

Study arms

Adequate gestational weight gain (N = 16831)

Inadequate gestational weight gain (N = 13728)

Excessive gestational weight gain (N = 24716)

Outcomes

Outcome	Adequate gestational weight gain, N = 16831	Inadequate gestational weight gain, N = 13728	Excessive gestational weight gain, N = 24716
Caesarean birth aOR (95% CI)	-	-	-
Prepregnancy BMI <18.5 aOR (95% CI)	referent	1.11 (0.90 to 1.38)	1.27 (0.96 to 1.70)
Prepregnancy BMI 18.5-24.9 aOR (95% CI)	referent	1.14 (1.07 to 1.23)	1.16 (1.08 to 1.23)
Prepregnancy BMI 25-29.9 aOR (95% CI)	referent	1.02 (0.91 to 1.15)	1.09 (1.00 to 1.19)
Prepregnancy BMI 30-34.9 aOR (95% CI)	referent	0.96 (0.82 to 1.13)	1.20 (1.06 to 1.36)
Prepregnancy BMI 35-39.9 aOR (95% CI)	referent	0.98 (0.80 to 1.20)	1.24 (1.04 to 1.48)
Prepregnancy BMI ≥40 aOR (95% CI)	referent	0.92 (0.74 to 1.14)	1.17 (0.94 to 1.44)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, race, ethnicity, educational level, marital status, household income, live birth order, alcohol use, gestational age, intendedness of pregnancy, infant birth weight, physical activity during pregnancy, comprehensiveness of prenatal care

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Moderate risk of bias *(The study sample represents the population of interest on some key characteristics. There is possibly some bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*

Section	Question	Answer
Overall risk of bias and directness	Risk of Bias	High *(Moderate risk of selection and measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Morken, 2013

Bibliographic Reference	Morken, N.-H.; Klungsoyr, K.; Magnus, P.; Skjaerven, R.; Pre-pregnant body mass index, gestational weight gain and the risk of operative delivery; Acta Obstetricia et Gynecologica Scandinavica; 2013; vol. 92 (no. 7); 809-815

Study details

Country/ies where study was carried out	Norway
Study type	Prospective cohort study Multivariate analysis
Study dates	1999 to 2008
Inclusion criteria	• singleton pregnancies with cephalic presentation • gestational age ≥37 weeks
Exclusion criteria	• women with preeclampsia, eclampsia, chronic hypertension, diabetes, gestational diabetes and placenta previa • women with a recorded height of <1.4 m

Patient characteristics	**Maternal age, years, n (%)** <20: 405 (0.8) 20 to 24: 4962 (9.8) 25 to 29: 17148 (34.0) 30 to 34: 19662 (39.0) 35 to 39: 7348 (14.6) ≥40: 891 (1.8) **Maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -difference between maternal pre-pregnancy weight and weight at the end of pregnancy Categories used for gestational weight gain: • <8 kg • 8 to 15.9 kg • ≥16 kg
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • smoking

	• parity • BMI category
Duration of follow-up	Until birth
Setting	Hospitals and maternity units
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported

Study arms

Gestational weight gain <8 kg (N = 4128)

Gestational weight gain 8 to 15.9 kg (N = 24771)

Gestational weight gain ≥16 kg (N = 21517)

Outcomes

Outcome	Gestational weight gain <8 kg, N = 4128	Gestational weight gain 8 to 15.9 kg, N = 24771	Gestational weight gain ≥16 kg, N = 21517
Caesarean birth aRR (95% CI)	0.9 (0.8 to 1.03)	referent	1.3 (1.26 to 1.4)

CI: confidence interval; RR: risk ratio

Covariates adjusted for: maternal age, smoking, parity, BMI category

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low

Section	Question	Answer
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Nohr, 2008

Bibliographic Reference	Nohr, E.A.; Vaeth, M.; Baker, J.L.; Sorensen, T.I.A.; Olsen, J.; Rasmussen, K.M.; Combined associations of prepregnancy body mass index and gestational weight gain with the outcome of pregnancy; American Journal of Clinical Nutrition; 2008; vol. 87 (no. 6); 1750-1759

Study details

Country/ies where study was carried out	Denmark
Study type	Retrospective cohort study Multivariate analysis
Study dates	1996 to 2002
Inclusion criteria	• pregnancies resulting in live, full-term singletons
Exclusion criteria	• women with type I diabetes • <18 years old • missing information about important study variables
Patient characteristics	**Maternal age, years, n** <25: 7270

	25 to 29: 25667 30 to 34: 20904 ≥35: 7051 **Maternal pre-pregnancy BMI, kg/m^2, n (%)** Underweight: 2679 (4.4) Normal weight: 41589 (68.3) Overweight: 11874 (19.5) Obese: 4810 (7.9) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -self reported from follow up survey after birth Independent categories used: • low (<10 kg) • medium (10 to 15 kg) • high (16 to 19 kg) • very high (≥20 kg)
Confounding factor(s) of interest	Covariates adjusted in analysis: • age • parity

	• height • smoking • alcohol consumption • social status • exercise • gestational age (in d) • birth weight
Duration of follow-up	6 months after birth
Setting	NR
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported

Study arms

Gestational weight gain <10 kg (N = 7672)

Gestational weight gain 10 to 15 kg (N = 27219)

Gestational weight gain 16 to 19 kg (N = 12726)

Gestational weight gain ≥20 kg (N = 13335)

Outcomes

Outcome	Gestational weight gain <10 kg, N = 7672	Gestational weight gain 10 to 15 kg, N = 27219	Gestational weight gain 16 to 19 kg, N = 12726	Gestational weight gain ≥20 kg, N = 13335
Caesarean birth - Before labour aOR (95% CI)	0.9 (0.8 to 1.0)	referent	1.0 (0.9 to 1.1)	1.2 (1.1 to 1.3)
Caesarean birth - During labour aOR (95% CI)	0.8 (0.8 to 0.9)	referent	1.2 (1.12 to 1.3)	1.4 (1.3 to 1.5)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: age, parity, height, smoking, alcohol consumption, social status, exercise, gestational age, birth weight

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*

Section	Question	Answer
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Park, 2011

Bibliographic Reference	Park, S; Sappenfield, WM; Bish, C; Salihu, H; Goodman, D; Bensyl, DM; Assessment of the Institute of Medicine recommendations for weight gain during pregnancy: Florida, 2004-2007.; Maternal and child health journal; 2011; vol. 15 (no. 3); 289-301

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2004 to 2007
Inclusion criteria	• 18 to 40 years • a singleton full-term live birth (37 to 41 weeks of gestation) • women with available information for pre-pregnancy BMI, gestational weight change, and LGA or SGA status
Exclusion criteria	• chronic diabetes • chronic hypertension • <18 years and >40 years • women delivering preterm or post term • multiple gestations • missing data or unrealistic data
Patient characteristics	**Maternal age, years, n (%)** 18 to 24: 197869 (34.7) 25 to 34: 297202 (52.1) 35 to 40: 75601 (13.2) **Maternal pre-pregnancy BMI, kg/m^2** NR

	Ethnicity, n NR
Risk factor(s) of interest	Gestational weight gain -description not reported Institute of Medicine (IOM) categories used: • adequate • insufficient (3 categories) • excessive (3 categories) *note: data are only extracted from one interval below/above IOM recommendation
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • maternal race/ethnicity • parity • gestational age • maternal education attainment • smoking status during pregnancy • WIC program participation • total number of prenatal visits • sex of infant • infant birth year

Duration of follow-up	Until birth
Setting	Hospital based
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported

Study arms

Adequate gestational weight gain (N = 163370)

Inadequate gestational weight gain (N = 115043)

Excessive gestational weight gain (N = 292259)

Outcomes

Outcome	Adequate gestational weight gain, N = 163370	Inadequate gestational weight gain, N = 115043	Excessive gestational weight gain, N = 292259
Large for gestational age aOR (95% CI)	0.36 (0.28 to 0.46)	referent	2.12 (1.82 to 2.48)
Small for gestational age aOR (95% CI)	1.87 (1.72 to 2.02)	referent	0.60 (0.55 to 0.67)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, maternal race/ethnicity, parity, gestational age, maternal education attainment, smoking status during pregnancy, WIC program participation, total number of prenatal visits, sex of infant, infant birth year

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Moderate risk of bias *(There is some missing information and therefore cannot concluded that PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*

Section	Question	Answer
Overall risk of bias and directness	Risk of Bias	Moderate *(Moderate risk of measurement bias)*
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Premru-Srsen, 2019

Bibliographic Reference	Premru-Srsen, T.; Kocic, Z.; Fabjan Vodusek, V.; Gersak, K.; Verdenik, I.; Total gestational weight gain and the risk of preeclampsia by pre-pregnancy body mass index categories: A population-based cohort study from 2013 to 2017; Journal of Perinatal Medicine; 2019; vol. 47 (no. 6); 585-591

Study details

Country/ies where study was carried out	Slovakia
Study type	Prospective cohort study Multivariate analysis
Study dates	2013 to 2017
Inclusion criteria	• singleton pregnancies
Exclusion criteria	• multiple pregnancies • missing or implausible data

Patient characteristics	**Mean (SD) maternal age, years** • women without PE: 30.2 (4.8) • women with PE: 30.3 (5.4) **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** • women without PE: 23.7 (4.5) • women with PE: 26.6 (5.8) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -difference between pre-pregnancy gestational weight and last recorded weight during pregnancy GWG charts derived for Swedish population used
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • parity • preventive treatment with low-dose Aspirin • smoking • pre-pregnancy diabetes mellitus • pre-pregnancy hypertension • pre-pregnancy BMI
Duration of follow-up	Until birth

Setting	Hospital based
Sources of funding	Not industry funded

BMI: body mass index; GWG: gestational weight gain; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight gain (N = 68224)

Gestational weight gain 6.7 kg to 10 kg (N = 11414)

Gestational weight gain 13.7 kg to 29 kg (N = 13300)

Gestational weight gain <0.5 kg to 6.9 kg (N = 3546)

Gestational weight gain >24.6 kg to ≥29.1 kg (N = 2120)

Outcomes

Outcome	Adequate gestational weight gain, N = 68224	Gestational weight gain 6.7 kg to 10 kg, N = 11414	Gestational weight gain 13.7 kg to 29 kg, N = 13300	Gestational weight gain <0.5 kg to 6.9 kg, N = 3546	Gestational weight gain >24.6 kg to ≥29.1 kg , N = 2120
Preeclampsia aOR (95% CI)	-	-	-	-	-
Prepregnancy BMI-Underweight	referent	NR	1.08 (0.32 to 3.67)	1.69 (0.73 to 3.59)	5.45 (2.10 to 14.18)

Outcome	Adequate gestational weight gain, N = 68224	Gestational weight gain 6.7 kg to 10 kg, N = 11414	Gestational weight gain 13.7 kg to 29 kg, N = 13300	Gestational weight gain <0.5 kg to 6.9 kg, N = 3546	Gestational weight gain >24.6 kg to ≥29.1 kg , N = 2120
aOR (95% CI)					
Prepregnancy BMI-Normal weight aOR (95% CI)	referent	0.69 (0.42 to 1.15)	0.59 (0.43 to 0.81)	2.29 (1.94 to 2.71)	4.53 (3.45 to 5.87)
Prepregnancy BMI-Overweight aOR (95% CI)	referent	0.49 (0.25 to 0.97)	0.58 (0.38 to 0.87)	2.03 (1.86 to 2.61)	4.77 (3.07 to 7.43)
Prepregnancy BMI-Obese (BMI ≥30) aOR (95% CI)	referent	0.33 (0.17 to 0.63)	0.47 (0.32 to 0.68)	1.76 (1.33 to 2.32)	2.22 (1.79 to 2.72)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, parity, preventive treatment with low-dose Aspirin, smoking, pre-pregnancy diabetes mellitus, pre-pregnancy hypertension, pre-pregnancy BMI

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*

Section	Question	Answer
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome .)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Santos, 2019

Bibliographic Reference	Santos, S; Voerman, E; Amiano, P; Barros, H; Beilin, L J; Bergstrom, A; Charles, M-A; Chatzi, L; Chevrier, C; Chrousos, G P; Corpeleijn, E; Costa, O; Costet, N; Crozier, S; Devereux, G; Doyon, M; Eggesbo, M; Fantini, M P; Farchi, S; Forastiere, F;

Georgiu, V; Godfrey, K M; Gori, D; Grote, V; Hanke, W; Hertz-Picciotto, I; Heude, B; Hivert, M-F; Hryhorczuk, D; Huang, R-C; Inskip, H; Karvonen, A M; Kenny, L C; Koletzko, B; Kupers, L K; Lagstrom, H; Lehmann, I; Magnus, P; Majewska, R; Makela, J; Manios, Y; McAuliffe, F M; McDonald, S W; Mehegan, J; Melen, E; Mommers, M; Morgen, C S; Moschonis, G; Murray, D; Ni Chaoimh, C; Nohr, E A; Nybo Andersen, A-M; Oken, E; Oostvogels, Ajjm; Pac, A; Papadopoulou, E; Pekkanen, J; Pizzi, C; Polanska, K; Porta, D; Richiardi, L; Rifas-Shiman, S L; Roeleveld, N; Ronfani, L; Santos, A C; Standl, M; Stigum, H; Stoltenberg, C; Thiering, E; Thijs, C; Torrent, M; Tough, S C; Trnovec, T; Turner, S; van Gelder, Mmhj; van Rossem, L; von Berg, A; Vrijheid, M; Vrijkotte, Tgm; West, J; Wijga, A H; Wright, J; Zvinchuk, O; Sorensen, Tia; Lawlor, D A; Gaillard, R; Jaddoe, Vwv; Impact of maternal body mass index and gestational weight gain on pregnancy complications: an individual participant data meta-analysis of European, North American and Australian cohorts.; BJOG : an international journal of obstetrics and gynaecology; 2019; vol. 126 (no. 8); 984-995

Study details

Country/ies where study was carried out	Europe: n=34 Multiple: n=1 North America: n=3 Oceania: n=1
Study type	Individual participant data meta-analysis Multivariate analysis
Study dates	1989 to 2014
Inclusion criteria	• mothers with singleton live-born children born from 1989 onwards • information available on maternal pre- or early-pregnancy BMI • at least one offspring measurement (birth weight or childhood BMI) • approved by their local institutional review boards
Exclusion criteria	NR

Patient characteristics	N=39 birth cohorts, with a total of 265270 singleton births **Median (95% range) maternal age, years** 30 (20.1-39.1) **Maternal pre-pregnancy BMI, kg/m^2, n** • underweight: 9065 • normal weight: 148697 • overweight: 42678 • obese I: 13084 • obese II: 3597 • obese III: 1095 **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -the difference between the latest weight before delivery and pre-pregnancy weight Maternal pre-pregnancy BMI specific weight gain for gestational age was calculated using z-scores, which were based on reference charts created using data from this meta-analysis. The z-scores were categorized into 6 categories: • <-2.0 standard deviation (SD) • -2.0 to -1.1 SD • -1.0 to -0.1 SD • 0 to 0.9 SD • 1.0 to 1.9 SD

	• ≥2.0 SD Weight categories used: • low (≤−1.1 SD) • medium (−1.0 to 0.9 SD) • high (≥1.0 SD)
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • educational level • parity • smoking habits during pregnancy • models for birth complications were additionally adjusted for child’s sex • models for weight gain across the full range were also adjusted for maternal pre-pregnancy BMI
Duration of follow-up	Until birth
Setting	NR
Sources of funding	Neither the individual participant data meta-analysis nor the birth cohorts were industry funded.
Other information	**Birth cohorts (country) included in individual participant data meta-analysis:** • ABCD (The Netherlands) • ALSPAC (UK) • AOB/F (Canada)

	• BAMSE (Sweden) • BIB (UK) • CHOP (Multiple • Co.N.ER (Italy) • DNBC (Denmark) • Eden (France) • FCOU (Ukraine) • GASPII (Italy) • GECKO Drenthe (The Netherlands) • Generation R (The Netherlands) • Generation XXI (Portugal) • GENESIS (Greece) • Gen3G (Canada) • HUMIS (Norway) • INMA (Spain) • KOALA (The Netherlands) • Krakow Cohort (Poland) • LISAplus (Germany) • LUKAS (Finland) • MoBa (Norway) • NINFEA (Italy)

	• PÉLAGIE (France) • PIAMA (The Netherlands) • Piccolipiù (Italy) • PRIDE Study (The Netherlands) • Project Viva (United States) • Raine Study (Australia) • REPRO_PL (Poland) • RHEA (Greece) • ROLO (Ireland) • SCOPE BASELINE (Ireland) • SEATON (United Kingdom) • Slovak PCB study (Slovakia) • STEPS (Finland)

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Low gestational weight gain (N = NR)

Medium gestational weight gain (N = NR)

High gestational weight gain (N = NR)

Outcomes

Outcome	Low gestational weight gain, N = NR	Medium gestational weight gain, N = NR	High gestational weight gain, N = NR
Gestational hypertension aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	0.56 (0.39 to 0.79)	0.65 (0.51 to 0.81)	1.07 (0.76 to 1.50)
Prepregnancy BMI- Normal weight aOR (95% CI)	0.98 (0.90 to 1.07)	referent	1.39 (1.28 to 1.52)
Prepregnancy BMI- Overweight aOR (95% CI)	1.46 (1.25 to 1.71)	2.10 (1.94 to 2.27)	2.71 (2.41 to 3.06)
Prepregnancy BMI- Obesity aOR (95% CI)	3.06 (2.57 to 3.66)	3.88 (3.53 to 4.26)	4.52 (3.86 to 5.31)
Preeclampsia aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	0.45 (0.26 to 0.78)	0.68 (0.53 to 0.86)	1.22 (0.82 to 1.79)

Outcome	Low gestational weight gain, N = NR	Medium gestational weight gain, N = NR	High gestational weight gain, N = NR
Prepregnancy BMI- Normal weight aOR (95% CI)	1.02 (0.92 to 1.13)	referent	1.24 (1.12 to 1.37)
Prepregnancy BMI- Overweight aOR (95% CI)	1.86 (1.61 to 2.15)	2.10 (1.93 to 2.28)	2.54 (2.23 to 2.90)
Prepregnancy BMI- Obesity aOR (95% CI)	3.52 (3.00 to 4.14)	4.01 (3.64 to 4.40)	4.58 (3.90 to 5.37)
Gestational diabetes aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	1.39 (0.77 to 2.49)	0.55 (0.34 to 0.90)	0.56 (0.23 to 1.36)
Prepregnancy BMI- Normal weight aOR (95% CI)	0.90 (0.73 to 1.09)	referent	1.34 (1.14 to 1.58)
Prepregnancy BMI- Overweight aOR (95% CI)	1.91 (1.46 to 2.50)	2.40 (2.09 to 2.75)	3.49 (2.89 to 4.22)
Prepregnancy BMI- Obesity aOR (95% CI)	4.44 (3.41 to 5.77)	5.09 (4.40 to 5.89)	7.84 (6.38 to 9.62)

Outcome	Low gestational weight gain, N = NR	Medium gestational weight gain, N = NR	High gestational weight gain, N = NR
Small for gestational age aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	3.12 (2.75 to 3.54)	1.76 (1.63 to 1.90)	0.79 (0.67 to 0.95)
Prepregnancy BMI- Normal weight aOR (95% CI)	1.81 (1.73 to 1.89)	referent	0.57 (0.54 to 0.61)
Prepregnancy BMI- Overweight aOR (95% CI)	1.23 (1.14 to 1.33)	0.77 (0.73 to 0.81)	0.51 (0.46 to 0.57)
Prepregnancy BMI- Obesity aOR (95% CI)	0.99 (0.87 to 1.12)	0.80 (0.74 to 0.86)	0.60 (0.51 to 0.70)
Large for gestational age aOR (95% CI)	-	-	-
Prepregnancy BMI- Underweight aOR (95% CI)	0.23 (0.15 to 0.35)	0.45 (0.38 to 0.53)	0.98 (0.79 to 1.22)
Prepregnancy BMI- Normal weight	0.52 (0.49 to 0.56)	referent	2.26 (2.17 to 2.37)

Outcome	Low gestational weight gain, N = NR	Medium gestational weight gain, N = NR	High gestational weight gain, N = NR
aOR (95% CI)			
Prepregnancy BMI- Overweight aOR (95% CI)	0.92 (0.84 to 1.01)	1.77 (1.69 to 1.85)	3.46 (3.24 to 3.69)
Prepregnancy BMI- Obesity aOR (95% CI)	1.45 (1.29 to 1.63)	2.57 (2.43 to 2.72)	4.77 (4.35 to 5.22)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, educational level, parity, smoking habits during pregnancy, models for birth complications were additionally adjusted for child's sex, models for weight gain across the full range were also adjusted for maternal pre-pregnancy BMI

Critical appraisal - NGA Critical appraisal – Wang et al 2021 checklist

Methodological items	Answer
Did the research questions and inclusion criteria for the review include the components of PICO?	Low risk of bias *(Study authors report all components of PICO)*
Did the report of the review contain an explicit statement that the review methods were established before conduct of the review and did the report justify any significant deviations from the protocol?	Unclear risk of bias *(Study authors do not report study protocol or deviations from protocol)*
Did the review authors explain their selection of the study designs for inclusion in the review?	Low risk of bias *(Study authors provide rationale for selection of included study design)*

Methodological items	Answer
Did the review authors use a comprehensive literature search strategy?	Low risk of bias *(Study authors report literature search for all cohorts included in study. Search strategies cover a range of databases and use appropriate search terms.)*
Did the review authors perform study selection in duplicate?	Unclear risk of bias *(Information unavailable)*
Did the review authors perform data extraction in duplicate?	Unclear risk of bias *(Information unavailable)*
Did the review authors provide a list of excluded studies and justify the exclusions?	Unclear risk of bias *(Information unavailable)*
Did the review authors describe the included studies in adequate detail?	Low risk of bias *(Study authors provide adequate details on included studies)*
Did the review authors use a satisfactory technique for assessing RoB in individual studies that were included in the review?	Low risk of bias *(Study authors provide adequate details on the technique used for assessing risk of bias)*
Did the review authors report on the sources of funding for the studies included in the review?	Low risk of bias *(Study authors provide adequate details on funding acquired in included studies in the review)*
If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	Low risk of bias *(Study authors provide adequate details on the impact of risk of bias on the overall review findings)*
Did the review authors account for RoB in primary studies when interpreting or discussing the results of the review?	Low risk of bias *(Study authors accounted for risk of bias in primary studies in the overall interpretation of the review findings)*
Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Low risk of bias *(Study authors explore heterogeneity and adequately report on it in the review findings)*
If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	Low risk of bias *(Study authors report on the impact of publication bias)*

Methodological items	**Answer**
Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Low risk of bias *(Study authors report potential sources of conflict of interest, including any funding they received for conducting the review)*
Was the quality of time-to-event-outcome data checked?	Low risk of bias *(Time-to-event outcome data not relevant to this review)*
Did researchers stratify or account for clustering of participants within trials using either a one or two stage approach to meta-analysis?	Low risk of bias *(Clustering of participants not relevant to this review)*
Was the choice of one or two stage analysis specified in advance or results for both approaches provided, or both?	Low risk of bias *(Two step analysis used and details/results provided)*
Were IPD obtained from a large proportion of the eligible trials?	Low risk of bias *(Study authors obtained data from 39 eligible birth cohorts)*
Were the reasons for not obtaining IPD provided?	Low risk of bias *(Study authors report reasons for why study cohorts were not available)*
Were there any strategies taken to account for unavailable IPD?	Unclear risk of bias *(Study authors do not report details on strategies taken to account for unavailable IPD)*
Were the data checked for missing, invalid, out of range, or inconsistent items?	Low risk of bias *(Study authors reported on missing data and methods to handle this)*
Did the author check any discrepancies with the trial report (if available)?	Unclear risk of bias *(Information unavailable)*
Were any issues queried and, if possible, resolved?	Unclear risk of bias *(Information unavailable)*
Were the methods of assessing whether effects of interventions vary by participant characteristics appropriate?	Low risk of bias *(Study authors used appropriate methods to assessing varying effects of interventions by participant characteristics)*
Was the choice of participant level characteristics and methods of assessing participant level interactions specified in advance?	Unclear risk of bias *(Information unavailable)*

