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Major types of diets in the management of metabolic syndrome and obesity: a systematic review

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Abstract

Introduction: Excessive weight gain generates comorbidities, many of which are characterized as metabolic syndrome (MS), in which the individual, to be diagnosed, must present three or more metabolic or anthropometric changes such as increased waist circumference, systemic arterial hypertension, hyperglycemia, hypertriglyceridemia, and reduced serum HDL levels. It is important to highlight the association of MS with cardiovascular diseases, increasing global mortality by approximately 1.5 times and cardiovascular mortality by approximately 2.5 times. In this sense, of the different types of diets such as the low-carb diet, very low-carb diet, and intermittent fasting diet, the traditional Brazilian diet, the DASH, and the Mediterranean diet stand out, as they present as the main therapeutic proposal in the treatment of MS. **Objective:** It was to carry out a systematic review to present the main types of diets in the management of metabolic syndrome, evaluating their effectiveness as a nutritional benefit in controlling health and quality of life. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from April to June 2024 in the Web of Science, Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE and AMSTAR-2 instrument and the risk of bias was analyzed appropriately. according to the Cochrane instrument. **Results and Conclusion:** 111 articles were found, and 30 were evaluated in full and included in this article, 21 of which were included in the systematic review. Considering the Cochrane tool for risk of bias, the global assessment resulted in 12 studies with a high risk of bias and 21 studies that did not reach GRADE and AMSTAR-2. Most studies showed homogeneity in their results, with X^2=79.8%>50%. It was concluded that the traditional Brazilian diet, DASH, and the Mediterranean diet have in common the characteristics of plant-based diet varieties that incorporate natural foods and reduce ultra-processed foods. These diets have shown good results for human health through the prevention and treatment of obesity in its different life cycles, and there is also evidence of a reduction in the risk of cardiovascular diseases and cancer in individuals with obesity. Furthermore, these diets promote a decrease in low-grade inflammation that affects individuals with obesity, having beneficial effects in reducing metabolic syndrome, even more so when added to physical activities. It has been shown that dietary factors can play a fundamental role both in the individual components and in the prevention and control of metabolic syndrome. Recent data associate the presence of metabolic syndrome with lower consumption of whole grains, fruits, and vegetables.

Keywords: Diets. Traditional Brazilian diet. Mediterranean diet. DASH. Metabolic syndrome. Obesity.

Introduction

Diets are always in fashion and are reinvented according to each individual's nutritional deficiencies or needs in terms of health and aesthetics in general. In this sense, the search for weight loss is one of the constants that impact the population to solve the problem of obesity **[1]**. Excessive weight gain generates comorbidities, many of which are characterized as metabolic syndrome (MS), in which the individual, to be diagnosed, must present three or more metabolic or anthropometric alterations such as increased waist circumference, systemic arterial hypertension, hyperglycemia, hypertriglyceridemia and reduced serum concentration of HDL levels **[1,2]**.

It is important to highlight the association of MS with cardiovascular diseases, increasing overall mortality by approximately 1.5 times and cardiovascular mortality by approximately 2.5 times. The primary measures to address the changes that trigger MS are the practice of physical activities, the reduction of caloric intake, and the reduction of body weight. These factors directly influence blood pressure stability, as well as the reduction of cholesterol and blood glucose levels and the reduction of waist circumference **[1,3]**.

According to Mathai **[4]**, correctly planning your diet to prepare balanced meals is an important factor in regulating these levels. The combination of proteins, fats, and carbohydrates during different meals or snacks allows for better control of blood glucose levels and lower insulin release than when eating only meals or snacks composed mainly of carbohydrates. However, there is no consensus on the most appropriate nutritional strategy for the treatment of MS. Although current proposals are related to behavioral changes, such as changes in eating habits and physical activity, nutritional recommendations can be established for healthy patients or those with isolated changes and have different results, since the genetic and cultural history of each individual must be considered.

The diet to be beneficial for most patients with MS should include fruits, vegetables, dried legumes, cereals, unsaturated fat (mono and polyunsaturated), and low-fat dairy products in adequate amounts **[1-4]**.In this sense, of the different types of diets such as the low-carbohydrate diet, the very low-carbohydrate diet, and the intermittent fasting diet, the traditional Brazilian diet, the DASH diet, and the Mediterranean diet stand out, as they are the main therapeutic proposal in the treatment of MS, since they correspond to caloric limitations without altering the patient's adequate nutritional status, and are characterized by a high intake of cereals, vegetables, fruits, and olive oil, moderate intake of fish and alcohol, especially wine, and low intake of dairy products, meats, and sweets **[5]**.

