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Review

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Attenuation of maternal weight gain impacts infant birthweight: systematic review and meta-analysis

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Abstract

Despite many interventions aiming to reduce excessive gestational weight gain (GWG), it is currently unclear the impact on infant anthropometric outcomes. The aim of this review was to evaluate offspring anthropometric outcomes in studies designed to reduce GWG. A systematic search of seven international databases, one clinical trial registry and three Chinese databases was conducted without date limits. Studies were categorised by intervention type: diet, physical activity (PA), lifestyle (diet + PA), other, gestational diabetes mellitus (GDM) (diet, PA, lifestyle, metformin and other). Meta-analyses were reported as weighted mean difference (WMD) for birthweight and birth length, and risk ratio (RR) for small for gestational age (SGA), large for gestational age (LGA), macrosomia and low birth weight (LBW). Collectively, interventions reduced birthweight, risk of macrosomia and LGA by 71 g (WMD: -70.67, 95% CI -101.90 to -39.43, P<0.001), 16% (RR: 0.84, 95% CI 0.73-0.98, P = 0.026) and 19% (RR: 0.81, 95% CI 0.69–0.96, P = 0.015), respectively. Diet interventions decreased birthweight and LGA by 99 g (WMD -98.80, 95% CI -178.85 to -18.76, P=0.016) and 65% (RR: 0.35, 95% CI 0.17-0.72, P=0.004). PA interventions reduced the risk of macrosomia by 51% (RR: 0.49, 95% CI 0.26-0.92, P = 0.036). In women with GDM, diet and lifestyle interventions reduced birthweight by 211 and 296 g, respectively (WMD: -210.93, 95% CI -374.77 to -46.71, P=0.012 and WMD: -295.93, 95% CI -501.76 to -90.10, P = 0.005, respectively). Interventions designed to reduce excessive GWG lead to a small reduction in infant birthweight and risk of macrosomia and LGA, without influencing the risk of adverse outcomes including LBW and SGA.

Introduction

Gestational weight gain (GWG) can be an indicative factor of both maternal and infant complications during pregnancy.^{1,2} The Institute of Medicine (IoM) stipulates guidelines in which weight gain during pregnancy can be classified as adequate, inadequate or excessive.³ In an attempt to reduce pregnancy complications, the IoM reformed the GWG guidelines in 2009 to include stratification by pre-conception body mass index (BMI).³ The higher the pre-conception BMI, the less weight a woman is recommended to gain during pregnancy. While inadequate GWG is still a problem in many developing nations, excessive GWG is experienced by almost half the pregnant population in developed nations.^{1,4} Excessive GWG increases the risk of pregnancy complications such as gestational diabetes mellitus (GDM), pre-eclampsia and caesarean section delivery.³ In the long term, women who gain excessive weight during pregnancy are also at higher risk of postnatal weight retention and therefore obesity and related diseases later in life.⁵

GWG has a significant impact on the developing fetus *in utero*. Excessive GWG is associated with an increased risk of large for gestational age (LGA) infants (>90% percentile) and macrosomia (birthweight >4000 g).⁶ However, the complications of excessive GWG are not limited to the size of the infant at birth. In the short term, children born to mothers who gained excessive GWG are more likely to acquire infection,⁷ have lower 5 min activity, pulse, grimace, appearance and respiration (APGAR) scores,⁷ suffer from meconium aspiration syndrome,⁷ hypoglycaemia⁷ and are more likely to have increased length of hospital stay at birth.^{7,8} In the long term, children who are born to mothers that experienced excessive weight gain during pregnancy are also more likely to have higher BMI *z*-scores as children⁹ and suffer from obesity, diabetes and high blood pressure later in life.¹⁰ In contrast, inadequate GWG

impairs fetal growth, increasing the risk of small for gestational age (SGA) infants, lower lean body mass, fat mass and head circumference.¹¹ In the long term, children of mothers who gain inadequate weight during pregnancy may be at higher risk of obesity,¹² cardiovascular disease,¹³ breast cancer¹² and glucose intolerance¹² in later life. This suggests that interventions designed to reduce GWG may have a significant influence on both the mother and the health of the next generation.¹⁴

Many reviews have considered the effect of diet, physical activity (PA) and lifestyle interventions on GWG.^{15–17} Of the reviews that have considered infant outcomes, two have shown no difference in any measures reported^{15,16} and one reported a significant reduction in birthweight in PA interventions.¹⁷ It remains unclear whether these interventions also impact infant anthropometry and thus impact offspring health in the longer term.¹⁸ Due to the severity of consequences related to undesirable fetal growth for both mother and baby, there is an urgent need to address this gap in the literature.¹⁸ Previous reviews in this area have been significantly limited in the translation of results due to two reasons: (i) either a small samples of studies included (≤ 4 studies) and/or (ii) excluding papers published in languages other than English, reducing global translatability and possibly biasing overall effect.^{19–21} Therefore, the aim of this systematic review

was to evaluate differences in infant anthropometric outcomes (birthweight, birth length, macrosomia, LGA, SGA and low birthweight (LBW)) in studies designed to reduce excessive GWG.

Methods

Protocol and registration

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews (PRISMA) and the protocol has been registered with PROSPERO (CRD: 42016035907). This manuscript reports on the secondary outcomes of this protocol. The primary outcomes have been reported elsewhere.²²

Eligibility criteria

The details of the inclusion exclusion criteria have been previously outlined.²² Briefly, studies were eligible if they were randomized controlled trials, conducted in humans with a primary or secondary aim to reduce excessive GWG. Studies that aimed to encourage GWG were excluded. This review also required studies to report on birthweight, birth length, SGA (<10th centile), LGA (>90th centile),



Fig. 1. PRISMA diagram of included studies.

Table 1. Infant anthropometric outcomes in studies with a dietary intervention

First author	Setting and date	Birthweight (g) (mean (s.p.) unless otherwise specified)	Birth length (cm) (mean (s.ɒ.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500g)	Overall risk of bias
Bonomo ⁵¹	Milan, Italy 1997–2002	3365 (436), 3436.6 (462), P=NS	50.2 (1.7), 50.1 (2.0), P=NS	5.3, 10.7, <i>P</i> = NS	6, 14, <i>P</i> = 0.046	8.7, 6.0, <i>P</i> = NS	-	Unclear
Deveer ⁵²	Turkey Published 2013	3310 (342.4), 3587 (460.2), <i>P</i> =0.001	-	2, 20, <i>P</i> = 0.004	4, 22, <i>P</i> =0.007	10, 6, <i>P</i> = 0.461	-	High
Di Carlo ⁵³	Naples, Italy Jun 2010–Jun 2011	BW: 3078.2 (372.3), 3121.5 (430), P=0.6	-	-	-	-	-	Unclear
Ilmonen ²⁹	Finland Apr 2002– Nov 2005	Diet + probiotic: 3489 (431), diet + placebo: 3602 (439), control: 3600 (515), P = 0.209	Diet + probiotic: 50.7 (1.8), diet + placebo: 51.3 (1.7), control: 51.0 (2.2), P = 0.197	-	-	-	-	Unclear
Korpi-Hyovalti ⁵⁴	Finland Published 2012	BW: 3871 (567), 3491 (573), P=0.047	-	-	-	-	-	Unclear
Liao ⁵⁵	Wuzhou, China Mar 2010–Mar 2012	BW: 3100.1 (304.74), 3216.6 (547.52), <i>P</i> = 0.037	-	-	-	-	-	High
Markovic ³⁹	Camper down, Australia Jan 2011–Oct 2012	Low GI: 3450 (410), high fibre: 3430 (510), P = 0.845	-	Low GI: 9.7, high fibre: 14.9, P=0.349	Low GI: 5.6, high fibre: 6.0, <i>P</i> = 0.916	Low GI: 5.6, high fibre: 7.5, <i>P</i> = 0.648	-	Unclear
Moses ³⁵	Australia Feb 2010–Sep 2012	Healthy eating: 3443 (485), low GI: 3465 (430), <i>P</i> = 0.57	Healthy eating: 50.3 (3.3), low GI: 50.3 (1.7), P=0.96	Healthy eating: 13.9, low GI: 10.5, P=0.25	-	-	-	Unclear
Rhodes ⁴⁰	Boston, USA Jan 2007–Jun 2009	Low-GI: 3507 (412), low-fat: 3133 (671), P=0.03	-	Low-GI: 8, low-fat: 5, <i>P</i> = 1.0	Low GI: 8, low-fat 14, P=0.65	-	-	Unclear
Thornton ⁴⁵	New York, USA Jun 1998–May 2005	3526 (608.4), 3586 (560.8), P=0.4	-	(>4500 g): 7.8, 3.4, P=0.153	-	-	-	Unclear
Walsh ⁵⁷	Dublin, Ireland Jan 2007–Jan 2011	4034 (510), 4006 (497), P=0.449	52.9 (2.7), 52.6 (2.1), P=0.189	51, 51, P=0.88	-	-	-	Unclear

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First author	Setting and date	Birthweight (g) (mean (s.b.) unless otherwise specified)	Birth length (cm) (mean (s.ɒ.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500 g)	Overall risk of bias
Wolff ⁵⁸	Copenhagen, Denmark Published 2008	3575 (617), 3895 (485), P=NR	52 (3), 53 (2), P = NR	1	T	I	1	Unclear
ye ⁵⁶	Guangzhou, China May 2012–May 2013	3390 (240), 3510 (310), P = 0.019	-	1	T	I	1	High
Zhang ³⁷	Ningbo, China Jan 2011–Dec 2011	3326 (292), 3556 (369), P < 0.05	1	1	1	I	1	High
ID not reported: NC n	tot simificant: GL alveaamic inde	av. (-) data not available						

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LBW (<2500 g) or macrosomia (>4000 g). To limit bias, there was no limit on the age of women, the length of intervention, the content of the intervention, publication language or date.

Search strategy and selection process

A systematic search was conducted using the following electronic databases: Cochrane Library, MEDLINE, EMBASE, PsycINFO, CINAHL, Scopus, LILACS and Clinical Trials.gov was also searched at the same time. The search strategy and keywords used are outlined in Supplementary Table 1. Two native Mandarin speakers (J.M. and F.W.) also independently conducted the systematic search in: China National Knowledge Infrastructure, WangFang and VIP databases. The search was conducted in April 2016. Duplicates were removed via an electronic automated title and author search. Following the removal of duplicates, all title and abstracts were independently screened by two reviewers. Any conflicts were resolved by an independent third reviewer (H.T.). Full texts were retrieved and reviewed via the same process. Corresponding authors were contacted if full texts were unable to be retrieved or further information was required. Systematic reviews identified through the search process were subject to a manual hand searching of reference lists for possible included trials. Multiple publications from the same dataset were reviewed and the publication with the largest sample size was included.

Data extraction and quality assessment

Data extraction was completed by J.M., F.W. and Y.W. for studies published in Chinese, and by R.E.W. and C.J.B. for studies published languages other than Chinese. Data were extracted using a template adapted from the 'Cochrane data extraction template for randomized controlled trials'.²³ All data were independently extracted and reviewed by at least two reviewers (C.J.B. and R.E. W. for studies published in languages other than Chinese and J. M., F.W. and Y.W. for studies published in Chinese).

Assessment of methodological quality was completed using the Cochrane risk of bias for randomized controlled trials.²⁴ The overall risk of bias was determined via the following domains: random allocation sequence, allocation concealment, blinding of participants, blinding of outcome assessment, incomplete outcome data, selective outcome reporting and other bias. Bias was then allocated to 'high', 'unclear' or 'low' for each of the domains. If domains were all 'low' the study was considered low risk of bias overall. If studies had one or more 'unclear' domains but no 'high' domains, the study was considered an unclear risk of bias overall. If a study had one or more domains that were 'high' the overall study was considered a high risk of bias. All manuscripts were independently assessed by two reviewers for risk of bias. If reviewers disagreed on any domain of the bias tool, resolutions were made between two primary reviewers (R.E.W., C.J.B. or J.M. and F.W.). If no resolution could be made, a blinded reviewer would make a third decision, with the binding decision formed by the domain with the majority of reviewer's decisions. This was in accordance with the Cochrane handbook.²⁵

Statistical analysis

The main outcome measures were birthweight, birth length, macrosomia, LBW, SGA and LGA. Studies were pooled into intervention categories for analysis. Eight categories emerged from the resultant literature: diet alone, PA alone, lifestyle (diet and PA), other, GDM diet, GDM lifestyle, GDM metformin and

presented: intervention, control

Results

First author	Setting and date	Birthweight (g) (mean (s.p.) unless otherwise specified)	Birth length (cm) (mean (s.p.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500g)	Risk of bias
Barakat 2013 ⁶²	Madrid, Spain Sep 2007–Jan 2011	3201 (446), 3257 (496), P=0.208	-	1, 10, <i>P</i> = 0.002	-	-	-	High
Barakat 2011 ⁶³	Madrid, Spain	3250 (493), 3402 (328), P>0.05	-	5, 10, <i>P</i> > 0.05	-	-	-	Unclear
Barakat 2012 ⁵⁹	Madrid, Spain	3404 (465), 3465 (411), P>0.05	50.07 (2.4), 49.95 (1.9), P>0.05	-	-	-	-	Unclear
Barakat 2009 ⁶⁰	Madrid, Spain Jan 2000-Mar 2002	3165 (411), 3307 (477), P>0.1	49.5 (1.8), 49.7 (1.8), P > 0.1	1.4, 10, <i>P</i> > 0.1	-	-	-	High
Barakat 2016 ⁶¹	Madrid, Spain Dec 2011–Jan 2015	3252 (438), 3218 (453), P=0.29	50.0 (2.2), 49.8 (2.1), P=0.11	1.8, 4.7, P=0.03	-	-	4.2, 6.5, <i>P</i> = 0.15	Unclear
Barakat 2014 ⁶⁴	Madrid, Spain	3203 (461), 3232 (488), P=0.56	49.5 (2.07), 49.7 (2.06), P=0.98	-	-	-	-	High
Bisson ⁶⁵	Quebec, Canada Oct 2011–Nov 2013	3575 (425), 3455 (368), P=NR	-	-	17, 13, <i>P</i> = NR	0, 8, <i>P</i> = NR	-	Unclear
Cavalcante ⁶⁶	Sao Paulo, Brazil Mar 2002–Nov 2004	3222.2 (562.7), 3312.7 (656.1), <i>P</i> = 0.54	-	-	-	-	10, 5, <i>P</i> = 0.54	High
Chen ⁶⁷	Chendou, China	3172.1 (312.59), 3364.6 (368.07), P=NR	-	-	-	-	-	High
Clapp 2000 ³²	Ohio, USA	3660 (800), 3430 (900), P=0.05 ^a	51.8 (1.4), 50.6 (1.5), P=0.05	-	-	-	-	Unclear
Clapp 2002 ³³	Ohio, USA	Lo-Hi ^b : 3340 (357), Mod-Mod ^c : 3440 (392), Hi-Lo ^d : 3900 (350), <i>P</i> < 0.0001	Lo-Hi: 51.1 (1.5), Mod- Mod ^c : 51.2 (1.5), Hi- Lo ^d : 52.6 (1.0), <i>P</i> = NR	-	-	-	-	Unclear
Dekker-Nikert ⁶⁸	Brisbane, Australia	3548 (459), 3597 (304), P=NR	50.6 (2.2), 50.5 (1.8), P = NR	-	-	-	-	High
Garshasbi ⁶⁹	Tehran, Iran Apr 2003–Jan 2004	3426 (675), 3500 (431), P=0.82	-	-	-	-	-	High
Kong ⁷⁰	Iowa, USA	Overweight: 3760 (440), 3590 (460), P = NR Obese: 3540 (510), 3940 (480), $P = NR$	-	Overweight: 33, 11,	-	-	Overweight: 0, 0, <i>P</i> = NR Obese: 0, 0, <i>P</i> = NR	Unclear

