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A Multidisciplinary Approach of Lifestyle in Overweight/Obese Pregnant Women: A Case-Control Study

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Abstract

Objective: To determine whether an early lifestyle change program (consisting of customized nutritional advices and a constant moderate physical activity) can reduce the incidence of unfavorable maternal and neonatal outcomes among overweight/obese women.

Research design and methods: This is a case-control study: women included in a lifestyle change program were labeled as cases; controls were randomly selected from the next three women delivering after one case and not undergoing any specific lifestyle change program, but only referred by the obstetrics of the National Health System. Cases attended a multidisciplinary counselling (by both the dietitian and the gynecologist) from enrollment (9th-12th week) until delivery (with four follow-up visits), consisting of a hypocaloric, low-glycemic index diet and a moderate physical activity program.

Results: Three-hundred seventy-five women were included: 95 cases and 275 controls. Overall gestational weight gain and the rate of women remaining within the Institute of Medicine recommendations was similar between groups. The occurrence of gestational diabetes mellitus was lower in cases (21.5%) than in controls (32.7%; p = 0.041), and remained statistically significant after correcting for confounding factors (BMI ≥30 kg/m^2, a family history of diabetes, age ≥35 y and ethnicity; p = 0.005). Pre-term births were significantly lower in cases (1.1%) than in controls (10.2%; p = 0.004). A higher number of controls developed hypertensive disorders (p = 0.024), in particular pregnancy-induced hypertension (1.1% in cases vs. 11.6% in controls, p = 0.0007). The frequency of macrosomic or large-for-gestational-age babies was significantly lower among cases (vedi prima) (p = 0.015 and p = 0.003 respectively).

Conclusion: An early behavioral intervention among overweight/obese pregnant women (an individualized counseling by a dietician, a physical activity program and a close follow-up) reduces the preterm birth, the hypertensive disorders and the gestational diabetes mellitus, thus the occurrence of macrosomic and large-for-gestational-age babies, while it doesn't affect the occurrence of small-for-gestational-age.

Keywords: Pregnancy; Obesity; Gestational diabetes mellitus; Gestational hypertension; Macrosomia; Large-for-gestational-age; Lifestyle change; Diet; Physical activity; Unfavourable outcomes

Abbreviations: BMI: Body Mass Index; g: Grams; GDM: Gestational Diabetes Mellitus; GI: Glycemic Index; GWG: Gestational Weight Gain; IOM: Institute of Medicine; kg: Kilograms; LGA: Large-for-Gestational-Age; OGTT: Oral Glucose Tolerance Test; PA: Physical Activity; PE: Pre-Eclampsia; PIH: Pregnancy-Induced Hypertension; pPROM: Pre-Term Premature Rupture of Membranes; PTB: Pre-Term Birth; SGA: Small-for-Gestational-Age

Introduction

As stated by the World Health Organization, over half of the adult population is classified as overweight or obese according to their Body Mass Index (BMI) [1]. Considering the risingmaternal age at first pregnancy, a high pre-pregnancy BMI is frequently encountered in the practice of obstetrics. A high pre-pregnancy BMI [2-5] and an excessive gestational weight gain (GWG) [6-9] are associated with many unfavourable pregnancy outcomes both for the mother and for the offspring. Moreover, the incidence of many maternal complications (i.e., gestational diabetes mellitus-GDM-, pregnancy induced hypertension-PIH-, pre-eclampsia (PE), pre-term birth (PTB) and caesarean deliveries) rises linearly as maternal BMI increases [10-14].

Several lifestyle interventions have been studied for the prevention of an excessive GWG and, probably as a consequence, of several unfavorable complications of pregnancy in women with an excessive BMI.

According to the last Cochrane review, while lifestyle interventions (diet, physical activity-PA or both) are effective in reaching an optimal GWG [15], they did not have a substantial effect on other clinical outcomes.

Dietary advices to prevent GDM appear to be beneficial in general, although the results are overly heterogeneous [16]. There is no clear difference in the risk of developing GDM, thus in delivering large for gestational age (LGA) newborns, for women receiving a mixed approach compared with women receiving no intervention [16]. Based on the data currently available, collected in the last Cochrane review [16], it is not possible to draw conclusive evidence about the prevention

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of GDM and related negative clinical outcomes to guide clinical practice guide of obstetrics.

