Review Article

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Vegetarian diets as a possible therapeutic approach to patients with metabolic syndrome

A brief review

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Approximately 25% of the adult worldwide population is estimated to have metabolic syndrome. Vegetarian diets have demonstrated effectiveness in improving each risk factor for developing metabolic syndrome, as compared with conventional dietary patterns and are useful in the prevention of metabolic syndrome. The present study reviews published literature concluding that following a vegetarian diet with the adequate nutritional support appears to be a mean to improve patients' metabolic condition and to decrease the risk of developing metabolic syndrome.
Keywords: metabolic syndrome, nutrition, vegan diet, vegetarian diet

Introduction

Metabolic syndrome (MetS) is a condition characterized by a cluster of clinical and metabolic risk markers, being a strong and independent contributor to the onset of coronary heart disease (CHD) and type 2 diabetes (T2D), doubling patients' risk for CHD and 5-folding patients' risk for T2D.[1]

Many health-related organizations, such as the World Health Organization (WHO),[2] the European Group for the Study of Insulin Resistance (EGIR),[3] the International Diabetes Federation (IDF)[4] and many others have proposed definitions for MetS. The most common definition used to diagnose MetS was developed based on the NCEP-ATP III criteria.[5] These criteria indicate that at least 3 of the following 5 risk factors must be present: abdominal adiposity—with the most important position among diagnostic criteria—, dyslipidemia, high blood pressure, insulin resistance and a proinflammatory state.[5]

Despite this definition being widely used, there is still controversy as some studies[6] suggest that the cut-off levels for the symptoms of MetS should be different for Asian people and non-Asians and thus, specific cut-off points have to be used for Asian groups.

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MetS has a high prevalence worldwide and its prevalence seems to be rising in parallel with the prevalence of obesity, being already labeled as a pandemic by some authors.[1,7] Several studies[8–10] were conducted to assess MetS prevalence in specific populations such as diabetics,[8] Asian-Americans[9] and Caucasians.[10] These values vary depending on the type of population assessed and on the criteria used to define MetS. Overall, MetS is about 3 times more common than diabetes, and thus the global prevalence can be estimated to be around one quarter of the world population.[7]

In addition to the lack of a consensus in its definition, MetS, as a unique disease entity, lacks effective therapeutic and preventive approaches. As far as research goes, it has been demonstrated that the management of MetS must involve lifestyle modifications, such as changes in diet and physical exercise,[11] yet, these changes improve MetS individual components but do not offer a treatment for MetS as a whole condition.

Vegetarian diets exclude the consumption of one or more types of animal-sourced foods, especially flesh from animals, and can refer to vegan (VEG) diets that completely exclude all animal derived foods or to lacto-ovo vegetarian (LOV) diets which include eggs and dairy products, but exclude fish and meat products.[12]

Vegetarian diets are gaining popularity around the world. The reasons to follow these diets are diverse and reported to be related to religion, animal welfare, sustainability and environmental reasons, as well as health related concerns.[13]

It is very important to consider that all 5 risk factors present in the MetS diagnosis criteria have a connection to diet. The worrying global prevalence and the comorbidities associated with MetS make it an important public health problem and therefore some studies have explored the association between diet and MetS. The aim of the present review is to summarize recent available evidence about the impact of vegetarian diets on the control of MetS.

Methods

To perform this review, the author searched the Pubmed database, using the following Keywords: "vegetarian diet", "vegan diet" and "plant-based diet" combined with "metabolic syndrome", "body mass index", "abdominal adiposity", "body

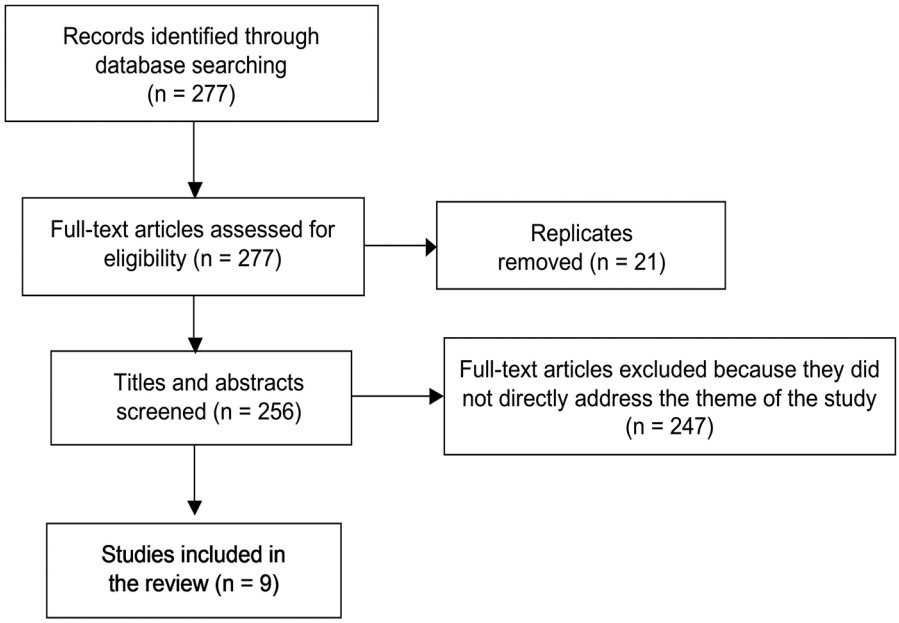

Figure 1. Literature review flowchart.

