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**Behavioural weight management interventions for postnatal women: a systematic review of systematic reviews of randomised controlled trials**

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1 **Summary**

2 This systematic review of systematic reviews investigated the effectiveness of lifestyle  
3 weight management interventions for postnatal women. We systematically reviewed Medline  
4 (PubMed), Embase, CINAHL Plus, The Cochrane Library and Scopus from 2000 until  
5 January 2018, to identify systematic reviews of randomised controlled trials that evaluated  
6 the effectiveness of behavioural lifestyle interventions for weight management in postnatal  
7 women. Results were summarised both descriptively and statistically using a mega meta-  
8 analysis of data from randomised controlled trials included in previous systematic reviews.  
9 Nine systematic reviews met our inclusion criteria. Overall the reviews concluded that  
10 lifestyle interventions involving physical activity and/or dietary changes resulted in a  
11 reduction in postnatal weight. Results from the overall mega meta-analysis confirmed this  
12 finding with a mean difference of -1.7kg (95% CI -2.3, -1.1). Findings for subgroup analyses  
13 gave mean differences of -1.9kg (95% CI -2.9, -1.0) for combined diet and physical activity  
14 interventions, -1.6kg (95% CI -2.1, -1.2) for physical activity only interventions, and -9.3kg  
15 (95% CI -16.5, -2.1) for diet only interventions (one study). Heterogeneity varied from 0% to  
16 68%. Interventions involving lifestyle interventions appeared to be effective in reducing  
17 weight in postnatal women, although these findings should be interpreted with some caution  
18 due to statistical heterogeneity.

19 **Introduction**

20 Obesity is a key contributor to many chronic co-morbidities including type 2 diabetes,  
21 cardiovascular disease (1), stroke, as well as a number of types of cancers such as colorectal  
22 and breast cancer (1-3). These conditions can be life threatening, detrimental to quality of life  
23 and expensive to treat.

24 The obesity epidemic is affecting all populations, including women of reproductive age.  
25 Recent national surveys reported that approximately 66%, 56% and 58% of women in the

26 United States of America, Australia and England, respectively either have overweight (body  
27 mass index (BMI) between 25-30kg/m<sup>2</sup>) or obesity (BMI over 30kg/m<sup>2</sup>) (4-6). This means  
28 that most women already have overweight when they become pregnant. A period of notable  
29 weight gain for many women occurs during and after pregnancy (7, 8). Studies have reported  
30 that among women who have a healthy BMI prior to pregnancy, 30% have overweight one  
31 year after giving birth (9, 10). Of women who have overweight prior to conception, 44% have  
32 obesity 1 year after giving birth, while 97% of women with obesity prior to pregnancy remain  
33 so at 1 year postnatally. On average women gain about 14-15kg during pregnancy and at 1  
34 year after birth 5-9kg is retained (8, 11). Some women are able to return to their pre-  
35 pregnancy weight after childbirth, but the amount of weight women retain postnatally varies  
36 considerably and many women never lose all of the weight gained during pregnancy (11, 12-  
37 15).

38 The weight gained, and then retained after pregnancy, tends to be centrally located on the  
39 body, which is an independent risk factor for the development of cardio-metabolic diseases  
40 such as diabetes and coronary artery disease (16, 17). Additionally, women are at risk of  
41 gaining more weight during each successive pregnancy, increasing their likelihood of  
42 complications during any future pregnancies, as well as developing obesity in later life (13,  
43 18-19). Evidence also shows an association between postnatal weight and poor mental  
44 health, which may adversely affect the behaviour and the family as a whole (20-22). This  
45 highlights the need for low cost and acceptable interventions to be designed and tested to help  
46 women successfully lose and manage their weight after giving birth. It is not clear which  
47 behavioural intervention approaches might be most successful in helping women lose weight,  
48 although in non-pregnant population strategies such as goal setting, self-monitoring of  
49 weight, calorie counting, attending a commercial weight loss programme, support from a  
50 dietician and physical activity have evidence of effectiveness (23, 24).

