International Journal of Nutrology
(Official Journal of the ABRAN - Brazilian Association of Nutrology)

REVIEW ARTICLE

DOI: 10.54448/ijn24405

Health promotion through the adoption of the mediterranean diet as a therapeutic proposal in the treatment and prevention of metabolic syndrome: a systematic review

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DOI: https://doi.org/10.54448/ijn24405

Received: 07-05-2024; Revised: 09-07-2024; Accepted: 09-16-2024; Published: 09-20-2024; IJN-id: e24405

Editor: Dr. Leah D. Whigham, MD, Ph.D., FTOS.

Abstract

Introduction: Excessive weight gain generates comorbidities, many of which are characterized as metabolic syndrome (MetS). It is important to highlight the association of MetS with cardiovascular diseases, increasing global mortality by approximately 1.5 times and cardiovascular mortality by approximately 2.5 times. In this sense, the Mediterranean diet presents itself as the main therapeutic proposal in the treatment of MetS, as it corresponds to caloric limitations without altering the patient's adequate nutritional status. **Objective:** It was to investigate the effects of health promotion through the adoption of the Mediterranean diet as a therapeutic proposal in the treatment and prevention of metabolic syndrome, evaluating the nutritional benefit on quality of life. **Methods:** The PRISMA Platform systematic review rules were followed. The research was carried out from April to June 2024 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 157 articles were found. A total of 26 articles were evaluated in full and 21 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 29 studies with a high risk of bias and 28 studies that did not meet GRADE and AMSTAR-2. It was concluded that the studies showed the beneficial effects of the Mediterranean diet in reducing the prevalence of MetS. Furthermore, the dietary pattern described in the Mediterranean diet combined with physical activities can be used as a useful clinical tool in the treatment of metabolic syndrome. The suggested menu, with foods rich in fiber, is associated with reducing cardiovascular risk and, therefore, the Mediterranean diet is recognized as an agent for

promoting health and preventing and treating obesity. In this sense, it appears 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 MetS with lower consumption of whole grains, fruits, and vegetables. Therefore, there is a close relationship between these foods and dietary fiber, and, probably, soluble fiber is more directly related to these effects. A reduced prevalence of MetS was also observed in patients with systemic lupus erythematosus, a result of the good level of adherence to the Mediterranean diet. Furthermore, 25(OH)D status is associated with the composition, diversity, and functionality of the gut microbiota, and lifestyle intervention can modulate both the gut microbiota and 25(OH)D levels, potentially influencing metabolic pathways.

Keywords: Mediterranean diet. Metabolic syndrome. Health promotion. Quality of life.

Introduction

Diets are modulated and targeted 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. Excessive weight gain generates comorbidities, many of which are characterized as metabolic syndrome, 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 (metabolic syndrome) with cardiovascular diseases, increasing overall mortality by approximately 1.5 times and cardiovascular mortality by approximately 2.5 times **[2]**. 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, the reduction of cholesterol and blood glucose levels, and the reduction of waist circumference **[1]**.

According to Mathai **[3]**, 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 treating 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 **[4]**.

In this sense, the Mediterranean diet is the main therapeutic proposal for treating MS, since it involves caloric limitations without altering the patient's adequate nutritional status. According to Salas et al. **[5]**, the traditional Mediterranean diet is characterized by a high intake of cereals, vegetables, fruits, and olive oil; a moderate intake of fish and alcohol, especially wine; and a low intake of dairy products, meats, and sweets. The Mediterranean diet has a high unsaturated fat content since olive oil is abundantly used in cooking. Dried fruits with a high unsaturated fat content are also foods commonly consumed in the Mediterranean diet. Evidence from epidemiological and clinical studies indicates that regular intake of nuts can have a positive effect on adiposity, insulin resistance, and other metabolic disorders related to MS **[4,5]**.

Thus, the present study aimed to investigate the health-promoting effects of adopting the Mediterranean diet as a therapeutic proposal for the treatment and prevention of metabolic syndrome, evaluating the nutritional benefit on 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: 05/17/2024. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 05/17/2024.

Search strategy, Study Quality, and Risk of Bias

The literature search process was carried out from April to June 2024 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, covering scientific articles from different periods to the present day. The following health science descriptors (DeCS/MeSH Terms) were used: "Mediterranean diet.

Metabolic syndrome. Health promotion. Quality of life", using the Boolean "and" between MeSH terms and "or" between historical findings.

