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The effect of antenatal dietary and lifestyle advice for women who are overweight or obese on emotional well-being: the LIMIT randomized trial

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Key words
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Conflict of interest
The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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Abstract

Introduction. Our aim was to evaluate the effect of dietary and lifestyle advice given to women who were overweight or obese during pregnancy on maternal quality of life, anxiety and risk of depression, and satisfaction with care. *Material and methods.* We conducted a randomized trial, involving pregnant women with body mass index ≥25 kg/m^2, recruited from maternity units in South Australia. Women were randomized to Lifestyle Advice or Standard Care, and completed questionnaires assessing risk of depression (Edinburgh Postnatal Depression Scale), anxiety (Spielberger State-Trait Anxiety Inventory), and quality of life (SF-36) at trial entry, 28 and 36 weeks' gestation, and 4 months postpartum. Secondary trial outcomes assessed for this analysis were risk of depression, anxiety, maternal quality of life, and satisfaction with care. *Results.* One or more questionnaires were completed by 976 of 1108 (90.8%) women receiving Lifestyle Advice and 957 of 1104 (89.7%) women receiving Standard Care. The risk of depression [adjusted risk ratio 1.01; 95% confidence interval (CI) 0.82–1.24; $p = 0.95$], anxiety (adjusted risk ratio 1.09; 95% CI 0.93–1.27; $p = 0.31$), and health-related quality of life were similar between the two groups. Women receiving Lifestyle Advice reported improved healthy food choice [Lifestyle Advice 404 (68.9%) vs. Standard Care 323 (51.8%); $p < 0.0001$], and exercise knowledge [Lifestyle Advice 444 (75.8%) vs. Standard Care 367 (58.8%); $p < 0.0001$], and reassurance about their health [Lifestyle Advice 499 (85.3%) vs. Standard Care 485 (77.9%); $p = 0.0112$], and health of their baby [Lifestyle Advice 527 (90.2%) vs. Standard Care 545 (87.6%); $p = 0.0143$]. *Conclusion.* Lifestyle advice in pregnancy improved knowledge and provided reassurance without negatively impacting well-being.

Abbreviations: BMI, body mass index; CI, confidence interval; IQR, interquartile range; STAI, Spielberger State-Trait Inventory Self Evaluation Questionnaire.

Introduction

Overweight and obesity are well recognized risk factors for depression, anxiety and other mental health conditions, particularly among women (1). Moreover, women may be more vulnerable to psychological stress, sleep deprivation, and physical inactivity, all independent factors contributing to weight gain (2). Although considered a time of emotional well-being, longitudinal studies have demonstrated that for many women, pregnancy is associated with increased depression and anxiety (3). Australian population data indicate that depression affects approximately 9% of women during pregnancy, increasing to 16% postpartum (4). Furthermore, increased anxiety has been reported to coexist with depression during pregnancy (5).

Up to 50% of women are overweight or obese [body mass index (BMI) $\geq$25 kg/m^2] on entering pregnancy (6). There are well documented risks associated with obesity during pregnancy and childbirth (7), with interest in intervention studies to limit gestational weight gain and improve pregnancy outcomes (8). While current recommendations advocate that all pregnant women have their height and weight measured and BMI calculated at their first antenatal visit, the psychological aspects of care focusing on gestational weight gain and repeated weighing is more controversial (9).

The primary findings of the LIMIT randomized trial evaluating antenatal dietary and lifestyle advice to women who were overweight or obese indicate a significant 18% relative risk reduction in infant birthweight above 4 kg (10). Despite no difference in gestational weight gain, women were successful in improving their diet and physical activity patterns (11). The aim of this prespecified analysis of secondary outcome measures was to evaluate the effect of providing antenatal dietary and lifestyle advice on maternal quality of life, anxiety, depression, and satisfaction with care.