Methodological items	Answer
If there was no evidence of a differential effect by trial or participant characteristic, was emphasis placed on the overall results?	Unclear risk of bias *(Information unavailable)*
Were exploratory analyses highlighted as such?	Unclear risk of bias *(Information unavailable)*
Does any report of the results adhere to the PRISMA-IPD?	Unclear risk of bias *(Information unavailable)*
Overall risk of bias and directness	Low
Overall risk of bias and directness	Directly applicable

IPD: Individual participant data; PICO: population, intervention, comparator, outcome

Simko, 2019

Bibliographic Reference	Simko, Martin; Totka, Adrian; Vondrova, Diana; Samohyl, Martin; Jurkovicova, Jana; Trnka, Michal; Cibulkova, Anna; Stofko, Juraj; Argalasova, Lubica; Maternal Body Mass Index and Gestational Weight Gain and Their Association with Pregnancy Complications and Perinatal Conditions.; International journal of environmental research and public health; 2019; vol. 16 (no. 10)

Study details

Country/ies where study was carried out	Slovakia
Study type	Retrospective cohort study Multivariate analysis
Study dates	2013 to 2015

Inclusion criteria	• singleton deliveries after 37 gestational weeks
Exclusion criteria	• chronic hypertension • fetal anomalies • diabetes mellitus type 1 and 2
Patient characteristics	**Mean maternal age, years** NR **Mean (SD) maternal pre-pregnancy BMI, kg/m^2** Underweight: 17.7 (0.7) Normal weight: 21.2 (1.6) Overweight: 26.8 (1.3) Obese: 34.9 (3.7) **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -the difference between the final weight and the pre-pregnancy weight Institute of Medicine (IOM) categories used: • weight gain below the guidelines • weight in the range specified by the guidelines • weight gain above the guidelines *numerical range values not reported

Confounding factor(s) of interest	• maternal age • gestational age • maternal BMI • smoking
Duration of follow-up	Until birth
Setting	Second Department of Gynecology and Obstetrics at the University Hospital in Bratislava
Sources of funding	Not industry funded

BMI: body mass index; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 2172)

Adequate gestational weight gain (N = 2738)

Excessive gestational weight gain (N = 2192)

Outcomes

Outcome	Inadequate gestational weight gain, N = 2172	Adequate gestational weight gain, N = 2738	Excessive gestational weight gain, N = 2191
Caesarean birth	0.9 (0.9 to 1.1)	referent	1.2 (1.0 to 1.3)

Outcome	Inadequate gestational weight gain, N = 2172	Adequate gestational weight gain, N = 2738	Excessive gestational weight gain, N = 2191
aOR (95% CI)			
Gestational hypertension aOR (95% CI)	1.1 (0.6 to 1.8)	referent	1.7 (1.0 to 2.7)
Preeclampsia aOR (95% CI)	0.5 (0.3 to 0.9)	referent	0.9 (0.6 to 1.5)
Gestational diabetes aOR (95% CI)	1.2 (0.9 to 1.8)	referent	0.6 (0.4 to 0.9)
Large for gestational (Macrosomia) aOR (95% CI)	0.8 (0.6 to 1.1)	referent	1.7 (1.3 to 2.1)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, gestational age, maternal BMI, smoking

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*

Section	Question	Answer
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome .)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Tanigawa, 2022

Bibliographic Reference	Tanigawa, K.; Kawanishi, Y.; Ikehara, S.; Ueda, K.; Kimura, T.; Ozono, K.; Iso, H.; Association between gestational weight gain and risk of overweight at 3 years old: The Japan Environment and Children's Study; Pediatric Obesity; 2022

Study details

Country/ies where study was carried out	Japan
Study type	Prospective cohort study Multivariate analysis
Study dates	2011 to 2014
Inclusion criteria	NR
Exclusion criteria	• missing data • extreme GWG
Patient characteristics	**Mean (SD) maternal age, years** 31.54 (NR) **Mean maternal pre-pregnancy BMI, kg/m^2** 21.12 **Ethnicity, n** NR Note: mean values calculated by technical team
Risk factor(s) of interest	Gestational weight gain -difference between the maternal weight before pregnancy and immediately before birth Japanese criteria of JSOG and Institute of Medicine (IOM) guidelines used:

	• JSOG criteria:
	  ○ underweight women- adequate GWG: 12 to 15 kg
	  ○ normal weight: 10 to 13 kg
	  ○ overweight: 7 to 10 kg
	  ○ obese: ≤5 kg
	• Institute of Medicine (IOM) categories:
	  ○ underweight women- adequate GWG: 12.5 to 18kg
	  ○ normal weight: 11.5 to 16.0 kg
	  ○ overweight: 7-11.5 kg
	  ○ obese: 5-9 kg
	*note data analysed using IOM categories to allow meta analyses

Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • maternal BMI before pregnancy • maternal education levels • smoking during pregnancy • the frequency of maternal passive smoking during pregnancy • drinking during pregnancy • household income during pregnancy • occupation during pregnancy • marital status during pregnancy

	• number of children during pregnancy • a history of hypertensive disorder of pregnancy • gestational diabetes • offspring sex • gestational age
Duration of follow-up	3 years after birth
Setting	Hospital based
Sources of funding	Not industry funded

BMI: body mass index; GWG: gestational weight gain; NR: not reported; SD: standard deviation

Study arms

Inadequate gestational weight gain (N = 39816)

Adequate gestational weight gain (N = 20028)

Excessive gestational weight gain (N = 4492)

Outcomes

Outcome	Inadequate gestational weight gain, N = 39816	Adequate gestational weight gain, N = 20028	Excessive gestational weight gain, N = 4492
Childhood overweight/obesity at 3 years aRR (95% CI)	-	-	-
BMI <18.5 kg/m^2 aRR (95% CI)	0.47 (0.42 to 0.53)	0.57 (0.49 to 0.68)	0.80 (0.50 to 1.28)
BMI 18.5-24.9 kg/m^2 aRR (95% CI)	0.83 (0.78 to 0.89)	referent	1.26 (1.13 to 1.42)
BMI 25-29.9 kg/m^2 aRR (95% CI)	1.09 (0.93 to 1.27)	1.39 (1.22 to 1.58)	1.82 (1.58 to 2.09)
BMI > 30 kg/m^2 aRR (95% CI)	1.93 (1.61 to 2.31)	1.87 (1.50 to 2.33)	2.21 (1.77 to 2.78)

CI: confidence interval; RR: risk ratio

Covariates adjusted for: maternal age, maternal BMI before pregnancy, maternal education levels, smoking during pregnancy, the frequency of maternal passive smoking during pregnancy, drinking during pregnancy, household income during pregnancy, occupation during pregnancy, marital status during pregnancy, number of children during pregnancy, a history of hypertensive disorder of pregnancy, gestational diabetes, offspring sex, gestational age

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

Voerman, 2019

Bibliographic Reference	Voerman, E.; Santos, S.; Golab, B.P.; Amiano, P.; Ballester, F.; Barros, H.; Bergstrom, A.; Charles, M.-A.; Chatzi, L.; Chevrier, C.; Chrousos, G.P.; Corpeleijn, E.; Costet, N.; Crozier, S.; Devereux, G.; Eggesbo, M.; Ekstrom, S.; Fantini, M.P.; Farchi, S.; Forastiere, F.; Georgiu, V.; Godfrey, K.M.; Gori, D.; Grote, V.; Hanke, W.; Hertz-Picciotto, I.; Heude, B.; Hryhorczuk, D.; Huang, R.-C.; Inskip, H.; Iszatt, N.; Karvonen, A.M.; Kenny, L.C.; Koletzko, B.; Kupers, L.K.; Lagstrom, H.; Lehmann, I.; Magnus, P.; Majewska, R.; Makela, J.; Manios, Y.; McAuliffe, F.M.; McDonald, S.W.; Mehegan, J.; Mommers, M.; Morgen, C.S.; Mori, T.A.; Moschonis, G.; Murray, D.; Chaoimh, C.N.; Nohr, E.A.; Andersen, A.-M.N.; Oken, E.; Oostvogels, A.J.J.M.; Pac, A.; Papadopoulou, E.; Pekkanen, J.; Pizzi, C.; Polanska, K.; Porta, D.; Richiardi, L.; Rifas-Shiman, S.L.; Ronfani, L.; Santos, A.C.; Standl, M.; Stoltenberg, C.; Thiering, E.; Thijs, C.; Torrent, M.; Tough, S.C.; Trnovec, T.; Turner, S.; van Rossem, L.; von Berg, A.; Vrijheid, M.; Vrijkotte, T.G.M.; West, J.; Wijga, A.; Wright, J.; Zvinchuk, O.; Sorensen, T.I.A.; Lawlor, D.A.; Gaillard, R.; Jaddoe, V.W.V.; Maternal body mass index, gestational weight gain, and the risk of overweight and obesity across childhood: An individual participant data meta-analysis; PloS Medicine; 2019; vol. 16 (no. 2); e1002744

Study details

Country/ies where study was carried out	Australia: n=1 Europe: n=33 Multiple: n=1 North America: n=2
Study type	Individual participant data meta-analysis Multivariate analysis
Study dates	January 1st, 1989, onwards (end date unclear)
Inclusion criteria	• information available on maternal pre- or early pregnancy BMI • at least 1 offspring measurement • approved by their local institutional review boards

Exclusion criteria	NR
Patient characteristics	N=37 birth cohorts, with a total of n=162129 singleton births **Maternal age, years** NR **Median (95% range) maternal pre-pregnancy BMI, kg/m^2** 22.7 (18.1 to 34.3) **Ethnicity,** NR
Risk factor(s) of interest	Gestational weight gain -the difference between the latest weight before delivery and pre-pregnancy weight Institute of Medicine (IOM) categories used: • inadequate • adequate • excessive
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • maternal educational level • maternal ethnicity • parity • maternal smoking during pregnancy

Duration of follow-up	4 years
Setting	Hospital based
Sources of funding	Not industry funded
Other information	Birth cohorts (country) included in individual participant data meta-analysis: • ABCD (The Netherlands) • ALSPAC (United Kingdom) • AOB/F (Canada) • BAMSE (Sweden) • BIB (United Kingdom) • CHOP (Multiple) • Co.N.ER (Italy) • DNBC (Denmark) • EDEN (France) • FCOU (Ukraine) • GASPII (Italy) • GECKO Drenthe (The Netherlands) • GENERATION R (The Netherlands) • GENERATION XXI (Portugal) • GENESIS (Greece) • GINIplus (Germany)

	• HUMIS (Norway) • INMA (Spain) • KOALA (The Netherlands) • Krakow Cohort (Poland) • LISAplus (Germany) • LUKAS (Finland) • MoBa (Norway) • NINFEA (Italy) • PÉLAGIE (France) • PIAMA (The Netherlands) • Piccolipiù (Italy) • Project Viva (United States) • Raine Study (Australia) • REPRO_PL (Poland) • RHEA (Greece) • ROLO (Ireland) • SCOPE BASELINE (Ireland) • SEATON (United Kingdom) • Slovak PCB study (Slovakia) • STEPS (Finland) • SWS (United Kingdom)

BMI: body mass index; NR: not reported

Study arms

Inadequate gestational weight gain (N = 40874)

Adequate gestational weight gain (N = 68218)

Excessive gestational weight gain (N = 72586)

Outcomes

Outcome	Inadequate gestational weight gain, N = 40874	Adequate gestational weight gain, N = 68218	Excessive gestational weight gain, N = 72586
Childhood overweight/obesity Early childhood 2-5years aOR (95% CI)	0.86 (0.78 to 0.93)	referent	1.39 (1.30 to 1.49)
Childhood overweight/obesity Mid childhood 5-10 years aOR (95% CI)	0.90 (0.84 to 0.92)	referent	1.55 (1.49 to 1.60)
Childhood overweight/obesity Late childhood 10-18 years aOR (95% CI)	0.91 (0.82 to 1.02)	referent	1.72 (1.56 to 1.91)

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, maternal educational level, maternal ethnicity, parity, maternal smoking during pregnancy

Critical appraisal - NGA Critical appraisal – Wang et al 2021 checklist

Methodological items	Answer
Did the research questions and inclusion criteria for the review include the components of PICO?	Low risk of bias *(Study authors report all components of PICO)*
Did the report of the review contain an explicit statement that the review methods were established before conduct of the review and did the report justify any significant deviations from the protocol?	Unclear risk of bias *(Study authors do not report study protocol or deviations from protocol)*
Did the review authors explain their selection of the study designs for inclusion in the review?	Low risk of bias *(Study authors provide rationale for selection of included study design)*
Did the review authors use a comprehensive literature search strategy?	Low risk of bias *(Study authors report literature search for all cohorts included in study. Search strategies cover a range of databases and use appropriate search terms.)*
Did the review authors perform study selection in duplicate?	Unclear risk of bias *(Information unavailable)*
Did the review authors perform data extraction in duplicate?	Unclear risk of bias *(Information unavailable)*
Did the review authors provide a list of excluded studies and justify the exclusions?	Unclear risk of bias *(Information unavailable)*
Did the review authors describe the included studies in adequate detail?	Low risk of bias *(Study authors provide adequate details on included studies)*

Methodological items	**Answer**
Did the review authors use a satisfactory technique for assessing RoB in individual studies that were included in the review?	Low risk of bias *(Study authors provide adequate details on the technique used for assessing risk of bias)*
Did the review authors report on the sources of funding for the studies included in the review?	Low risk of bias *(Study authors provide adequate details on funding acquired in included studies in the review)*
If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	Low risk of bias *(Study authors provide adequate details on the impact of risk of bias on the overall review findings)*
Did the review authors account for RoB in primary studies when interpreting or discussing the results of the review?	Low risk of bias *(Study authors accounted for risk of bias in primary studies in the overall interpretation of the review findings)*
Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	Low risk of bias *(Study authors explore heterogeneity and adequately report on it in the review findings)*
If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	Low risk of bias *(Study authors report on the impact of publication bias)*
Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Low risk of bias *(Study authors report potential sources of conflict of interest, including any funding they received for conducting the review)*
Was the quality of time-to-event-outcome data checked?	Low risk of bias *(Outcome data not relevant to review type)*
Did researchers stratify or account for clustering of participants within trials using either a one or two stage approach to meta-analysis?	Low risk of bias *(Methodology not relevant to review type)*
Was the choice of one or two stage analysis specified in advance or results for both approaches provided, or both?	Low risk of bias *(Two step analysis used and details/results provided)*
Were IPD obtained from a large proportion of the eligible trials?	Low risk of bias

Methodological items	Answer
	(Study authors obtained data from 39 eligible trials)
Were the reasons for not obtaining IPD provided?	Low risk of bias *(Study authors report reasons for why study cohorts were not available)*
Were there any strategies taken to account for unavailable IPD?	Unclear risk of bias *(Study authors do not report details on strategies taken to account for unavailable IPD)*
Were the data checked for missing, invalid, out of range, or inconsistent items?	Low risk of bias *(Study authors reported on missing data and methods to handle this)*
Did the author check any discrepancies with the trial report (if available)?	Unclear risk of bias *(Information unavailable)*
Were any issues queried and, if possible, resolved?	Unclear risk of bias *(Information unavailable)*
Were the methods of assessing whether effects of interventions vary by participant characteristics appropriate?	Low risk of bias *(Study authors used appropriate methods to assessing varying effects of interventions by participant characteristics)*
Was the choice of participant level characteristics and methods of assessing participant level interactions specified in advance?	Unclear risk of bias *(Information unavailable)*
If there was no evidence of a differential effect by trial or participant characteristic, was emphasis placed on the overall results?	Unclear risk of bias *(Information unavailable)*
Were exploratory analyses highlighted as such?	Unclear risk of bias *(Information unavailable)*
Does any report of the results adhere to the PRISMA-IPD?	Unclear risk of bias *(Information unavailable)*
Overall risk of bias and directness	Low
Overall risk of bias and directness	Directly applicable

IPD: Individual participant data; PICO: population, intervention, comparator, outcome

Whitaker, 2022

Bibliographic Reference	Whitaker, K.M.; Ryan, R.; Becker, C.; Healy, H.; Gestational Weight Gain in Twin Pregnancies and Maternal and Child Health: An Updated Systematic Review; Journal of Women's Health; 2022; vol. 31 (no. 3); 362-381

Study details

Country/ies where study was carried out	Japan: n=1 Korea: n=1 NR: n=4 USA: n=4
Study type	Systematic review Multivariate analysis
Study dates	2019 to 2021
Inclusion criteria	• GWG in twin pregnancies within the Institute of Medicine provisional guidelines for twin pregnancies • studies reporting maternal and/or child health outcomes • cohort studies • case-control studies
Exclusion criteria	• case studies • systematic reviews
Patient characteristics	N=29 studies, with a total of n >224383* women

	Note: n=10 studies, with a total of n=174942* women were extracted from this systematic review, to avoid double counting included studies from another included systematic review. *some studies did not report a sample size and therefore total sample size is inferred. **Mean maternal age, years** 32.08 Note: value calculated by technical team. Data for 4 studies was not reported. **Mean maternal pre-pregnancy BMI, kg/m^2** NR **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -definition varied IOM categories for twin pregnancies used
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • parity • pre-existing diabetes or hypertension • pre-pregnancy BMI • chorionicity • gestational age at delivery • infant sex

	• race/ethnicity • height • smoking • employment and student status • marital status • insurance • education • fertility treatment • fetal sex of the twin pair • cerclage • prior preterm birth • payer status • diabetes • mode of conception • gestational age
Duration of follow-up	Until birth
Setting	Hospital based
Sources of funding	Not industry funded
Other information	Note: only the following studies were extracted so as not to double count included studies from another SR:

	• Choi et al. (2020) • Gandhi et al. (2018) • Hinkle et al. (2017) • Lal and Kominiarek (2015) • Lal et al. (2014) • Likins et al. (2021) • Ram et al. (2018) • Salmanian et al. (2015) • Shimura et al. (2021) • Yee et al. (2017) Systematic review does not report aOR for outcomes where there is no association, so outcome data were only extracted for the following studies: • Choi et al. (2020) • Lal et al. (2014) • Lal and Kominiarek (2015) • Shimura et al. (2021) • Yee et al. (2017) The risk of bias of included studies from this systematic review were not assessed separately. The risk of bias for the systematic review was used to assess the quality of evidence.

BMI: body mass index; GWG: gestational weight gain; IOM: Institute of Medicine; NR: not reported; SD: standard deviation

Study arms

Adequate gestational weight again (N = NR)

Inadequate gestational weight again (N = NR)

Excessive gestational weight again (N = NR)

Outcomes

Outcome	Adequate gestational weight again, N = NR	Inadequate gestational weight again, N = NR	Excessive gestational weight again, N = NR
Gestational hypertension aOR (95% CI)	-	-	-
Choi 2020 aOR (95% CI)	referent	0.43 (0.30 to 0.60)	NR
Lal 2014 aOR (95% CI)	referent	NR	2.6 (1.3 to 5.3)
Lal and Kominiarek 2015 Prepregnancy BMI- Obese aOR (95% CI)	referent	NR	3.3 (1.4 to 7.7)
Shimura 2021 aOR (95% CI)	3.82 (1.17 to 11.7)	referent	NR
Yee 2017	referent	0.76 (0.72 to 0.79)	1.77 (1.70 to 1.84)

Outcome	Adequate gestational weight again, N = NR	Inadequate gestational weight again, N = NR	Excessive gestational weight again, N = NR
aOR (95% CI)			
Preeclampsia aOR (95% CI)	-	-	-
Choi 2020 aOR (95% CI)	referent	0.49 (0.32 to 0.76)	NR
Lal 2014 aOR (95% CI)	referent	NR	2.1 (1.3 to 3.5)
Lal and Kominiarek 2015 Prepregnancy BMI-Underweight/Normal weight aOR (95% CI)	referent	NR	2.4 (1.5 to 3.8)
Lal and Kominiarek 2015 Prepregnancy BMI- Obese aOR (95% CI)	referent	0.2 (0.1 to 0.4)	NR
Gestational diabetes aOR (95% CI)	-	-	-
Choi 2020 aOR (95% CI)	referent	3.38 (2.17 to 5.27)	NR

Outcome	Adequate gestational weight again, N = NR	Inadequate gestational weight again, N = NR	Excessive gestational weight again, N = NR
Caesarean birth aOR (95% CI)	-	-	-
Yee 2017 aOR (95% CI)	referent	NR	1.22 (1.18 to 1.27)
Large for gestational age aOR (95% CI)	-	-	-
Choi 2020 aOR (95% CI)	referent	0.51 (0.35 to 0.74)	1.79 (1.15 to 2.81)
Small for gestational age aOR (95% CI)	-	-	-
Choi 2020 aOR (95% CI)	referent	1.92 (1.42 to 2.60)	NR

CI: confidence interval; NR: not reported; OR: odds ratio

Covariates adjusted for: maternal age, parity, pre-existing diabetes or hypertension, pre-pregnancy BMI, chorionicity, gestational age at delivery, infant sex, race/ethnicity, height, smoking, employment and student status, marital status, insurance, education, fertility treatment, fetal sex of the twin pair, cerclage, prior preterm birth, payer status, diabetes, mode of conception, gestational age

Critical appraisal - NGA Critical appraisal - ROBIS checklist

Section	Question	Answer
Study eligibility criteria	Concerns regarding specification of study eligibility criteria	Low *(Study eligibility criteria clearly described, with appropriate restrictions on eligibility, justified where appropriate. SR protocol registered in PROSPERO, demonstrating that objectives and eligibility criteria were pre-specified. These pre-specified objectives and eligibility criteria were reported in the study.)*
Identification and selection of studies	Concerns regarding methods used to identify and/or select studies	Low *(The search included an appropriate range of sources to identify relevant published and unpublished reports and the terms and structure of the search strategy were comprehensive. Search restrictions applied were appropriate and justified. Two independent reviewers conducted data extraction to minimise error.)*
Data collection and study appraisal	Concerns regarding methods used to collect data and appraise studies	Low *(Methods of data collection clearly described, with sufficient data extracted from studies and presented clearly. Risk of bias was assessed by independent reviewers using the Newcastle-Ottawa risk of bias scale for cohort studies)*
Synthesis and findings	Concerns regarding the synthesis and findings	Low *(The synthesis included all relevant studies and adhered to pre-defined analyses (or departures were clearly explained). Heterogeneity was addressed in the synthesis and explored where high. The reported findings were robust, as demonstrated through a funnel plot. The biases in primary studies were addressed.)*
Overall study ratings	Overall risk of bias	Low
Overall study ratings	Applicability as a source of data	Fully applicable

SR: systematic review

Yee, 2013

Bibliographic Reference	Yee, L.M.; Cheng, Y.W.; Inturrisi, M.; Caughey, A.B.; Gestational weight loss and perinatal outcomes in overweight and obese women subsequent to diagnosis of gestational diabetes mellitus; Obesity; 2013; vol. 21 (no. 12); e770-e774

Study details

Country/ies where study was carried out	USA
Study type	Retrospective cohort study Multivariate analysis
Study dates	2001-2004
Inclusion criteria	• overweight and obese women with gestational diabetes mellitus
Exclusion criteria	• preexisting diabetes mellitus • multi-fetal gestations • pregnancies with fetal anomalies

Patient characteristics	**Maternal age, years, %**
	• Weight loss
	  ○ <35 years: 5.1
	  ○ >35 years: 5.4
	• No weight loss
	  ○ <35 years: 94.9
	  ○ >35 years: 94.62

	Maternal pre-pregnancy BMI, kg/m^2 NR **Ethnicity, n** NR
Risk factor(s) of interest	Gestational weight gain -weight change from first to last Sweet Success visits Independent categories used: • weight loss • no weight loss
Confounding factor(s) of interest	Covariates adjusted in analysis: • maternal age • race/ethnicity • parity • education • primary language
Duration of follow-up	Until birth
Setting	Sweet Success California Diabetes and Pregnancy Program
Sources of funding	NR

BMI: body mass index; NR: not reported

Study arms

Weight loss (N = 1367)

No weight loss (N = 24838)

Outcomes

Outcome	Weight loss, N = 1367	No weight loss, N = 24838
Caesarean birth aOR (95% CI)	0.86 (0.75 to 0.98)	referent

CI: confidence interval; OR: odds ratio

Covariates adjusted for: maternal age, race/ethnicity, parity, education, primary language

Critical appraisal - NGA Critical appraisal - QUIPS checklist

Section	Question	Answer
Study participation	Summary Study participation	Low risk of bias *(The study sample represents the population of interest on key characteristics, sufficient to limit potential bias of the observed relationship between PF and outcome)*
Study Attrition	Study Attrition Summary	Low risk of bias *(Loss to follow-up (from baseline sample to study population analysed) is not associated with key characteristics (that is, the study data adequately represent the sample) sufficient to limit potential bias to the observed relationship between PF and outcome)*

Section	Question	Answer
Prognostic factor measurement	Prognostic factor Measurement Summary	Low risk of bias *(PF is adequately measured in study participants to sufficiently limit potential bias)*
Outcome Measurement	Outcome Measurement Summary	Low risk of bias *(Outcome of interest is adequately measured in study participants to sufficiently limit potential bias)*
Study Confounding	Study Confounding Summary	Low risk of bias *(Important potential confounders are appropriately accounted for, limiting potential bias with respect to the relationship between PF and outcome)*
Statistical Analysis and Reporting	Statistical Analysis and Presentation Summary	Low risk of bias *(The statistical analysis is appropriate for the design of the study, limiting potential for presentation of invalid or spurious results)*
Overall risk of bias and directness	Risk of Bias	Low
Overall risk of bias and directness	Directness	Directly applicable

PF: prognostic factor

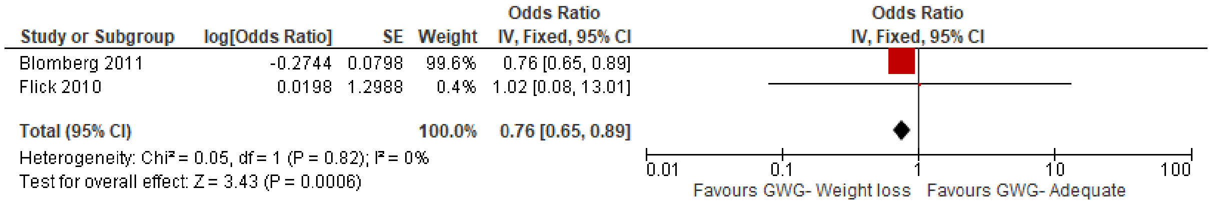
Appendix E Forest plots

Forest plots for review question: What gestational weight change is healthy and appropriate during pregnancy?

