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ASSOCIAÇÃO DE PADRÃO ALIMENTAR COM DIABETES MELLITUS GESTACIONAL - UMA REVISÃO SISTEMÁTICA NARRATIVA

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Trabalho de Conclusão de Residência desenvolvido no segundo ano de Residência Integrada Multiprofissional em Saúde da Universidade Federal de Santa Catarina, sob orientação da professora Yara Maria Franco Moreno.

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Title Page

TITLE: Association of dietary pattern with gestational diabetes mellitus – a narrative systematic review

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Abstract

Gestational Diabetes Mellitus (GDM) is defined as any degree of glucose intolerance at any stage of pregnancy. There are studies reporting that Lifestyle changes and / or adherence to certain dietary patterns can help to control the blood glucose of pregnant women and decrease the risk of developing gestational diabetes. The aim of the study was to evaluate the effect of dietary patterns with GDM. The search was conducted on PubMed, Scopus, Web of Science, SciELO, Latin American and Caribbean Health Sciences (LILACS) and Cochrane databases using predetermined keywords and MeSH Terms or equivalent for each electronic database. All articles published until July 13, 2020, were collected and included. The included studies were those with a prospective and retrospective observational studies relating to the dietary pattern, lifestyle and the risk of developing GDM. There were excluded clinical trials, studies with different population and women with pre-existing diseases or GDM, studies focused on specific foods and/or nutrients and supplementation and, studies that evaluated only lifestyle behaviors. Nineteen studies were included. The results generally indicated that Mediterranean pattern and dietary patterns including fruits, vegetables, legumes, fish and seafood products, rice, and nuts have a protective factor for the development GDM. Western diet pattern and dietary patterns composed by red meat, and high-fat processed meats, sweet food, fried and/or full-fat food and also seafood products are associated with increased risk for GDM. According to this narrative systematic review the western dietary pattern may be associated to increased risk for GDM, and the Mediterranean dietary pattern to lower risk, it is not conclusive that an exclusive dietary pattern alone can protect or cause a higher risk in the development of GDM. According to our findings it is not conclusive that the influence of a dietary pattern alone can protect or cause a higher risk in the development of GDM.

Keywords: Dietary pattern, Gestational diabetes mellitus, Pregnancy, Nutrition, Systematic review

Resumo

A Diabetes Mellitus Gestacional (DMG) é definida como qualquer grau de intolerância à glicose em qualquer fase da gravidez. Há estudos relatando que mudanças no estilo de vida e/ou adesão a certos padrões alimentares podem ajudar no controle glicêmico de mulheres grávidas e diminuir o risco de desenvolver diabetes gestacional. O objetivo do estudo foi avaliar o efeito dos padrões alimentares com o DMG. A busca foi realizada nas bases de dados PubMed, Scopus, Web of Science, SciELO, Latin American and Caribbean Health Sciences (LILACS) e Cochrane, utilizando palavras-chave pré-determinadas e termos MeSH ou equivalentes para cada base eletrônica. Todos os artigos publicados até 13 de julho de 2020 foram selecionados. Os estudos incluídos foram aqueles método observacional prospectivos e retrospectivos relacionados ao padrão alimentar, estilo de vida e risco de desenvolver DMG. Foram excluídos ensaios clínicos, estudos com diferentes populações e mulheres com doenças pré-existentes ou DMG, estudos com foco em alimentos e/ou nutrientes específicos e suplementação e, estudos que avaliaram apenas comportamentos de estilo de vida. Dezenove estudos foram incluídos. Os resultados geralmente indicaram que o padrão mediterrâneo e padrões alimentares incluindo frutas, vegetais, legumes, peixes e frutos do mar, arroz e nozes têm um fator protetor para o desenvolvimento de DMG. O padrão alimentar ocidental e os padrões dietéticos compostos por carnes vermelhas e processadas com alto teor de gordura, alimentos doces, alimentos fritos e/ou gordurosos e também frutos do mar estão associados a maior risco de DMG. De acordo com esta revisão sistemática narrativa, o padrão alimentar ocidental pode estar associado ao aumento do risco de DMG, e o padrão alimentar mediterrâneo a diminuir o risco, não é conclusivo que um padrão dietético exclusivo por si só possa proteger ou causar um maior risco no desenvolvimento de DMG . De acordo com nossos achados, não é conclusivo que a influência de um padrão alimentar por si só possa proteger ou causar um risco maior no desenvolvimento de DMG.

Palavras-chave: Padrão alimentar, Diabetes mellitus gestacional, Gravidez, Nutrição, Revisão sistemática

Main Document

Introduction

Gestational Diabetes Mellitus (GDM) is defined as any degree of glucose intolerance at any stage of pregnancy (1). The prevalence of GDM has been increasing, causing a lot of concern about the consequences for maternal and child health. GDM is indicative of beta cell dysfunction, which can lead to the development of type 2 diabetes mellitus (DM2) after delivery (2). Thus, for the prevention of DM2, a care protocol must be followed for all pregnant women who have altered blood glucose. The strategy for identification of the International Association of the Diabetes Pregnancy Study Group (IADPSG) was intended to perform diagnosis and pre-treatment of pregnant women with GDM (3). The IADPSG defined it in two stages, which can be only with the oral glucose tolerance test (OGTT), or in two stages, with the 50 g glucose load test (GLT) and the TOTG. After the adoption of the protocol in several countries, the diagnosis of GDM increased, from 5–6% to 15–20%, mainly due to the result of an abnormal value in the tests would be enough for the diagnosis of GDM(3,4).

When decompensated, GDM can consequently cause a higher risk of stillbirths, perinatal mortality and congenital malformations (5). Among the risk factors for GDM are advanced maternal age; overweight, obesity or excessive weight gain in current pregnancy; excessive central deposition of body fat; family history of diabetes in first-degree relatives; excessive fetal growth, polyhydramnios, hypertension or pre-eclampsia in current pregnancy; obstetric history of repeated abortions, malformations, fetal or neonatal death, macrosomia or GDM; polycystic ovary syndrome; and short stature.(6).

Treatment for GDM varies according to the pregnant's glycemic control. It is based mainly on individual nutritional monitoring. In addition, the practice of physical activity should be encouraged, as it helps in glycemic control, and when combined with adequate nutrition, it allows for appropriate weight gain during the pregnancy and metabolic control. If the blood glucose remains decompensated, pharmacological treatment should be started (7).

Lifestyle changes, as adherence to healthy dietary patterns can help to control the blood glucose of pregnant women and decrease the risk of developing gestational diabetes. Some evidence shows positive results with the Mediterranean dietary pattern (8–10) and Dietary Approaches to Stop Hypertension (DASH) (8,11) on control and prevention of GDM. However, the generally recommendation for the treatment of diabetes, is planning individualized meals, promoting greater adherence to the eating plan and for a longer period of time (12).

Considering the importance in the clinical practice of health professionals to know the dietary patterns that are associated to higher or lower risk for the development of GDM and the recent systematic reviews did not include all methods for derivate dietary patterns (13) or findings observed only in prepregnancy period (14), we aimed to systematically review observational studies to identify if there is an association of dietary patterns, derived by a priori, a posteriori or reduced rank regression (RRR), on the development and risk of GDM.

Methods

We followed the systematic review structure according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (15) and used the PICO search approach (16). The protocol of this review follows the guidelines for the Preferred Reporting Items for Systematic Reviews and MetaAnalyses (PRISMA) (15). Furthermore, this study was registered on the PROSPERO (http://www.crd.york.ac.uk/PROSPERO), as an international prospective register of systematic reviews. Registration number is CRD42020188418.

Search strategy

The search was conducted on PubMed, Scopus, Web of Science, SciELO, Latin American and Caribbean Health Sciences (LILACS) and Cochrane databases using predetermined keywords and MeSH Terms or equivalent for each electronic database. All articles published until July 13, 2020, were collected and included. The search question was: “What dietary pattern is related to the development of GDM?" The search strategy included the following terms: [("Pregnancy, High-Risk" OR "pregnancy" OR "Maternal Nutrition Physiology") AND ("Dietary Patterns" OR "eating pattern" OR "dietary habit" OR "eating habit" OR "dietary quality" OR "healthy eating index" OR "Diet, Carbohydrate-Restricted" OR "Caloric Restriction" OR "Diet, Diabetic" OR "Food pattern" OR "Feeding Behavior" OR "Gestational Weight Gain" OR "Glycemic Index" OR "Glycemic load" OR "Life Style" OR "Exercise") AND ("Diabetes, Gestational" OR "GDM" OR "Insulin Resistance" OR "Glucose Intolerance" OR "hyperglycemia") AND ("Humans")].

