

Reducing excessive weight gain in pregnancy: a randomised controlled trial

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Excessive gestational weight gain has been shown to be associated with higher rates of caesarean delivery, failed induction, instrumental delivery, pre-eclampsia and gestational diabetes mellitus. For the neonate, it increases the incidence of hypoglycaemia, hyperbilirubinaemia, high birthweight, and infant obesity.¹⁻⁵ Excess gestational weight gain is also associated with postpartum weight retention up to 10 years after pregnancy.⁶ Unfortunately, excessive weight gain during pregnancy is common, particularly among women who are overweight before pregnancy.^{7,8} A study in the United States found that 37% of normal weight women and 64% of overweight women experienced excessive gestational weight gain.⁸

In 1990, the US Institute of Medicine (IOM) published gestational weight-gain guidelines based on body mass index (BMI) before pregnancy (Box 1).⁹ These guidelines have been widely adopted in clinical practice and are supported by studies showing that weight gain within these guidelines is associated with optimal pregnancy outcomes.^{1,5,7,10}

Few studies have examined measures that may aid women in appropriate gestational weight control and none have examined a simple intervention of regular self-weighing.^{8,11-15} Outside of pregnancy, the value of frequent self-weighing has been demonstrated.¹⁶

The Royal College of Obstetricians and Gynaecologists (London) recommends that, in clinical practice, maternal weight should not be routinely measured during pregnancy. They caution that frequent weighing and feedback may cause undue anxiety among women, with no additional benefit.¹⁷ However, this has been refuted for adults who are not pregnant.¹⁸

Our aim was to assess the effect on gestational weight gain of regular weight measurement combined with advice about the recommended weight-gain range.

METHODS

We performed a randomised controlled trial at a public tertiary obstetric hospital in Melbourne between July 2007 and May 2008. Ethics approval was provided by the

ABSTRACT

Objective: To determine if regular weight measurement throughout pregnancy can reduce excessive gestational weight gain.

Design: A randomised controlled trial.

Setting: A tertiary obstetric hospital in Melbourne, between July 2007 and May 2008.

Participants: 236 pregnant women recruited at \leq 14 weeks' gestation.

Intervention: Women allocated to the intervention group were given a personalised weight measurement card, advised of their optimal gestational weight gain (based on their body mass index at the time of recruitment and the United States Institute of Medicine guidelines), and instructed to record their weight at 16, 20, 24, 28, 30, 32 and 34 weeks' gestation. The control group were weighed at recruitment, but were not given instructions about regular weight measurement. All participants were blinded to the purpose of the study.

Main outcome measure: Weight gain from recruitment to follow-up at 36 weeks' gestation.

Results: In the study population, there was a trend to less weight gain in the intervention group. The women in the intervention group experienced a mean (SD) per-week weight gain of 0.44 (0.173) kg compared with those in the control group, who gained 0.46 (0.156) kg/week (mean difference, 0.02 kg/week; 95% CI, -0.02 to 0.07 kg/week). The intervention significantly reduced gestational weight gain in the group of women who were overweight but not obese at recruitment: those in the intervention group (20 women) gained a mean (SD) of 0.42 (0.153) kg/week and the control group (18 women) gained 0.54 (0.123) kg/week (mean difference, 0.12 kg/week; 95% CI, 0.03 to 0.22 kg/week; $P = 0.01$).

Conclusion: Regular weight measurement in pregnancy was not found to be effective in reducing weight gain, except among women who were overweight but not obese before pregnancy.

Trial registration: Australian Clinical Trials Registry ACTRN12607000272493

MJA 2009; 191: 429-433

For editorial comment, see page 421. See also page 425

Mercy Health Human Research Ethics Committee.

Objective

Our aim was to assess the effect on total weight gain during pregnancy of a personalised gestational weight-gain recommendation (based on early pregnancy BMI) and regular weight measurement. We hypothesised that personalised weight-gain recommendations and awareness of weight change during pregnancy would reduce excessive gestational weight gain.

Participants

Pregnant women were recruited by the student researcher (KJ) at their first antenatal appointment in the outpatients clinic at or before 14 weeks' gestation. The exclusion

criteria were: age < 18 years or > 45 years, type 1 or type 2 diabetes mellitus, multiple pregnancy, or non-English speaking. All women were given a patient information and consent form, offering participation in an observational study of diet and exercise in pregnancy. Participants were unaware that the primary aim of the study was the effect of regular weight measurement on gestational weight gain.