This section includes forest plots only for outcomes that are meta-analysed. Outcomes from single studies are not presented here. The quality assessment for all outcomes is provided in the GRADE profiles in appendix F.

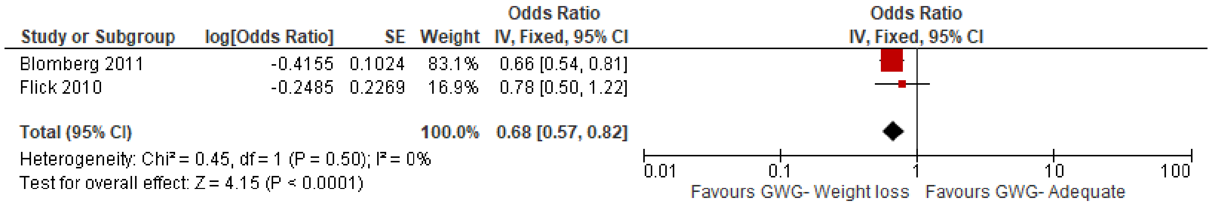
1. Association between weight loss (IOM gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton pregnancies

Figure 2: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class I)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 3: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class II)



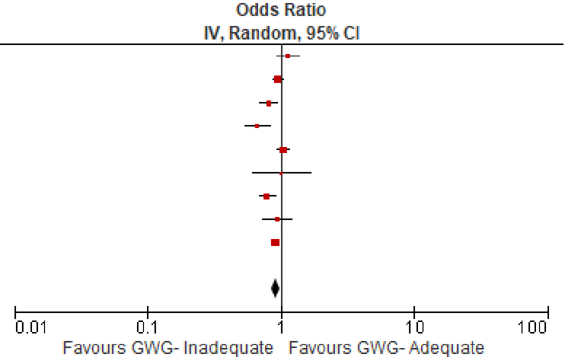
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

2. Association between inadequate gestational weight gain (IOM gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton and twin pregnancy

Figure 4: Caesarean birth (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Breckenkamp 2019	0.1222	0.0939	9.2%	1.13 [0.94, 1.36]
Chen CN 2020	-0.0513	0.0449	16.2%	0.95 [0.87, 1.04]
Chen-Xu 2022	-0.2107	0.0818	10.7%	0.81 [0.69, 0.95]
Gante 2015	-0.4005	0.1101	7.6%	0.67 [0.54, 0.83]
Gavard 2017	0.0392	0.0516	15.1%	1.04 [0.94, 1.15]
Haile 2019	0.01	0.2573	2.0%	1.01 [0.61, 1.67]
Kiefer 2022	-0.2357	0.0691	12.4%	0.79 [0.69, 0.90]
Lautredou 2022	-0.0619	0.129	6.2%	0.94 [0.73, 1.21]
Simko 2019	-0.0943	0.0113	20.5%	0.91 [0.89, 0.93]
Total (95% CI)			**100.0%**	**0.91 [0.84, 0.98]**

Heterogeneity: Tau² = 0.01; Chi² = 27.02, df = 8 (P = 0.0007); I² = 70%
Test for overall effect: Z = 2.52 (P = 0.01)

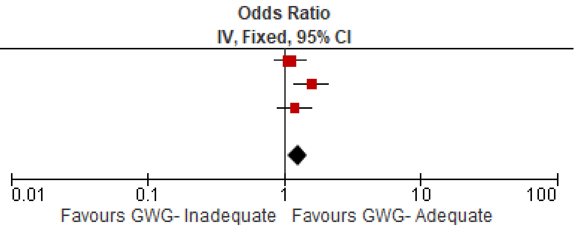


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 5: Gestational diabetes (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Chen CN 2020	0.0953	0.1315	38.6%	1.10 [0.85, 1.42]
Lautredou 2022	0.4637	0.1479	30.5%	1.59 [1.19, 2.12]
Simko 2019	0.1823	0.1468	30.9%	1.20 [0.90, 1.60]
Total (95% CI)			**100.0%**	**1.26 [1.08, 1.48]**

Heterogeneity: Chi² = 3.65, df = 2 (P = 0.16); I² = 45%
Test for overall effect: Z = 2.87 (P = 0.004)

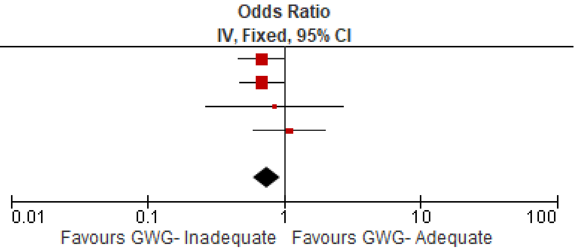


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 6: Gestational hypertension (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Chen CN 2020	-0.3711	0.1959	38.0%	0.69 [0.47, 1.01]
Chen-Xu 2022	-0.3711	0.1852	42.5%	0.69 [0.48, 0.99]
Lautredou 2022	-0.1625	0.5851	4.3%	0.85 [0.27, 2.68]
Simko 2019	0.0953	0.3093	15.2%	1.10 [0.60, 2.02]
Total (95% CI)			**100.0%**	**0.75 [0.59, 0.95]**

Heterogeneity: Chi² = 1.96, df = 3 (P = 0.58); I² = 0%
Test for overall effect: Z = 2.41 (P = 0.02)

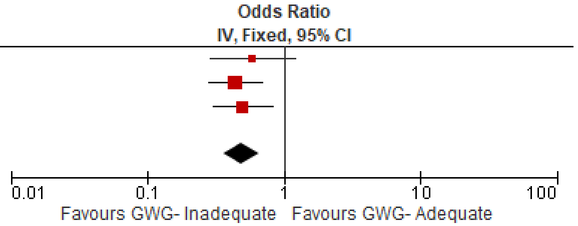


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 7: Preeclampsia (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Chen CN 2020	-0.5276	0.3624	18.5%	0.59 [0.29, 1.20]
Chen-Xu 2022	-0.821	0.2306	45.7%	0.44 [0.28, 0.69]
Simko 2019	-0.6931	0.2606	35.8%	0.50 [0.30, 0.83]
Total (95% CI)			**100.0%**	**0.49 [0.36, 0.66]**

Heterogeneity: Chi² = 0.48, df = 2 (P = 0.78); I² = 0%
Test for overall effect: Z = 4.62 (P < 0.00001)

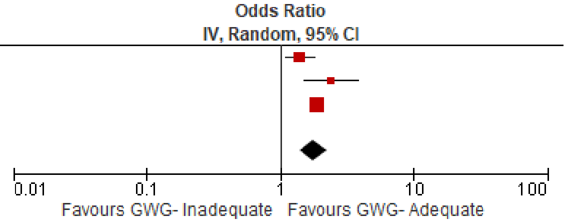


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 8: Small for gestational age (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Chen-Xu 2022	0.3365	0.1277	33.4%	1.40 [1.09, 1.80]
Hautier 2022	0.8796	0.2419	17.1%	2.41 [1.50, 3.87]
Park 2011	0.6259	0.0427	49.5%	1.87 [1.72, 2.03]
Total (95% CI)			**100.0%**	**1.77 [1.40, 2.25]**

Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 5.95$, $df = 2$ ($P = 0.05$); $I^2 = 66\%$
Test for overall effect: $Z = 4.71$ ($P < 0.00001$)

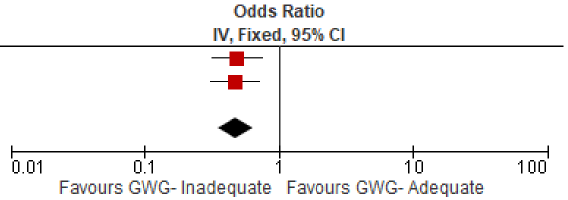


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 9: Preeclampsia (twin pregnancy) (All pre-pregnancy BMI categories)

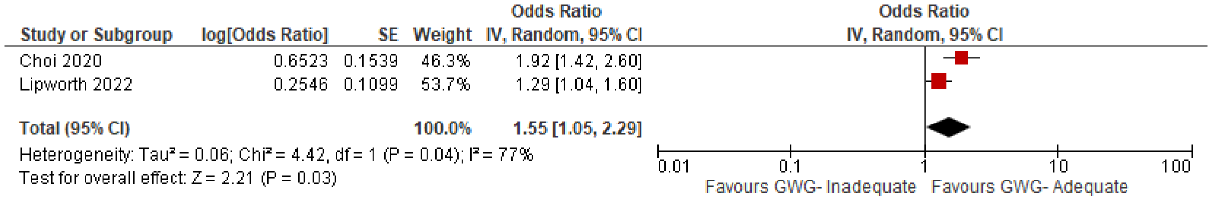
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Choi 2020	-0.7133	0.2174	48.8%	0.49 [0.32, 0.75]
Lipworth 2022	-0.755	0.2123	51.2%	0.47 [0.31, 0.71]
Total (95% CI)			**100.0%**	**0.48 [0.36, 0.65]**

Heterogeneity: $Chi^2 = 0.02$, $df = 1$ ($P = 0.89$); $I^2 = 0\%$
Test for overall effect: $Z = 4.84$ ($P < 0.00001$)



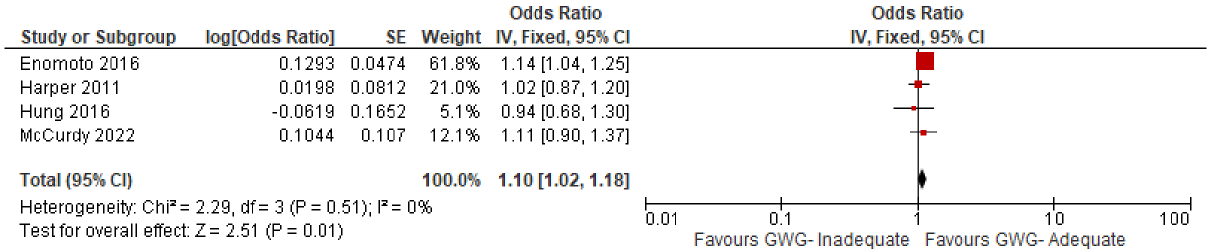
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 10: Small for gestational age (twin pregnancy) (All pre-pregnancy BMI categories)



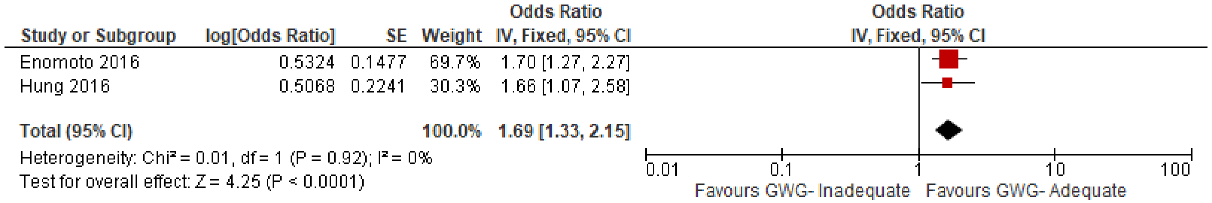
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 11: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Underweight)



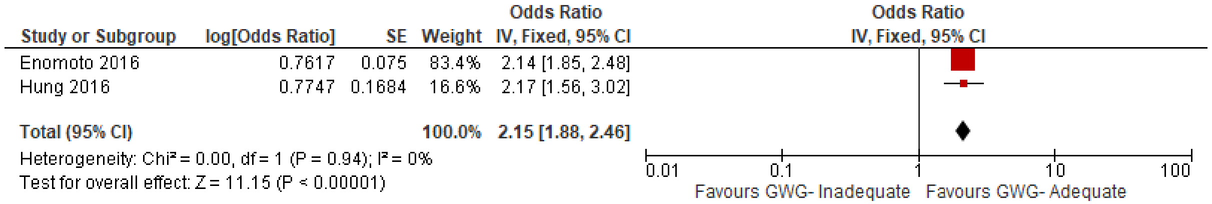
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 12: Gestational diabetes (singleton pregnancy) (Pre-pregnancy BMI Underweight)



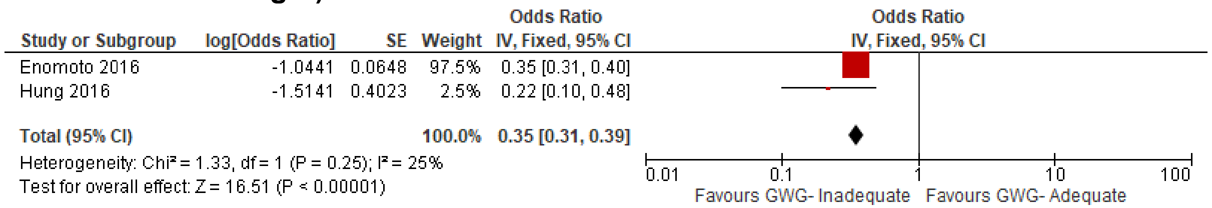
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 13: Small for gestational age (singleton pregnancy) (Pre-pregnancy BMI Underweight)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 14: Large for gestational age (singleton pregnancy) (Pre-pregnancy BMI Underweight)

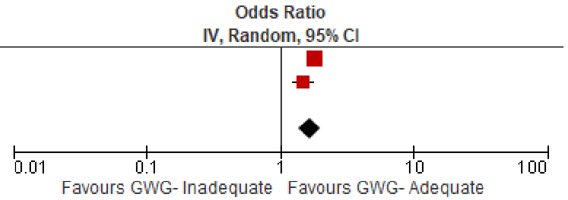


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 15: Gestational diabetes (singleton pregnancy) (Pre-pregnancy BMI Normal weight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Enomoto 2016	0.5955	0.0536	56.7%	1.81 [1.63, 2.01]
Hung 2016	0.3988	0.0896	43.3%	1.49 [1.25, 1.78]
Total (95% CI)			**100.0%**	**1.67 [1.38, 2.02]**

Heterogeneity: Tau² = 0.01; Chi² = 3.55, df = 1 (P = 0.06); I² = 72%
Test for overall effect: Z = 5.23 (P < 0.00001)

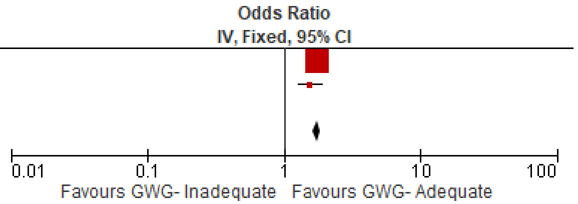


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 16: Small for gestational age (singleton pregnancy) (Pre-pregnancy BMI Normal weight)

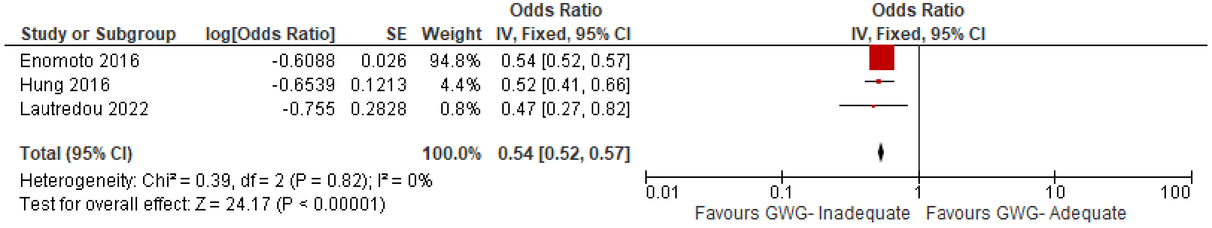
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Enomoto 2016	0.5676	0.035	89.4%	1.76 [1.65, 1.89]
Hung 2016	0.4383	0.1017	10.6%	1.55 [1.27, 1.89]
Total (95% CI)			**100.0%**	**1.74 [1.63, 1.86]**

Heterogeneity: Chi² = 1.45, df = 1 (P = 0.23); I² = 31%
Test for overall effect: Z = 16.74 (P < 0.00001)



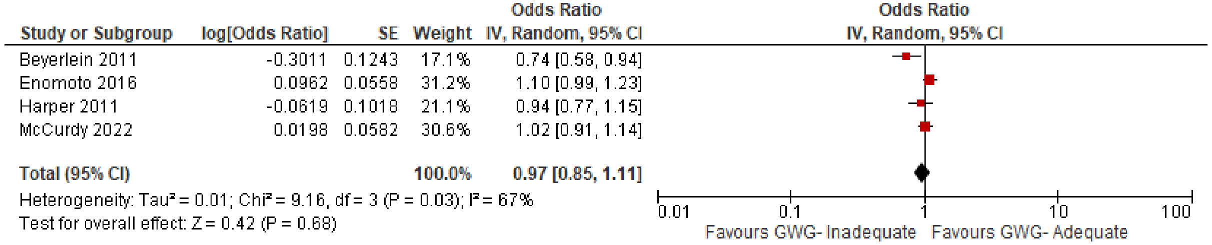
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 17: Large for gestational age (singleton pregnancy) (Pre-pregnancy BMI Normal weight)



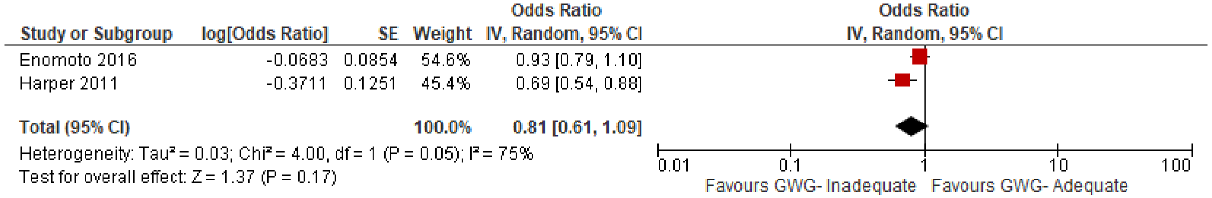
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 18: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Overweight)



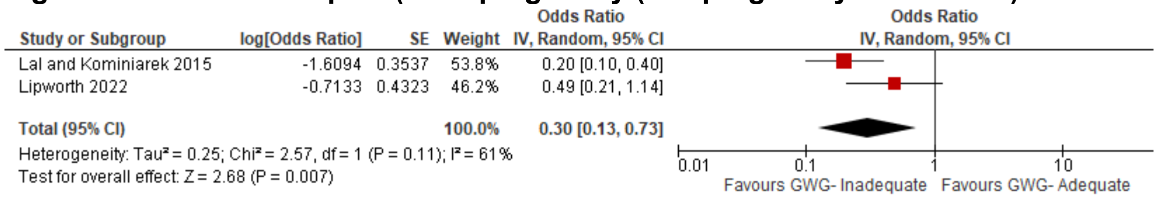
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 19: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese)



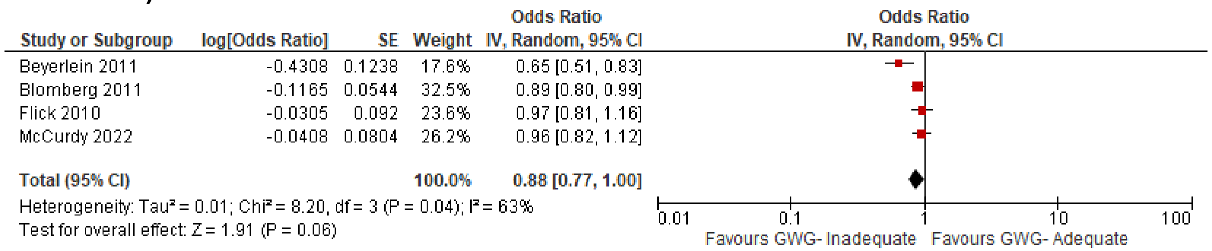
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 20: Preeclampsia (Twin pregnancy (Pre-pregnancy BMI Obese)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 21: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class I)

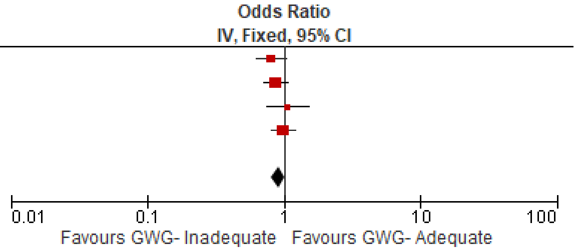


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 22: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class II)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Beyerlein 2011	-0.2231	0.13	21.3%	0.80 [0.62, 1.03]
Blomberg 2011	-0.1393	0.1024	34.4%	0.87 [0.71, 1.06]
Flick 2010	0.0583	0.1834	10.7%	1.06 [0.74, 1.52]
McCurdy 2022	-0.0202	0.1035	33.6%	0.98 [0.80, 1.20]
Total (95% CI)			**100.0%**	**0.91 [0.81, 1.02]**

Heterogeneity: Chi² = 2.38, df = 3 (P = 0.50); I² = 0%
Test for overall effect: Z = 1.60 (P = 0.11)



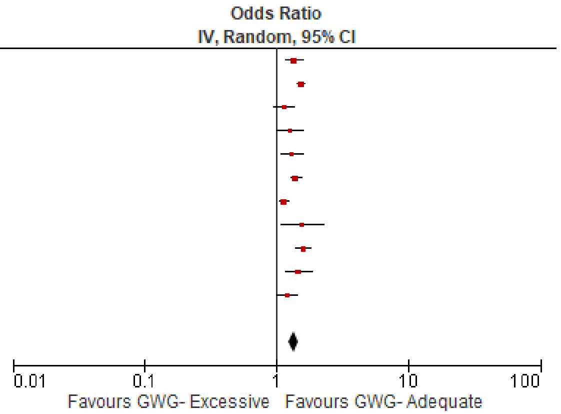
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