weight", "dyslipidemia", "cholesterol", "blood pressure", "insulin resistance" and "inflammation". The search was performed in May 2020 and the filters used were: date of publication between 2008 and 2020 (May 2020), type of article being cross-sectional studies, cohort studies and clinical trials and papers written in English. A total of 277 papers were retrieved from the initial search. After screening for replicates (n=21) and after excluding papers that did not directly address the theme of the study (n=247), 9 papers were included in the present review (Fig. 1).

Results

Vegetarian diets and MetS risk factors

Literature has shown several health benefits of these diets particularly related to the MetS risk factors[14–19] as can be seen in Table 1. Regarding the efficiency of vegetarianism in promoting weight loss, in studies where a LOV or VEG diet are administered to participants, even the participants with previous vegetarian diets that do not fully adhere to the prescribed weight loss diet loose more weight when compared to non-vegetarians.[14] Moreover, VEG diets have been shown to be more effective in improving body weight, fat mass and insulin resistance, when compared to an omnivorous diet.[15] Despite the above referred evidence regarding beneficial effects on weight loss, some studies find no statistical differences between vegetarians and omnivorous[16] or Mediterranean diets[17] on weight loss. Vegetarian diets were also found to improve glycaemic control and insulin sensitivity. In fact, there is evidence on vegetarians having lower fasting insulin level and higher insulin sensitivity compared with matched omnivores.[18] Moreover, these diets are considered to have a low inflammatory load to the point of being considered as an approach to lower inflammatory markers in patients with coronary artery disease.[19]

Vegetarian diets and metabolic syndrome

Studies that assessed Adventists—an important group in what concerns the study of vegetarianism since these individuals consume predominantly vegetarian diets—show that vegetarian dietary patterns are associated with significantly lower risk of having MetS when compared with a non-vegetarian dietary pattern.[20] These diets are proven to reduce the risk of individual components of the MetS (except for low high-density lipoprotein (HDL) cholesterol), being associated with lower waist circumference, lower concentrations of triglycerides, total and low-density lipoprotein (LDL) cholesterol, glycaemia, and blood pressure.[20]

Moreover, literature shows evidence that the consumption of a vegetarian diet is associated with a lower prevalence of MetS when compared with a consumption of a non-vegetarian diet, in a sample of postmenopausal vegetarian women.[21]

One study did not show a positive association between vegetarian dietary patterns and the decrease of the risk for developing MetS. This was a retrospective cohort study conducted in Taiwan that concluded that a VEG diet do not decrease the risk of MetS. This study was carried out comparing a VEG diet with LOV and non-vegetarian diets.[22]

To the best of this research, all the studies, except one, suggest that vegetarian diets are beneficial and can decrease the prevalence and risk factors to MetS, being an approach to decreasing the risk of developing the syndrome.

Discussion

Current evidence from several studies show an association between the consumption of a vegetarian diet and a reduced prevalence or risk of developing MetS. Despite lack of consensus in the definition of MetS, its components present major health hazards of the modern world and all of them can be either treated or attenuated by changes in diet. Dietary patterns such as vegetarian, that feature a high consumption of fruits and vegetables may then reduce the risk of MetS through mechanisms that rely on a beneficial synergetic combination of nutrients, antioxidants and phytochemicals, which may result in a decrease in body weight, fat mass, blood pressure, triacylglycerides, oxidative stress, insulin resistance and systemic inflammation.

Table 1

Overview of selected studies on vegetarian dietary patterns and their impact on metabolic syndrome