Material and methods

We conducted a multicenter randomized trial in three public maternity hospitals in Adelaide, South Australia, following ethics approval from each center. The methods (12) and primary findings (10,11,13) of the LIMIT trial have been reported, and the trial registered on the Australian and New Zealand Clinical Trials Registry (ACTRN12607000161426). Women with a singleton pregnancy between 10^{+0} and 20^{+0} weeks, and a BMI $\geq$25 kg/m^2 were eligible. The height and weight of each woman presenting at her first antenatal visit was measured, and BMI calculated. Written information was given to eligible women who provided written informed consent to participate.

Randomization used a central telephone service, with computer-generated schedule, and balanced variable blocks. Stratification variables were parity (0 vs. 1/more), BMI at antenatal booking (25–29.9 kg/m^2 vs. $\geq$30 kg/m^2), and collaborating center. Women were randomized to "Lifestyle Advice" or "Standard Care."

Women randomized to Lifestyle Advice participated in a comprehensive dietary and lifestyle intervention over the course of pregnancy including a combination of dietary, exercise, and behavioral strategies, delivered by a research dietician and trained research assistants (12). Dietary advice was consistent with current Australian standards (14), and physical activity focused predominantly on increasing walking and incidental activities (15). The content of the lifestyle intervention has been described in detail previously (11–13).

Women randomized to Standard Care continued care according to local hospital guidelines, which did not include dietary, lifestyle or behavioral advice related to diet or gestational weight gain.

Outcome measures

Women completed questionnaires relating to quality of life (SF-36 Health Survey Questionnaire) (16), depression (Edinburgh Postnatal Depression Scale) (17), and anxiety (the Short Form Speilberger State-Trait Inventory) (18,19), at trial entry, 28 and 36 weeks, and 4 months postpartum.

Risk of depression was assessed using the 10-item Edinburgh Postnatal Depression Scale and defined as a score of >12 (17). Although originally developed to screen for postnatal depression, the instrument has subsequently been used during pregnancy. Women responded to a series of statements assessing depressive symptoms over the past 7 days (17). Women scoring >12 were contacted by research staff, who explained the results and encouraged them to contact thire care provider for further clinical management.

Maternal anxiety was assessed using the Spielberger State-Trait Inventory Self-Evaluation Questionnaire (STAI), a self-rating scale consisting of six items, with scores above 15 considered high (18,19). Women scoring >15

Key Message

Providing lifestyle advice during pregnancy for women who are overweight or obese is associated with improved knowledge and reassurance. There was no evidence of harm in terms of risk of depression, anxiety or poorer quality of life.

were contacted by research staff, who explained the results and encouraged them to contact their care provider for further management.

Health-related quality of life utilized the SF-36-Health Survey Questionnaire, where scores range from 0 (worst) to 100 (best) (16). Domains include physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health, providing an overall physical component and overall mental component (16).

Satisfaction with pregnancy and birth experiences were assessed at 4 months postpartum, using a 10-point Likert Scale (0 complete dissatisfaction and 10 complete satisfaction). Women were asked to indicate their agreement with a variety of statements (options "I strongly agree," "I agree," "I neither agree nor disagree," "I disagree" or "I strongly disagree"), relating to knowledge of healthy food choices and exercise during pregnancy, reassurance about their and their baby's health, concern about their and their baby's future health, and their sense of control during pregnancy and birth. Women were asked if they recognized that they had a problem with their weight when approached to participate in the trial, and whether participation had prompted changes in their diet and lifestyle.

Statistical analysis

Analyses were performed on an intention-to-treat basis, according to treatment group allocated at randomization. Women were included in the analysis if they returned one or more questionnaires and did not withdraw consent to use their data or have a miscarriage, termination of pregnancy, or stillbirth.

Outcomes were analyzed using linear mixed effects models including treatment group, time, and their interaction, with adjustment made for the stratification variables center, parity and BMI as fixed effects. Outcomes measured on different subjects were assumed to be independent but outcomes measured on the same subject across the four time points were allowed to be correlated by specifying an unstructured covariance matrix for the error term. Where the treatment by time interaction was significant, post hoc tests were performed to assess the effect of treatment group at each time point. Where the interaction was not significant, it was removed from the model. Exploratory analyses were conducted to assess variation in the effect of treatment by BMI category (overweight vs. obese) by including an interaction between treatment group, time, and BMI category (where the effect of treatment varied over time) or an interaction between treatment group and BMI category. Responses to the maternal questionnaire at 4 months were compared between treatment groups using chi-squared tests for categorical responses and Wilcoxon rank-sum tests for responses measured on a visual analogue scale. Statistical significance was assessed at the two-sided $p < 0.05$ level and no adjustment was made for multiple comparisons. All analyses were performed using SAS v9.3 (SAS Institute, Cary, NC, USA). The sample size of 2180 women was predetermined based on the primary outcome of the trial (large-for-gestational-age infant) as reported previously (10).

