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Adherence to Mediterranean Diet and Prevention of Excessive Weight Gain during Pregnancy: Study in a Cohort of Normal Weight Caucasian Women

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Abstract

This study investigated the association between adherence to Mediterranean Diet (MD) and the risk of excessive Gestational Weight Gain (GWG).

Ninety five Caucasian normal weight pregnant women were recruited within the 16th gestational week. We evaluated the adherence to MD at recruitment (T0) and at third trimester (T1) by validated food frequency questionnaire. Adherence to MD was indicated by a score between 0 and 13. Adequate GWG was defined in according with IOM (Institute of Medicine, 2009) recommendations.

The 26.3% dropped out, then the completer participants were 70 (33.2±3.5 ys, 74.3% nulliparous).

MD score at T0 was 7.2±1.5 and it did not significantly change at T1. Mean MD score between T0 and T1 was 7.3±1.3: a good adherence to MD, defined by MD score≥8, was satisfied by 27.1%. The GWG at T1 was adequate in 64.3%, while exceed in 35.7%. Women with adequate GWG showed a MD score significantly higher than women with excessive GWG (MD score: 7.5±1.3 vs 6.8±1.0, p=0.02).

A good adherence to MD was associated with a significantly lower risk ratio of excessive GWG (RR 0.24, 95% CI 0.1-0.9, p=0.04).

MD could be a dietary pattern able to prevent excessive GWG in normal weight women.

Keywords

Mediterranean Diet (MD), Gestational Weight Gain (GWG), normal weight, pregnancy

1. Introduction

Several studies have shown that excessive weight gain during pregnancy is a strong predictor of postpartum weight retention (Vesco et al., 2009; Siega-Riz et al., 2004) and this may contribute to obesity in women of childbearing age (Rooney & Schauberger, 2002).

The Institute of Medicine (IOM) developed guidelines for adequate weight gain during pregnancy, dependent on pre-pregnant Body Mass Index (BMI): normal weight women (BMI: 18.5-24.9 kg/m^2) are recommended to gain between 11.5 and 15.9 kg during pregnancy, overweight women (BMI: 25-29.9 kg/m^2) between 6.8 and 11.4 kg and obese women (BMI≥30 kg/m^2) between 5.0 and 9.0 kg (Institute of Medicine and National Research Council, 2009). There is the evidence suggesting that weight gains within IOM recommendations are potentially associated with healthy fetal and maternal outcomes (Siega-Riz et al., 2009).

Maternal obesity is associated with several negative pregnant outcomes, including, hypertensive conditions, preeclampsia, gestational diabetes, required induction of labor, cesarean section, having a stillbirth, perinatal death, macrosomia (birth>4000 g), preterm birth (<37 week of gestation), congenital anomaly, increased risk of childhood obesity and development of type 2 diabetes (Begum et al., 2011; Ovesen et al., 2011; Walsh et al., 2014). Not only is maternal obesity associated with complications during pregnancy, but also excessive Gestational Weight Gain (GWG) among normal weight women is a risk factor for negative pregnancy outcomes (Chung et al., 2013; Hinkle et al., 2012). Many epidemiological studies reported that a substantial proportion of normal weight women gains more than recommended (Chung et al., 2013; Ouzounian et al., 2011; Josefson et al., 2013). Therefore, achieving a healthy weight gain during pregnancy is an important issue for all women and not only for overweight or obese subjects.

Over the last decades, many evidences supported the hypothesis that diet and dietary factors play a relevant role in the occurrence of overweight, obesity and diseases correlated such as diabetes and cardiovascular diseases. Recently, Mediterranean Diet (MD), defined by a high consumption of plant foods such as legumes, cereals, fruits and vegetables, fish, nuts and seeds, low consumption of meat and dairy products, olive oil as main source of fat and moderate consumption of wine, has been extensively reported to be associated with a favorable health outcome and a better quality of life (Sofi et al., 2013). Several epidemiological studies carried out in Spanish population have shown an inverse correlation between adherence to MD, body mass index and risk to gain body weight (Razquin et al., 2009; Schroder et al., 2004; Mendez et al., 2006).