The Mediterranean diet has a high content of unsaturated fat since olive oil is abundantly used in cooking. Dried fruits with a high content of unsaturated fat are also foods commonly consumed in the Mediterranean diet. Evidence from epidemiological and clinical studies indicates that regular nut intake can positively affect adiposity, insulin resistance, and other metabolic disorders related to MS **[5,6]**.

Thus, the present study carried out a systematic review to present the main types of diets in managing metabolic syndrome, evaluating their effectiveness as a nutritional benefit in controlling health and quality of life.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 05/20/2024. The AMSTAR 2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 05/20/2024.

Search Strategy and Search Sources

The literature search process was carried out from April to June 2024 and developed based on Web of Science, Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The following descriptors (MeSH Terms) were used: "Diets. Traditional Brazilian diet. Mediterranean diet. DASH. Metabolic syndrome. Obesity", and using the Boolean "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

The quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials, prospective controlled studies, and retrospective observational studies. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed

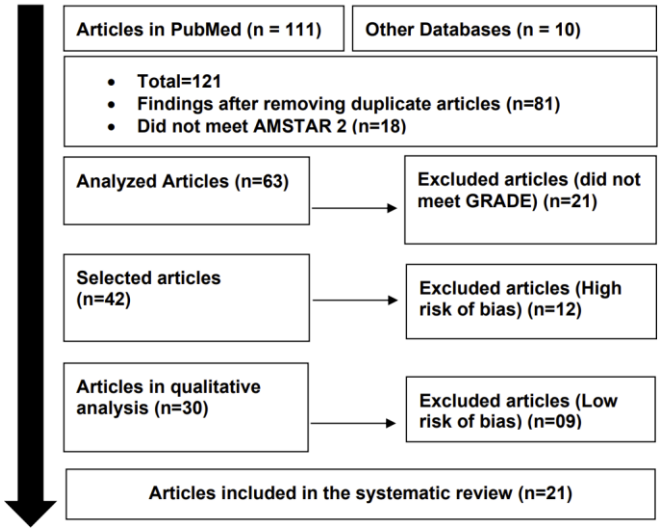
according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using Cohen's d test.

Results and Discussion

Summary of Findings

A total of 111 articles were found and submitted to eligibility analysis, with 21 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=79.8%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 12 studies with a high risk of bias and 21 studies that did not meet GRADE.

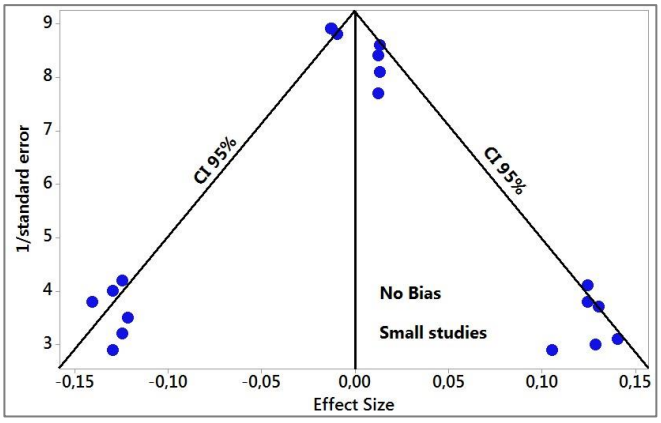
Figure 1. Flowchart showing the article selection process.



Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) that are shown at the bottom of the graph and in studies with large sample sizes that are shown at the top.

Figure 2. The symmetrical funnel plot suggests no risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. Studies with high confidence and high recommendation are shown above the graph (n=21 studies).



Source: Own Authorship.

Main Approaches and Clinical Findings (n=21 studies)

According to the literature findings, it is evident that MS is composed of a set of metabolic abnormalities. The most relevant individual components of metabolic syndrome are obesity, arterial hypertension, hypertriglyceridemia, hyperglycemia, dyslipidemia, and reduced serum HDL levels **[7]**.

In this context, the traditional Brazilian diet is characterized by dividing a plate of food, with one half divided into three parts: one part rice, one part beans, and one part lean red or white meat. The other half of the plate is filled with cooked or raw vegetables in the form of salad, grilled, or roasted culinary preparations **[8-11]**.

The dietary pattern called the traditional Brazilian diet was tested in a randomized clinical trial as a treatment in individuals with grade II/III obesity (BMI = 35 kg/m^2), in which more than 85% of the sample are women. Plant-based foods and foods with low levels of ultra-processed foods were included in this diet. It is a healthy dietary pattern that can be easily incorporated into dietary habits due to its common food components, such as rice, beans, fruits, and vegetables, which are widely consumed in many cultures. This dietary pattern does not include foods such as nuts, olive oil, seafood, and wine, which may be difficult to find in most countries or are expensive for people living in low- or middle-income countries. A comparative analysis of the Mediterranean diet and the traditional Brazilian diet can be found in a previous publication. In this study, the intervention of the traditional Brazilian diet was effective in reducing some cardiometabolic risk parameters in individuals with severe obesity, mainly LDL-cholesterol, HbA1c, triglycerides, and triglycerides/HDL ratio **[11]**.