Results

A total of 2212 women were randomized, 1108 to Lifestyle Advice and 1104 Standard Care (Figure 1). There were 2142 women (1075 Lifestyle Advice; 1067 Standard Care) included in the analyses, with one or more questionnaires from 1933 women [976 (90.8%) Lifestyle Advice; 957 (89.7%) Standard Care]. Baseline characteristics of women completing any questionnaire were similar between treatment groups (Tables 1 and S1) and the complete randomized group (10).

Mean depressive scores [adjusted difference in means 0.22; 95% confidence interval (CI) −0.15 to 0.59; $p = 0.25$] or risk of depression (adjusted risk ratio 1.01; 95% CI 0.82–1.24; $p = 0.95$) were not higher among women in the Lifestyle Advice group (Table 2). Both the mean score and proportion of women at risk of depression fell across pregnancy and postpartum, with Edinburgh Postnatal Depression Scale scores approximately one point higher on average, and risk of depression 43% greater at trial entry (Table S2).

There were no statistically significant differences in symptoms of anxiety (adjusted difference in means 0.10; 95% CI −0.19 to 0.38; $p = 0.51$) or risk of high-level anxiety, defined as an STAI score of 15 or above (adjusted risk ratio 1.09; 95% CI 0.93–1.27; $p = 0.31$) between treatment groups, an effect that was unchanged across pregnancy and postpartum (Table 2). Reported anxiety was greatest at trial entry, with mean STAI scores approximately 0.5 points higher, and risk of high anxiety 30% greater, compared with 4 months postpartum (Table S2).

There were no statistically significant differences between treatment groups for any of the domains assessing health-related quality of life (Table 3). Among women in both groups, physical functioning, physical role, bodily pain, and overall physical component deteriorated between trial entry and 36 weeks' gestation, before improving 4 months postpartum. Mean scores in the physical role domain were approximately 44 points lower at 36 weeks' gestation compared with 4 months postpartum (adjusted difference in means −44.26, 95% CI

