Short Communication

Benefits of repeated individual dietary counselling in long-term weight control in women after delivery

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Abstract

As pregnancy may trigger overweight in women, new means for its prevention are being sought. The aim here was to investigate the effect of individual dietary counselling during and after pregnancy on post-partum weight and waist circumference up to 4 years post-partum. A cohort of women ($n = 256$) were randomized to receive repeated individual dietary counselling by a nutritionist during and after pregnancy, or as controls not receiving dietary counselling, from the first trimester of pregnancy until 6 months after delivery. Counselling aimed to bring dietary intake into line with recommendations, with particular focus on the increase in the intake of unsaturated fatty acids instead of saturated. Pre-pregnancy weight was taken from welfare clinic records. Weight and waist circumference were measured at 4 years after delivery. The proportion of overweight women increased from 26% prior to pregnancy to 30% at 4 years after delivery among women receiving dietary counselling, as against considerably more, from 32% to 57%, among controls. The prevalence of central adiposity was 31% in women receiving dietary counselling, 64% in controls. Likewise, both the risk of overweight (odds ratio: 0.23, 0.08–0.63, $P = 0.005$) and central adiposity (odds ratio: 0.18, 0.06–0.52, $P = 0.002$) were lower in women receiving dietary counselling compared with controls. Repeated dietary counselling initiated in early pregnancy can be beneficial in long-term weight control after delivery.

Keywords: individual dietary counselling, long-term weight control, women, after delivery.

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Introduction

In women, pregnancy may trigger the development of overweight and further obesity which are related to risk of diseases (Bahia *et al.* 2012). Especially, central adiposity is the main indicator for type 2 diabetes and cardiovascular diseases (Siren *et al.* 2012). Weight gain during pregnancy enables normal growth of the fetus and prepares the mother for lactation by storing fat in maternal deposits (Butte & King 2005). Several factors such as overweight prior to pregnancy, excessive weight gain during pregnancy (Mannan *et al.* 2013, Nehring *et al.* 2011) and dietary intake as well as

physical activity (Ostbye *et al.* 2012) influence the recovery of the mother from pregnancy and further from the risk of overweight and obesity.

This study focused on the impact of dietary counselling during and after delivery and its effect on long-term maternal weight and adiposity. Previous studies have shown that dietary changes may be achieved by dietary counselling (Ostbye *et al.* 2009), and this again is useful in weight control at 6 months (Tanentsapf, Heitmann & Adegbove 2011) and 1 year after delivery (O'Toole *et al.* 2003). We have previously shown that dietary counselling with probiotic capsules decreases central adiposity of women over 1 year

after delivery (Ilmonen *et al.* 2011). The aim here is to examine whether this effect extends in long-term, 4 years after delivery.

Materials and methods

Subjects and study design

A cohort of 256 women was recruited for the study in the city of Turku and neighbouring areas in South-West Finland. A more detailed description of recruitment has previously been presented (Laitinen *et al.* 2009) (clinicaltrials.gov as NCT 00167700, section 3). Written informed consent was obtained from the participants, and the study protocol was approved by the Ethics Committee of the Hospital District of South-West Finland. All women attended regular follow-up visits for standard health and dietary counselling given by nurses according to a national programme in the Finnish welfare clinics.

Background data on age, education and parity as well as smoking were collected by interview. At the first trimester of pregnancy, the pregnant women were randomly assigned to three study groups according to computer-generated block randomization. The allocation was 1:1:1 and the block size were six women. Two groups received dietary counselling (with probiotics or placebo) given by a nutritionist and one group was controls group without counselling (with placebo). Dietary counselling was provided at each visit, three times during pregnancy and 1 and 6 months and 1, 2 and 4 years after delivery. Dietary counselling focused especially on increasing in intake of unsaturated fatty acids and restricting intake of saturated fatty acids below 10% of energy. The mothers in dietary counselling groups were provided with conventional food products with favourable fat content to be used at

home, including spreads and salad dressing from the beginning of pregnancy until 6 months after delivery. Dietary counselling was executed individually by consideration of individual's body weight – in overweight women dietary advice was given on regular meal frequency, smaller portion sizes and reduction in consumption of sweet or savoury delicacies. In all women in the dietary counselling groups, the dietary advice highlighted choice of foods so that recommended diet would be fulfilled also considering the individual's preferences. The subjects were encouraged to increase their consumption of vegetables, fruits and whole grain bread and cereals, to consume leaner meat products low-fat cheese and milk products and to use vegetable oil or soft margarine as a spread and in food preparation. Fish was recommended as one of the main meals twice a week. Practical individual dietary advice was given taking into consideration the mothers' current dietary habits.