Adherence to MD in pregnant women resulted protective for wheeze and atopy in childhood (Chatzi et al., 2008) and preterm delivery (Mikkelsen et al., 2008). However, although the inadequate weight gain in pregnancy is well recognized as risk factor for maternal and fetal complications, no study investigated the possible protective effect of MD pattern on excessive GWG.

Therefore the aim of the present study was to investigate the adherence to Mediterranean Diet in a cohort of normal weight pregnant women in association to weight gain during gestational period.

2. Methods

2.1 Study Design and Subjects

This study was carried out in a cohort of normal weight caucasian pregnant women (Pre-pregnant Body Mass Index: 18.5-24.9 kg/m^2) recruited at Department of Woman, Mother and Neonate, Buzzi Children's Hospital (Milan, Italy) in the occasion of the obstetrical and gynaecological visit programmed at beginning of pregnancy (T0) (within 16th gestational week).

Exclusion criteria were chronic gastrointestinal diseases, pre-pregnant diabetes, celiac disease, history of eating disorders such as anorexia or bulimia, vegan, vegetarian or macrobiotic regimens, diet-therapy in progress.

The institutional review board approved the study procedures and each subject provided written informed consent. The study was carried out according to the Declaration of Helsinki.

Anthropometric measures and administration of a modified validated food frequency questionnaire to assess Mediterranean dietary pattern were made at recruitment (T0) and at third trimester of pregnancy (T1) (≥34th gestational week).

2.2 Anthropometry

Anthropometric measurements were taken at T0 and T1 by the same operator, according to standard criteria and measuring procedures (Lohman et al., 1988).

With a pregnant wearing only underwear, weight (to the nearest 0.1 kg) and standing height (SH; to the nearest 0.1 cm) were measured using the same calibrated scale that had a telescopic vertical steel stadiometer (SECA 711, Hamburg, Germany).

BMI (Body Mass Index) was calculated as weight (kg)/stature (m)^2. Pre-pregnant BMI was calculated considering self reported body weight prior to pregnancy.

Biceps, triceps and subscapular skinfolds thickness were measured as proposed by Lohman et al. (1988) using a Holtain LTD calliper. The skinfolds were measured twice and mean values were reported; at T0 and T1 the measurements were made by the same operator.

Arm circumference was measured according criteria indicated by Lohman et al. (1988); AFA (Arm Fat Area) was calculated from arm circumference and triceps skinfold measure as indicated by formula (http://www.giorgiobedogni.it/archivio/testi/stato_nutrizionale_2/aree/paree.html).

Institute of Medicine's recommended range of weight gain per week according to pre-pregnant BMI were used to classify the proportion of women who had an excessive weight gain from T0 and T1. Excessive Gestational Weight Gain (GWG) was defined when delta weight T1-T0 was greater than maximum weight gain (+0.5 kg x number of gestational weeks after the 12th) accepted by IOM guidelines.

Weight and skinfold thickness gain were computed by subtracting values measured at T0 from whose measured at T1. Gain per week was calculated by dividing the respective gain by the number of weeks between T0 and T1.

2.3 Mediterranean Dietary Pattern

Adherence to the traditional MD was assessed using a validated 14-item questionnaire (Martınez-Gonzalez et al., 2004). In accordance to indications of Guides Lines for Pregnancy (Istituto Superiore Sanità, Ministero della Salute) where alcohol consumption is forbidden, we did not consider in the validated questionnaire the item about wine consumption to evaluate Mediterranean score in pregnant women. Thus we calculated Mediterranean score considering 13 items instead of 14 and participants who scored 8 points (MED-score), instead of 9 as indicated by original questionnaire criteria, were considered with a good adherence to MD pattern. Values of 0 or 1 were assigned to each dietary components. Participants who ate less than the specified amount of the following "healthy" foods were categorised 0: olive oil as main culinary lipid (yes), olive oil—4 tablespoons, vegetables—2 servings/day, fruit—3 servings/day, legumes—3servings/week, fish/seafood—3 servings/week, tree nuts—1 servings/week, poultry more than red meats (yes) and use of sofrito sauce—2 servings/week. Those who had a higher intake of them were designated as 1. On the contrary, participants whose intake was above or lower than the specified amount of the following "unhealthy" foods were categorised as 0, or 1: red/processed meat<1 serving/day, butter, cream, margarine<1 serving/day, soda drinks<1 serving/day and commercial sweets and confectionery<3 servings/week (Martınez-Gonzalez et al., 2004). The questionnaire was considered valid only when all items were completed.