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First author	Setting and date	Birthweight (g) (mean (s.o.) unless otherwise specified)	Birth length (cm) (mean (s.p.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (> 90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500 g)	Risk of bias
Nascimento ⁷¹	Sao Paulo, Brazil	3267.4 (700.4), 3228.4 (591.3), P = 0.790 Aug 2008-Mar 2010	1	I	24.2, 24.2, <i>P</i> =1	6.1, 3.0, <i>P</i> =1	1	Unclear
0ostd am ⁴⁴	Amsterdam, Netherlands Jan 2007– Jan 2011	3524 (591), 3352 (591), P=0.14	1	I	12.8, 1, P=NR ^e	1	1	Unclear
Perales ⁷²	Madrid, Spain Oct 2009–Jan 2013	3347 (307.04), 3346 (307.04), <i>P</i> =0.99	1	I	1	1		Unclear
Ruiz ⁷³	Madrid, Spain Sep 2007–Jan 2011	3234 (453), 3239 (433), P=NR	1	2.1, 5.0, <i>P</i> = NR	1	1	5.0, 4.8, <i>P</i> = NR	Unclear
VR, not reported; NS, Results presented: inte	not significant; '-' = data not av ?rvention, control.	ailable.						

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GDM 'other'. Studies categorized as 'other' did not have interventions that satisfied the other categories listed. Where studies reported results of subgroups but not overall results (such as by maternal BMI category), the groups were combined using the Cochrane formula for combining groups.²⁵ For studies with more than one arm, only the most intensive arm was chosen for the meta-analysis as not to duplicate representation from control groups.²⁶⁻³¹ However, an exception to this rule was a study conducted by Ainuddin et al.³⁰ compared metformin alone, metformin and insulin and insulin alone. For this study only the metformin and insulin alone arms were included in the metaanalysis to ensure appropriate comparison to other studies included. Further, comparator groups were defined as standard care following antenatal care guidelines as appropriate. Studies that reported standard error of the mean (S.E.M.) were converted to standard deviation (s.D.).³²⁻³⁸ Studies were excluded from the meta-analysis for the following reasons: (i) no true control $(n=6)^{33-35,39-41}$ (ii) inadequate statistical reporting,^{42,43} (iii) studies did not have standard criteria for LGA, 26,44 SGA or macrosomia,45 (iv) studies that were too heterogeneous to compare (other and GDM other category) 36,46-49 and (v) data were reported as mean \pm s.E.M. but when converted to s.D. data were biologically implausible.32

Actual mean difference meta-analyses were conducted on birthweight and birth length to enable ease of interpretation.⁵⁰ Risk ratio meta-analyses were conducted for dichotomous data which includes the prevalence of LGA, SGA, macrosomia and LBW. The I^2 statistic was used as an assessment of heterogeneity, with an I^2 statistic of >50% regarded as substantial heterogeneity.²⁵ Funnel plots were used to visually analyze if large studies were influencing the results of the meta-analyses. Sensitivity analyses were conducted removing one study at a time, to assess the bias of one study. Meta-regression used 'high' risk of bias as a covariate to explain heterogeneity and explore the relationship with effect size of studies with a 'high' risk of bias. Statistical analyses were conducted using Stata/SE 13.1. *P*-values <0.05 were considered statistically significant.

Results

^bLo-Hi: 20min 5 days a week through week 20, gradually increasing to 60min 5 days a week by week 24 and maintaining that regimen until delivery. Mod-Mod: 40min 5 days a week from week 8 until delivery. ⁴Hi-Lo: 60 min 5 days a week through week 20, gradually decreasing to 20 min 5 days a week by week 24 and maintaining that regimen until delivery

Reported >97th percentile

Reported as mean±s.E.M.

Of the 20,578 records screened, 77 studies were included in this review (Fig. 1). Information regarding the intervention and demographic information are available in Supplementary Tables 2–6. Briefly, all interventions included singleton pregnancies with mean maternal age ranging from 24 to 36 years, baseline BMI ranging from 20.2 to 38.6 and percentage of preterm births ranging from 0.8 to 19%. Further, the included studies represent results from 19,806 infants from 20 countries including: America, Australia, New Zealand, Brazil, Canada, China, Denmark, Finland, Iran, Ireland, Italy, Germany, Spain, United Kingdom, Pakistan, Norway, Belgium, Turkey, Sweden and The Netherlands.

Interventions were categorized into the following groups; diet (n = 14),^{29,35,37,39,40,45,51–58} PA (n = 18),^{32,33,44,59–74} lifestyle (diet and PA) (n = 21),^{26–28,31,43,74–89} diet alone for women with GDM (n = 6),^{33,34,38,42,90–92} metformin compared with standard care of insulin for women with GDM (n = 5),^{30,93–96} metformin compared with glyburide for women with GDM (n = 1),⁴¹ lifestyle for women with GDM (n = 1),¹⁰² 'other' in women without GDM $(n = 5)^{36,46-49}$ and

Table 3. Infant anthropometric outcomes in studies with a lifestyle intervention

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First author	Setting and date	Birthweight (g) (mean (s.ɒ.) unless otherwise specified)	Birth length (cm) (mean (s.ɒ.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500 g)	Overall risk of bias
Althuizen ⁷⁵	Netherlands Feb 2005–May 2006	3550 (466), 3431 (456), P=NR	-	19, 14, <i>P</i> = NR	-	-	-	High
Asci ⁷⁶	lstanbul, Turkey Jun 2011–Jul 2012	3268 (380), 3298 (423), P=0.76	50.04 (1.78), 50.40 (1.90), P=0.29	-	-	-	-	Unclear
Bogaerts ³¹	Flanders, Belgium Mar 2008–Apr 2011	Brochure: 3386 (682), lifestyle: 3444 (503), control: 3504 (583), P=0.54	-	-	-	-	-	Unclear
Dodd ⁷⁷	Adelaide, Australia Jun 2008–Dec 2011	-	-	15, 19, P=0.04	19, 21, <i>P</i> = 0.24	-	-	Unclear
Guelinckx ²⁷	Leuven, Belgium Mar 2006–Jan 2008	Passive: 3585 (398), active: 3492 (468), control: 3419 (425), P=0.106	Passive 51.0 (2.1), active: 50.6 (2.0), control: 50.0 (1.8), <i>P</i> =0.182	Passive: 13.5, active: 11.9, control: 7.0, P = 0.312	-	-	-	Unclear
Hawkins ⁷⁸	Massachusetts, USA Apr 2010–Aug 2011	3338.8 (640.7), 3429.8 (532.6), <i>P</i> =0.64	-	-	-	-	-	Unclear
Hui 2012 ⁷⁹	Manitoba, Canada Jul 2004–Feb 2010	3490 (509), 3516 (530), P=0.73	-	-	11.8, 17.0, P=0.41	-	-	Unclear
Hui 2014 ⁸⁰	Manitoba, Canada May 2009–Dec 2011	Healthy weight: 3356 (474), 3633 (555), P = 0.047 Overweight/obese: 3665 (506), 3650 (481), P = 0.26	-	-	Healthy weight: 7, 11, P = 0.902 Overweight/obese: 15, 3, P = 0.13	-	-	Unclear
Liang ⁸¹	Bingzhou, China Jul 2005–Nov 2008	3313.1 (385.7), 3331.5 (393.7), <i>P</i> > 0.05	-	-	-	-	-	High
Luoto ⁸²	Pirkanmaa, Finland Oct 2007–Dec 2008	3313.1 (385.7), 3331.5 (393.7), <i>P</i> = 0.035	-	17.2, 20.8, <i>P</i> = 0.31	12.1, 19.7, <i>P</i> = 0.043	4.7, 2.9, <i>P</i> = 0.53	-	Unclear
Petrella ⁷⁴	Modena, Italy April–Oct 2011	3498 (342), 3010 (715), P=0.001	-	-	-	-	-	Unclear
Phelan ⁸³	Rhode Island, USA 2006–2008	Healthy weight: 3367 (459), 3271 (467), P = NR Overweight/obese: 3430 (650), 3442 (629), P = NR	-	Healthy weight 7, 3, P = NR Overweight/obese: 17, 16, P = NR	-	-	Healthy weight 4, 3, P = NR Overweight/ obese: 6, 5, P = NR	Unclear

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First author	Setting and date	Birthweight (g) (mean (s.p.) unless otherwise specified)	Birth length (cm) (mean (s.p.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500 g)	Overall risk of bias
Polley ⁴³	Pittsburgh, USA	Health weight: 3133, 3226.4, P = NR Overweight: 3282.8, 3349.0, P = NR	-	Health weight: 3, 0, $P = NR$ Overweight: 0, 0, $P = NR$	-	-	Health weight: 13, 10, P = NR Overweight: 4, 9, P = NR	Unclear
Poston ⁸⁴	United Kingdom	3420 (580), 3450 (580), P=0.37	-	14, 14, P=0.93	13, 11, <i>P</i> =0.35	7, 5, <i>P</i> =0.12	4, 5, <i>P</i> = 0.93	Unclear
Rauh ⁸⁵	Munich, Germany Feb 2010–Aug 2011	3406 (406), 3414 (445), P=0.890	51.4 (2.4), 51.7 (2.4), P=0.351	-	6.4, 8.9, P=0.495	3.8, 3.8, P=0.985	-	Unclear
Ruchat ²⁸	Ontario, Canada	Low ^a : 3559 (391), 3550 (378), P = NR Mod ^b : 3452 (453) Control ^c : 3550 (378), P = NR	Low ^a : 51.0 (2.0) Mod ^b : 51.1 (2.7) Control ^c : 51.1 (2.5), <i>P</i> = NR	Low ^a : 9 Mod ^b : 12 Control ^c : 7, <i>P</i> = NR	-	-	Low ^a : 0	Unclear
Renault ²⁶	Copenhagen, Denmark Mar 2009–Mar 2012	Median (IQR), PA + D: 3605 (1945–5450), PA: 3695 (805–4910), control: 3641 (1223–5280)	-	PA + D: 22%, PA: 30%, control: 25% <i>P</i> = NS	PA + D: 6.9%, PA: 6.4%, control: 6.7% <i>P</i> = NS ^d	PA+D: 5.4%, PA: 3.2%, control: 1.5% P=NS ^e	-	Unclear
Sagedal ⁸⁶	Norway Sep 2009–Feb 2013	3411 (485), 3450 (538), P=0.361	50.0 (2.1), 49.9 (2.7), P=0.867	11.8, 14.0, P=0.451	2.4, 3.7, P=0.351	10.5, 9.2, <i>P</i> = 0.679	-	Low
Skouteris ⁸⁷	Melbourne, Australia Aug 2011–Aug 2013	3517.56 (507.89), 3523.46 (531.35), <i>P</i> = NR	-	-	-	-	-	Unclear
Vesco ⁸⁸	Oregon and Washington, USA Oct 2009–July 2011	3484 (583), 3678 (583), P=NR	-	11, 22, <i>P</i> = NR	9, 26, <i>P</i> = NR	5, 7, <i>P</i> = NR	-	High
Vinter ⁸⁹	Denmark Oct 2007– 2010	Median (IQR) 3742 (3464–4070), 3593 (3335–3930), P=0.039	-	32, 25.3, <i>P</i> = 0.07	15.4, 11.7, <i>P</i> = 0.340	-	-	Unclear

IQR, interquartile range; NR, not reported; NS, not significant; PA, physical activity; D, diet symbols; '--', data not available. Results presented: intervention, control.

^aLow = low intensity physical activity + diet intervention. ^bMod = moderate intensity physical activity + diet intervention. ^cControl = dietary advice. ^d124% of relative birthweight. ^e76% or less of relative birthweight.