The randomization to receive probiotics (*Lactobacillus rhamnosus* GG, ATCC 53 103, Valio Ltd, Helsinki, Finland and *Bifidobacterium lactis* Bb12, Chr. Hansen, Hoersholm, Denmark, 10^{10} colony-forming units day⁻¹ each) or placebo (microcrystalline cellulose and dextrose anhydrate; Chr. Hansen) occurred in double-blind manner and controls to receive placebo in single-blind manner as previously described (Laitinen *et al.* 2009). Capsules were consumed from the first trimester of pregnancy until the end of exclusive breastfeeding, a maximum of 6 months after delivery.

Measures

Height was measured at the first study visit, while weight was measured on a calibrated scale at each study visit and waist circumference from the narrow-

Key messages

- The proportion of overweight women increased from 26% prior to pregnancy to 30% at 4 years after delivery among women receiving dietary counselling compared with 32% to 57%, among women not receiving dietary counselling.
- Both the risk of overweight and central adiposity at 4 years after delivery were lower in women receiving dietary counselling compared with women who are not.
- Overweight prior to pregnancy and excessive gestational weight gain during pregnancy predict weight retention after delivery.

est section of the waist after delivery by trained nurses. Pre-pregnancy body weight was taken from welfare clinic records. Body mass index (BMI) was calculated as weight (kilograms) divided by the square of height (m^2). Central adiposity was defined as a waist circumference of 80 cm or more, which has been found to be related to an increased risk of Western diseases (International Diabetes Federation 2005). Women were considered normal-weight when BMI was below 25 and overweight when BMI was 25 or more according to the World Health Organization reference (WHO 2011).

Participants' dietary intake during pregnancy and after delivery was assessed from 3-day food diaries including one weekend day at each study visit. The subjects were given personal and written instructions on recording food diary with household measures. The records were reviewed for completeness and accuracy with the aid of a portion picture booklet.

Daily intakes of energy and nutrients were calculated using the program Micro-Nutrica, version 2.5. (Research Centre of the Social Insurance Institution, Turku, Finland). All mothers were given written numeric feedback on the food diary whereas women receiving dietary counselling were given oral and written numeric and verbal feedback with proposals on how to improve dietary intake closer to the recommendations. Feedback included intakes of energy and energy yielding nutrients and vitamins and minerals (e.g. vitamins A, C, E and D, folic acids, calcium, iron, fibre and salt) with reference to that recommended. Practical advice on choice of foods to improve the diet was provided.

Statistical analysis

Of the women recruited at the first trimester of pregnancy, 49% (125 of 256) were followed-up till 4 years after delivery; 50% (86 of 171) in intervention groups and 48% (41 of 85) in control group. After excluding the eight women who were pregnant again, the completed cases population comprised 117 (46%) mothers. The missingness mechanisms were studied closer and the missing measurements were imputed in order to conduct the intention-to-treat (ITT) analysis. The last observation carried forward (LOCF) imputa-

tion method was assessed to be appropriate, because at least one follow-up measurement after delivery was available in 90% of mothers vs. multiple imputation methods would be based on 46% of mothers only. In LOCF, the last non-pregnant BMI and waist circumference measurements were included.

The Kaplan–Meier analysis with log-rank test was used to compare the groups with respect to the actual follow-up time and the Chi-squared test was used to compare the lost to follow-up rates.

The baseline homogeneity of study groups was analysed. Analysis of variance (ANOVA) was used for continuous variables and the Chi-squared test for categorical baseline variables. As there was a significant difference between the three study groups in BMI prior to pregnancy (ANOVA $P = 0.047$), group comparisons were adjusted for BMI prior to pregnancy. Smoking and total duration of breastfeeding had no significant effect on BMI, waist circumference, overweight or central adiposity.

The BMI and waist circumference at 4 years after delivery were the primary variables. They were classified into two categories ($\text{BMI} \geq 25 \text{ kg m}^{-2}$ vs. $< 25 \text{ kg m}^{-2}$ and waist circumference $\geq 80 \text{ cm}$ vs. $< 80 \text{ cm}$, respectively). Logistic regression analysis was used to assess the effect of dietary counselling with respect to the prevalence of $\text{BMI} \geq 25 \text{ kg m}^{-2}$ and waist circumference $\geq 80 \text{ cm}$. BMI prior to pregnancy was included as a dichotomous or as a continuous covariate, respectively. The results are given as adjusted odds ratios (ORs) with 95% confidence intervals (CIs).