2.4 Statistical Analysis

Statistical analysis was performed using SPSS version 21. All data were expressed as mean±Standard Deviation (SD) for continuous variables and as% for categorical variables. Continuous variables between T0 and T1 were compared using paired Student's t test, while nominal variables by Chi Square test.

Univariate and multivariate linear regression analysis adjusted for maternal age, parity and physical activity were used to investigate the association between mean Mediterranean Score (independent) and weight, skinfold thickness and AFA increase (dependent). Mean MD score was calculated considering the mean between MD score registered at T0 and at T1.

For MD Score≥8 (as mean between T0 and T1) was calculated Risk Ratio (RR), adjusted for any variable, and 95% confidence interval for outcome based on excessive GWG.

Significant values were considered for $p \leq 0.05$.

3. Results

The total sample at inclusion (T0) was represented by 95 Caucasian normal weight pregnant women that voluntarily decided to participate at the protocol. The 26.3% of the sample dropped out at T1 (visit of third trimester); the dropout depended on logistic difficulty to reach the hospital in the 53.3%, on preterm livery in the 20% and on unknown raisons in the 26.7% of the cases.

Table 1 reports general characteristics of the sample completer (n=70). Only one woman was smoker during pregnancy and two have smoked until the beginning of pregnancy. More than 70% of the

women were nulliparous and declared to have a degree. At T0 the 54.2% were inactive, while the 45.8% declared to go in for sports at least 1 time/week. The mean frequency of physical activity at T0 was 1.0 ±1.2 times/week: no significant change was observed at T1 (p=0.92).

Table 2 reports anthropometric data and MD score in the completer sample at inclusion (T0) and at third trimester (T1) (n=70). As expected between T0 and T1 we observed a significant increase of weight, of skinfold thickness, of arm circumference and of arm fat area. The GWG at T1 was within IOM recommendations in the 64.3% of the sample, while exceed in the 35.7% (+2 ±1.7 kg with respect the maximum weight gain recommended by IOM).

MD score at inclusion was 7.2 ±1.5 and it did not significantly change at T1. Mean MD Score between T0 an T1 was 7.3 ±1.3 (range: 4.5-11): mean MD score≥8 was satisfied by 27.1% of the sample. The Mediterranean items that met low adherence in the whole sample were: Olive oil≥4 tablespoons (10.3%), Fruits≥3 servings/day (29.4%), Legumes≥3/week (8.8%), Fish/seafoods≥3/week (6%), Free nuts≥1/week (27.9%).

Women with adequate GWG (n=45) showed a mean Mediterranean score significantly higher than women with excessive weight gain (n=25) (7.5 ±1.3 vs 6.8 ±1.0, p=0.02) (Figure 1).

Comparing the adherence to single items defining Mediterranean score, the two groups ("adequate GWG" vs "excessive GWG") did not significantly differ: however we observed a trend toward a lower habitual consumption of commercial sweets and higher employ of sofrito sauce prepared with olive oil, garlic or onion and tomato to dress pasta or rice by women with adequate GWG with respect women with excessive GWG (p=0.1).

We observed a trend toward a direct association between maternal age and MD score (r=0.21, p=0.08).

Univariate and multivariate linear regression analysis adjusted for maternal age, parity and physical activity showed an inverse association between MD score (independent), weight gain and fat mass increase during gestation (Table 4).

The frequency of excessive GWG was higher in the women with Med Score<8 with respect women with Med Score≥8 (43% vs 15%, p=0.03). In this study the adherence to Mediterranean diet resulted associated with a lower risk of excessive GWG (RR 0.24, 95% CI 0.1-0.9, p=0.04).