Authors (year)	Study design	Population	Results
Moore et al (2015)[14]	2-Year randomized clinical trial (n = 63)	LOV (n = 13) VEG (n = 12) Pesco-vegetarian (n = 13) Semi-vegetarian (n = 13) Non-vegetarian (n = 12) Age n = 63: mean (±SD) = 48.5 (8.3) years	Reference group: VEG VEG and LOV: lost significantly more weight (−6.0 ± 6.7%) than non-adherent omnivore participants (−0.4 ± 0.6%, *P* = .04) and had significantly greater decrease in cholesterol intake (−190.2 ± 199.2 mg) than pesco-vegetarian/semi-vegetarian (n = 15, −2.3 ± 200.3 mg, *P* = .02) or omnivore participants (n = 7, 17.0 ± 36.0, *P* = .04).
Kahleova et al (2018) [15]	16-week randomized clinical trial (n = 75)	VEG (n = 38) Non-vegetarian (n = 37) Age n = 75: mean (±SD) = 53.2 (12.6) years	Reference group: Non-vegetarian VEG: reductions in body weight (treatment effect −6.5 [95% CI −8.9 to −4.1] kg; Gxt, *P* < .001), fat mass (treatment effect −4.3 [95% CI −5.4 to −3.2] kg; Gxt, *P* < .001), and HOMA-IR (treatment effect −1.0 [95% CI −1.2 to −0.8]; Gxt, *P* = .004).
Burke et al (2008) [16]	18-month randomized clinical trial (n = 176)	LOV (n = 80) Non-vegetarian (n = 96)	Reference group: Non-vegetarian Vegetarian: no difference was observed in weight loss when compared with non-vegetarian. Despite that, both groups showed significant weight loss.
Sofi et al (2018) [17]	6-month randomized clinical trial (n = 118)	LOV (n = 60) Non-vegetarian (n = 58) Age n = 118: median (IQR) = 50 (21–75) years	Reference group: Non-vegetarian (Mediterranean diet) LOV: no difference in body weight was observed. Similar results were observed for body mass index and fat mass.
Cui et al (2019) [18]	Cross-sectional (n = 558)	Vegetarian (n = 279); Age: median (IQR) = 33 (28–41) years [VEG n = 73, LOV n = 206] Non-vegetarian (n = 279); Age: median (IQR) = 32 (27–40) years	Reference group: Non-vegetarian VEG and LOV: both VEG diet [β= -0.25, 95% CI: (-0.38, -0.14)] and LOV diet [β=-0.10, 95% CI: (-0.18, -0.01)] were negatively associated with HOMA-IR after adjusting for BMI. VEG diet was negatively associated with fasting glucose [β=-0.16, 95% CI: (-0.30, -0.01)] and HOMA-IR [β = -0.17, 95% CI: (-0.32, -0.03)] after adjusting for all confounders.
Shah et al (2018) [19]	8-week randomized clinical trial (n = 100)	VEG (n = 50); Age: median (IQR) = 63.0 [57.0–68.0] years Non-vegetarian (n = 50); Age: median (IQR) = 59.5 [53.0–67.0] years	Reference group: Non-vegetarian (Recommended Diet in Coronary Artery Disease Trial) VEG: significant 32% lower high-sensitivity C-reactive protein (β, 0.68, 95% confidence interval [0.49–0.94]; *P* = .02) when compared with the American Heart Association diet.
Rizzo et al (2011) [20]	Cross-sectional (n = 773)	Vegetarian (n = 35%) Semi-vegetarian (n = 16%) Non-vegetarian (n = 49%) Age n = 733: mean age of 60 years	Reference group: Non- vegetarian Vegetarian: significantly lower means for all metabolic risk factors except high density lipoprotein (*P* for trend, .001 for those factors) and a lower risk of having MetS (OR 0.44, 95% CI 0.30–0.64, *P* = .001).
Kim and Bae (2012) [21]	Cross-sectional (n = 107)	Vegetarian (n = 55%) Non-vegetarian (n = 45%) Age n = 107: mean (±S.D) = 62.63 (8.85) years	Reference group: Non-vegetarian Vegetarian: lower means for body weight, body mass index, percent body fat, waist circumference, systolic blood pressure, diastolic blood pressure and fasting blood glucose. The prevalence of MetS tended to be lower (33.9%) compared with non-vegetarian (47.9%).
Shang et al (2011) [22]	Cohort (n = 93209), data from 1997 to 2006	VEG (n = 1116); Age: mean (±SD) = 44.1 (14.9) years Pescovegetarian (n = 2461); Age: mean (±SD) = 43. (13.9) years LOV (n = 4313); Age: mean (±SD) = 37.9 (14.4) years Non-vegetarian (n = 85319); Age: mean (±SD) = 46.8 (11.8) years	Reference group: VEG Non-vegetarians, pescovegetarians and LOV: hazard ratios of MetS were 0.75 (95% CI, 0.64, 0.88), 0.68 (95% CI, 0.55, 0.83) and 0.81 (95% CI, 0.67, 0.97). Non-vegetarians and pescovegetarians hazard ratios for MetS components were 0.72 (95% CI, 0.62, 0.84), 0.70 (95% CI, 0.57, 0.84) times risk of developing low high density lipoprotein cholesterol, while non-vegetarians had 1.16 (95% CI, 1.02, 1.32) times risk of developing high fasting plasma glucose.

CI = confidence interval, Gxt = interaction between group and time, IQR = interquartile range, LOV = Ovo-lacto vegetarian, MetS = metabolic syndrome, SD = standard deviation, VEG = vegan.

Since the literature suggests that these dietary patterns can decrease the prevalence and risk for MetS, patients suffering from MetS should consider being targeted for nutritional support and a plant-based diet, monitored by a registered nutritionist, should be considered as a mean to possibly improve their metabolic condition.

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