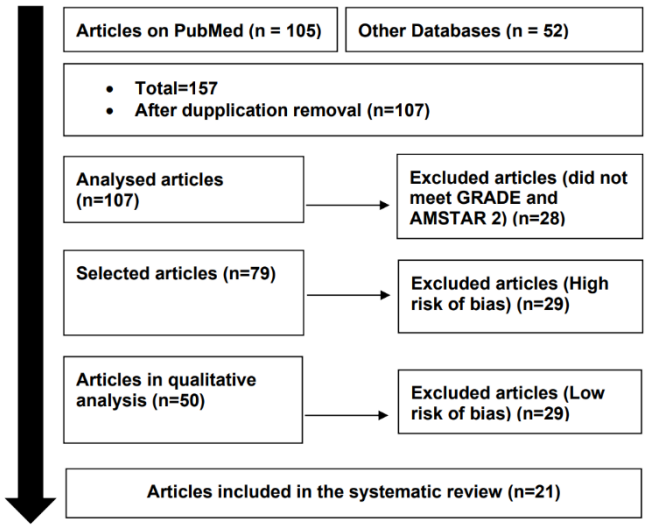
Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. Low 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 through the analysis of the Funnel Plot graph (Sample size versus Effect size), using Cohen's test (d).

Results and Discussion

Summary of Findings

As a corollary of the literary search system, a total of 157 articles were found that were subjected to eligibility analysis and, then, 21 of the 26 final studies were selected to compose the results of this systematic review. The listed studies presented medium to high quality (Figure 1), considering firstly the level of scientific evidence of the studies in study types such as meta-analysis, consensus, randomized clinical trial, 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=83.5%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 29 studies with a high risk of bias and 28 studies that did not reach GRADE and AMSTAR-2.

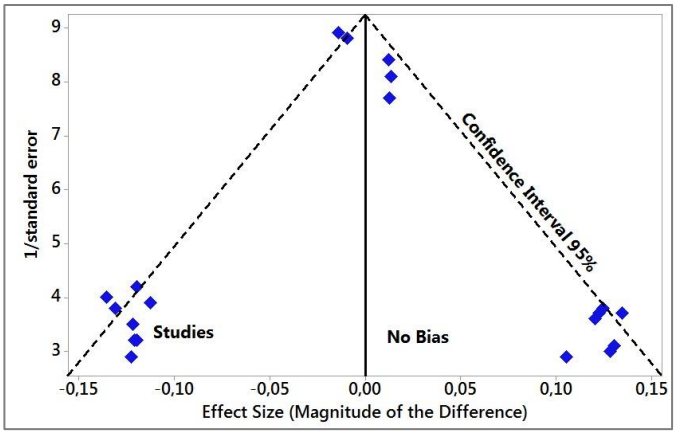
Figure 1. Flowchart showing the article selection process.



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 base of the graph and in studies with large sample sizes that are shown at the top.

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=21 studies).



Source: Own Authorship.

Major Clinical Findings and Considerations

Metabolic syndrome (MS) is composed of a set of metabolic abnormalities, of which insulin resistance (IR) stands out **[6]**. The most relevant individual components of the metabolic syndrome and possible interventions for them are described below, highlighting preventive measures related to diet.

Given this, obesity, now known as an "epidemic" disease, is considered by the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) as the main reason for the increase in the prevalence of MS; it contributes to hypertension, low HDL, high cholesterol and hyperglycemia; factors that are associated with an increased cardiovascular risk **[6,7]**. As a primary intervention measure, dietary approaches are adopted that can vary in the prescription of total energy value and macronutrients. However, the reduction of daily energy intake is the most important determinant of effective weight loss. It should be remembered that the association of diet with physical activity increases weight loss and decreases abdominal fat **[7]**.

Furthermore, blood pressure as a component of metabolic syndrome is a factor that increases the likelihood of cardiovascular diseases, as well as cardiovascular and renal morbidity and mortality. Among the environmental factors related to blood pressure levels, diet appears to play an important role in both the prevention and treatment of systemic arterial hypertension **[5]**. Hypertriglyceridemia results from the elevation of lipoproteins responsible for transporting triglycerides and is slightly associated with obesity. Reducing triglyceride levels can be achieved by reducing the consumption of rapidly absorbed carbohydrates, as well as the consumption of omega-3 fatty acids derived from saltwater fish **[8]**.

Hyperglycemia is defined as impaired fasting blood glucose, impaired glucose tolerance, or type 2 diabetes mellitus. Diets that take into account the glycemic index (GI) of foods are among the current proposals for the management of hyperglycemia, especially for patients with MS. Among these proposals, high fiber intake, especially soluble fiber, which has beneficial effects on glucose and lipid metabolism, stands out **[5]**.