The reference lists of the selected articles were searched manually. Selected papers were exported to Rayyan QCRI® (Qatar Computing Research Institute, Doha, Qatar), excluding the duplicates. Articles that were not available or with incomplete information, the authors were contacted by electronic mail. Titles and abstracts were analyzed for eligibility independently by two authors. In case of any disagreement, a third author made the final decision.

Selection process

In the first stage, articles with duplicates were excluded and afterwards, articles were selected by title and abstract. Then, after reading in full, the related articles were studied by the reviewers to extract the data. The proceedings were carried out by two authors separately and the disagreements were resolved by consensus with the third researcher.

Inclusion and Exclusion criteria

The included studies were those with a prospective and retrospective observational method relating to the pregestational and gestational period considering dietary pattern, lifestyle and pre-gestational at risk of developing GDM.

Clinical trials were excluded, with a different population of women in the pregestational and gestational period, and women with pre-existing diseases or GDM already diagnosed. In addition, studies focused on specific foods, macro and micronutrients and/or nutrient supplementation were also excluded. Moreover, studies that did not evaluate dietary pattern were excluded.

Data extraction

Data extraction was completed independently by two reviewers (R.M.C and LH.S.K.) and any disagreement was resolved by a third author (Y.M.F.M). Data collection included study characteristics (author, Country and year of publication); study design, participants' age, race/ethnicity, setting, dietary assessment method, method for dietary patterns' assessment, the reported dietary patterns, adjusted odds ratio (OR)/ relative risk (RR) with 95% confidence intervals (CI), and confounding factors adjusted in the analysis.

Results

There were 8,922 articles identified from the search. After excluding for duplicates and unrelated articles based on title and abstract, a total of 62 articles met eligibility criteria, of which, 20 studies were included in this systematic review (Figure 1). From the 20 articles included in this review, 3 were cross-sectional studies (15%) and 17 (85%) were observational cohort studies, 16 (80%) were prospective and, 1 (5%) was retrospective. Regarding the approaches to define the dietary pattern, 3 (15%) articles used a priori approach (Table 1). The majority used a posteriori approach (n = 15; 75%). Of these, 2 (13,3%) used factor analysis and 13 (86,6%), principal component analysis (PCA) (Table 2). The Reduced Rank Regression (RRR) method was used in 2 (10%) articles (Table 3). There were described 77 dietary patterns (Supplementary Table). Of the articles found, 13 used only the food frequency questionnaire (FFQ), ranging from 25 to 142 food items(17,18,27–29,19–26). One used the three-day food diary (TFD) with FFQ (30). The 24h recall (24hR) was used in 6 studies(31–36), one of them together with FFQ(35) and the other with TFD(36). No results were found in the included studies that assessed lifestyle and physical activity and dietary pattern with risk factors for GDM.

The Western dietary pattern was associated with the risk of developing GDM in adjusted models on two studies (20,28). The dietary patterns were basically composed of processed foods, high-fat food, red and processed meat, fried food, snacks and sweets(20,24,28,32,33). Of the five articles that included the Western (or similar) dietary pattern, 3 of them showed that elevated adherence to the dietary patterns was associated higher risk of GDM(20,28,32). Also, the consumption of red meat and processed meat were found on 7 articles as a risk for the development of

GDM. The “Sweets The “Sweets and seafood”(35) dietary pattern was also associated with higher GDM risk and, a “sweet-based”(34) dietary pattern was associated with a higher GDM among non-overweight women. On the other hand, one study did not found association with Western pattern and risk for GDM, but found with the Traditional pattern, composed by: light-colored vegetables, fine grain, red meat and tubers as risk factor for GDM (OR 2.92; 95%CI 1.19, 7.17) (33). A dietary pattern named "Fish – meat – eggs", composed of higher intakes of freshwater fish, red meat and eggs was associated with increased risk for GDM (OR 1.83; 95% CI 1.21, 2.79)(29).

The "Mediterranean” dietary pattern described by Donazar-Ezcurra et al. included poultry, olive oil, nuts, low-fat dairy products, whole grain bread, fish, fruits, vegetables. While the "Mediterranean-style" dietary pattern described by Schoenaker et al. had high factor loadings for vegetables, legumes, nuts, tofu, rice, pasta, rye bread, red wine and fish. The "Mediterranean-style" dietary pattern had a protective factor for GDM(25), but the "Mediterranean” dietary pattern was not associated to GDM (20).

The “seafood and noodle-based” dietary pattern was associated with reduced odds of developing GDM, in the adjusted model, of the Asian Singapore cohort (36). The “high vegetable” dietary pattern also was associated to a protective effect on GDM, being more evident in women with family history of diabetes (35) and, the high protein-low starch dietary pattern was associated with lower risk for GDM among women who were overweight at pre-pregnancy in the adjusted model (23).

One of the studies used methods of Three-day Food Diaries (TFD) and Food Frequency Questionnaire (FFQ) to assess dietary intake. Both TFD and FFQ presented the “traditional pattern”, consisting of high vegetable, fruit, and rice intake and, the dietary patterns were associated with lower risk for GDM being more evident in women aged >35 years old. While the whole grain–seafood TFD dietary pattern was associated with higher risk of GDM (OR: 1.73; 95% CI: 1.10–2.74) (30).

Two studies showed unexpected results (22,37). While a study showed higher scores (3rd tertile) in the “Junk” and “Traditional / White bread” dietary patterns were associated to lower odds for GDM in the adjusted model (22), another study found lower risk of GDM associated to with Sugar, spread & creamer, Condiments & spices (DP2) and Sugar, spread & creamer, Condiments & spices, Oils & fats (DP5) dietary patterns in the adjusted model (27).

Jarman et al.(21) did not found association between dietary patterns and GDM, however, they found a positive relationship between “beans, cheese and salad” dietary pattern with a higher physical activity score. In addition, in the univariate model, higher levels of physical activity before pregnancy was associated with lower odds of GDM in the adjusted model (OR 0.8 95% CI: 0.6; 0.9).

All articles in this review with a priori method used the sample from Nurses' Health Study II (NHS II) (17–19). Bao et al. (2014) evaluated low-carbohydrate diets (LCD) and found that association of diets with higher LCD and protein with fat from animal-food sources were associated with higher risk of GDM (17). Higher Index Healthy Eating Alternative (AHEI-2010) and Prime Diet Quality Score (PDQS) scores, 5^{th} quintile, were associated to lower risk for GDM (18). Higher adherence to Alternative Mediterranean Score (aMED), AHEI-2010 and Dietary Approaches to Stop Hypertension (DASH), composed by a diet pattern rich in fruit, vegetables, whole grains, and nuts and vegetables and a low consumption of red and processed meats ,were protective factors for GDM (19).

Shin; Lee; O. Song(32) and Sartorelli et al.(31) used the RRR method. The first one reported that “High Refined Grains, Fats, Oils and Fruit Juice”, Low Milk and Cheese”, and “High Added Sugar and Organ Meats; Low Fruits, Vegetables and Seafood” dietary patterns were associated to higher risk of GDM (32). While the second one identified that a dietary pattern composed of high rice, beans, and vegetables, with low full-fat dairy products, biscuits, and sweets was associated to lower odds of GDM (31).