Table 1. General Characteristics of the Sample (n=70) at Baseline

Age (y)	mean	sd
Pre-pregnant BMI (kg/m^2)	33.2	3.5
	21.3	1.7
Nulliparous (n, %)	n	%
	52	74.3
Education level (n, %)		
High school medium level	1	1.5

High school high level	19	27.1
University	50	71.4
Physical activity		
None	34	49.2
1 time/week	14	20
2 times/week	10	13.8
3 times/week	12	17

Table 2. Anthropometric Measures and Mediterranean Score at Inclusion (T0) and at Third Trimester (T1) (n=70)

	At inclusion (T0)				**At third trimester (T1)**		
Gestational week	mean	sd			mean	sd	P value
	15.4	1.6			37.1	1.1	
Weight (kg)	60	6.7			70	8	0.001
Skinfold measure biceps (mm)	9	2.7			11.1	4	0.001
Skinfold measure triceps (mm)	17.4	3.7			18.5	4.6	0.02
Skinfold measure subscular (mm)	12	2.9			14.5	3.6	0.001
Sum of skinfolds (mm)	38.4	7.7			44.1	10.4	0.001
Circumference Arm (cm)	25.8	2.1			26.8	2.6	0.001
AFA (Arm Fat Area) (cm^2)	527.4	92.8			572.6	122.2	0.001
Mediterranean Score	7.2	1.5			7.3	1.3	0.42
Weight gain according to IOM guidelines			n	%			
Excessive			25	35.7			
Adequate			45	64.3			

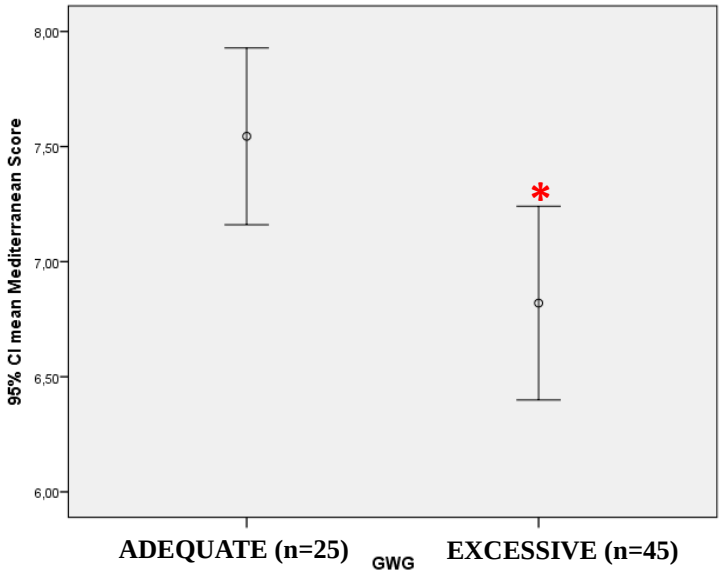

Figure 1. Mean Mediterranean Score in Women with Adequate GWG (n=45) and in Women with Excessive GWG (n=25) in according to IOM Guidelines

Table 3. Association between Mean Mediterranean Score (Independent) and Weight, Skinfold and AFA Increase (Dependent) during Gestation

	Model 0		Model 1	
	β	p	β	p
Weight gain (kg per week)	-0.26	**0.03**	-0.26	**0.03**
Biceps skinfold increase (mm per week)	-0.1	0.41	-0.1	0.41
Triceps increase (mm per week)	-0.18	0.12	-0.19	0.11
Subscapular skinfold increase (mm per week)	-0.23	**0.05**	-0.25	**0.04**
Total skinfold increase (mm per week)	-0.23	0.06	-0.24	0.06
AFA increase (mm^2 per week)	-0.23	0.35	-0.14	0.26

Note. Model 0 is univariate analysis; Model 1 is adjusted for maternal age, parity and physical activity.

4. Discussion

To our knowledge, this is the first time that a prospective cohort study analyses the effect of the adherence to MD on GWG.

We choose to study normal weight pregnant women (18≤pre-pregnant BMI<25 kg/m^2) because often in clinical practice they are overlooked being at low risk, however epidemiological studies showed that not only pre-pregnant obesity or overweight are risk factors for complications during pregnancy, but also excessive GWG among normal weight women. More than 40% of women with a normal pre-pregnancy Body Mass Index (BMI) exceed the 2009 Institute of Medicine (IOM) guidelines'

recommended weight gain of 25-35 lb (Josefson et al., 2013). Excessive weight gain in women with a normal pre-pregnancy BMI is associated with increased neonatal adiposity, postpartum weight retention, development of overweight, obesity, diabetes and metabolic syndrome (Rooney & Schauberger, 2002; Ouzounian et al., 2011; Josefson et al., 2013; Nehring et al., 2011). Therefore pregnancy can really be a tricky moment in the life of a normal weight woman.