First author	Sotting and data	Pirthusisht (s)	Pirth length (cm)	Macrosomia (%)	Large for gestational age (%) (>90th	Small for gestational age (%) (<10th	Low birth weight (96) ($c = 2500$ g)	Overall
	Setting and date	Birtiweight (g)	Birtil tengtil (cili)	(>4000g)	percentite)	percentite)	(%) (<2500 g)	
Diet								
Garner ⁹⁰	Ottawa, Canada Sep 1991–May 1994	3437 (575), 3544 (601), P=0.118	-	16.1, 18.7, <i>P</i> =0.666	-	-	-	Unclear
Grant ³⁸	Toronto, Canada Apr 2006–Jan 2007	3124 (526), 3330 (984), P=NS	-	-	-	-	-	Unclear
Louie ³⁴	Camperdown, Australia	LGI: 3300 (686), HF: 3300 (671), P=0.619	LGI: 49.7 (2.1), HF: 49.7 (2.0), P=0.995	LGI: 2.1, HF:6.7, P=0.286	LGI: 12.8, HF: 4.4, P=0.157	LGI: 10.6, HF: 8.9, <i>P</i> = 0.787	-	Unclear
Moreno- Castilla ⁹¹	Catalonia, Spain Nov 2008–Jul 2011	-	-	1.4, 6.7, <i>P</i> =0.21	4.1, 8, P=0.49	10.8, 16.0, <i>P</i> = 0.47	-	Unclear
Rae ⁴²	Perth, Australia Feb 1992–Jun 1995	3461 (NR), 3267 (731), P=0.105	-	16.7, 10.7, <i>P</i> = NR	28.8, 24.6, <i>P</i> = NR	-	-	Unclear
Zhang 2011 ⁹²	Shandong, China Feb 2009–Jul 2009	3279.5 (447.9), 3590.7 (457.8), P < 0.05	-	-	-	-	-	High
Metformin								
Ainuddin ³⁰	Karachi, Pakistan Dec 2008–Dec 2010	M: 3400 (400), M+1: 3300 (500), I: 3700 (500), M and M+1: P=0.546, M+1 and 1: P=0.001, M and 1: P=0.002	-	-	M: 23.3, M+I 28.1, I: 37.3, M and M+I: P=0.632, M and I: P=0.115, I and M+I: P=0.359	M: 11.6, M+I: 15.6, I: 6.6, M and M+I: P=0.432, M and I: P=0.273, I and M+I: P=0.138	-	High
Niromanesh ⁹³	Tehran, Iran Dec 2010-Jan 2012	3300 (400), 3400 (400), P=0.005	50.4 (2.0), 51.1 (2.3), P=0.033	3.8, 10.0, <i>P</i> = 0.118	17.5, 35.0, <i>P</i> = 0.12	3.8, 2.5, P=1	-	Unclear
Rowan ⁹⁴	Australia and New Zealand Oct 2002–Nov 2006	3372 (572), 3413 (569), P=0.33	50.3 (2.8), 50.3 (2.4), P=0.91	-	19.3, 18.6, <i>P</i> = 0.83	7.2, 9.7, P=0.21	-	Unclear
Silva ⁴¹	Brazil Jul 2008–Oct 2009	G: 3463 (535.6) M: 3360 (509.5), P=0.36	-	G: 15, M: 6.2, P=0.24	G: 22.5, M: 9.4, <i>P</i> = 0.14	-	-	Unclear

Table 4	Continued
Table 4.	Continueu

First author	Setting and date	Birthweight (g)	Birth length (cm)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500g)	Overall risk of bias
Spaulonci ⁹⁵	Sao Paulo, Brazil Nov 2007–Jan 2010	3143.7 (446.6), 3237.6 (586.8), <i>P</i> =0.390	-	0, 6.5, <i>P</i> = 0.242	-	-	-	Unclear
Tertti ⁹⁶	Turku, Finland Jun 2006–Dec 2010	3604 (488), 3589 (448), <i>P</i> = NR	-	20, 15, P=0.38	14.5, 15.9, <i>P</i> = 0.8	-	-	Unclear
Lifestyle								
Chen ¹⁰¹	Foshan, China Oct 2001–Oct 2005	3210 (750), 3790 (690), P<0.05	-	-	-	-	-	High
Sun ⁹⁷	Guangzhou, China May 2012–Dec 2012	3220 (1320), 3350 (2160), P < 0.05	-	-	-	-	-	High
Xie ⁹⁸	Wuzhou, China Oct 2006–Oct 2010	3074 (770), 37920 (690), <i>P</i> = NR	-	-	-	-	-	High
Yang ⁹⁹	Tianjin, China Dec 2010–Oct 2012	3371 (530), 3469 (570), <i>P</i> =0.021	50.1 (1.8), 50.2 (1.9), P=0.248	11.2, 17.5, <i>P</i> = 0.019	-	-	4.1, 3.9, P=0.865	Unclear
Zhang 2012 ¹⁰⁰	Shenzhen, China Jul 2009–Jan 2011	3403.3 (326.5), 3601.1 (409.9), P<0.05	-	-		-	-	High
Physical Activity								
Halse ¹⁰²	Perth, Australia	3176 (526), 3319 (478), <i>P</i> > 0.05	49.8 (2.5), 49.9 (2.9), <i>P</i> > 0.05	-	-	-	-	Unclear
Other								
Jie ¹⁰³	Guangdong, China Sep 2012–Sep 2014	-	-	8, 27, P=0.000	-	-	-	High

M, metformin; I, insulin; G, glyburide; LGI, low glycaemic index; HF, high fibre; NS, not significant; NR, not reported; '-', data not available. Results presented: intervention, control.

First author	Setting and date	Birthweight (g) (mean (s.b.) unless otherwise specified)	Birth length (cm) (mean (s.b.) unless otherwise specified)	Macrosomia (%) (>4000 g)	Large for gestational age (%) (>90th percentile)	Small for gestational age (%) (<10th percentile)	Low birth weight (%) (<2500 g)	Overall risk of bias
Brownfoot ⁴⁷	Melbourne, Australia Jan 2010–Nov 2012	3404.7 (561.3), 3364.9 (623.8), <i>P</i> = 0.36	I	1	7.3, 7.1, <i>P</i> = 0.97	9.2, 12.6, <i>P</i> =0.16	1	Unclear
Herring ⁴⁹	Philadelphia, USA 2013–2014	3147, 3361, <i>P</i> = NR	I	I	8, 7, <i>P</i> =1.0	4, 0, <i>P</i> = 0.48	1	Unclear
Jeffries ⁴⁸	Melbourne, Australia Jul 2007–May 2008	3416 (452.4), 3421 (504.7), <i>P</i> =0.95	I	I	6.5, 9.9, P = 0.47	7.3, 10.8, <i>P</i> = 0.37	1	Unclear
Quinlivan ³⁶	Melbourne, Australia	3500 (556), 3400 (781), <i>P</i> =0.162	I	I	1	1	1	Unclear
Syngelaki ⁴⁶	London, United Kingdom Oct 2010–Jun 2013	T	I	I	16.8, 15.4, <i>P</i> = 0.79	1	1	Unclear
IS, not significant	;; NR, not reported; '-', data not a	available.						

Results presented: intervention, control

'other' for women with GDM (n = 1).¹⁰³ Study characteristics and methodological quality have been reported previously.²² For individual results reported in this review, see Tables 1-5.

Overall

Regardless of intervention type, studies designed to reduce excessive GWG reduced offspring birthweight by 71 g (WMD: -70.67, 95% CI -101.90 to $-39.43, P < 0.001, I^2 = 67.2\%$) (n = 56studies, Fig. 2) and reduced the risk of macrosomia by 16% (RR: 0.84, 95% CI 0.73–0.98, P = 0.026, $I^2 = 46.9\%$) (n = 28 studies, Fig. 3). Studies that reported LGA incidence (n = 20 studies)reduced the prevalence of LGA by 19% (RR: 0.81, 95% CI 0.68-0.96, P = 0.015, $I^2 = 45.4\%$) (Fig. 4). No intervention type significantly influenced the birth length (Fig. 5), risk of LBW (Fig. 6) or SGA (Fig. 7).

Women who started interventions without GDM

Diet interventions reduced infant birthweight by 99g (WMD: -98.8, 95% CI -178.85 to -18.76, P = 0.016, $I^2 = 79.3\%$). Lifestyle and PA interventions did not result in a difference in birthweight (Fig. 2). PA interventions reduced the risk of macrosomia by 59% (RR: 0.41, 95% CI 0.25–0.68, P < 0.001, $I^2 = 16.3\%$) (Fig. 3). No significant differences in risk of macrosomia were found for any other intervention type. The risk of LGA was reduced 65% by diet interventions (RR: 0.35, 95% CI 0.17–0.72, P = 0.004, $I^2 = 6.6\%$) (Fig. 5). No other intervention type had significant results for birthweight, birth length, macrosomia, LBW, SGA and LGA.

Women with GDM

Diet and lifestyle interventions in women with GDM decreased infant birthweight by 211 and 296 g, respectively (WMD: -210.74, 95% CI -374.77 to -46.71, P = 0.012, $I^2 = 58.87\%$ and WMD: -295.93, 95% CI -501.76 to -91.10, P = 0.005, $I^2 = 73.6\%$, respectively). Furthermore, interventions that used metformin did not significantly reduce or increase birth weight compared with insulin (Fig. 2). No other intervention type had significant results for birthweight, birth length, macrosomia, LBW, SGA and LGA.

Risk of bias

Overall risk of bias is available in Tables 1-5 and further details available in Supplementary Tables 2-6. Twenty-one studies received an overall 'high risk' of bias. Of the studies that received a 'high risk' of bias half did not clearly state the blinding protocol of participants or personnel. Furthermore, almost half did not adequately explain the randomization procedure (n=9) or method of allocation concealment (n=8). Fifty-five studies received an overall 'unclear risk' of bias. Of the studies that received an overall 'unclear risk', n = 44 did not state the blinding of personnel and n = 43 did not state the blinding of participants. Regardless of the overall risk of bias, n = 52 studies received an 'unclear' for selective outcome reporting due to an inability to check reported outcomes with planned outcomes due to studies not having a published protocol. Visual, subjective assessment of funnel plots suggest a low to medium level of publication bias (Appendices 1-6).

Sensitivity analyses

When single studies were removed to examine sensitivity of estimates, the WMD and RR did not alter considerably, indicating that no single study introduced a high degree of bias.

Table 5. Infant anthropometric outcomes in studies with an intervention categorized as 'other