51 *Objective*

52 Many studies, using a variety of methodological designs, have tested a range of weight-loss  
53 interventions during the postnatal period (9, 25). Many of these studies have since been  
54 included in systematic reviews of interventions for postnatal weight management. The  
55 purpose of this systematic review is to both descriptively and statistically (using a mega  
56 meta-analysis) summarise the findings of systematic reviews of randomised controlled trials  
57 (RCTs) that have examined the effectiveness of behavioural lifestyle interventions for weight  
58 loss in postnatal women.

59 The aim was to determine whether lifestyle interventions have been successful in helping  
60 women lose weight, and if data allow, to further identify which types of interventions have  
61 been successful. When several systematic reviews have performed a meta-analysis, a mega  
62 meta-analysis is useful because it provides a comprehensive statistical summary of all the  
63 evidence. A mega meta-analysis is also useful when previous systematic reviews have not  
64 been able to perform meta-analysis or subgroup analyses because of a lack of trials. The  
65 results of this systematic review of systematic reviews will help to provide direction and  
66 context for the design of future weight management interventions for postnatal women and  
67 will contribute to the evidence base for the development of clinical guidelines.

68 **Methods**

69 The protocol for this systematic review of systematic reviews was registered in 2017 in the  
70 International Prospective Register of Systematic Reviews (PROSPERO), trial registration  
71 number CRD42017072475.

72 *Information sources, search strategy and eligibility criteria for systematic reviews*

73 A comprehensive systematic search of the literature was conducted using the following  
74 databases: MEDLINE (PubMed), Embase, CINAHL Plus, The Cochrane Library and Scopus.

75 The search terms used included postnatal, obesity, BMI, diet therapy, physical activity

76 therapy, body weight, systematic reviews, meta-analyses and derivatives of these search  
77 terms. A sample search strategy is shown in the Supplementary Information. Databases were  
78 searched from January 2000 to January 2018. We applied this date restriction as it coincided  
79 with the introduction of better reporting standards for research, particularly for RCTs and  
80 systematic reviews. The criteria for the inclusion and exclusion of systematic reviews are  
81 shown in Table 1. In summary, to be eligible for inclusion, systematic reviews had to include  
82 RCTs and/or quasi RCTs that had assessed the effectiveness of behavioural lifestyle weight  
83 management interventions, namely diet and physical activity interventions or a combination  
84 of these, in any format, context and setting, and against any comparator. A wide range of  
85 definitions are typically used when referring to the postnatal period, but for the purpose of  
86 this systematic review of systematic reviews the postnatal period is defined as used by the  
87 authors of the included systematic reviews, which typically starts immediately after childbirth  
88 and lasts until 2-3 years after giving birth.

#### 89 *Screening and data extraction*

90 The titles and abstracts of potentially eligible systematic reviews were screened by two  
91 independent researchers (JAF, HMP or AJD). When insufficient information was available  
92 from the title or abstract, full-text articles were retrieved and considered for inclusion. The  
93 full-text articles of potentially eligible systematic reviews were further screened for eligibility  
94 by two independent reviewers (JAF and either HMP or AJD) with any disagreements  
95 discussed with a third reviewer until consensus reached. Two reviewers independently  
96 extracted data from the eligible systematic reviews (JAF and either HMP or AJD) and any  
97 disagreements were discussed with a third reviewer until consensus reached. Data extracted  
98 for the systematic reviews included author and year of publication, dates of literature search  
99 for studies included in the review, participant inclusion criteria, intervention and comparator  
100 inclusion criteria, description of studies included in the review, results of any meta-analyses  
101 performed, main conclusions of review and any additional comments.

102 *Quality assessment of systematic reviews*

103 The AMSTAR tool (26) was used to assess the quality of the included systematic reviews.  
104 This was performed independently by two reviewers (JAF, HMP or AJD) and any  
105 disagreements were discussed with a third reviewer until consensus reached. A third reviewer  
106 was consulted on two occasions to discuss the scoring of some points on the AMSTAR tool.