Dietary pattern plays a relevant role in the modulation of body weight and in the occurrence of diseases during the life: epidemiological data show a direct association between Western Diet and risk of overweight, obesity and co-morbidities associated such as hypertension, diabetes and dyslipidemia (Cordain et al., 2005; Lutsey et al., 2008); on the other hand Mediterranean Diet has been extensively reported to be associated with a favourable health outcome and a better quality of life. In particular the adherence to a Mediterranean lifestyle is not related to weight gain in normal-weight people and protect against the risk of experiencing a state of overweight, obesity and metabolic syndrome (Sofi et al., 2013; Martínez-González et al., 2008). In the SUN study, the authors evaluated the graduates of the University of Pamplona, 10376 men and women for a total of over 5 years of follow-up. The analysis of eating habits showed that subjects with low adherence to the Mediterranean Diet had a higher weight gain during follow-up than those who has followed more strictly the principles of the Mediterranean Diet (Beunza et al., 2010). Mediterranean Diet in pregnancy is reported as a dietary pattern protective versus preterm delivery and wheeze and atopy in childhood (Chatzi et al., 2008), while no study investigate the effect on Gestational Weight Gain.

In this study we reported a good adherence to Mediterranean Diet (mean score≥8) in the 27% of the sample; it is difficult to compare our results with others present in literature because of different sample characteristics and questionnaires used. In our experience we applied the same questionnaire, including also the question about wine consumption, in 1472 Italian patients (71.3% women, 20% normal weight) seeking a weight loss program: we found a good adherence to MD in the 11.1% of the sample without gender and BMI difference; Mediterranean score resulted positively associated to age and education level (Bertoli et al., 2015). The higher prevalence of good adherence to Mediterranean Diet found in the sample of this study could be attributed to different factors; first, it is possible that pregnant status is a condition that ameliorates the attention of the women towards food and health; second, the mean education level was high (71.3% university degree) and this could have promoted a good adherence.

In our study the level of adherence to MD detected at beginning of the pregnancy resulted similar at the end of pregnancy; this result suggests that food behaviour of our sample did not change during gestation. During the first trimester the food intake can be often affected by nausea and vomiting, physiological phenomena linked to hormonal changes in the early pregnancy (Jewell et al., 2003), however women recruited in this study were all after the 13th week; this date could explain why there were not significant differences between food habits detected at begin and at the end of the study.

In this study we showed an inverse correlation between MD score and GWG, after adjustment for age, parity and physical activity; in particular we observed that Mediterranean score of women that

adequately increase their body weight was significantly higher than that exceed recommendations of IOM. Moreover we observed that the risk ratio of excessive GWG was lower in women with a good adherence to Mediterranean dietary pattern (med score≥8). Interesting is to observe that the association between Mediterranean Diet and weight gain, depended on the whole pattern and not on a single food.

Shroder et al. (2004) showed in Spanish population that traditional Mediterranean dietary pattern is inversely associated with BMI and obesity, while Romaguera et al. (2009) reported that adherence to MD is associated with lower abdominal adiposity in European men and women. No study has ever investigated the association between MD and fat mass in pregnant women; in our study we followed up the fat mass changes during gestation measuring biceps, triceps and subscapular skinfolds. We did not used waist circumference as adiposity marker because affected by foetal growth and position. Very interesting was to find an inverse association between adherence to MD and the increase of skinfold thickness, in particular subscapular skinfold thickness that it is known to refer to central/visceral fat (Cicek et al., 2014). Recent studies suggested that assessing maternal body composition may predict perinatal outcomes more accurately than maternal weight; Sommer et al. (2014) showed that weight gain, total fat mass evaluated as mean skinfold thickness and especially truncal fat were positively associated with gestational diabetes mellitus in multi-ethnic population. Therefore the weight gain associated to fat gain follow up should be encouraged during gestation in order to control the risk of adverse perinatal outcomes.

In conclusion, the results of this study suggest that the adherence to MD during pregnancy could prevent excessive weight gain, modulating fat mass increase. Further studies in larger cohorts are encouraged in order to confirm these results and to promote educational life style interventions aimed to indicate MD as healthy dietary pattern to prevent excessive weight gain and adverse pregnancy outcomes.

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