3. Association between excessive gestational weight gain (IOM gestational weight change categories) and maternal/neonatal/fetal outcomes in singleton and twin pregnancy

Figure 23: Caesarean birth (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Breckenkamp 2019	0.3001	0.0774	9.7%	1.35 [1.16, 1.57]
Chen CN 2020	0.4253	0.0381	12.2%	1.53 [1.42, 1.65]
Chen-Xu 2022	0.1398	0.0921	8.7%	1.15 [0.96, 1.38]
Gaillard 2013	0.2311	0.1179	7.1%	1.26 [1.00, 1.59]
Gante 2015	0.27	0.1033	8.0%	1.31 [1.07, 1.60]
Gavard 2017	0.3365	0.0457	11.8%	1.40 [1.28, 1.53]
Gawade 2011	0.1222	0.0375	12.2%	1.13 [1.05, 1.22]
Haile 2019	0.4447	0.1924	4.0%	1.56 [1.07, 2.27]
Kiefer 2022	0.47	0.0645	10.6%	1.60 [1.41, 1.82]
Lautredou 2022	0.3784	0.1174	7.1%	1.46 [1.16, 1.84]
Simko 2019	0.1823	0.093	8.6%	1.20 [1.00, 1.44]
Total (95% CI)			**100.0%**	**1.34 [1.23, 1.47]**

Heterogeneity: Tau² = 0.02; Chi² = 46.89, df = 10 (P < 0.00001); I² = 79%
Test for overall effect: Z = 6.41 (P < 0.00001)

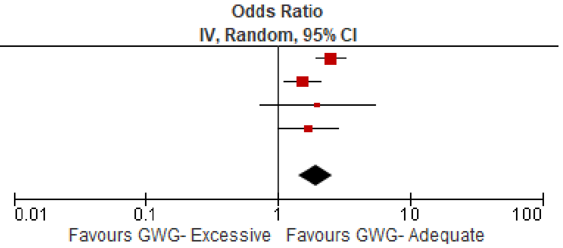


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 24: Gestational hypertension (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Chen CN 2020	0.9203	0.1314	38.7%	2.51 [1.94, 3.25]
Chen-Xu 2022	0.4253	0.1637	33.4%	1.53 [1.11, 2.11]
Lautredou 2022	0.6881	0.5117	7.7%	1.99 [0.73, 5.42]
Simko 2019	0.5306	0.2707	20.2%	1.70 [1.00, 2.89]
Total (95% CI)			**100.0%**	**1.93 [1.43, 2.61]**

Heterogeneity: Tau² = 0.04; Chi² = 6.02, df = 3 (P = 0.11); I² = 50%
Test for overall effect: Z = 4.28 (P < 0.0001)

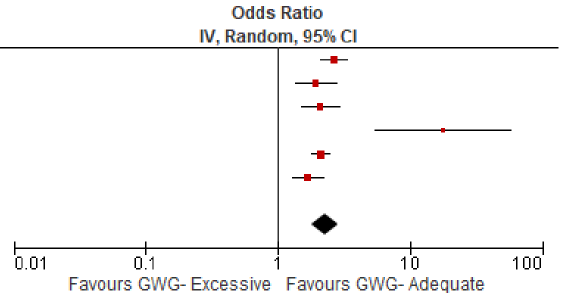


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 25: Large for gestational age (singleton pregnancy) (All pre-pregnancy BMI categories)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Chen CN 2020	0.9783	0.1182	20.7%	2.66 [2.11, 3.35]
Chen-Xu 2022	0.6627	0.185	16.0%	1.94 [1.35, 2.79]
Lautredou 2022	0.7372	0.1692	17.1%	2.09 [1.50, 2.91]
Liang 2021	2.873	0.6026	3.4%	17.69 [5.43, 57.63]
Park 2011	0.7514	0.0778	23.4%	2.12 [1.82, 2.47]
Simko 2019	0.5306	0.1369	19.4%	1.70 [1.30, 2.22]
Total (95% CI)			**100.0%**	**2.25 [1.78, 2.84]**

Heterogeneity: Tau² = 0.05; Chi² = 18.77, df = 5 (P = 0.002); I² = 73%
Test for overall effect: Z = 6.81 (P < 0.00001)

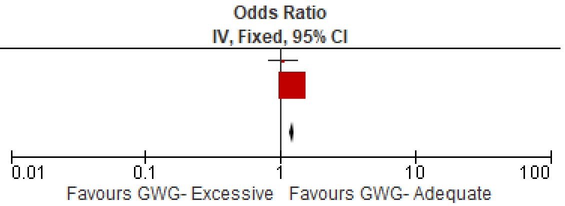


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 26: Caesarean birth (twin pregnancy) (All pre-pregnancy BMI categories)

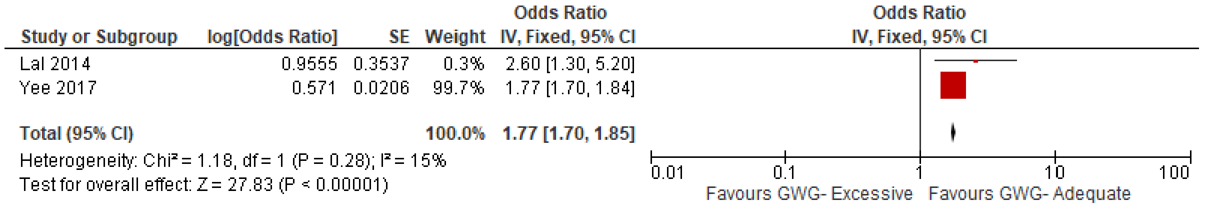
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Lipworth 2022	0.0392	0.1213	1.9%	1.04 [0.82, 1.32]
Yee 2017	0.1989	0.017	98.1%	1.22 [1.18, 1.26]
Total (95% CI)			**100.0%**	**1.22 [1.18, 1.26]**

Heterogeneity: Chi² = 1.70, df = 1 (P = 0.19); I² = 41%
Test for overall effect: Z = 11.63 (P < 0.00001)



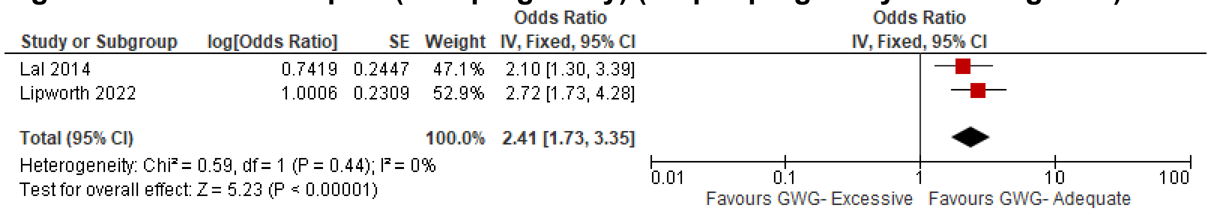
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 27: Gestational hypertension (twin pregnancy) (All pre-pregnancy BMI categories)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 28: Preeclampsia (twin pregnancy) (All pre-pregnancy BMI categories)

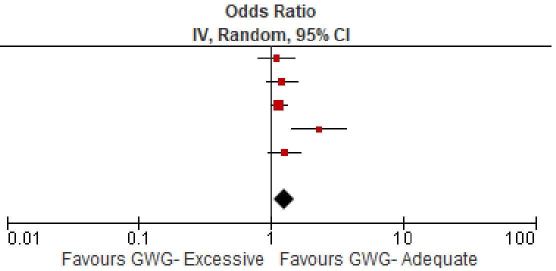


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 29: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Underweight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Di Benedetto 2012	0.0953	0.1625	17.5%	1.10 [0.80, 1.51]
Enomoto 2016	0.1865	0.1405	20.4%	1.21 [0.91, 1.59]
Harper 2011	0.1398	0.0764	31.5%	1.15 [0.99, 1.34]
Hung 2016	0.8416	0.2398	10.4%	2.32 [1.45, 3.71]
McCurdy 2022	0.239	0.1428	20.1%	1.27 [0.96, 1.68]
Total (95% CI)			**100.0%**	**1.26 [1.06, 1.51]**

Heterogeneity: Tau² = 0.02; Chi² = 8.27, df = 4 (P = 0.08); I² = 52%
Test for overall effect: Z = 2.61 (P = 0.009)

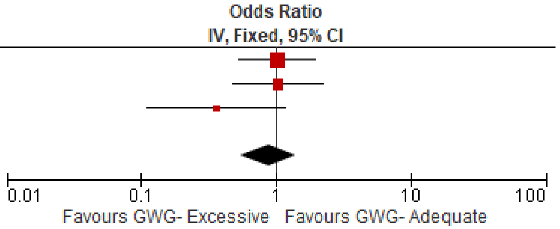


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 30: Gestational diabetes (singleton pregnancy) (Pre-pregnancy BMI-Underweight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Chuang 2022	0.01	0.3387	48.7%	1.01 [0.52, 1.96]
Enomoto 2016	0.0296	0.3938	36.0%	1.03 [0.48, 2.23]
Hung 2016	-1.0217	0.6049	15.3%	0.36 [0.11, 1.18]
Total (95% CI)			**100.0%**	**0.87 [0.55, 1.38]**

Heterogeneity: Chi² = 2.51, df = 2 (P = 0.29); I² = 20%
Test for overall effect: Z = 0.59 (P = 0.55)

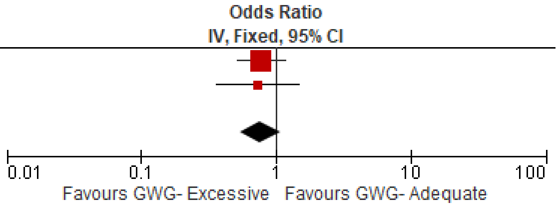


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 31: Small for gestational age (singleton pregnancy) (Pre-pregnancy BMI Underweight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Enomoto 2016	-0.2562	0.2069	75.2%	0.77 [0.52, 1.16]
Hung 2016	-0.3147	0.3607	24.8%	0.73 [0.36, 1.48]
Total (95% CI)			**100.0%**	**0.76 [0.54, 1.08]**

Heterogeneity: Chi² = 0.02, df = 1 (P = 0.89); I² = 0%
Test for overall effect: Z = 1.51 (P = 0.13)

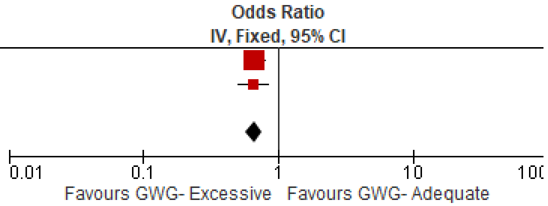


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 32: Small for gestational age (singleton pregnancy) (Pre-pregnancy BMI Normal weight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Enomoto 2016	-0.417	0.0886	69.5%	0.66 [0.55, 0.78]
Hung 2016	-0.4308	0.1339	30.5%	0.65 [0.50, 0.85]
Total (95% CI)			**100.0%**	**0.66 [0.57, 0.76]**

Heterogeneity: Chi² = 0.01, df = 1 (P = 0.93); I² = 0%
Test for overall effect: Z = 5.70 (P < 0.00001)

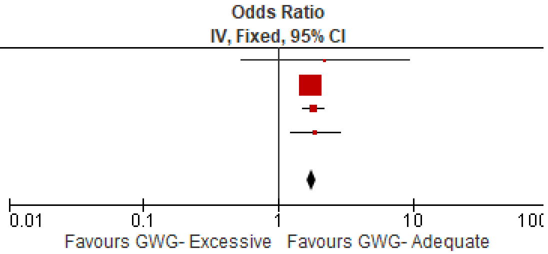


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 33: Large for gestational age (singleton pregnancy) (Pre-pregnancy BMI Normal weight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Di Benedetto 2012	0.7885	0.7359	0.3%	2.20 [0.52, 9.31]
Enomoto 2016	0.5504	0.0436	78.1%	1.73 [1.59, 1.89]
Hung 2016	0.5878	0.0896	18.5%	1.80 [1.51, 2.15]
Lautredou 2022	0.6259	0.2179	3.1%	1.87 [1.22, 2.87]
Total (95% CI)			**100.0%**	**1.75 [1.62, 1.89]**

Heterogeneity: Chi² = 0.33, df = 3 (P = 0.95); I² = 0%
Test for overall effect: Z = 14.54 (P < 0.00001)

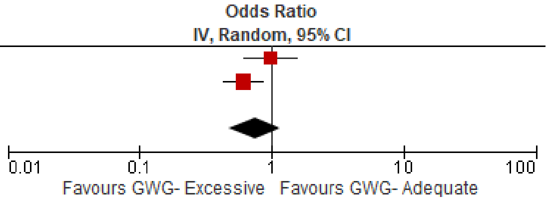


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 34: Gestational diabetes (singleton pregnancy) (Pre-pregnancy BMI Overweight/Obese)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Chuang 2022	-0.0305	0.2367	44.4%	0.97 [0.61, 1.54]
Hung 2016	-0.4943	0.1784	55.6%	0.61 [0.43, 0.87]
Total (95% CI)			**100.0%**	**0.75 [0.48, 1.18]**

Heterogeneity: Tau² = 0.06; Chi² = 2.45, df = 1 (P = 0.12); I² = 59%
Test for overall effect: Z = 1.25 (P = 0.21)

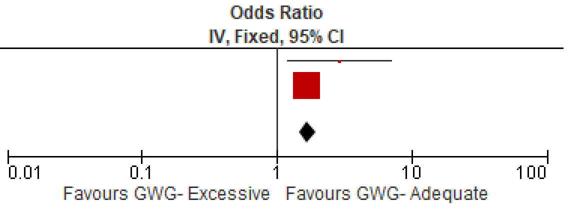


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 35: Large for gestational age (singleton pregnancy) (Pre-pregnancy BMI Overweight)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Di Benedetto 2012	1.0647	0.4502	2.6%	2.90 [1.20, 7.01]
Enomoto 2016	0.5038	0.0735	97.4%	1.65 [1.43, 1.91]
Total (95% CI)			**100.0%**	**1.68 [1.46, 1.94]**

Heterogeneity: Chi² = 1.51, df = 1 (P = 0.22); I² = 34%
Test for overall effect: Z = 7.15 (P < 0.00001)

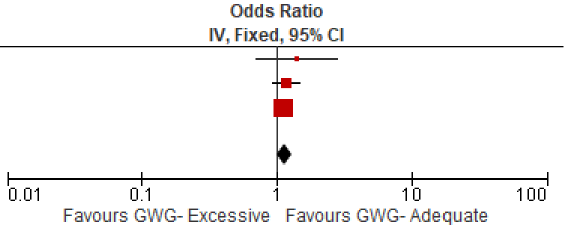


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 36: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese)

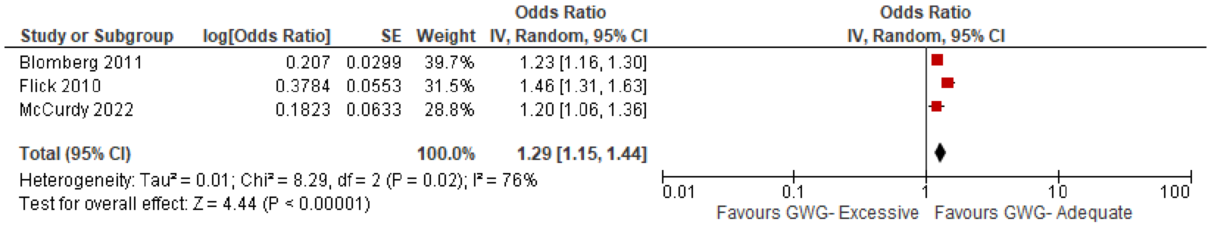
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Di Benedetto 2012	0.3365	0.3537	3.2%	1.40 [0.70, 2.80]
Enomoto 2016	0.1579	0.1137	31.3%	1.17 [0.94, 1.46]
Harper 2011	0.1133	0.0786	65.5%	1.12 [0.96, 1.31]
Total (95% CI)			**100.0%**	**1.14 [1.01, 1.30]**

Heterogeneity: Chi² = 0.44, df = 2 (P = 0.80); I² = 0%
Test for overall effect: Z = 2.11 (P = 0.03)



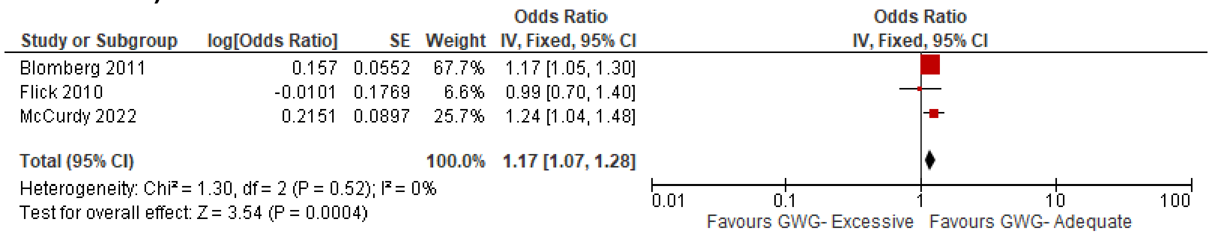
BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 37: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class I)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 38: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class II)

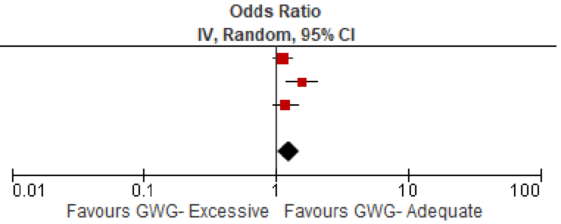


BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Figure 39: Caesarean birth (singleton pregnancy) (Pre-pregnancy BMI Obese class III)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Blomberg 2011	0.1133	0.0894	39.3%	1.12 [0.94, 1.33]
Flick 2010	0.4574	0.1361	27.5%	1.58 [1.21, 2.06]
McCurdy 2022	0.157	0.1117	33.2%	1.17 [0.94, 1.46]
Total (95% CI)			**100.0%**	**1.25 [1.03, 1.51]**

Heterogeneity: Tau² = 0.02; Chi² = 4.66, df = 2 (P = 0.10); I² = 57%
Test for overall effect: Z = 2.27 (P = 0.02)



BMI: body mass index; CI: confidence interval; GWG: gestational weight gain; IV: inverse variance; SE: standard error

Appendix F Adapted GRADE tables

Adapted GRADE tables for review question: What gestational weight change is healthy and appropriate during pregnancy?

Table 5: Evidence profile for association between weight loss (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy), age-stratified

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Weight loss (referent: appropriate weight gain in 20-34 years)	Caesarean birth (age stratified) <15 years old	1 study (Beaudrot 2016), 57568 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	very serious[2]	none	aOR[a] 0.75 (0.08 to 7.03)	VERY LOW **NO ASSOCIATION**
Weight loss (referent: appropriate weight gain in 20-34 years)	Caesarean birth (age stratified) 15-17 years old	1 study (Beaudrot 2016), 57568 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.43 (0.29 to 0.64)	MODERATE **LOW RISK**
Weight loss (referent: appropriate weight gain in 20-34 years)	Caesarean birth (age stratified) 18-19 years old	1 study (Beaudrot 2016), 57568 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.59 (0.47 to 0.74)	MODERATE **LOW RISK**
Weight loss (referent: appropriate weight gain in 20-34 years)	Caesarean birth (age stratified) 20-34 years old	1 study (Beaudrot 2016), 57568 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.22 (1.03 to 1.45)	LOW **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies

[a] Covariates adjusted for in Beaudrot 2016 were maternal race, labour induction, smoking status.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Serious risk of bias in the evidence contributing to the outcomes as per QUIPS.
[2] 95% CI crosses 2 MIDs (0.8 and 1.25)
[3] 95% CI crosses 1 MID (0.8 or 1.25)

Table 6: Evidence profile for association between weight loss (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class I strata (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Weight loss (referent: adequate weight gain)	Caesarean birth (Both nulliparous and multiparous)	2 studies[1,] 46595 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.76 (0.65 to 0.89)	MODERATE **LOW RISK**
Weight loss (referent: adequate weight gain)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.21 (0.11 to 0.40)	HIGH **LOW RISK**
Weight loss (referent: adequate weight gain)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.61 (0.44 to 0.85)	MODERATE **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] 95% CI crosses 1 MID (0.8 or 1.25)

Table 7: Evidence profile for association between weight loss (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class II strata (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Weight loss (referent: adequate weight gain)	Caesarean birth	2 studies[1,] 46595 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.68 (0.57 to 0.82)	MODERATE **LOW RISK**
Weight loss (referent: adequate weight gain)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[3]	none	aOR[a] 0.81 (0.48 to 1.37)	LOW **NO ASSOCIATION**
Weight loss (referent: adequate weight gain)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.82 (0.60 to 1.12)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
[**]Unclear how many participants contributed to this subgroup. The N value represents total participants.
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] 95% CI crosses 2 MIDs (0.8 or 1.25)
[3] 95% CI crosses 1 MID (0.8 and 1.25)

Table 8: Evidence profile for association between weight loss (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class III (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Weight loss (referent: adequate weight gain)	Caesarean birth (Both nulliparous and multiparous)	1 study (Blomberg 2011), 46595 participants	cohort studies	no serious risk of bias	very serious[1]	no serious indirectness	serious[2]	none	aOR[a] 0.77 (0.60 to 0.99)	VERY LOW **LOW RISK**
Weight loss (referent: adequate weight gain)		1 study (Flick 2010), number of participants NR	cohort studies	no serious risk of bias		no serious indirectness	no serious imprecision	none	aOR[a] 1.46 (1.31 to 1.63)	LOW **HIGH RISK**
Weight loss (referent: adequate weight gain)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[3]	none	aOR[a] 0.79 (0.49 to 1.27)	LOW **NO ASSOCIATION**
Weight loss (referent: adequate weight gain)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 4210 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.76 (0.56 to 1.03)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; NR: not reported; QUIPS: Quality in Prognostic Studies
[a] See corresponding evidence table in Appendix D for adjusted covariates
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
[**]Unclear how many participants contributed to this subgroup. The N value represents total participants.
[1] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[2] 95% CI crosses 1 MID (0.8 or 1.25)
[3] 95% CI crosses 2 MIDs (0.8 and 1.25)

Table 9: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy), age-stratified

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) <15 years old	1 study (Beaudrot 2016), 85216 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.48 (0.25 to 0.92)	LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 15-17 years old	1 study (Beaudrot 2016), 85216 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.57 (0.51 to 0.64)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 18-19 years old	1 study (Beaudrot 2016), 85216 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.62 (0.57 to 0.67)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 20-34 years old	1 study (Beaudrot 2016), 85216 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.20 (1.13 to 1.27)	LOW **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Adjusted covariates in Beaudrot 2016 were maternal race, labour induction, smoking status.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[2] 95% CI crosses 1 MID (0.8 or 1.25).

