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# Abordaje de la diabetes gestacional a partir de la caracterización de la dieta pregestacional como factor de riesgo

## Approach to gestational diabetes from the characterization of the pregestational diet as a risk factor

Marín Martínez, Lorena[1,2]; Blesa, Jesús[1,2]; Soriano, Jose M.[1,2,3]; Merino Torres, Juan F.[2,4]

*1 Department of Preventive Medicine and Public Health, Food Sciences, Toxicology and Legal Medicine, University of Valencia, Valencia, Spain.*
*2 Joint Research Unit on Endocrinology, Nutrition and Clinical Dietetics, University of Valencia-Health Research Institute La Fe, Spain.*
*3 Food & Health Lab, Institute of Materials Science, University of Valencia, Valencia, Spain.*
*4 Department of Endocrinology and Nutrition, University and Polytechnic Hospital La Fe, Spain.*

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## ABSTRACT

**Introduction:** Gestational diabetes (GD) is characterized by hyperglycemia that appears during pregnancy.

**Objective:** To characterize the food habits prior to the diagnosis of GD in a group of patients and assess as a modifiable risk factor related to the development of GD.

**Methods:** In this study, pregnant women with GD origin were selected according to criteria of nationality, age and history of GD. Data on body composition, family history, physical activity and pregestational food consumption were collected, in order to assess the role of food as a modifiable risk factor related to the development of GD being carried out with a dietary interview collected by a dietitian.

**Results:** The age and body mass index (BMI) of the study population is 36.7 ± 4.1 years and 26.9 ± 5.1 kg/m$^2$, respectively. In addition, 75% of the women studied had a family history of diabetes and 32.5% conducived to physical activity.

**Discussion:** The studied population followed to food pattern based in the Western diet with consumption of meat products and processed food, contrary to the Mediterranean dietary pattern characterized by a high consumption of vegetables, fruits, legumes, whole grains, fish and unprocessed foods.

**Conclusions:** The dietary pattern prior to pregnancy is characterized by westernized diet away from the preventive dietary pattern. Diet is a modifiable factor and therefore it would be desirable to include early intervention on the dietary pattern in GD prevention programs in the population at risk.

## KEYWORDS

Food habits; gestational diabetes, pregnancy, pregestational intervention.

## ABBREVIATURES

BMI: Body Mass Index.

GD: Gestational diabetes.

## INTRODUCTION

Gestational diabetes (GD) is that situation in which the woman faces a diagnosis of diabetes mellitus in the course of a pregnancy, and is usually resolved or terminated at the end of pregnancy. GD produce resistance to insulin action, glucose intolerance and hyperglycemia[1]. The prevalence of GD ranges from 7-14% in Chinese pregnant women and this value is rising due to changes in the dietary habits of patients, sedentary lifestyle, increased maternal age, as well as a high body mass index (BMI). The main risk factors associated with the presentation of GD are: maternal age (over 30 years), overweight-obesity, family history of diabetes and patients with GD in previous pregnancies, and finally, inadequate eating habits[2]. In general, the specific risks of uncontrolled diabetes in pregnancy include spontaneous abortion, fetal abnormali-

**Correspondencia:**
Jose M. Soriano
Jose.soriano@uv.es

ties, preeclampsia, fetal death, macrosomia, neonatal hypoglycemia and neonatal hyperbilirubinemia, among others. In addition, diabetes in pregnancy can increase the risk of obesity and type II diabetes in the offspring throughout their lives[3]. For all these reasons, it is important to maintain correct blood glucose levels during pregnancy since the complications of the GD that can affect both the fetus and the pregnant woman depend on a good control of these values. A direct relationship between adherence to a healthy dietary model prior to pregnancy can be corroborated with a lower risk of developing gestational diabetes[4]. In addition, it has been shown that high consumption of animal fats (red and processed meats), cholesterol, refined grains, sweets and fried foods are associated with GD[5]. Therefore, to minimize the risk of suffering from the disease, women of reproductive age should adopt a diet rich in vegetables, whole grains, nuts and fish, and reduce both red and processed meats and snacks[6]. In fact, it has been observed that an intervention based on healthy eating as a primary prevention of GD, greatly reduces cases in women who are overweight and obese, who are candidates for the development of the disease[7]. The aim of this study is to characterize the food habits prior to the diagnosis of GD in a group of patients and assess as a modifiable risk factor related to the development of GD. Thus, it is intended to ask whether it would be necessary to carry out a nutritional intervention prior to the screening test to minimize cases of GD in patients with risk factors.

