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CLINICAL RESEARCH

Lifestyle After Bariatric Surgery: a Multicenter, Prospective Cohort Study in Pregnant Women

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Abstract

Background To ensure a good pregnancy outcome after bariatric surgery, a healthy life-style and a multidisciplinary prenatal follow-up is recommended. The aim of this prospective multicenter trial was to compare diet quality and physical activity (PA) of pregnant women with bariatric surgery with current lifestyle recommendations.

Methods Pregnant women (>18 years, prepregnancy BMI 28±6 kg/m², 39 % nulliparae, 25 % smokers) with a history of bariatric surgery were recruited and allocated to two groups according to surgery type: restrictive (N=18) and bypass group (N=31). One 7-day dietary record and one Kaiser questionnaire on PA were collected during the first and second trimester. Dietary quality was assessed using the Healthy Eating Index.

Results The diet quality did not change during pregnancy (restrictive group p=0.050; bypass group p=0.975) and was comparable between groups (first trimester p=0.426; second trimester p=0.937). During the first trimester, 15 % of the pregnant women had a healthy diet quality, 82 % had a diet that needed improvement, and 3 % had a poor diet quality. This was independent of surgery type and was comparable in the second trimester (p=0.525). No difference between groups was observed for the PA level, but the PA level in the bypass group significantly decreased from the first to the second trimester (p=0.033).

Conclusions Nutritional advice and lifestyle coaching in this high-risk population seems recommendable since only 15 % of the pregnant women had a healthy diet quality, 25 % was smoking at the beginning of pregnancy, and the reported PA levels were low.

Keywords Bariatric surgery · Pregnancy · Vitamins · Dietary habits · Healthy eating index · Physical activity

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Introduction

Bariatric surgery has been proven to efficiently reduce body weight and consequently reduce or even resolve obesity-related medical conditions such as diabetes, hypertension, and sleep apnea [1]. In general, this improves general quality of life of the patients [2]. However, bariatric surgery is on the short term also associated with a risk for surgical complications (e.g., internal hernia and anastomotic strictures). On a longer term, there is a chance for weight regain, but also food aversions, nausea, and vomiting may occur consequently leading to the development of nutritional deficiencies [3, 4]. Behavioral changes such as increasing physical activity level, consuming a varied and healthy diet and applying modified eating behaviors are necessary to avoid the long-term risks mentioned above [5, 6]. Bariatric surgery can therefore be considered a “forced behavioral modification” since changes made to the digestive tract in essence require patients to change their eating pattern [7].

However, noncompliance to the postoperative behavioral modification and to the use of dietary supplements is high; follow-up rates vary from 10 to 45 % [8]. Once the surgery is completed and weight loss is induced, patients may abate their motivation to change their unhealthy preoperative life-style [8]. A pregnancy could enhance the perceived value of a healthy life-style since women are then not only becoming aware of their future function as a role model for their child, but pregnancy may also prompt feelings of fear about the well-being of the fetus [9]. When women with bariatric surgery become pregnant, the risk for a sub-optimal nutritional status is higher given the increased nutritional requirements [10]. Previous studies indicate that the dietary modifications made by women when becoming pregnant are mostly food safety measures (e.g., avoiding raw meat) instead of diet quality improvements [11–13]. The macro- and micronutrient intake of obese pregnant women has been shown to fare from the recommended intake [14]. Given the results of these previous studies in pregnant women and the high noncompliance to behavioral modification after bariatric surgery [8], we hypothesize that the life-style of pregnant women with bariatric surgery are inadequate. The aim of this study was therefore to compare diet quality and physical activity of pregnant women with bariatric surgery with current lifestyle recommendations.

Certain complications are specific to the mode of action of a bariatric surgery type: dumping and endogenous hyperinsulinaemic hypoglycaemia are observed after a gastric bypass [15], whereas vomiting and regurgitation are more frequently related to a gastric band [16]. The food choices to avoid these complications could therefore also be surgery specific. The nutritional status in gastric bypass patients may also worsen depending on the degree of malabsorption [4]. A secondary aim is therefore to compare the dietary habits of pregnant women according to bariatric surgery procedure.

