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# Association between the adherence to the Mediterranean diet and overweight and obesity in pregnant women in Gran Canaria

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**Abstract**

***Objective:*** **To evaluate the impact of the Mediterranean diet (MD) on weight gain and obesity in pregnant women in Gran Canaria.**

***Methods:*** **Cross sectional study in 170 pregnant women We measured the adherence to the MD before and during pregnancy by a food frequency questionnaire. Body mass index (BMI) was determined in the first prenatal visit. Appropriate weight gain was calculated according to the recommendations set by the American Institute of Medicine.**

**We established the association between the degree of compliance with the MD and the increase in BMI (regression coefficients [b] and their confidence intervals (CI) ([95% CI]) and weight gain (Odds ratios [OR] and their 95% CI) during pregnancy.**

***Results:*** **Women with a high baseline adherence to the Mediterranean diet gained less weight during pregnancy (b -1.54; CI 95% -2.53 to -0.56) than women with poor adherence. One point increase in the adherence to this diet during pregnancy was associated with an enhanced probability of appropriate weight gain (OR 1.39; CI 95%1.06 to 1.82).**

***Conclusions:*** **A high baseline adherence to the MD may protect against overweight and obesity during pregnancy. Intensifying this habit during gestation can increase the probability of an appropriate weight gain.**

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Key words: *Mediterranean diet. Obesity. Weight gain. Pregnancy.*

**ASOCIACIÓN ENTRE EL SEGUIMIENTO DE LA DIETA MEDITERRÁNEA CON EL SOBREPESO Y LA OBESIDAD EN GESTANTES DE GRAN CANARIA**

**Resumen**

***Objetivo:*** **Estimar el grado de adhesión al Patrón de Dieta Mediterránea (DM) en gestantes de Gran Canaria antes del embarazo y en el tercer trimestre valorando su relación con el incremento ponderal y la ganancia adecuada de peso durante el mismo.**

***Sujetos y método:*** **Estudio transversal en 170 gestantes de Gran Canaria. Se estimó la adhesión a DM al inicio del embarazo y en el tercer trimestre mediante un cuestionario frecuencia de consumo validado. El índice de masa corporal (IMC) se determinó al inicio y en el tercer trimestre a partir de los datos de peso y talla de la historia clínica. Se calculó la ganancia adecuada de peso según las recomendaciones establecidas por el Instituto de Medicina Estadounidense.**

**Se estableció la asociación entre la adhesión a DM y sus cambios durante el embarazo y el incremento en el IMC (coeficientes de regresión (b) y sus intervalos de confianza al 95% (IC 95%)) y una ganancia de peso adecuada (Odds Ratios (OR) y sus IC 95%).**

***Resultados:*** **Las mujeres con muy alta adhesión a la DM antes del embarazo ganaron menos peso durante el mismo (b: -1,54; IC 95%: 95% -2,53 a -0,56) que las mujeres con muy baja adhesión al patrón. El incremento en un punto en la adhesión a la DM durante el embarazo se asoció con una mayor probabilidad de ganancia de peso adecuada (OR: 1,39; IC 95%: 1,06 a 1,82).**

***Conclusiones:*** **Una alta adhesión a la DM antes del embarazo podría proteger frente a estados de sobrepeso y obesidad durante el mismo. Un mayor incremento en la adhesión a la DM durante la gestación puede aumentar la probabilidad de una ganancia adecuada de peso en el embarazo.**

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Palabras clave: *Dieta Mediterránea. Obesidad. Ganancia de peso. Embarazo.*

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## Abbreviations

MD: Mediterranean Diet.
OR: Odds Ratios.
BMI: Body Mass Index.
CI: Confidence Interval.
T: Tertil.

## Introduction

Obesity is a serious public health problem. It is considered a risk factor for the development of many chronic diseases such as hypertension, insulin resistance, diabetes, and hyperlipidemia. In addition, obesity is associated with an increased risk for mortality.[1]

The incidence of overweight and obesity in women at reproductive age has more than doubled in the past 30 years. In a recent review, Guelinckx et al. reported a prevalence of obesity in pregnant women from different countries ranging from 1.8 to 25.4%.[2] In a study carried out in the Canary Islands, Bautista-Castaño et al. reported values around 25% of overweight and 17.1% of obesity among pregnant women.[3]

The environmental characteristics transmitted to the fetus from the obese pregnant woman affects its development, resulting in an adapted transfer of nutrients (like glucose, fatty acids, amino acids), hormones (like insulin, leptin, and adiponectin), and possibly inflammatory markers through the placenta.[4]