Discussion

The aim of the study was to evaluate the effect of dietary patterns, which could be an a priori, a posteriori or RRR method on the risk of GDM or on the development of GDM. The results generally induced that dietary patterns with fruits, vegetables, legumes, fish and seafood products, rice and nuts have a protective factor in the development of GDM. While red meat and high-fat processed meats, sweet food (cakes, biscuits, fruit juice, sugar-sweetened beverages, chocolate) and fried and/or full-fat food present a risk factor for GDM. The importance of this study is to note that some dietary patterns may be associated with an increased risk of developing GDM, while others have a greater protective factor. With this knowledge, it is possible to prevent the onset of GDM and encourage the follow-up of healthy dietary patterns and, also future risks for the mother, like development of DM2 after delivery, and fetus, like perinatal mortality, congenital malformations (2,5)

The western dietary pattern or similar dietary patterns were described in five studies. Du et al.(33) did not observed an association between Western dietary pattern and GDM, however they reported that the traditional dietary pattern, composed by light-colored vegetables, fine grain, red meat and tubers, was associated with higher risk for GDM and higher concentrations of serum HbA1c. Refined grains and sugar products have a higher glycemic load when compared to foods rich in fiber, fruits and vegetables. These constant elevations in blood glucose along with an increase in hormones secreted from the intestine, stimulate pancreatic insulin secretion. When the input of these foods becomes repetitive daily, a chronic hyperglycemia tends to appear (38,39). Previous systematic reviews presented similar results and showed that western dietary pattern is associated to risk of GDM(13,14).

Two articles reported the Mediterranean dietary pattern (20,25). The benefits of the Mediterranean dietary pattern are well evidenced in the literature, with benefits found on blood pressure, insulin sensitivity, lipid profiles, inflammation, oxidative stress, and carotid atherosclerosis. In addition, a vegetable-based Mediterranean diet rich in unsaturated fat and polyphenols can be a sustainable and ideal model for cardiovascular disease prevention(40).

Of the a priori method, one of the articles related the LCD standard to animal protein and fat and LCD to vegetable protein and fat (17). Tobias et al.,(19) also found protective factors for GDM in the aMED, AHEI-2010 and DASH dietary pattern, suggesting that a diet rich in fruit, vegetables, whole grains, and nuts and vegetables and a low consumption of red and processed meats as a protective factor for GDM. Both studies agreed with most of the a posteriori studies that presented a risk factor for GDM when the dietary pattern was composed by red meat, processed meat and high fat

(20,26,28,29,33). The relationship between processed meat and GDM suggests that products involved in the processing of these meats, such as advanced glycation end products (AGEs), imply β-cell toxicity(41,42). However, even after consuming only animal protein, it remained associated with the risk of GDM, and may be associated with amino acids as substrates for hepatic glucose production and liver lipotoxicity (43–45). Saturated fats also interfere with insulin signaling, which can generate inflammation and endothelial dysfunction, being considered pathogenic for GDM (46). In addition, red meats and animal proteins and low intake of dietary fiber are associated to an decrease in intestinal bacteria called Firmicutes, which seem to be relevant in the pathogenesis of GDM, even though the mechanisms are not yet known. These same bacteria increase when there is dietary fiber in the diet (47).

Although dietary patterns composed by fruits, vegetables and legumes, presented a protective factor for GDM, the "High red meats, full fat dairy, chocolate powder and fruits with low chicken and margarine" dietary pattern, described by Sartorelli et al.(31), has fruits in its composition and showed in their results a risk for the development of DMG. However, when evaluating the entire composition of the mentioned dietary pattern, there is a variety composition of foods, including red meat, full fat milk and sugary foods that presented higher contribution when statistically evaluated. In line with the results of our systematic review, previous reviews reported increased GDM risk in dietary patterns with high content of saturated fat, refined sugar and red and processed meat, while rich diets in fiber, micronutrients and polyunsaturated fat is associated with lower risk of GDM (13,48). Foods associated with reduced risk of DMG, such as fruits, vegetables, rice and nuts have fibers in their composition. Dietary fibers are associated with GDM protection due to reduced appetite or slowed glucose absorption, reducing demand on β-cells and insulin signaling mediators(49).

Of the nine dietary patterns that presented seafood in the composition, five were presented a risk factor (26,29,30,32,35) and four as a protective factor for GDM (19,25,28,36). However, it is questioned what makes up the rest of the dietary pattern, since four of them were composed by seafood, sweetened foods and / or red meat(26,29,32,35). He et al.(35) described seafood in two different dietary patterns, "Sweets and seafood", which also had cantonese desserts, molluscs and shellfish, sugar-sweetened beverages, grains, leafy and cruciferous vegetables, while in "Vegetable" dietary pattern, was composed by root vegetables, beans, mushrooms, melon vegetables, seaweed, other legumes, fruits, leafy and cruciferous vegetables, processed vegetables and nuts. The first dietary pattern was presented as a risk factor for GDM and, while the other as a protective dietary pattern(35). Thus, it is not known whether seafood alone is considered a risk or protection factor for GDM. In this way, two Systematic Reviews showed that a diet rich in fruit, vegetables, legumes, whole grains, nuts and fish is protective for GDM, associated with low consumption of red and processed meat, sugar-sweetened beverages, refined grains, and high- fat dairy.(50,51) Therefore, the consumption of fish can become protective, however when it is generalized to the consumption of seafood, the results are not clear.

Yong et al.(27) aimed to determine the association of dietary patterns before and during pregnancy and the risk of GDM in Malaysian pregnant women. The risk was lower in women with a relatively unhealthy dietary pattern, being they Sugar, spread & creamer, Condiments & spices (DP 2) in the pre-pregnancy period and Sugar, spread & creamer, Condiments & spices, Oils & fats (DP 5) in the first trimester of pregnancy. Although this study presents controversial results when compared to other studies, there is a different dietary pattern division and the patterns were defined at different times during pregnancy. The authors justified that the results may be due to other factors, such as lower body mass index and reduced energy intake. Another controversial finding was reported by Lawrence et al.(22) In their longitudinal cohort study where they observed that the "Junk" dietary pattern, composed by confectionary, snacks, takeaways, hot chips, processed meats, soft and energy drinks, battered fried fish or seafood, ice-cream and cakes or biscuits, was protective factor for GDM. The authors hypothesized that women with GDM avoided foods and drinks rich in fat and sugar after healthy eating information from health professionals compared to women without GDM. Also, they concluded that adherence to these significant changes in diet during pregnancy shows greater adherence when there is a diagnosis of GDM.

Gicevic et al.(18) evaluated dietary diversity scores (DDS), using Measures of dietary diversity (MDD-W and FGI) and Measures of dietary quality (AHEI-2010 and PDQS). DDS is based on food groups, being more used to predict nutrient adequacy. However, the food composition of the groups is very variable. While Dietary Diversity is defined as the number of foods or groups of foods consumed in a period of time, Dietary Quality refers more to the adequacy of energy and nutrients(52). The results of Gicevic et al.(18) showed that the Measures of dietary quality are better for predicting the development of GDM, while FGI and MDD-W did not make a good prediction.

It is important to highlight that the studies used different methods to evaluate the diet. This variety of food intake methods can alter the results and, consequently the dietary patterns. Some studies with a posteriori method showed differences in composition, mixing different food groups. In addition, data collection on food intake methods varied with respect to the gestational period. While some studies obtained the food intake in the pre-gestational period (n=5) (17,19,25,28,32), others evaluated it in the second trimester (n=3)(23,24,30) or third trimester (n=2)(35,36). Other studies obtained the dietary data in more than one moment (n=7) (18,26,27,29,31,33,34). And few studies (n=3) did not provide the exact time of collection(20–22). This difference might generate controversial results, since it will not be known the true influence of a dietary pattern and at what specific time it acts in the risk or protection of GDM. Another important factor to consider is the samples characteristics in the studies and, the wide variety of countries with different cultures in this systematic review, such as China (n=6), United States of America (n=5), Brazil (n=3), Spain (n=1), Canada (n=1), New Zealand (n=1), Australia (n=1), Singapore (n=1) and Malaysia (n=1). The samples' characteristics differ among them in socioeconomic conditions, health system, religion and regional foods.

A dietary pattern represents the totality of all foods and beverages consumed. According to the American Diabetes Association (ADA)(7), the food patterns with emphasis on whole grains, legumes, nuts, fruits, vegetables and minimal refined and processed foods, are appropriate for patients with prediabetes and diabetes(12). The metanalysis from Shirin et al.(13) showed that the vegetable dietary pattern was protectively related with GDM. The systematic review of Pistollato et al.(53)

indicates that a high intake of fiber during pregnancy is beneficial in preventing the development of GDM. Another systematic review found an association between dietary patterns with high intake of vegetables, fruits, whole grains, nuts, legumes, and fish and a low consumption of red and processed meats, before pregnancy and a lower risk of GDM(14). As stated by ADA, dietary patterns like the Mediterranean style, low-carbohydrate, low-fat, vegetarian or plant-based eating, Healthy Eating Index, AHEI and DASH are examples of healthful dietary patterns(12).