Moreover, dietary interventions have the potential to reduce the risk of PE [17]. However, there is a need to evaluate the effect of dietary interventions in women with pre-existing metabolic risk factors on PE, because currently there are not well defined evidences to recommend any kind of dietary intervention rather than an exercise program to prevent PE.

The risk of PTB, both spontaneous and medically indicated, especially for hypertensive disorders and diabetes, increases with increasing BMI categories, namely for extremely weeks of gestation [14]. Although the conclusions of a recent meta-analysis [18] of randomized controlled trials show that dietary interventions are more effective in reducing pregnancy complications related to excessive-GWG such as GDM, PIH and PTB (compared with PA alone or mixed approach), nowadays there aren't strong evidences that recommend a specific lifestyle intervention rather than others.

Starting from these assumptions, we aimed to evaluate whether an early customized lifestyle program consisting of a hypocaloric, low glycemic index (low-GI) diet and moderate but constant PA can reduce the incidence of adverse maternal (such as GDM, hypertensive disorders and PTB) and neonatal outcomes (macrosomia, LGA and small-for-gestational-age (SGA) babies) among overweight/obese women.

Research Design and Methods

Study design

This is a retrospective, case-control study. Ninety-five overweight/obese women referred from antenatal clinics in Modena (Italy) were enrolled in early pregnancy in a lifestyle change program at the Obstetric Unit of Mother-Infant Dept. of Policlinico Hospital at the University of Modena. These women were included as Cases.

Controls (two-hundred seventy-five women) were randomly selected from the next three women, which delivered after one case and met the inclusion criteria. The inclusion criteria for both groups were BMI ≥25 kg/m^2, age >18 years and singleton pregnancy. The exclusion criteria were chronic diseases including diabetes mellitus (first trimester glycosuria >100 mg/dl or fasting plasma glucose ≥126 mg/dL or random glycaemia ≥200 mg/dL), previous GDM, medical conditions or dietary supplements that might affect the body weight (i.e., thyroid diseases), previous bariatric surgery, smoking habits and contraindications to exercise. All the participants provided written informed consent.

Cases

Women were counselled by a dietitian and a gynecologist, both attendant, from the enrollment (between the 9th-12th week of gestation) until delivery, with four follow-up visits planned at 16th, 20th, 28th and 36th week of pregnancy. The lifestyle program started with a one-hour multidisciplinary counselling session about the importance of reaching an appropriate GWG (according to the Institute of Medicine (IOM) guidelines [19] and on the benefits of a healthy lifestyle as reported below.

Dietery intervention

The dietary intervention was a hypocaloric, low-GI diet and consisted of an average intake of 1500 kcal/day, which corresponded approximately to the baseline metabolism of a pregnant woman. In view of the PA program, the dietitian added 200 kcal/day for obese and 300 kcal/day for overweight women [20]. The target macronutrient composition was arranged as follow: 55% carbohydrate (80% complex with low glycemic index and 20% simplex), 20% protein (50% animal and 50% vegetable) and 25% fat (12% monounsaturated, 7% polyunsaturated and 6% saturated) with moderately low saturated fat levels. The daily calories were divided into small frequent meals to avoid ketonuria and acidosis, which often occur following prolonged fasting. The daily intake of carbohydrates was at least 225 g/day (the minimum daily intake to prevent ketosis is 180 g/day) [20,21]. The dietitian encouraged a wide consumption of fresh vegetables and fruit, cereals, legumes, and fish, with olive oil as the main source of fat and moderate consumption of red wine, in harmony with the Mediterranean eating habits.

Exercise intervention

Exercise intervention focused on increasing walking and developing a more active lifestyle (i.e., walking rather than driving for short distances, spending less time watching television etc.) if not control indicated [22]. Recommendations set forth by the U.S. Department of Health and Human Services (DHHS) in 2008 state that pregnant women should engage in a minimum of 150 minutes of moderate-intensity aerobic activity a week, even if not physically active before pregnancy [23]. The American College of Sports Medicine (ACSM) currently recommends a minimum of 3 exercise sessions completed in at least 15 minute sessions, gradually increasing to 30 minutes per day, preferably all days of the week [24]. All participants were advised to participate minimum in 15 minute sessions gradually increasing to 30 minutes of mild intensity PA per day at least 4-5 days a week. Because of heart rate variability during pregnancy, women were encouraged to use the "talk test" (being able to maintain a conversation during activity) to monitor exercise intensity.