Randomisation

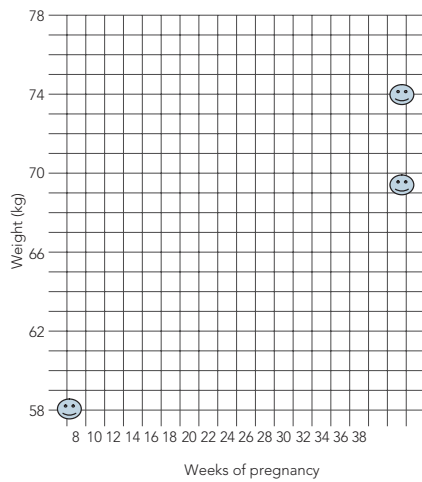
The randomisation sequence was obtained using a computer random number generator. Blocking (which is used to ensure that comparison groups will be of approximately the same size) was not used. Numbered cards allocating women to either the intervention or control group were placed in

1 IOM guidelines for total weight gain in pregnancy by prepregnancy body mass index (BMI) category⁹

Weight-for-height category (BMI, kg/m ²)	Recommended weight gain (kg)
Underweight (≤ 19.8)	12.5–18.0
Normal ($> 19.8, \leq 26.0$)	11.5–16.0
Overweight ($> 26.0, \leq 29.0$)	7.0–11.5
Obese (> 29.0)	> 6.8

IOM = Institute of Medicine (United States). ◆

2 Personalised weight-measurement card for recording weight



Sample patient record — a patient with a weight at recruitment of 58 kg, a body mass index of 22 kg/m², and an ideal weight gain of 11.5–16.0 kg. ◆

opaque, sequentially numbered envelopes: 138 women were allocated to the control group and 148 women were allocated to the intervention group. The person generating the allocation sequence was also responsible for participant recruitment; however, allocation concealment was maintained.

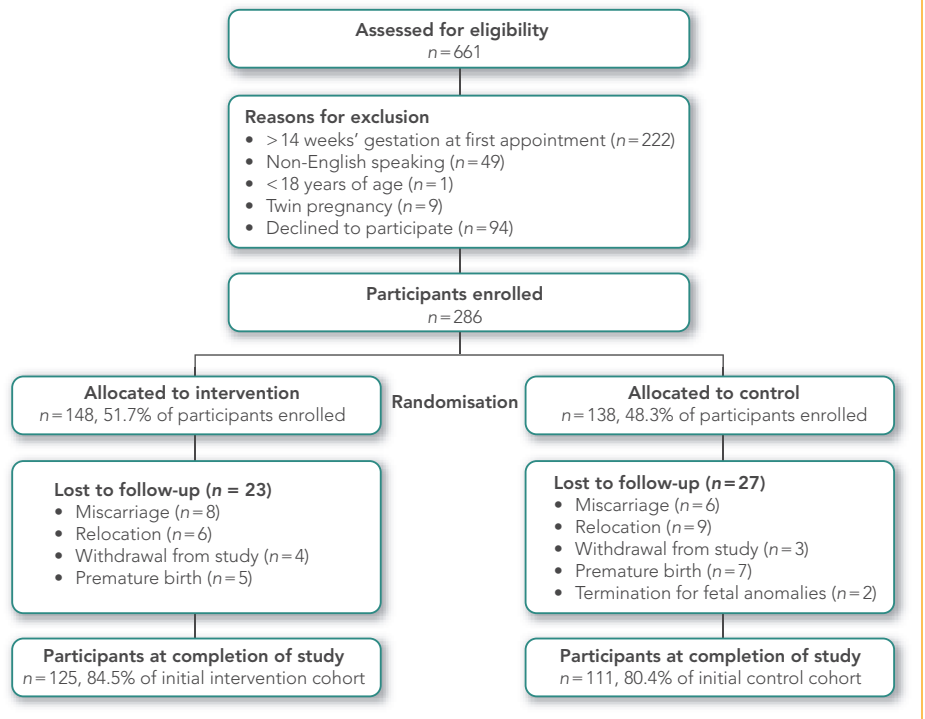
Study design

Participants were seen at recruitment and at 36 weeks' gestation. They were blinded to the purpose of the study. Of necessity, the researcher conducting the study was not blinded to treatment group after allocation.