## METHODS

This is a retrospective study carried out in Valencia (Spain). The participants (n=80) were selected for the debut of diabetes with pregnancy, without having previously suffered from diabetes, being Spanish and of legal age. The study was conducted in accordance with the Helsinki declaration and approved by the Biomedical Research Ethics Committee of the University and Polytechnic Hospital La Fe (registration number 2016/0133). This study conforms to the ethical regulations on biomedical research with human subjects and is viable in terms of the scientific approach, objectives and material and methods described in the application, as well as in the Patient Information Sheet and its respective Informed Consent. To compile the study data, dietitian compiled a series of variables related to gestational diabetes, such as: previous gestations, age, weight and pregestational BMI, family history of diabetes, history of GD and the performance of physical activity in the pregestational period. Data of the dietary intake of patients were obtained by the food frequency questionnaire (FFQ) validated developed and validated using four 1-week dietary records in an adult population in Valencia[8] and provided by dietitian in a directly interview, using the Spanish recommendations[9], and recorded the occasions per week or month that rations were consumed being data expressed as daily rations of each food. Furthermore, we have divided, to evaluate the consumption of food, in two groups consumers that ingested each food group versus total consumers (including consumers and non-consumers each food group). For statistical analysis, all categorical variables were described as percentages, while means and standard deviations were reported for continuous variables and analyzed using Statistical Package for the Social Sciences software (SPSS for Windows, SPSS, Inc., Chicago, IL) version 16.0.

## RESULTS

The characteristics of pregnant women are presented in Table 1. Data reflected a mean of the age greater than 35 years, a BMI greater than 25 kg/m$^2$, 75% of pregnant women had a family history of diabetes and approximately one third performed pregestational activity. Table 2 shows the pregestational food consumption, the results have been expressed as daily rations, showing the data for both the consumer group and the total group of the sample. For vegetables, 97.5% (n=78) of the studied females consumed an intake of 0.23 daily ration, which is equivalent to 1.6 ration per week.

Studied females consumed dairy products (98.8%, n = 79) with an intake of 2.49 daily rations. The type of milk most chosen by consumers were semi-skimmed (56.3%, n=45), followed by skimmed (23.8%, n=19) and whole (8.8%, n=7),

**Table 1.** Characteristics of the studied subjects.

| Parameters | Value[a] |
|---|---|
| Age (years) | 36.7 ± 4.1 |
| First-time mothers (%) | 46.3 |
| Gestational age when diagnosed (weeks) | 26.0 ± 7.1 |
| Gestational diabetes (GD) in previous pregnancies (%) | 32.5 |
| Pregestational weight (kg) | 66.2 ± 15.4 |
| Height (cm) | 162.6 ± 6.6 |
| Pregestational BMI (kg/m$^2$) | 26.9 ± 5.1 |
| Underweight (%) | 1.3 |
| Normal range (%) | 51.3 |
| Overweight (%) | 21.3 |
| Obesity (%) | 26.3 |
| Family history of diabetes (%) | 75.0 |
| Pregestacional physical exercise (%) | 32.5 |

[a] Data shows as mean± standard deviation or percentage (%).