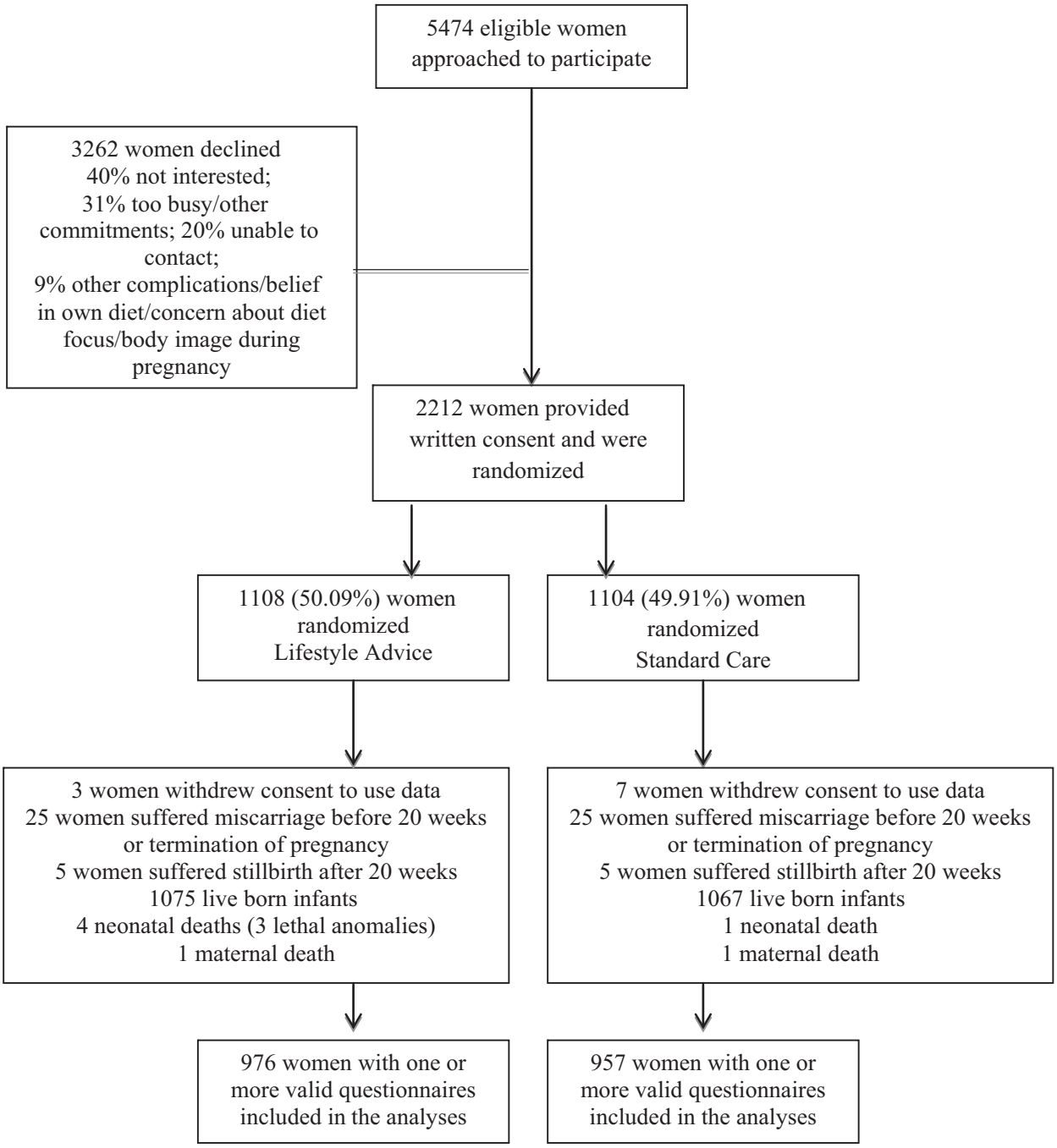

Figure 1. Flow of participants through the trial.

−46.63 to −41.90, $p < 0.001$). Changes during pregnancy varied for general health, vitality, social functioning, and overall mental component, but all domains showed a significant improvement between trial entry and 4 months postpartum (Table S3).

For the emotional role and mental health domains, there was a significant interaction between treatment group and time point ($p = 0.03$ and $p = 0.007$, respectively). Although there were no significant differences between the treatment groups at any individual time point (Table 3), the pattern of change over pregnancy differed according to treatment group. Mean emotional role scores were significantly lower at trial entry in the Lifestyle Advice group, whereas the only change over time

Table 1. Baseline characteristics of women by treatment group.

Characteristic	Lifestyle advice *n* = 976	Standard care *n* = 957
Maternal age (years)[a]	29.4 (5.4)	29.6 (5.4)
Gestational age at entry (weeks)[b]	14.3 (12.0–17.0)	14.3 (12.0–17.1)
Body mass index category[c]		
BMI 25.0–29.9 kg/m^2	409 (41.9)	422 (44.1)
BMI 30.0–34.9 kg/m^2	284 (29.1)	271 (28.3)
BMI 35.0–39.9 kg/m^2	180 (18.4)	157 (16.4)
BMI ≥40.0 kg/m^2	103 (10.6)	107 (11.2)
Public patient[c]	955 (97.8)	934 (97.6)
Caucasian[c]	883 (90.5)	872 (91.1)
Smoker[c]	126 (12.9)	101 (10.6)
Nulliparous[c]	408 (41.8)	386 (40.3)
Index of socio-economic disadvantage[d]		
Unknown	2 (0.2)	1 (0.1)
Quintile 1 (Most disadvantaged)	297 (30.4)	276 (28.8)
Quintile 2	231 (23.7)	237 (24.8)
Quintile 3	157 (16.1)	147 (15.4)
Quintile 4	139 (14.2)	151 (15.8)
Quintile 5 (Least disadvantaged)	150 (15.4)	145 (15.2)