Various epidemiological studies have demonstrated an association between pregestational obesity and birth defects.[5,6,7] The most consistent findings include an increased incidence of neural tube defects (spina bifida,anencephaly, encephalocele) in obese compared to non-obese pregnant women.[7]

Other phenotypes related with maternal obesity, but with a lower incidence, comprise congenital heart defects, cleft palate, anorectal atresia, hydrocephalus, hypospadias (in primiparous as well as older women), and deficiencies in the extremities.[8]

Weight gain during pregnancy is a complex biological phenomenon that supports growth and development of the fetus. The latter is not only affected by changes in the maternal metabolism and physiology but also by the placental metabolism.

Observational studies have clearly demonstrated a reduced number of complications during pregnancy and childbirth in women with an appropriate weight gain.[9,10]

In general, diet quality during pregnancy tends to be lower in obese than in non-obese women. Much remains unknown about the contribution of this phenomenon to the mechanisms involved in the occurrence of related birth defects.[11] However, more effort should go into the prevention of unhealthy weight gain through diet. In a systematic review of evidence for the avoidance of overweight and obesity through the Mediterranean diet (MD), 13 out of 21 studies concluded that adherence to this dietary pattern contributes significantly to weight loss in the general population.[12]

However, little is known about the potential influence of this healthful diet on an appropriate weight gain during pregnancy.

Therefore, the main objective of this study was to evaluate a possible association between the adherence to the MD prior to and during pregnancy with the compliance of the recommendations of the Institute of Medicine of the U.S. for weight gain among women with singleton pregnancies.

## Materials and methods

### *Study sample*

This is a cross-sectional study, enrolling 170 white Spanish pregnant women between 16 and 44 years who gave birth at the University Hospital Materno Infantil of Gran Canaria between July and September 2010. Only women with singleton pregnancies with no history of arterial hypertension, heart disease, diabetes mellitus, high cholesterol, concominant use of folic acid supplements or viral infection were included in the analysis. We further excluded women who underwent high-risk pregnancies and those who gave birth to children with any pathology. The study was approved by the Ethics Committee of the University Hospital Materno Infantil of Gran Canaria, of which all pregnant women were informed and provided written informed consent. All subject data were coded to maintain confidentiality.

### *Exposure assessment*

Baseline adherence to the MD referred to prior and during pregnancy was assessed by means of a reminder using a validated,[13] self-administered food frecuency questionnaire including 14 items. It was completed at two time points (first prenatal visit and early postpartum period).

The 14-item screener is described in the Appendix.

The maximum possible score was 14 points. In addition to the considered quantitative aspects of dietary habits, initial compliance with the MD was categorized into tertiles (T): low levels of adherence (0-6 points), moderate adherence (7-9 points), and high levels of adherence (10-14 points). A change in the category of dietary compliance was calculated as the difference between the adherence score in the third trimester and the one prior to pregnancy. Furthermore, this change was assigned to one of three categories: decrease (change $< 0$), maintenance (change $= 0$), and increase (change $> 0$) in adherence to the MD during pregnancy.

**Appendix**
*The 14-point mediterranean diet adherence screener*

| Food consumption frequency/Food intake habits | **1 point** |
|---|---|
| 1. Do you use olive oil as the principal source of fat for cooking? | Yes |
| 2. How many *tablespoons of olive oil do you consume per day (including that used in frying, salads, meals eaten away from home, etc.)? | ≥ 4 Tbsp |
| 3. How many servings of vegetables do you consume per day? Count garnish and side servings as 1/2 point; a full serving is 200 g. | ≥ 2 |
| 4. How many pieces of fruit (including fresh-squeezed juice) do you consume per day? | ≥ 3 |
| 5. How many servings of red meat, hamburger, or sausages do you consume per day? A full serving is 100-150 g. | < 1 |
| 6. How many servings (12 g) of butter, margarine, or cream do you consume per day? | < 1 |
| 7. How many carbonated and/or sugar-sweetened beverages do you consume per day? | < 1 |
| 8. How many servings (150 g) of pulses do you consume per week? | ≥ 3 |
| 9. How many servings of fish/seafood do you consume per week? (100-150 g of fish, 4-5 pieces or 200 g of seafood) | ≥ 3 |
| 10. How many times do you consume commercial (not homemade) pastry such as cookies or cake per week? | < 2 |
| 11. How many times do you consume nuts per week? (1 serving = 30 g) | ≥ 3 |
| 12. Do you prefer to eat chicken, turkey or rabbit instead of beef, pork, hamburgers, or sausages? | Yes |
| 13. How many times per week do you consume boiled vegetables, pasta, rice, or other dishes with a sauce of tomato, garlic, onion, or leeks sauted in olive oil? | ≥ 2 |
| 14. Do you drink wine? How much do you consume per week? | ≥ 7 cups** |

Criterium to score 1 point. Otherwise, 0 recorded.
*1 Tablespoon = 13,5 g.
**1 Cup = 100 ml.