**Table 2.** Consumption by food group of consumers and the total sample in daily rations.

| Food | Daily rations in relation to the consumers of this food (number of consumers of the total sample) | Daily rations in relation to the studied total subject (n=80) |
|---|---|---|
| *Fruits* | 1.36 (n=74) | 1.26 |
| *Vegetables* | 1.63 (n=80) | 1.63 |
| *Cooked vegetable* | 0.92 (n=79) | 0.92 |
| *Raw vegetable* | 0.76(n=75) | 0.72 |
| *Milk* | 2.49 (n=71) | 2.46 |
| *Skimmed milk* | 1.57 (n=19) | 0.38 |
| *Semi-skimmed milk* | 1.36 (n=45) | 0.76 |
| *Whole milk* | 1.13 (n=7) | 0.01 |
| *Yogurts* | 0.42 (n=64) | 0.32 |
| *Natural* | 0.37 (n=15) | 0.01 |
| *Sweetened* | 0.36 (n=28) | 0.13 |
| *Skimmed* | 0.48 (n=21) | 0.13 |
| *Cheese* | 0.84 (n=74) | 0.78 |
| *Fresh* | 0.45 (n=50) | 0.28 |
| *Semi-cured/cured* | 0.57 (n=70) | 0.50 |
| *Dairy with added sugar* | 0.45 (n=44) | 0.25 |
| *Reduced fat dairy* | 1.65 (n=75) | 1.54 |
| *Starch* | 3.92 (n=80) | 3.92 |
| *Cereals* | 3.67 (n=80) | 3.67 |
| *Sugary* | 1.00 (n=51) | 0.64 |
| *Refined* | 2.26 (n=79) | 2.24 |
| *Wholemeal* | 1.06 (n=34) | 0.45 |
| *Legumes* | 0.23 (n=78) | 0.22 |
| *Nuts* | 0.41 (n=69) | 0.35 |
| *Meats* | 0.95 (n=80) | 0.95 |
| *Processed meat* | 1.21 (n=78) | 1.18 |
| *Fish* | 0.41 (n=75) | 0.38 |
| *Processed fish* | 0.34 (n=75) | 0.32 |
| *Eggs* | 0.39 (n=80) | 0.39 |
| *Oils* | 2.78 (n=80) | 2.78 |
| *Vegetals* | 2.60 (n=80) | 2.60 |
| *Animals* | 0.28 (n=17) | 0.18 |
| *Processed rich in sugar and/or fat* | 1.84 (n=80) | 1.84 |
| *Alcoholic drinks* | 0.30 (n=43) | 0.16 |
| *Sugary drinks* | 1.17 (n=50) | 0.73 |

with a consumption of 1.36, 1.57 and 1.13 daily rations, respectively. For yogurt, the value was 0.42 daily rations among consumers (86.3%, n=69). The different types of yogurts studied, natural (18.8%, n=15), sweetened (35%, n=28) and skimmed (26.3%, n=21), had a consumption of 0.37, 0,36 and 0.48 daily rations, respectively. Furthermore, a consumption of 0.37 daily rations was the dairy dessert (32.5%, n=26) of flan, pudding or custard type. The sugary yogurts and dairy desserts together are consumed by just over half of the studied females (55%, n = 44), so dairy products with added sugar had a consumption of 0.45 daily rations. For cheese, the consumption among consumers (92.5%, n=74) was 0.84 daily rations, its consumption by type was distributed in fresh (0.45 daily rations, 62.5%, n=5) and semi-cured or cured (0.57 daily rations, 87.5%, n=70). Semi-skimmed and skim milk, skimmed yogurt and fresh cheese were mostly preferred by the all consumers, 93.8% (n=75), with a consumption of 1.65 daily rations. The largest contributions to the dairy ration for all subjects (n = 80) was due to the consumption of semi-skimmed milk (32%), semi-cured/cured cheese (20.3%), skimmed milk (15.1%), fresh cheese (11.4%), sweetened yogurt (5.17%) and skimmed yogurt (5.15%), these foods meaning more than 80% of the contributions of this food group.