Recruitment

All women enrolled in the study received standard antenatal care, including a brief dietary history taken by midwives and written information on healthy eating. Women

3 Flow diagram of the recruitment and randomisation of trial participants



were weighed at their first antenatal appointment using balance-beam scales, but standard antenatal care did not involve further routine weight measurement. Weight and height were measured in street clothing without shoes. For two women, self-reported weight at the time of recruitment was used, as the scales measured a maximum weight of 125 kg and these women weighed 129 and 157 kg, respectively.

All participants completed two previously validated questionnaires about eating habits and energy expenditure in the 12 months before pregnancy and the first trimester of pregnancy. These questionnaires were primarily used to distract participants' attention from the primary aim of the project.

Intervention

Women assigned to the intervention group were given an optimal gestational weight-gain range for their pregnancy, defined by their BMI and the IOM guidelines for weight gain during pregnancy.⁹ This ideal weight range, together with their weight as measured at recruitment, was recorded on a personalised weight-measurement card (Box 2). Participants were told to record their own weight at 16, 20, 24, 28, 30, 32 and 34 weeks' gestation, using either a tabular or graphical format provided on the measurement cards. Weight measurements during pregnancy were done on either the

participants' own scales at home or those at the hospital, according to patient preference. Women in the control group were weighed at recruitment and at 36 weeks' gestation, but were not given any further advice regarding optimal weight gain or regular weighing.

Follow-up

All women were weighed at about 36 weeks' gestation, using the same scales used at the initial weight measurement. Seventeen women cared for in a satellite clinic or in hospital were unable to be weighed on the same scales, and were weighed on different scales that had been calibrated to the balance-beam scales. For a further 12 women (eight intervention and four control), self-reported weight at 36 weeks' gestation was recorded (two were too heavy for the hospital scales, and the remainder had changed clinics during their pregnancy). Participants again completed the questionnaires regarding diet and exercise.

Further data collection

Demographic information (eg, age, parity, socioeconomic status) was obtained from participants' medical records at recruitment and by direct questioning. Gestational age was determined by the treating clinician by routine obstetric methods and obtained from the medical record.

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Obstetric records were reviewed after delivery to obtain infant birthweight, gestational age at delivery, Apgar scores, and any complications during pregnancy and delivery. Records were complete except for one woman who delivered at another hospital. Obstetric outcomes were defined by, and obtained through, the Mercy Hospital's Birthing Outcomes System (the hospital's data collection process).

Sample size justification and statistical analysis

Sample size was set so that the study had a power of 0.8 to show a weight difference of 2 kg between the control and intervention groups. At a power of 0.8, a mean weight gain of 16.8 kg, standard deviation of 4.9, and a type I error rate of 0.05, a sample size of 192 women (96 in each group) was required. A total of 286 women were recruited to allow for loss to follow-up.

Data are presented as mean (SD), median (25th–75th percentile) or number (%) according to distribution. The primary out-

come was weight gain per week of observation; secondary outcomes were the proportion of women exceeding the IOM guidelines, and pregnancy outcomes. For obese women, the IOM recommends a weight gain of 6.8 kg or above. We considered obese women who exceeded 11.5 kg to be above the IOM guidelines, based on the upper limit assigned to overweight women.⁹

Statistical tests used were the two-sided Fisher's exact test for numerical data, and the independent two-samples *t* test or the Wilcoxon rank-sum test for continuous variables according to their distribution. Subgroup analysis based on BMI categories was also performed for weight gain per week, and the proportion of participants exceeding IOM guidelines.

For all statistical analyses, we used Stata (version 10, StataCorp, College Station, Tex, USA). Data were analysed on an intention-to-treat basis. Statistical significance was defined as (two-sided) $P \leq 0.05$, and was adjusted for multiple comparisons in the

subgroup analyses using the Bonferroni correction.

RESULTS

Flow of participants

Recruitment took place from July to October 2007. Of the 661 women approached, 281 women were excluded from the study (the reasons are given in Box 3), and 94 women declined to participate (concerns about time and convenience, anxiety about pregnancy, issues about their diet and weight, and plans to deliver at another institution). Of the 286 participants enrolled, 236 completed the study. Those women who were lost to follow-up (Box 3) were not weighed at 36 weeks' gestation and excluded from the analysis. Participants excluded from the analysis were similar in weight, BMI, age, parity and socioeconomic status to those who completed the study (data not shown).

Baseline characteristics

Baseline characteristics and BMI distribution of the participants are shown in Box 4. There were no clinically meaningful differences between the women in the control and intervention groups in terms of demographic characteristics — age, smoking status, parity, marital status or educational attainment. The ranges of gestational age at recruitment and follow-up were 7.1–14.8 weeks and 36.3–38.3 weeks, respectively.

