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Mighty Mums – An antenatal health care intervention can reduce gestational weight gain in women with obesity

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ABSTRACT

Background: overweight and obesity are growing public health problems and around 13% of women assigned to antenatal health care (AHC) in Sweden have obesity (Body Mass Index, BMI ≥ 30). The risk of complications during pregnancy and childbirth increase with increasing BMI. Excessive gestational weight gain (GWG) among obese women further increases the risks of adverse pregnancy outcomes. In this pilot-study from AHC in Gothenburg, a co-ordinated project with standardised care, given by midwives and supported by dietitian and aiming at reducing weight gain in obese pregnant women, is evaluated.

Objective: to evaluate the effects of a behavioural intervention programme for women with BMI ≥ 30, with emphasis on nutrition and physical activity, with regards to GWG and effect on weight at the post partum check-up.

Methods: in the pilot study, the intervention group consisted of the first 50 enrolled obese pregnant women in a large life style project within the AHC in Gothenburg. The control group consisted of 50 obese pregnant women in the same city. The intervention included 60 minutes extra time with the midwife and also offered food discussion group, walking poles and pedometers. The intervention group was prescribed physical activity and could choose from food advice with different content. If needed, the woman was offered referral to the dietitian for a personal meeting. A network was formed with the surrounding community. Outcome measures were GWG, weight change at the postnatal check-up compared with when signing in to antenatal health care, and change in BMI during the same period.

Findings: women in the intervention group had a significantly lower GWG (8.6 ± 4.9 kg versus 12.5 ± 5.1 kg; $p=0.001$) and a significantly lower weight at the postnatal check up versus the first contact with AHC (-0.2 ± 5.7 kg versus $+2.0 \pm 4.5$ kg; $p=0.032$), as well as a decrease in BMI (-0.04 ± 2.1 versus $+0.77 \pm 2.0$; $p=0.037$). More women in the intervention than in the control group managed GWG <7 kg [18 (36%) versus 8 (16%); $p=0.039$].

Conclusion: obese pregnant women adhering to a standardised life style project in primary care using restricted resources can limit their weight gain during pregnancy, and show less weight retention after pregnancy compared to controls.

Abbreviations: AHC, Antenatal Health Care; BMI, Body Mass Index; FoU, Forskning och Utveckling; GD, Gestational Diabetes; GWG, Gestational Weight Gain; HC, Health Care; IOM, Institute of Medicine (USA); IUFD, Intra Uterine Fetal Death; LGA, Large for Gestational Age; MI, Motivational Interviewing; MM, Mighty Mums; PC, Primary Care; PPWR, Postpartum Weight Retention; PTD, Preterm Delivery (born before gestational week 38)

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Introduction

Obesity is acknowledged as a growing threat to the well-being of the pregnant woman during and after pregnancy, and is highly prevalent in women of childbearing age. The proportion of pregnant women with obesity enrolled in antenatal care in Sweden has more than doubled in the past 20 years, during which the age-adjusted average weight of pregnant women has increased from 59.5 kg (body mass index (BMI) 21.7) to 68.2 kg (BMI 24.7) (Brynhildsen et al., 2006). Women's weight at enrolment in antenatal health care (AHC) has thus increased to a high level (Andersson and Fransson, 2011). Of women enrolling in AHC in 2012 in Sweden, 13% had obesity (BMI ≥ 30) and 25% had overweight (BMI ≥ 25) (Socialstyrelsen, 2013). Internationally, the corresponding figures are even higher, e.g. 32% of US women of child-bearing age being classified as obese (Drake and Reynolds, 2010).