All females (n = 80) ingested a value of 3.92 daily rations of starches. For cereals, the following groups have been differentiated: sugary cereals (breakfast cereals and sugary biscuits) with an intake of 1.00 daily rations (63.8%, n=51), refined (white bread, white rice, white pasta, cous-cous and sugar-free cookies) with a consumption of 2.26 daily rations (98.8%, n=79) and whole grains (oatmeal, whole wheat bread, brown rice, whole grain pasta and the pseudocereal quinoa) with a value of 1.06 daily rations (42.5%, n = 34). If the total sample is taken into account, 0.45 daily rations belong to the group of whole grains representing 12% of the intake of this food group.

For nuts, 86% (n=69) of the females indicated an ingestion of 0.41 daily rations, being only nuts with peel, peeled and/or roasted without the addition of salt or sugar, a value that decreased to 0.35 daily rations for the studied subjects.

For meat and fish, the meat was consumed by the total sample (n = 80) with an intake of 0.95 daily rations, that was, 6.65 ration/week, of which 65.9% is lean meat. However, 97.5% (n=78) added to this consumption the processed meat (viscera, cold meat, sausage, pate, hamburger and bacon) with an intake of 1.21 daily rations, being consumed cold cuts and hamburgers in 62.9 and 16.7%, respectively. On the other hand, a 6.25% (n=5) of the sample never ate fish. The rest of the population (93.8%, n = 75) consumed fish as 0.41 daily rations, that was, 2.87 ration/weeks, and ingested processed fish (canned fish and salted fish) in an amount of 0.34 daily rations, of which 88.1% was canned fish, mostly tuna. For eggs, the total sample (n=80) consumed eggs with an intake of 0.39 daily rations or 2.73 ration/week.

Oil was consumed for all the studied subject (n=80), where olive oil (98.8%, n=79) and seed oils (18.8%, n=15) had a consumption of 2.5 and 0.68 daily rations, respectively. Other oils, such as butter/margarine (46.3%, n=37) and cream (37.5%, n=30) had a consumption of 0.29 and 0.11 daily rations, respectively.

For processed foods rich in sugar and/or fat, this group included condensed milk (5%, n=4), industrial sauces (75%, n=60), snacks (82.5%, n=66), cookies (78.8%, n=63), pastries (72.5%, n=58), chocolate powder (35%, n=28), jams (35%, n=28) and ice cream (56.3%, n=45). Studied females showed an intake of 1.84 daily rations.

## DISCUSSION

In the treatment of GD, it is essential to control the modifiable risk factors associated with an increased risk of disease, such as: starting from a healthy body weight, habitual practice of physical activity and healthy eating. These factors are relevant when planning a pregnancy and minimize the risks of suffering from the disease. In a prospective study where 823 pregnant women were evaluated after diagnosis of GD and several risk factors were related such as: no smoking, more than 150 minutes/week of physical activity and eating a healthy diet, with 41% less of risk of suffering GD. Also presenting a BMI of less than 25kg/m$^2$, the increase was even more noticeable, the cases were reduced to 52 %[10]. On the other hand, a value of BMI greater than 25kg/m$^2$ during the 10-20 week of pregnancy contributed to the development of GD and as a risk factor to give birth to a baby of greater weight[11]. In addition, all this is reinforced in a prospective observational study that included 168 pregnant women, where it was concluded that the prevalence of GD was 2.3% among women with normal weight before pregnancy (n=86) and 18.3% among women with overweight or obese (n = 82)[12].

Furthermore, a study conducted an exhaustive search of observational studies relating the practice of physical activity with eating patterns such as the Mediterranean Diet and a 46% reduction in the probability of suffering from GD was determined with the practice of 90 minutes of activity physical per week[13]. In the sample studied, the 80 pregnant women begin pregnancy with a BMI of 26.9 kg/m$^2$, being 47.6% overweight and/or obese. In addition, 67.5% did not practice physical activity before pregnancy. Therefore, the sample studied presents relevant data of overweight and obesity along with physical inactivity, which implies an increased risk of GD[14].