Def Transport 2010 Decer 201		rear	WMD (95% CI)	Treigi
Brown 004 - 718 (1-123, 30, 006) 2.3 Hore Hyper (197, 102, 102, 007) 1.1 Hore Hyper (197, 102, 102, 007) 1.1 Hyper (197, 102, 102	Diet			
Dicate 313	Bonomo	2004	-71.60 (-173.26, 30.06)	2.39
Device 2010	Di-Carlo	2013	-43.30 (-187.07, 100.47)	1.91
Component <	Dovoor	2012	977.00 (425.00 - 119.01)	1 75
Number Type Other Type Mail Type	Deveel		-2/7.00 (-435.99, -118.01)	1.75
Interem D11 D1 (2018) D10 (2018) D11 (2018)	Korpi- Hyovalti	2011	380.00 (75.94, 684.06)	0.79
Line 012 Here 010 Water 010 Wa	Illomen	2011	-111.00 (-258.89, 36.89)	1.86
Domes 2000 → 0.00 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) 2000 (101.23 (100.21) <td>Lino</td> <td>2012</td> <td>016 50 (200 01 00 60)</td> <td>0.14</td>	Lino	2012	016 50 (200 01 00 60)	0.14
Throutom 2009 We 2000 We 200	Lidu	2012	-210.00 (-009.01, -90.09)	2.14
Wash 2012	Thornton	2009	-60.00 (-210.57, 90.57)	1.83
World 2008	Walsh	2012	28.00 (-43.68, 99.68)	2.74
Ym 308	Wolff	2008	-138.00 (-449.53, 173.53)	0.76
************************************		2008	-130.00 (-443.33, 173.33)	0.70
Zhang 203	Ye	2016	-120.00 (-219.20, -20.80)	2.42
Bachal (rangened - 70, 2%, p = 0.000) -8.80 (+7.82.6, -18.70) 21.4 Physical Activity -10.00 (+16.93, 40.02) 21.5 Bachal 2016 -20.00 (+10.92, 40.02) 21.5 Bachal 2016 -10.00 (+10.92, 40.02) 21.5 Bachal 2016 -10.00 (+10.92, 40.02) 21.5 Bachal 2016 -10.00 (+10.92, 40.02) 21.5 Bachal 2017 -10.00 (+10.92, 40.02) 21.5 Bachal 2018 -10.00 (+10.92, 10.93, 10.10) 21.5 Bachal 2018 -10.00 (+10.92, 10.93, 10.10) 21.5 Control 2018 -10.00 (+10.	Zhang	2013	-230.00 (-290.04, -169.96)	2.86
Physical Action (2010 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 244.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.82) 1200 (1-104.82, 147.	Subtotal (I-squared =	79.3%, p = 0.000)	-98.80 (-178.85, -18.76)	21.45
The start of the star	Physical Activity	i		
Seal 010 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000	Disease	0015		1.00
Bankal 2014	bisson	2015	120.00 (-104.92, 344.92)	1.20
Bankat 2016 44.0.0 (24.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0, 124.0.0,	Barakat	2014	-29.00 (-138.24, 80.24)	2.30
Bankak 2009	Barakat	2016	34.00 (-29.15.97.15)	2.83
Bandal 200 -1420 (2518, 47.69) 18 Bandal 201 -4200 (2518, 47.69) 18 Bandal 2010 -400 (420, 518, 47.69) 18 Bandal 2010 -400 (420, 518, 47.69) 18 Bandal 2010 -400 (420, 518, 47.69) 120 Chen 2014 -400 (420, 52, 300, 50) 120 Bandal 2015 -400 (420, 52, 300, 51, 30) 201 Chen 2014 -400 (430, 52, 300, 51, 30) 201 Chen 2015 -740 (420, 50, 300, 51, 30) 201 Chen 2013 -740 (420, 71, 80, 58) 201 Chen 2014 -740 (420, 71, 80, 58) 201 Chen 2	Dalakat	2010	34.00 (-23.13, 37.13)	2.00
Bankat 2011 -152.00 (451.56, 47.96) 1.43 Bankat 2012 -40.00 (420.56, 130.59) 1.44 Bankat 2013 -40.00 (420.56, 130.59) 1.44 Bankat 2013 -40.00 (420.56, 130.59) 1.64 Bankat 2013 -40.00 (412.56, 130.59) 1.64 Charlen Mei 2014 -40.00 (415.51, 182.59) 1.74 Dakas Munit 2015 -124.20 (41.52, 182.59) 1.72 Stational () +squared = 28.4%, p = 0.150) -22.33 2.23 Dakas Munit 2011 -40.00 (41.57, 180.10) 2.23 Maxiemen 2013 -40.00 (41.57, 180.10) 1.72 Stational () +squared = 28.4%, p = 0.150) -22.33 2.34 -71.24.07 2.21 Marken 2013 -40.00 (41.52, 180.49) 1.72 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22 -72.01 2.22	Barakat	2009	-142.00 (-288.62, 4.62)	1.88
Bankat 912 -100 (200 38) (200 38) 100 (200 38) (200 38) Chen 2010 -450 (1426 40, 0433 200 - 100 (200 38) 200 (200 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 -	Barakat	2011	-152 00 (-351 96 47 96)	1.38
samata Banada unite Banada u	Developt	0010		
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Cancelarine 300 Cham 2014 1920 (347, 17, 103, 17) 088 1920 (345, 35, 368) 200 1920 (345, 358, 368) 102 1920 (345, 358, 368) 103 1920 (345, 358, 358) 102 1920 (345, 358, 358) 103 1920 (345, 358) 103 1920 (345,	Barakat	2013	-56.00 (-142.69, 30.69)	2.57
Comm Loss The set of the set o	Cavalcante	2009	-00 50 (-974 17 102 17)	0.00
Units 2014 -11022013(20:83:5), 50:85) 20.0 Gardwald 2004 -42.0 (20:83:5), 50:85) 10.0 Gardwald 2004 -74.00 (20:83:5), 50:85) 10.0 Oraction 2011 -74.00 (20:83:5), 50:85) 10.0 Oraction 2011 -74.00 (20:83:5), 50:85) 10.0 Oraction 2012 -72.00 (20:43:7, 72.0) 10.0 Previous 2013 -74.00 (20:83:5) 20:0 Gardwald 2013 -74.00 (20:81:6) 20:0 Maluxinn 2013 -10.00 (15:8:1:18:10) 20:0 Maluxinn 2013 -10.00 (15:8:1:18:10) 11.00 (15:78:642.70) 20:0 Gardwald 2010 -10.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40) 11.00 (20:8:8:6, 46:40)	ouvaival ILE		-30.50 (-374.17, 193.17)	0.88
Dekam-Niem 2014 	Chen	2014	-192.50 (-326.35, -58.65)	2.01
Cashabal 205 -7.00 (-25.16, 73.51) 18 Nacimanto 2014 -7.00 (-25.16, 73.51) 18 Nacimanto 2011 -7.00 (-25.16, 73.51) 18 Nacimanto 2013 -7.00 (-25.16, 73.51) 18 Nacimanto 2013 -5.00 (-10.0, 51.00) 296 Subtrail (Fsquared = 28.4%, p = 0.198) -7.00 (-21.67, 81.91) 29.2 Maulanno 2013 -7.00 (-21.67, 81.91) 19.00 (-5.10, 71.20) 29.2 Subtrail (Fsquared = 28.4%, p = 0.198) -7.00 (-21.78, 82.11) 14.00 (-22.77, 85.71) 29.8 Regarati 2013 -7.00 (-17.48, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) Hai 2011 -7.00 (-17.48, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.28, 92.11) 14.00 (-10.0, 71.18, 92.11) 14.00 (-10.0, 71.18, 92.11) 14.00 (-10.0, 71.18, 92.11) 14.00 (-10.0, 71.18, 92.11) 14.00 (-10.0, 71.18, 92.11) 14.00 (-10.0, 71.18, 71.1) 14.00	Dekker-Nitert	2014	-49.00 (-303.53, 205.53)	1 02
Just Ham COO	Carebook:	0005		1.02
Köng 2014 -1-20.0 (+4.15.3, 195.33) 0.7.7 Maximento 2012 -17.200 (+5.4.03, 198.09) 1.22 Prelate 2015 -1.200 (+5.4.03, 198.09) 1.22 Maximento 2012 -2.200 (+5.4.03, 198.09) 1.22 Maximento 2013 -3.200 (+5.10, 51.00) 2.00 Maximento 2013 -3.200 (+17.02, 17.20) 2.11 Addi 2013 -3.200 (+17.02, 17.20, 17.20) 1.11 Addi 2013 -4.200 (+17.02, 17.20, 17.20, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 17.10, 1	GarsnasDi	2003	-/4.00 (-226.16, /8.16)	1.82
Nacimento 2011 Prevente 2013 Subtratul (requared = 28,4%, p = 0,158) Lifestyle Attalianta 2013 Subtratul (requared = 28,4%, p = 0,158) Lifestyle Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2013 Attalianta 2014 Hui 2011 Hui 2013 Hui 2013 Hui 2013 Hui 2014 Hui 2013 Hui 2014 Hui 2013 Hui 2014 Hui 2014 Hui 2013 Hui 2014 Hui 2013 Hui 2014 Hui	Kong	2014	-124.00 (-441.53, 193.53)	0.74
machine 201 900 (268, rt, 253, 74) 0.0 But 2013 1720 (1420, 9500) 122 But 2013 1720 (1420, 9500) 225 Subtrall (regund = 26, 4%, p = 0.150) 226 1700 (1420, 1510) 229 Utersyle 1100 (5.76, 243.76) 213 100 (5.76, 243.76) 213 Subtrall (regund = 26, 4%, p = 0.150) 200 (1614, 1851.4) 168 300 (1614, 1851.4) 168 Bogerin 213 100 (5.76, 243.76) 213 168 1730 (1171, 833.18) 148 Hul 2011 140 (122, 7, 853.71) 238 148 1400 (5.76, 243.76) 213 Subtrall (regund = 27, 78, 577) 238 148 1400 (123, 27, 237) 128 Subtrall (regund = 27, 78, 577) 238 140 1400 (123, 27, 237) 128 Subtrall (regund = 27, 27, 8577) 238 140 1400 (123, 27, 28, 27) 238 Subtrall (regund = 27, 28, 19, 28) 140 1400 (123, 27, 28, 27) 238 230 (121, 27, 48, 27) 238 Subtrall (regund = 47, 28, 19, 28)	Naccimonto	2011	20.00 (0.45 74, 202 74)	0.07
Coatian 2012 172.00 (-54.06, 380.09) 1.82 Ruiz 2015 1.00 (-115.82, 117.52, 117.52, 117.52, 117.52, 127.52, 243.70) 2.23 Ruiz 2013	INASCIIIIEIIIO	2011	39.00 (-245.74, 323.74)	0.87
Pendes 2015 Ruiz 2013 Subtolut (beguand = 28.4%, p = 0.158) Lifestyle Abrizon 2013 Abrizon 2014 Hul 2014 Abrizon 2010 Hul 2014 Hul 2014	Oostdam	2012	172.00 (-54.09, 398.09)	1.20
The main Dots	Perales	2015	1 00 (-115 02 117 02)	2 21
Huz 2013 Huz 2013 		2010	1.00 (110.02, 111.02)	2.21
Skatotal (Jesquared = 26.4%, p = 0.158) -22.43 (.716.8, 6.82) 27.2 Lifestyle 119.00 (-5.76, 243.76) 21.3 Araci 2016 -30.00 (-180.41, 136.14) 1.66 Degarts 2010 -40.60 (.24.67, 123.07) 1.56 Guaincock 2010 -40.00 (.24.67, 123.07) 1.56 Hul 2011 -40.00 (.24.67, 123.07) 1.56 Lange 2010 -40.00 (.24.67, 123.07) 2.53 Hul 2014 -40.00 (.23.8, 14.45) 1.48 Hul 2014 -40.00 (.23.8, 14.45) 1.48 Parella 2011 -40.00 (.23.8, 14.45) 1.48 Parella 2011 -40.00 (.23.8, 14.45) 2.49 Parella 2011 -40.00 (.23.8, 14.45) 2.49 Parella 2014 -40.00 (.23.8, 14.45) 2.49 Ruchat 2012 -40.00 (.24.66, 10.86.0) 2.31 Skototal (Lequared = 47.6%, p = 0.018) -40.00 (.24.69, 10.86.0) 2.31 Skototal (Lequared = 52.7%, p = 0.018) -14.10 (.40.60.7, 20.07) 2.20 Guart 2010 -14.10 (.40.60.7, 20.07) 2.20 Skototal (Lequared = 56.7%, p = 0.018) -14.10 (.40.60.7, 20.07) 2.82 Guart 2010 -14.10 (.40.60.7, 2	Ruiz	2013	-5.00 (-61.00, 51.00)	2.90
Lifestyle Althukan 2013 Akad 2016 Bogenetis 2013 Hul 2011 Hul 2011 Hul 2014 Hul 2015 Hul	Subtotal (I-squared =	26.4%, p = 0.158)	-32.43 (-71.69, 6.82)	27.28
Multicine 2013 Hallweine Hal	l ifestule	1		
Althuizen 2013 Acid 2016 Bogerins 2013 Hill 00 (1-78, 243-76) 213 Bogerins 2013 Hill 2011 Hill 2012 Hill 2011 Hill 2012 Hill 2015 Hill 2015 Hill 2016 Hill 2017 Hill 2017 Hil	Lifestyle			
Acci 2016	Althuizen	2013	119.00 (-5.76, 243.76)	2.12
Bogenits 013 -00.01(243.07, 123.07) 15 Bogenits 010 -70.07(174.59, 122.37) 15 Hui 011 -25.00(174.59, 122.37) 12 Hui 010 -71.67.07 15 35 Ling 010 -71.67.07 12 12 Ling 011 -71.67.07 12 12 Patralia 014 -71.67.07 12 12 Patralia 014 -71.67.07 12 12 Patralia 014 -71.67.07 12 12 Patralia 011 -71.67.07 12 12 Patralia 014 -71.67.07 12 12 Patralia 014 -71.07.07 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 <	Asci	2016	-30.00 (-196.14, 136.14)	1.68
stogasts 2013 -00.00 (243.07, 122.07) 12.2 Hu 2011 -70.00 (243.07, 122.07) 12.2 Hu 2011 -70.00 (243.07, 122.07) 12.8 Ling 2010 -70.00 (243.07, 122.07) 12.8 Ling 2010 -70.00 (243.07, 122.07) 12.8 Ling 2010 -71.07.00 (242.07, 25.97) 2.9 Patella 2014 -71.07.00 (242.07, 12.8, 27.7) 2.9 Patella 2014 -70.00 (124.67, 19.8, 22.2, 24.7) 2.6 Rush 2012 -90.00 (124.66, 10.66, 66) 2.2 Stotofaris 2016 -99.00 (121.66, 10.66, 66) 2.2 Stotofaris 2016 -99.00 (121.66, 10.66, 66) 2.2 Stotofari 2016 -90.00 (124.62, 2.63.2) 2.00 Gamer 1997 -01.00 (240.52, 26.32) 2.00 Gamer 1997 -01.00 (240.52, 26.32) 2.00 Gamer 1997 -00.00 (24.64, 22, -135.38) 1.68 Nicomanesh 2012 -00.00 (24.64, 22, -135.38) 1.68 Subtofari (Lequared = 58.7%, p = 0.089) -10.00 (23.6	5			1.00
Gueinack 2010 73.00 (117.18, 263.18) 1.44 Hui 2011 -26.00 (174.39, 122.39) 1.88 Hui 2011 -26.00 (174.39, 122.39) 1.88 Hui 2011 -26.00 (174.39, 26.87) 2.28 Luoto 2011 -26.00 (174.39, 26.97) 2.38 Prelan 2011 -26.00 (174.39, 25.97) 2.38 Prelan 2011 -26.00 (174.39, 159.82) 2.27 Pauh 2015 -30.00 (124.66, 108.26) 2.27 Bauh 2016 -30.00 (121.59, 43.59) 2.66 Scutoris 2016 -39.00 (121.59, 43.59) 2.66 Scutoris 2016 -19.00 (240.52.26.26) 20.00 Vesco 2014 -19.00 (240.52.26.26) 20.00 Gammar 1997 -01.07.00 (240.52.26.22) 20.00 Gammar 1201 -19.00 (240.52.26.22) 20.00 Gammar 1211 -19.00 (240.52.26.22) 20.00 Gammar 1201 -20.00 (700.98, 280.99) 0.38 Shutofall (I-squared = 58.7%, p = 0.008) -210.71 4.36	Bogaerts	2013	-60.00 (-243.07, 123.07)	1.52
Hui 9011 Hui 9014 Ling 2010 Ling 2010 Patralla 2014 Present 2011 Present 2015 Reach 2015 Reach 2016 Sectoring 2017 Carner 1997 Grant 2010 Charles 27%, p = 0.089 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 2010 Charles 27%, p = 0.089 Carner 2014 Anucdaim 2014 Anucdaim 2014 Anucdaim 2014 Sectoring 2014 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 1997 Carner 2010 Charles 27%, p = 0.089 Carner 2019 Carner 1997 Carner	Guelinckx	2010	73.00 (-117.18, 263.18)	1.46
nu 2011 Hul 2014 Lang 2010 Lang 2010 Lang 2010 Lang 2010 Hul 2011 Peterlia 2014 Peterlia 2014 Peterlia 2014 Peterlia 2015 Rauh 2012 Sequelat 2015 Rauh 2012 Sequelat 2016 Sequelat 2017 Sequelat 2016 Sequelat 2017 Sequelat 2010 Sequelat 2010 Sequelat 2017 Sequelat 2010 Sequelat 2017 Sequelat 2010 Sequelat 2017 Sequelat 2017	L	2011	26.00 (174.20, 122.20)	1.96
Hu 2014 Liang 2010 Liang 2010 Liang 2010 Liang 2010 Liang 2010 Liang 2011 Preatin 2011 Preatin 2011 Preatin 2011 Preatin 2013 Ruchat 2012 Sincuriar 1997 Grant 907 Grant 907 Grant 907 Grant 2010 Zhang 2011 Subtotal (Liquared = 75.7%, p = 0.018) CDM - Metrom Anuddin 2013 Subtotal (Liquared = 55.7%, p = 0.089) CDM - Metrom Anuddin 2014 Subtotal (Liquared = 55.7%, p = 0.049) CDM - Litertyle Yang 2014 Subtotal (Liquared = 75.6%, p = 0.040) CDM - Litertyle CDM - Litertyle		2011	-20.00 (-174,33, 122,33)	1.00
Ling 2010 Link 2011 Percenta 2014 Percenta 2014 Percenta 2011 Percenta 2015 Rauh 2015 Rauh 2015 Rauh 2016 Structaris 2017 Structaris 2018 Structaris 2016 Structaris 2016 Structaris 2016 Structaris 2016 Structaris 2016 Structaris 2016 Structaris 2017 Structaris 2016 Structaris 2018 Structaris 2016 Structaris 2017 Structaris 2018 Structaris 2018 Structaris 2019 Structaris 2014 Structaris 2014 Structaris 2013 Structaris 2013 Structaris 2013 Structaris 2013 Structaris 2013 Structaris 2013 Structaris 2013 Structaris 2014 Structaris 2015 Structaris 2015 Structari	Hui	2014	-140.00 (-328.45, 48.45)	1.48
Lundo 2011 -172 C0 (222 c1, 3139) 2.46 Pheraina 2014 -485 00 (1986, 777.40) 0.28 Pheraina 2015	Liang	2010	-18.40 (-122.77, 85.97)	2.36
Lunity 2011 -127.00 (122.61, 31.33) 2.44 Pherinal 2011 -48.00 (173.82, 159.82) 2.21 Phetan 2013 -49.00 (128.60, 777.40) 0.86 Rauh 2013 -9.00 (128.60, 777.40) 0.86 Sagedal 2016 -9.00 (128.60, 777.40) 0.86 Sagedal 2016 -9.00 (128.60, 777.40) 0.86 Soucheria 2016 -9.00 (128.60, 77.00) 1.28 Vesco 2014 -9.00 (128.00, 120.20) 2.01 GDM - Diet -194.00 (408.07, 20.07) 1.28 Gamer 1997 -107.00 (240.32, 26.32) 2.02 Grant 2010 -0.008) -116.24 (34.94, 175.50) 2.13 Stototal (I-squared = 58.7%, p = 0.089) -210.74 (374.77, 46.71) 4.55 GDM - Metrom -100.00 (243.86, 23.86) 2.02 Anuddin 2013 -100.00 (128.64, 18.16) 2.16	g			0.40