Methods

Design

This study is part of a large prospective follow-up study (PABAS-project: Pregnancy After Bariatric Surgery) conducted from April 2009 until January 2011 at the antenatal clinics of five hospitals in the region of Flanders, Belgium (Diest General Hospital, Virga Jesse Hospital Hasselt, Ziekenhuis Oost Limburg Genk, Gasthuiszusters Antwerpen, campus Sint-Augustinus Wilrijk, and University Hospitals Leuven). The study protocol was approved by the central and local ethical committees. All participants signed a written informed consent.

Subjects

All pregnant women of West-European origin older than 18 years with a medical history of bariatric surgery presenting at the antenatal clinic before 15 weeks amenorrhea were eligible for recruitment. Exclusion criteria were multiple pregnancy, age less than 18 years, and inclusion after 15 weeks pregnancy. Subjects were classified according to the type of bariatric procedure. The type of bariatric procedure was self-reported.

Dietary Habits

Nutritional data were obtained from 7-day dietary records. Patients were asked to record in as much detail as possible all foods and beverages consumed over a period of 7 consecutive days during the first and second trimester of the pregnancy (week 7–12 and 20). The third and final study contact moment was on the day of the delivery itself. Given the uncertain timing of a delivery, collecting a third dietary record one week prior to the study contact moment was difficult from a logistical perspective. The servings used for the 7-day dietary records were either weight-measures or described in household units. Subjects were instructed to record specific recipes or the name of a food brand. The 7-day dietary records were entered and processed with Becel Institute Nutrition Software 2005. The observed intake levels were compared to the official National Dietary Recommendations [17].

All 7-day food records of each patient were also analyzed using the Healthy Eating Index (HEI) [18, 19]. The score of the HEI represents the degree to which a dietary pattern fits into official guidelines as summarized in the United States Department of Agriculture Food Guide Pyramid [19, 20]. The HEI consists of ten components. For each component, the score ranges from 0 to 10. If the consumed servings conform to the recommendations, the maximum score is given. The minimal score is equivalent to zero servings and all intermediate scores were computed proportionally. Therefore, the range of the total HEI score is from 0 to 100. Nine components score major food groups or nutrients: grains, vegetables (including potatoes), fruits and fruit juice, milk, meat, and the intake of total fat, saturated fat, cholesterol, and sodium. The last component is based on the amount of variety in a person's diet. The sodium component covers sodium in the consumed food, but not table salt. The recommended servings/day for grains, vegetables, fruits, milk, and meat are 9, 4, 3, 2, and 2.4 servings/day, respectively. A HEI score <51 (50 % of maximum score) was considered to indicate an unhealthy dietary pattern with nutrient intake far from the recommended values. A HEI from 51 to 80 (80 % of the maximum score) was considered to indicate a dietary pattern susceptible to improvements and a HEI >80 corresponds with a healthy dietary pattern [19].

Each time the patient handed in her 7-day dietary record, she was provided with written recommendations to improve her food habits towards a balanced, healthy diet according to the official Belgian Dietary Recommendations (9–11 % of the energy should come from proteins, 30–35 % from fat, and 50–55 % from carbohydrates) [17]. Alcohol should be avoided [21]. The recommendations were delivered through paper mail. The dietary recommendations aimed at limiting the intake of energy-dense foods, such as fast food and sweets by substituting them with healthier alternatives such as fruits, increasing low fat dairy products, increasing whole-wheat grains and reducing the intake of mono-/disaccharides and saturated fatty acids. Energy intake during pregnancy was never restricted in any group. In case of a gestational weight gain (GWG) above the Institute of Medicine (IOM) recommendations [10], patients were advised to limit the intake of energy-dense foods.

Physical Activity

A score for physical activity (PA) was calculated during the first and second trimester of the pregnancy using the Kaiser questionnaire. The Kaiser questionnaire is an instrument to assess multiple domains of PA among pregnant women: occupational activities, household/care-giving, sports/exercise, and non-sports leisure time activities [22]. The questionnaire has been compared with both direct (accelerometer and PA records) and indirect measures (cardiorespiratory fitness and percent body fat) of PA and has been demonstrated to be a reliable instrument to detect regular activities among women with a broad range of physical activity habits [23]. There are several questions for each domain, scored on a five-point scale, ranging from “never”, “seldom”, “sometimes”, “very often” to “always”. A total score for PA from a minimum of 3.75 to a maximum of 20 can be obtained.