Obesity and high gestational weight gain (GWG) are related to an elevated incidence of adverse outcomes for mother and child. The risks increase with the degree of obesity, often persisting after accounting for other confounding factors (Sebire et al., 2001), and present huge challenges for AHC. Hypertensive disorders, including preeclampsia (Baeten et al., 2001; Sebire et al., 2001; O'Brien et al., 2003) and eclampsia (Baeten et al., 2001), are more common, as is gestational diabetes (GD) (Baeten et al., 2001; Lu et al., 2001; Sebire et al., 2001; Torloni et al., 2009; Magann et al., 2013). Need for induction of labour (Sebire et al., 2001; Magann et al., 2013), caesarean childbirth (Parker and Abrams, 1992; Baeten et al., 2001; Sebire et al., 2001; Chu et al., 2007; Magann et al., 2013), increased duration of pregnancy and prolonged duration of labour (Bogaerts et al., 2013) are more frequent, as are pelvic pain (Biering et al., 2011), wound, urinary and genital tract infections (Sebire et al., 2001; Usha Kiran et al., 2005; Magann et al., 2013) and post partum haemorrhage (Sebire et al., 2001; Magann et al., 2013). Venous thrombotic disease (Morgan et al., 2012) occurs more often and the higher prevalence of macrosomia carries an augmented risk for perineal tears (Samuelsson et al., 2002).

There is also an increased risk for a number of other perinatal complications when the mother is obese, such as sporadic and recurrent miscarriage (Lo et al., 2012), intrauterine fetal death (IUFD) (Sebire et al., 2001; Cnattingius et al., 2013), death within the first year (Baeten et al., 2001), preterm delivery (PTD) (Cnattingius et al., 2013) and large for gestational age (LGA) (Magann et al., 2013). Obesity in the mother is associated with an overrepresentation of congenital malformations (Blomberg and Kallen, 2010) that may be difficult to detect in this group (Racusin et al., 2012). Macrosomia leads to an augmented risk of birth trauma and shoulder dystocia (Spellacy et al., 1985) and maternal obesity can lead to metabolic disorders in the baby (Symonds et al., 2013), low Apgar score (Spellacy et al., 1985), longer hospitalisation period and increased risk of admission to the Neonatal Intensive Care Unit (Galtier-Dereure et al., 2000; Chu et al., 2007). Both maternal pre-pregnancy BMI and GWG are positively associated with mean offspring BMI at 3 years of age (Stamnes Kopp et al., 2012), and there is an association between maternal obesity and increased risk of obesity in the offspring, as neonates, children and young adults (Drake and Reynolds, 2010). The woman with overweight is often living in conditions with a generally unhealthy lifestyle, contributing to an elevated risk of diabetes and heart conditions, a lifestyle which is at risk of being inherited (Bearman et al., 2008). High maternal body weight is related with the way of nurturing the child, leading to the child having a higher energy intake (Rising and Lifshitz, 2005), and an association has been found between the mother being obese and the child having a "junk" dietary pattern at 3.5 years of age (Wall et al., 2013).

High GWG is associated with abnormalities in maternal glycaemia, hypertensive disorders, childbirth complications, incipient obesity and adverse cardio-metabolic sequelae, as well as with postpartum weight retention (PPWR) (Herring and Oken, 2010). Elevated GWG is linked to increased fetal growth and subsequent childhood obesity (Herring and Oken, 2010), and GWG is a strong predictor of infant outcomes at birth.

If GWG is limited, the increased risk of complications for both woman and baby can be reduced (Cedergren, 2007; Rasmussen et al., 2010; Blomberg, 2011; Quinlivan et al., 2011). Recommendations for GWG in Sweden are varying and IOM recommendations (IOM, 2009) are only partly used. There is no official consensus, but many AHC's in Sweden use GWG > 6–7 kg as a recommendation when BMI exceeds 30. In a Swedish study population of 298,648 singleton pregnancies, a GWG of maximum 6 kg in obese women was associated with a less increased risk of adverse obstetric and neonatal outcomes (Cedergren, 2007).

Previous research has shown that obese women have more negative attitudes towards being pregnant, as well as more fear of childbirth and less caregiver continuity (Hildingsson and Thomas, 2012). They experience encounters with health care (HC) as negative and unpleasant (Nyman et al., 2010; Furber and McGowan, 2011), and feel that pregnancy is medicalised, with a focus on fetal well-being rather than on the mother and the infant as a whole (Furber and McGowan, 2011). Obese women are more often recommended an excessive GWG, which affects how much they actually gain (Cogswell et al., 1999), and they tend to aim at and expect a GWG that exceeds recommendations (Phelan et al., 2011). In a qualitative study, obese women stated that they need unambiguous advice regarding healthy lifestyle, diet and types of exercise during pregnancy in order to handle the ever-changing media messages and combat unhelpful internal dialogues (Furness et al., 2011).