[a]Mean and standard deviation.
[b]Median and interquartile range.
[c]Number and percentage.
[d]Socio-economic index of disadvantage (as measured by SEIFA).

seen in the Standard Care group was an increase between 36 weeks' gestation and 4 months postpartum. For mental health, the improvement in mean scores was seen earlier in the Lifestyle Advice group (between trial entry and 28 weeks) than in the Standard Care group (between 28 and 36 weeks) but, once achieved, the improvement was maintained in both groups (Table S3).

There was no evidence to suggest that the effect of treatment on depression, anxiety or health-related quality of life varied by maternal BMI (data not shown).

All women reported a high degree of satisfaction with their pregnancy [Lifestyle Advice median score 8.7 (interquartile range, IQR 7.3–9.8) vs. Standard Care median score 8.8 (IQR 7.3–9.8); $p = 0.8722$] and with birth [Lifestyle Advice median score 8.1 (IQR 5.3–9.6) vs. Standard Care median score 8.1 (IQR 5.0–9.7); $p = 0.9235$]. Most women agreed or strongly agreed that they felt in control during their pregnancy [Lifestyle Advice 434 (74.0%) vs. Standard Care 463 (74.3%); $p = 0.9945$] and birth [Lifestyle Advice 327 (56.0%) vs. Standard Care 353 (56.8%); $p = 0.4510$], and they liked their care providers [Lifestyle Advice 542 (92.4%) vs. Standard Care 559 (89.8%); $p = 0.1530$]. These findings did not differ significantly between treatment groups.

Most women participating in the trial recognized that they had a problem with their weight, findings that did not differ between treatment groups [Lifestyle Advice 433 (73.9%) vs. Standard Care 440 (70.8%); $p = 0.5342$]. However, women receiving lifestyle advice were more likely to indicate that the approach to participate in the trial prompted changes to both their diet [Lifestyle Advice 364 (62.1%) vs. Standard Care 280 (45.0%); $p < 0.0001$] and their lifestyle [Lifestyle Advice 336 (57.7%) vs. Standard Care 269 (43.2%); $p < 0.0001$]. Women who received the intervention indicated greater knowledge about healthy food choices [Lifestyle Advice 404 (68.9%) vs. Standard Care 323 (51.8%); $p < 0.0001$], and exercise during pregnancy [Lifestyle Advice 444 (75.8%) vs. Standard Care 367 (58.8%); $p < 0.0001$] compared with women who received Standard Care. There were no differences with regard to the proportion of women who felt healthy during pregnancy [Lifestyle Advice 457 (78.0%) vs. Standard Care 454 (72.9%); $p = 0.3517$], although women who received the intervention were more likely to feel reassured about both their own health [Lifestyle Advice 499 (85.3%) vs. Standard Care 485 (77.9%); $p = 0.0112$], and that of their baby [Lifestyle Advice 527 (90.2%) vs. Standard Care 545 (87.6%); $p = 0.0143$].

In the postpartum period, most women felt healthy [Lifestyle Advice 421 (72.0%) vs. Standard Care 466 (74.7%); $p = 0.5942$] and were not concerned about their future health [Lifestyle Advice 376 (64.2%) vs. Standard Care 407 (65.3%); $p = 0.9444$] or the future health of their baby or child [Lifestyle Advice 437 (74.8%) vs. Standard Care 455 (72.9%); $p = 0.9467$]. Although there were no significant differences in the proportion of women who indicated that they would participate in the study again [Lifestyle Advice 433 (74.4%) vs. Standard Care 467 (74.8%); $p = 0.7222$] or recommend participation to a friend [Lifestyle Advice 484 (82.7%) vs. Standard Care 492 (78.8%); $p = 0.2302$], women who received the intervention were more likely to be satisfied with their group allocation [Lifestyle Advice 506 (87.5%) vs. Standard Care 439 (70.6%); $p < 0.0001$].