Clinical Parameters

In this article, the clinical parameters are only briefly discussed. The total pregnancy and neonatal outcome of this study population in relation to nutritional deficiencies were described elsewhere [24]. At each antenatal visit, the subject’s weight was measured with a calibrated balance (Seca alpha model 770), accurate to 0.1 kg. Shoes were not included, but indoor clothing was. The prepregnancy weight, preoperative weight, and maximal postoperative weight loss were self-reported. Total GWG was defined as weight measured on the day of partus minus prepregnancy weight. GWG was evaluated according to the recommendations of the IOM: 12.5–18.0 kg in underweight women, 11.5–16.0 kg in normal weight women, 7.0–11.5 kg in overweight women, and 5.0–9.0 kg in obese women [10]. The height of the subject was measured once at the first visit, with a microtoise to the nearest 0.5 cm. Measured height and prepregnancy weight were used to calculate the BMI (kg/m^2), defined as weight (kg) divided by height^2 (m^2). Age, parity, and smoking behavior were recorded at inclusion. At the time of inclusion, none of the subjects were counseled by a dietician.

Further, the following data were recorded: gestational age at delivery (weeks, days), presence of gestational diabetes (GD), birth weight, and height. GD was diagnosed in accordance to the Carpenter and Coustan criteria using two or more abnormal plasma glucose values (fasting >95 mg/dl; 1 h, >180 mg/dl; 2 h, >155 mg/dl; and at 3 h, >140 mg/dl) [25].

Statistical Analysis

All analyses were performed using the Statistical Package SPSS (release 16.0). A two-sided level of significance of 0.05 was used. Continuous variables were compared using Student's *T* test. Normal distribution was assessed with Shapiro–Wilk test and the assumption of equal variation was checked with the Levene's test. When the assumptions were not fulfilled, continuous variables were compared using a Mann–Whitney *U* test. Categorical variables were analyzed using a Chi square test with a Fisher exact correction when cells had an expected frequency less than 5. Within each procedure group, the macro- and micronutrient intake, the PA scores, the HEI score, and the individual components of the HEI of the first and second trimester were compared using a Wilcoxon signed ranks test.

Results

Fifty four patients were recruited into the study of which 19 had a laparoscopic adjustable gastric band, one had a vertical banded gastroplasty, one had a Scopinaro, and 33 had a gastric bypass. Two patients (4 %) lost interest in the study. One pregnancy in the restrictive group was terminated due to severe congenital malformation (meningomyelocoele) in the fetus, and the patient with the Scopinaro procedure had a spontaneous miscarriage. The final analysis was therefore performed on data from 49 pregnant women, representing 91 % of the originally recruited population (Fig. 1). Two groups were defined: one group (N=18; 37 %) with purely restrictive types of bariatric surgery (adjustable gastric banding) and a second group (N=31; 63 %) with a gastric bypass as bariatric procedure, resulting in both a restricted intake and a certain degree of malabsorption.

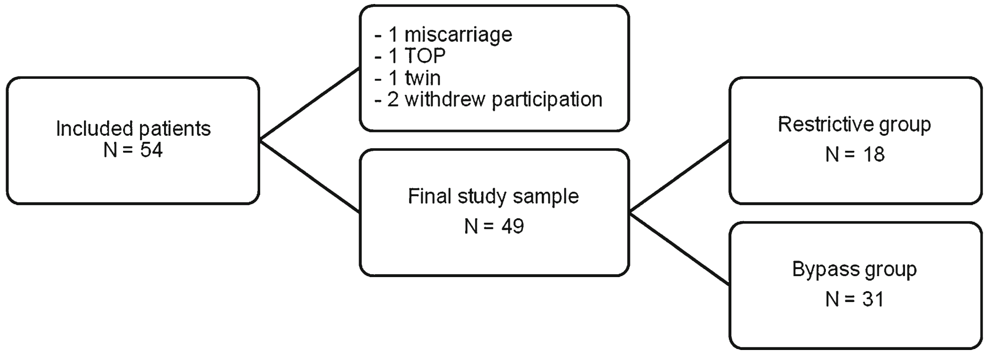

Fig. 1 Flowchart of patient recruitment

The maternal and infant characteristics are presented in Table 1. The mean preoperative weight and the time interval between the bariatric surgery and conception were comparable in both groups. The time between surgery and conception ranged from 2 months (minimum) to 9 years (maximum). The postoperative weight loss was significantly higher ($p=0.001$) in the bypass group, resulting in a lower prepregnancy BMI ($p=0.002$). All women were supplemented with standard prenatal vitamins. Thirty-nine percent of the patients were nulliparae and 25 % smoked at inclusion.