107 *Mega meta-analysis*

108 We aimed to statistically summarise weight change data reported in the original RCTs within  
109 the included systematic reviews.

110 For inclusion in the mega meta-analysis, RCTs within the included systematic reviews had to  
111 have reported data on body weight in a format that would allow us to perform statistical  
112 synthesis. We excluded RCTs that only reported comparisons between two types of diet  
113 and/or two physical activity interventions. Trials that had recruited women antenatally, but  
114 then offered an intervention postnatally, or which tested interventions that took place both  
115 antenatally and postnatally were eligible for inclusion in the mega meta-analysis as long as a  
116 postnatal weight had been reported at baseline as well as at follow up (baseline weight used  
117 in mega meta-analysis was first reported postnatal weight). Studies that were included in  
118 previous systematic reviews that were not RCTs were excluded from the mega meta-analysis.  
119 In addition, we excluded interventions shorter than three weeks as these are unlikely to have  
120 any longer term impact on weight.

121 Data were extracted by two independent reviewers (HMP and JAF) with any disagreements  
122 referred to a third reviewer (AJD). Review Manager, version 5.3 (27) was used to statistically  
123 summarise data from RCTs across all included systematic reviews. Data regarding weight  
124 change was summarised using mean difference in weight in kilograms. If this was presented  
125 using other metrics, a conversion calculation into kilograms was performed. When trials

126 within reviews only published baseline and follow-up weight data, a weight change calculator  
127 (28) was used to calculate the weight change and the associated standard deviations.

128 We expected some heterogeneity due to the variability in the type of interventions tested in  
129 RCTs, therefore a random effects model was used in the mega meta-analyses. The  $I^2$  value  
130 was calculated as a measure of heterogeneity (29, 30). Subgroup analyses were performed to  
131 compare the type of lifestyle intervention (diet only, physical activity only or diet and  
132 physical activity), intervention duration ((3-12 weeks or > 12 weeks) and length of follow up  
133 ( $\leq$  12 weeks, 13 weeks–6 months and > 6 months)). The threshold of 12 weeks was chosen  
134 for intervention duration as this is the typical timespan used in lifestyle interventions. The  
135 effect of lifestyle interventions in women with or without a history of gestational diabetes  
136 mellitus (GDM) was also assessed.

137 A funnel plot was conducted to investigate the possibility of publication bias due to sample  
138 size.

## 139 **Results**

140 The searches identified 1291 potentially eligible articles. After the removal of duplicates and  
141 screening, nine systematic reviews of RCTs were eligible for inclusion in the systematic  
142 review of reviews (see PRISMA flow diagram in Figure 1). Further details of the full papers  
143 excluded and reasons for their exclusion are summarised in Table S1.

### 144 *Description of included systematic reviews*

145 The characteristics of the nine included systematic reviews are summarised in Table 2 and  
146 described below. The reviews were published between 2008 and 2017 and included RCTs  
147 with publication dates between 1994 and 2016. The majority of trials in the systematic  
148 reviews were conducted in the USA, with the remaining trials conducted in Australia,  
149 Canada, Greece, Iran, Japan, Malaysia, Sweden, Taiwan and Thailand (Table 2 and Table

150 S2). All of the included systematic reviews scored as either medium or high quality, except  
151 for the review by Kuhlman et al. (31) which was also the oldest included systematic review  
152 (details of the AMSTAR scoring for each included systematic review are listed in Table S3).

153 Seven of the nine systematic reviews had performed meta-analyses (32-38), while two  
154 reported only a narrative synthesis (31, 39). No systematic review included exactly the same  
155 RCTs. Each systematic review included between two and 33 RCTs, and there was overlap in  
156 the RCTs included (see Table S2). Twenty-two RCTs were included in more than one  
157 systematic review. Overall, there were 48 unique RCTs in the nine included systematic  
158 reviews. The definition of the postnatal period also varied between systematic reviews. Three  
159 defined this as up to 12 months after childbirth (32, 34, 38), one up to 18 months (36), one up  
160 to 24 months (36). The remaining four systematic reviews stated that they included studies  
161 with postnatal women, but did not define the postnatal period (31, 33, 37, 39).