*Outcome assessment*

Initially mothers reported pre-pregnancy weight and height at their first prenatal visit. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared and rounded to 1 decimal place. Women were classified as low weigh (BMI < 18.5 kg/m$^2$), normal weight (BMI 18.5-24.9 kg/m$^2$), overweight (BMI 25.0-29.9 kg/m$^2$) and obese (BMI ≥ 30 kg/m$^2$). Then, we used prenatal medical records to obtain pregnancy weights, and calculated total gestational weight gain as the difference between the last clinically recorded weight before delivery and self-reported pre-pregnancy weight.The references established by the American Institute of Medicine were applied to determine appropriate weight gain during pregnancy. This reference guide considers weight gain during pregnancy to be conditioned by the BMI before pregnancy.

Thus, women with prepregnancy BMI < 18.5 kg/m$^2$ should increase their weight from 12.5 to 18.0 kg (28-40 lbs); women with a BMI of 18.5 to 24.9 kg/m$^2$ should gain between 11.5 -16.0 kg (25-35 lbs); women with a BMI of 25.0 to 29.9 kg/m$^2$ at the most should raise their weight from 7.0 to 11.5 kg (15-25 lbs), and finally women with a BMI ≥ 30 kg/m$^2$ should gain 5-9 kg (11-20 lbs).[14]

Additional information about variables like age, educational level, and zip code was provided together with the study material. The variable age was categorized into the following groups: 16-20 years (y); 21-25 y; 26-30 y and ≥ 31 y.

Education levels were assigned to three groups: lower, intermediate and higher.

*Statistical analysis*

To assess the association between the adherence to the MD prior to pregnancy (T), the change during follow-up (no change, decrease, increase), and changes in the BMI over that period, age-adjusted regression coefficients (b) and their CI 95% were calculated though generalized linear models. To ascertain the relationship between the level of pre-pregnancy adherence to the Md, its changes during pregnancy, and the probability of undergoing appropiate, extremely low, or excessively high weight gain, logistic regression models were applied.

The poorest level of adherence prior to pregnancy (T1) or a stable level of adherence to the MD for the duration of pregnancy was considered as the reference category.

All analyses were repeated considering exposure to the MD before and its changes during pregnancy as quantitative variables. The statistical software package SPSS 19 (SPSS Inc., Chicago, IL) was used for all data analyses.

## Results

Table I shows the basic demographic characteristics of the sample. Older mothers exhibited higher levels of

**Table I**
*Sample characteristics according to adherence to the Mediterranean diet prior to pregnancy*

| *Characteristic* | *T1 (0-6) N = 46* | *T2 (7-9) N = 71* | *T3 (10-14) N = 47* |
|---|---|---|---|
| Age groups | | | |
| 16-20 (y) | 4.5 | 2.9 | 4.3 |
| 21-25 (y) | 31.8 | 14.3 | 8.7 |
| 26-30 (y) | 43.2 | 28.6 | 39.1 |
| > 31 (y) | 20.5 | 54.3 | 47.8 |
| Educational level (%) | | | |
| Lower | 54.5 | 37.0 | 26.3 |
| Intermediate | 27.3 | 29.6 | 31.6 |
| Higher | 18.2 | 33.3 | 42.1 |
| BMI prior to pregnancy (mean. SD) | 25.1 (4.5) | 24.6 (4.6) | 24.3 (4.7) |
| BMI after pregnancy (mean. SD) | 30.6 (4.3) | 28.2 (4.3) | 28.2 (4.3) |
| MD prior to pregnancy (mean. SD) | 5.2 (1.2) | 7.9 (0.9) | 10.9 (0.9) |
| MD during pregnancy (mean. SD) | 7.3 (2.4) | 8.7 (1.5) | 11.2 (1.1) |

compliance with the Mediterranean dietary pattern than the younger ones. 54.3% and 47.8% of women in T2 and 3, respectively were older than 31 years, while this percentage was 20.5 for poor levels of dietary adherence before pregnancy.