In the total population, only one woman was diagnosed with GD. This diagnosis was made after the second 7-day dietary record and will therefore not have affected the dietary analysis. Half of the study population (51 %) had an excessive GWG according to their prepregnancy BMI, while 23 % had a weight gain below the recommended range. The weight gain pattern was comparable in both groups ($p=0.474$). Mean birth weight in the bypass group was significantly lower than that of the restrictive group ($p=0.023$).

The diet quality measured by the HEI score (Table 2) did not change during pregnancy and was comparable between both groups. The analysis of the individual components of the HEI showed comparable results: there was no change during pregnancy and no difference between the two groups, except for the intake of grains and fruits (Table 2). The grain consumption was significantly higher in the restrictive group than in the bypass group ($p=0.011$). The fruit consumption in the second trimester was significantly higher than in the first trimester in the bypass group ($p=0.046$). The highest scores (closest to meeting the dietary recommendations) were obtained for cholesterol, variety of the diet, meat, and sodium. The lowest scores were obtained for the components

Table 1 Maternal and infant characteristics according to bariatric surgery procedure

	Restrictive procedure *N*=18	Bypass procedure *N*=31	*U*/*F* value	*P* value
Maternal characteristics				
Gestational age at inclusion (weeks)	10 (6–12)	12 (5–15)	196	0.075
Age (years)	31 (25–36)	30 (18–38)	256	0.632
Height (m)	1.68 (1.50–1.74)	1.65 (1.54–1.79)	274	0.917
Preoperative weight (kg)	107 (88–140)	110 (86–150)	218	0.205
Preoperative Body Mass Index (kg/m²)	40 (31–50)	41(29–57)	223	0.250
Maximum postoperative weight loss (kg)	28 (16–57)	42 (24–80)	101	0.001
Interval between surgery and conception (months)	44 (4–108)	22 (2–96)	217	0.198
Prepregnancy weight (kg)	86 (63–110)	69 (54–112)	152	0.008
Prepregnancy Body Mass Index (kg/m²)	31 (22–44)	25 (22–39)	132	0.002
Gestational weight gain (kg)	13.6 (0.0–30.2)	13.0 (2.0–23.0)	261	1.000
Gestational diabetes; *N* (%)	0 (0)	1 (3)	0.593 (df=1)	1.000
Nulliparae; *N* (%)	6 (33)	13 (42)	0.355 (df=1)	0.762
Smokers; *N* (%)	6 (33)	6 (19)	1.203 (df=1)	0.316
Infants characteristics				
Birth weight (g)	3.393 (0.632)	3.090 (0.678)	170	0.023
Infant length (cm)	50.2 (2.0)	50.0 (2.2)	192	0.092

Continuous data are presented as median (range) and analyzed with Mann–Whitney *U* test, $p<0.05$. Dichotomous variables are presented as a number (%) and analyzed with Chi square test, $p<0.05$

Table 2 Total HEI score and HEI scores of individual components by bariatric surgery procedure and pregnancy trimester