162 Two of the systematic reviews placed no restrictions on the type of postnatal women they  
163 included from studies (34, 35). However, three reviews included only women who either  
164 have overweight and/ or have obesity (33, 36, 38), one systematic review only included  
165 women with a history of gestational diabetes (39) and one included only healthy women (32).  
166 Two did not report if they placed any restrictions on the type of postnatal women they would  
167 include (31, 37).

168 The scope of the included systematic reviews varied. Five of the reviews included studies that  
169 investigated the effectiveness of lifestyle interventions both during pregnancy and the  
170 postnatal period (31-33, 37, 38). However, as the review authors performed analyses for these  
171 populations separately, they were eligible for inclusion in this review of reviews. Two  
172 reviews focused exclusively on e-health technology interventions (37, 38). One review  
173 restricted its inclusion criteria to physical activity only interventions (32) while one focused  
174 on postnatal lifestyle interventions to prevent type 2 diabetes (39). The remaining five

175 systematic reviews focused on different diet and physical activity modification interventions  
176 (31, 33-36) (see Table 2).

### 177 *Mega meta-analysis of weight data*

178 While there were 48 unique RCTs included in the systematic reviews, 13 did not report  
179 weight-related data, therefore only 35 of these were considered potentially eligible for  
180 inclusion in the mega meta-analysis. However, two were published in Chinese (40, 41) and  
181 therefore excluded. This meant 33 unique trials were eligible for inclusion in the meta-  
182 analysis. In addition to the above exclusion, a further 11 RCTs were excluded from the mega  
183 meta-analysis, mostly due to a lack of useable reported weight data (other reasons for  
184 exclusion are given in Table S4).

185 All the included RCTs reported that they objectively assessed weight, except for the RCT by  
186 Youngwanichsetha et al. (42), which did not clearly state that weight-related data were  
187 objectively collected. Therefore the mega meta-analysis included data from 22 unique RCTs  
188 and 1553 postnatal women and demonstrated that overall women randomised to a lifestyle  
189 intervention had significantly lower body weight at last follow up than comparators (mean  
190 difference of -1.7kg (95% CI -2.3, -1.1) (Figure 2).

191 Most RCTs included in the reviews did not report data by weight status and those that did  
192 reported it inconsistently or in a format that could not be used in the mega meta-analysis,  
193 therefore a sub-group analysis on the basis of weight status was not possible.

### 194 Subgroup analyses

#### 195 *Intervention type (Figure 2)*

196 When analyses were restricted to combined physical activity and diet interventions trials the  
197 mean change in weight was -1.9kg (95% CI -2.9, -1.0,  $P < 0.01$ ,  $I^2 = 62\%$ , 16 comparisons)  
198 relative to comparators. Analysis of physical activity only interventions resulted in a weight

199 change of -1.6kg (95% CI -2.1, -1.2,  $P<0.01$ , 9 comparisons) relative to comparators and no  
200 heterogeneity ( $I^2=0\%$ ). There was only one study in the diet only subgroup analysis (43) and  
201 this showed that the dietary intervention significantly reduced postnatal weight (MD = -9.3kg  
202 (95% CI -16.5, -2.1,  $P=0.01$ ) relative to comparators.

### 203 *Intervention duration (Figure 3)*

204 The mean weight change for participants who received interventions of between 3-12 weeks  
205 duration was -2.6kg lower than the comparator group (95% CI -3.6, -1.6,  $P<0.01$ ,  $I^2=68\%$ , 12  
206 comparisons). In the analysis where only trials greater than 12 weeks duration were included,  
207 participants who received an intervention were 1.5kg lighter than comparators at follow up  
208 (95% CI -2.5, -0.6,  $P=0.002$ ,  $I^2=24\%$ , 12 comparisons).