Controls

Controls were recruited among women delivering at the Mother-Infant Dept. of Policlinico Hospital (University of Modena, Italy) and did not undergo a lifestyle change counselling, having had a general advice about diet from their antenatal care-givers.

The entire cohort of cases and controls underwent fasting glucose assessment until the 12th week, than to 75-g-2 h OGTT (oral glucose tolerance test) between 16th-18th and, if negative, repeated at 24th-28th week as recommend by the Italian Guidelines [25]. The diagnosis of GDM was made for any glucose values exceeding the normal cut-off, according to the Guidelines [26]. When OGTT was positive, women were referred to other health care specialists for further clinical evaluation and/or insulin treatment.

Data regarding pregnancy and delivery were collected from clinical charts, focusing in particular on pre-pregnancy weight and BMI, weight at delivery and GWG, occurrence of GDM, PIH and PTB, newborns' weight and birth weight centile.

Anthropometric data regarding newborns were defined as follow: LGA if birth weight centile was ≥90°, SGA if birth weight centile was ≤10°, macrosomia if birth weight ≥4000 g.

Statistical analysis

To compare the continuous variables, the Student's t-test was employed. A Chi-squared test was used for the categorical variables. For the demographic variables, we used the frequencies and Student's t-test comparisons. A logistic regression was used to evaluate the determinants for GDM, PIH and macrosomia occurrence in cases and control groups.

The data are reported as the mean ± standard deviation (SD) or numbers with % in brackets.

We considered a p-value less than 0.05 as the threshold for statistical significance. The data were analysed with SPSS Statistics software v 21.0 (SPSS Statistics software v 21.0, IBM Corp., Armonk, NY, USA).

Results

Three-hundred seventy women were included: 95 cases and 275 controls.

Age at enrollment, as reported in Table 1, was not different between the two groups while BMI was higher in cases than in controls, due to a higher prevalence of obese women in the first group (67.4% vs. 54.5%; p = 0.029).

The socio-demographic characteristics are summarized in Table 1.

Overall GWG and GWG stratified by BMI categories, as well as the rate of women remaining within the IOM recommendations are reported in Table 2. No significant difference was found between cases and controls.

Maternal and delivery's outcomes of the cohort studied are shown in Table 3. In controls GDM occurred more frequently than in cases (32.7% and 21.5% respectively; p = 0.041).

A higher number of controls developed hypertensive disorders in comparison with cases. Table 4 shows the distribution of hypertensive disorders during pregnancy. A statistical significant difference was found between the two groups regarding the occurrence of PIH (1.1% in cases vs. 11.6% in controls, p = 0.0007) while the incidence of PE and superimposed PE was similar.

The rate of PTB was significantly lower in cases (1.1%) than in controls (10.2%, p = 0.004). Among women belonging to the control group, the 28 PTB were distributed as follow: 8 pre-term premature rupture of membranes (pPROM), 6 spontaneous and 14 medically indicated (3 for Intrauterine Growth Restriction, 1 for severe haemorrhage, 3 for PIH, 1 for pre-eclampsia, 5 for GDM/macrosomia, 1 for Rh isoimmunisation). The only case of PTB that occurred among the cases was medically indicated for severe PIH.

The incidence of labour induction and caesarean delivery were similar in cases and controls (Table 3).

Restricting the analysis to obese women, only the occurrence of PTB remained significant between the two groups (1.6% in cases vs. 12.7% in controls, p = 0.009).

The frequency of macrosomia and LGA babies was significantly higher among controls if compared with cases (Table 5), whereas mean birthweight and incidence of SGA babies were not different between the two groups (Table 5).

At logistic regressions, the occurrence of GDM was explained by the group of allocation (p = 0.005) after correcting for confounding factors (BMI ≥30 kg/m², a family history of diabetes, age ≥35 y, Caucasian ethnicity).