	Restrictive procedure *N*=18	Bypass procedure *N*=31	*U* value*	*P* value
Total HEI score				
First trimester	70±10	66±13	159	0.426
Second trimester	66±7	67±9	117	0.937
Z value	−1.961	−0.031		
P value	0.050	0.975		
Grains				
First trimester	6.0±1.5	4.5±1.6	96	0.011
Second trimester	5.1±1.9	5.0±1.7	101	0.633
Z value	−1.726	−0.594		
P value	0.084	0.552		
Vegetables				
First trimester	6.8±1.9	6.3±1.9	171	0.645
Second trimester	6.8±1.8	6.1±2.0	92	0.284
Z value	−0.078	−0.408		
P value	0.937	0.683		
Fruits and fruit juice				
First trimester	5.2±3.4	4.4±2.5	182	0.878
Second trimester	4.5±3.2	5.5±2.4	79	0.495
Z value	−0.980	−1.992		
P value	0.327	0.046		
Meat				
First trimester	8.4±2.2	8.1±1.6	159	0.423
Second trimester	7.5±1.8	7.4±1.7	89	0.233
Z value	−1.580	−1.503		
P value	0.114	0.133		
Milk				
First trimester	8.8±2.3	6.4±3.5	127	0.078
Second trimester	7.7±2.1	6.6±3.4	103	0.505
Z value	−1.599	−0.311		
P value	0.110	0.756		
Fat				
First trimester	6.0±2.9	5.9±2.0	160	0.442
Second trimester	5.8±2.5	6.3±2.6	93	0.463
Z value	−0.089	−0.723		
P value	0.929	0.470		
Saturated Fat				
First trimester	7.0±3.1	6.8±2.0	50	0.103
Second trimester	5.7±3.7	4.8±2.3	35	0.717
Z value	−1.289	−1.153		
P value	0.197	0.249		
Cholesterol				
First trimester	9.3±1.7	10.0±0.0	156	0.070
Second trimester	9.8±0.6	10.0±0.0	111	0.270
Z value	−1.342	0.0		
P value	0.180	1.000		
Sodium				
First trimester	6.9±2.8	8.9±1.6	143	0.206
Second trimester	7.8±2.2	9.0±1.5	89	0.211
Z value	−0.978	−0.153		

Table 2 (continued)

	Restrictive procedure *N*=18	Bypass procedure *N*=31	*U* value*	*P* value
P value	0.328	0.878		
Variety				
First trimester	9.0±1.5	8.4±2.5	175	0.714
Second trimester	8.6±2.4	9.0±1.5	110	0.700
Z value	−1.153	−1.127		
P value	0.249	0.260		

Data are presented as mean ± SD and analyzed using a Mann–Whitney *U* test (*$p<0.05$) or a Wilcoxon signed ranks test, $p<0.05$

HEI Healthy Eating Index

fruits, grains, and total fat intake. During the first trimester, only 15 % of the pregnant women had a healthy diet, 82 % had a diet requiring improvement and 3 % had a poor diet quality, independent of the type of surgery. In the second trimester, the same distribution was observed: 10 % had a healthy diet quality and 90 % had a diet requiring improvement (trimester comparison $p=0.525$).

When comparing the analysis of the macro- and micronutrient intake and those of the HEI, a comparable picture was observed: the micro- and micronutrient intake during the first and second trimester were comparable, as well as the intake between both groups (Table 3). The intake levels were far from the recommended values. Mean daily intake of fat and saturated fat was far above the recommended range of 30–35 E% (energy%) and upper limit of 10 E%, respectively. Protein intake was higher than the recommended range of 9–11 E%, and carbohydrate intake was below the minimal level of 50 E%. The amount of dietary fiber consumed a day was only half of the recommended amount of 30 g/day. The recommended value for calcium intake in pregnant women is 1,200 mg/day. The subjects' values did not even reach the recommended value of 900 mg/day for non-pregnant women. The only recommendation met by the study population was the iron intake (recommended daily intake for pregnant women 10 mg/day).

No difference between groups was observed for the PA levels. When comparing the pregnancy trimesters, the results indicate that the PA level in the bypass group significantly decreased as pregnancy progressed ($p=0.033$).

Discussion

To our knowledge, this is the first study reporting on diet quality of women with bariatric surgery during pregnancy. The study results indicate that the diet quality of the majority of pregnant women (82 to 90 %) with a history of bariatric surgery needs improvement. Only 10–15 % of these women have a balanced diet according to the HEI. This observation is in line with the study results reported by our group on the diet quality of obese pregnant woman without bariatric surgery: only 13 % of the 31 obese pregnant women had a balanced diet quality according to the HEI [26]. The macro- and micronutrient intake of this pregnant population with bariatric surgery also do not fulfill the dietary recommendation, although the observed means were comparable to the intake levels of the general Belgian population [27].

Besides diet quality, the reported energy intake was moderate, but GWG still exceeded the targets defined by the IOM. Only 24 % of the women gained weight in accordance to the current guidelines.