Analysis of covariance was used as a secondary approach in which the continuous BMI and waist circumference were compared between study groups and the BMI prior to pregnancy was included as a continuous covariate. The results are given as adjusted means with 95% CIs. Also the within-subject BMI changes (from pre-pregnancy BMI) were calculated and analysed using ANOVA. The three pairwise group comparisons were Bonferroni-corrected. The possible effect of breastfeeding was also checked. In all analyses, the dietary counselling groups were combined as differences between women receiving dietary counselling with or without probiotics were non-significant. The main results are given for the 117

mothers without imputation (A; complete cases) and the 230 mothers with or without imputation (B; complete cases + imputed cases). Analysis was performed using IBM SPSS (version 20, SPSS Inc., Chicago, IL, USA).

Results

The mean BMI of the women was 23.5 kg m⁻² (ranged 17.4–34.8) and the prevalence of overweight was 28.2% prior to pregnancy. The mean age of the women was 30.7 (21.2–41.8) years, 50% held an academic degree and 60% were primigravidas at baseline. The clinical characteristics of the randomized population (*n* = 256) and the complete cases (*n* = 117) in the different study groups are presented in Table 1. Lost to follow-up was not significantly associated to study group, mother's age, number of children, education, smoking or BMI prior to pregnancy. However, in women with shorter (<9 months) duration of breastfeeding, the lost to follow-up rate was higher than in those with longer duration. After imputation,

the data were available from 230 mothers at 4 years after delivery, which is 90% of the ITT population. The reasons for interrupting the study were migration to an outer locality, scheduling conflicts, illnesses and diseases in mother or child. The lost to follow-up rates during the follow-up time were 52.9, 45.9 and 54.7% among control, diet/probiotics and diet/placebo groups, respectively. The difference between groups was non-significant (Chi-squared test, *P* = 0.478). Also the difference between the follow-up times was non-significant (Kaplan–Meier analysis, log-rank test, *P* = 0.455).

BMI (kg m⁻²) and waist circumference (cm)

In the group of complete cases (group A), the women receiving dietary counselling had lower mean BMI and mean waist circumference (adjusted for BMI prior to pregnancy) compared with controls at 4 years after delivery (Table 2). The treatment difference was −1.7 kg m⁻² (95% CI −2.4 to −0.9, *P* < 0.001) for BMI

Table 1. Clinical characteristics of 117 women (A) who followed-up in the study until 4 years after delivery and of all 256 randomized women (B) are presented in the different study groups at baseline. Results for groups (A and B) are given as mean (range) or % of subjects

	Control		Dietary counselling with probiotics		Dietary counselling with placebo	
	Group A (<i>n</i> = 37)	Group B (<i>n</i> = 85)	Group A (<i>n</i> = 43)	Group B (<i>n</i> = 85)	Group A (<i>n</i> = 37)	Group B (<i>n</i> = 86)
Prior to pregnancy						
Smoker	37.8	36.9	28.6	29.8	40.5	45.3
Body mass index (BMI; kg m ⁻²)	23.7 (18.0–31.8)	23.7 (18.0–33.3)	22.5 (17.4–31.8)	22.9 (17.4–31.8)	24.3 (19.0–34.8)	24.3 (18.2–40.7)
Overweight (BMI ≥ 25 kg m ⁻²)	32.4	30.6	18.6	18.8	35.1	34.9
At baseline						
Age (years)	30.9 (23–42)	30.2 (17–41)	29.9 (21–38)	29.7 (20–37)	31.4 (24–41)	30.1 (17–44)
Number of children						
0	56.8	55.3	67.4	63.5	54.1	52.3
1	18.9	24.7	27.9	27.1	32.4	26.7
≥2	24.3	20.0	4.7	9.4	13.5	20.9
College or university education	43.2	47.1	59.5	48.8	45.9	40.7
Duration of breastfeeding (month)*						
Exclusive	3.8 (0–6.0)	3.5 (0–6.3)	3.5 (0–6.0)	4.0 (0–8.0)	4.5 (0–6.5)	4.0 (0–6.5)
Total	10.5 (1–18)	8.8 (1–24)	8.0 (0.5–18)	8.0 (0.5–18)	11.5 (2–36)	10.0 (0–36)

*Median (range).