The degree of dietary adherence prior to pregnancy rose with educational level. Among women with modest adherence (first T), 54.5% had lower education and only 18.2% held a higher education. Conversely, 42.1% of the women with a strong adherence (T3) to the MD had experienced higher education.

Poor compliance with the MD before pregnancy resulted in a slightly higher BMI than a strong one. This difference increased with advancing pregnancy.

The results in table II suggest an inverse relationship between the degree of compliance with the Mediterranean dietary pattern prior to and a change in the BMI during pregnancy.

Women complying strongly to the MD prior to pregnancy (T3) experienced a lower mean BMI increase

**Table II**
*Association* between the adherence to the Mediterranean diet prior to pregnancy and changes in body mass index throughout pregnancy*

| | *Tertiles* | | | *MD prior to pregnancy (1 point)* |
|---|---|---|---|---|
| | *1* | *2* | *3* | |
| Change in BMI | 0 (ref.) | -0.9 (-1.82 to -0.03) | -1.54 (-2.53 to -0.56) | -0.22 (-0.38 to -0.06) |
| Change in BMI (%) | 0 (ref.) | -3.08 (-7.17 to 1.02) | -5.58 (-10.07 to -1.08) | -0.76 (-1.50 to -0.03) |

*Age-adjusted.regression coefficients and CI 95%.
Change in BMI = BMI in third trimester-BMI prior to pregnancy.
Change in BMI (%) = (BMI in third trimester-BMI prior to pregnancy)/BMI prior to pregnancy.

than those with poor dietary adherence (T1) (b = -1.54). Moreover, this difference was statistically significant (95% CI -2.53 to -0.56).

Each additional point of initial adherence to the Mediterranean diet resulted in a comparatively smaller increase (about 22 points less) in BMI. We obtained identical results when taking into account the BMI at the first prenatal visit.

The data in table III confirm the association between changes in compliance with the MD during pregnancy and changes in BMI. We did not find any statistically significant correlation between these variables.

Table IV shows the association between adherence to the MD and an appropriate weight gain throughout pregnancy. Although every one-point increase in the level of adherence to this diet prior to pregnancy was associated with an augmented risk of extremely low weight gain during pregnancy (OR 1.38, 95% CI 0.07-1.79), the rise of one point of the dietary compliance status during pregnancy resulted in a greater likelihood of appropriate weight gain (OR 1.39, 95% CI 1.06-1.82).

The additional adjustment for educational level did not alter any of the obtained associations.

## Discussion

In this study, we observed a high prevalence of overweight in pregnant women. In fact, 37% of the participating women were overweight (22.8% overweight and 14.8% obese) on starting their pregnancy. This result confirms data reported by Bautista-Castaño et al.[3]

Although a change in compliance with the Mediterranean dietary pattern during pregnancy was not associated with a significant change in BMI, women with a strong adherence prior to pregnancy had a minor increase in BMI all the way through pregnancy than those with poor adherence, regardless of their weight before getting pregnant. Furthermore, we detected an association between enhanced compliance with the MD during pregnancy and reduced weight gain.

Observational studies[9,10] have consistently shown that complications during pregnancy and childbirth occur less frequently in women who gain weight appropriately, according to the recommendations of the American Institute of Medicine.[15]

Thus, it is important to emphasize maternal nutrition at conception influences the metabolic response to pregnancy and fetal growth and development.[16]

Although prenatal multiple micronutrients can improve fetal growth, their benefit on postnatal health remains uncertain.[17] Fetal anomalies as well as deviations in fetal growth rates are more common among obese compared with normal-weight women, suggesting that maternal adiposity affects development during both the embryonic period as well as later in gestation. The

**Table III**
*Association* between changes in the adherence to the Mediterranean diet and body mass index during pregnancy*

| | Change in MD | | | | |
|---|---|---|---|---|---|
| | *No change* | *Increase* | *Decrease* | *1 point* | *(%)* |
| Change in BMI | 0 (ref.) | 0.35 (-0.42 to 1.12) | 0.08 (-1.40 to 1.56) | 0.09 (-0.15 to 0.32) | 0.005 (-0.006 to 0.016) |
| Change in BMI (%) | 0 (ref.) | 1.65 (-1.81 to 5.12) | 0.71 (-5.97 to 7.39) | 0.25 (-0.82 to 1.30) | 0.010 (-0.038 to 0.058) |

*Age-adjusted.regression coefficients and CI 95%.
Change in BMI = BMI in third trimestre-BMI prior to pregnancy
Change in BMI (%) = (BMI in third trimestre-BMI prior to pregnancy)/BMI prior to pregnancy.