There are some limitations in the present study. The analyzed samples were ethnically diverse and of different socioeconomic conditions, such factors can induce heterogeneous findings, reinforcing the need for further studies in order to assess the association between dietary patterns and the risk of developing GDM in different populations. In some studies, there were women at an advanced age, which in itself represents a risk for the development of GDM, making the influence of dietary patterns on the risk of GDM less clear. Food assessment through FFQ, 24hR or TFD can cause recall failures or responses that do not match reality. Reports of ingestion of insufficient, excessive or with foods that are not part of the subject's routine are some of the factors that can alter the interpretation of the results. There were differences in the composition of some analyzed dietary patterns, where they received the same name, however the foods included belonged to different food groups. Besides that, not all studies have controlled the dietary patterns for total energy intake and this could interfere the results. And finally, not all studies have diagnosed GDM by OGTT. Of the 14 studies that were diagnosed using the OGTT, six different references were used to detect GDM, which can diagnose the same population differently.

In conclusion, the use of a dietary pattern plays an important role to prevent or reduce the GDM risk. Using an approach that focuses only on alone nutrients creates a gap in important nutrient interactions, oversimplifying the complexity of foods and dietary patterns. Dietary patterns are an important strategy to prevent or reduce the risk of GDM, an individualized nutrition therapy, based on the preferences, values, abilities and treatment goals of the patient is crucial for a good adherence of the treatment (54). Although the western dietary pattern may be associated to increased risk for GDM, and the Mediterranean dietary pattern to lower risk, the results were not unanimous. In addition, further studies relating lifestyle and physical activity with adherence to dietary patterns are required, since these factors were used only for adjusted statistical models.

According to our findings it is not conclusive that the influence of a dietary pattern alone can protect or cause a higher risk in the development of GDM. Besides that, we reinforce the importance of evidence-based dietary prescription by health professionals in clinical practice. More observational studies relating dietary pattern and risk and/or development of GDM are needed to obtain more consistent responses.

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Figure 1 - Flow chart of studies' selection process.

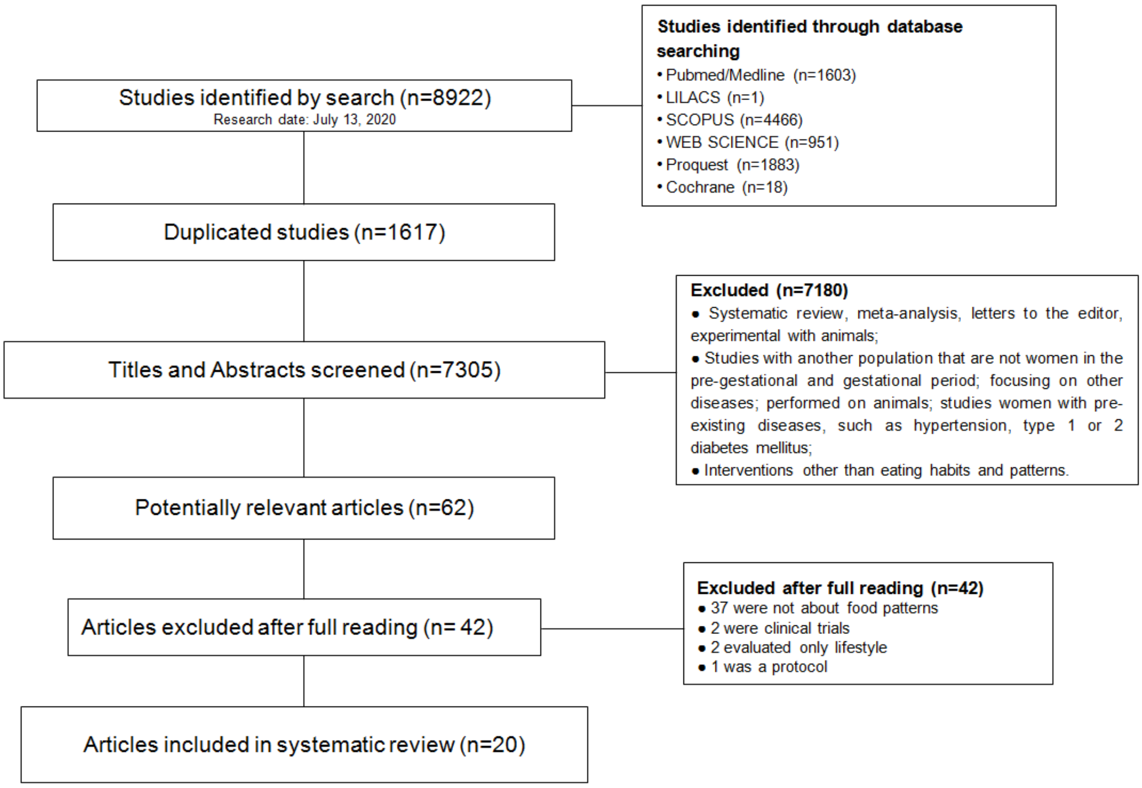

Table 1 – Summary of the studies included in the review with a priori dietary pattern method

Author, year, (Country)	Study Design	Sample Characteristics	Setting	GDM Diagnosis	Food Intake Method	Pattern Method	Dietary Pattern	Outcomes	Results
Bao, et al., 2014 (USA)[29]	prospective cohort	NHS II White, African American, Hispanic, Asian, and others n=867 age: 25–44yr	National Institutes of Health	medical records	61-food item semiquantitative FFQ.	A priori	LCD scores: Overall LCD; Animal LCD, and Vegetable LCD scores.	self-report GDM	**↑ GDM Risk:** ***Overall LCD score*** (Q4): RR 1.27 (95%CI 1.06; 1.51) ***Animal LCD*** (Q4): RR 1.36 (95%CI 1.13; 1.64). **↔ GDM Risk** ***Vegetable LCD*** (Q4): RR 0.84 (95%CI 0.69; 1.03) Adjusted for age, parity, race-ethnicity, family history of diabetes, cigarette smoking, alcohol intake, physical activity, total energy intake and BMI
Gicevic et al., 2018 (USA)[30]	prospective cohort	NHS II White, African American, Hispanic, Asian, and others n = 916 age: 24–44 yr	National Institutes of Health	medical records	131-food item semiquantitative FFQ.	A priori	MDD-W; FGI; AHEI-2010 and PDQS	GDM risk	**↔ GDM Risk**: ***MDD-W*** (Q5): OR 1.00 (95%CI 0.79, 1.27) ***FGI*** (Q5): OR 0.96 (95%CI 0.76, 1.22) **↓ GDM Risk** ***AHEI-2010*** (Q5): OR 0.63 (95%CI 0.50, 0.81) ***PDQS*** (Q5): OR 0.68 (95%CI 0.54, 0.86) Adjusted for age, race, parity, smoking status, physical activity, sedentary time, parental history of type 2 diabetes, alcohol intake, pre-pregnancy BMI. AHEI-2010 also adjusted for total caloric intake.