Pregnancy is often considered a "window of opportunity" with elevated motivation for a change of lifestyle (Thomas, et al. 2014). Diet and physical activity are the main contributors to success with GWG restriction. According to a meta-analysis, physical activity, together with nutritional advice and regular weight surveillance, have shown effect on limiting GWG (Streuling et al., 2010). Several other meta-analyses and systematic reviews have shown that antenatal dietary and lifestyle interventions in pregnant women with obesity reduce GWG, but considerable heterogeneity in methods and outcomes are reported (Gardner et al., 2011; Quinlivan et al., 2011; Tanentsapf et al., 2011; Oteng-Ntim et al., 2012; Thangaratinam et al., 2012).

Against this background, it is essential to investigate whether a lifestyle intervention in primary care (PC) among pregnant women can be successful in restricting GWG. We wanted to test this hypothesis in an everyday practice setting and with limited resources, so that the intervention programme – if successful – could be implemented in routine AHC. The primary aim of this study was to evaluate whether a lifestyle intervention project in AHC, offered to pregnant women with BMI ≥ 30, would result in lower mean GWG and a larger proportion of women with a GWG less than the target of 7 kg, compared to women given standard AHC. Seven kg was chosen as target for GWG in line with other studies (Wolff, et al. 2008; Claesson, 2010), and 6 kg has been shown to be a safe GWG for mother and child (Cedergren, 2007). The secondary aim was to evaluate whether the intervention would result in lower weight at the postnatal check-up two-three months after childbirth, coinciding with the last visit with the midwife according to the regular antenatal programme.

Methods

At AHC centres in Göteborg, Sweden, a three-year co-ordinated lifestyle intervention project, Mighty Mums (MM), was undertaken in 2011–2013 with standardized methods based on midwife consultations and support from a dietitian. The main purpose of the project was to investigate the short- and long-term effects of the intervention on GWG and PPWR. The MM project was approved by the Regional Ethics Committee in Göteborg (October 2010).

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This article reports the results for the first 50 women who completed the study.

Inclusion criteria in the intervention group were BMI ≥ 30 and < 40 at the first AHC visit. Not speaking or understanding Swedish was not an exclusion criterion as interpreter service was offered. Participating in another intervention study, multiple pregnancy, miscarriage, PTD, IUFD, gastric bypass surgery and GD, referral to specialist AHC for other medical reasons or enrolling too late (after gestational week 20) were exclusion criteria (Fig. 1). The 50 control women were chosen in the same way, i.e. with the same exclusion criteria, lived in the same city, enrolled in AHC the same year (2011) and were selected from the Swedish National Maternity Health Register.

The controls were matched for age, parity and BMI class (BMI 30–34.9, BMI 35–39.9). Controls were selected by identifying the woman closest in age, with the same parity and BMI class. Having been invited to participate in the intervention was an exclusion criterion for controls.

Intervention

Both intervention and control groups received regular antenatal care, usually consisting of about 9 visits with the midwife throughout the pregnancy. Regular antenatal care is a midwife support during pregnancy and ends with the post partum visit 2–3 months after childbirth. Apart from laboratory tests and measuring weight, the woman's total health is taken into account. The midwife can give life style advice and when needed refer the woman to psychologist, social worker, physiotherapist or dietitian. The intervention in the project consisted of 60 minutes of extra time with the midwife, including two extra 30-minute appointments early in pregnancy. During the rest of the pregnancy, about 5 minutes of each 30-minute appointment were dedicated to lifestyle follow-up. The women's weight was checked at every appointment. The control women's weight was checked according to the regular antenatal programme, i.e. at enrolment, at weeks 25 and 37 and at the postnatal check-up which was the natural endpoint as the study was carried out at PC level.

The women in the intervention group were offered individualised dietary advice, a prescription for physical activity, walking poles and pedometers, participation in food discussion groups with a dietitian and information about community health centres offering lifestyle education and lighter exercise.

The dietary advice was based on the Swedish Nutritional Recommendations and adjusted to the needs of obese pregnant women. The food groups were offered a combination of lectures and interactive discussions on nutritional and dietary challenges and weight problems, in three 90-minute sessions. The women who preferred not to participate in group discussions had the possibility to see the dietitian individually. The midwives and the women agreed on the type, frequency and duration of the planned physical activity. Examples of activities were walking, swimming, aqua-aerobics, gym sessions and activities that could be performed at home, i.e. dancing, playing with their children and repeatedly walking up- and downstairs.