Looking at PA level, the score of this study population is low compared with the scores measured in a survey of non-pregnant women (median 11.1, IQR 10.1–12.3) [23] and in a survey of pregnant women without bariatric surgery (median 10.70, range 8.7–11.7) [22]. During pregnancy, PA is generally reduced due to the physical impediments experienced by the women as pregnancy progresses [28]. However, the questionnaires in this study were recorded during the first and second trimester; therefore, the physical impediments should still be limited. Since prepregnancy PA level is the best predictor for PA level during pregnancy, the assumption can be made that the women with bariatric surgery in this study already had a sedentary life-style before pregnancy which they did not change when becoming pregnant [29].

Next to diet quality and physical activity level, lifestyle behavior also includes smoking. In this study, 24 % of the women smoked at inclusion is remarkably higher than the prevalence in a cohort study of pregnant women without bariatric surgery (6 %)[26]. The prevalence number of smoking in the bariatric surgery group is comparable to the prevalence of smoking in the general female non-pregnant population in Belgium; the last national survey indicated that 21 to 25 % of the women aged 15–44 years smoked [30]. Given the already increased risk of intrauterine growth restriction in the postbariatric population [31] and the well known effect of smoking on fetal growth and pregnancy outcome [32], smoking behavior should absolutely be ceased preconceptionally.

Table 3 Energy, macro- and micronutrient intake and physical activity score by bariatric surgery procedure and pregnancy trimester

	Restrictive procedure $N=18$	Bypass procedure $N=31$	U value*	P value
Energy intake (kcal/day)				
first trimester	1,971±430	1,786±283	188	0.738
Second trimester	1,978±472	1,895±542	106	0.580
Z value	−0.105	−0.804		
P value	0.917	0.422		
Protein (E%)				
first trimester	15.1±1.5	15.8±2.1	187	0.718
Second trimester	15.5±2.2	15.1±2.4	108	0.621
Z value	−0.524	−1.156		
P value	0.600	0.248		
Carbohydrate (E%)				
first trimester	49.8±5.4	48.5±3.9	165	0.349
Second trimester	49.4±4.4	49.9±4.4	88	0.206
Z value	−0.245	−1.398		
P value	0.807	0.162		
Mono-/disaccharides (E%)				
first trimester	19.9±5.0	21.6±5.0	171	0.438
Second trimester	20.9±8.5	21.6±5.3	104	0.514
Z value	−0.594	−0.140		
P value	0.552	0.889		
Total fat (E%)				
first trimester	35.3±4.7	35.9±3.3	191	0.297
Second trimester	35.4±5.3	35.1±4.0	89	0.220
Z value	−0,140	−0.875		
P value	0.889	0.382		
Saturated Fat (E%)				
first trimester	13.0±2.6	13.6±2.4	164	0.336
Second trimester	14.2±2.3	14.2±1.9	96	0.343
Z value	−1.783	−0.699		
P value	0.075	0.485		
Total dietary fiber (g/day)				
first trimester	19.5±5.4	17.5±5.3	181	0.610
Second trimester	17.7±5.8	18.2±3.5	116	0.874
Z value	−1.619	−0.035		
P value	0.105	0.972		
Calcium (mg/day)				
first trimester	822±273	702±228	163	0.323
Second trimester	806±384	764±370	107	0.607
Z value	−0.035	−0.419		
P value	0.972	0.675		
Iron (mg/day)				
first trimester	11±2	9±2	133	0.068
Second trimester	10±2	10±3	118	0.936
Z value	−1.876	−0.316		
P value	0.061	0.752		
Total physical activity score				
first trimester	8.6±1.1	8.7±1.9	165	0.265
Second trimester	8.4±1.1	8.1±2.1	130	0.238
Z value	−0.220	−2.128		
P value	0.826	0.033		

Data are presented as mean ± SD and analyzed using a Mann–Whitney U Test (*$p<0.05$) or a Wilcoxon signed ranks test, $p<0.05$