### 209 *History of GDM (Figure 4)*

210 When analysis was restricted to trials that had included only women without a history of  
211 GDM the intervention group lost 1.8kg more than comparators at follow up (95% CI -2.5, -  
212 1.1,  $P<0.01$  and  $I^2=54\%$ , 21 comparisons). When the analyses were repeated for women with  
213 a history of GDM participants who received an intervention were 1.6kg lighter than  
214 comparators at follow up (95% CI -2.9, -0.2,  $P=0.02$ ,  $I^2=17\%$ , 5 comparisons).

### 215 *Length of follow up (Figure 5)*

216 The mean weight change for participants at follow up 12 weeks or less was -2.0kg lower than  
217 the comparator group (95% CI -2.8, -1.1,  $P<0.01$ ,  $I^2=54\%$ , 8 comparisons). At follow up  
218 between 13 weeks and six months, participants who received an intervention were 1.5kg  
219 lighter than comparators at follow up (95% CI -2.6, -0.4,  $P=0.006$ ,  $I^2=24\%$ , 10 comparisons),  
220 while at more than six months follow up, participants who received an intervention were  
221 1.9kg lighter than comparators at follow up (95% CI -3.4, -0.5,  $P=0.01$ ,  $I^2=56\%$ , 8  
222 comparisons).

223 The funnel plot (Figure S1) displayed some asymmetry, suggesting the possibility of some  
224 bias, due to a lack of published studies with larger sample sizes.

## 225 **Discussion**

226 This systematic review of systematic reviews of RCTs has comprehensively and  
227 systematically synthesised both descriptive and statistical evidence of the effects of lifestyle  
228 interventions for postnatal weight management for the first time. Nine systematic reviews  
229 that had included RCTs were eligible for inclusion in this review of reviews. Overall these  
230 reviews concluded that lifestyle interventions were effective in reducing weight in postnatal  
231 women. Based on the current available evidence, pooled results in our mega meta-analysis  
232 also showed that lifestyle interventions significantly reduced weight in postnatal women by -  
233 1.7kg (95% CI -2.3, -1.1) relative to comparators at follow up. Interventions that involved  
234 both diet and physical activity interventions, physical activity alone and dietary interventions  
235 alone were all effective, relative to comparators, although there was only one trial in the diet  
236 only analysis. In women with a history of GDM postnatal weight was -1.6kg (95% CI -2.9, -  
237 0.2) lower than comparators, and lifestyle interventions appeared as effective in women with  
238 and without a history of GDM (1.6kg versus 1.8kg respectively). Interventions of shorter  
239 duration (3-12 weeks) appeared to be more effective in reducing postnatal weight than longer  
240 interventions, although this may be the result of recidivism where it becomes harder to lose  
241 and maintain weight over time in longer interventions and which therefore have longer follow  
242 up assessments. The AMSTAR scores for the systematic reviews increased in line with the  
243 year of publication and coincided with the transition of QUORUM (44) to PRISMA (45) and  
244 requirements from journals for better reporting of trials and systematic reviews (46).

### 245 *Comparison with the literature*

246 Despite some variation in the inclusion and exclusion criteria adopted by the nine included  
247 systematic reviews, all reviews reported that lifestyle interventions reduced postnatal weight.

248 This is consistent with the findings of reviews involving other adult populations (47). The  
249 mega meta-analysis showed that lifestyle interventions to date have been moderately  
250 effective in helping women lose about 1.7kg of weight in the postnatal period, but weight loss  
251 does not have to be large to be important for health. This reduction in weight is similar to that  
252 reported by several of the meta-analyses reported in the included systematic reviews,  
253 demonstrating consistency of results (32, 33, 36). Clinical guidance from the National  
254 Institute for Health and Care Excellence (NICE) in England suggests that weight loss of  
255 approximately 2kg is clinically important for health (48) and can contribute towards an  
256 effective reduction in the risk of cardiovascular disease and type II diabetes mellitus (49).  
257 Modelling has also shown that even if a small amount of weight is lost, this weight loss  
258 remains cost effective if the weight regained occurs on a lower weight trajectory (50).  
259 Furthermore, as the relationship between obesity and mortality is linear even small amounts  
260 of weight loss may be clinically important (49, 51, 52).