After including a woman in the intervention group, the midwife received a kit with material, and more information and leaflets could be found on the AHC homepage. A log book was introduced and the woman and the midwife mapped current diet and activity status. The woman was prescribed physical activity and given dietary advice. The log was used throughout the pregnancy to register weight, changes in activity and food, use of walking poles and pedometers, as well as participation in food discussion groups, exercise classes or other matters of interest. At the postnatal check-up, the post partum weight was inserted and the log was completed and returned to the project leader.

Before the start of the project, the midwives who would be engaged with the intervention women were given education about obesity and nutrition and physical activity during pregnancy. They were also trained in Motivational Interviewing (MI) (Emmons and Rollnick, 2001) and learned how to use the log book. A network with the surrounding community was formed and HC providers and doulas (coaching the woman during pregnancy and labour) were contacted to find areas for interaction and support. Cooperation was initiated with community health centres that organised walks and exercise classes especially created for pregnant women, and some municipal sports and recreation facilities offered price reductions at fitness centres and public swimming pools.

Statistical analysis

The descriptive results in the tables are presented as numbers, means (± standard deviation (SD)) and medians (quartiles). Parametric statistics were applied (Student's *t*-test) for comparisons between the intervention and control groups, in which numeric data were normally distributed. Where numeric data were not normally distributed, non-parametric statistics were applied (Mann–Whitney *U*-test, Wilcoxon). For categorical data, Pearson's χ^2 test and Fisher's exact test were applied.

Multiple regression analysis was used to account for confounders in analyses on the effect of the intervention on the primary outcome of weight gain. The significance level was set at 0.05. IBM SPSS Statistics 19 and Microsoft Excel 2010 were used for analysing the data.

Findings

The approach rate, i.e. proportion invited to participate, for the project was 65% and the consent rate was 62%. Descriptive data concerning the participating women's baseline characteristics

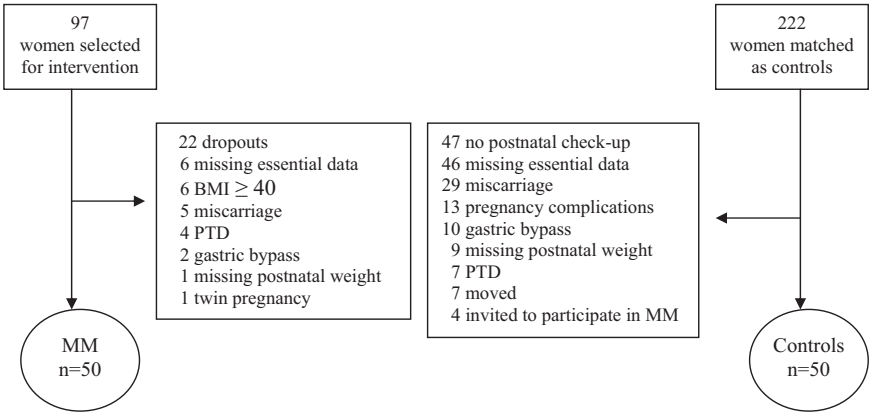

Fig. 1. Flow chart of inclusion and participation in the MM pilot project.

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showed that there were no significant differences between the groups, except language abilities and need for interpreter (Table 1). The baseline weight was derived from the first antenatal visit and BMI is calculated from this weight. Compliance characteristics are shown in Table 2 and weight gain outcomes are shown in Table 3. The women in the two groups had similar mean weight at the end of pregnancy, but as the intervention group had a higher mean weight at enrolment, their GWG was significantly lower than the controls (Fig. 2).

Multiple regression analysis was performed to evaluate effects of possible confounding variables, i.e. (1) use of interpreter, (2) Swedish as first language and (3) level of education. None of these variables exhibited a confounding effect when included in the model. Furthermore, the intervention was significantly associated with GWG ($p < 0.001$), also in the model in which these three variables were included.