Discussion

Our findings indicate that providing dietary and lifestyle advice to pregnant women who are overweight or obese is not associated with an increased risk of depression, anxiety or poorer health-related quality of life, when compared with standard antenatal care. Among all women, we observed a decline in physical functioning over pregnancy, followed by improvement after birth, in addition to improvement in general health, vitality, and social functioning between trial entry and postpartum. While women reported a high degree of satisfaction with

Table 2. Assessment of depression and anxiety – between-group comparison.

Outcome	Time point	Dietary advice $n = 976$	Standard care $n = 957$	Adjusted treatment × time interaction, p-value[b]	Adjusted time effect, p-value[b]	Adjusted treatment effect, p-value[b]	Adjusted treatment effect (95% CI)
EPDS Score	Trial entry	6.55 (4.70)	6.30 (4.93)	0.43	<0.001	0.25	0.22 (−0.15, 0.59)
	28 weeks	6.28 (4.53)	6.12 (4.75)				
	36 weeks	5.83 (4.58)	5.63 (4.72)				
	4 months	5.34 (4.51)	5.02 (4.30)				
EPDS Score >12[a]	Trial entry	81/709 (11.42%)	75/694 (10.81%)	0.60	0.04	0.95	1.01 (0.82, 1.24)
	28 weeks	68/732 (9.29%)	80/758 (10.55%)				
	36 weeks	65/695 (9.35%)	62/687 (9.02%)				
	4 months	47/597 (7.87%)	41/624 (6.57%)				
STAI	Trial entry	10.86 (3.78)	10.76 (3.92)	0.80	<0.001	0.51	0.10 (−0.19, 0.38)
	28 weeks	10.56 (3.56)	10.48 (3.66)				
	36 weeks	10.64 (3.62)	10.41 (3.56)				
	4 months	10.18 (3.64)	10.14 (3.50)				
STAI Score ≥15[a]	Trial entry	161/898 (17.93%)	145/882 (16.44%)	0.50	0.03	0.31	1.09 (0.93, 1.27)
	28 weeks	113/733 (15.42%)	120/756 (15.87%)				
	36 weeks	110/694 (15.85%)	96/688 (13.95%)				
	4 months	83/596 (13.93%)	70/624 (11.22%)				

Values are mean (SD) and treatment effects are differences in means across all time points estimated from a linear mixed effects model adjusted for center, parity, and BMI.

EPDS, Edinburgh Postnatal Depression Scale; STAI, Spielberger State-Trait Anxiety Inventory.

[a]Values are number (%) and treatment effects are relative risks across all time points estimated from a log binomial mixed effects model adjusted for center, parity, and BMI.

[b]Where the treatment × time interaction was not significant, it was dropped from the model and p-values for the main effects of treatment and time are presented.

their pregnancy and birth, we observed some additional benefits, with women receiving the intervention reporting improved knowledge about healthy food choices and exercise during pregnancy, and expressing greater reassurance about both their own health and that of their baby.

Our trial utilized robust methodology and is the largest to evaluate the specific effects of an antenatal dietary and lifestyle intervention for women who are overweight or obese during pregnancy on maternal quality of life, anxiety, and depression. Most trials to date have reported gestational weight gain as an outcome (8), with limited reporting of health outcomes, including maternal psychological well-being. Our findings address this gap.

A limitation of our trial is reliance on self-reported questionnaires. Although there was a decline in questionnaire response rates during pregnancy and postpartum, the proportion of women contributing data to the analyses was high. Furthermore, women included in the analysis had similar baseline characteristics to, and can therefore be considered representative of, the complete randomized groups (10).

Our findings are consistent with other, smaller reported trials. Although the assessment tools are not directly comparable with those in our trial, Nascimento and colleagues (20) identified no differences in maternal quality of life following an exercise intervention, while also demonstrating deterioration in physical and social functioning towards the end of pregnancy (20). Poston and colleagues (21) also identified no significant effect of providing a dietary and lifestyle intervention on risk of depression or anxiety, and similarly report an increase in physical discomfort between trial entry and 28 weeks' gestation (21). In contrast, Bogaerts and colleagues (22) report reduced anxiety following an antenatal intervention, although risk of depression assessed during the third trimester of pregnancy did not differ between treatment groups.