Table 10: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participant**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	9 studies[1], 36631 participants	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	no serious imprecision	none	aOR[a] 0.91 (0.84 to 0.98)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	1 study (Langford 2011), 8992 participants	cohort studies	very serious[3]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aRR[a] 0.92 (0.83 to 1.02)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	3 studies[1], 8643 participants**	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[4]	none	aOR[a] 1.26 (1.08 to 1.48)	LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	4 studies[1], 29960 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 0.75 (0.59 to 0.95)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Singleton pregnancy	3 studies[1], 27954 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.49 (0.36 to 0.66)	HIGH **LOW RISK**
Inadequate GWG (referent: adequate GWG)	SGA Singleton pregnancy	3 studies[1], 288370 participants**	cohort studies	serious[3]	serious[2]	no serious indirectness	no serious imprecision	none	aOR[a] 1.77 (1.40 to 2.25)	LOW **HIGH RISK**
Inadequate GWG	LGA	1 study (Chen CN	cohort studies	no serious risk of bias	very serious[5]	very serious[6]	serious[4]	none	aOR[a] 0.59 (0.42 to 0.83)	VERY LOW **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participant	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
(referent: adequate GWG)	Singleton pregnancy	2020), 19052 participants								
Inadequate GWG (referent: adequate GWG)		1 study (Chen-Xu 2022), 13467 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[4]	none	aOR[a] 0.74 (0.49 to 1.12)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)		1 study (Lautredou 2022), 3162 participants	cohort studies	no serious risk of bias		very serious[6]	serious[4]	none	aOR[a] 0.53 (0.33 to 0.85)	VERY LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Liang 2021), 2210 participants	cohort studies	no serious risk of bias		very serious[6]	no serious imprecision	none	aOR[a] 0.02 (0.00 to 0.13)	VERY LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Park 2011), 570672 participants	cohort studies	serious[3]		no serious indirectness	no serious imprecision	none	aOR[a] 0.36 (0.28 to 0.46)	VERY LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Simko 2019), 7102 participants	cohort studies	no serious risk of bias		very serious[6]	serious[4]	none	aOR[a] 0.80 (0.60 to 1.07)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[7]	none	aOR[a] 0.95 (0.71 to 1.27)	LOW **NO ASSOCIATION**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participant**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
		(Lipworth 2022)								
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 study (Choi 2020)[8], number of participants NR	cohort studies	no serious risk of bias	very serious[5]	no serious indirectness	no serious imprecision	none	aOR[a] 3.38 (2.17 to 5.26)	LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)		1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2020)	systematic review	no serious risk of bias		no serious indirectness	serious[4]	none	aOR[a] 1.37 (1.06 to 1.77)	VERY LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension Twin pregnancy	1 study (Choi 2020)[8], number of participants NR	cohort studies	no serious risk of bias	very serious[5]	no serious indirectness	no serious imprecision	none	aOR[a] 0.43 (0.30 to 0.62)	LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Yee 2017)[8], number of participants NR	cohort studies	no serious risk of bias		no serious indirectness	serious[4]	none	aOR[a] 0.76 (0.72 to 0.80)	VERY LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	2 studies[1, 8], 34686 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.48 (0.36 to 0.65)	HIGH **LOW RISK**
Inadequate GWG (referent: adequate GWG)	SGA Twin pregnancy	2 studies[1, 8], 34686 participants**	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[4]	none	aOR[a] 1.55 (1.05 to 2.29)	LOW **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participant**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	LGA Twin pregnancy	1 study (Choi 2020)[8], number of participants NR	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.51 (0.35 to 0.74)	HIGH **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.
[**]Unclear how many participants contributed to this subgroup. The N value represents total participants.
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[4] 95% CI crosses 1 MID (0.8 or 1.25).
[5] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[6] Outcome is very indirect because it includes data defined as macrosomia.
[7] 95% CI crosses 2 MIDs (0.8 and 1.25).
[8] Primary study data extracted from systematic review by Whitaker 2022.

Table 11: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth	4 studies[1], 167942 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.10 (1.02 to 1.18)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes	2 studies[1], 98387 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.69 (1.33 to 2.15)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.73 (0.59 to 0.83)	LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Preeclampsia	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 1.72 (0.28 to 10.57)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	SGA	2 studies[1], 98387 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.15 (1.88 to 2.46)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	LGA	2 studies[1], 98387 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.35 (0.31 to 0.39)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years	1 study (Tanigawa 2022), 59844 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.47 (0.42 to 0.53)	HIGH **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[3] 95% CI crosses 1 MID (0.8 or 1.25).
[4] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 12: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI normal weight (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	1 study (Beyerlein 2011), 445323 participants	cohort studies	no serious risk of bias	very serious[1]	no serious indirectness	serious[2]	none	aOR[a] 1.13 (0.84 to 1.52)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97157 participants	cohort studies	serious[3]		no serious indirectness	no serious imprecision	none	aOR[a] 1.12 (1.07 to 1.17)	VERY LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Harper 2011), 76675 participants	cohort studies	serious[3]		no serious indirectness	no serious imprecision	none	aOR[a] 1.00 (0.87 to 1.15)	VERY LOW **NO ASSOCIATION**
Inadequate GWG		1 study (Hung 2016),	cohort studies	no serious risk of bias		no serious indirectness	serious[2]	none	aOR[a] 0.76 (0.65 to 0.89)	VERY LOW **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: adequate GWG)		10970 participants								
Inadequate GWG (referent: adequate GWG)		1 study (Lautredou 2022), 3162 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[2]	none	aOR[a] 1.55 (0.94 to 2.56)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)		1 study (McCurdy 2022), 55275 participants	cohort studies	very serious[4]		no serious indirectness	no serious imprecision	none	aOR[a] 1.14 (1.07 to 1.21)	VERY LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	2 studies[5], 98387 participants**	cohort studies	serious[3]	serious[6]	no serious indirectness	no serious imprecision	none	aOR[a] 1.67 (1.38 to 2.02)	LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[3]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.90 (0.83 to 0.98)	LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Singleton pregnancy	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[7]	none	aOR[a] 1.13 (0.58 to 2.20)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	LGA Singleton pregnancy	3 studies[5], 100393 participants**	cohort studies	serious[3]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.54 (0.52 to 0.57)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Inadequate GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 59844 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 0.83 (0.78 to 0.88)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[7]	none	aOR[a] 0.75 (0.30 to 1.87)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[7]	none	aOR[a] 0.89 (0.52 to 1.52)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.68 (0.48 to 0.96)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[7]	none	aOR[a] 1.06 (0.53 to 2.12)	LOW **NO ASSOCIATION**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
		pregnancies (Lipworth 2022)								

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age

[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.

**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*

***Unclear how many participants contributed to this subgroup. The N value represents total participants.*

[1] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.

[2] 95% CI crosses 1 MID (0.8 or 1.25).

[3] Majority of evidence at moderate risk of bias according to QUIPS checklist.

[4] Majority of evidence at high risk of bias according to QUIPS checklist.

[5] See corresponding forest plot in appendix E for studies contributing to this outcome.

[6] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.

[7] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 13: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight/obese weight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 0.95 (0.55 to 1.64)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.75 (1.15 to 2.66)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Preeclampsia	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 0.76 (0.27 to 2.14)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	SGA	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 1.30 (0.62 to 2.73)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	LGA	1 study (Hung 2016), 8101 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.66 (0.37 to 1.18)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Covariates adjusted in Hung 2016 were maternal age at delivery, parity, prior fetal death, prior preterm birth, conception methods, genetic amniocentesis, smoking during pregnancy, group B streptococcal colonization at the genitorectal tract, fetal sex, intrapartum epidural analgesia
Note: Study reported results for pre-pregnancy BMI overweight and obese as a combined adjusted effect estimate.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*

[1] *95% CI crosses 2 MIDs (0.8 and 1.25).*
[2] *95% CI crosses 1 MID (0.8 or 1.25).*

Table 14: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Inadequate GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	4 studies[1], 605164 participants**	cohort studies	serious[2]	serious[3]	no serious indirectness	no serious imprecision	none	aOR[a] 0.97 (0.85 to 1.11)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.75 (1.47 to 2.08)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.97 (0.82 to 1.15)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	SGA Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 1.49 (1.21 to 1.83)	LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	LGA Singleton pregnancy	1 study (Enomoto 2016), 90286	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.65 (0.56 to 0.76)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
		participants**								
Inadequate GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 59844 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[4]	None	aOR[a] 1.09 (0.93 to 1.28)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	none	aOR[a] 0.82 (0.38 to 1.77)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 0.58 (0.32 to 1.05)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	none	aOR[a] 1.09 (0.63 to 1.89)	LOW **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age

[a] *Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.*
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] *See corresponding forest plot in appendix E for studies contributing to this outcome.*
[2] *Majority of evidence at moderate risk of bias according to QUIPS checklist.*
[3] *Serious heterogeneity unexplained by subgroup analysis. Random effects model used.*
[4] *95% CI crosses 1 MID (0.8 or 1.25).*
[5] *95% CI crosses 2 MIDs (0.8 and 1.25).*

Table 15: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	2 studies[1], 129282 participants**	cohort studies	serious[2]	serious[3]	no serious indirectness	serious[4]	none	aOR[a] 0.81 (0.61 to 1.09)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.70 (1.32 to 2.19)	MODERATE **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 0.98 (0.78 to 1.24)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	SGA Singleton pregnancy	1 study (Enomoto 2016), 90286	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 1.63 (1.09 to 2.44)	LOW **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
		participants**								
Inadequate GWG (referent: adequate GWG)	LGA Singleton pregnancy	1 study (Enomoto 2016), 90286 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.59 (0.48 to 0.74)	MODERATE **LOW RISK**
Inadequate GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 59844 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 1.93 (1.61 to 2.31)	HIGH **HIGH RISK**
Inadequate GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[4]	none	aOR[a] 0.76 (0.54 to 1.07)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	none	aOR[a] 1.09 (0.49 to 2.42)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	2 studies[1, 6], 34686 participants**	cohort studies	no serious risk of bias	serious[3]	no serious indirectness	no serious imprecision	none	aOR[a] 0.30 (0.13 to 0.73)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Inadequate GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	none	aOR[a] 1.22 (0.63 to 2.36)	LOW **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Majority of evidence at moderate risk of bias according to QUIPS checklist
[3] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[4] 95% CI crosses 1 MID (0.8 or 1.25).
[5] 95% CI crosses 2 MIDs (0.8 and 1.25).
[6] Primary study data extracted from systematic review by Whitaker 2022.

Table 16: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class I (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth	4 studies[1], 493805 participants**	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[3]	none	aOR[a] 0.88 (0.77 to 1.00)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.85 (0.62 to 1.17)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.88 (0.74 to 1.05)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] 95% CI crosses 1 MID (0.8 or 1.25).

Table 17: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class II (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth	4 studies[1], 493805 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.91 (0.81 to 1.02)	HIGH **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[2]	none	aOR[a] 1.10 (0.74 to 1.64)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.82 (0.66 to 1.02)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies

[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.

**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*

***Unclear how many participants contributed to this subgroup. The N value represents total participants.*

[1] See corresponding forest plot in appendix E for studies contributing to this outcome.

[2] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 18: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class III (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Caesarean birth	1 study (Beyerlein 2011), 445323 participants	cohort studies	no serious risk of bias	very serious[1]	no serious indirectness	serious[2]	none	aOR[a] 0.76 (0.60 to 0.96)	VERY LOW **LOW RISK**
Inadequate GWG (referent: adequate GWG)		1 study (Blomberg 2011), 46595 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[2]	none	aOR[a] 0.82 (0.65 to 1.03)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)		1 study (Flick 2010), number of participants NR	cohort studies	no serious risk of bias		no serious indirectness	no serious imprecision	none	aOR[a] 1.54 (1.33 to 1.78)	LOW **HIGH RISK**
Inadequate GWG (referent: adequate GWG)		1 study (McCurdy 2022), 55275 participants	cohort studies	very serious[5]		no serious indirectness	serious[2]	none	aOR[a] 0.92 (0.74 to 1.14)	VERY LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Nulliparous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[3]	none	aOR[a] 1.10 (0.71 to 1.70)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: adequate GWG)	Caesarean birth (Parous)	1 study (Kominiarek 2013), 6641 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.77 (0.59 to 1.00)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies

[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[2] 95% CI crosses 1 MID (0.8 or 1.25).
[3] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 19: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories, age-stratified (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) <15 years old	1 study (Beaudrot 2016), 202799 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.62 (0.47 to 0.82)	MODERATE LOW RISK
Excessive GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 15-17 years old	1 study (Beaudrot 2016), 202799 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.61 (0.57 to 0.65)	HIGH LOW RISK
Excessive GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 18-19 years old	1 study (Beaudrot 2016), 202799 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.68 (0.66 to 0.70)	HIGH LOW RISK
Excessive GWG (referent: adequate GWG in 20-34 years)	Caesarean birth (age stratified) 20-34 years old	1 study (Beaudrot 2016), 202799 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.14 (1.11 to 1.17)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Covariates adjusted in Beaudrot 2016 were maternal race, labour induction, smoking status.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25)

Table 20: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	11 studies[1], 51679 participants	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	no serious imprecision	none	aOR[a] 1.34 (1.23 to 1.47)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	1 study (Langford 2011), 32356 participants	cohort studies	very serious[3]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aRR[a] 1.30 (1.24 to 1.36)	LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Chen CN 2020), 19052 participants	cohort studies	no serious risk of bias	very serious[4]	no serious indirectness	serious[5]	none	aOR[a] 1.27 (0.99 to 1.63)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Lautredou 2022), 3162 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[5]	none	aOR[a] 1.55 (1.17 to 2.05)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Simko 2019), 7102 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[5]	none	aOR[a] 0.60 (0.40 to 0.90)	VERY LOW **LOW RISK**
Excessive GWG (referent: adequate GWG)	Gestational hypertension	4 studies[1], 28895 participants**	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	no serious imprecision	none	aOR[a] 1.93 (1.43 to 2.61)	MODERATE **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
	Singleton pregnancy									
Excessive GWG (referent: adequate GWG)	Preeclampsia Singleton pregnancy	1 study (Chen CN 2020), 19052 participants	cohort studies	no serious risk of bias	very serious[4]	no serious indirectness	no serious imprecision	none	aOR[a] 3.17 (2.04 to 4.93)	LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Chen-Xu 2022), 13467 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[5]	none	aOR[a] 1.26 (0.86 to 1.85)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Simko 2019), 7102 participants	cohort studies	no serious risk of bias		no serious indirectness	very serious[6]	none	aOR[a] 0.90 (0.60 to 1.35)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	SGA Singleton pregnancy	1 study (Chen-Xu 2022), 13467 participants	cohort studies	no serious risk of bias	very serious[4]	no serious indirectness	no serious imprecision	none	aOR[a] 0.97 (0.72 to 1.31)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Park 2011), 570672 participants	cohort studies	serious[7]		no serious indirectness	no serious imprecision	none	aOR[a] 0.60 (0.55 to 0.65)	VERY LOW **LOW RISK**
Excessive GWG (referent: adequate GWG)	LGA Singleton pregnancy	6 studies[1], 485820 participants	cohort studies	serious[7]	serious[2]	serious[8]	no serious imprecision	none	aOR[a] 2.25 (1.78 to 2.84)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	2 studies[1, 9], 28473 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[5]	none	aOR[a] 1.22 (1.18 to 1.26)	MODERATE **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[6]	none	aOR[a] 0.94 (0.52 to 1.70)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Twin pregnancy	2 studies[1, 9], number of participants NR	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.77 (1.70 to 1.85)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	2 studies[1, 9], 28473 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.41 (1.73 to 3.35)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[5]	none	aOR[a] 0.66 (0.43 to 1.01)	MODERATE **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	LGA Twin pregnancy	1 study (Choi 2020, Whitaker 2022)[9], number of participants NR	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[5]	none	aOR[a] 1.79 (1.15 to 2.79)	MODERATE **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age

[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] Majority of evidence at high risk of bias according to QUIPS checklist.
[4] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[5] 95% CI crosses 1 MID (0.8 or 1.25).
[6] 95% CI crosses 2 MIDs (0.8 and 1.25).
[7] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[8] Outcome is very indirect because it includes data defined as LGA and macrosomia.
[9] Primary study data extracted from systematic review by Whitaker 2022

Table 21: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	4 5 studies[1], 73151 participants**	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[3]	none	aOR[a] 1.26 (1.06 to 1.51)	LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.71 (0.85 to 3.44)	MODERATE **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 1.25 (0.40 to 3.91)	LOW **NO ASSOCIATION**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
	Singleton pregnancy									
Excessive GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	3 studies[1], 44919 participants**	cohort studies	no serious risk of bias	no serious inconsistency	serious[5]	very serious[4]	none	aOR[a] 0.87 (0.55 to 1.38)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.38 (1.63 to 3.46)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Preeclampsia Singleton pregnancy	1 study (Hung 2016), 7814 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 4.58 (0.62 to 33.83)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	SGA Singleton pregnancy	2 studies[1], 42966 participants**	cohort studies	serious[6]	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 0.76 (0.54 to 1.08)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	LGA Singleton pregnancy	1 study (Di Benedetto 2012), 2225 participants	cohort studies	no serious risk of bias	very serious[7]	serious[8]	no serious imprecision	none	aOR[a] 1.00 (0.99 to 1.01)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97175 participants	cohort studies	serious[6]		no serious indirectness	serious[3]	none	aOR[a] 1.44 (1.07 to 1.95)	VERY LOW **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)		1 study (Hung 2016), 10970 participants	cohort studies	no serious risk of bias		no serious indirectness	no serious imprecision	none	aOR[a] 2.58 (1.38 to 4.82)	LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 24520 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 0.80 (0.50 to 1.28)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 0.84 (0.54 to 1.31)	LOW **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] 95% CI crosses 1 MID (0.8 or 1.25).
[4] 95% CI crosses 2 MIDs (0.8 and 1.25).
[5] Outcome is very indirect because it includes data that defined GWG differently to other included studies.
[6] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[7] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[8] Outcome is very indirect because it includes data defined as LGA and macrosomia.

Table 22: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight/normal weight (twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Excessive GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 study (Lal and Kominiarek 2015, Whitaker 2022), number of participants NR	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.40 (1.50 to 3.84)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Covariates adjusted in Whitaker 2022 were maternal age, parity, pre-existing diabetes or hypertension, pre-pregnancy BMI, chorionicity, gestational age at delivery, infant sex, race/ethnicity, height, smoking, employment and student status, marital status, insurance, education, fertility treatment, fetal sex of the twin pair, cerclage, prior preterm birth, payer status, diabetes, mode of conception, gestational age
Note: Study reported results for pre-pregnancy BMI underweight and normal weight as a combined adjusted effect estimate.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*

Table 23: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI normal weight (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	1 study (Di Benedetto 2012), 2225 participants	cohort studies	no serious risk of bias	very serious[1]	no serious indirectness	no serious imprecision	none	aOR[a] 1.00 (0.99 to 1.01)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97157 participants	cohort studies	serious[2]		no serious indirectness	no serious imprecision	none	aOR[a] 1.36 (1.25 to 1.47)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Harper 2011), 76675 participants	cohort studies	serious[2]		no serious indirectness	no serious imprecision	none	aOR[a] 1.35 (1.27 to 1.44)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Hung 2016), 10970 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[3]	none	aOR[a] 1.35 (1.16 to 1.57)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Lautredou 2022), 3162 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[3]	none	aOR[a] 1.59 (0.95 to 2.66)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (McCurdy), 55275 participants	cohort studies	very serious[4]		no serious indirectness	serious[3]	none	aOR[a] 1.16 (1.08 to 1.25)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.44 (1.28 to 1.62)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.48 (1.23 to 1.78)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Chuang 2022), 1953 participants	cohort studies	no serious risk of bias	very serious[1]	serious[5]	very serious[6]	none	aOR[a] 1.11 (0.52 to 2.37)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97157 participants	cohort studies	serious[2]		no serious indirectness	serious[3]	none	aOR[a] (1.48 (1.23 to 1.77)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Hung 2016), 10970 participants	cohort studies	no serious risk of bias		no serious indirectness	serious[3]	none	aOR[a] 0.89 (0.72 to 1.10)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.85 (1.59 to 2.16)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Preeclampsia Singleton pregnancy	1 study (Hung 2016), 7814 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.65 (2.18 to 6.11)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	SGA Singleton pregnancy	2 studies[7], 42966 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.66 (0.57 to 0.76)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	LGA Singleton pregnancy	4 studies[7], 47315 participants**	cohort studies	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.75 (1.62 to 1.89)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 24520 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.26 (1.31 to 1.41)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[6]	none	aOR[a] 0.83 (0.50 to 1.38)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[6]	none	aOR[a] 0.75 (0.42 to 1.34)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.04 (1.43 to 2.91)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.

[2] Majority of evidence at moderate risk of bias according to QUIPS checklist.
[3] 95% CI crosses 1 MID (0.8 or 1.25).
[4] Majority of evidence at high risk of bias according to QUIPS checklist.
[5] Outcome is very indirect because it includes data that defined GWG differently to other studies.
[6] 95% CI crosses 2 MIDs (0.8 and 1.25).
[7] See corresponding forest plot in appendix E for studies contributing to this outcome.

Table 24: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight/obese (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth	1 study (Hung 2016), 7814 participants	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.32 (0.92 to 1.89)	MODERATE **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational diabetes	2 studies[2], 9767 participants**	cohort studies	no serious risk of bias	serious[3]	serious[4]	serious[1]	none	aOR[a] 0.75 (0.48 to 1.18)	VERY LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Preeclampsia	1 study (Hung 2016), 7814 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	none	aOR[a] 1.24 (0.64 to 2.40)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	SGA	1 study (Hung 2016), 7814 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.64 (0.35 to 1.17)	HIGH **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	LGA	1 study (Hung 2016), 7814 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.30 (0.91 to 1.86)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
Note: Study reported results for pre-pregnancy BMI overweight and obese as a combined adjusted effect estimate.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).
[2] See corresponding forest plot in appendix E for studies contributing to this outcome.
[3] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[4] Outcome is very indirect because it includes data that defined GWG differently to other studies.
[5] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 25: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	1 study (Di Benedetto 2012), 2225 participants	cohort studies	no serious risk of bias	very serious[1]	no serious indirectness	no serious imprecision	none	aOR[a] 1.00 (0.99 to 1.01)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97157 participants	cohort studies	serious[2]		no serious indirectness	serious[3]	none	aOR[a] 1.18 (1.04 to 1.33)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Harper 2011), 76675 participants	cohort studies	serious[2]		no serious indirectness	serious[3]	none	aOR[a] 1.27 (1.13 to 1.43)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (McCurdy), 55275 participants	cohort studies	very serious[4]		no serious indirectness	no serious imprecision	none	aOR[a] 1.09 (1.08 to 1.10)	VERY LOW **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.42 (1.14 to 1.77)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.95 (1.41 to 2.70)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.71 (0.56 to 0.90)	MODERATE **LOW RISK**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.54 (1.28 to 1.86)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	SGA Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	serious[4]	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.86 (0.66 to 1.12)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	LGA Singleton pregnancy	2 studies[1], 37377 participants**	cohort studies	serious[4]	no serious inconsistency	serious[5]	no serious imprecision	none	aOR[a] 1.68 (1.46 to 1.94)	LOW **HIGH RISK**
Excessive GWG	Childhood Overweight/Obesity at 3 years	1 study (Tanigawa	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.82 (1.58 to 2.10)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: adequate GWG, pre-pregnancy BMI normal)	Singleton pregnancy	2022), 24520 participants**								
Excessive GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[6]	none	aOR[a] 0.51 (0.20 to 1.30)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.18 (0.06 to 0.54)	HIGH **LOW RISK**
Excessive GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.82 (1.15 to 2.88)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	SGA Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 0.51 (0.23 to 1.13)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[2] Majority of evidence at moderate risk of bias according to QUIPS checklist
[3] 95% CI crosses 1 MID (0.8 or 1.25).
[4] Majority of evidence at high risk of bias according to QUIPS checklist.
[5] Outcome is very indirect because it includes data defined as LGA and macrosomia.
[6] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 26: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese (singleton and twin pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth Singleton pregnancy	3 studies[1], 176057 participants	cohort studies	very serious[2]	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.14 (1.01 to 1.30)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.39 (1.04 to 1.86)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous Singleton pregnancy	1 study (Haugen 2014), 45898 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.21 (0.85 to 1.72)	MODERATE **NO ASSOCIATION**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Gestational diabetes Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 1.03 (0.76 to 1.39)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.15 (0.85 to 1.54)	MODERATE **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	SGA Singleton pregnancy	1 study (Enomoto 2016), 35152 participants**	cohort studies	serious[5]	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.11 (0.71 to 1.72)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	LGA Singleton pregnancy	1 study (Di Benedetto 2012), 2225 participants	cohort studies	no serious risk of bias	very serious[6]	serious[7]	no serious imprecision	none	aOR[a] 8.30 (2.40 to 28.71)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)		1 study (Enomoto 2016), 97157 participants	cohort studies	serious[5]		no serious indirectness	serious[3]	none	aOR[a] 1.47 (1.16 to 1.86)	VERY LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG, pre-pregnancy BMI normal)	Childhood Overweight/Obesity at 3 years Singleton pregnancy	1 study (Tanigawa 2022), 24520 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.21 (1.77 to 2.76)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Excessive GWG (referent: adequate GWG)	Caesarean birth Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 1.07 (0.76 to 1.51)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational diabetes Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 1.37 (0.67 to 2.80)	LOW **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Gestational hypertension Twin pregnancy	1 study (Lal and Kominiarek 2015, Whitaker 2022), number of participants NR	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.30 (1.40 to 7.78)	HIGH **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Preeclampsia Twin pregnancy	1 systematic review with 19 studies and 36023 twin pregnancies (Lipworth 2022)	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.43 (1.02 to 2.00)	MODERATE **HIGH RISK**
Excessive GWG	SGA Twin pregnancy	1 systematic review with 19 studies and 36023	systematic review	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	none	aOR[a] 0.91 (0.41 to 2.02)	LOW **NO ASSOCIATION**

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: adequate GWG)		twin pregnancies (Lipworth 2022)								

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; LGA: large for gestational age; MID: minimal important difference; QUIPS: Quality in Prognostic Studies; SGA: small for gestational age
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Majority of evidence at high risk of bias according to QUIPS checklist.
[3] 95% CI crosses 1 MID (0.8 or 1.25).
[4] 95% CI crosses 2 MIDs (0.8 and 1.25).
[5] Majority of the evidence at moderate risk of bias according to QUIPS checklist.
[6] Very serious heterogeneity (I2 > 80%). Results were not meta-analysed where there was very serious heterogeneity.
[7] Outcome is very indirect because it includes data defined as LGA and macrosomia.