Interpreters were used by 15 women, 3 in the intervention group and 12 in the control group. When women using interpreters were compared, the GWG was slightly lower in the intervention group, compared to the control group (8.7 ± 4.9 kg; $p = 0.82$ versus 9.5 ± 5.7 kg; $p =$ ns). There was no difference in GWG between women in the intervention group using interpreters and those who did not (8.7 ± 4.9 kg versus 8.6 ± 4.7 kg; $p =$ ns). However, in the control group, the women using interpreters gained 4.0 kg less than those who did not (9.5 ± 5.7 kg versus 13.5 ± 4.6 kg; $p = 0.04$).

Discussion

The primary aim was to evaluate the effect of a lifestyle intervention on GWG in obese women. The key results are:

In comparison with the control group, the intervention group had significantly lower GWG, significantly lower weight gain per week and significantly lower weight at the postnatal check-up, compared with weight at AHC enrolment. The women in the intervention group had a significantly larger decrease in BMI at the postnatal check-up, compared with enrolment, and more women in the intervention group were successful in gaining less than 7 kg during pregnancy.

Our results are in line with other lifestyle studies, in which effect on GWG has been shown when nutritional advice alone, or combined with physical activity advice, has been given (Wolff et al., 2008; Claesson, 2010; Shirazian et al., 2010; Quinlivan et al., 2011; Vinter et al., 2011; Bogaerts et al., 2012). This has also been reported in many reviews (Gardner et al., 2011; Tanentsapf et al., 2011; Oteng-Ntim et al., 2012; Thangaratinam et al., 2012).

Wolff et al found that pregnant women with BMI > 35 given ten one-hour dietary consultations had lower energy intake and limited their GWG to 6.6 kg, compared to 13.3 kg in the control group (Wolff et al., 2008). This is a larger difference than we found in our study and might be explained by the much more intensive nutritional counselling. Claesson offered women with BMI > 30 weekly visits to the midwife and two aqua-aerobic classes per week, leading to 8.7 kg GWG in the intervention group, compared to 11.3 kg in the control group (Claesson, 2010). We conclude that we achieved better results with a less resource-demanding intervention. Shirazian and co-workers found that pregnant women with BMI > 30, undergoing an intervention with an intensity level similar to ours, had a GWG of 8 kg, versus 16 kg in controls (Shirazian et al., 2010); not so different from our results. Quinlivan and colleagues let pregnant women with BM > 25 see a food technologist and be weighed at every AHC visit, which led to GWG of 7.0 kg, compared to 13.8 kg in the control group (Quinlivan et al., 2011); also quite similar to our results. Vinter et al offered pregnant women with BMI > 30 an intense regimen with fitness centre, physiotherapist and dietitian, which led to a median GWG of 7.0 kg, versus 8.6 kg among controls (Vinter et al., 2011). Compared to the GWG in our study, it might have been expected that such an ambitious intervention would have produced a larger

Table 2
Compliance characteristics in the intervention group.

Mighty Mums Intervention	Mean ± SD		Range
Gestational week at inclusion	11.9 ± 3.0		7–19
Interval from enrolment to inclusion, weeks	2.7 ± 2.4		0–9
Number of log entries (of 7 possible)	6.3 ± 0.9		3–7
	n	**%**	**Range**
Participated in food discussion group (2–3 meetings of 3 possible)	17	34	2–3
Used pedometers	25	50	
Used walking poles	11	22	

Table 1
Baseline characteristics of the participating women at first visit to Maternity Health Care.

Characteristic	Mighty Mums n=50		Controls n=50		*p*
	Mean ± SD	**Range**	**Mean ± SD**	**Range**	
Age (years)	31.7 ± 6.0	19.6–46.3	31.5 ± 6.3	21.1–44.1	ns*
Parity†	1.1 ± 1.3	0–6	1.1 ± 1.2	0–5	ns#
Education†,δ	2.1 ± 1.0	0–3	1.7 ± 1.1	0–3	ns#
Gestational week at enrolment	9.2 ± 2.6	4–17	8.6 ± 3.0	5–20	ns*
Weight at enrolment	90.8 ± 10.2	68–111	87.3 ± 10.0	72–106	ns*
BMI at enrolment	33.1 ± 2.5	29.7–39.3	32.6 ± 2.7	29.6–38.5	ns*
	n	**%**	**n**	**%**	***p***
Parous†	30	60%	30	60%	ns#
Swedish as first language	46	92%	32	64%	0.001¶
Need for interpreter	3	6%	12	24%	0.011¶
Smoker	7	14%	5	10%	ns¶