Petrella 2014 Petron 2015 Rauh 2013 Rauh 2013 Sagedal 2016 Skouterls 2014 Vesco 2014 Use 2012 Cont 2010 Cont 201	Luolo	2011	-127.00 (-222.01; -31.39)	2.40
Phelan 2011 Petaton 2015 Rauh 2013 Rauh 2013 Sagedal 2018 Scutteris 2016 GMU - Diet Gamer 2007 Carent 2010 GMU - Diet Gamer 2010 Control (4807, 2017) Subtotal (I-squared = 47.6%, p = 0.018) CDM - Diet Gamer 2010 Control (4807, 2017) Control (4807, 2017) Subtotal (I-squared = 57.5%, p = 0.004) CDM - Lifestyle Yang 2014 Sinotal (I-squared = 60.0%, p = 0.004) CDM - Lifestyle Yang 2014 Sinotal (I-squared = 67.5%, p = 0.004) CDM - Lifestyle Yang 2014 Sinotal (I-squared = 67.5%, p = 0.004) CDM - Lifestyle Yang 2014 Sinotal (I-squared = 67.5%, p = 0.000) Coveral (I-squared = 6	Petrella	2014	488.00 (198.60, 777.40)	0.85
Poston 2015	Phelan	2011	43 00 (-73 82 159 82)	2 21
Positin 2015 -30.00 (+34.46; 1/4) 2.67 Ruchat 2013 -90.80 (-30.42), (10.66) 2.21 Ruchat 2016 -30.00 (+34.46; 1/4), (10.66) 2.21 Skouteris 2016 -30.00 (+34.46; 1/4), (10.66) 2.21 Skouteris 2016 -30.00 (+34.47, 20.47) 2.60 Skouteris 2016 -5.90 (+13.20, 120.20) 2.10 Subtotal (I-squared = 47.6%, p = 0.018) -107.00 (-24.03.2, 26.32) 2.00 GDM - Diet -107.00 (-24.03.2, 26.32) 2.00 Gamer 1997 -107.00 (-24.03.2, 26.32) 2.00 GOM - Metrom -107.00 (-24.03.2, 26.32) 2.00 2.00 Almuddin 2014 -107.00 (-24.03.2, 26.32) 2.00 GOM - Metrom -30.00.00 (464.62, -135.38) 1.66 Almuddin 2014 -30.00.00 (464.62, -135.38) 1.66 Shubtal (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -90.00 (-179.8, -16.21) 2.62 Yang 2014 -90.00 (-179.8, -90.01) -91.83 (-185.42, 1.77) 9.83 Subtotal (I-squared = 67.2%, p	Destan	0015		0.07
Rauh 2013 -8.00 (124.66, 108.66) 2.21 Sapedal 2016 -9.80.00 (304.20, 108.20) 1.34 Saquedal 2016 -5.90 (124.66, 108.66) 2.21 Vesco 2014 -1.94.00 (408.07, 20.07) 1.28 Subtroat -1.92.00 (20.38, 28.98) 0.33 Subtroat -1.90.00 (23.84, 94.167.50) 2.13 Subtroat -2.00.00 (0.464.62, -135.38) 1.66 Spaulonci 2013 -1.00.00 (23.84, 92.39.6) 1.53 Subtroat -2.00.00 (0.464.62, -135.38) 1.66 -3.90.00 (0.190.80, 1.29.1) 1.28 Subtroat -2.00.00 (0.00, 1.90.00, 1.90.1) 1.28 -1.90.0	Poston	2015	-30.00 (-88.47, 28.47)	2.87
Ruchat 2012 -98.00 (-304.20, 108.20) 1.33 Sagedal 2016 -39.00 (-121.59, 43.59) 2.61 Skouteris 2016 -19.00 (-408.07, 20.07) 1.28 Vesco 2014 -19.00 (-408.07, 20.07) 1.28 Subtral (1-squared = 47.6%, p = 0.018) -107.00 (-240.32, 26.32) 2.02 GDM - Diet -007.00 (-240.32, 26.32) 2.00 2.02 Garner 1997 -007.00 (-240.32, 26.32) 2.00 Zhang 2011 -007.00 (-240.32, 26.32) 2.00 Subtral (I-squared = 58.7%, p = 0.089) -017.00 (-240.32, 26.32) 2.00 GDM - Metrorm -017.00 (-240.32, 26.32) 2.00 2.02 Ainudiain 2014 -000.00 (-464.62, -195.38) 1.66 Nicomanesh 2012 -000.00 (-464.62, -195.38) 1.66 Rowan 2008 Spaulorci 2013 -000.00 (-464.62, -195.38) 1.66 Subtral (I-squared = 60.7%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -90.00 (-179.79, -16.21) 2.62 2.62 Yang 2014 -90.0	Rauh	2013	-8.00 (-124.66, 108.66)	2.21
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Sagedal 2016 Solution is 2016 Vesco 2014 Subtral (l-squared = 47.6%, p = 0.018) GDM - Diet Garen 1997 Grant 2010 Subtral (l-squared = 58.7%, p = 0.089) GDM - Metform Anuddin 2014 Niromanesh 2012 GDM - Metform Anuddin 2014 Niromanesh 2012 Termi 2013 Subtral (l-squared = 58.7%, p = 0.040) GDM - Litestyle Yang 2014 Subtral (l-squared = 67.2%, p = 0.000) Cheral (l-squared = 67.2%, p = 0.000) COveral (l-squared = 67.2%, p = 0.000) COVER Weights are from random effects analysis		2012	50.00 (004.20, 100.20)	1.04
Skouteris 2016 Vesco 2014 Subtotal (I-squared = 47.6%, p = 0.018) GDM - Diet Garner 1997 Grant 2010 Thang 2011 Subtotal (I-squared = 58.7%, p = 0.089) CDM - Metrorn Anuddin 2014 Niromanesh 2012 GDM - Metrorn Anuddin 2014 Niromanesh 2012 Ferri 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Ferri 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Niromanesh 2012 Comment 2013 Comment 2013 Comment 2014 Comment 2014 Comment 2014 Comment 2013 Comment 2014 Comment 2014 Comment 2014 Comment 2014 Comment 2013 Comment 2013 Comment 2014 Comment 2014 Comment 2014 Comment 2014 Comment 2014 Comment 2014 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Comment 2014 Comment 2013 Comment 2013 Comment 2013 Comment 2013 Comment 2014 Comment 2014 Comment 2014 Comment 2013 Comment 2013 Comment 2014 Comment 2014 Comment 2014 Comment 2014 Comment 2015 Comment 2014 Comment 2015 Comment 2015	Sagedal	2016	-39.00 (-121.59, 43.59)	2.61
Vesco 2014 -194.00 (408.07, 20.07) 1.28 Subtotal (I+squared = 47.6%, p = 0.018) -18.17 (+53.19, 26.36) 30.4 GDM - Diet -107.00 (240.32, 26.32) 2.00 Grant 2010 -206.00 (-700.98, 288.98) 0.35 Zhang 2011 -311.22 (434.94, -187.50) 2.13 Subtotal (I-squared = 57, 5%, p = 0.089) -300.00 (-464.62, -135.38) 1.66 Anuodin 2014 -300.00 (-464.62, -135.38) 1.66 Nicomanesh 2012 -100.00 (-223.96, 23.96) 2.13 Soutoral 2013 -93.89 (-307.00, 119.20) 1.28 Ferriti 2013 -93.89 (-307.00, 119.20) 1.28 Soutoral (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.66 Yang 2014 -98.00 (-179.79, -16.21) 2.66 Stabutal (I-squared = 60.0%, p = 0.004) -98.38 (-165.42, 1.77) 9.83 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.66 Yang 2013 -98.38 (-165.42, 1.77) 9.83 Stabutal (I-squared = 73.6%, p = 0.000) -71.67 (-10	Skouteris	2016	-5.90 (-132.00, 120.20)	2.10
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GDM - Diet -107.10 (-240.32, 26.32) 200 Gamer 1997 -206.00 (-700.98, 288.98) 0.33 Zhang 2011 -206.00 (-700.98, 288.98) 0.33 Subtrall (I-squared = 58.7%, p = 0.089) -210.74 (-374.77, -46.71) 4.50 GDM - Metform -000.00 (+223.61, 41.61) 2.61 Ainuddin 2014 -000.00 (+223.61, 41.61) 2.61 Spaulonci 2013 -010.00 (+22.61, 41.61) 2.61 Spaulonci 2013 -93.90 (-0179.79, -16.21) 2.62 Subtrall (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.62 Yang 2014 -98.00 (-179.79, -16.21) 2.62 Subtrall (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.62 Yang 2014 -98.00 (-179.79, -16.21) 2.62 Subtrall (I-squared = 67.2%, p = 0.000) -70.67 (-01.90, -39.43) 0.38 Chen 2006 -71.60.01 (-113.64, -238.36) 0.38 Subtrall (I-squared = 67.2%, p = 0.000) -70.67 (-101.90, -39.4	Vesco Subtotal (Leguarod -	2014 47.6% p = 0.018)	-194.00 (-408.07, 20.07)	1.28
GDM - Diet	Subiolai (i-squareu -	47.0%, p = 0.010)	-10.17 (-03.19, 20.00)	50.4
Gamer 1997 -107.00 (240.32, 26.32) 2.02 Grant 2010 -206.00 (-700.98, 288.98) 0.35 Zhang 2011 -210.74 (374.77, -46.71) 4.50 GDM - Metform -00.00 (464.62, -135.38) 1.66 Niromanesh 2012 -100.00 (423.9, 62.39, 96) 2.13 Rowan 2008 -100.00 (423.9, 62.39, 96) 2.13 Spaulonci 2013 -93.90 (307.00, 119.20) 1.26 Stotbtal (I-squared = 60.0%, p = 0.040) -91.80 (-179.79, -16.21) 2.66 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.66 Yang 2014 -98.00 (-179.79, -16.21) 2.67 Subtotal (I-squared = 60.0%, p = 0.040) -91.80 (-180.8, 139.89) 2.11 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.68 Yang 2014 -98.00 (-179.79, -16.21) 2.69 Subtotal (I-squared = 73.6%, p = 0.004) -95.93 (-501.76, -90.10) 5.76 GDM - Lifestyle -716.60 (-119.8, 4.99, -00.60) -76.77 (-101.90, -39.43) 0.00 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.68 -76.60 (-119.8, 4.99, -00.60) -76.77 (-101.90, -39.43)	GDM - Diet			
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Califier Color (10000 (120000) 0.03 Subtotal (I-squared = 58.7%, p = 0.089) -311.22 (434.94, 167.50) 2.13 GDM - Metform	Grant	2010	-206 00 (-700 08 289 08)	0.25
Zhang 2011 -311.22 (+33.49, +187.50) 2.13 Subtotal (I-squared = 58.7%, p = 0.089) -210.74 (-374.77, -46.71) 4.50 GDM - Metform			-200.00 (-700.96, 200.96)	0.35
Subtotal (I-squared = 58.7%, p = 0.089) -210.74 (-374.77, -46.71) 4.50 GDM - Metform -300.00 (-464.62, -135.38) 1.68 Niromanesh 2012 -100.00 (-223.66, 23.96) 2.13 Rowan 2008 -100.00 (-223.66, 23.96) 2.13 Bowan 2013 -100.00 (-223.66, 23.96) 2.13 Terri 2013 15.00 (-103.89, 139.89) 2.12 Subtotal (I-squared = 60.0%, p = 0.040) -91.80 (-179.79, -16.21) 2.62 GDM - Lifestyle -91.80 (-179.79, -16.21) 2.62 Yang 2013 -91.80 (-179.79, -16.21) 2.62 Subtotal (I-squared = 73.6%, p = 0.040) -91.80 (-179.79, -16.21) 2.62 Subtotal (I-squared = 73.6%, p = 0.004) -91.80 (-179.79, -16.21) 2.62 Subtotal (I-squared = 73.6%, p = 0.004) -91.80 (-179.79, -16.21) 2.62 Subtotal (I-squared = 73.6%, p = 0.004) -91.80 (-179.79, -16.21) 2.62 Chen 2006 -716.00 (-1193.64, -238.36) 0.38 Subtotal (I-squared = 73.6%, p = 0.004) -91.75 (-364.90, -30.60) 1.67 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Haise	Zhang	2011	-311.22 (-434.94, -187.50)	2.13
GDM - Metform -300.00 (-464.62, -135.38) 1.66 Niromanesh 2012 -100.00 (-223.66, 23.96) 2.13 Rowan 2008 -41.00 (-123.61, 41.61) 2.61 Spaulonci 2013 15.00 (-109.89, 139.89) 2.12 Subtotal (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -91.83 (-185.42, 1.77) 9.83 Yang 2014 -130.00 (686.64, 426.64) 0.29 Subtotal (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -91.83 (-185.42, 1.77) 9.83 Yang 2014 -91.83 (-185.42, 1.77) 9.83 Subtotal (I-squared = 67.2%, p = 0.004) -716.00 (-1193.64, 426.64) 0.29 Subtotal (I-squared = 67.2%, p = 0.004) -91.75 (-364.90, -30.60) 1.67 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) -70.67 (-101.90, -39.43) 100 NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100 <td>Subtotal (I-squared =</td> <td>58.7%, p = 0.089)</td> <td>-210.74 (-374.77, -46.71)</td> <td>4.50</td>	Subtotal (I-squared =	58.7%, p = 0.089)	-210.74 (-374.77, -46.71)	4.50
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Subtotal (I-squared = 60.0%, p = 0.040) -91.83 (-185.42, 1.77) 9.83 GDM - Lifestyle -98.00 (-179.79, -16.21) 2.62 Sun 2013 -130.00 (-686.64, 426.64) 0.22 Xie 2012 -716.00 (-1193.64, -238.36) 0.38 Chen 2006 -560.00 (-800.02, -279.98) 0.38 Zhang 2012 -197.75 (-364.90, -30.60) 1.67 Subtotal (I-squared = 73.6%, p = 0.004) -143.00 (-454.49, 168.49) 0.76 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) •70.67 (-101.90, -39.43) 100	Terrti	2013	15.00 (-109.89, 139.89)	2.12
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Charlen Lettype -98.00 (-179.79, -16.21) 2.62 Sun 2013 -130.00 (-686.64, 426.64) 0.29 Xie 2012 -716.00 (-1139.64, -238.36) 0.38 Chan 2006 -580.00 (-880.02, -279.98) 0.81 Subtal (1-59.49, -30.60) 1.67 Subtal (1-59.49, -30.60) 1.67 Subtal (1-59.49, -30.60) 1.67 Subtal (1-59.49, -30.60) 1.67 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) • -70.67 (-101.90, -39.43) 100 NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100	GDM - Lifestyle			
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Sun 2013 Xie 2012 Chen 2006 Zhang 2012 Subtotal (I-squared = 67.2%, p = 0.000) NOTE: Weights are from random effects analysis Sub Chen 2006 -13.00 (-486.04, 2426.64) 0.22 -716.00 (-1193.64, -238.36) 0.81 -97.75 (-364.90, -30.60) 1.67 -295.93 (-501.76, -90.10) 5.76 -143.00 (-454.49, 168.49) 0.76 -70.67 (-101.90, -39.43) 100	·			2.02
Xie 2012 -716.00 (-1193.64, -238.36) 0.38 Chen 2006 -550.00 (-380.02, -279.98) 0.81 Subtotal (I-squared = 73.6%, p = 0.004) -197.75 (-364.49, -33.60) 1.67 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Haise 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) Image: Control of the standysis -70.67 (-101.90, -39.43) 100	Sun	2013	-130.00 (-686.64, 426.64)	0.29
Chen 2006	Xie	2012	-716.00 (-1193.64, -238.36)	0.38
Orient 2000 580.00 (+380.02, -279.98) 0.81 Shang 2012 -197.75 (+584.89, -30.60) 1.67 Subtotal (I-squared = 73.6%, p = 0.004) -295.93 (+501.76, -90.10) 5.76 GDM - Exercise -143.00 (+454.49, 168.49) 0.76 Haise 2015 -143.00 (+454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) ♦ -70.67 (-101.90, -39.43) 100 NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100	Chan	2006	500.00 (1100.01, 200.00)	0.00
Zhang 2012 -197.75 (-364.90, -30.60) 1.67 Subtotal (I-squared = 73.6%, p = 0.004) -295.93 (-501.76, -90.10) 5.76 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) Image: Constraint of the squared square	CHELL	2000	-580.00 (-880.02, -279.98)	0.81
Subtotal (I-squared = 73.6%, p = 0.004) -295.93 (-501.76, -90.10) 5.76 GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) • -70.67 (-101.90, -39.43) 100 NOTE: Weights are from random effects analysis - - - -	Zhang	2012	-197.75 (-364.90, -30.60)	1.67
GDM - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) ♦ -70.67 (-101.90, -39.43) 100 NOTE: Weights are from random effects analysis - - - -	Subtotal (I-squared =	73.6%, p = 0.004)	-295.93 (-501.76, -90.10)	5.76
Guine - Exercise -143.00 (-454.49, 168.49) 0.76 Halse 2015 -143.00 (-454.49, 168.49) 0.76 Overall (I-squared = 67.2%, p = 0.000) Image: Construction of the squared square squar	CDM Exercise	i l		
Overall (I-squared = 67.2%, p = 0.000) -70.67 (-101.90, -39.43) 100. NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100.	Halse	2015	-143 00 (-454 49 168 49)	0.76
Overall (I-squared = 67.2%, p = 0.000) -70.67 (-101.90, -39.43) 100. NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100.			- 140.00 (~404.40, 100.49)	0.70
Overall (I-squared = 67.2%, p = 0.000) -70.67 (-101.90, -39.43) 100. NOTE: Weights are from random effects analysis -70.67 (-101.90, -39.43) 100.				
NOTE: Weights are from random effects analysis		67.2%, p = 0.000)	-70.67 (-101.90, -39.43)	100.0
	Overall (I-squared =			
	Overall (I-squared = NOTE: Weights are fr	om random effects analysis		