The studied sample is rich in meat, processed meat, processed foods and sugary drinks leaving behind the dietary pattern characterized by consumption of vegetables, fruits, legumes, whole grains, nuts, fish and unprocessed foods. Giving greater prominence to proteins of animal origin compared to proteins of plant origin, leads to a high risk of suffering from GD in the second trimester of pregnancy, being an important factor to be taken into account to reduce cases[15]. This aspect is reinforced in a prospective study, where 172 incident cases of GD were identified and pre-pregnancy feeding was evaluated, finding an association between high consumption of processed meat and red meat with a higher risk of GD[16]. In the sample studied, there is an excessive consumption of meat, specifically, 6.65 ration/week, and processed meat 8.47 ration/week. If the Spanish recommendations[9] are used, which stipulates a lean meat consumption of 3 ration/week and an occasional consumption of meat products, excessive consumption is observed.

Consecutively, and related to both body composition factors and the dietary pattern prior to pregnancy, it has been shown that they can reduce the risk of GD up to 76%. These factors are: BMI under 25 kg/m$^2$, age below 28 years and a dietary pattern characterized by high consumption of vegetables, fruits, fish and low consumption of ultraprocessed and processed meat[17]. If the data extracted from the sample of consumers are compared with the Spanish recommendations[9], in many cases, the group studied does not meet these recommendations in terms of quality and quantity of daily and/or weekly rations.

As for daily consumption foods, fruits, vegetables, cereals and nuts do not reach the recommendations being dairy and fat those that meet them. Spanish recommendations[9] indicated a consumption of 3-4 daily rations of fruits and at least 2 daily rations of vegetables and not being consumed by the studied subjects (fruits and vegetables was intake as 1.36 and 1.63 daily rations, respectively). The consumption of cereals is 3.67 daily rations, however, in a large proportion it is based on refined cereal and sugary cereals, leaving behind whole grain cereal, where is recommended[9] that mostly cereal consumption should be whole grain. A change of refined carbohydrates for whole grain could maintain glycemia at optimal levels and thereby reduce cases of GD[18]. It has even been observed that it is a prevention factor since a diet with a low glycemic index beneficially influences birth weight and length[19]. For dairy products, the recommendation is 2-3 daily rations, with the appropriate sample consumption being 2.46 daily rations[9]. Although this consumption is divided between milk, yogurts and cheese, and presentations with reduced fat intake are widely accepted, it is necessary to reduce the consumption of sugary derivatives, especially sugary yogurts and dairy desserts that represent 0.45 daily rations for more than half of the sample. On the other hand, the fat is consumed mostly in the form of extra virgin olive oil (2.5 daily rations) compared to other refined oils and from animal origin. A consumption of 3-4 daily rations of extra virgin olive oil is recommended[9] as the main source for cooking and dressing.

The weekly consumption foods, such as legumes, meats, fish and eggs, the daily and weekly consumption frequencies

correspond to: 0.23 daily rations (1.6 ration/week), 0.95 daily rations (6.65 ration/week), 0.41 daily rations (2.87 ration/week), 0.39 daily rations (2.73 ration/week), respectively. Legumes do not reach 2-4 daily rations, and there is a very high consumption of meat and processed meat, reducing the intake of fish and eggs. In a prospective study where 3298 healthy Spanish women were recruited and meat and processed meat intake was evaluated, using a validated semi-quantitative food frequency questionnaire of 136 items, it was concluded that a pregestational consumption of meat, especially red [OR = 2.37 (CI of 95% 1.49-3.78, trend p <0.001)] and processed meat [OR = 2.01 (95% CI 1.26-3.21, trend p 0.003)], is significantly associated with GD[16].

All this is reinforced by a prospective cohort study, which examined the association of protein intake in the diet before pregnancy (total, animal and vegetable protein), as well as the main sources of protein at risk of GD. The consumption of red meat before pregnancy was significantly and positively associated with the risk of GD, on the contrary, a higher consumption of nuts before pregnancy was associated with a lower risk. With all this, it was concluded that a substitution of 5% of the energy from animal protein with vegetable protein and the substitution of red meat for poultry, fish, nuts or legumes is associated with a lower risk of GD[20].