* Student's *t*-test.
† For clarity, data are presented as mean ± SD, although the variables were ordinal; median (quartiles) for parity: 1 (0.2), for controls: 1 (0.3); median (quartiles) for education: 2 (1.3), for controls: 2 (0.4).
# χ^2 test.
δ 0=incomplete elementary, 1=complete elementary, 2=upper secondary, 3=post-secondary.
¶ Fisher's exact test.

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Table 3
Comparison of intervention on total gestational weight gain, length of pregnancy, gestational weight gain per week, gestational weight gain less than 7 kg, postnatal BMI.

	Mighty Mums		Controls		*p*
	n=50		n=50		
	Mean ± SD	**Range**	**Mean ± SD**	**Range**	
Weight, end of pregnancy (kg)	99.5 ± 10.3	78–120	99.8 ± 10.2	83–121	ns*
Weight gain, total (kg)	8.6 ± 4.9	−1 to +21	12.5 ± 5.1	−1 to +24	< 0.001*
Gestational week, last measurement	37.8 ± 1.4	35–41	37.8 ± 1.6	35–41	
Weight gain/week (from first visit)	0.29 ± 0.2	±0 to +0.7	0.40 ± 0.2	±0 to +0.8	ns*
Weight, postnatal check-up	90.5 ± 10.5	71–114	89.3 ± 9.9	72–113	0.004*
Weight change, postnatal check-up	−0.2 ± 5.7	−12.1 to +10.0	2.0 ± 4.5	−8.0 to +14.0	ns*
BMI, postnatal check-up	33.0 ± 3.1	27.9–40.9	33.3 ± 3.2	28.4–44.1	0.032*
BMI change, postnatal check-up	−0.04 ± 2.1	−4.1 to +4.0	+0.77 ± 2.0	−3.1 to +5.6	ns*
Length of pregnancy, weeks	39.4 ± 1.2	37–42	39.5 ± 1.3	37–42	0.037*
Time from delivery until postnatal check-up, weeks	8.5 ± 3.6	4–15	8.2 ± 7.9	4–18	ns*
					ns*
	n **%**		**n** **%**		***P***
GWG < 7 kg	18 36		8 16		0.039δ

* *t*-test.
δ Fisher's exact test.

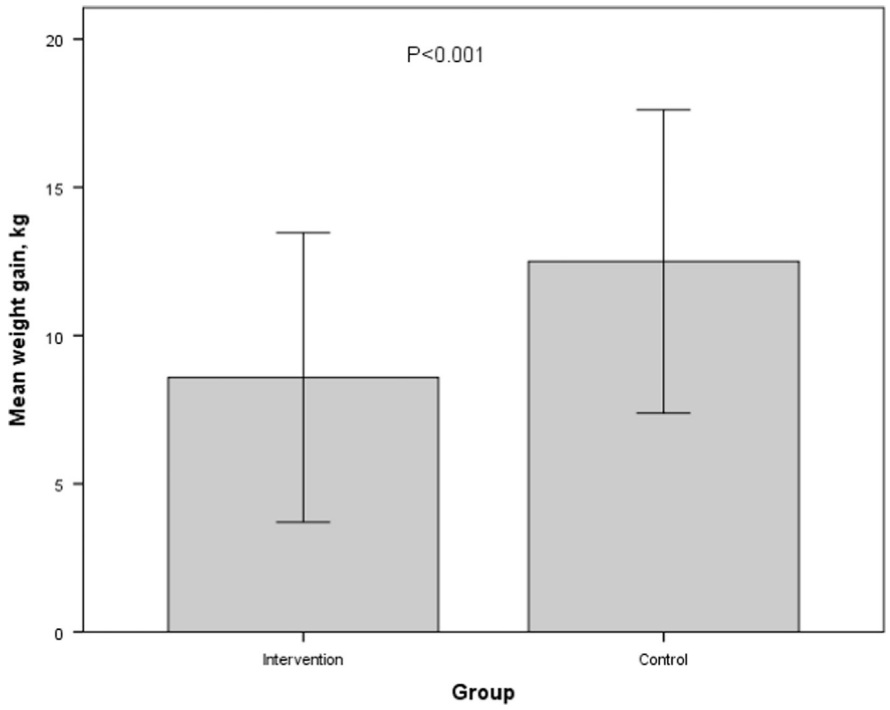

Fig. 2. The mean weight gain (± SD) was significantly lower in the intervention group.