**Table IV**
*Association* between the adherence to the Mediterranean diet prior to and changes during pregnancy and appropiate gestational weight gain*

| | Weight gain | | |
|---|---|---|---|
| | *Appropriate* | *Extremely low* | *Excessively high* |
| MD prior to pregnancy | | | |
| T1 | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| T2 | 1.01 (0.38-2.74) | 4.16 (0.84-20.66) | 0.50 (0.17-1.48) |
| T3 | 0.59 (0.19-1.82) | 10.35 (1.80-59.54) | 0.82 (0.23-2.92) |
| MD prior (1 point) | 0.91 (0.76-1.09) | 1.38 (1.07-1.79) | 0.98 (0.80-1.20) |
| Change in MD | | | |
| No change (change = 0) | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Increase (change > 0) | 1.52 (0.66-3.46) | 0.62 (0.23-1.68) | 0.66 (0.25-1.73) |
| Decrease (change < 0) | 0.30 (0.03-2.65) | 1.08 (0.08-14.11) | 4.23 (0.45-40.29) |
| Change in MD (1 point) | 1.39 (1.06-1.82) | 0.70 (0.48-1.02) | 0.74 (0.55-1.00) |

*Age-adjusted odds ratios and CI 95%.

intrauterine effects on fetal growth and development may also affect postnatal development of the child, particularly if fetal growth rates are abnormal. Large-for-gestational age infants are at increased risk for childhood obesity, which can lead to insulin resistance, diabetes, and hypertension later in life.[10]

Despite influence of diet on the incidence of a large number of diseases including obesity is well known, there is a lack of dietary advice in order to prevent obesity in pregnancy.[4]

Impact of different food groups on obesity has been established. Moreover, the concept of nutrition as a multidimensional exposure has emerged only recently.

The study of dietary patterns, among them the MD, has come out as an alternative tool to examine the relationship between food and chronic diseases. Epidemiological evidence of the links between compliance with the MD and overweight and obesity is limited, even for the general population that differs substantially from the profile of our sample. According to our knowledge, none of these studies refer to gestation.

There are various physiological mechanisms that might explain a potentially protective effect of the components of the MD against weight gain. The low amount of energy, low glycemic load, high water content, and the prevalence of plant foods, rich in fiber, may be determinant. As a consequence, increased satiety may occur, gastric juice volume decreased, and the release of cholecystokinin augmented. This would lead to a reduced sensation of hunger and therefore could serve as a prevention factor against excessive intake.[18]

The present study has some limitations. The applied questionnaire did not collect information on physical activity. Given that women with better dietary habits usually care about a more healthful lifestyle, part of the effect resulting from compliance with the Mediterranean dietary pattern on appropriate gestational weight gain could be explained by a higher level of physical activity.

The academic level may be considered as an indicator of a healthy lifestyle and increased physical activity. However, adjustment of our results by educational category did not change the obtained associations. So, we do not think that the amount of physical activity of the pregnant women in our sample has biased our estimates.

Furthermore, to assess the normal diet of the pregnant study participants, we used a short questionnaire

about food consumption frequency. While this tool provides nutrition information that tends to overestimate average consumption, previous research has demonstrated that the food consumption frequency questionnaire is an appropriate tool to obtain reliable estimates of energy and nutrient intake during pregnancy.[19] In any case, a possible bias would not have resulted in differential information and have led estimates toward null so that the impact of adherence to the MD on weight change during pregnancy would have been even more substantial than observed.

Compliance with MD is declining in the Canary Islands, due to a number of motives related to family life, the educational environment, and the sociocultural context.[20]

In fact, in this study, adherence to the MD was especially low among young and poorly educated women.

In this sense, while education is related to social class, it also represents the depth of knowledge and is related to the capability of understanding health messages, making adequate use of health services, and adopting appropriate personal care.

In conclusion, similar to previous studies in the general population, this study revealed that higher levels of adherence to the MD reduce the likelihood of overweight and obesity in pregnant women. An increase in compliance with this diet could contribute to appropriate weight gain during pregnancy and reduce the risk of complications associated with obesity.

Therefore, further measures should be taken to disseminate information about the benefits of this diet, especially among young women with a low educational level.

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