Our findings do not suggest that women who are overweight or obese have an increased risk of depression, either during pregnancy or postpartum, with rates consistent with those reported in general obstetric populations involving women across all BMI categories (5). In contrast, however, are the findings of a recent systematic review of predominantly observational studies (23), in which women who were overweight or obese were at increased risk of depressive symptoms and anxiety, both during pregnancy and postpartum, when compared with women of normal BMI.

Several longitudinal studies have described changes in self-reported depression and anxiety symptoms during

Table 3. Assessment of health-related quality of life – between-group comparison.

Outcome	Time point	Dietary advice $N = 975$	Standard care $N = 956$	Adjusted treatment × time interaction p value[b]	Adjusted time effect p value[b]	Adjusted treatment effect p value[b]	Adjusted treatment effect (95% CI)
Physical Functioning	Trial entry	77.85 (19.07)	78.45 (19.51)	0.29	<0.001	0.53	0.44 (−0.93, 1.82)
	28 weeks	65.93 (20.01)	64.85 (20.92)				
	36 weeks	53.15 (23.30)	53.19 (23.76)				
	4 months	88.22 (16.01)	87.62 (17.05)				
Physical Role	Trial entry	67.54 (38.90)	70.42 (37.91)	0.42	<0.001	0.59	−0.66 (−3.05, 1.72)
	28 weeks	59.02 (40.12)	59.60 (39.39)				
	36 weeks	42.21 (41.42)	43.20 (40.72)				
	4 months	87.14 (27.99)	86.80 (27.66)				
Bodily Pain	Trial entry	71.11 (22.04)	70.85 (22.66)	0.70	<0.001	0.27	0.89 (−0.68, 2.46)
	28 weeks	62.71 (21.08)	62.01 (21.06)				
	36 weeks	56.39 (21.58)	55.36 (21.24)				
	4 months	77.42 (21.52)	76.25 (22.64)				
General Health	Trial entry	66.73 (19.48)	67.03 (19.90)	0.50	<0.001	1.00	0.00 (−1.50, 1.50)
	28 weeks	69.84 (18.46)	69.45 (19.17)				
	36 weeks	70.98 (18.64)	70.68 (18.98)				
	4 months	71.76 (19.06)	72.37 (18.46)				
Vitality	Trial entry	48.82 (20.55)	49.47 (20.28)	0.78	<0.001	0.48	−0.55 (−2.04, 0.95)
	28 weeks	52.35 (18.53)	52.91 (19.06)				
	36 weeks	49.08 (19.46)	49.81 (19.47)				
	4 months	58.26 (19.86)	58.57 (19.96)				
Social Functioning	Trial entry	78.91 (23.50)	79.27 (23.31)	0.36	<0.001	0.52	−0.52 (−2.12, 1.08)
	28 weeks	81.31 (20.95)	80.89 (21.78)				
	36 weeks	77.50 (22.13)	78.48 (21.50)				
	4 months	85.51 (21.64)	86.58 (20.11)				
Emotional Role[a]	Trial entry	82.07 (32.22)	84.18 (30.95)	0.03	N/A	0.11	−2.39 (−5.30, 0.52)
	28 weeks	87.02 (28.76)	85.42 (30.00)			0.29	1.58 (−1.34, 4.51)
	36 weeks	86.78 (29.88)	84.08 (31.49)			0.16	2.27 (−0.91, 5.44)
	4 months	87.21 (28.22)	87.27 (27.62)			0.66	−0.70 (−3.79, 2.39)
Mental Health[a]	Trial entry	76.30 (16.79)	76.52 (17.22)	0.007	N/A	0.66	−0.35 (−1.90, 1.20)
	28 weeks	78.72 (15.17)	78.26 (15.90)			0.15	1.13 (−0.40, 2.67)
	36 weeks	78.91 (15.23)	79.58 (14.88)			0.45	−0.58 (−2.09, 0.93)
	4 months	78.86 (16.29)	80.09 (15.00)			0.07	−1.59 (−3.28, 0.10)
Physical Component	Trial entry	46.31 (8.72)	46.58 (8.91)	0.38	<0.001	0.47	0.23 (−0.39, 0.86)
	28 weeks	41.33 (9.01)	41.19 (9.26)				
	36 weeks	36.10 (9.82)	36.02 (9.77)				
	4 months	51.23 (8.11)	50.73 (7.81)				
Mental Component	Trial entry	48.34 (10.26)	48.66 (10.13)	0.10	<0.001	0.36	−0.34 (−1.08, 0.39)
	28 weeks	52.43 (9.07)	52.28 (9.59)				
	36 weeks	53.87 (8.88)	54.01 (9.10)				
	4 months	49.71 (10.12)	50.34 (9.29)				