In this context, the prevalence of MS worldwide has reached worrying rates. In the United States, it is estimated at 24%, and in people over 60 years of age, this number rises to 43.5%. In general, the prevalence of MS has increased and these findings are associated with the epidemic of obesity and diabetes mellitus **[9]**. Although the data alert society, there are still few studies that report statistics on the syndrome in some countries, and, therefore, more studies on the prevalence of MS are needed that prioritize awareness and its risks. However, studies in different populations, such as Mexican, North American, and Asian, reveal a high prevalence of MS, depending on the criteria used and the characteristics of the population studied, with rates ranging from 12.4% to 28.5% in men and from 10.7% to 40.5% in women **[9,10]**.

Studies conducted by DiBello et al. **[11]** found that a more modern dietary pattern associated with a high intake of processed and refined foods, including rice, French fries, and pancakes, was positively associated with the presence of MS. Thus, Noel et al. **[12]** identified that a traditional dietary pattern rich in rice, beans and fat, in addition to sugar-rich sweets, sugary drinks and dairy desserts was associated with a higher probability of having MS and low HDL-cholesterol concentrations. In this context, the Mediterranean diet has been presented as the main element in the treatment of MS.

The Mediterranean region is composed of parts of three continents. The countries of Europe - Italy, Spain, Greece, Yugoslavia, France, and Albania; of Africa - Egypt, Libya, Tunisia, Algeria, and Morocco; and Asia - Turkey, Israel, Syria, and Lebanon represent the region bathed by the Mediterranean Sea. Despite the great cultural, social, and economic differences between these countries, certain common geographical elements, such as relief, climate, soil, and hydrography, influenced agriculture and, consequently, eating habits, making them co-founders of Mediterranean cuisine **[13]**.

Since the mid-20th century, researchers have identified an epidemic of cardiovascular disease in industrialized countries. However, studies have shown that the incidence of cardiovascular disease was much lower on the island of Crete, located in the Mediterranean **[14]**. This incidence is probably due to the population's use of monounsaturated fatty acids, such as olive oil. Several studies have sought to confirm the unique characteristics and establish the benefits of Mediterranean food **[15]**.

Recognized gastronomically and nutritionally for its excellent combination of tasty flavor and healthy effects on the body, the Mediterranean diet is promoted as an ideal dietary model. Shaped by the region's climate and agricultural tradition, it consists of a high consumption of vegetables, fruits, cereals, legumes, oilseeds, fish, olive oil, wine and a low intake of animal products, simple sugars, and saturated fats **[16,17]**.

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 **[6,10]**.

The results of a review conducted by Babio et al. **[18]** indicated that a healthy dietary pattern characterized mainly by high consumption of vegetables, fruits, nuts, olive oil, legumes, and fish; moderate alcohol consumption and reduced consumption of red meat, processed meat, refined carbohydrates, and high-fat dairy products are beneficial for individuals at increased risk or individuals with MS.

In addition, Gouveri et al. **[19]**, 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 adjustment for age, sex, smoking, light physical activity, LDL cholesterol and γ-glutamyl transferase concentrations, diabetes, cardiovascular disease, family history of hypertension and/or hyperlipidemia. In 1993, the World Health Organization (WHO) and the Oldways Preservation & Exchange Trust, together with researchers from the

Harvard Center for Nutritional Epidemiology, promoted the development of food guides in the form of pyramids. At this conference, the Mediterranean Diet food pyramid was organized, which is based on the dietary patterns existing in the 1960s, typical of the island of Crete.

The base of the Mediterranean food pyramid is made up of whole grains and olive oil, which can be consumed daily. Next, the food groups are represented by vegetables and fruits. Above, legumes, nuts, and cooked vegetables. Near the apex of the pyramid are eggs, fish and seafood, poultry, milk, and dairy products, which should be consumed a few times a week. At the top of the pyramid are red meat, simple sugars, and saturated fats, which should not be consumed more than once a month. This population has a habit of regular physical activity, drinking plenty of water, and drinking wine in moderation. Thus, the Mediterranean diet is widespread as a health perspective, when adopted correctly, followed by physical activity habits and dissociated from tobacco and excessive alcohol, and has satisfactory results in quality of life and in the prevention of diseases that constitute metabolic syndrome **[10]**.