Table 27: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class I (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG	Caesarean birth	3 studies[1], 48482 participants	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[3]	none	aOR[a] 1.29 (1.15 to 1.44)	LOW HIGH RISK

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: adequate GWG)										
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.20 (1.00 to 1.44)	MODERATE **NO ASSOCIATION**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.30 (1.10 to 1.54)	MODERATE **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] 95% CI crosses 1 MID (0.8 or 1.125).

Table 28: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class II (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth	3 studies[1], 48482 participants	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.17 (1.07 to 1.28)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.50 (1.10 to 2.05)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.10 (0.93 to 1.30)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] 95% CI crosses 1 MID (0.8 or 1.125).

Table 29: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese class III (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Caesarean birth	3 studies[1], 48482 participants	cohort studies	no serious risk of bias	serious[2]	no serious indirectness	serious[3]	none	aOR[a] 1.25 (1.03 to 1.51)	LOW **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Nulliparous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.70 (1.20 to 2.41)	MODERATE **HIGH RISK**
Excessive GWG (referent: adequate GWG)	Caesarean birth Parous	1 study (Kominiarek 2013), 16740 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	none	aOR[a] 1.10 (0.94 to 1.29)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference
[a] Studies were pooled despite not adjusting for the same covariates, but there was overlap for some adjusted covariates. For adjusted covariates in individual studies see corresponding evidence table in Appendix D.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] See corresponding forest plot in appendix E for studies contributing to this outcome.
[2] Serious heterogeneity unexplained by subgroup analysis. Random effects model used.
[3] 95% CI crosses 1 MID (0.8 or 1.25).

Table 30: Evidence profile for association between low gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[2]	none	aOR[a] 1.39 (0.77 to 2.51)	LOW **NO ASSOCIATION**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.56 (0.39 to 0.80)	MODERATE **LOW RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.45 (0.26 to 0.78)	HIGH **LOW RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.12 (2.75 to 3.54)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.23 (0.15 to 0.35)	HIGH **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*

[1] *95% CI crosses 1 MID (0.8 or 1.25).*
[2] *95% CI crosses 2 MIDs (0.8 and 1.25).*

Table 31: Evidence profile for association between low gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI normal weight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.90 (0.73 to 1.11)	MODERATE **NO ASSOCIATION**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.98 (0.90 to 1.07)	HIGH **NO ASSOCIATION**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.02 (0.92 to 1.13)	HIGH **NO ASSOCIATION**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.81 (1.73 to 1.89)	HIGH **HIGH RISK**
Low GWG[ǂ]	LGA	1 IPD with 39 birth cohorts	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.52 (0.49 to 0.55)	HIGH **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: medium weight gain in pre-pregnancy BMI normal)		and 265270 participants** (Santos 2019)								

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 32: Evidence profile for association between low gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.91 (1.46 to 2.50)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.46 (1.25 to 1.71)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.86 (1.61 to 2.15)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.23 (1.14 to 1.33)	MODERATE **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.92 (0.84 to 1.01)	HIGH **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*

[1] *95% CI crosses 1 MID (0.8 or 1.25).*

Table 33: Evidence profile for association between low gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 4.44 (3.41 to 5.78)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.06 (2.57 to 3.64)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.52 (3.00 to 4.13)	HIGH **HIGH RISK**
Low GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.99 (0.87 to 1.13)	HIGH **NO ASSOCIATION**
Low GWG[ǂ] (referent: medium	LGA	1 IPD with 39 birth cohorts and 265270	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.45 (1.29 to 1.63)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
weight gain in pre-pregnancy BMI normal)		participants** (Santos 2019)								

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
ⱡSantos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*

Table 34: Evidence profile for association between medium gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Medium GWGⱡ (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.55 (0.34 to 0.89)	MODERATE LOW RISK
Medium GWGⱡ	Gestational hypertension	1 IPD with 39 birth cohorts and 265270	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.65 (0.51 to 0.83)	MODERATE LOW RISK

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: medium weight gain in pre-pregnancy BMI normal)		participants** (Santos 2019)								
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.68 (0.53 to 0.87)	HIGH LOW RISK
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.76 (1.63 to 1.90)	HIGH HIGH RISK
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.45 (0.38 to 0.53)	HIGH LOW RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*

***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 35: Evidence profile for association between medium gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.40 (2.09 to 2.76)	HIGH **HIGH RISK**
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.10 (1.94 to 2.27)	HIGH **HIGH RISK**
Medium GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.10 (1.93 to 2.29)	HIGH **HIGH RISK**
Medium GWG[ǂ] (referent: medium weight gain in pre-	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.77 (0.73 to 0.81)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
pregnancy BMI normal)										
Medium GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.77 (1.69 to 1.85)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ƚ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 36: Evidence profile for association between medium gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Medium GWG[ƚ] (referent: medium	Gestational diabetes	1 IPD with 39 birth cohorts and 265270	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 5.09 (4.40 to 5.89)	HIGH **HIGH RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
weight gain in pre-pregnancy BMI normal)		participants** (Santos 2019)								
Medium GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.88 (3.53 to 4.26)	HIGH **HIGH RISK**
Medium GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 4.01 (3.64 to 4.42)	HIGH **HIGH RISK**
Medium GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.80 (0.74 to 0.86)	MODERATE **LOW RISK**
Medium GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.57 (2.43 to 2.72)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ƚ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 37: Evidence profile for association between high gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI underweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
High GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 0.56 (0.23 to 1.36)	LOW **NO ASSOCIATION**
High GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 1.07 (0.76 to 1.51)	LOW **NO ASSOCIATION**
High GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.22 (0.82 to 1.82)	MODERATE **NO ASSOCIATION**
High GWG[ƚ] (referent: medium	SGA	1 IPD with 39 birth cohorts and 265270	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.79 (0.67 to 0.93)	MODERATE **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
weight gain in pre-pregnancy BMI normal)		participants** (Santos 2019)								
High GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	aOR[a] 0.98 (0.79 to 1.22)	LOW **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ƚ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 2 MIDs (0.8 and 1.25).
[2] 95% CI crosses 1 MID (0.8 or 1.25).

Table 38: Evidence profile for association between high gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI normal weight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
High GWG[ƚ]	Gestational diabetes	1 IPD with 39 birth cohorts	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.34 (1.14 to 1.58)	MODERATE

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
(referent: medium weight gain in pre-pregnancy BMI normal)		and 265270 participants** (Santos 2019)								**HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.39 (1.28 to 1.51)	HIGH **HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.24 (1.12 to 1.37)	MODERATE **HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.57 (0.54 to 0.60)	HIGH **LOW RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.26 (2.17 to 2.35)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age

[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 39: Evidence profile for association between high gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI overweight (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.49 (2.89 to 4.21)	HIGH **HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.71 (2.41 to 3.05)	HIGH **HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 2.54 (2.23 to 2.89)	HIGH **HIGH RISK**
High GWG[ǂ] (referent: medium weight gain in pre-	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.51 (0.46 to 0.57)	HIGH **LOW RISK**

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
pregnancy BMI normal)										
High GWG[ƚ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 3.46 (3.24 to 3.69)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ƚ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*

Table 40: Evidence profile for association between high gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: Pre-pregnancy BMI obese (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
High GWG[ƚ] (referent: medium weight gain in pre-	Gestational diabetes	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 7.84 (6.38 to 9.63)	HIGH HIGH RISK

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
pregnancy BMI normal)										
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Gestational hypertension	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 4.52 (3.85 to 5.29)	HIGH HIGH RISK
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	Preeclampsia	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 4.58 (3.90 to 5.38)	HIGH HIGH RISK
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	SGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.60 (0.51 to 0.71)	HIGH LOW RISK
High GWG[ǂ] (referent: medium weight gain in pre-pregnancy BMI normal)	LGA	1 IPD with 39 birth cohorts and 265270 participants** (Santos 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 4.77 (4.35 to 5.23)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data; LGA: large for gestational age; MID: minimal important difference; SGA: small for gestational age
[a] Covariates adjusted in Santos 2019 were maternal age, educational level, parity, smoking habits during pregnancy.
[ǂ]Santos 2020 describes inadequate GWG as low weight gain, adequate GWG as medium weight gain, and excessive GWG as high weight gain. No further information about GWG provided.

**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).
[2] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 41: Evidence profile for association between inadequate gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 2 to 5 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.86 (0.78 to 0.95)	MODERATE LOW RISK
Inadequate GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 5 to 10 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.90 (0.84 to 0.96)	HIGH LOW RISK
Inadequate GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 10 to 18 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.91 (0.82 to 1.01)	HIGH NO ASSOCIATION

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data
[a] Covariates adjusted for in Voerman 2019 were maternal age, maternal ethnicity, educational level, parity, maternal smoking during pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup*
[1] 95% CI crosses 1 MID (0.8 or 1.25).
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Table 42: Evidence profile for association between excessive gestational weight gain (IOM categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Excessive GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 2 to 5 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.39 (1.30 to 1.49)	HIGH HIGH RISK
Excessive GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 5 to 10 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.55 (1.49 to 1.61)	HIGH HIGH RISK
Excessive GWG (referent: adequate GWG)	Childhood overweight/obesity Early childhood- 10 to 18 years	1 IPD with 37 birth cohorts and 162129 participants** (Voerman 2019)	IPD	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.72 (1.56 to 1.90)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; IPD: individual participant data
[a] Covariates adjusted in Voerman 2019 were maternal age, maternal ethnicity, educational level, parity, maternal smoking during pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup.*

Table 43: Evidence profile for association between low (<8 kg) gestational weight gain (Independent Swedish GWG categories) and maternal/neonatal/fetal outcomes (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Inadequate GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI <20	1 study (Cedergren 2006), 175135 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 1.07 (0.89 to 1.29)	LOW **NO ASSOCIATION**
Inadequate GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 20-24.9	1 study (Cedergren 2006), 175135 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.98 (0.92 to 1.04)	MODERATE **NO ASSOCIATION**
Inadequate GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 25-29.9	1 study (Cedergren 2006), 175135 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 0.88 (0.82 to 0.94)	MODERATE **LOW RISK**
Inadequate GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 30-34.9	1 study (Cedergren 2006), 175135 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.81 (0.73 to 0.90)	LOW **LOW RISK**
Inadequate GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI ≥35	1 study (Cedergren 2006), 175135 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	none	aOR[a] 0.75 (0.66 to 0.85)	LOW **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Covariates adjusted in Cedergren 2006 were maternal age, parity, smoking in early pregnancy, years of birth.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Study has a moderate risk of bias according to QUIPS checklist.
[2] 95% CI crosses 1 MID (0.8 or 1.25).

Table 44: Evidence profile for association between high (>16 kg) gestational weight gain (Independent Swedish GWG categories) and maternal/neonatal/fetal outcomes (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
Excessive GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI <20	1 study (Cedergren 2006), 216197 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 1.29 (1.17 to 1.42)	LOW **HIGH RISK**
Excessive GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 20-24.9	1 study (Cedergren 2006), 216197 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 1.24 (1.19 to 1.29)	LOW **HIGH RISK**
Excessive GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 25-29.9	1 study (Cedergren 2006), 216197 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 1.23 (1.17 to 1.29)	LOW **HIGH RISK**
Excessive GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI 30-34.9	1 study (Cedergren 2006), 216197 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 1.22 (1.10 to 1.35)	LOW **HIGH RISK**
Excessive GWG (referent: 8 to 16 kg GWG)	Caesarean birth Pre-pregnancy BMI ≥35	1 study (Cedergren 2006), 216197 participants**	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 1.27 (1.05 to 1.54)	LOW **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; IOM: Institute of Medicine; MID: minimal important difference; QUIPS: Quality in Prognostic Studies
[a] Covariates adjusted in Cedergren 2006 were maternal age, parity, smoking in early pregnancy, years of birth.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] Study has a moderate risk of bias according to QUIPS checklist.
[2] 95% CI crosses 1 MID (0.8 or 1.25).

Table 45: Evidence profile for association between gestational weight gain 0.5 kg to 6.9 kg (Swedish categories) and maternal/neonatal/fetal outcomes (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
0.5 kg to 6.9 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Underweight	1 study (Premru-Srsen 2019), 81524 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	None	aOR[a] 1.08 (0.32 to 3.64)	LOW **NO ASSOCIATION**
0.5 kg to 6.9 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Normal weight	1 study (Premru-Srsen 2019), 81524 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 0.59 (0.43 to 0.81)	MODERATE **LOW RISK**
0.5 kg to 6.9 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Overweight	1 study (Premru-Srsen 2019), 81524 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	None	aOR[a] 0.58 (0.38 to 0.89)	MODERATE **LOW RISK**
0.5 kg to 6.9 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Obese	1 study (Premru-Srsen 2019), 81524 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.47 (0.32 to 0.69)	HIGH **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Premru-Srsen 2019 were maternal age, parity, preventative treatment with low-dose Aspirin, pre-pregnancy diabetes mellitus, pre-pregnancy hypertension, pre-pregnancy BMI, smoking in early pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 2 MIDs (0.8 and 1.25).
[2] 95% CI crosses 1 MID (0.8 or 1.25).

Table 46: Evidence profile for association between gestational weight gain 6.7 kg to 10 kg (Swedish categories) and maternal/neonatal/fetal outcomes (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome (subgroup)	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
6.7 kg to 10 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Normal weight	1 study (Premru-Srsen 2019), 79638 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	None	aOR[a] 0.69 (0.42 to 1.13)	MODERATE **NO ASSOCIATION**
6.7 kg to 10 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Overweight	1 study (Premru-Srsen 2019), 79638 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	None	aOR[a] 0.49 (0.25 to 0.96)	MODERATE **LOW RISK**
6.7 kg to 10 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Obese	1 study (Premru-Srsen 2019), 79638 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 0.33 (0.17 to 0.64)	HIGH **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Premru-Srsen 2019 were maternal age, parity, preventative treatment with low-dose Aspirin, pre-pregnancy diabetes mellitus, pre-pregnancy hypertension, pre-pregnancy BMI, smoking in early pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 47: Evidence profile for association between gestational weight gain 13.7 kg to 29 kg (Swedish categories) and maternal/neonatal/fetal outcomes (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
13.7 kg to 29 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Underweight	1 study (Premru-Srsen 2019), 71770 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	None	aOR[a] 1.69 (0.73 to 3.91)	LOW **NO ASSOCIATION**
13.7 kg to 29 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Normal weight	1 study (Premru-Srsen 2019), 71770 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 2.29 (1.94 to 2.70)	HIGH **HIGH RISK**
13.7 kg to 29 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Overweight	1 study (Premru-Srsen 2019), 71770 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 2.03 (1.86 to 2.22)	HIGH **HIGH RISK**
13.7 kg to 29 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Obese	1 study (Premru-Srsen 2019), 71770 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 1.76 (1.33 to 2.33)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Premru-Srsen 2019 were maternal age, parity, preventative treatment with low-dose Aspirin, pre-pregnancy diabetes mellitus, pre-pregnancy hypertension, pre-pregnancy BMI, smoking in early pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 2 MIDs (0.8 and 1.25).

Table 48: Evidence profile for association between gestational weight gain >24.6 kg to ≥29.1 kg (Swedish categories) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
>24.6 kg to ≥29.1 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Underweight	1 study (Premru-Srsen 2019), 70344 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 5.45 (2.10 to 14.14)	HIGH HIGH RISK
>24.6 kg to ≥29.1 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Normal weight	1 study (Premru-Srsen 2019), 70344 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 4.53 (3.45 to 5.95)	HIGH HIGH RISK
>24.6 kg to ≥29.1 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Overweight	1 study (Premru-Srsen 2019), 70344 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 4.77 (3.07 to 7.41)	HIGH HIGH RISK
>24.6 kg to ≥29.1 kg GWG (referent: adequate GWG)	Preeclampsia Pre-pregnancy BMI- Obese	1 study (Premru-Srsen 2019), 70344 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 2.22 (1.79 to 2.75)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain
[a] Covariates adjusted in Premru-Srsen 2019 were maternal age, parity, preventative treatment with low-dose Aspirin, pre-pregnancy diabetes mellitus, pre-pregnancy hypertension, pre-pregnancy BMI, smoking in early pregnancy.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*

Table 49: Evidence profile for association between >20kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
>20kg GWG (referent: ≤20kg)	Preeclampsia	1 study (Chen L 2020), number of participants NR	cohort studies	serious[1]	no serious inconsistency	no serious indirectness	no serious imprecision	None	aOR[a] 13.60 (3.78 to 48.88)	MODERATE **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; ET: embryo transfer; GWG: gestational weight gain; ICSI: intracytoplasmic sperm injection; QUIPS: Quality in Prognostic Studies
[a] Covariates adjusted in Chen L 2020 were endocrine parameters, mother's age, age of the male partner, BMI, infertility diagnosis, ovarian stimulation protocol, duration of ovarian stimulation, maximal endometrial thickness, number oocytes retrieved, number of embryos transferred, use of ICSI, use of blastocyst- stage ET, occurrence of multiple pregnancies, pregnancy weight gain.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
[1] Study has a moderate risk of bias according to QUIPS checklist.

Table 50: Evidence profile for association between <8kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	Outcome	No of studies & participants	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Relative* (95% CI)	
<8kg GWG (referent: GWG 8-15.9kg)	Caesarean birth	1 study (Morken 2013), 28899 participants	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	None	aOR[a] 0.90 (0.80 to 1.01)	MODERATE **NO ASSOCIATION**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Morken 2013 were maternal age, smoking, parity, BMI category.

**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 51: Evidence profile for association between ≥16 kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
≥16kg GWG (referent: GWG 8-15.9kg)	Caesarean birth	1 study (Morken 2013), 46288 participants	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.30 (1.26 to 1.34)	HIGH **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain
[a] Covariates adjusted in were Morken 2013 maternal age, smoking, parity, BMI category.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*

Table 52: Evidence profile for association between <10 kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
<10kg GWG (referent: GWG 10-15kg)	Caesarean birth Before labour	1 study (Nohr 2008), 34891 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.90 (0.80 to 1.01)	MODERATE **NO ASSOCIATION**
<10kg GWG (referent: GWG 10-15kg)	Caesarean birth During labour	1 study (Nohr 2008), 34891 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.80 (0.79 to 0.81)	MODERATE **LOW RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Nohr 2008 were age, parity, height, smoking, alcohol consumption, social status, exercise, gestational age (in days), birthweight.

**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 53: Evidence profile for association between 16-19 kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
16-19kg GWG (referent: GWG 10-15kg)	Caesarean birth Before labour	1 study (Nohr 2008), 39945 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.00 (0.90 to 1.11)	HIGH **NO ASSOCIATION**
16-19kg GWG (referent: GWG 10-15kg)	Caesarean birth During labour	1 study (Nohr 2008), 39945 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.20 (1.12 to 1.29)	MODERATE **HIGH RISK**

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] Covariates adjusted in Nohr 2008 were age, parity, height, smoking, alcohol consumption, social status, exercise, gestational age (in days), birthweight.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 54: Evidence profile for association between ≥20 kg gestational weight gain (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative (95% CI)**	
≥20kg GWG (referent: GWG 10-15kg)	Caesarean birth Before labour	1 study (Nohr 2008), 40554 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 1.20 (1.10 to 1.31)	MODERATE HIGH RISK
≥20kg GWG (referent: GWG 10-15kg)	Caesarean birth During labour	1 study (Nohr 2008), 40554 participants**	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	aOR[a] 1.40 (1.30 to 1.51)	HIGH HIGH RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] covariates adjusted for in Nohr 2008 were age, parity, height, smoking, alcohol consumption, social status, exercise, gestational age (in days), birthweight.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
***Unclear how many participants contributed to this subgroup. The N value represents total participants.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Table 55: Evidence profile for association between weight loss (study defined category) and maternal/neonatal/fetal outcomes: all pre-pregnancy BMI categories (singleton pregnancy)

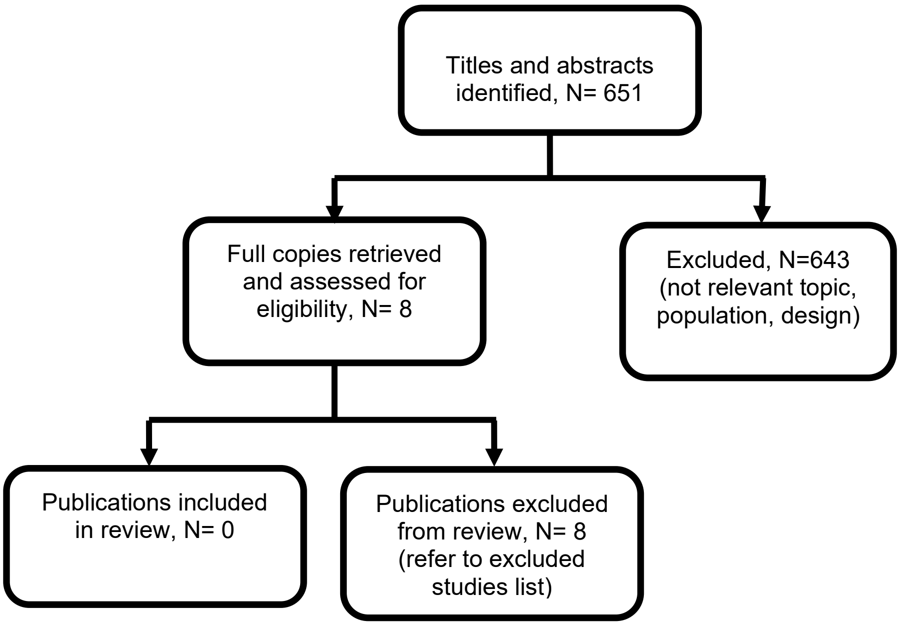
Quality assessment									Effect	Quality
Risk factor	**Outcome (subgroup)**	**No of studies & participants**	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Relative* (95% CI)**	
Weight loss (referent: no weight loss)	Caesarean birth Before labour	1 study (Yee 2013), 26205 participants	cohort studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	aOR[a] 0.86 (0.75 to 0.99)	MODERATE LOW RISK

aOR: adjusted odds ratio; BMI: body mass index; CI: confidence intervals; GWG: gestational weight gain; MID: minimal important difference
[a] covariates adjusted for in Yee 2013 were maternal age, race/ethnicity, parity, education, primary language.
**Adjusted relative estimates and 95% CIs >1 represent an increased risk; relative estimates and 95% CIs <1 represent a decreased risk.*
[1] 95% CI crosses 1 MID (0.8 or 1.25).