Weight gain

Overall, the control group had a mean (SD) weight gain of 0.46 (0.156) kg/week, compared with 0.44 (0.173) kg/week in the intervention group, a mean difference of

4 Baseline characteristics of study participants

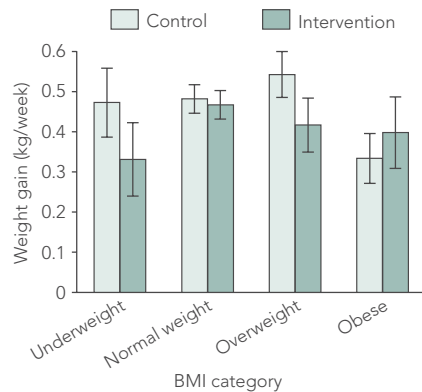
Variable	Intervention (n = 125)	Control (n = 111)
Mean (SD) weight at recruitment (kg)	68 (15.8)	68 (12.9)
Body mass index category (kg/m ²), no. (%)		
Underweight (≤ 19.8)	5 (4%)	5 (5%)
Normal ($> 19.8, \leq 26.0$)	75 (60%)	67 (60%)
Overweight ($> 26.0, \leq 29.0$)	20 (16%)	18 (16%)
Obese (> 29.0)	25 (20%)	21 (19%)
Mean (SD) gestation at recruitment (weeks)	11.6 (1.96)	11.4 (2.00)
Mean (SD) gestation at follow-up (weeks)	36.2 (0.62)	36.3 (0.73)
Mean (SD) duration of study participation (weeks)	25.0 (1.90)	25.0 (2.10)

5 Gestational weight gain within body mass index (BMI) categories

BMI category (kg/m ²)	Weight gain per week				Total weight gain				
	Mean (SD) weight gain (kg)		Between-group difference (mean, 95% CI)	<i>P</i> *	Mean (SD) weight gain (kg)		Proportion gaining more weight than IOM guidelines [†]		<i>P</i> ‡
	Intervention	Control			Intervention	Control	Intervention	Control	
Underweight (≤ 19.8)	0.33 (0.104)	0.47 (0.098)	0.14 (−0.00 to 0.29)	0.06	8.3 (2.55)	12.8 (2.87)	0/5	0/5	—
Normal weight ($> 19.8, \leq 26.0$)	0.47 (0.157)	0.48 (0.149)	0.01 (−0.04 to 0.07)	0.58	11.5 (3.95)	12.0 (3.84)	7/75 (9%)	11/67 (16%)	0.22
Overweight ($> 26.0, \leq 29.0$)	0.42 (0.153)	0.54 (0.123)	0.12 (0.03 to 0.22)	0.01	10.0 (3.63)	13.3 (3.57)	7/20 (35%)	10/18 (56%)	0.33
Obese (> 29.0)	0.40 (0.226)	0.33 (0.145)	−0.06 (−0.18 to 0.05)	0.27	9.5 (5.17)	8.2 (3.02)	9/25 (36%)	5/21 (24%)	0.52
Total	0.44 (0.173)	0.46 (0.156)	0.02 (−0.02 to 0.07)	0.28	10.7 (4.21)	11.5 (4.03)	23/125 (18%)	26/111 (23%)	0.42

* Between-group difference tested using an unpaired *t* test. † Institute of Medicine guidelines.⁹ ‡ Difference in proportions tested using Fisher's exact test. ◆

6 Weight gain per week (95% CI) in the control and intervention groups by body mass index (BMI) category*



* See Box 5.

0.02 kg/week (95% CI, -0.02 to 0.07 kg/week). There was a statistically significant reduction in gestational weight gain in the overweight group (BMI, >26.0, ≤29.0 kg/m²), with a mean difference of 0.12 kg/week (95% CI, 0.03 to 0.22 kg/week; $P=0.01$) between the intervention and the control groups.

For participants classified as underweight, normal or obese, there was no significant difference in weight gain between intervention and control groups (Box 5). Weight gain for each BMI category is presented in Box 5 and Box 6. The number of women gaining more weight than the IOM-recommended amount was 26/111 (23%) in the control group compared with 23/125 (18%) in the intervention group (Fisher's exact test, $P=0.42$) (Box 5).

Pregnancy outcomes

Pregnancy outcomes are shown in Box 7. There were no significant differences in obstetric or neonatal outcomes between the intervention and control groups.