Table 2. BMIs and waist circumferences and proportion of women with overweight (BMI ≥ 25) and central adiposity (waist circumference > 80 cm) with adjusted BMI prior to pregnancy at 4 years after delivery presented in the three study groups and in the combined dietary counselling group

		Control	Dietary counselling with probiotics	Dietary counselling with placebo	ANCOVA* <i>P</i>	Combined dietary counselling group
A	BMI (kg m ⁻²)	<i>n</i>	37	43		37
		Adjusted mean	25.6	24.3 ²		23.6 ³
		95% CI	25.0–26.3	23.7–24.9		22.9–24.2
	Change from BMI prior to pregnancy (kg m ⁻²)	Mean	2.1	0.8 ²		0.1 ³
		95% CI	1.4–2.9	0.3–1.3		–0.5–0.8
	BMI ≥ 25 kg m ⁻²	%	56.8	20.9		40.5
	Waist circumference (cm)	<i>n</i>	33	40		37
		Adjusted mean	82.8	77.7 ²		78.4 ²
		95% CI	80.8–84.9	75.9–79.6		76.4–80.3
	≥ 80 cm	%	63.6	25.0		37.8
B	BMI (kg m ⁻²)	<i>n</i>	74	79		77
		Adjusted mean	25.0	24.5		24.4
		95% CI	24.6–25.5	24.1–25.0		23.9–24.8
	Change from BMI prior to pregnancy (kg m ⁻²)	Mean	1.5	1.0		0.9
		95% CI	1.0–2.0	0.6–1.3		0.4–1.4
	BMI ≥ 25 kg m ⁻²	%	45.9	26.6		36.4
	Waist circumference (cm)	<i>n</i>	71	75		73
		Adjusted mean	80.0	78.6		79.1
		95% CI	78.7–81.4	77.3–79.9		77.8–80.4
	≥ 80 cm	%	53.5	26.7		35.3

The results are given in the group of complete cases (A, $n = 117$) and in the group where the missing values in BMI and waist circumference were imputed using LOCF (B, $n = 230$).

ANCOVA, analysis of covariance; BMI, body mass index; CI, confidence interval; LOCF, last observation carried forward.

*Control vs. dietary counselling with probiotics vs. dietary counselling with placebo groups was compared using ANCOVA, where the BMI prior to pregnancy was included as a covariate.

Bonferroni-corrected comparisons vs. the control group: ² $P < 0.05$, ³ $P < 0.001$.

and -4.8 cm (95% CI -7.2 to -2.4 , $P < 0.001$) for waist circumference. Compared with the situation prior to pregnancy, BMI increased less in the dietary counselling groups (0.5 units) compared with the controls (2.1 units) by 4 years after delivery ($P < 0.001$, Table 2A.) In the larger group B (complete cases + cases with imputed missing values), the treatment difference was -0.6 kg m⁻² (-1.1 to -0.01 , $P = 0.045$) for BMI and -1.2 cm (-2.7 to 0.5 , $P = 0.156$) for waist circumference. The changes from BMI prior to pregnancy were 0.9 and 1.5 kg m⁻² in dietary counselling and control groups, respectively ($P = 0.040$, Table 2B).

Overweight (BMI ≥ 25 kg m⁻²) and central adiposity (waist circumference ≥ 80 cm)

In group A, the prevalence of overweight and central adiposity were lower in women receiving dietary counselling when compared with controls at 4 years

after delivery (Table 2A). Specifically, the proportion of overweight women increased in the period prior to pregnancy to 4 years after delivery from 26% to 30% among women receiving dietary counselling, as against considerably more, from 32% to 57%, among controls (Table 1 and 2). Summarizing the factors affecting weight and central adiposity at 4 years after delivery, overweight prior to pregnancy was found to be the main predictor (OR 27.1, 8.4–87.2, $P < 0.001$). Further, the women receiving dietary counselling carried a significantly lower risk of overweight compared with controls (OR 0.23, 0.08–0.63, $P = 0.005$) when overweight prior to pregnancy was included as a simultaneous random factor. The BMI-adjusted risk of central adiposity was significantly lower in women receiving dietary counselling compared with controls (OR 0.18, 0.06–0.52, $P = 0.002$). In group B, overweight prior to pregnancy was still found to be the main predictor for overweight and central adiposity

at 4 years after delivery (OR 55.2, 21.1–144.2, $P < 0.001$). Again, the risk for overweight and central adiposity was lower in women receiving dietary counselling compared with controls (OR 0.43, 0.19–0.94, $P = 0.034$ and OR 0.31, 0.15–0.66, $P = 0.002$, respectively). Consumption of probiotics during 6 months after delivery provided no additional benefit for weight control at 4 years after delivery.