Appendix G Economic evidence study selection

Study selection for review question: What gestational weight change is healthy and appropriate during pregnancy?

Figure 40: Study selection flow chart



Appendix H Economic evidence tables

Economic evidence tables for review question: What gestational weight change is healthy and appropriate during pregnancy?

No economic evidence was identified which was applicable to this review question.

Appendix I Economic model

Economic model for review question: What gestational weight change is healthy and appropriate during pregnancy?

No economic analysis was conducted for this review question.

Appendix J Excluded studies

Excluded studies for review question: What gestational weight change is healthy and appropriate during pregnancy?

Excluded clinical evidence studies

Table 56: Excluded studies and reasons for their exclusion

Study	Code [Reason]
Abenhaim, H.A. and Benjamin, A. (2011) Higher Caesarean Section Rates in Women With Higher Body Mass Index: Are We Managing Labour Differently?. Journal of Obstetrics and Gynaecology Canada 33(5): 443-448	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study.*
Abenhaim, H.A., Kinch, R.A., Morin, L. et al. (2007) Effect of prepregnancy body mass index categories on obstetrical and neonatal outcomes. Archives of Gynecology and Obstetrics 275(1): 39-43	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Abrams, B.F., Leonard, S.A., Kan, P. et al. (2022) Interpregnancy weight change: associations with severe maternal morbidity and neonatal outcomes. American Journal of Obstetrics and Gynecology MFM 4(3): 100596	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI change between 2 consecutive pregnancies with outcomes in the second pregnancy. No gestational weight change was reported by the study*
Adane, A.A.; Tooth, L.R.; Mishra, G.D. (2017) Pre-pregnancy weight change and incidence of gestational diabetes mellitus: A finding from a prospective cohort study. Diabetes Research and Clinical Practice 124: 72-80	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Al-Hassany, L., Wahab, R.J., Steegers, E.A.P. et al. (2020) Smoking cessation in early-pregnancy, gestational weight gain and subsequent risks of pregnancy complications. European Journal of Obstetrics and Gynecology and Reproductive Biology 253: 7-14	- Risk factor does not match protocol *Risk factor is smoking cessation in early pregnancy. The study includes an analysis by gestational weight gain and risks of maternal pregnancy complications, however the comparison group is those who continued smoking during pregnancy with no reference to gestational weight gain, therefore this is not a relevant comparison*
Alberico, S., Montico, M., Barresi, V. et al. (2014) The role of gestational diabetes,	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth

Study	Code [Reason]
pre-pregnancy body mass index and gestational weight gain on the risk of newborn macrosomia: Results from a prospective multicentre study. BMC Pregnancy and Childbirth 14(1): 23	cohorts from Europe, North America, and Oceania published before 2019
Albers, Lucia, Sobotzki, Christina, Kus, Oliver et al. (2018) Maternal smoking during pregnancy and offspring overweight: is there a dose-response relationship? An individual patient data meta-analysis. International journal of obesity (2005) 42(7): 1249-1264	- Risk factor does not match protocol *Risk factor is maternal smoking during pregnancy. No gestational weight change was reported by the study*
Amark, H.; Westgren, M.; Persson, M. (2019) Prediction of large-for-gestational-age infants in pregnancies complicated by obesity: A population-based cohort study. Acta Obstetricia et Gynecologica Scandinavica 98(6): 769-776	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Andersen, Camilla Schou, Gamborg, Michael, Sorensen, Thorkild I A et al. (2011) Weight gain in different periods of pregnancy and offspring's body mass index at 7 years of age. International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity 6(22): e179-86	- Article unavailable
Antonakou, A.; Papoutsis, D.; Kechagia, A. (2017) Does gestational weight gain of more than 12 kg in women increase the risk of a cesarean section delivery, gestational diabetes and pregnancy induced hypertension? A retrospective case series. Clinical and Experimental Obstetrics and Gynecology 44(4): 540-544	- Study did not adjust for covariates in the analysis
Ardic, Cuneyt, Colak, Sabri, Uzun, Kerem et al. (2020) Maternal Gestational Diabetes and Early Childhood Obesity: A Retrospective Cohort Study. Childhood obesity (Print) 16(8): 579-585	- Risk factor does not match protocol *Risk factor is gestational diabetes. No gestational weight change by reported by the study*
Ashtree, Deborah N, Osborne, Deborah A, Lee, Amelia et al. (2022) Gestational weight gain is associated with childhood height, weight and BMI in the Peri/Postnatal Epigenetic Twins Study.	- Analysis not relevant to this protocol *Study assessed the association between gestational weight gain and childhood anthropometric parameters. However the*

Study	Code [Reason]
Journal of developmental origins of health and disease: 1-9	*absolute values for gestational weight were not reported, these were incorporated in the analyses as z-scores, therefore the reported results are not relevant for this review question*
Badon, Sylvia E, Dublin, Sascha, Nance, Nerissa et al. (2021) Gestational weight gain and adverse pregnancy outcomes by pre-pregnancy BMI category in women with chronic hypertension: A cohort study. Pregnancy hypertension 23: 27-33	- Analysis not relevant to this protocol *Study assessed the association between gestational weight gain and adverse birth outcomes. However the absolute values for gestational weight were not reported, these were incorporated in the analyses as z-scores, therefore the reported results are not relevant for this review question*
Bakketeig, L.S., Jacobsen, G., Hoffman, H.J. et al. (1993) Pre-pregnancy risk factors of small-for-gestational age births among parous women in Scandinavia. Acta Obstetricia et Gynecologica Scandinavica 72(4): 273-279	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Bar-Zeev, Y.; Haile, Z.T.; Chertok, I.A. (2020) Association between Prenatal Smoking and Gestational Diabetes Mellitus. Obstetrics and Gynecology 135(1): 91-99	- Risk factor does not match protocol *Risk factor is prenatal smoking. No gestational weight change was reported by the study*
Barau, G., Robillard, P.-Y., Hulsey, T.C. et al. (2006) Linear association between maternal pre-pregnancy body mass index and risk of caesarean section in term deliveries. BJOG: An International Journal of Obstetrics and Gynaecology 113(10): 1173-1177	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study.*
Barnes, R A, Edghill, N, Mackenzie, J et al. (2013) Predictors of large and small for gestational age birthweight in offspring of women with gestational diabetes mellitus. Diabetic medicine : a journal of the British Diabetic Association 30(9): 1040-6	- Study design does not match protocol *Retrospective audit of clinical data.*
Barquiel, B., Herranz, L., Grande, C. et al. (2014) Body weight, weight gain and hyperglycaemia are associated with hypertensive disorders of pregnancy in women with gestational diabetes. Diabetes and Metabolism 40(3): 204-210	- Analysis not relevant to this protocol *Multivariate analysis conducted, which did not report association effect estimates.*

Study	Code [Reason]
Barquiel, Beatriz, Herranz, Lucrecia, Meneses, Diego et al. (2018) Optimal Gestational Weight Gain for Women with Gestational Diabetes and Morbid Obesity. Maternal and child health journal 22(9): 1297-1305	- Study did not adjust for covariates in the analysis *Univariate regression and correlation analysis were reported. Adjusted estimates were reported as sensitivity and specificity, which are not relevant outcomes measures for this review*
Basraon, S.K., Mele, L., Myatt, L. et al. (2015) Relationship of Early Pregnancy Waist-to-Hip Ratio versus Body Mass Index with Gestational Diabetes Mellitus and Insulin Resistance. American Journal of Perinatology 33(1): 114-122	- Risk factor does not match protocol *Risk factor is BMI and waist to hip ratio in early pregnancy. No gestational weight change was reported by the study*
Ben-Haroush, Avi, Hadar, Eran, Chen, Rony et al. (2009) Maternal obesity is a major risk factor for large-for-gestational-infants in pregnancies complicated by gestational diabetes. Archives of gynecology and obstetrics 279(4): 539-43	- Risk factor does not match protocol *Risk factor is maternal obesity. No gestational weight change was reported by the study*
Berggren, E.K.; Stuebe, A.M.; Boggess, K.A. (2014) Excess Maternal Weight Gain and Large for Gestational Age Risk among Women with Gestational Diabetes. American Journal of Perinatology	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Bergholt, T., Lim, L.K., Jorgensen, J.S. et al. (2007) Maternal body mass index in the first trimester and risk of cesarean delivery in nulliparous women in spontaneous labor. American Journal of Obstetrics and Gynecology 196(2): e1-163	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study.*
Berntorp, Kerstin, Anderberg, Eva, Claesson, Rickard et al. (2015) The relative importance of maternal body mass index and glucose levels for prediction of large-for-gestational-age births. BMC pregnancy and childbirth 15: 280	- Risk factor does not match protocol *Risk factor is maternal age, BMI, 2-h glucose, smoker and parity. No gestational weight change was reported by the study*
Black, MH, Sacks, DA, Xiang, AH et al. (2013) The relative contribution of prepregnancy overweight and obesity, gestational weight gain, and IADPSG-defined gestational diabetes mellitus to fetal overgrowth. Diabetes care 36(1): 56-62	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*

Study	Code [Reason]
Bodnar LM, Pugh SJ, Abrams B, Himes KP HJ (2014) Gestational weight gain in twin pregnancies and maternal and child health: a systematic review. Journal of Perinatology 4(34): 252-63	- Superseded by more recent publication *More recent SR included all the same studies - Whitaker 2022*
Bodnar, L.M., Catov, J.M., Klebanoff, M.A. et al. (2007) Prepregnancy body mass index and the occurrence of severe hypertensive disorders of pregnancy. Epidemiology 18(2): 234-239	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Bodnar, L.M., Himes, K.P., Abrams, B. et al. (2019) Gestational Weight Gain and Adverse Birth Outcomes in Twin Pregnancies. Obstetrics and Gynecology 134(5): 1075-1086	- Study from a systematic review that is included
Bodnar, L.M., Himes, K.P., Abrams, B. et al. (2018) Early-pregnancy weight gain and the risk of preeclampsia: A case-cohort study. Pregnancy Hypertension 14: 205-212	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Bodnar, L.M., Ness, R.B., Markovic, N. et al. (2005) The risk of preeclampsia rises with increasing prepregnancy body mass index. Annals of Epidemiology 15(7): 475-482	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Boghossian, N.S., Frongillo, E.A., Cai, B. et al. (2019) Associations of maternal gestational weight gain with the risk of offspring obesity and body mass index Z scores beyond the mean. Annals of Epidemiology 32: 64-71e2	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Borghesi, Y., Labreuche, J., Duhamel, A. et al. (2017) Risk of cesarean delivery among pregnant women with class III obesity. International Journal of Gynecology and Obstetrics 136(2): 168-174	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Bottalico, JN (2007) Recurrent Gestational Diabetes: risk Factors, Diagnosis, Management, and Implications. Seminars in perinatology 31(3): 176-184	- Study design does not match protocol *Narrative review*

Study	Code [Reason]
Brawarsky, P., Stotland, N.E., Jackson, R.A. et al. (2005) Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. International Journal of Gynecology and Obstetrics 91(2): 125-131	- Study did not adjust for covariates in the analysis
Catov, J.M., Sun, B., Lewis, C.E. et al. (2022) Prepregnancy weight change associated with high gestational weight gain. Obesity 30(2): 524-534	- Outcome(s) not relevant to this protocol *Study reported gestational weight gain as an outcome rather than the risk factor.*
Catov, Janet M, Ness, Roberta B, Kip, Kevin E et al. (2007) Risk of early or severe pre-eclampsia related to pre-existing conditions. International journal of epidemiology 36(2): 412-9	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI, amongst other risk factors. No gestational weight change was reported by the study*
Ceulemans, D., De Mulder, P., Lebbe, B. et al. (2021) Gestational weight gain and postpartum weight retention after bariatric surgery: data from a prospective cohort study. Surgery for Obesity and Related Diseases 17(4): 659-666	- Study did not adjust for covariates in the analysis
Chasan-Taber, Lisa, Silveira, Marushka, Waring, Molly E et al. (2016) Gestational Weight Gain, Body Mass Index, and Risk of Hypertensive Disorders of Pregnancy in a Predominantly Puerto Rican Population. Maternal and child health journal 20(9): 1804-13	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Chattrapiban, T., Smit, H.A., Wijga, A.H. et al. (2020) The joint effect of maternal smoking during pregnancy and maternal pre-pregnancy overweight on infants' term birth weight. BMC Pregnancy and Childbirth 20(1): 132	- Risk factor does not match protocol *Risk factor is maternal smoking status and pre-pregnancy BMI. No gestational weight change was reported by the study*
Cheng, Christine J, Bommarito, Kerry, Noguchi, Akihiko et al. (2004) Body mass index change between pregnancies and small for gestational age births. Obstetrics and gynecology 104(2): 286-92	- Study design does not match protocol *Case-control study*
Chu, S.Y., Callaghan, W.M., Kim, S.Y. et al. (2007) Maternal obesity and risk of gestational diabetes mellitus. Diabetes Care 30(8): 2070-2076	- Risk factor does not match protocol

Study	Code [Reason]
	Risk factor is BMI. No gestational weight change was reported by the systematic review
Chu, S.Y., Kim, S.Y., Schmid, C.H. et al. (2007) Maternal obesity and risk of cesarean delivery: A meta-analysis. Obesity Reviews 8(5): 385-394	- Risk factor does not match protocol *Risk factor is BMI. No gestational weight change was reported by the systematic review*
Cooray, S.D., Boyle, J.A., Soldatos, G. et al. (2019) Prognostic prediction models for pregnancy complications in women with gestational diabetes: A protocol for systematic review, critical appraisal and meta-analysis. Systematic Reviews 8(1): 270	- Review protocol
Daly, Amy L, Sriram, Nina, Woodall, Cheryl et al. (2018) Risk factors associated with hypertensive disorders of pregnancy within an urban indigenous population in south western Sydney. Internal medicine journal 48(3): 269-275	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Danilack, Valery A; Brousseau, E Christine; Phipps, Maureen G (2018) The Effect of Gestational Weight Gain on Persistent Increase in Body Mass Index in Adolescents: A Longitudinal Study. Journal of women's health (2002) 27(12): 1456-1458	- Outcome(s) not relevant to this protocol *Outcome is persistent BMI increase*
Daundasekara, S.S., O'connor, D.P., Cardoso, J.B. et al. (2020) Risk of excess and inadequate gestational weight gain among hispanic women: Effects of immigration generational status. International Journal of Environmental Research and Public Health 17(18): 1-13	- Outcome(s) not relevant to this protocol *Study reported on pregnancy alcohol use, smoking during pregnancy*
Deierlein, A L, Siega-Riz, A M, Herring, A H et al. (2012) Gestational weight gain and predicted changes in offspring anthropometrics between early infancy and 3 years. Pediatric obesity 7(2): 134-42	- Outcome(s) not relevant to this protocol *Study reported on weight-for-age, length-for-age, and weight-for-length z-scores*
Dempsey, J.C., Ashiny, Z., Qiu, C.-F. et al. (2005) Maternal pre-pregnancy overweight status and obesity as risk factors for	- Risk factor does not match protocol

Study	Code [Reason]
cesarean delivery. Journal of Maternal-Fetal and Neonatal Medicine 17(3): 179-185	*Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Dietz, P.M., Callaghan, W.M., Smith, R. et al. (2009) Low pregnancy weight gain and small for gestational age: a comparison of the association using 3 different measures of small for gestational age. American Journal of Obstetrics and Gynecology 201(1): e1-53	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Duckitt, K. and Harrington, D. (2005) Risk factors for pre-eclampsia at antenatal booking: Systematic review of controlled studies. British Medical Journal 330(7491): 565-567	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI, amongst other risk factors. No gestational weight change was reported by the study*
Eraslan Sahin, M. and Col Madendag, I. (2019) Effect of Gestational Weight Gain on Perinatal Outcomes in Low Risk Pregnancies with Normal Prepregnancy Body Mass Index. BioMed Research International 2019: 3768601	- Study conducted in an OECD low-middle income country *Study conducted in Turkey*
Faucher, MA and Barger, MK (2015) Gestational weight gain in obese women by class of obesity and select maternal/newborn outcomes: A systematic review. Women and birth : journal of the Australian College of Midwives 28(3): e70-9	- Systematic review. Included studies checked for eligibility and included if relevant *Studies by Blomberg and Kominiarek included for the caesarean birth outcome*
Fortner, R.T., Pekow, P., Solomon, C.G. et al. (2009) Prepregnancy body mass index, gestational weight gain, and risk of hypertensive pregnancy among Latina women. American Journal of Obstetrics and Gynecology 200(2): e1-167	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Fox, N.S., Rebarber, A., Roman, A.S. et al. (2010) Weight gain in twin pregnancies and adverse outcomes: Examining the 2009 institute of medicine guidelines. Obstetrics and Gynecology 116(1): 100-106	- Studies from a systematic review that is included
Fujiwara, Kana, Aoki, Shigeru, Kurasawa, Kentaro et al. (2014) Associations of maternal pre-pregnancy underweight with	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth

Study	Code [Reason]
small-for-gestational-age and spontaneous preterm birth, and optimal gestational weight gain in Japanese women. The journal of obstetrics and gynaecology research 40(4): 988-94	cohorts from Europe, North America, and Oceania published before 2019
Gao, Ming, Cao, Shu, Li, Ninghua et al. (2022) Risks of overweight in the offspring of women with gestational diabetes at different developmental stages: A meta-analysis with more than half a million offspring. Obesity reviews : an official journal of the International Association for the Study of Obesity 23(3): e13395	- Review protocol
Gavard, J.A. and Artal, R. (2014) Gestational weight gain and maternal and neonatal outcomes in term twin pregnancies in obese women. Twin Research and Human Genetics 17(2): 127-133	- Studies from a systematic review that is included
Gavard, Jeffrey A and Artal, Raul (2014) The association of gestational weight gain with birth weight in obese pregnant women by obesity class and diabetic status: a population-based historical cohort study. Maternal and child health journal 18(4): 1038-47	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Getahun, D., Ananth, C.V., Peltier, M.R. et al. (2007) Changes in prepregnancy body mass index between the first and second pregnancies and risk of large-for-gestational-age birth. American Journal of Obstetrics and Gynecology 196(6): e1-530	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI between the first 2 pregnancies. No gestational weight change was reported*
Getahun, D., Fassett, M.J., Jacobsen, S.J. et al. (2022) Perinatal outcomes after bariatric surgery. American Journal of Obstetrics and Gynecology 226(1): 121e1-121e16	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Gibson, K.S.; Waters, T.P.; Catalano, P.M. (2012) Maternal weight gain in women who develop gestational diabetes mellitus. Obstetrics and Gynecology 119(3): 560-565	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*

Study	Code [Reason]
Goldstein, RF, Abell, SK, Ranasinha, S et al. (2017) Association of Gestational Weight Gain With Maternal and Infant Outcomes: A Systematic Review and Meta-analysis. JAMA 317(21): 2207-2225	- Systematic review. Included studies checked for eligibility and included if relevant
Grandfils, S., Demondion, D., Kyheng, M. et al. (2019) Impact of gestational weight gain on perinatal outcomes after a bariatric surgery. Journal of Gynecology Obstetrics and Human Reproduction 48(6): 401-405	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Groth, S.W., Holland, M.L., Smith, J.A. et al. (2017) Effect of Gestational Weight Gain and Prepregnancy Body Mass Index in Adolescent Mothers on Weight and Body Mass Index of Adolescent Offspring. Journal of Adolescent Health 61(5): 626-633	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Gu, Y., Lu, J., Liu, H. et al. (2019) Joint Associations of Maternal Gestational Diabetes and Hypertensive Disorders of Pregnancy With Overweight in Offspring. Frontiers in Endocrinology 10: 645	- Study conducted in an OECD low-middle income country *Study conducted in China*
Guler, Tuba, Sivas, Filiz, Baskan, Bedriye Mermerci et al. (2007) The effect of outfitting style on bone mineral density. Rheumatology international 27(8): 723-7	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Hantoushzadeh, S., Sheikh, M., Bosaghzadeh, Z. et al. (2016) The impact of gestational weight gain in different trimesters of pregnancy on glucose challenge test and gestational diabetes. Postgraduate Medical Journal 92(1091): 520-524	- Study did not adjust for covariates in the analysis
Harita, N., Kariya, M., Hayashi, T. et al. (2012) Gestational bodyweight gain among underweight Japanese women related to small-for-gestational-age birth. Journal of Obstetrics and Gynaecology Research 38(9): 1137-1144	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
He, X.-J.; Dai, R.-X.; Hu, C.-L. (2020) Maternal prepregnancy overweight and obesity and the risk of preeclampsia: A	- Risk factor does not match protocol

Study	Code [Reason]
meta-analysis of cohort studies. Obesity Research and Clinical Practice 14(1): 27-33	*Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Heude, B, Thiebaugeorges, O, Goua, V et al. (2012) Pre-pregnancy body mass index and weight gain during pregnancy: relations with gestational diabetes and hypertension, and birth outcomes. Maternal and child health journal 16(2): 355-63	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Hillier, T.A., Ogasawara, K.K., Pedula, K.L. et al. (2020) Timing of Gestational Diabetes Diagnosis by Maternal Obesity Status: Impact on Gestational Weight Gain in a Diverse Population. Journal of Women's Health 29(8): 1068-1076	- Study did not adjust for covariates in the analysis
Horosz, Edyta, Bomba-Opon, Dorota A, Szymanska, Monika et al. (2013) Maternal weight gain in women with gestational diabetes mellitus. Journal of perinatal medicine 41(5): 523-8	- Analysis not relevant to this protocol *Case series*
Huang, Yuan-Der, Luo, Yun-Ru, Lee, Meng-Chih et al. (2022) Effect of maternal hypertensive disorders during pregnancy on offspring's early childhood body weight: A population-based cohort study. Taiwanese journal of obstetrics & gynecology 61(5): 761-767	- Risk factor does not match protocol *Risk factors are hypertensive disorders of pregnancy. No gestational weight change was reported by the study*
Hulsey, Thomas C, Neal, Diane, Bondo, Shana Catoe et al. (2005) Maternal prepregnant body mass index and weight gain related to low birth weight in South Carolina. Southern medical journal 98(4): 411-5	- Study did not conduct multivariate regression analysis
Hung, T.-H.; Hsieh, T.-T.; Chen, S.-F. (2018) Risk of abnormal fetal growth in women with early- and late-onset preeclampsia. Pregnancy Hypertension 12: 201-206	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Jin, Wen-Yuan, Lv, Yao, Bao, Yu et al. (2016) Independent and Combined Effects of Maternal Prepregnancy Body Mass Index and Gestational Weight Gain on	- Study conducted in an OECD low-middle income country *Study conducted in China*

Study	Code [Reason]
Offspring Growth at 0–3 Years of Age. BioMed Research International 2016: 1-10	
Juhasz, G., Gyamfi, C., Gyamfi, P. et al. (2005) Effect of body mass index and excessive weight gain on success of vaginal birth after cesarean delivery. Obstetrics and Gynecology 106(4): 741-746	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Kawakita, T., Franco, S., Ghofranian, A. et al. (2021) Interpregnancy Body Mass Index Change and Risk of Intrapartum Cesarean Delivery. American Journal of Perinatology 38(8): 759-765	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Kawakita, Tetsuya, Downs, Sarah K, Franco, Stephanie et al. (2022) Interpregnancy body mass index change and risk of hypertensive disorders in pregnancy. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians 35(17): 3223-3228	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Kiel, D.W., Dodson, E.A., Artal, R. et al. (2007) Gestational weight gain and pregnancy outcomes in obese women: How much is enough?. Obstetrics and Gynecology 110(4): 752-758	- Analysis not relevant to this protocol *Study data are presented graphically and insufficient information available to accurately extract raw data for analysis*
Kim, S.-Y., Hong, S.-Y., Kim, Y. et al. (2021) Maternal pre-pregnancy body mass index and the risk for gestational diabetes mellitus in women with twin pregnancy in South Korea. Taiwanese Journal of Obstetrics and Gynecology 60(5): 863-868	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Kwon, Ha Yan, Kwon, Ja-Young, Park, Yong Won et al. (2016) The risk of emergency cesarean section after failure of vaginal delivery according to prepregnancy body mass index or gestational weight gain by the 2009 Institute of Medicine guidelines. Obstetrics & gynecology science 59(3): 169-77	- Study conducted in an OECD low-middle income country *Study conducted in Korea*