Tobias et al., 2012 (USA)[31]	prospective cohort	NHS II White, African American, Hispanic, Asian, and others N = 872 age: 24–44 yr	National Institutes of Health	medical records	61-food item semiquantitative FFQ.	A priori	aMED; DASH; AHEI-2010	GDM risk	**↓ GDM risk:** ***aMED*** **(**Q4): RR 0.76 (95% CI 0.60, 0.95); ***DASH*** (Q4): RR 0.66 (95% CI 0.53, 0.82); ***aHEI*** (Q4): RR 0.54 (95% CI 0.43, 0.68) Adjusted for age, total energy intake, gravidity, smoking status, physical activity, sedentary time parental history of type 2 diabetes, prepregnancy BMI. DASH also adjusted for alcohol

↑ Risk; ↓Protection; ↔ No association

95%CI: 95% confidence intervals; **AHEI-2010**: Index Healthy Eating Alternative; **aMED**: Alternative Mediterranean Score; **BMI**: body mass index; **DASH**: Dietary Approaches to Stop Hypertension; **FFQ**: Food Frequency Questionnaire; **FGI**: Food Groups Index; **GDM**: Gestational Diabetes Mellitus; **LCD**: Low-carbohydrate diet**; MDD-W**: Minimum Dietary Diversity – Women; **NHS II:** Nurses' Health Study II; **NIH:** National Institutes of Health; **OR**: Odds Ratio; **PDQS**: Prime Diet Quality Score; **Yr**: year

Table 2 – Summary of the studies included in the review with *a posteriori* dietary pattern method

Author, year, (Country)	Study Design	Sample Characteristics	Setting	Diagnosis	Food Intake Method	Pattern Method	Dietary Pattern	Outcomes	Results
Donazar-Ezcurra et al., 2017 (Spain)[17]	prospective cohort	SUN Project Caucasian woman n= 3455 mean age: 35.1 yr (SD 10.7)	College (Spanish graduated woman)	medical records	136-food item FFQ	PCA	• Western • Mediterranean	GDM risk	**↑ GMD risk** ***Western*** (Q4): OR 1.56 (95%CI 1.0; 2.43) **↔ GMD risk** ***Mediterranean*** (Q4): OR 1.08 (95%CI 0.68; 1.70) Adjusted for age, baseline BMI, family history of diabetes, smoking status, physical activity, number of pregnancies before and multiple pregnancies
Du et al., 2017 (China)[21]	prospective cohort	pregnant women n=753 n GDM = 64 age: 19-38 yr	Antenatal clinic of the hospital	OGTT IADPSG	3 days 24hR recorded twice	PCA	• Western • Traditional • Mixed • Prudent	GDM	**↔ GDM** ***Western*** (Q4): OR 1.68 (95%CI 0.66, 4.29) ***Mixed*** (Q4): OR 0.70 (95%CI 0.32, 1.55**)** ***Prudent*** (Q4): OR 0.49 (95%CI 0.20, 1.22) **↑GDM** ***Traditional*** (Q4): OR 2.92 (95%CI 1.19, 7.17) Adjusted for age maternal age, pre-pregnancy BMI, education, partner smoking, family history of diabetes, parity, daily food energy intake and physical activity

He et al., 2015 (China)[19]	prospective cohort	BIGCS Pregnant women attending their first routine antenatal examinations n= 3063 mean age: 28.9 (SD 3.2) yr.	first routine antenatal examinations	OGTT IADPSG	FFQ1 at 24–27 weeks of gestation + 3 days 24hR 29–31 of gestation + FFQ2 at 33–35 weeks of gestation	PCA	• Vegetable • Protein-rich • Prudent • Sweets and seafood	GDM risk	↓ **GDM Risk:** ***Vegetable*** (T3): OR 0.79 (95%CI 0.64, 0.97) ↔ **GDM Risk** ***Protein-rich*** (T3): OR 0.95 (95%CI 0.78, 1.16) ***Prudent*** (T3): OR 1.00 (95%CI 0.82, 1.22) ↑ **GDM Risk** ***Sweets and seafood*** (T3): OR 1.23 (95%CI 1.02, 1.49) Adjusted for other dietary patterns, maternal age, education level, monthly income, pre-pregnancy BMI, family history of diabetes and parity

Hu et al., 2019 (China)[25]	prospective cohort	BISCS women with single pregnancies at 21–24 weeks of gestation n = 1014 age: categorize into four groups (<25, 25–29, 30–34, ≥35 yr).	hospitals and community health care centers	OGTT IADPSG	25-food item FFQ and TFD	PCA	**TFD**: • Traditional • Sweet foods • Fried food–beans • Whole grain-seafood **FFQ**: • Fish–seafood • Protein–sweets • Traditional	GDM risk	**GDM risk** **↓ GDM** TFD ***Traditional*** (Q4): 0.40 (95%CI 0.23, 0.71) FFQ ***Traditional* Q4:** 0.44 (95%CI 0.27, 0.70) **↔ GDM** TDF ***Sweet foods*** (Q4): 0.73 (95%CI 0.46, 1.16) ***Fried food–beans*** (Q4): 1.08 (95%CI 0.67, 1.74) FFQ ***Fish–seafood*** (Q4): 0.95 (95%CI 0.56, 1.59 ***Protein–sweets*** (Q4): 1.18 (95%CI 0.69, 2.03) **↑ GDM** TDF ***Whole grain–seafood*** (Q4): 1.73 (95%CI 1.10, 2.74) Adjusted for other dietary patterns derived from the same dietary assessment tool (TFD or FFQ), pre-pregnancy BMI, age, parity, family income, education level, ethnicity, smoking status, total energy intake, and physical activity
Jarman et al., 2018 (Canada)[28]	prospective cohort	APrON n = 1545 mean age 31.4 (±4.2) yr	NR	Medical records	142- food item FFQ	PCA	• Healthy • Meat and Refined Carbohydrate • Beans, Cheese and Salad • Tea and Coffee	GDM	**NR*** There was no association in univariate analysis. Does not show data

Lawrence et al., 2020 (New Zeland)[26]	longitudinal cohort	Growing Up in New Zealand study n = 5384 nGDM = 280 age: categorize into <35yr and ≥35yr	NR	OGTT New Zealand Society for the Study of Diabetes criteria	44-food item FFQ	PCA	• Junk • Health conscious • Traditional/White bread • Fusion/Protein	GDM	**↔ GDM** ***Health conscious*** (T3): OR 1.24 (95% I 0.87, 1.77) ***Fusion Protein*** (T3): OR 1.25 (95%CI 0.87, 1.81) **↓ GDM** ***Traditional/White bread*** (T3): OR 0.47 (95% I 0.32, 0.68) ***Junk*** (T3): OR 0.49 (95%CI 0.34, 0.70) Adjusted for maternal age, ethnicity, socioeconomic deprivation, pre-pregnancy BMI, pre-pregnancy and first trimester physical activity, smoking, alcohol consumption and dietary patterns
Mak et al., 2011 (China)[24]	prospective cohort	pregnant women in Western China nt = 1337 nGDM= 199 age: 18–40 yr	maternity hospitals in Chengdu, Sichuan Province.	OGTT IADPSG	93- food items FFQ	FA	• Plant-based • Meat-based • High protein-low starch	GDM risk	**↔ GDM risk** ***Plant-based*** (T3): OR 0.97 (95%CI 0.64, 1.47) ***Meat-based*** (T3): OR 0.89 (95%CI 0.58, 1.36) ***High protein-low starch*** (T3): OR 0.73 (95% CI 0.48, 1.10) Adjusted for age, pre-pregnancy BMI, family history of diabetes, parity, education and total physical activity.

Nascimento et al., 2016 (Brazil)[34]	prospective cohort	IMIP, Brazil pregnant women with an annual income below US $ 6,000.00 age: 18 to 40 yr n= 841	prenatal health care clinic at IMIP	OGTT IADPSG	81-food item FFQ	PCA	• Traditional • Mixed • Western	GDM	**↔ GDM risk** ***Traditional*** (T3): RR 0.88 (95%CI 0.49, 1.58) ***Mixed*** (T3): RR 0.93 (95%CI 0.51, 1.71) ***Western*** (T3)**:** RR 0.78 (95%CI 0.43, 1.43) Adjusted for age maternal age, maternal education, pre-pregnancy BMI, family history of diabetes and parity
Schoenaker et al., 2015 (Australia)[37]	Prospective cohort	Australian women selected from the national Medical e Health database. Nt = 3853 NGDM = 292 Age: 18-75 yr	NR	OGTT The Australasian Diabetes in Pregnancy Society	101-item food FFQ	PCA	• Meats, snacks and sweets • Mediterranean -style • Fruit and low-fat dairy • Cooked vegetables	GDM risk	**↔ GDM risk** ***Meats, snacks and sweets*** (T3): OR 1.23 (95% CI 0.76, 1.97) ***Fruit and low-fat dairy*** (T3): OR 1.01 (95%CI 0.76, 1.37) ***Cooked vegetables*** (T3): OR 1.04 (95%CI 0.77, 1.38) **↓ GDM risk** ***Mediterranean-style*** (T3): OR 0.56 (95%CI 0.41, 0.77) Adjusted for age, total energy intake, highest qualification completed, parity, parous, hypertensive disorders of pregnancy, polycystic ovary syndrome, inter-pregnancy interval, smoking, physical activity and BMI