Fig. 2. Infant birthweight weighted mean difference meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.

Study	Year	RR (95% CI)	Weight
Diet			
Bonomo	2004	0.50 (0.22, 1.13)	2.62
Deveer	2013	0.10 (0.01, 0.75)	0.53
Walsh	2012	0.99 (0.86, 1.14)	10.69
Subtotal (I-square	ed = 74.8%, p = 0.019)	0.55 (0.22, 1.40)	13.84
Physical Activity	i		
Barakat	2016	0.39 (0.16, 0.92)	2.41
Barakat	2009	0.14 (0.02, 1.10)	0.50
Barakat	2011	0.65 (0.12, 3.63)	0.71
Barakat	2013	0.14 (0.03, 0.60)	0.97
Kong	2014	0.88 (0.32, 2.38)	1.90
Ruiz	2013	0.42 (0.20, 0.86)	3.13
Subtotal (I-square	ed = 16.3%, p = 0.309)	0.41 (0.25, 0.68)	9.62
Lifestyle			
Althuizen	2013	1.39 (0.75, 2.56)	3.98
Dodd	2015 🔶	0.81 (0.67, 0.98)	9.94
Guelinckx	2010	1.71 (0.44, 6.69)	1.09
Luoto	2011	0.85 (0.56, 1.29)	6.21
Phelan	2011	1.22 (0.66, 2.26)	3.98
Polley	2002	2.79 (0.12, 67.10)	0.22
Poston	2015	0.99 (0.77, 1.27)	8.86
Renault	2014	0.91 (0.59, 1.40)	5.90
Ruchat	2012	1.73 (0.38, 7.96)	0.89
Sagedal	2016	0.84 (0.55, 1.30)	5.92
Vesco	2014	0.48 (0.20, 1.17)	2.27
Vinter	2011	1.26 (0.88, 1.81)	7.05
Subtotal (I-square	ed = 7.4%, p = 0.373)	0.94 (0.83, 1.07)	56.31
GDM - Diet			
Garner	1997	0.86 (0.53, 1.42)	5 15
Moreno-Castilla	2013	0.20 (0.02, 1.69)	0.48
Rae	2000	1.61 (0.64, 4.08)	2.13
Subtotal (I-square	pd = 41.6%, $p = 0.180$)	0.92 (0.45, 1.89)	7.76
GDM - Metformin	i		
Niromanesh	2012	0.38 (0.10, 1.36)	1.21
Spaulonci	2013	0.14 (0.01, 2.69)	0.26
Terrti	2013	1.35 (0.75, 2.43)	4.21
Subtotal (I-square	ed = 60.5%, p = 0.080)	0.64 (0.19, 2.16)	5.68
GDM - Lifestyle			
Yang	2014	0.64 (0.44, 0.93)	6.80
-	\diamond		
	i		
Overall (I-squared	d = 46.9%, p = 0.004)	0.84 (0.73, 0.98)	100.00
NOTE: Weights ar	e from random effects analysis		
	0.00759 1 13	32	

Fig. 3. Macrosomia relative risk meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.

Meta-regression quality assessment

'High risk' of bias used a covariate had a significant negative effect on the birthweight analysis (b = -106.82, 95% CI -171.71 to -41.94, P = 0.002). No other meta-analysis effect size was significantly impacted by risk of bias.

Discussion

This review found that interventions designed to prevent excessive GWG during pregnancy had a significant impact on infant anthropometric outcomes including birthweight, macrosomia and LGA. In women without GDM, diet interventions were effective in reducing birthweight, while PA interventions reduced the risk of macrosomia. In women with GDM, both diet and 'lifestyle' interventions reduced offspring birthweight.

Results indicate that interventions delivered to the mother during the antenatal period can reduce birthweight and the risk of macrosomia and LGA. Previous research has suggested that a reduction of only 1–2 kg during pregnancy is not enough to reduce adverse pregnancy outcomes, especially in the overweight

and obese population, and hence interventions are not worthwhile.¹⁰⁴ However, this theory is not supported by the findings of this systematic review. The primary outcomes of this review showed that interventions designed to reduce GWG, were modestly successful, but only reduced GWG by 1-2 kg on average,²² which is consistent with previous systematic reviews.^{16,17,21} In juxtaposition, the infant anthropometric results of this review are contrary to some previous reviews, which suggest that there was no significant difference between infant birth weight and risk of macrosomia, when intervention and control groups were compared.^{15,17} The current review builds on the previous review as it has a more diverse sample and is tightly controlled for bias. Furthermore, results suggests that regardless of the IOM classifications of excessive GWG, interventions can reduce the risk of adverse infant anthropometric outcomes associated with excessive GWG.

Maternal diet has been shown to influence infant body composition.¹⁰⁵ Multiple methods of dietary interventions that lead to macronutrient distribution manipulation were included in this review. The success of diet interventions observed in this review are supported by findings from animal and human studies which

				%
Study	Year		RR (95% CI)	Weight
Diet		I.		
Bonomo	2004 —	• · · ·	0.43 (0.20, 0.90)	3.83
Deveer	2013		0.18 (0.04, 0.78)	1.25
Subtotal (I-square	ed = 6.6%, p = 0.301)		0.35 (0.17, 0.72)	5.08
		-		
Physical Activity		1		
Bisson	2015		1.33 (0.33, 5.33)	1.37
Nascimento	2011	•	1.05 (0.44, 2.53)	3.00
Subtotal (I-square	ed = 0.0%, p = 0.776)		1.13 (0.54, 2.36)	4.36
Lifestyle				
Dodd	2015	-	0.90 (0.76, 1.07)	12.71
Hui	2011	• ·	0.69 (0.34, 1.39)	4.18
Hui	2014		1.47 (0.44, 4.94)	1.74
Luoto	2011		0.63 (0.40, 1.01)	6.89
Poston	2015	· · · · · · · · · · · · · · · · · · ·	1.14 (0.87, 1.50)	10.53
Rauh	2013		0.79 (0.31, 1.99)	2.73
Sagedal	2016		0.63 (0.25, 1.61)	2.71
Vesco	2014	• <u> </u>	0.35 (0.13, 0.89)	2.66
Vinter	2011	· · · · · · · · · · · · · · · · · · ·	1.73 (0.94, 3,19)	5.05
Subtotal (I-square	ed = 46.6%, p = 0.059)	\diamond	0.89 (0.70, 1.13)	49.19
0.014				
GDM - Diet		-		
Moreno-Castilla	2013		0.51 (0.13, 1.95)	1.44
Hae	2000		1.19 (0.66, 2.16)	5.26
Subtotal (I-square	ed = 24.1%, p = 0.251)		0.97 (0.47, 2.00)	6.70
GDM - Metform				
Ainuddin	2014	_	0.62 (0.34, 1.15)	5.00
Niromanesh	2012	<u>+</u>	0.50 (0.29, 0.88)	5.63
Rowan	2008		1.03 (0.77, 1.39)	10.04
Terrti	2013	••	0.92 (0.49, 1.73)	4.88
Subtotal (I-square	ed = 50.9%, p = 0.106)	\triangleleft	0.77 (0.54, 1.11)	25.55
GDM - Lifestyle	0014		0.05 (0.40, 0.00)	0.40
Yang	2014		0.65 (0.46, 0.92)	9.12
Overall (I-square	d = 45.4%, p = 0.015)	\diamond	0.81 (0.68, 0.96)	100.00
NOTE: Weights a	re from random effects analysis			
	0.0424		1	
	0.0424	I	20.0	

Fig. 4. Large for gestational age relative risk meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.

suggested that manipulating the macronutrient distribution to provide a low protein diet could increase fat deposition,¹⁰⁶ predominantly centrally deposited,¹⁰⁷ which in turn can also affect an infant's body composition.^{105,108} More specifically, maternal low protein and low ratio of protein:carbohydrate diets are associated with abdominal fat deposition.¹⁰⁵ Further, maternal high polyunsaturated fat diets are associated with healthful upper thigh fat deposition.¹⁰⁵ Therefore, the results of this review support existing literature and suggest offspring of women who are at high risk of excessive GWG may benefit from maternal dietary counselling in pregnancy.

The influence of interventions on infant anthropometric outcomes in women with GDM was the most profound. Women with GDM are three times as likely to have a high birthweight infant compared with normoglycaemic mothers, due to increased insulin resistance in the mother.¹⁰⁹ The modified Penderson's hypothesis purports that the size of the infant is not directly fuel mediated, but indirectly through fetal hyperinsulinemia response which increases fat deposition.¹¹⁰ This hypothesis suggests that maternal glycaemic control is imperative to the health of the fetus and therefore the decreased risk of macrosomia and LGA may be partially explained by improved glycaemic control in the intervention groups compared with controls. The results of this study highlights the importance of maternal glycaemic and GWG control in GDM for the health of both mother and child, supporting currently primary care guidelines. Furthermore, interventions that reduce infant birthweight and risk of macrosomia and LGA, without increasing adverse outcomes such as SGA and LBW may have long term positive outcomes for the infants. Infants born macrosomic are more likely need an caesarean section delivery, suffer from birth trauma and have an increased risk of severe neonatal morbidity.¹¹¹

Strengths and limitations

A strength and novel aspect of this systematic review was the international sample of studies included. This is the first systematic review considering the infant anthropometrics of studies designed to prevent GWG that has included studies from China, largely inaccessible to those outside of China. The Chinese population contribute almost 20% of the world's population.^{112,113} Furthermore, globalization is increasing and therefore, healthcare settings and recommendations need to be applicable to a wider variety of ethnicities. A limitation of this review was the inclusion of only a small number of studies that addressed the outcomes SGA and LBW. For future studies considering the role of intervention in preventing or reducing GWG, it is recommended to report infant outcomes such as SGA and LBW. Further, the majority of studies defined macrosomia to be >4000 g. However, it has been suggested that a cut off of >4500 g may be more indicative of complications in some ethnic groups.¹¹⁴ Therefore, future studies should endeavour to use appropriate cut

Study	Year	WMD (95% CI)	% Weigh
Diet	<u>r</u>		
Bonomo	2004	0.10 (-0.32, 0.52)	7.41
Illomen	2011	-0.30 (-0.93, 0.33)	3.33
Walsh	2012	0.30 (-0.05, 0.65)	10.98
Wolff	2008	-1.00 (-2.44, 0.44)	0.63
Subtotal (I-sq	uared = 41.2%, p = 0.165)	0.03 (-0.32, 0.39)	22.36
Physical Activ	ty I		
Barakat	2014	0.20 (-0.28, 0.68)	5.77
Barakat	2016	0.20 (-0.10, 0.50)	14.07
Barakat	2009	-0.20 (-0.79, 0.39)	3.73
Barakat	2012	0.12 (-0.82, 1.06)	1.49
Dekker-Nitert	2014	0.10 (-1.23, 1.43)	0.74
Subtotal (I-sq	uared = 0.0%, p = 0.830)	0.13 (-0.09, 0.36)	25.81
Lifestyle			
Asci	2016	-0.36 (-1.12, 0.40)	2.26
Guelinckx	2010	0.60 (-0.21, 1.41)	2.00
Rauh	2013	-0.30 (-0.95, 0.35)	3.10
Ruchat	2012	0.00 (-1.27, 1.27)	0.81
Sagedal	2016	0.00 (-0.31, 0.31)	13.77
Subtotal (I-sq	uared = 0.0%, p = 0.441)	-0.02 (-0.27, 0.22)	21.94
GDM - Metfor	n l		
Niromanesh	2012	-0.70 (-1.37, -0.03)	2.93
Rowan	2008	0.00 (-0.38, 0.38)	9.16
Subtotal (I-sq	uared = 68.7%, p = 0.074)	-0.29 (-0.97, 0.38)	12.09
GDM - Lifesty	e		
Yang	2014	0.10 (-0.17, 0.37)	17.34
GDM - Exercis	e I		
Halse	2015	-0.10 (-1.78, 1.58)	0.46
Overall (I-sou	ared = 0.0% n = 0.487)	0.05 (-0.06, 0.16)	100.0
		0.03 (-0.00, 0.10)	100.0
NOTE: Weigh	s are from random effects analysis		
		I 0.44	

Fig. 5. Infant birth length weighted mean difference meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.