261 It is important to set the results of this study in context with other types of weight loss  
262 interventions that postnatal women may choose to use. Evidence suggests that commercial  
263 weight loss programmes are an effective intervention for weight loss and people attending  
264 these types of programmes will lose on average about 5kg (24), which is substantially higher  
265 than our pooled estimate here (-1.7kg).

266 Three trials in the mega meta-analysis reported weight loss (relative to comparators) of the  
267 same magnitude or greater than reported for commercial weight loss programmes (43, 53,  
268 54), but these trials all involved very intensive and expensive interventions that would be  
269 difficult for health care services to fund for the large number of women who need to lose  
270 weight after having a baby. The study by O'Toole et al. (53) involved an individually  
271 structured diet and physical activity intervention developed by a dietician and a physiologist.  
272 Participants were asked to record their daily food consumption in a food diary and attended

273 weekly group sessions for the first 12 weeks, then once every two weeks for two months and  
274 then once a month until one year postnatal. The other two trials with weight loss greater than  
275 4.5kg in the mega meta-analysis (43, 54) also involved intensive and/or lengthy interventions  
276 involving behaviour modification counselling, motivational interviewing or specialised  
277 dietetic support, none of which can be easily implemented at a population or community  
278 health level. Additionally, all three of the trials reporting effects greater than 4.5kg  
279 randomised very small numbers of participants (ranged from 23-57 participants) (43, 53, 54)  
280 and their estimates may therefore be susceptible to bias.

281 Taken together this raises the question of whether it might be more useful to refer or  
282 encourage postnatal women, who wish to lose weight, to a commercial weight loss  
283 programme since this may be more effective and provision is already in place for women to  
284 attend such programmes, both during and after pregnancy. Some even promote their  
285 programme as being suitable for all, including pregnant and breastfeeding women (55) or  
286 from six weeks after childbirth (56). Furthermore, a very recent trial in the UK (23) found  
287 that referral of adult patients with obesity to commercial weight management programmes by  
288 family doctors during routine consultations can be an effective weight loss intervention.  
289 Nevertheless, postnatal women are a unique subgroup of the population with many  
290 challenges and barriers that may impact their ability to consistently attend commercial weight  
291 loss programmes, for example, availability of childcare, child feeding and sleeping patterns.  
292 Future research should address this question.

293 Research evidence has been inconsistent on the preference of postnatal women for different  
294 types of weight management interventions with some reporting that women prefer to attend  
295 group-based sessions (57, 58), while others found that home-based interventions are preferred  
296 due to issues such as time constraints, convenience and childcare requirements (59, 60). A  
297 recent systematic review that compared self-help interventions (such as printed materials,

298 internet, mobile phone apps, etc.) with controls in general populations reported a significant  
299 effect favouring the interventions at six months follow up (-1.9kg (95% CI -2.9, -0.8)) (61).  
300 Self-help interventions are attractive because they are low cost, varied, flexible and can be  
301 tailored to the specific needs of the individual. Given many postnatal women might find it  
302 difficult to attend more formal weight loss programmes and some have expressed a  
303 preference for home-based programmes, self-help interventions for postnatal weight loss are  
304 worthy of consideration. Particularly as the effect estimate (-1.9kg (95% CI -2.9, -0.8)) in  
305 self-help interventions is similar to the result in our mega meta-analysis (-1.7kg (95% CI -2.3,  
306 -1.1), in which the interventions tested, typically, involved professional support and/or more  
307 resource intensive interventions than self-help interventions.