difference. Bogaerts found that pregnant women with BMI > 29 given a brochure had a GWG of 9.5 kg, compared with 10.6 kg in women who had motivating interviews with the midwife and 13.5 kg in the normal-care group (Bogaerts et al., 2012). The results of these trials seem to indicate that the effect of obtaining information from brochures, seminars and websites (Shirazian et al., 2010; Vinter et al., 2011; Bogaerts et al., 2012) should not be underestimated and that large and lavish interventions (Claesson, 2010; Vinter et al., 2011) do not always yield the best results.

It is not possible to determine which parts of our intervention that contributed to the significant difference in GWG between the intervention and control groups, i.e. the variety of support and activities, the possibility to choose participation at their own preferred level and according to their wishes, extra time with the midwife, sessions with a dietitian, prescription of physical activity, food pamphlets, the possibility to take part in health centre offers and activities, being offered and using pedometers and walking poles and/or registering food and physical activity. The diversity of offered activities may have been a favourable factor. Also, the mandatory weighing in our study has been shown to be a successful method (Quinlivan et al., 2011).

There are several patient- and provider-level factors that limit success in restricting GWG. The woman's acceptance of her actual weight and lack of motivation for lifestyle change, as well as sensitivity to being scrutinised and observed in connection with her weight, negatively impact success at maintaining GWG within the recommended limits (Nyman et al., 2010; Phelan et al., 2011). Lacking proper knowledge of BMI-based definitions of obesity, as

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well as limited time, unclear assignment and reimbursement factors, can impede the midwife in correctly counselling pregnant women on making lifestyle changes (Herring et al., 2010). Feeling confident in giving advice on GWG and personal body satisfaction are also important predictors of higher guideline adherence among practitioners (Herring et al., 2010). In order to manage obese pregnant women efficiently and with dignity, the midwives should have access to nutrition and lifestyle expertise. Studies show that between 14% (Herring et al., 2010) and 66% (Huurre et al., 2006) of AHC staff referred patients to a nutritionist, the lower number probably because nutritional expertise is often randomly available and a scarce resource in AHC. In our setting, the midwife had access to expertise concerning nutrition, physical activity and motivational interviewing, which probably contributed to the success of the project.

The number of visits to the midwife did not differ between groups. It might be assumed that a woman in the intervention group would have spent more total time with her midwife, considering the extra two visits included in the project. However, both groups made the same total number of visits to the midwife, which may have different explanations. The care provided in the intervention might have reduced anxiety, either because of the extra opportunities to discuss with the midwife or because the intervention itself had a positive and empowering effect that reduced the need for extra visits. Meeting and bonding with the midwife at the beginning of pregnancy when there are many questions and everything is new, especially for the nullipara, may be another explanation. The women in the intervention group might also have been able to handle some of their issues more easily with caregivers from other professions, such as the dietitian and other HC providers. They might also have been more physically active, alone or together with others, which might have had a positive effect on their well-being. The opportunity to meet other participants in the intervention group activities may also have contributed to well-being.

One strength of this study is that it was conducted under real-life circumstances, i.e. under everyday PC conditions. Another strength is that the midwives are not involved in the project due to extra interest or motivation, but are instead representative of the ordinary AHC staff. Also, the women who were eligible for the original project were from geographically and socio-economically similar parts of the city as controls.