In another study, the traditional Brazilian diet showed a significant reduction of 46% in anxiety symptoms, 50% in depression, and 67% in both anxiety

and depression. After a 12-week follow-up, participants with severe obesity had a mean weight reduction of -2.83 ± 5.79 kg. Even modest weight loss can have health benefits. This dietary pattern is more effective in reducing other risk factors affecting women with severe obesity than weight loss alone. The Traditional Brazilian Diet may potentially be a good option for treating women with obesity when the goals are to reduce cardiometabolic risk, depression, and anxiety symptoms **[8]**.

In addition, another study summarized the scientific evidence on the effects of different types of diets for women with obesity and their impact on cardiovascular disease and cancer risk. Epidemiological and clinical studies on adult women and different types of diets were included, such as the Mediterranean diet (MED), the Traditional Brazilian Diet, the Dietary Approach to Stop Hypertension (DASH), intermittent fasting (IF), calorie (energy) restriction, dietary reeducation, low-carbohydrate diet (LCD), and very low-carbohydrate diet (VLCD). The main findings showed that although LCD, VLCD, and IF are difficult to adhere to for a long period, they can be good options for achieving improvements in body weight and cardiometabolic parameters. MED, DASH, and the Traditional Brazilian Diet are based on natural foods and reduced processed foods. These diets have been associated with better health outcomes in women, including lower risk of CVD and cancer and prevention and treatment of obesity **[12]**.

Furthermore, recognized gastronomically and nutritionally for its excellent combination of flavor and healthy effects on the body, the Mediterranean diet is promoted as an ideal dietary model. Shaped by the climate and agricultural tradition of the region, it consists of a high consumption of vegetables, fruits, cereals, legumes, oilseeds, fish, olive oil, and wine and a low intake of animal products, simple sugars, and saturated fats **[13-21]**.

In this context, the traditional Mediterranean diet is known for the health and longevity benefits it provides. It is characterized by a high consumption of unsaturated fat since olive oil is widely used in cooking. Dried fruits with a high content of unsaturated fat are also commonly consumed foods in the Mediterranean diet. Evidence from epidemiological and clinical studies indicates that regular intake of nuts may have a positive effect on adiposity, insulin resistance, and other metabolic disorders related to MS **[7,18]**.

Results of a review carried out by Babio et al. **[22]** indicated that a healthy dietary pattern characterized mainly by high consumption of vegetables, fruits, nuts, olive oil, legumes, and fish; moderate alcohol intake, and reduced intake of red meat, processed meat, refined carbohydrates, and high-fat dairy products is beneficial for individuals at increased risk of MetS or individuals with MS.

Gouveri et al. **[23]**, in a multivariate analysis, revealed that the Mediterranean diet is associated with a 20% reduction in MetS (odds ratio: 0.80; 95% CI: 0.65–0.98), after adjusting for age, sex, smoking status, light physical activity, LDL cholesterol and γ-glutamyl transferase concentrations, diabetes, cardiovascular disease, family history of hypertension, and/or hyperlipidemia.

A meta-analysis study evaluated dietary approaches for weight loss and remission in people with type 2 diabetes to inform clinical practice and guidelines. It was identified 19 meta-analyses of weight loss diets, involving 2–23 primary trials (n=100–1587), published between 2013–2021. Twelve were of AMSTAR 2 'critically low' or 'low' quality, with seven of 'high' quality. The greatest weight loss was reported with very-low-energy diets, 1.7–2.1 MJ/day (400–500 kcal) over 8–12 weeks (high-quality meta-analysis, GRADE low), achieving 6.6 kg (95% CI -9.5, -3.7) greater weight loss than low-energy diets (4.2–6.3 MJ/day [1000–1500 kcal]). Formulated meal replacements (high quality, moderate GRADE) achieved 2.4 kg (95% CI -3.3, -1.4) greater weight loss over 12–52 weeks. Low-carbohydrate diets were no better for weight loss than high-carbohydrate, low-fat diets (high quality, high GRADE). High-protein, Mediterranean, high monounsaturated fatty acid, vegetarian, and low-glycaemic index diets achieved minimal (0.3–2 kg) or no difference from control diets (low to critically low quality, very low/moderate GRADE). For type 2 diabetes remission, of 373 records, 16 met the inclusion criteria. Remissions at 1 year were reported for a median of 54% of participants in randomized controlled trials including initial low-energy total diet replacements (low risk of bias trial, GRADE high) and 11% and 15% for meal replacement and Mediterranean diets, respectively (some concerns about risk of bias in trials, GRADE moderate/low). For ketogenic/very low-carbohydrate and very low-energy diets, the evidence of remission (20% and 22%, respectively) is a serious and critical risk of bias, and GRADE certainty is very low **[24]**.