As for processed products rich in sugars and/or fat along with sugary drinks, these are characterized by fast-absorbing sugars, increasing blood sugar levels and insulin resistance and consumption, following the guideline of the World Organization Health[21] should not exceed the contribution of 10% of daily energy from free sugars. If the consuming sample is taken into account, it consumes 1.84 and 1.17 daily rations of products rich in sugars and/or fat and sugary drinks respectively, while the recommendation is occasional consumption or substitution by equivalents no added sugars[9]. Subsequently, it has been shown that dietary patterns during pregnancy influence the development of GD[22]. If the quality of the pregestational feeding pattern of the sample studied is evaluated, the food pattern followed approximates the western model, that is, with a high consumption of meat, processed meat, sugary drinks, foods rich in fat and/or sugar, leaving behind the Mediterranean dietary pattern. A study evaluating 388 pregnant women (122 cases and 266 controls), where the pre-pregnancy dietary intake was collected using a questionnaire on food consumption frequency, semi-quantitative and validated, identified two dietary patterns, the western and the Mediterranean, where a positive association of the western pattern with the risk of suffering GD[23] was observed. With all the scientific evidence that supports correct pre-gestational eating habits to minimize the impact of the GD, an intervention plan would be necessary where the diagnosis of the GD was performed in those women who had some risk factor and then an evaluation of the food guideline to minimize cases of suffering the disease. This aspect has been confirmed in a meta-analysis, in which 29 randomized controlled trials with 11,487 women were identified in which it was shown that a change in lifestyle (diet and physical activity) prior to the 15th week of gestation could reduce the fact of developing a GD in 18% of cases[24]. On the other hand, a study related the degree of adherence to a pattern based on Mediterranean Diet after 12 weeks of pregnancy with the association of reducing the risk of maternal fetal outcomes and GD, for this the Mediterranean diet pattern was defined with the compliance with the consumption of different foods (> 12 ration/week of vegetables and fruit, <2 ration/week of fruit juices,> 3 ration/week of nuts,> 6 days/weekly consumption of olive oil and> 40 ml/day). The high adherence had to exceed between 5-6 objectives, concluding that in pregnant women with high adherence the risk of GD and complications in pregnancy outcomes was reduced[25]. All this is reinforced in another case-control study (130 pregnant women with GD and 148 pregnant women without GD) where dietary intake was evaluated during the last year prior to pregnancy through a validated food frequency questionnaire of 67 items. It was concluded that a pre-pregnancy adherence of a Mediterranean dietary pattern is significantly associated with a reduced risk of GD[26].

Finally, maternal nutritional status during pregnancy will affect the health of the mother and the newborn. The evaluation of the maternal diet of 150 pregnant women during the first trimester, determined a significant association between a diet high in carbohydrates and fat over the number of babies with macrosomia[27]. In addition, having a GD during pregnancy is associated with an increased risk of childhood overweight, obesity and high body fat compared to children born to mothers without suffering from the disease[28]. Even a Food Education is necessary during pregnancy as a correct adherence to healthy dietary patterns, such as the Mediterranean Diet, is associated with a lower risk of suffering from Type II Diabetes among women with a history of GD[29,30]. Furthermore, an improvement in nutrition through nutritional intervention can mean an improvement at the moment, in the rest of the pregnancy and in the future of both the woman and the offspring. The establishment of pregestational screening, in planned pregnancies or prior to the diagnosis of GD, would be necessary to identify candidates for Food Education who could benefit from an improvement in their diet as a factor reducing the risk of GD. In our viewpoint, the limitations of this study included the need to incorporate more dietitians to the service in order to cover a greater number of patients.