The occurrence of PIH, after correcting for BMI ≥30 kg/m², age ≥35 y, hypertension family history, and Black African ethnicity, maintained its relation with high BMI and not-intervention (p = 0.003 and p = 0.029 respectively).

Finally, a logistic regression was used to examine the effects of the intervention on the incidence of macrosomia. After correcting for BMI ≥30 kg/m², GDM and family history of diabetes, macrosomia maintained only a positive trend with the group of allocation (p = 0.057).

Discussion

Our lifestyle intervention, which included a customized hypocaloric low-GI diet, one hour individualized counselling by a dietitian, a constant PA and a close follow-up during the different trimesters of pregnancy, reduced the occurrence of GDM and hypertensive disorders during pregnancy. Interestingly, despite the higher prevalence of a positive family history of diabetes and hypertension in cases than in controls, the GDM diagnosis and PIH occurrence were lower in cases than in controls. This could be due to a higher motivation of cases to change their behavioural habits into healthier lifestyle, following the

	Cases (n = 95)	Controls (n = 275)	P value
Age (years)	31.5 ± 4.7	32.3 ± 5.5	0.181
Ethnicity	Caucasian 78 (82.1%)	Caucasian 189 (68.8%)	0.033
	Black African 5 (5.3%)	Black African 43 (15.6%)	
	Other 12 (12.6%)	Other 43 (15.6%)	
Nulliparity	60 (63.2%)	175 (63.3%)	0.933
Family history of Diabetes	53 (55.8%)	106 (38.5%)	0.003
Family history of Hypertension	59 (62.1%)	138 (50.2%)	0.045
Pre-pregnancy weight (kg)	91.6 ± 17.7	85.4 ± 15.0	0.095
Pre-pregnancy BMI (kg/m²)	33.5 ± 6.2	31.6 ± 5.1	0.004
Obese	64 (67.4%)	150 (54.5%)	0.029
Morbidly Obese (BMI ≥40 kg/m²)	14 (14.7%)	21 (7.6%)	0.006

Table 1: Socio-demographic characteristics.

	CASES (n = 95)	CONTROLS (n = 275)	P value
GWG (kg)	9.2 ± 7.1	8.9 ± 6.2	0.652
GWG in overweight (kg)	10.6 ± 7.8	10.1 ± 6.2	0.699
GWG in obese I (kg)	9.4 ± 7.6	8.8 ± 6.3	0.689
GWG in obese II (kg)	9.1 ± 4.7	7.3 ± 5.6	0.222
GWG in obese III (kg)	6.3 ± 6.9	5.8 ± 6.3	0.826
Women remaining within IOM Reccomendations	58 (65.2%)	173 (65.2%)	0.984

Table 2: GWG and rate of women remaining within the IOM recommendations.

	Cases (n = 95)	Controls (n = 275)	P value
GDM	20 (21.5%)	89 (32.7%)	0.041
PTB	1 (1.1%)	28 (10.2%)	0.004
Inductions of labour	35 (36.8%)	93 (33.8%)	0.593
Caesarean deliveries	24 (25.3%)	94 (34.3%)	0.103

Table 3: Maternal outcomes.

	Cases (n = 95)	Controls (n = 275)	P value
Hypertensive Disorders in Pregnancy	11 (11.6%)	62 (22.5%)	0.024
PIH	1 (1.1%)	32 (11.6%)	0.0007
PE	4 (4.2%)	10 (3.6%)	ns
Chronic Hypertension	6 (6.7%)	20 (7.3%)	ns
Superimposed PE	1 (1.1%)	7 (2.5%)	ns

Table 4: Onset of specific hypertensive disorders.

	Cases (n = 95)	Controls (n = 275)	P value
Birthweight (gr)	3395.5 ± 376.3	3344.5 ± 592.6	0.432
LGA (> 90° percentile)	1 (1.1 %)	30 (10.9%)	0.003
Macrosomia (>4.000 g)	3 (3.2%)	32 (11.6%)	0.015
SGA (<10° percentile)	10 (10.5%)	43 (15.6%)	0.22

Table 5: Neonatal outcomes.

suggested prescriptions by a multidisciplinary équipe. Our results are in accordance with several systematic reviews that suggest that lifestyle interventions could have a crucial role in preventing both GDM [18,27-29] and PE [17]. Nevertheless, the last Cochrane review, focused on the reduction of GDM [16], is not so rigorous in recommending a behavioural prescription rather than another, and a recent meta-analysis [17] doesn't state a clear conclusion on the prevention of PE.