Diet versus Benefits

The word diet is of Greek origin and means lifestyle. Despite socially representing deprivation and renunciation, the term expresses the connection between man and the region in which he lives. The diet present in Mediterranean countries seems to confer a connection with health and longevity to the population **[16,17]**. By following the dietary principles suggested by the diet, it is possible to benefit and prevent many factors that trigger metabolic syndrome. The Mediterranean diet has demonstrated several benefits, both in the development of MS **[20]** and at the level of its components. In a meta-analysis of 50 randomized controlled studies, involving a total of 534,906 participants, Kastorini et al. (2011) **[21]** found a significant reduction in the risk of MS in individuals following the diet, with a reduction in waist circumference, blood glucose, triglycerides, systolic and diastolic blood pressure and an increase in HDL-c levels when compared to other diets.

As for the factors of the dietary pattern, it is rich in fruits and vegetables; moderate in low-fat dairy products; and low animal protein content, but with a substantial amount of vegetable protein, from legumes and dried fruits, which act to reduce systolic and diastolic blood pressure among hypertensive and normotensive individuals. In addition, the diet is associated with a lower risk of cardiovascular disease and MS **[17]**.

The combination of a good eating plan and the regulation of physical activity practices are fully related to the benefits of MS **[22]**. It has been proven that this combination causes a significant reduction in abdominal circumference and visceral fat, significantly improves insulin sensitivity, reduces plasma glucose levels, and can prevent and delay the onset of type 2 diabetes, a significant reduction in blood pressure and triglyceride levels, with an increase in HDL cholesterol **[10]**.

Psychosocial status and lifestyle are the main risk factors for non-communicable diseases (NCDs), which, in turn, are the main drivers of healthcare costs and morbidity and mortality worldwide, including Chile. The Mediterranean diet (MedDiet) is one of the healthiest dietary patterns studied. However, its impact on high-risk conditions such as metabolic syndrome (MetS) and NCDs outside the Mediterranean Basin remains largely unexplored. Although Central Chile has an environment, food production, and culinary traditions comparable to those present in Mediterranean countries, few studies have evaluated the effect of the MedDiet on health and/or disease in Chilean individuals **[23]**.

Importantly, a Mediterranean lifestyle is a modus vivendi that integrates physical health with mental and social well-being. Psychological well-being (PWB) is associated with healthy behaviors, positive health outcomes, and longevity, thus emerging as a new health goal. We report an ongoing randomized controlled trial in Chilean patients with MetS that seeks to test whether (1) an intervention based on PWB theory facilitates induction and increases long-term adherence to a locally adapted MedDiet, and (2) a MedDiet intervention, implemented alone or combined with well-being promotion, is more effective in reversing MetS compared with individuals following a low-fat diet without psychological support. The CHILEan MEDIterranean Dietary Intervention Study (CHILEMED) is a 1-year trial that includes patients with MetS living in Chile. Participants will be randomly assigned by a computer-generated random number sequence to one of three intervention arms: a) low-fat diet as a control group, b) MedDiet alone, and c) MedDiet plus wellness support. Patients will be followed through individual and/or group online or telephone nutritional sessions, as well as 6- and 12-month in-person reassessment of medical history, medication use, food intake, PWB, anthropometry/physical examination, and blood collection for laboratory analysis. The primary outcome of the study will be the effect of MedDiet—with or without PWB intervention—on the overall reversal of MetS compared with a low-fat diet alone. Based on a statistical superiority trial, expected impact, and patient attrition, the estimated study sample size is 339 subjects (113 subjects per arm in 3 equally sized groups) **[23]**.

Treatment and Prevention of Metabolic Syndrome

Treatment of MetS aims to improve resistance to insulin action. In this sense, weight loss represents the basis of treatment, as it improves insulin sensitivity, reducing the risk of cardiovascular complications. According to Salas et al. (2008) **[5]**, the main focus of patients with MS is the control of individual cardiovascular risk factors, which can be achieved through lifestyle changes, including dietary intervention. A balanced caloric intake is recommended, which, combined with physical activity, allows the patient to reach and/or maintain an ideal weight. In this sense, it can be stated that implementing a diet plan for weight reduction, combined with physical exercise, is considered the first-choice therapy for the treatment of patients with metabolic syndrome **[10]**.

As for prevention, the ideal is to adhere to healthy eating habits since obesity and insulin resistance play a central role in the pathogenesis of MS, and all strategies used to improve them appear to be effective in its prevention and treatment. Maintaining a moderate to high level of physical activity and/or limiting sedentary activities, especially in children, is one of the points of interest in the prevention or treatment of MS **[10]**. However, it is important to correctly promote physical activity, as there is a positive association between its practice and the reduction of body fat **[12]**.