## CONCLUSIONS

The dietary pattern prior to pregnancy is characterized by westernized diet away from the preventive dietary pattern. Diet is a modifiable factor and therefore it would be desirable to include early intervention on the dietary pattern in GD pre-

vention programs in the population at risk. The need to incorporate more dietitians into the service could help improve the health of these women

## BIBLIOGRAPHY


1. Acosta Santa J, Suárez Armando R. Sobrepeso y obesidad en embarazadas cubanas. Nutr clín diet hosp. 2011;31(3):28-34.
2. Bi J, Ji C, Wu Y, Wu M, Liu Y, Song L, et al. Association between maternal normal range HbA1c values and adverse birth outcomes. J Clin Endocrinol Metab. 2020;105(6):2185-91.
3. American Diabetes Association. Management of diabetes in pregnancy: standards of medical care in diabetes-2019. Diabetes Care. 2019;42(Supplement 1):S165-S172.
4. Tobias DK, Zhang C, Chavarro J, Bowers K, Rich-Edwards J, Rosner B et al. Prepregnancy adherence to dietary patterns and lower risk of gestational diabetes mellitus. Am J Clin Nutr. 2012;96(2):289-95.
5. Bowers K, Tobias DK, Yeung E, Williams MA, Qi L, Tobias DK et al. A prospective study of prepregnancy dietary fat intake and risk of gestational diabetes. Am J Clin Nutr. 2012;95(2):446-53.
6. Siddiqui S, Zainal H, Harun SN, Ghadzi SMS, Ghafoor S. Gender differences in the modifiable risk factors associated with the presence of prediabetes: A systematic review. Diabetes Metab Syndr. 2020;14(5):1243-52.
7. Pombo F, Neri C, Cano L, Reyes M, Dominguez B, Rempel MI, et al. Impacto de los nuevos criterios diagnósticos para la diabetes gestacional. Ensayo clínico aleatorizado. Nutr clín diet hosp. 2017;37(3):44-52.
8. Vioque J, Navarrete EM, Giménez-Monzó D, García-de-la-Hera M, Granado F, Young IS et al. Reproducibility and validity of a food frequency questionnaire among pregnant women in a Mediterranean area. Nutr J. 2013;12(1):12-26.
9. Aranceta-Bartrina J, Partearroyo T, López-Sobaler AM, Ortega RM, Varela-Moreiras G, Serra-Majem L, et al. Updating the food-based dietary guidelines for the Spanish population: The Spanish Society of Community Nutrition (SENC) Proposal. Nutrients. 2019;11:2675.
10. Zhang C, Tobias DK, Chavarro JE, Bao W, Wang D, Ley SH et al. Adherence to healthy lifestyle and risk of gestational diabetes mellitus: prospective cohort study. BMJ 2014;349:1-11.
11. Martin KE, Grivell RM, Yelland LN, Dodd JM. The influence of maternal BMI and gestational diabetes on pregnancy outcome. Diabetes Res Clin Pract. 2015;108(3): 508-13.
12. Tryggvadottir EA, Medek H, Birgisdottir BE, Geirsson RT, Gunnarsdottir I. Association between healthy maternal dietary pattern and risk for gestational diabetes mellitus. Eur J Clin Nutr. 2016;70(2):237-42.
13. Du M, Ouyang Y, Nie X, Huang Y. Effects of physical exercise during pregnancy on maternal and infant outcomes in overweight and obese pregnant women: a meta analysis. Birth. 2018; 46(2):211-21.
14. Mijatovic-Vukas J, Capling L, Cheng S, Stamatakis E, Louie J, Cheung NW, et al. Associations of diet and physical activity with risk for gestational diabetes mellitus: a systematic review and meta-analysis. Nutrients. 2018;10(6): 698.
15. Liang Y, Gong Y, Zhang X, Yang D, Zhao D, Quan L, et al. Dietary protein intake, meat consumption, and dairy consumption in the year preceding pregnancy and during pregnancy and their associations with the risk of gestational diabetes mellitus: a prospective cohort study in southwest China. Front Endocrinol. 2018; 9:596.
16. Marí-Sanchis A, Díaz-Jurado G, Basterra-Gortari FJ, de la Fuente-Arrillaga C, Martínez-González MA, Bes-Rastrollo M. Association between pre-pregnancy consumption of meat, iron intake, and the risk of gestational diabetes: the SUN project. Eur J Clin Nutr. 2018;57(3):939-49.
17. Donazar-Ezcurra M, Lopez-del Burgo C, Martinez-Gonzalez MA, Basterra-Gortari FJ, de Irala J, Bes-Rastrollo M. Pre-pregnancy adherences to empirically derived dietary patterns and gestational diabetes risk in a Mediterranean cohort: the Seguimiento Universidad de Navarra (SUN) project. Brit J Nutr. 2017;118(9): 715-21.
18. Soto R, Guilloty N, Anzalota L, Rosario Z, Cordero JF, Palacios C. Association between maternal diet factors and hemoglobin levels, glucosetolerance, blood pressure and gestational age in a Hispanic population. Arch Latinoam Nutr. 2017;65(2): 86-96.
19. Kizirian NV, Kong Y, Muirhead R, Brodie S, Garnett SP, Petocz P, et al. Effects of a low–glycemic index diet during pregnancy on offspring growth, body composition, and vascular health: a pilot randomized controlled trial. Am J Clin Nutr. 2016;103(4): 1073-82.
20. Bao W, Bowers K, Tobias DK, Hu FB, Zhang, C. Prepregnancy dietary protein intake, major dietary protein sources, and the risk of gestational diabetes mellitus: a prospective cohort study. Diabetes Care 2013;36(7),2001-8.
21. World Health Organization. Information note about intake of sugars recommended in the WHO guideline for adults and children (No. WHO/NMH/NHD/15.3). 2015. World Health Organization.
22. Hu J, Oken E, Aris IM, Lin PID, Ma Y, Ding N, et al. Dietary patterns during pregnancy are associated with the risk of gestational diabetes mellitus: evidence from a Chinese prospective birth cohort study. Nutrients. 2019;11(2):405.
23. Sedaghat F, Akhoondan M, Ehteshami M, Aghamohammadi V, Ghanei N, Mirmiran P, Rashidkhani B. Maternal dietary patterns and gestational diabetes risk: a case-control study. J Diabetes Res. 2017; 5173926.
24. Song C, Li J, Leng J, Ma RC, Yang X. Lifestyle intervention can reduce the risk of gestational diabetes: a meta analysis of randomized controlled trials. Obes Rev. 2016; 17(10), 960-9.
25. Assaf-Balut C, García de la Torre N, Fuentes M, Durán A, Bordiú E, Del Valle L, et al. A high adherence to six food targets of the Mediterranean diet in the late first trimester is associated with a