Study	Code [Reason]
Kyozuka, H., Jin, T., Fujimori, M. et al. (2022) Effect of gestational weight gain on preeclampsia among underweight women: A single tertiary referral center study in Japanese women. Journal of Obstetrics and Gynaecology Research 48(5): 1141-1148	- Outcome(s) not relevant to this protocol *Study does not report on information on the referent risk factor population*
Laitinen, J, Jaaskelainen, A, Hartikainen, A-L et al. (2012) Maternal weight gain during the first half of pregnancy and offspring obesity at 16 years: a prospective cohort study. BJOG : an international journal of obstetrics and gynaecology 119(6): 716-23	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Lau, E.Y., Archer, E., McDonald, S.M. et al. (2014) Maternal weight gain in pregnancy and risk of obesity among offspring: A systematic review. Journal of Obesity 2014: 524939	- Systematic review. Included studies checked for eligibility and included if relevant *No relevant studies identified*
Leng, Junhong, Li, Weiqin, Zhang, Shuang et al. (2015) GDM Women's Pre-Pregnancy Overweight/Obesity and Gestational Weight Gain on Offspring Overweight Status. PloS one 10(6): e0129536	- Study conducted in an OECD low-middle income country *Study conducted in China*
Leonard, Stephanie A, Carmichael, Suzan L, Main, Elliott K et al. (2020) Risk of severe maternal morbidity in relation to prepregnancy body mass index: Roles of maternal co-morbidities and caesarean birth. Paediatric and perinatal epidemiology 34(4): 460-468	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Lewandowska, M.; Wieckowska, B.; Sajdak, S. (2020) Pre-pregnancy obesity, excessive gestational weight gain, and the risk of pregnancy-induced hypertension and gestational diabetes mellitus. Journal of Clinical Medicine 9(6): 1-13	- Study did not adjust for covariates in the analysis *Relevant effect estimates (OR) were not adjusted for covariates. Analyses adjusted for covariates were reported as AUC, which is not a relevant outcome in the review protocol*
Lewandowska, M., Wieckowska, B., Sajdak, S. et al. (2020) Pre-pregnancy obesity vs. Other risk factors in probability models of preeclampsia and gestational hypertension. Nutrients 12(9): 1-19	- Study design does not match protocol *Case-control study design*

Study	Code [Reason]
Li, M.; Zhang, C.-Y.; Yue, C.-Y. (2022) Effects of pre-pregnancy BMI and gestational weight gain on adverse pregnancy outcomes and complications of GDM. Journal of Obstetrics and Gynaecology 42(4): 630-635	- Study conducted in an OECD low-middle income country *Study conducted in China*
Liang, Z., Liu, H., Wang, L. et al. (2020) Maternal Gestational Diabetes Mellitus Modifies the Relationship Between Genetically Determined Body Mass Index During Pregnancy and Childhood Obesity. Mayo Clinic Proceedings 95(9): 1877-1887	- Risk factor does not match protocol *Risk factor is gestational diabetes mellitus. No gestational weight gain was reported by the study*
Liu, L.Y.; Zafman, K.B.; Fox, N.S. (2021) Weight gain and pregnancy outcomes in overweight or obese women with twin gestations. Journal of Maternal-Fetal and Neonatal Medicine 34(11): 1774-1779	- Studies from a systematic review that is included
Loh, H.H.; Taipin, H.; Said, A. (2021) The effect of obesity in pregnancy and gestational weight gain on neonatal outcome in glucose-tolerant mothers. Obesity Science and Practice 7(4): 425-431	- Study conducted in an OECD low-middle income country *Study conducted in Malaysia*
Longmore, Danielle K, Barr, Elizabeth L M, Lee, I-Lynn et al. (2019) Maternal body mass index, excess gestational weight gain, and diabetes are positively associated with neonatal adiposity in the Pregnancy and Neonatal Diabetes Outcomes in Remote Australia (PANDORA) study. Pediatric obesity 14(4): e12490	- Outcome(s) not relevant to this protocol *Study reported on neonatal length, head circumference, sum of skinfolds, total body fat, and percentage body fat.*
Lucovnik, M., Blickstein, I., Verdenik, I. et al. (2015) Maternal obesity in singleton versus twin gestations: A population-based matched case-control study. Journal of Maternal-Fetal and Neonatal Medicine 28(6): 623-625	- Study design does not match protocol *Case-control study*
Lucovnik, M., Tul, N., Verdenik, I. et al. (2012) Risk factors for preeclampsia in twin pregnancies: A population-based matched case-control study. Journal of Perinatal Medicine 40(4): 379-382	- Study design does not match protocol *Case-control study*

Study	Code [Reason]
Lucovnik, Miha, Blickstein, Isaac, Verdenik, Ivan et al. (2014) Impact of pre-gravid body mass index and body mass index change on preeclampsia and gestational diabetes in singleton and twin pregnancies. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians 27(18): 1901-4	- Study did not adjust for covariates in the analysis
Macdonald-Wallis, Corrie, Tilling, Kate, Fraser, Abigail et al. (2013) Gestational weight gain as a risk factor for hypertensive disorders of pregnancy. American journal of obstetrics and gynecology 209(4): 327e1-17	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
MacRI, F., Pitocco, D., Di Pasquo, E. et al. (2018) Gestational weight gain as an independent risk factor for adverse pregnancy outcomes in women with gestational diabetes. European Review for Medical and Pharmacological Sciences 22(14): 4403-4410	- Study did not adjust for covariates in the analysis
Maeda, Y., Ogawa, K., Morisaki, N. et al. (2022) The association between gestational weight gain and perinatal outcomes among underweight women with twin pregnancy in Japan. International Journal of Gynecology and Obstetrics 159(2): 420-426	- Data presented graphically and cannot be extracted for analysis
May, R. (2007) Prepregnancy weight, inappropriate gestational weight gain, and smoking: Relationships to birth weight. American Journal of Human Biology 19(3): 305-310	- Analysis not relevant to this protocol *Multiple regression analysis was used. Data reporting association between risk factor and maternal/fetal/neonatal outcomes not reported.*
McDonald, ACE; Wise, MR; Thompson, JM (2018) Effect of excessive gestational weight gain on trial of labour after caesarean: A retrospective cohort study. The Australian & New Zealand journal of obstetrics & gynaecology 58(1): 64-71	- Conference abstract.

Study	Code [Reason]
McDonald, Sarah D, Woolcott, Christy, Chapinal, Nuria et al. (2018) Interprovincial variation in pre-pregnancy body mass index and gestational weight gain and their impact on neonatal birth weight with respect to small and large for gestational age. Canadian journal of public health = Revue canadienne de sante publique 109(4): 527-538	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Meinich, T. and Trovik, J. (2020) Early maternal weight gain as a risk factor for SGA in pregnancies with hyperemesis gravidarum: A 15-year hospital cohort study. BMC Pregnancy and Childbirth 20(1): 255	- Risk factor does not match protocol *Risk factor are women with hyperemesis gravidarum who regained their pre-pregnancy BMI*
Miao, Miao, Dai, Mei, Zhang, Yue et al. (2017) Influence of maternal overweight, obesity and gestational weight gain on the perinatal outcomes in women with gestational diabetes mellitus. Scientific reports 7(1): 305	- Study conducted in an OECD low-middle income country *Study conducted in China*
Mourtakos, S P, Tambalis, K D, Panagiotakos, D B et al. (2017) Association between gestational weight gain and risk of obesity in preadolescence: a longitudinal study (1997-2007) of 5125 children in Greece. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association 30(1): 51-58	- Outcome(s) not relevant to this protocol *Outcomes are not reported as a summary estimate as specified in the protocol*
Najafi, F., Hasani, J., Izadi, N. et al. (2019) The effect of prepregnancy body mass index on the risk of gestational diabetes mellitus: A systematic review and dose-response meta-analysis. Obesity Reviews 20(3): 472-486	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Nakanishi, K., Saijo, Y., Yoshioka, E. et al. (2022) Severity of low pre-pregnancy body mass index and perinatal outcomes: the Japan Environment and Children's Study. BMC Pregnancy and Childbirth 22(1): 121	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight gain was reported by the study*
Okah, Felix A, Cai, Jinwen, Dew, Paul C et al. (2010) Risk factors for recurrent small-	- Study did not adjust for covariates in the analysis

Study	Code [Reason]
for-gestational-age birth. American journal of perinatology 27(1): 1-7	*Weight change in relation to SGA not reported in multivariate analysis*
Oken, Emily, Taveras, Elsie M, Kleinman, Ken P et al. (2007) Gestational weight gain and child adiposity at age 3 years. American journal of obstetrics and gynecology 196(4): 322e1-8	- Population and outcomes fully overlap with Voerman 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Olmos, Pablo Roberto, Borzone, Gisella Rosa, Olmos, Roberto Ignacio et al. (2012) Gestational diabetes and pre-pregnancy overweight: possible factors involved in newborn macrosomia. The journal of obstetrics and gynaecology research 38(1): 208-14	- Study conducted in an OECD low-middle income country *Study conducted in Chile*
Olson, C.M.; Strawderman, M.S.; Dennison, B.A. (2009) Maternal weight gain during pregnancy and child weight at age 3 years. Maternal and Child Health Journal 13(6): 839-846	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Ouzounian, J.G., Hernandez, G.D., Korst, L.M. et al. (2011) Pre-pregnancy weight and excess weight gain are risk factors for macrosomia in women with gestational diabetes. Journal of Perinatology 31(11): 717-721	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Paramsothy, Pathmaja, Lin, Yvonne S, Kernic, Mary A et al. (2009) Interpregnancy weight gain and cesarean delivery risk in women with a history of gestational diabetes. Obstetrics and gynecology 113(4): 817-823	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Pecheux, Oceane, Garabedian, Charles, Drumez, Elodie et al. (2019) Maternal and neonatal outcomes according to gestational weight gain in twin pregnancies: Are the Institute of Medicine guidelines associated with better outcomes?. European journal of obstetrics, gynecology, and reproductive biology 234: 190-194	- Studies from a systematic review that is included
Pettersen-Dahl, Anita, Murzakanova, Gulim, Sandvik, Leiv et al. (2018) Maternal body mass index as a predictor for delivery	- Risk factor does not match protocol

Study	Code [Reason]
method. Acta obstetricia et gynecologica Scandinavica 97(2): 212-218	*Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Pezzarossa, A, Orlandi, N, Baggi, V et al. (1996) Effects of maternal weight variations and gestational diabetes mellitus on neonatal birth weight. Journal of diabetes and its complications 10(2): 78-83	- Population not relevant to this protocol *Study reported on pregnant women diagnosed with gestational diabetes.*
Phaloprakarn, C. and Tangjitgamol, S. (2020) Risk score for predicting primary cesarean delivery in women with gestational diabetes mellitus. BMC Pregnancy and Childbirth 20(1): 607	- Study conducted in an OECD low-middle income country *Study conducted in Thailand*
Pham, Michelle T, Brubaker, Katherine, Pruett, Kimberly et al. (2013) Risk of childhood obesity in the toddler offspring of mothers with gestational diabetes. Obstetrics and gynecology 121(5): 976-982	- Population not relevant to this protocol *Study reported on children whose mothers were diagnosed with gestational diabetes during their pregnancy with that child*
Poorolajal, Jalal and Jenabi, Ensiyeh (2016) The association between body mass index and preeclampsia: a meta-analysis. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians 29(22): 3670-6	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Pugh, Sarah J, Hinkle, Stefanie N, Kim, Sungduk et al. (2018) Combined Influence of Gestational Weight Gain and Estimated Fetal Weight on Risk Assessment for Small- or Large-for-Gestational-Age Birth Weight: A Prospective Cohort Study. Journal of ultrasound in medicine : official journal of the American Institute of Ultrasound in Medicine 37(4): 935-940	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Ramos-Levi, A.M., Fernandez-Pombo, A., Garcia-Fontao, C. et al. (2022) Gestational weight gain influences neonatal outcomes in women with obesity and gestational diabetes. Endocrinologia, Diabetes y Nutricion	- Outcome(s) not relevant to this protocol *Outcomes are not reported as a summary estimate as specified in the protocol*

Study	Code [Reason]
Ray, J.G., Vermeulen, M.J., Shapiro, J.L. et al. (2001) Maternal and neonatal outcomes in pregestational and gestational diabetes mellitus, and the influence of maternal obesity and weight gain: The DEPOSIT study. QJM - Monthly Journal of the Association of Physicians 94(7): 347-356	- Population not relevant to this protocol *Study reported on pregnant women diagnosed with gestational diabetes.*
Restall, A., Taylor, R.S., Thompson, J.M.D. et al. (2014) Risk factors for excessive gestational weight gain in a healthy, nulliparous cohort. Journal of Obesity 2014: 148391	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Ricci, Elena, Parazzini, Fabio, Chiaffarino, Francesca et al. (2010) Pre-pregnancy body mass index, maternal weight gain during pregnancy and risk of small-for-gestational age birth: results from a case-control study in Italy. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians 23(6): 501-5	- Study design does not match protocol *Case-control study*
Rosett, H., Siegel, A.M., Tucker, A. et al. (2022) The impact of excessive gestational weight gain timing on neonatal outcomes in women with class III obesity. Journal of Maternal-Fetal and Neonatal Medicine 35(16): 3059-3063	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study.*
Saftlas, Wang, Risch et al. (2000) Prepregnancy body mass index and gestational weight gain as risk factors for preeclampsia and transient hypertension. Annals of epidemiology 10(7): 475	- Conference abstract.
Schack-Nielsen, L., Michaelsen, K.F., Gamborg, M. et al. (2010) Gestational weight gain in relation to offspring body mass index and obesity from infancy through adulthood. International Journal of Obesity 34(1): 67-74	- Population not relevant to this protocol *Birth cohort between 1959 and 1961. This review protocol was restricted to studies from 1970*
Shin, Dayeon and Song, Won O (2015) Prepregnancy body mass index is an	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth

Study	Code [Reason]
independent risk factor for gestational hypertension, gestational diabetes, preterm labor, and small- and large-for-gestational-age infants. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians 28(14): 1679-86	cohorts from Europe, North America, and Oceania published before 2019
Simas, Tiffany A Moore, Waring, Molly E, Liao, Xun et al. (2012) Prepregnancy weight, gestational weight gain, and risk of growth affected neonates. Journal of women's health (2002) 21(4): 410-7	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Simmons, D, Devlieger, R, van Assche, A et al. (2018) Association between Gestational Weight Gain, Gestational Diabetes Risk, and Obstetric Outcomes: A Randomized Controlled Trial Post Hoc Analysis. Nutrients 10(11)	- Study design does not match protocol *Randomised controlled trial.*
Stamnes Kopp, U M, Dahl-Jorgensen, K, Stigum, H et al. (2012) The associations between maternal pre-pregnancy body mass index or gestational weight change during pregnancy and body mass index of the child at 3 years of age. International journal of obesity (2005) 36(10): 1325-31	- Outcome(s) not relevant to this protocol *The study reports a combined effect of gestational weight change and expected BMI in children at 3 years, which is not of use for this review*
Swank, M.L., Caughey, A.B., Farinelli, C.K. et al. (2014) The impact of change in pregnancy body mass index on the development of gestational hypertensive disorders. Journal of Perinatology 34(3): 181-185	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Tabet, M., Harper, L.M., Flick, L.H. et al. (2017) Gestational Weight Gain in the First Two Pregnancies and Perinatal Outcomes in the Second Pregnancy. Paediatric and Perinatal Epidemiology 31(4): 304-313	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Takimoto, H., Sugiyama, T., Nozue, M. et al. (2011) Maternal antenatal body mass index gains as predictors of large-for-gestational-age infants and cesarean deliveries in Japanese singleton	- Analysis not relevant to this protocol *Study data are presented graphically and insufficient information available to accurately extract raw data for analysis*

Study	Code [Reason]
pregnancies. Journal of Obstetrics and Gynaecology Research 37(6): 553-562	
Teshome, A.A., Li, Q., Garoma, W. et al. (2021) Gestational diabetes mellitus, pre-pregnancy body mass index and gestational weight gain predicts fetal growth and neonatal outcomes. Clinical Nutrition ESPEN 42: 307-312	- Study conducted in an OECD low-middle income country *Study conducted in China*
Vahratian, A., Siega-Riz, A.M., Savitz, D.A. et al. (2005) Maternal pre-pregnancy overweight and obesity and the risk of cesarean delivery in nulliparous women. Annals of Epidemiology 15(7): 467-474	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Von Kries, R., Ensenauer, R., Beyerlein, A. et al. (2011) Gestational weight gain and overweight in children: Results from the cross-sectional German KiGGS study. International Journal of Pediatric Obesity 6(1): 45-52	- Study design does not match protocol *Cross-sectional study*
Voskamp, BJ, Kazemier, BM, Ravelli, ACJ et al. (2013) Recurrence of small-for-gestational-age pregnancy: analysis of first and subsequent singleton pregnancies in the Netherlands. American journal of obstetrics and gynecology 208(5): 374.e1-374.e6	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight change was reported by the study*
Wang, F., Liang, Z.X., Mao, W.R. et al. (2020) Influence of pre-pregnancy body mass index and gestational weight gain in twin pregnancies on blood glucose, serum lipid and perinatal outcomes. Clinical and Experimental Obstetrics and Gynecology 47(3): 376-382	- Study conducted in an OECD low-middle income country *Study conducted in China*
Watanabe, Hiroko, Inoue, Kazuko, Doi, Masako et al. (2010) Risk factors for term small for gestational age infants in women with low prepregnancy body mass index. The journal of obstetrics and gynaecology research 36(3): 506-12	- Risk factor does not match protocol *Risk factor is pre-pregnancy BMI. No gestational weight gain was reported in the study*
Wei, X., Shen, S., Huang, P. et al. (2022) Gestational weight gain rates in the first and second trimesters are associated with small for gestational age among	- Study conducted in an OECD low-middle income country *Study conducted in China*

Study	Code [Reason]
underweight women: a prospective birth cohort study. BMC Pregnancy and Childbirth 22(1): 106	
Weschenfelder, F., Lehmann, T., Schleussner, E. et al. (2019) Gestational Weight Gain Particularly Affects the Risk of Large for Gestational Age Infants in Non-obese Mothers. Geburtshilfe und Frauenheilkunde 79(11): 1183-1190	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Wrotniak, BH, Shults, J, Butts, S et al. (2008) Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. The American journal of clinical nutrition 87(6): 1818-24	- Population and outcomes fully overlap with Voerman 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Xu, H., Hutcheon, J.A., Liu, X. et al. (2022) Risk of gestational diabetes mellitus in relation to early pregnancy and gestational weight gain before diagnosis: A population-based cohort study. Acta Obstetricia et Gynecologica Scandinavica	- Population and outcomes fully overlap with Santos 2019 IPD, which included birth cohorts from Europe, North America, and Oceania published before 2019
Yuanmei, L., Qian, Z., Fengsen, X. et al. (2019) Restricted gestational weight gain in overweight/obese women with gestational diabetes mellitus and pregnancy outcomes. Clinical and Experimental Obstetrics and Gynecology 46(5): 763-769	- Study conducted in an OECD low-middle income country *Study conducted in China*
Zhang, X. and Xiao, Y. (2019) The Association Between Trimester-Specific Weight Gain and Severe Preeclampsia/Adverse Perinatal Outcome in Gestational Diabetes Mellitus Complicated by Preeclampsia: A Retrospective Case Study. Diabetes Therapy 10(2): 725-734	- Study conducted in an OECD low-middle income country *Study conducted in China*
Zheng, W., Huang, W., Liu, C. et al. (2021) Weight gain after diagnosis of gestational diabetes mellitus and its association with adverse pregnancy outcomes: a cohort study. BMC Pregnancy and Childbirth 21(1): 216	- Study conducted in an OECD low-middle income country *Study conducted in China*

Study	Code [Reason]
Zhong, C., Li, X., Chen, R. et al. (2017) Greater early and mid-pregnancy gestational weight gain are associated with increased risk of gestational diabetes mellitus: A prospective cohort study. Clinical Nutrition ESPEN 22: 48-53	- Study conducted in an OECD low-middle income country *Study conducted in China*
Zhong, W., Fan, X., Hu, F. et al. (2021) Gestational Weight Gain and Its Effects on Maternal and Neonatal Outcome in Women With Twin Pregnancies: A Systematic Review and Meta-Analysis. Frontiers in Pediatrics 9: 674414	- Systematic review. Included studies checked for eligibility and included if relevant *Relevant studies have been included in the systematic review by Whitaker 2022. Whitaker 2022 was prioritised over Zhong 2021 for inclusion as it covered the same population and outcomes, but included a larger number of studies*

AUC: area under the curve; BMI: body mass index; IPD: individual patient data; OECD: Organisation for Economic Co-operation and Development; OR: odds ratio

Excluded economic studies

Study	Reason for exclusion
Azher, S., Pinheiro, J.M.B., Philbin, B. et al. (2022) The Impact of Maternal Obesity on NICU and Newborn Nursery Costs. Frontiers in Pediatrics 10: 863165	Costs linked to gestational BMI at birth and not to gestational weight change
Denison, F.C., Norrie, G., Graham, B. et al. (2009) Increased maternal BMI is associated with an increased risk of minor complications during pregnancy with consequent cost implications. BJOG: An International Journal of Obstetrics and Gynaecology 116(11): 1467-1472	Costs linked to gestational BMI at first antenatal appointment, and not to gestational weight change
Denison, F.C., Norwood, P., Bhattacharya, S. et al. (2014) Association between maternal body mass index during pregnancy, short-term morbidity, and increased health service costs: A population-based study. BJOG: An International Journal of Obstetrics and Gynaecology 121(1): 72-82	Costs linked to gestational BMI measured prior to 16 weeks of gestation, and not to gestational weight change
Lenoir-Wijnkoop, I., van der Beek, E.M., Garssen, J. et al. (2015) Health economic modeling to assess short-term costs of maternal overweight, gestational diabetes, and related macrosomia - a pilot evaluation. Frontiers in Pharmacology 6(may): 103	No comparison group; only costs associated with overweight reported
Liang, Ching-Chung, Chao, Minston, Chang, Shuenn-Dhy et al. (2021) Pregnancy weight gain may affect perinatal outcomes, quality of life during pregnancy, and child-bearing expenses: an observational cohort study. Archives of gynecology and obstetrics 304(3): 599-608	None OECD country (Taiwan)

Study	Reason for exclusion
Rowlands, I., Graves, N., de Jersey, S. et al. (2010) Obesity in pregnancy: outcomes and economics. Seminars in Fetal and Neonatal Medicine 15(2): 94-99	Review; no costs reported
Trasande, Leonardo, Lee, Menjean, Liu, Yinghua et al. (2009) Incremental charges, costs, and length of stay associated with obesity as a secondary diagnosis among pregnant women. Medical care 47(10): 1046-52	Costs linked to obesity status during pregnancy, and not to gestational weight change
Whiteman, V.E., Salemi, J.L., Mejia De Grubb, M.C. et al. (2015) Additive effects of Pre-pregnancy body mass index and gestational diabetes on health outcomes and costs. Obesity 23(11): 2299-2308	Costs linked to pre-pregnancy BMI, and not to gestational weight change

BMI: body mass index; OECD: Organisation for Economic Co-operation and Development

Appendix K Research recommendations – full details

Research recommendations for review question: What gestational weight change is healthy and appropriate during pregnancy?

No research recommendations were made for this review question.