Study	Year	RR (95% CI)	% Weight
Physical Act	vity	1	
Barakat	2016	0.64 (0.35, 1.18)	17.53
Barakat	2009	• 0.97 (0.25, 3.74)	3.61
Cavalcante	2009 —	1.68 (0.30, 9.45)	2.20
Ruiz	2013 -	1.04 (0.60, 1.82)	21.06
Kong	2014	(Excluded)	0.00
Subtotal (I-s	quared = 0.0%, p = 0.584)	0.88 (0.60, 1.29)	44.41
Lifestyle			
Phelan	2011 —	↓ 1.04 (0.42, 2.56)	8.09
Polley	2002	0.93 (0.29, 3.03)	4.69
Poston	2015 —	• 0.85 (0.53, 1.36)	29.72
Ruchat	2012	5.11 (0.22, 121.09)	0.65
Subtotal (I-s	quared = 0.0%, p = 0.727)	0.92 (0.62, 1.35)	43.16
GDM - Lifest	vle		
Yang	2014	1.06 (0.52, 2.20)	12.44
Overall (I-so	uared = 0.0%, p = 0.901)	0.92 (0.71, 1.18)	100.00
NOTE: Weig	hts are from random effects analysis		
	0.00826	1 121	

Fig. 6. Low birth weight relative risk meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.



Fig. 7. Small for gestational age relative risk meta-analysis of randomized controlled trials designed to reduce excessive gestational weight gain.

offs for the ethnic population represented.¹¹⁵ Another limitation of this review is that n = 28 studies included in this review were considered to be 'high' risk of bias. To ensure these studies were not significantly influencing results a meta-regression was conducted with 'high-risk' as a covariate. This showed that birthweight, but no other outcome was significantly influenced. Therefore, the weighted mean difference of birthweight should be interpreted with caution. However, this highlights that research in this area need to improve reporting clarity and transparency. Not including studies with a high risk of bias would have significantly reduced the translatability of results to a global sample, as studies published in languages other than English had a higher prevalence of high risk of bias. Further, the meta-analyses show high statistical heterogeneity. However, steps were taken to account or examine the effects of this issue, for example, use of random effects model and conducting sensitivity analyses. It is recognized by the authors of this review that to blind participants in a diet, exercise or lifestyle intervention is extremely difficult. However, future studies in this area should clearly report the blinding procedure of both participants and personnel. As with any systematic review, the results of this review contain the available evidence and therefore is limited by the selection bias of the studies included.

Conclusion

Interventions designed to reduce excessive GWG produce a small reduction in infant birthweight and risk of macrosomia and LGA, without influencing birth length or risk of adverse outcomes such as LBW and SGA. Regardless of the intervention type (diet, PA or lifestyle (diet + PA)), these interventions have the potential to significantly reduce the life-long consequences of high birthweight in offspring born to women at high risk of excessive GWG and GDM. Interventions designed to reduce excessive GWG are confirmed to be an important strategy available to improve the health of the next generation.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S2040174418000879

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References

- 1. Goldstein RF, Abell SK, Ranasinha S, *et al.* Association of gestational weight gain with maternal and infant outcomes: a systematic review and meta-analysis. *JAMA*. 2017; 317, 2207–2225.
- DeVader SR, Neeley HL, Myles TD, Leet TL. Evaluation of gestational weight gain guidelines for women with normal prepregnancy body mass index. *Obstet Gynecol.* 2007; 110, 745–751.
- National Research Council. Weight Gain During Pregnancy: Reexamining the Guidelines, 2010. National Academies Press: Washington, DC.
- Deputy NP, Sharma AJ, Kim SY. Gestational weight gain United States, 2012 and 2013. Morb Mortal Wkly Rep. 2015; 64, 1215–1220.
- Mamun AA, Kinarivala M, O'Callaghan MJ, *et al.* Association of excess weight gain during pregnancy with long-term maternal overweight and obesity: evidence from 21 y postpartum follow-up. *Am J Clin Nutr.* 2010; 91, 1336–1341.

- Frederick IO, Williams MA, Sales AE, Killien M. Pre-pregnancy body mass index, gestational weight gain and other maternal characteristics in realtion to infant birth weight. *Matern Child Health J.* 2008; 12, 557–567.
- Stotland NE, Cheng YW, Hopkins LM, Caughey AB. Gestational weight gain and adverse neonatal outcome among term infants. *Obstet Gynecol.* 2006; 108, 635–643.
- Walker LO, Hoke MM, Brown A. Risk factors for excessive or inadequate gestational weight gain among Hispanic women in a US-Mexico Border State. J Obstet Gynecol Neonatal Nurs. 2009; 38, 418–429.
- Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adipositiy at age 3 years. Am J Obstet Gynecol. 2007; 196, 322.e1–322.e8.
- Wrotniak BH, Shults J, Butts S, Stettler N. Gestational weight gain and risk of overweight in the offspring at age 7y in a multicenter, multiethnic cohort study. *Am J Clin Nutr.* 2008; 87, 1818–1824.
- 11. Catalano PM, Mele L, Landon MB, *et al.* Inadequate weight gain in overweight and obese pregnant women: what is the effect on fetal growth? *Am J Obstet Gynecol.* 2014; 211, 137.e1–137.e7.
- 12. Roseboom T, de Rooij S, Painter R. The Dutch famine and its long-term consequences for adult health. *Early Hum Dev.* 2006; 82, 485–491.
- 13. Poston L. Gestational weight gain: influences on the long-term health of the child. *Curr Opin Clin Metab Care.* 2012; 15, 252–257.
- 14. Siega-Riz AM, Viswanathan M, Moos MK, *et al.* A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: birthweight, fetal growth, and postpartum weight retention. *Am J Obstet Gynecol.* 2009; 201, e1–e14.
- Muktabhant B, Lumbiganon P, Ngamjarus C, Dowswell T. Interventions for preventing excessive weight gain during pregnancy. *Cochrane Database Syst Rev.* 2012; 4, CD007145.
- Tanentsapf I, Heitmann BL, Adegboye ARA. Systematic review of clinical trials on dietary interventions to prevent excessive weight gain during pregnancy among normal weight, overweight and obese women. *BMC Pregnancy Childbirth.* 2011; 11.
- 17. Thangaratinam S, Jolly K, Glinkowski S, *et al.* Effects of interventions in pregnancy on maternal weight and obstetric outcomes: meta-analysis of randomised evidence. *BMJ.* 2012; 344, e2088.
- O'Higgins AC, Doolan A, Mullaney L, et al. The relationship between gestational weight gain and fetal growth: time to take stock? J Perinat Med. 2014; 42, 409–415.
- Pham B, Klassen TP, Lawson ML, Moher D. Language of publication restrictions in systematic reviews gave different results depending on whether the intervention was conventional or complementary. *J Clin Epidemiol.* 2005; 58, 769–776.
- Sterne JA, Gavaghan D, Egger M. Publication and related bias in metaanalysis: power of statistical tests and prevalence in the literature. *J Clin Epidemiol.* 2000; 53, 1119–1129.
- The International Weight Management in Pregnancy (i-WIP) Collaborative Group. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: metaanalysis of individual participant data from randomised trials. *BMJ*. 2017; 358, j3119.
- Walker RE, Bennett CJ, Blumfield ML, et al. Attenuating pregnancy weight gain—what works and why: a systematic review and metaanalysis. Nutrients. 2018; 10, 944.
- Higgins JPT, Green S (eds.). Chapter 7: selecting studies and collecting data. In *Cochrane Handbook for Systematic Reviews of Interventions Version 510*, 2011. Cochrane Collaboration: London.
- Higgins JPT, Green S (eds.). Chapter 8: assessing risk of bias in included studies. In *Cochrane Handbook for Systematic Reviews of Interventions Version 510*, 2011. Cochrane Collaboration: London.
- Higgins JPT, Green S (eds.). Chapter 7.7.3.8: combining groups. In Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. 2011, Cochrane Collaboration: London.
- 26. Renault KM, Nørgaard K, Nilas L, *et al.* The Treatment of Obese Pregnant Women (TOP) study: a randomized controlled trial of the effect of physical activity intervention assessed by pedometer with or without dietary intervention in obese pregnant women. *Am J Obstet Gynecol.* 2014; 210, 134.e1–134.e9.

- Guelinckx I, Devlieger R, Mullie P, Vansant G. Effect of lifestyle intervention on dietary habits, physical activity, and gestational weight gain in obese pregnant women: a randomized controlled trial. *Am J Clin Nutr.* 2010; 91, 373–380.
- Ruchat SM, Davenport MH, Giroux I, et al. Nutrition and exercise reduce excessive weight gain in normal-weight pregnant women. Med Sci Sports Exerc. 2012; 44, 1419–1426.
- Ilmonen J, Isolauri E, Poussa T, Laitinen K. Impact of dietary counselling and probiotic intervention on maternal anthropometric measurements during and after pregnancy: a randomized placebocontrolled trial. *Clin Nutr.* 2011; 30, 156–164.
- Ainuddin J, Karim N, Hasan AA, Naqvi SA. Metformin versus insulin treatment in gestational diabetes in pregnancy in a developing country: a randomized control trial. *Diabetes Res Clin Pract.* 2015; 107, 290–299.
- Bogaerts A, Devlieger R, Nuyts E, *et al.* Effects of lifestyle intervention in obese pregnant women on gestational weight gain and mental health: a randomized controlled trial. *Int J Obes.* 2013; 37(6), 814–821.
- Clapp IJF, Kim H, Burciu B, Lopez B. Beginning regular exercise in early pregnancy: effect on fetoplacental growth. *Am J Obstet Gynecol.* 2000; 183(6), 1484–1488.
- Clapp IJF, Kim H, Burciu B, et al. Continuing regular exercise during pregnancy: effect of exercise volume on fetoplacental growth. Am J Obstet Gynecol. 2002; 186(1), 142–147.
- Louie JC, Markovic TP, Perera N, *et al.* A randomized controlled trial investigating the effects of a low-glycemic index diet on pregnancy outcomes in gestational diabetes mellitus. *Diabetes Care.* 2011; 34, 2341– 2346.
- 35. Moses RG, Casey SA, Quinn EG, et al. Pregnancy and glycemic index outcomes study: effects of low glycemic index compared with conventional dietary advice on selected pregnancy outcomes. Am J Clin Nutr. 2014; 99, 517–523.
- 36. Quinlivan JA, Lam LT, Fisher J. A randomised trial of a four-step multidisciplinary approach to the antenatal care of obese pregnant women. Aust N Z J Obstet Gynaecol. 2011; 51, 141–146.
- Zhang H. Effects of individulized nutrition instruction on gestational complications and birth outcomes. *Zhejiang Preventive Medicine*. 2013; 25, 73–75.
- Grant SM, Wolever TM, O'Connor DL, Nisenbaum R, Josse RG. Effect of a low glycaemic index diet on blood glucose in women with gestational hyperglycaemia. *Diabetes Res Clin Pract.* 2011; 91, 15–22.
- 39. Markovic TP, Muirhead R, Overs S, et al. Randomized controlled trial investigating the effects of a low-glycemic index diet on pregnancy outcomes in women at high risk of gestational diabetes mellitus: the GI Baby 3 Study. *Diabetes Care.* 2016; 39, 31–38.
- 40. Rhodes ET, Pawlak DB, Takoudes TC, *et al.* Effects of a low-glycemic load diet in overweight and obese pregnant women: a pilot randomized controlled trial. *Am J Clin Nutr.* 2010; 92, 1306–1315.
- Silva JC, Pacheco C, Bizato J, *et al*. Metformin compared with glyburide for the management of gestational diabetes. *Int J Gynaecol Obstet*. 2010; 111, 37–40.
- 42. Rae A, Bond D, Evans S, *et al.* A randomised controlled trial of dietary energy restriction in the management of obese women with gestational diabetes. *Aust N Z J Obstet Gynaecol.* 2000; 40, 416–422.
- Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes.* 2002; 26, 1494– 1502.
- 44. Oostdam N, Van Poppel MNM, Wouters MGAJ, *et al.* No effect of the FitFor2 exercise programme on blood glucose, insulin sensitivity, and birthweight in pregnant women who were overweight and at risk for gestational diabetes: results of a randomised controlled trial. *BJOG.* 2012; 119(9), 1098–1107.
- 45. Thornton YS, Smarkola C, Kopacz SM, et al. Perinatal outcomes in nutritionally monitored obese pregnant women: a randomized clinical trial. J Natl Med Assoc. 2009; 101, 569–577.
- Syngelaki A, Nicolaides KH, Balani J, *et al.* Metformin versus placebo in obese pregnant women without diabetes mellitus. *N Engl J Med.* 2016; 374, 434–443.