Seymour et al., 2016 (Singapure)[23]	prospective cohort	GUSTO Singapore citizens or permanent residents who are Chinese, Malay or Indian n = 909 age: ≥ 18 yr	Public maternity units	**OGTT** WHO,1999	**24hR + TFD**	FA	• Vegetable-fruit-rice-based-diet • Seafood-noodle-based-diet • Pasta-cheese-processed-meat-diet	GDM risk	↔ **GDM risk** ***Vegetable-fruit-rice-based-diet:*** OR 1.10 (95%CI 0.90, 1.35) ***Pasta-cheese-processed-meat-diet***:OR 0.96 (95%CI 0.79, 1.17) ↓ **GDM risk** ***Seafood-noodle-based-diet:*** OR 0.74 (95%CI 0.59, 0.93) Adjusted for energy intake, pregnancy BMI, birth order, smoking, alcohol intake, age, ethnicity, education, previous GDM, family history of diabetes, household monthly income, and other dietary patterns.
Wen et al., 2020 (China)[39]	prospective cohort	LoTiS Women pregnant with twins n =324 age: categorize into four groups (<25, 25–29, 30–34, ≥35 yr).	Hospital of Chongqing Medical University and Chongqing Women and Children's Health Center	**OGTT** IADPSG	93- food items FFQ	PCA	• Vegetable-based • Poultry-fruit-based • Sweets -based • Plant protein-rich-based	GDM risk	↔ **GDM risk** ***Poultry-fruit-based*** (Q4) OR 0.96 (95%CI 0.45, 2.03) ***Sweets-based*** (Q4) OR 1.97 (95%CI 0.94, 4.12) ***Plant protein-rich-based*** (Q4): OR 1.02 (95%CI 0.49, 2.09) ***Vegetable-based*** (Q4) OR 1.23 (95%CI 0.57, 2.66) Adjusted for other dietary patterns, maternal age, ethnicity, prepregnancy BMI, education level, smoking status, parity, previous history of GDM and family history of DM

Yong et al., 2020 (Malasya)[27]	prospective cohort	SECOST Malasyan pregnant women in the first trimester n = 452 age: >18 yr)	maternal and child health clinics	OGTT Perinatal Care Manual 3rd Edition from Putrajaya, Malaysia	126-food item semi-quantitative FFQ	PCA	• **Pre-pregnancy:** DP 1; DP 2; DP 3 • **First trimester:** DP 4; DP 5; DP 6 • **Second trimester:** DP 7; DP 8; DP 9	GDM risk	Pre-pregnancy ↓ **GDM risk** ***DP 2*** (T3): OR 0.45 (95%CI 0.20, 0.91) ↔ **GDM risk** ***DP 1*** (T3): OR 0.82 (95%CI 0.38, 1.75) ***DP 3*** (T3): OR 0.79 (95%CI 0.38, 1.64) First trimester **4 - 6** ↓ **GDM risk** ***DP 5*** (T3): OR 0.28 (95%CI 0.11, 0.68) ↔ **GDM risk** ***DP 4*** (T3): OR 0.81 (95%CI 0.38, 1.71) ***DP 6*** (T3) OR 1.15 (95%CI 0.54, 2.47) Second Trimester: ↔ **GDM risk** ***DP 7*** (T3) OR 0.51 (95%CI 0.24, 1.11) ***DP 8*** (T3) OR 0.73 (95%CI 0.34, 1.58) ***DP 9*** (T3) OR 0.73 (95%CI 0.33, 1.63) Adjusted for clinic, gestational week at OGTT performed, maternal age, ethnicity, medical history of GDM and family history of DM

Zhang et al., 2006 (USA)[18]	prospective cohort	NHSII White, African American, Hispanic, Asian, and others nt =13110 nGDM=758 age: 25-42 yr	National Institutes of Health	Medical records	133-food item semiquant itative FFQ	PCA	• Western • Prudent	GDM risk	↓ **GDM risk** ***Prudent*** (Q1)**:** RR 1.37 (95%CI 1.09–1.72) ↑ **GDM risk** ***Western*** (Q5): RR 1.68 (95%CI 1.33, 2.11) Adjusted for age, parity and BMI
Zhou et al., 2018 (China)[22]	Prospective cohort	Healthy pregnant women with 8-16 weeks of gestation. n = 2775 age = divided age into four groups (≤24, 25–29, 30–35 and ≥36 yr).	maternity clinic in one of three public hospitals in Wuhan, China.	OGTT IADPSG	61- item food FFQ	PCA	• Beans–vegetables • Nuts–whole grains • Organs–poultry–seafood • Fish–meat–eggs • Rice–wheat–fruits	GDM risk	↔**GDM risk** ***Beans–vegetables*** (Q4): OR 0.97 (95% CI 0.64, 1.46) ***Nuts–whole grains*** (Q4): OR 1.25 (95% CI 0.84, 1.86) ***Organs–poultry–seafood*** (Q4): OR 1.01 (95% CI 0.68, 1.51) ***Rice–wheat–fruits*** (Q4): OR 0.72 (95% CI 0.48, 1.08) ↑**GDM risk** ***Fish–meat–eggs*** (Q4): OR 1.83 (95% CI 1.21, 2.79) Adjusted for other dietary patterns, maternal age, ethnology, maternal education, average personal income, family history of diabetes, family history of obesity, smoking, alcohol, parity, pre-pregnancy BMI, weight gain before GDM diagnosis and total energy intake

Zuccolotto et al., 2018 (Brazil)[20]	cross-sectional	Ribeirão Preto, state of São Paulo age: ≥ 20 yr n = 785	users of the Unified Health System	OGTT WHO, 2014	Two 24hR	PCA	• Traditional Brazilian • Snacks • Coffee • Healthy	GDM	↔ **GDM** ***Traditional Brazilian*** (T3): OR 0.64 (95%CI 0.39, 1.04) ***Snacks*** (T3): OR 0.96 (95%CI 0.59, 1.55) ***Coffee*** (T3): OR 0.97 (95%CI 0.59, 1.59) ***Healthy*** (T3): OR 1.04 (95%CI 0.64, 1.68) Adjusted for age, gestational week at the time of the interview, previous GDM, schooling, family history of DM, smoking, physical activity, number of children, and maternal excessive body weight

↑ Risk; ↓Protection; ↔ No association

24hR: 24-Hour Recall Questionnaire**; 95%CI**: 95% confidence intervals; **APrON**: Alberta Pregnancy Outcomes and Nutrition cohort; **BIGCS**: Born in Guangzhou Cohort Study; **BISCS**: Born in Shenyang Cohort Study; **BMI**: body mass index; **DP**: Dietary Pattern; **FA**: Factor Analysis; **GDM**: Gestational Diabetes Mellitus; **GUSTO**: Growing up in Singapore towards healthy outcomes; **IADPSG**: The International Association of Diabetes and Pregnancy Study Groups; **IMIP**: Instituto de Medicina Integral Prof. Fernando Figueira; **LoTiS**: Chongqing Longitudinal Twin Study; **MET**: Metabolic Equivalent Tasks; **NR**: not reported; **OR**: Odds Ratio ; **PCA**: principal component analysis; **SECOST**: Seremban Cohort Study; **SUN Project**: The Seguimiento Universidad de Navarra Project; **TDF**: Three-day food diaries; **WHO**: World Health Organization; **Yr**: year

Table 3 – Summary of the studies included in the review with reduced rank regression pattern method