E% Energy percentage

The written lifestyle advice given in the first trimester in this study failed to induce a changed life-style during the second trimester. Even though pregnancy might increase the susceptibility to lifestyle promotion and weight control as indicated in the introduction [9], inducing a positive, sustained behavioral change is complex. The psychological model published by Prochaska and DiClemente (1986) indicated that a behavior change is a process of phases and that the interventions required to trigger a successful behavioral changes are depending on the motivational state of the patient [33]. A well-know, scientifically tested method which puts the theoretical model of Prochaska and DiClemente (1986) into practice is the technique of motivational interviewing [34]. This method has been demonstrated to be effective in different areas of behavioral changes including weight loss, smoking cessation, and psychological diseases [34]. We suggest that this technique should be used in this target population since preoperative disordered eating patterns, psychological difficulties, and coping problems are present in many surgically treated patients and these factors can cause the non compliance to lifestyle advice [15]. Given the challenges and complexity of the prenatal care of women with bariatric surgery, this intervention should be part of rigorous medical follow-up and multidisciplinary collaboration between obstetricians, surgeons, endocrinologists, dieticians, and behavioral therapist including a psychological and psychiatric assessment [4, 31]. This medical follow-up should focus on the detection of nutritional deficiencies surgery, especially after mixed and malabsorptive bariatric procedures [1]. Even though this study indicates that nutrient intake was not different between the restrictive and bypass group, the surgically induced malabsorption will influence the uptake of micronutrients. Consequently, the nutritional status may possibly differ between the different bariatric procedures despite of a comparable nutrient intake.

To role of the dietician in this multidisciplinary follow-up is to perform dietary assessments and provide nutritional counseling [35]. No specific quantitative directives regarding intake of macro- and micronutrients are made for patients after bariatric surgery, except for the minimum intake of 60 g/day dietary protein for pregnant patients [35, 36]. Besides protein, carbohydrates are another macronutrient that deserves some attention. Patients with a gastric bypass can experience dumping syndrome after eating calorie-dense liquids or foods. Avoiding mono-/disaccharides and increasing the intake of dietary fiber and complex carbohydrates are usually recommended in this population [35]. Regarding energy intake during pregnancy, the American Dietetic Association advises an intake ranging from 2,200 to 2,900 kcal day^{-1}, but they specifically mention that this advice does not apply to the postbariatric population [37] We suggest to tailor the recommended energy intake to the patient's prepregnancy BMI, GWG, and physical activity level.

During the dietary assessment, the dietician should also screen for the presence of food aversions or incorrect eating habits. Seven weeks after surgery, patients in general should be able to consume a balanced diet with a variety of foods [35]. During the first few months after surgery, however, some foods are often less well tolerated (e.g., red meat, bread, rice, and pasta); this can persist up to 2 years after the procedure and may even cause continuous food aversions [38]. Patients should be educated on how to prepare these food items in such a way that they can be eaten smoothly [35]. Guidelines on eating habits for postoperative patients such as no drinking half an hour before and after eating, chewing food well and consuming frequent, small portions on scheduled times without grazing should also be followed during pregnancy. The results of the HEI and the nutrient content derived from the 7-day food dietary, however, cannot indicate the presence of food aversions or incorrect eating habits. To map these eating habits of patients with bariatric surgery, an additional instrument, such as a specific questionnaire or food frequency questionnaire, seems appropriate.

The major strengths of this study are the presence of restrictive types and a mixed type of bariatric surgery, the repeated measurement of the diet quality during pregnancy, and the combined analysis of macro- and micronutrient intake and dietary index. The prospective study design increased the accuracy and completeness of the collected data. The GWG data were compared to the latest published IOM GWG recommendations [10]. GWG could be biased due to the recalled prepregnancy weight. This potential bias is considered to be limited since self-reported weight correlates well with actual weight in a non-pregnant population [39]. The procedure type, preoperative weight, and postoperative weight loss were also self-reported by the patients. Even though the presence of different bariatric procedure is a benefit, the sample size for each subgroup was relatively small.

In conclusion, this study shows that the lifestyle habits of pregnant women with a history of bariatric surgery are far below the recommendations. The diet quality of this specific pregnant population is poor, irrespective of the type of surgery. One fourth of the patients are smoking at the beginning of pregnancy and the reported physical activity levels are low. A multidisciplinary approach involving nutritional advice and lifestyle coaching starting from the early postoperative phase and being continued during pregnancy in this high-risk population seems therefore advisable. However, so far, no data are available that such an approach effectively improves outcome in these patients.

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Conflict of Interest All authors state to have no conflict of interest.

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