The intervention group and control group were matched for age, parity and BMI class and did not differ significantly regarding week at AHC enrolment, smoking or education. A possible source of bias is that the controls were less fluent in Swedish and required interpreters to a greater extent. This may have negatively affected their ability to keep GWG within the recommended limit, due to difficulties in understanding and assimilating the midwives' information and advice. Hence, using an interpreter and speaking Swedish as the first language were evaluated as possible confounders. Multiple regression analysis showed that the intervention still had a significant effect on weight change when language and use of interpreter had been controlled for. This is an interesting finding, as the current perception is that it is difficult to reach women with minority ethnicity, language or culture. Women in the control group using interpreters had significantly lower GWG (3.9 kg) than women in the control group who did not. When women in the intervention and control groups using interpreters were compared, there was no significant difference in GWG, i.e. there seems to have been no study effect among the women using interpreters, which might explain why the differing use of interpreters between the groups did not affect the main finding. This might be due to the fact that midwives in areas with a high percentage of women with other first languages than Swedish have had to develop certain professional skills with regard to lifestyle issues. When discussing the effect of interpreters, the fact that the number of women using interpreters was much lower in the intervention group (three women) than in the control group (12 women) must be taken into account.

The skills to handle lifestyle issues in areas with lower socio-economic status can arise from experience with managing the heavier burden of medical and psychological conditions in these areas, and may have balanced the effect of the project on the GWG outcome among women using interpreters. These women and their children might also have been reached by other ongoing health projects targeting nutrition, physical activity and weight in lower-resource areas, which may have had an effect on GWG. Whether women of non-Swedish origin have more respect for authorities is uncertain, but the midwife can be an important person for a woman who is new to the country and the HC system. Stigmatisation around obesity might also be less for women coming from countries where food is scarce and being thin is not the body ideal.

There are several limitations associated with the methods used in this study. The study was not randomised, due to the design of the project as funding was limited. As in all prospective observational studies, there is an obvious risk of bias. On the other hand, we believed that the simplicity of an observational design would increase the willingness of both midwives and women to participate. A likely selection bias is that the most motivated and probably most capable women opted to join the project. It is very likely that the midwives inviting the women were more comfortable in dealing with lifestyle issues and that the women accepting participation were more ready to cope with lifestyle changes. This did not apply to the control group in the pilot study being evaluated here, as controls were selected from the National Maternity Health Register and were not involved in the project at all, which could be an additional strength – or a limitation because of selection bias. Another limitation is that all pregnant women with BMI >30 were intended to be reached by the project, as there is almost 100% attendance in to AHC in Sweden. However, it turned out that only 65% were invited to participate. This low approach rate might be due to midwives neglecting or abstaining from informing about the project, or simply forgetting due to a heavy workload. The fact that not all midwives and staff feel comfortable in addressing obesity (Nyman et al., 2010; Furber and McGowan, 2011; Hildingsson and Thomas, 2012) may explain why the approach rate was only 65%. The consent rate of 62% may be explained by the women not wanting or feeling able to adhere to the intervention, or being less health-conscious. Obese women have reported more negative attitudes towards being pregnant (Hildingsson and Thomas, 2012), as well as more unpleasant experiences from attending AHC (Nyman et al., 2010; Furber and McGowan, 2011). The study was not powered to find differences other than GWG, but as weight is a recognised proxy for pregnancy complications, a lower GWG has a clear clinical significant value as discussed in the introduction.

In conclusion, our study shows that it is possible to guide the woman in AHC toward lifestyle changes that decrease GWG with a modest and economically realistic endeavour, undertaken with simple measures possible to adhere to after pregnancy as well. These changes in everyday living are favourable for the future of the woman, the child and the growing family. The findings suggest that obese pregnant women adhering to and fulfilling a short-term, standardized lifestyle project during pregnancy can limit their GWG and exhibit less weight gain after pregnancy, compared to controls. Optimal management of obesity in pregnancy includes informing about and supporting appropriate GWG, giving advice on diet and physical activity early in pregnancy, monitoring weight regularly and discussing diet and physical activity with the midwife or other professionals throughout pregnancy. Our project contributes with the knowledge that a simple toolbox can help substantially in combatting the huge and increasing challenge of overweight and obesity in pregnancy. Randomised interventions focusing on identifying women at risk of excessive weight gain during pregnancy and finding methods for taking care of them should be initiated. It is also of great interest to investigate how the woman's

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weight is affected in a longer perspective, how the baby's birth weight and weight development can be affected by different types of lifestyle interventions, and how short- and long-term weight and other outcomes for both mother and baby can be influenced.

Conflict of interest

None of the authors declare any conflict of interest in relation to this article.

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