DISCUSSION

The aim of our study was to prevent excessive weight gain during pregnancy. The intervention included the regular measurement and recording of weight throughout pregnancy from recruitment at ≤14 weeks' gestation to 36 weeks' gestation. The control group received standard antenatal care that did not include regular weighing. To our knowledge, this is the first study of its kind to consider routine weight measurement, without diet and exercise counselling, as a tool to reduce excessive gestational weight gain.

7 Pregnancy outcomes in the intervention and control groups

Pregnancy outcome	Intervention (n=124)*	Control (n=111)	P	Relative risk (95% CI)
Birthweight				
Mean (SD) birthweight (g)	3416 (452.4)	3421 (504.7)	0.95	
< 10th centile [†]	9 (7.3%)	12 (10.8%)	0.37	0.68 (0.30–1.56)
> 90th centile [†]	8 (6.5%)	11 (9.9%)	0.47	0.66 (0.28–1.59)
Delivery				
Weeks' gestation at delivery (median, 25th–75th percentile)	39.6 (38.6–40.7)	39.7 (38.7–39.8)	0.65	
Preterm (< 37 weeks)	3 (2.4%)	4 (3.6%)	0.71	0.67 (0.15–2.93)
Instrumental delivery	29 (23.4%)	18 (16.2%)	0.19	1.44 (0.85–2.45)
Caesarean	41 (33.1%)	30 (27.0%)	0.32	1.25 (0.85–1.86)
Pregnancy complications				
Pre-eclampsia	6 (4.8%)	2 (1.8%)	0.29	2.68 (0.55–13.0)
Pregnancy-induced hypertension	4 (3.2%)	1 (0.9%)	0.37	3.58 (0.41–31.6)
Gestational diabetes mellitus	13 (10.5%)	10 (9.0%)	0.83	1.16 (0.53–2.54)
Neonatal complications				
Apgar score < 7 at 5 min	1 (0.8%)	2 (1.8%)	0.60	0.45 (0.04–4.87)
Hypoglycaemia	3 (2.4%)	1 (0.9%)	0.62	2.68 (0.28–25.4)
Shoulder dystocia	1 (0.8%)	1 (0.9%)	0.99	0.89 (0.06–14.1)

Data are presented as number (%) unless otherwise indicated.

* The pregnancy outcomes of one participant in the intervention group were unavailable, as she delivered at another hospital. † Birthweight corrected for gestational age and sex.

In the total study population, there was a trend towards less weight gain in women in the intervention group in all BMI subgroups, except for the obese group (those with a BMI >29 kg/m²). Women with a BMI >29 kg/m² before pregnancy were told to gain at least 6.8 kg, but, in accordance with IOM recommendations, these women were not given an upper weight-gain limit, and this advice may explain the lack of effect in this group.⁹ A concerning finding was that in the small group of underweight women in our study, there was a non-statistically significant trend towards gaining less weight than the IOM guidelines ($P=0.06$; adjusted for multiple comparisons, $P=0.01$).

There are two other published randomised controlled trials of interventions to reduce gestational weight gain, both of which showed reduction in some subgroups. These studies included intensive diet and exercise counselling throughout pregnancy and neither were adequately powered (120 and 50 participants, respectively) to demonstrate differences in obstetric or neonatal outcomes.^{8,15}

The limitations of our study include the timing of the first and final weight measurements. The total weight gain in our study was calculated from early pregnancy (≤14

weeks' gestation) until 36 weeks' gestation. Little weight is gained before 12 weeks' or after 36 weeks' gestation, but ideally recruitments should have been before pregnancy, and follow-up continued until labour.¹⁹ Our study was also limited by inadequate power to demonstrate differences in obstetric and neonatal outcomes. Moreover, although our finding of reduced weight gain in overweight women in the intervention group reached statistical significance, this result needs to be interpreted with caution, as it was not a pre-specified endpoint for which the study was appropriately powered.

We did not assess the emotional effect that routine weight measurement had on women during pregnancy, or the effect of self-weighing versus weighing by a health professional. Although weight measurement has been shown to have no impact on depressive symptoms in the general population,¹⁸ this needs to be further assessed in pregnant women.

Additionally, the advice given to the intervention group may have had more impact and authority if it had been delivered by a member of the treating team, rather than a medical student researcher. Thus, our results may give a conservative indication of the effect of regular weight measurement on weight gain during pregnancy.