Given the exposure to MS, it is clear that there is an urgent need to act immediately and effectively to prevent the growing trend that this problem tends to maintain since the proportion of children and young people who suffer from it is worrying. Therefore, lifestyle changes are undoubtedly necessary to minimize this problem and necessarily involve increasing the practice of physical exercise and the consequent reduction of sedentary activities **[9,10]**.

Changes in diet, especially in this age group, are essential, since high-energy-density foods are often used, which end up providing many calories; other measures must be taken, such as the use of medications or other types of more specific treatments, when the objectives are not achieved at all with the aforementioned lifestyle changes alone. It has been proven that even small reductions in body weight greatly improve the components of MS and, since almost all individuals who suffer from it are overweight or even obese, perhaps starting a diet suited to their health problems and lifestyle is a good starting point **[10]**.

Furthermore, a cross-sectional clinical study carried out by DelOlmo-Romero et al. (2024) **[24]** determined the prevalence of MS and associations with clinical features of systemic lupus erythematosus (SLE), cardiovascular risk, and dietary pattern in a population with 293 patients (90.4% women; mean age 46.8 (12.94)). The diagnosis of MS was established based on the criteria of the National Cholesterol Education Program Adult Treatment Panel III. MS was present in 15% of patients with SLE. Triglycerides, high-density lipoprotein cholesterol, systolic blood pressure, and waist circumference increased significantly in the group of patients with MS. Patients with MetS had significantly increased SDI damage index (1.70 (1.69) vs 0.88 (1.12), $p<0.001$) and complement C3 level (118.70 (32.67) vs 107.55 (26.82), $p=0.011$).

In addition, authors Boughanem et al. (2023) **[25]** investigated changes in gut microbiota and serum vitamin D levels after adherence to the Mediterranean diet within a lifestyle intervention. The study included 91 patients with obesity and metabolic syndrome, who were categorized based on their serum vitamin D levels as having optimal or low levels of 25-hydroxyvitamin D [25(OH)D]. The gut microbiota profile was analyzed by 16S rRNA sequencing, inferring its functionality through PICRUsT. Participants underwent a low-calorie MedDiet and lifestyle modification for 1 year. At baseline, gut microbiota profiles differed qualitatively between participants with optimal or low 25(OH)D levels. Furthermore, participants with optimal 25(OH)D levels had greater gut microbiota diversity than those with low 25(OH)D levels. Differential abundance analysis between the Low and Optimal 25(OH)D groups revealed differences in the levels of Bacteroides, Prevotella, and two Clostridiales traits. After 1 year of dietary intervention, both groups increased their 25(OH)D levels. Furthermore, both groups showed no significant differences in gut microbiota diversity, although the Low 25(OH)D group showed greater improvement in gut microbiota diversity compared to baseline and after dietary intervention. Metabolic pathway analysis indicated differences in microbial functions between the groups.

Finally, a recent randomized clinical trial developed by García-Gavilán et al. (2024) **[26]** investigated the effects on weight loss of a 1-year lifestyle intervention based on a reduced-energy Mediterranean diet associated with physical activity (intervention group), compared with an ad libitum MedDiet (control group), on fecal metabolites, fecal microbiota and its potential association with risk factors for cardiovascular disease. A total of 400 participants (200 from each study group) aged between 55 and 75 years and at high risk of cardiovascular disease were included. Compared with the control group, the intervention group showed greater weight loss and improvement in several risk factors for cardiovascular disease. A reduction in the abundance of the species *Eubacterium hallii* and genus Dorea and an increase in alpha diversity were observed in the intervention group after 1 year of follow-up.

Conclusion

It was concluded that the studies demonstrated the beneficial effects of the mediterranean diet in reducing the prevalence of metabolic syndrome. Furthermore, the dietary pattern described in the mediterranean diet, combined with physical activity, can be used as a useful clinical tool in the treatment of metabolic syndrome. The suggested menu, with foods rich in fiber, is associated with reduced cardiovascular risk and, therefore, the Mediterranean diet is recognized as an agent for promoting health and preventing and treating obesity. In this sense, it is clear 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. Therefore, there is a close relationship between these foods and dietary fiber, and soluble fiber is probably more directly related to these effects. A reduced prevalence of metabolic syndrome was also observed in patients with systemic lupus erythematosus, resulting from a good level of adherence to the Mediterranean diet. Furthermore, 25(OH)D status is associated with the composition, diversity, and functionality of the gut microbiota, and lifestyle intervention may modulate both the gut microbiota and 25(OH)D levels, potentially influencing metabolic pathways.

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Acknowledgment

Not applicable.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Peer Review Process

It was performed.

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