Author, year, (Country)	Study Design	Sample Characteristics	Setting	Diagnosis	Food Intake Method	Pattern Method	Dietary Pattern	Outcomes	Results
Sartorelli et al., 2018 (Brazil)[33]	cross-sectional study	Pregnant women n = 785 age: ≥ 20 yr	Prenatal care in the Public Health System, São Paulo, Brazil	OGTT WHO, 2014	24hR were obtained on non-consecutive days, at least 1 wk apart	RRR	**DP1 -** High rice, beans, vegetables with low full-fat dairy, biscuits, and sweets; **DP 2 -** High red meats, fullfat dairy, chocolate powder and fruits with low chicken and margarine	GDM	↓ **GDM**: ***DP1*** (T3): OR 0.58 (95% CI: 0.36, 0.95) ↔ **GDM** ***DP2*** (T3): OR 1.48 (95% CI 0.91, 2.40) Adjusted for age, age, education, smoking, physical activity, parity, prior GDM, family history of DM, excess body weight for the gestational age, total energy intake and dietary underreporting

Shin; Lee; O.Song, 2015 (USA)[32]	cross-sectional study	NHANES (2003–2012); n= 249 age:16–41 yr	NR	OGTT IADPSG	24hR and A second dietary recall, 3–10 days after the first dietary recall.	RRR	"High Refined Grains, Fats, Oils and Fruit Juice" Pattern; Low Milk and Cheese" Pattern; "High Added Sugar and Organ Meats; Low Fruits, Vegetables and Seafood" Pattern	GDM risk	↑ **GDM risk** ***High Refined Grains, Fats, Oils and Fruit Juice*** (T3): OR 4.9 (95%CI 1.4, 17.0) ***High Nuts, Seeds, Fat and Soybean; Low Milk and Cheese*** (T3): OR 7.5 (95%CI 1.8, 32.3) ***High Added Sugar and Organ Meats; Low Fruits, Vegetables and Seafood*** (T3): OR 22.3 (95%CI 3.9, 127.4) Adjusted for age, race/ethnicity, family poverty income ratio, education level, and marital status, energy intake, prepregnancy (BMI), gestational weight gain and C-reactive protein

↑ Risk; ↓Protection; ↔ No association or significant result

24hR: 24-Hour Recall Questionnaire**; 95%CI**: 95% confidence intervals**; BMI**: body mass index; **DP**: Dietary Pattern; **FFQ**: Food Frequency Questionnaire; **GDM**: Gestational Diabetes Mellitus; **IADPSG**: The International Association of Diabetes and Pregnancy Study Groups; **NHANES**: National Health and Nutrition Examination; **NR**: not reported; **OR**: Odds Ratio**; OGTT**: oral glucose tolerance test; **RRR**: Reduced Rank Regression; **WHO**: World Health Organization; **Yr**: year

Supplementary Table 1 –Description of the dietary patterns of the articles included in the review

Author, yr, Country	Pattern Method	Dietary Patterns
Bao, et al., 2014 (USA)[29]	A priori	**3 LCD scores (ie, overall LCD, animal LCD, and vegetable LCD scores)**. Was conducted tests of linear trend across quartiles of the LCD score by assigning the median value for each quartile and fitting this as a continuous variable in models.
Gicevic et al., 2018 (USA)[30]	A priori	**Measures of dietary diversity:** **MDD-W** - 10-item food-based indicator, developed specifically to measure nutrient intake adequacy among women living in under-resourced set- tings and in developing countries. It includes the following food groups: 1) starchy staples, 2) pulses, 3) nuts and seeds, 4) dairy, 5) meat, poultry and fish, 6) eggs, 7) dark green leafy vegetables, 8) other vitamin-A rich fruits and vegetables, 9) other vegetables, and 10) other fruits; **FGI** - consists of eight items: 1) starchy staples, 2) legumes and nuts, 3) dairy, 4) flesh foods (meat, fish, poultry and liver/organ meats), 5) eggs, 6) vitamin-A rich fruits and vegetables, 7) other fruits and vegetables, and 8) fats and oils. **Measures of dietary quality:** **AHEI-2010 -** 11-unit, combined nutrient- and food-based score. Points are awarded for intake of each item on a scale from 0 (poorest) to 10 (highest). Higher intake of vegetables (excluding potatoes), fruits, whole grains, nuts and legumes, long chain (n-3) fatty acids, polyunsaturated fats (PUFAs), and moderate alcohol is scored positively, while higher intake of sugar-sweetened beverages and fruit juice, red and processed meats, trans fat, and sodium is scored in reverse; **PDQS -** 21-unit food-based score developed using a modified PrimeScreen questionnaire. Contains 14 "healthy" food and 7 "unhealthy" food groups. Scores are allocated according to consumption frequency.
Tobias et al., 2012 (USA)[31]	A priori	**aMED** - encourages greater intake: Fruit (servings/d), Vegetables (servings/d), Nuts, legumes, soy (servings/d), Fish and seafood (servings/d), Whole grains (servings/d), Moderate alcohol (servings/d), MUFA:SFA; encourages no/less intake: Red and processed meats (servings/d); **DASH** - encourages greater intake: Fruit (servings/d), Vegetables (servings/d), Nuts, legumes, soy (servings/d), Whole grains (servings/d), Low-fat dairy (servings/d), ; encourages no/less intake: Red and processed meats (servings/d), Sweetened beverages (servings/d), Sodium (mg/d); **aHEI** - encourages greater intake: Fruit (servings/d), Vegetables (servings/d), Nuts, legumes, soy (servings/d), White:red meat ratio (servings/d), Cereal fiber (g/d), Moderate alcohol (servings/d), PUFA:SFA, Multivitamin use (servings/d) ; encourages no/less intake: trans Fat (% of energy/d);

Shin; Lee; O.Song, 2015 (USA)[32]	RRR	**"High Refined Grains, Fats, Oils and Fruit Juice" Pattern:** high loadings of refined grains, solid fats, oils, and fruit juice; "High Nuts, Seeds, Fat and Soybean; **Low Milk and Cheese" Pattern:** high loadings of nuts and seeds, solid fats, soybean products and low loadings of milk and cheese; **"High Added Sugar and Organ Meats; Low Fruits, Vegetables and Seafood" Pattern:** high loadings of added sugars and organ meats and low loadings of fruits and vegetables and seafood.
Sartorelli et al., 2018 (Brazil)[33]	RRR	**DP1 - High rice, beans, vegetables with low full-fat dairy, biscuits, and sweets:** high consume of rice, beans, vegetables and low consume of hard cheese, full-fat milk and yogurt and biscuits and crackers. **DP 2 - High red meats, full fat dairy, chocolate powder and fruits with low chicken and margarine:** high consume of beans, fruits, beef and pork, hard cheese, full-fat milk and yogurt, chocolate powder and low consume of chicken, Butter and margarine
Seymour et al., 2016 (Singapure)[23]	FA	**Vegetable-fruit-rice-based-diet :** high in vegetables, fruit, white rice, bread, low-fat meat and fish, and low in fried potatoes, burgers, carbonated and sugar-sweetened beverages; **Seafood-noodle-based-diet:** high in soup, fish and seafood products, noodles (flavoured and/or in soup), low-fat meat, and seafood, and low in ethnic bread, legumes and pulses, white rice, and curry-based gravies; **Pasta-cheese-processed-meat-diet:** high in pasta, cheese, processed meats, tomato-based and cream-based gravies.
Donazar-Ezcurra et al., 2017 (Spain)[17]	PCA	**Western dietary pattern:** Red meat, High-fat processed meats, Potatoes, Commercial bakery, Whole dairy products, Fast food, Sauces, Pre-cooked foods, Eggs, Soft drinks, Sweets and chocolates; **Mediterranean dietary pattern:** Poultry, Olive oil, Nuts, Low-fat dairy products, Whole grain bread, Fish, Fruits, Vegetables
Du et al., 2017 (China)[21]	PCA	**Western pattern:** dairy, baked/fried food and white meat; **Traditional pattern:** light-colored vegetables, fine grain, red meat and tubers; **Mixed pattern:** edible fungi, shrimp/shellfish and red meat; **Prudent pattern**: dark-colored vegetables and deep-sea fish.
He et al., 2014 (China)[19]	PCA	**Vegetable:** root vegetables, beans, mushrooms, melon vegetables, seaweed, other legumes, fruits, leafy and cruciferous vegetables, processed vegetables, nuts; **Protein-rich:** poultry, red meat, animal organ meat, grains, processed meat, fish, soups, leafy and cruciferous vegetables, eggs; **Prudent:** dairy products, nuts, eggs, fish, soups, fruits, processed meat, sugar-sweetened beverages, processed vegetables; **Sweets and seafood** cantonese desserts, molluscs and shellfish, sugar-sweetened beverages, grains, leafy and cruciferous vegetables