RESEARCH

All interventional studies conducted thus far have included intensive diet and exercise counselling. An ideal intervention does not affect consultation length, is easy to administer, and is accepted by pregnant women. Our intervention is a simple and inexpensive option for the promotion of appropriate weight gain during pregnancy.

Larger studies are needed to confirm the findings of our study, to establish the effects on obstetric outcomes and thus the safety of the intervention, especially in underweight women, and to determine the long-term effects on postpartum weight.

Our study shows that if overweight women are made aware of their personalised recommended weight gain, and encouraged to monitor and record their weight change over their pregnancy, excessive gestational weight gain may be reduced. This may help decrease the incidence of adverse pregnancy outcomes and postpartum weight retention. Routine weighing and advising women of optimal weight gain should be reconsidered for inclusion into standard antenatal care for overweight women.

ACKNOWLEDGEMENTS

We would like to thank the women who participated in the study and the staff at the Mercy Hospital for Women for their assistance.

COMPETING INTERESTS

None identified.

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REFERENCES

- 1 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.
- 2 Hedderson MM, Weiss NS, Sacks DA, et al. Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia. *Obstet Gynecol* 2006; 108: 1153-1161.
- 3 Oken E, Taveras EM, Kleinman KP, et al. Gestational weight gain and child adiposity at age 3 years. *Am J Obstet Gynecol* 2007; 196: 322.e1-e8.
- 4 Stotland NE, Cheng YW, Hopkins LM, Caughey AB. Gestational weight gain and adverse neonatal outcome among term infants. *Obstet Gynecol* 2006; 108: 635-643.
- 5 Thorsdottir I, Torfadottir JE, Birgisdottir BE, Geirsson RT. Weight gain in women of normal weight before pregnancy: complications in pregnancy or delivery and birth outcome. *Obstet Gynecol* 2002; 99: 799-806.
- 6 Rooney BL, Shauberg W. Excess pregnancy weight gain and long-term obesity: one decade later. *Obstet Gynecol* 2002; 100: 245-252.
- 7 Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: implications of the 1990 Institute of Medicine guidelines. *Am J Public Health* 1993; 83: 1100-1103.
- 8 Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnancy. *Int J Obes Relat Metab Disord* 2002; 26: 1494-1502.

9 Institute of Medicine. Committee on Nutritional Status during Pregnancy and Lactation. Nutrition during pregnancy. Part I: weight gain. Part II: nutrient supplements. Washington, DC: National Academy of Sciences, 1990.

- 10 Parker JD, Abrams B. Prenatal weight gain advice: an examination of the recent prenatal weight gain recommendations of the Institute of Medicine. *Obstet Gynecol* 1992; 79: 664-669.
- 11 Claesson IM, Sydsjö G, Brynhildsen J, et al. Weight gain restriction for obese pregnant women: a case-control intervention study. *BJOG* 2008; 115: 44-50.
- 12 Gray-Donald K, Robinson E, Collier A, et al. Intervening to reduce weight gain in pregnancy and gestational diabetes mellitus in Cree communities: an evaluation. *CMAJ* 2000; 163: 1247-1251.
- 13 Kinnunen TI, Pasanen M, Aittasalo M, et al. Preventing excessive weight gain during pregnancy — a controlled trial in primary health care. *Eur J Clin Nutr* 2007; 61: 884-891.
- 14 Olson CM, Strawderman MS, Reed RG. Efficacy of an intervention to prevent excessive gestational weight gain. *Am J Obstet Gynecol* 2004; 191: 530-536.
- 15 Wolff S, Legarth J, Vangsgaard K, et al. A randomized trial of the effects of dietary counseling on gestational weight gain and glucose metabolism in obese pregnant women. *Int J Obes (Lond)* 2008; 32: 495-501.
- 16 Linde JA, Jeffery RW, French SA, et al. Self-weighing in weight gain prevention and weight loss trials. *Ann Behav Med* 2005; 30: 210-216.
- 17 National Collaborating Centre for Women's and Children's Health. Antenatal care: routine care for the healthy pregnant woman. Clinical examination of pregnant women. London: Royal College of Obstetricians and Gynaecologists, 2003.
- 18 Wing RR, Tate DF, Gorin AA, et al. STOP regain: are there negative effects of daily weighing? *J Consult Clin Psychol* 2007; 75: 652-656.
- 19 Dawes MG, Grudzinskas JG. Patterns of maternal weight gain in pregnancy. *Br J Obstet Gynaecol* 1991; 98: 195-201.

(Received 19 Feb 2009, accepted 6 Aug 2009) □