#### 308 *Physical activity and diet only interventions*

309 Our findings showed that both physical activity and diet only interventions can be effective in  
310 reducing weight in postnatal women. Only one trial that recruited a small sample was  
311 eligible for inclusion in the diet only analysis highlighting the need for more studies on this  
312 question in this population of women. The recent scientific report and systematic review by  
313 the American Physical Activity Guidelines Committee concluded that there was insufficient  
314 evidence to determine whether physical activity is associated with weight loss during  
315 postnatal period. Our systematic review provides an up to date summary of the current  
316 evidence by concluding physical activity interventions can play a role in reducing weight  
317 after childbirth (-1.6 kg), relative to comparator groups (62).

#### 318 *Strengths and limitations*

319 This review has a number of strengths and limitations that need to be considered when  
320 interpreting the findings. Our review focused only on systematic reviews that had included  
321 RCTs in order to summarise high quality evidence. Drawing together these findings in one  
322 place has generated a comprehensive evidence-based review of the effectiveness of lifestyle

323 interventions for postnatal women. Data from this systematic review of systematic reviews  
324 can be used to guide the development and design of future interventions in this population, as  
325 well as future health policy for postnatal women. By performing a mega meta-analysis of  
326 previous meta-analyses, we have provided a quantitative estimate of the amount of weight  
327 loss that can be obtained from behavioural lifestyle interventions for weight loss in this  
328 population of women.

329 A limitation of some of the trials included in the individual systematic reviews was the broad  
330 range in the number of months postnatal women could be to meet the systematic review  
331 inclusion criteria. It was therefore not possible to determine the effect of the intervention in  
332 relation to the time it was initiated during the postnatal period. We excluded unpublished  
333 systematic reviews and we did not search grey literature. We were unable to include one  
334 systematic review (63) due to a lack of clarity regarding the inclusion and exclusion criteria  
335 and the authors did not respond to our request for more information.

336 Most of the trials within the included systematic reviews were conducted in America and  
337 most participants were of white ethnicity, so the findings from the systematic reviews, and by  
338 implication our findings, may not be generalisable to other ethnic groups. We did not contact  
339 study authors of RCTs where there was unusable weight data because most were more than  
340 five years old. As expected there was some overlap of trials between the nine included  
341 systematic reviews. However, this is a particular advantage of performing a mega meta-  
342 analysis since each trial only contributes once to the overall pooled findings. In the overall  
343 pooled estimate there was a moderate level of heterogeneity which is likely to be the result of  
344 the variation in the types/content of interventions (64). This heterogeneity was only partially  
345 resolved by subgroup analyses.

346 There were limited data (one small trial) on diet only interventions and this remains an  
347 important avenue for future research. The most recent RCT included in any systematic review

348 was published in 2015, highlighting the need now for more trials to test the feasibility and  
349 effectiveness of novel lifestyle interventions for weight loss in postnatal women. Bias was  
350 considered with the aid of a funnel plot (Figure S1). The asymmetry of the funnel plot  
351 suggests the possibility of some bias, due to a lack of published studies with larger sample  
352 sizes.

353 Our review did not find any RCTs that have tested an intervention embedded within routine  
354 health care appointments and this might be a pragmatic way to offer support to all postnatal  
355 women who wish to lose weight after having a baby. Evaluation of these types of  
356 interventions is an important direction for further research. The analysis involving women  
357 with a history of GDM only included five small trials, therefore this result should be  
358 interpreted as preliminary.

### 359 **Conclusion**

360 This systematic review of systematic reviews and mega meta-analysis of RCTs found that  
361 lifestyle interventions are moderately effective in reducing weight after childbirth. Clinical  
362 guidance for the care of postnatal women should be updated to reflect the findings of this  
363 review and the accompanying mega meta-analysis.

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367 **List of figures and tables**

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373 **Table 1:** Inclusion and exclusion criteria for selection of systematic reviews

374 **Table 2:** Characteristics of included systematic reviews

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