reduction in the risk of materno-foetal outcomes: The St. Carlos gestational diabetes mellitus prevention study. Nutrients. 2019;11(1): 66.

26. Asadi M, Shahzeidi M, Najarzadeh A, Hashemi Yusefabad H, Mansoori A. The relationship between pre pregnancy dietary patterns adherence and risk of gestational diabetes mellitus in Iran: a case–control study. Nutr Diet. 2019;76(5): 597-603.

27. Paknahad Z, Fallah A, Moravejolahkami AR. Maternal dietary patterns and their association with pregnancy outcomes. Clin Nutr Res. 2019;8(1): 64-73.

28. Wang J, Wang L, Liu H, Zhang S, Leng J, Li W, et al. Maternal gestational diabetes and different indicators of childhood obesity: a large study. Endocr Connect. 2018;7(12): 1464–71.

29. Tobias DK, Hu FB, Chavarro J, Rosner B, Mozaffarian D, Zhang C. Healthful dietary patterns and type 2 diabetes mellitus risk among women with a history of gestational diabetes mellitus. Arch Intern Med. 2012;172(20): 1566-72.

30. Torres Lucero M, Canchari Aquino A, Lozano López T, Calizaya Milla Y, Javier Aliaga D, Saintila J. Hábitos alimentarios, estado nutricional y perfil lipídico en un grupo de pacientes con diabetes tipo 2. Nutr clín diet hosp. 2020;40(2):135-42.