Hu et al., 2019 (China)[25]	PCA	**FD:** **"Traditional pattern (TFD)":** high intake of tubers, vegetables, fruits, rice, red meat, eggs, and nuts; **"Sweet foods pattern (TFD)":** high intake of pastry and candy, sweet beverages, shrimps, crabs, mussels, fruits, and red meat; **"Fried food–beans pattern (TFD)":** high intake of fried foods, beans and products, and dairy products, and a low intake of organ meats; **"Whole grain-seafood pattern (TFD)"**, was characterized by a high intake of whole grains, shrimps, crabs, mussels, nuts, and seaweed, and a low intake of eggs, dairy products, and rice. **FFQ:** **"Fish–seafood pattern (FFQ)"**: high intake of marine fish, shrimps, crabs, mussels, freshwater fish, seaweed, and organ meat; **"Protein–sweets pattern (FFQ)":** high intake of dairy products, milk, eggs, beans and products, nuts, pastries, and candies; **"Traditional pattern (FFQ)"**: high intake of vegetables, fruits, rice, and nuts.
Jarman et al., 2018 (Canada)[28]	PCA	**Healthy Pattern**: Green vegetables, Orange vegetable, Other vegetables, Tomatoes, Fruit, Brown rice and pasta, White rice and pasta, Oils; **Meat and Refined Carbohydrate Pattern**: Boiled potatoes, Fries, White bread, Red meat, Processed meat; **Beans, Cheese and Salad Pattern:** Salad vegetables, Beans and pulses, Cheese, **Tea and Coffee Pattern**: Added sugar, Full-fat milk, Reduced-fat milk, Cream, Tea, Decaf tea, Coffee, Decaf coffee
Lawrence et al., 2020 (New Zeland)[26]	PCA	**'Junk' dietary pattern:** high loadings of confectionary, snacks, takeaways, hot chips, processed meats, soft and energy drinks, battered fried fish or seafood, ice-cream and cakes or biscuits; **'Health conscious' dietary pattern:** high loadings of vegetables, cheese, brown wholemeal bread, non-citrus fruits, yoghurt, dried fruits, high fibre cereal, and Vegemite™ or Marmite™ **'Traditional/White bread' dietary pattern**: high factor loadings for whole or standard milk, white bread, margarine, jam honey marmalade, peanut butter, Nutella™ and low fibre and/or high sugar cereals **'Fusion/Protein' dietary pattern:** high factor loadings for noodles, rice, pasta, seafood, chicken, green leafy vegetables, eggs and red meat

Yong et al., 2020 (Malasya)[27]	PCA	**Pre-pregnancy**: DP 1 (Other vegetables, Nuts, seeds & legumes, Green leafy vegetables, Fruits, Eggs, Milk & dairy products); DP 2 (Sugar, spread & creamer, Condiments & spices); DP 3 (Rice, noodles & pasta, Oils & fats, High energy beverages, Fish & seafood, Sweet foods, Poultry & meat) **First trimester:** DP 4 (Other vegetables, Nuts, seeds & legumes, Green leafy vegetables, Fruits); DP 5 (Sugar, spread & creamer, Condiments & spices, Oils & fats); DP 6 (Eggs, Milk & dairy products, Rice, noodles & pasta, High energy beverages, Fish & seafood, Sweet foods, Poultry & meat, Bread, cereal & cereal products, Processed meat) **Second trimester:** DP 7 (Other vegetables, Nuts, seeds & legumes, Green leafy vegetables, Rice, noodles & pasta); DP 8 (Sugar, spread & creamer, Condiments & spices); DP 9 (Fruits, Eggs, Milk & dairy products, High energy beverages, Fish & seafood, Sweet foods, Poultry & meat, Bread, cereal & cereal products, Processed meat)
Wen et al., 2020 (China)[39]	PCA	**Vegetable-based pattern**: Root vegetables, Gourd/melon family vegetables, Freshwater fish, Leafy and cruciferous vegetables, Red meat, Fried breads, White rice, Deep-sea fish and seafood products, Dumplings; **Poultry-fruit-based pattern**: Poultry, Fresh fruit, Processed fruit, Soups, Meat Innards, Noodles, Cereals, Dairy products, Deep-sea fish and seafood products, Nuts/seeds, Eggs, White rice; **Sweets -based pattern**: Biscuits\pastries\cakes, Bread, Deep-sea fish and seafood products, Ethnic breads, Dessert soup, Dairy products, Noodles, Meat products, Dumplings; **Plant protein-rich--based pattern:** Soya milk, Legumes, Beans/bean products, Bun, Rice, Bread, Ethnic breads, Cereals
Mak et al., 2011 (China)[24]	FA	**"Plant-based pattern"**: Green leafy vegetables, Root vegetables, Gourd/melon family vegetables, Red/orange vegetables, Cruciferous vegetables, Bean vegetables, Potatoes, Mushrooms, Bean products, Fruits; **"Meat-based pattern":** Mushrooms, Organ meat, Ox tripe, Pig blood curd, Squid, Pork, Processed meat; **"High protein-low starch pattern":** Eggs, Milk, Lean Pork meat, Fish, Noodles, Bread;
Nascimento et al., 2016 (Brazil)[34]	PCA	**"Traditional Pattern"**: Legumes, Vegetables, Fruit, Juice, Milk, Rice, Yogurt, Fish, Cheese; **"Mixed Pattern"**: Cassava, Pizza, Canned food, Cheese, Juice, Red meat, Fried food; **"Western Pattern"**: White bread, Savory, Sweet, Chocolate, Cookies, Soft drinks, Pasta, Fried food, Pizza, Chicken, Canned food
Schoenaker et al., 2015 (Australia)[37]	PCA	**Meats, snacks and sweets:** high consumption of red and processed meat, cakes, sweet biscuits, fruit juice, chocolate and pizza; **Mediterranean-style:** high factor loadings for vegetables, legumes, nuts, tofu, rice, pasta, rye bread, red wine and fish; **Fruit and low-fat dairy:** fruits and low fat dairy including yoghurt, low-fat cheese and skimmed milk; **Cooked vegetables:** high consumption of carrots, peas, cooked potatoes, cauliflower and pumpkin.
Zhang et al., 2006 (USA)[18]	PCA	**Western Pattern**: red meat, processed meat, refined grain products, snacks, sweets and deserts, French fries and pizza; **Prudent Pattern:** fruits, tomatoes, cabbages, green leafy vegetables, dark yellow vegetables, legumes, other vegetables, poultry and fish

Zhou et al., 2018 (China)[22]	PCA	**Beans–vegetables:** higher intakes of root vegetables, melons and solanaceous vegetables, mushrooms and algae, beans and bean products (soyabean, mung bean, soyabean milk), and leafy and cruciferous vegetables; **Nuts–whole grains:** higher intakes of nuts, whole grains and dairy products (milk, milk powder and yogurt); **Organs–poultry–seafood**: had higher intakes of animal organs, blood, seafood and poultry; **Fish–meat–eggs:** higher intakes of freshwater fishes, red meat and eggs; **Rice–wheat–fruits:** higher intakes of rice, wheat products and fruits.
Zuccolotto et al., 2018 (Brazil)[20]	PCA	**"Traditional Brazilian" pattern:** characterized by consumption of rice, bean;,meat, vegetables, and inversely associated with the consumption of hard and soft cheese, snacks pizzas and sandwiches; **"Snacks" pattern:** characterized by the consumption of breads, butter and margarine, milk and yogurt, hard and soft cheese, sweets, chocolate milk and cappuccino; **"Coffee" pattern:** characterized by consumption of coffee, sugar, butter and margarine. **"Healthy" pattern:** characterized by the consumption of vegetables, fruit and natural fruit juice, and it was inversely associated with the consumption of soda and artificial juice.

RRR: Reduced Rank Regression; FA: Factor Analysis; PCA: principal component analysis