- Brownfoot FC, Davey MA, Kornman L, Brownfoot FC. Routine weighing to reduce excessive antenatal weight gain: a randomised controlled trial. *BJOG*. 2016; 123, 254–261.
- Jeffries K, Shub A, Walker SP, Hiscock R, Permezel M. Reducing excessive weight gain in pregnancy: a randomised controlled trial. *Med J Aust.* 2009; 191, 429–433.
- Herring SJ, Cruice JF, Bennett GG, et al. Preventing excessive gestational weight gain among African American women: a randomized clinical trial. Obesity. 2016; 24(1), 30–36.
- Takeshima N, Sozu T, Tajika A, et al. Which is more generalizable, powerful and interpretable in meta-analyses, mean difference or standardized mean difference? BMC Med Res Methodol. 2014; 14, 30.
- 51. Bonomo M, Corica D, Mion E, *et al.* Evaluating the therapeutic approach in pregnancies complicated by borderline glucose intolerance: a randomized clinical trial. *Diabet Med.* 2005; 22, 1536–1541.
- 52. Deveer R, Deveer M, Akbaba E, *et al.* The effect of diet on pregnancy outcomes among pregnants with abnormal glucose challenge test. *Eur Rev Med Pharmacol Sci.* 2013; 17, 1258–1261.
- 53. Di Carlo C, Iannotti G, Sparice S, *et al.* The role of a personalized dietary intervention in managing gestational weight gain: a prospective, controlled study in a low-risk antenatal population. *Arch Gynecol Obstet.* 2014; 289, 765–770.
- Korpi-Hyovalti E, Schwab U, Laaksonen DE. Effect of intensive counselling on the quality of dietary fats in pregnant women at high risk of gestational diabetes mellitus. Br J Nutr. 2012; 108, 910–917.
- 55. Liao Q, Zhu S, Pang Y, Wei Z. The effect of individual nutrition instruction on nutritional status of pregnant women and birth outcome. *Maternal and child health care of China*. 2012; 27, 4388–4390.
- Ye L, Xu H, Ye W. Application analysis of individualized nutrition education in the prenatal follow-up of community. *Medical Innovation* of China. 2016; 13(356), 106–110.
- Walsh JM, McGowan CA, Mahony R, Foley ME, McAuliffe FM. Low glycaemic index diet in pregnancy to prevent macrosomia (ROLO study): randomised control trial. *BMJ.* 2012; 345, e5605.
- Wolff S, Legarth J, Vangsgaard K, Toubro S, Astrup A. A randomized trial of the effects of dietary counseling on gestational weight gain and glucose metabolism in obese pregnant women. *Int J Obes.* 2008; 32, 495– 501.
- 59. Barakat R, Cordero Y, Coteron J, Luaces M, Montejo R. Exercise during pregnancy improves maternal glucose screen at 24–28 weeks: a randomised controlled trial. *Br J Sports Med.* 2012; 46, 656–661.
- Barakat R, Lucia A, Ruiz JR. Resistance exercise training during pregnancy and newborn's birth size: a randomised controlled trial. *Int J Obes.* 2009; 33, 1048–1057.
- Barakat R, Pelaez M, Cordero Y, et al. Exercise during pregnancy protects against hypertension and macrosomia: randomized clinical trial. Am J Obstet Gynecol. 2016; 214, 649.e1–649.e8.
- 62. Barakat R, Pelaez M, Lopez C, Lucia A, Ruiz JR. Exercise during pregnancy and gestational diabetes-related adverse effects: a randomised controlled trial. *Br J Sports Med.* 2013; 47, 630–636.
- Barakat R, Pelaez M, Montejo R, Luaces M, Zakynthinaki M. Exercise during pregnancy improves maternal health perception: a randomized controlled trial. *Am J Obstet Gynecol.* 2011; 204(5), 402.e1–402.e7.
- Barakat R, Pelaez M, Montejo R, Refoyo I, Coteron J. Exercise throughout pregnancy does not cause preterm delivery: a randomized, controlled trial. J Phys Act Health. 2014; 11, 1012–1017.
- 65. Bisson M, Almeras N, Dufresne SS, et al. A 12-week exercise program for pregnant women with obesity to improve physical activity levels: an open randomised preliminary study. PLoS ONE. 2015; 10, e0137742.
- 66. Cavalcante SR, Cecatti JG, Pereira RI, *et al*. Water aerobics II: maternal body composition and perinatal outcomes after a program for low risk pregnant women. *Reprod Health.* 2009; 6.
- 67. Chen R, Zhang Y, Hu D, *et al.* Effect of exercise intervention on pregnancy weight gain and delivery outcomes. *Journal of Preventive Medicine Information.* 2014; 30, 739–741.
- Dekker Nitert M, Barrett HL, Denny KJ, et al. Exercise in pregnancy does not alter gestational weight gain, MCP-1 or leptin in obese women. *Aust N Z J Obstet Gynaecol.* 2015; 55, 27–33.

- 69. Garshasbi A, Faghih Zadeh S. The effect of exercise on the intensity of low back pain in pregnant women. *Int J Gynaecol Obstet.* 2005; 88, 271–275.
- Kong KL, Campbell CG, Foster RC, Peterson AD, Lanningham-Foster L. A pilot walking program promotes moderate-intensity physical activity during pregnancy. *Med Sci Sports Exerc.* 2014; 46, 462–471.
- 71. Nascimento S, Surita F, Parpinelli M, Siani S, Pinto ESJ. The effect of an antenatal physical exercise programme on maternal/perinatal outcomes and quality of life in overweight and obese pregnant women: a randomised clinical trial. *BJOG*. 2011; 118, 1455–1463.
- 72. Perales M, Cordero Y, Vargas M, Lucia A, Barakat R. Exercise and depression in overweight and obese pregnant women: a randomised controlled trial. *Arch Med Deporte*. 2015; 32, 156–163.
- 73. Ruiz JR, Perales M, Pelaez M, *et al.* Supervised exercise-based intervention to prevent excessive gestational weight gain: a randomized controlled trial. *Mayo Clinic Proc.* 2013; 88, 1388–1397.
- 74. Petrella E, Malavolti M, Bertarini V, *et al.* Gestational weight gain in overweight and obese women enrolled in a healthy lifestyle and eating habits program. *J Matern Fetal Neonatal Med.* 2014; 27, 1348–1352.
- Althuizen E, van der Wijden CL, van Mechelen W, Seidell JC, van Poppel MN. The effect of a counselling intervention on weight changes during and after pregnancy: a randomised trial. *BJOG*. 2013; 120, 92–98.
- 76. Aşcı Ö, Rathfisch G. Effect of lifestyle interventions of pregnant women on their dietary habits, lifestyle behaviors, and weight gain: a randomized controlled trial. J Health Popul Nutr. 2016; 35, 1–9.
- Dodd JM, Turnbull D, McPhee AJ, et al. Antenatal lifestyle advice for women who are overweight or obese: LIMIT randomised trial. BMJ. 2014; 348, g1285.
- Hawkins M, Hosker M, Marcus BH, et al. A pregnancy lifestyle intervention to prevent gestational diabetes risk factors in overweight Hispanic women: a feasibility randomized controlled trial. *Diabet Med.* 2015; 32(1), 108–115.
- Hui A, Back L, Ludwig S, *et al.* Lifestyle intervention on diet and exercise reduced excessive gestational weight gain in pregnant women under a randomized controlled trial. *Obstet Gynecol Surv.* 2012; 67(5), 263–264.
- 80. Hui AL, Back L, Ludwig S, et al. Effects of lifestyle intervention on dietary intake, physical activity level, and gestational weight gain in pregnant women with different pre-pregnancy body mass index in a randomized control trial. BMC Pregnancy Childbirth. 2014; 14, 331.
- Liang K, Wei X, Yang Y, Wang J, Sun L. The study of preventing excessive weight gain during pregnancy through dietary lifestyle counselling. *Prog Obstet Gynecol.* 2010; 19, 358–361.
- Luoto RM, Kinnunen TI, Aittasalo M, *et al.* Prevention of gestational diabetes mellitus and large-for-gestational age newborns by lifestyle conseling: a cluster-randomized controlled trial. *PLoS ONE.* 2011; 8, e1001036.
- Phelan S, Phipps MG, Abrams B, *et al.* Randomized trial of a behavioral intervention to prevent excessive gestational weight gain: the Fit for Delivery Study. *Am J Clin Nutr.* 2011; 93, 772–779.
- Poston L, Bell R, Croker H, et al. Effect of a behavioural intervention in obese pregnant women (the UPBEAT study): a multicentre, randomised controlled trial. Lancet Diabetes Endocrinol. 2015; 3, 767–777.
- Rauh K, Gabriel E, Kerschbaum E, *et al.* Safety and efficacy of a lifestyle intervention for pregnant women to prevent excessive maternal weight gain: a cluster-randomized controlled trial. *BMC Pregnancy Childbirth*. 2013; 13, 151.
- Sagedal LR, Øverby NC, Bere E, *et al.* Lifestyle intervention to limit gestational weight gain: the Norwegian Fit for Delivery randomised controlled trial. *BJOG.* 2017; 124, 97–109.
- Skouteris H, McPhie S, Hill B, *et al.* Health coaching to prevent excessive gestational weight gain: a randomized-controlled trial. *Br J Health Psychol.* 2016; 21, 31–51.
- Vesco KK, Karanja N, King JC, *et al.* Efficacy of a group-based dietary intervention for limiting gestational weight gain among obese women: a randomized trial. *Obesity.* 2014; 22, 1989–1996.
- Vinter CA, Jensen DM, Ovesen PG, Beck-Nielsen H, Jørgensen JO. Lifestyle and pregnancy (LIP) study: the clinical effect of lifestyle intervention during pregnancy in obese women. *Diabetes Care.* 2011; 34, 2502–2507.

- Garner P, Okun N, Keely E, et al. A randomized controlled trial of strict glycemic control and tertiary level obstetric care versus routine obstetric care in the management of gestational diabetes: a pilot study. Am J Obstet Gynecol. 1997; 177, 190–195.
- 91. Moreno-Castilla C, Hernandez M, Bergua M, *et al.* Low-carbohydrate diet for the treatment of gestational diabetes mellitus: a randomized controlled trial. *Diabetes Care.* 2013; 36, 2233–2238.
- Zhang X. Effect of medical nutritional thrapy on perinatal outcome of patients with gestational diabetes mellitus. *Matern Child Health Care China.* 2011; 26, 5501–5503.
- 93. Niromanesh S, Alavi A, Sharbaf FR, et al. Metformin compared with insulin in the management of gestational diabetes mellitus: a randomized clinical trial. Diabetes Res Clin Pract. 2012; 98, 422–429.
- Rowan JA, Hague WM, Gao W, Battin MR, Moore MP. Metformin versus insulin for the treatment of gestational diabetes. N Engl J Med. 2008; 358, 2003–2015.
- Spaulonci CP, Bernardes LS, Trindade TC, Zugaib M, Francisco RPV. Randomized trial of metformin vs insulin in the management of gestational diabetes. *Am J Obstet Gynecol.* 2013; 209(1), 34.e1–34.e7.
- Tertti K, Ekblad U, Koskinen P, Vahlberg T, Rönnemaa T. Metformin vs. insulin in gestational diabetes. A randomized study characterizing metformin patients needing additional insulin. *Diabetes Obes Metab.* 2013; 15, 246–251.
- Sun K, Chen M, Liang L. Influence of foods exchange portion of dietary intervention based on glycemic load concept on pregnant women with gestational diabetes. *Chinese Nurs Res.* 2013; 27, 3862–3864.
- Xie D. Effects of individualized nutrition therapy and education intervention on treatment of gestational diabetes in pregnant women. *China Health Care Nutr.* 2012; 22, 1616–1617.
- 99. Yang X, Tian H, Zhang F, *et al.* A randomised translational trial of lifestyle intervention using a 3-tier shared care approach on pregnancy outcomes in Chinese women with gestational diabetes mellitus but without diabetes. *J Transl Med.* 2014; **12**, 290.
- Zhang H, Yang Z. Effect analysis of personal medical nutrition therapy combined with exercise therapy for gestational diabetes mellitus. *Jinlin Med J.* 2012; 33(16), 3369–3372.
- Chen Y, Fang Y, Zhen X. The significance of individualized nutrition therapy on gestational diabetes mellitus. *Hainan Med J.* 2006; 17(08), 72–73.
- 102. Halse RE, Wallman KE, Dimmock JA, Newnham JP, Guelfi KJ. Homebased exercise improves fitness and exercise attitude and intention in women with GDM. *Med Sci Sports Exerc.* 2015; 47(8), 1698–1704.

- 103. Jie SQ, Liang X, Hong P, Wu D, Ke WL. Application of seamless care service with multidisciplinary diagnosis and treatment in patients with gestational diabetes. *Int J Clin Exp Med.* 2015; 8(9), 16688–16693.
- 104. Oteng-Ntim E, Tezcan B, Seed P, Poston L, Doyle P. Lifestyle interventions for obese and overweight pregnant women to improve pregnancy outcome: a systematic review and meta-analysis. *Lancet.* 2015; 386, S61.
- 105. Blumfield ML, Hure AJ, MacDonald-Wicks LK, et al. Dietary balance during pregnancy is associated with fetal adiposity and fat distribution. Am J Clin Nutr. 2012; 96, 1032–1041.
- 106. Rehfeldt C, Lang IS, Gors S, *et al.* Limited and excess dietary protein during gestation affects growth and compositional traits in gilts and impairs offspring fetal growth. *J Anim Sci.* 2011; 89, 329–341.
- Langley-Evans SC. Nutritional programming of disease: unravelling the mechanism. J Anat. 2009; 215, 36–51.
- Blumfield ML, Collins CE. High-protein diets during pregnancy: healthful or harmful for offspring? Am J Clin Nutr. 2014; 100, 993–995.
- 109. Kc K, Shakya S, Zhang H. Gestational diabetes mellitus and macrosomia: a literature review. Ann Nutr Metab. 2015; 66(Suppl. 2), 14–20.
- Kamana KC, Shakya S, Zhang H. Gestational diabetes mellitus and macrosomia: a literature review. *Ann Nutr Metab.* 2015; 66(Suppl. 2), 14–20.
- 111. Khambalia AZ, Algert CS, Bowen JR, Collie RJ, Roberts CL. Long-term outcomes for large for gestational age infants born at term. *J Paediatr Child Health.* 2017; 53, 876–881.
- 112. The World Bank. Population, total [cited 2017 Oct 12]. Retrieved 12 October 2017 from https://data.worldbank.org/indicator/SP.POP.TOTL? page=2.
- The World Bank. Population, total: China [cited 2017 Oct 12]. Retrieved
 October 2017 from https://data.worldbank.org/indicator/SP.POP. TOTL?locations=CN&page=2.
- 114. Ye J, Torloni MR, Ota E, *et al.* Searching for the definition of macrosomia through an outcome-based approach in low- and middle-income countries: a secondary analysis of the WHO Global Survey in Africa, Asia and Latin America. *BMC Pregnancy Childbirth.* 2015; 15, 324.
- 115. Pasupathy D, McCowan LM, Poston L, et al. Perinatal outcomes in large infants using customised birthweight centiles and conventional measures of high birthweight. *Paediatr Perinat Epidemiol*. 2012; 26, 543–552.