In addition, women (group A) gaining weight during pregnancy according to or less than the recommendations had lower mean BMI (23.0) at 4 years after delivery compared with women gaining weight above than the recommendations (BMI 26.1) ($P < 0.001$). Overweight prior to pregnancy was a significant predictor for excessive weight gain during pregnancy ($P < 0.001$). Duration of breastfeeding had no significant effect on BMI, waist circumference, overweight or central adiposity in univariate analysis (data not shown). Pregnancy weight gain did not, however, influence the beneficial impact of dietary counselling on BMI or waist circumference.

Discussion

In this follow-up study, we found individual dietary counselling during and after pregnancy to be effective in weight and adiposity control at 4 years after delivery. Evidence concerning the association between dietary counselling and maternal long-term weight retention after delivery is scarce. However, it has previously been shown that lifestyle changes, including both dietary intake and exercise, are useful in reducing weight until 1 year after delivery (Amorim, Linne & Lourenco 2007, van der Pligt *et al.* 2013; Ash *et al.* 2006; Keller *et al.* 2008; Kuhlmann *et al.* 2008), but no intervention effect on long-term weight and central adiposity control has hitherto been reported. Here, we evaluated long-term effect of dietary intervention on weight control. We also examined central adiposity, a key risk factor for type 2 diabetes and cardiovascular disease (Siren *et al.* 2012), by simple measure of waist circumference and found a benefit by counselling. In addition, we observed as previously found that overweight prior to pregnancy (Montpetit *et al.* 2012) and excessive gestational weight gain during

pregnancy (Nehring *et al.* 2011; Mannan *et al.* 2013) predict weight retention after delivery.

A limitation to the study is the estimation of the body weight prior to pregnancy, which is from welfare clinic records instead of measuring the weight in the study. Further limitation is the large proportion of women that was lost to follow-up by 4 years after delivery, 54% of the original study population. The reasons for dropping out from the study were, however, similar among the study groups although possibility for bias exist (Bell *et al.* 2013). One exception was breastfeeding, since more women who breastfed less than 9 months left the study compared with those who breastfed longer. This may be one explanation for why less significant differences between the study groups were detected in the ITT analyses. Longer duration of breastfeeding may protect from the post-partum weight retention (Baker *et al.* 2008). Nevertheless, although less significant differences in BMI and waist circumference between dietary counselling and control groups were seen in the ITT analysis, the BMI and waist circumference were still lower in women who received dietary counselling but non-significantly. The significant difference was seen between the study groups in BMI and waist circumference when overweight prior to pregnancy was taken into account. It must be considered that the imputation itself as a method to account for the lost to follow-up may introduce an error to the study. LOCF analysis used at this study may under- or overestimate the results causing also bias for CIs (Cook, Zeng & Yi 2004).

The subjects in the present study received individual oral and written feedback with proposals on how to improve dietary intake from a food diary as completed at all study visits. This may enhance the self-monitoring of diet and thus increase weight loss. However, in our study, controls also received numeric feedback on their food diaries, which may have reduced the difference in dietary intake and BMI and waist circumference between women with dietary counselling and women without.

By adding a probiotics intervention to the dietary counselling, a reduction in central adiposity was achieved at 1 year after delivery (Ilmonen *et al.* 2011). As shown here, this effect was transient, whereas

that of dietary counselling lasted until 4 years after delivery. Dietary counselling possibly altered dietary intake more permanently. Thus, dietary intervention has a longer-lasting effect on weight control than probiotic supplementation.

Conclusion

Nutrition counselling, initiated in early pregnancy and implemented repeatedly but relatively rarely, one to three times a year, resulted in beneficial changes in weight and waist circumference at 4 years after delivery. The simple method (Michie *et al.* 2009) of individual feedback with proposals for improvement diet on food diaries adopted in our study may constitute a supportive and motivational tool to modify individuals' lifestyles. This study thus offers new angles on maternal weight control after delivery. We therefore suggest that a small investment in developing and intensifying the current dietary counselling (Ilmonen *et al.* 2012) in health care clinics, in which a large proportion of families are reached, might help in halting the progress of the overweight epidemic, possibly achieving long-term health effects on the whole family.

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Conflict of interest

The authors declare that they have no conflicts of interest.

Contributions

KL, EI and JJ were responsible for the design of the study and organization of data collection. JJ contrib-

uted to data collection. TP conducted the statistical analyses. KL and JJ analysed the data and wrote the first draft of the paper. All authors contributed to the writing and revision of the manuscript and approved the final draft.

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