Plant-based diets (PBDs) have become very popular in recent years and have been identified as a dietary strategy associated with protection against chronic diseases. However, the classifications of PBDs vary depending on the type of diet. Some PBDs have been recognized as healthy due to their high content of vitamins, minerals, antioxidants, and fiber, or harmful if they are rich in simple sugars and saturated fat. Depending on this classification, the types of PBDs have favorable effects on the management of patients with

metabolic syndrome. The different types of plant-based diets (vegan, lacto-vegetarian, lacto-ovo-vegetarian, or pescatarian) are discussed with a focus on the specific effects of the dietary components on maintaining a healthy weight, protection against dyslipidemia, insulin resistance, hypertension, and low-grade inflammation **[25]**.

Furthermore, a review study conducted by the authors Pavlidou et al. (2023) **[26]** summarized the results of clinical studies conducted over the past 15 years, shedding light on the efficacy, mechanisms, and nuances of different diets in the treatment of diabetes, with a special focus on the Mediterranean diet (MD). The MD appears to be the most recognized diet, exerting favorable effects against obesity and diabetes. Low-carbohydrate diets have been found to improve glycemic regulation and decrease insulin resistance. Plant-based diets have demonstrated potential benefits in weight management and cardiometabolic health. High-protein, low-fat dietary models have exhibited positive effects on satiety and body weight decline. Intermittent fasting regimens have also exerted metabolic improvements and body weight decline. Personalization has emerged as a crucial factor in dietary recommendations. Finally, the authors Dinu et al. (2017) **[27]** analyzed through a meta-analysis the association between vegetarian and vegan diets, risk factors for chronic diseases, risk of all-cause mortality, incidence and mortality from cardio-cerebrovascular diseases, total cancer and specific types of cancer (colorectal, breast, prostate and lung), through meta-analysis. Eighty-six cross-sectional studies and 10 prospective cohort studies were included. The overall analysis among cross-sectional studies reported significantly reduced levels of body mass index, total cholesterol, LDL cholesterol, and glucose levels in vegetarians and vegans versus omnivores. Regarding prospective cohort studies, the analysis showed a significant reduction in the risk of incidence and/or mortality from ischemic heart disease (RR 0.75; 95% CI, 0.68 to 0.82) and incidence of total cancer (RR 0.92; 95% CI 0.87 to 0.98), but not for total cardiovascular and cerebrovascular diseases, all-cause mortality, and cancer mortality. No significant association was found when specific types of cancer were analyzed. The analysis performed among vegans reported a significant association with the risk of total cancer incidence (RR 0.85; 95% CI, 0.75 to 0.95), although obtained only in a limited number of studies. Therefore, there is a significant protective effect of a vegetarian diet against the incidence and/or mortality from ischemic heart disease (-25%) and total cancer incidence (-8%). The vegan diet conferred a significant reduction in the risk (-15%) of total cancer incidence.

Conclusion

It was concluded that the traditional Brazilian diet, the DASH diet, and the Mediterranean diet have in common the characteristic of being varieties of plant-based diets with incorporation of natural foods and reduction of ultra-processed foods. These diets have shown positive results for human health through the prevention and treatment of obesity in its different life cycles, and there is also evidence of a reduction in the risk of cardiovascular disease and cancer in obese individuals. In addition, these diets promote a reduction in low-grade inflammation that affects obese individuals, addressing beneficial effects in reducing metabolic syndrome, even more so when combined with physical activity. It has been shown that dietary factors can play a fundamental role in both the individual components and in the prevention and control of metabolic syndrome. Recent data associate the presence of metabolic syndrome with lower consumption of whole grains, fruits, and vegetables.

CRediT

Author contributions: **Conceptualization -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Data curation -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Formal Analysis -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Investigation -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Methodology -** Luciana Corrêa dos Santos Leão; **Project administration -** Pedro Luiz Ferreira de Siqueira Júnior; **Supervision -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Writing - original draft -** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão; **Writing-review & editing-** Pedro Luiz Ferreira de Siqueira Júnior, Luciana Corrêa dos Santos Leão.

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Conflict of Interest

The authors declare no conflict of interest.

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