Dietary interventions seem to show a more significant reduction in GWG compared with PA interventions or mixed approach [18] and seem the most effective in reducing pregnancy complications excessive-GWG related such as GDM, PIH, PTB, compared with PA alone or mixed approach. Nevertheless, we chose to use a mixed approach (diet and PA combined) with the purpose to show to the pregnant women a healthier behavioural habits composed by a less sedentary lifestyle (spend less time watching television or sleeping) and a different way of eating. Our women were trained to eat often and in a healthier way. The dietitian encouraged a wide consumption of fresh vegetables and fruit, cereals, legumes, and fish, with olive oil as the main source of fat and moderate consumption of red wine, in harmony with the Mediterranean eating habits. We think that it is a very important goal to reach, since a substantial portion of women are not Caucasian, and are not used to eat a Mediterranean diet or eat more times a day, especially if Muslim's religion.

In our sample of cases, the incidence of PE was not affected by the intervention. Previously, a meta-analysis of eighteen studies [17] stated that the risk of PE could be reduced by lifestyle interventions. Although the risk was lower in women receiving nutritional advices rather than a mixed approach, the prevention programs considered included heterogeneous dietary approaches.

Moreover, although our lifestyle changes program did not significantly affect superimposed PE on chronic hypertension, it is possible that increasing sample size there will be the possibility to demonstrate such an effect. Generally speaking, a lifestyle changes program could prevent the worsening of pre-existing chronic conditions, in particular among women with metabolic risk factors, as previous hypothesized by Allen et al. [17].

Our intervention did not reduce the rates of caesarean deliveries and inductions of labour, and these results agree with the most recent Cochrane meta-analysis [16].

The number of women delivering pre-term was considerably lower in the cases. In particular, pPROM and spontaneous pre-term labours were exclusively observed in the control group. A previous report agrees with our findings [29], although others reported only weak evidence [18,28]. Factors affecting PTB are several, including obstetrical history. A limit of our report is that we ignore the presence of previous PTB or late abortions in our population.

The number of macrosomic or LGA babies was significantly lower in the intervention group. These data agree with those authors who found a positive correlation between a high pre-pregnancy BMI and the risk of delivering LGA babies [30,31]. Others have already pointed out a protective role of a behavioural program in pregnancy in reducing the incidence of macrosomia [32] or LGA babies [27]. However many meta-analyses did not show a clear decrease of macrosomia and LGA occurrence among women undergoing a nutritional and/or physical activity counselling [16,18,28]. This could depend on either the specific program adopted and/or the compliance to the treatment. Moreover, in contrast with other reports [33-35] and our previous pilot study [36], GWG remained unaffected by the behavioural intervention. It is possible that GWG is an imprecise marker, because the identical weight gain could be related with a diverse body composition, in terms of fat and fat free mass that cannot be evaluated with BMI assessment [19]. The limit of this study could be the lack of additional information about previous pregnancies. Adding more dowels in the obstetric history of our cohort of women could help us to draw more firm conclusions about factors affecting the incidence of LGA or PTB.

Conclusions

In conclusion, despite an unbalanced excess of obesity and positive family history of diabetes and hypertension among cases respect to controls, an early lifestyle change program significantly reduces GDM, PIH, PTB and LGA incidence in such at risk population if compared with women receiving standard antenatal care by the National Health System. Our study suggests that a customized/multidisciplinary counseling, held together by a gynecologist and a dietitian, based on a healthier eating habits and a constant moderate PA improves maternal as well as neonatal outcomes in pregnancies complicated by obesity/overweight. A structured, multidisciplinary approach could solve these issues and increase the compliance with the healthier lifestyle recommendations in such at risk population.

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The study was conducted in accordance with ethical principles derived from the Declaration of Helsinki, Good Clinical Practice, and International Conference of Harmonization Guidelines. All patients provided written informed consent. The study was approved by local Ethics Committee in October 2015, reference number 136/15.

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