Values are mean (SD) and treatment effects are differences in means across all time points estimated from a linear mixed effects model adjusted for center, parity and BMI.

[a]Values are mean (SD) and treatment effects are differences in means by time point estimated from a linear mixed effects model adjusted for center, parity and BMI.

[b]Where the treatment × time interaction was not significant, it was dropped from the model and p values for the main effects of treatment and time are presented. Where the treatment × time interaction was significant, p values for the effect of treatment at each time point are presented.

pregnancy and postpartum (24–26). Although some report a reduction in mean anxiety and depression scores (24,26), this is not universal; Setse and colleagues (25) noted, for example, that while symptoms of depression were relatively stable during the first and second trimester, they increased during the third trimester, before declining postpartum (25). Furthermore, women with evidence of depression in the third trimester of pregnancy

demonstrated significantly lower health-related functioning across the majority of functional domains (25).

Importantly, these studies (24–26) have involved pregnant women in all BMI categories, and have not specifically evaluated the effect of maternal obesity on mental health and health-related quality of life. Claesson (27), in a non-randomized study involving obese women, identified little variation in symptoms of either depression or anxiety throughout pregnancy, before an improvement in both after birth, findings similar to those reported by McPhie and colleagues (28). Amador and colleagues (29) assessed maternal quality of life among 220 pregnant women, of whom 110 were obese. Physical functioning in all women declined over pregnancy, and particularly in the third trimester, but the decline was greatest among obese women (29). Furthermore, obese pregnant women also reported a decline in mental health (29).

We report that women were highly satisfied with pregnancy, birth, and their care-providers. Although consistent with findings of a smaller qualitative study (30), high satisfaction with care is not universally described, obese women reporting judgement, humiliation and stigmatization during health professional interactions, reinforcing their discomfort about body size (31,32).

While there is an extensive literature describing risks associated with maternal obesity, both for the woman and her infant, women's knowledge of pregnancy complications and the impact on neonatal health is poor (33). Our findings indicate that few women expressed concern for their future health, or the future health of their baby or child, despite increasing evidence highlighting longer-term health risks, including type 2 diabetes and hypertension for women and childhood obesity. These longer-term, more remote risks may serve as poor motivators for women to make lasting changes to diet and physical activity during pregnancy, where the short-term focus is on the birth of a healthy baby.

We have noted evidence of considerable barriers to behavior change in pregnant women who are overweight and obese (34), with only 50% of women indicating confidence in their ability to modify diet and exercise during pregnancy (33). Promisingly, women randomized to Lifestyle Advice were more likely to initiate changes to both their diet and lifestyle than were women who received Standard Care.

Conclusions

Our findings indicate that providing antenatal dietary and lifestyle advice is not associated with harm, specifically poorer maternal mental health or quality of life. Furthermore, there are benefits for women, including improved knowledge of healthy choices, and reassurance about their and their baby's health.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Baseline characteristics of women according to whether they responded to quality of life questionnaires.

Table S2. Changes in depression and anxiety over the course of pregnancy and postpartum period.

Table S3. Changes in health-related quality of life over the course of pregnancy and postpartum period.