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The Benefits of Culturally and/or Religiously Motivated Plant-Based Diets for Metabolic Health

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ABSTRACT

Metabolic syndrome is a cluster of conditions including hypertension, central obesity, dyslipidemia, and insulin resistance that increase the risk of cardiovascular disease and type 2 diabetes mellitus. Dietary patterns have emerged as modifiable risk factors, with plant-based diets gaining attention for their potential protective effects. Plant-based diets, when composed of minimally processed and nutrient dense foods, may offer a protective role against metabolic syndrome. In addition to nutrition science, religion and cultural practices play a significant role in shaping dietary behaviors. Specifically, many religious and cultural traditions promote plant-based eating, fasting, or the avoidance of certain animal products, which may aid metabolic health. Understanding this influence is essential for developing culturally sensitive dietary recommendations and for recognizing the broader social and spiritual dimensions of food choices. The intent of this paper is to examine the health impacts of plant-based dietary patterns, as related to both religious or cultural practices and norms.

Keywords

Plant-based diet, Metabolic syndrome, MetS, Cultural, Nutrients, Religious.

Abbreviations

BMI: body mass index, BP: blood pressure, BV: Breakfast vegetarian, CKD: Chronic kidney disease, CVD: Cardiovascular disease, DASH: Dietary approaches to stop hypertension, DBP: Diastolic blood pressure, DF: Daniel Fast, HbA1c: glycated hemoglobin, HDL: High density lipoprotein, HOMA-IR: Homeostasis model assessment for insulin resistance, HPBD: High plant-based diet, hPDI: Healthful plant-based diet indices, HT: Health training, LDL: Low density lipoprotein, LOV: Lacto-ovo-vegetarian, LPBD: Low plant-based diet, LV: Lacto-vegetarian, MetS: Metabolic syndrome, mmHg: Millimeters of mercury, MMT: Mindfulness meditation training, NV: non-vegetarian, OV: ovo-vegetarian, PDI: plant-based diet indices, PVG: pro-vegetarian diet index, SAT: Subcutaneous adipose tissue, SBP: systolic blood pressure, TAG: Triacylglycerol, T2DM: type 2 diabetes mellitus, TNF-a: tumor necrosis factor-alpha, uPDI: Unhealthful plant-based diet indices, VAT: Visceral adipose tissue, VEG: Vegetarian, VLDL: Very low-density lipoprotein cholesterol, WC: Waist circumference, WHR: Waist-to-hip ratio.

Introduction

Metabolic syndrome (MetS) is a global public health concern that disproportionately affects Hispanics and African Americans, followed by Europeans, East Asians, South Asians, and people of Indigenous ancestry [1]. Characterized by a cluster of metabolic risk factors, including abdominal (central) obesity, insulin resistance, elevated blood pressure and dyslipidemia, this condition significantly increases the likelihood of developing type

2 diabetes mellitus and cardiovascular disease [2]. Age, sedentary lifestyles, socioeconomic status and limited access to nutritious foods and education, and historical disparities in health care all contribute to the higher prevalence of MetS in these groups [2-5]. With these challenges, plant-based diets have emerged as a food-first intervention for improving cardiometabolic outcomes [6-8]. These dietary patterns prioritize a nutrient dense approach that is characterized by high consumption of fruits, vegetables, whole grains, legumes, healthy oils and nuts [6], while minimizing or eliminating animal products and processed foods [7,9-12]. Evidence indicates that not only do vegetarians have lower values for metabolic concerning traits when compared to non-vegetarians [13], but such diets may improve weight loss, lower blood pressure, improve insulin sensitivity, and reduce inflammation, making them beneficial for managing multiple chronic conditions [7,14-18].

This paper examines the role of plant-based diets in the prevention and management of metabolic diseases. Considering that cultural heritage, religious practices, and traditional foods shape food/meal choices and perceptions of health [19-23], this paper also explores cultural and spiritual/religious dimensions of food that can be leveraged to support dietary change in ways that can be widespread and effective.

Pathophysiology and Biomarkers of MetS

Understanding Metabolic Syndrome

Metabolic syndrome (MetS) is a multifactorial condition characterized by a multitude of metabolic abnormalities that significantly increase the risk for cardiovascular diseases and type 2 diabetes mellitus (T2DM). The US National Health and Nutrition Examination Survey showed that the prevalence of MetS has increased in US adults from 37.6% in 2011-12 to 41.8% in 2017-18 [24]. It is important to note that MetS is not a disease per se. Rather, it is an umbrella term used to encapsulate various metabolic factors that significantly increase the risk of cardiovascular disease and diabetes mellitus [25]. The most up to date criteria for MetS states that any individual with three or more of the following are classified as having MetS: hyperglycemia,

Table 1: Biomarkers of Metabolic Syndrome.

Metabolic Risk Factor	Parameters	Modifiable Risks	Non-modifiable Risk	Reference
Hypertension	Stage 1: SBP 130-139 mmHg and DBP 80-89 mmHg Stage 2: SBP >140 mmHg and DBP >90 mmHg	Physical inactivity Overweight/Obesity Smoking Active/Secondhand Increase ethanol consumption Diabetes Dyslipidemia Poor Diet Intake	Chronic Kidney Disease Advanced Age Obstructive Sleep Apnea Psychological Stress Low socioeconomic or education status Male (sex)	[3,27]
Insulin Resistance	Impaired fasting glucose Glucose Intolerance Diabetes Mellitus Type 2	Increased Visceral Adiposity Physical Inactivity/Sedentary Behavior Obesity Poor Dietary Intake Certain Medications/Health Conditions Smoking Poor Sleep Habits Stress Glucose Toxicity Lipotoxicity	Polycystic Ovarian Syndrome Genetics Age Ethnicity	[28-30]
Hyperglycemia	Fasting glucose>125 mg/dL Fasting plasma glucose 100-125 mg/dL	Obesity Fatty Liver Disease Physical Inactivity Gestational Diabetes Poor Dietary Intake Obstructive Sleep Apnea >120% Ideal Body Weight	Age: >45 years History of gestational diabetes Polycystic Ovary Syndrome Ethnic Background: African American Hispanic/Latino American Indian	[10,31,32]
Abdominal Obesity	WHR: >0.90 BMI >30 kg/m^2 WC: >94 cm	Upper body fat distribution Poor Dietary Intake Smoking	Genetics/Family History Age Ethnicity Parental BMI/Metabolic History	[33-39]
Dyslipidemia	Abnormal Blood Levels of fat Hypertriglyceridemia Low HDL	Poor Dietary Intake Physical Inactivity Obesity Diabetes Hypothyroidism Certain Medications	Genetics/Family History Male (sex) Ethnicity Increased Age	[40-42]

obesity, dyslipidemia (elevated or decreased concentrations of cholesterol or triglycerides, low high-density lipoproteins (HDL), or hypertension [26].

Physical inactivity further exacerbates these mechanisms by impairing glucose and lipid metabolism. Socioeconomic and environmental factors, such as limited access to healthcare services and healthy foods [5] also places individuals at a higher risk. While this paper focuses on the role of diet, it is important to acknowledge that other lifestyle factors such as exercise and cessation of smoking can have positive effects on modifiable causes of MetS.

Biomarkers

The most common biomarkers used to identify MetS include hypertension (elevated systolic and/or diastolic blood pressure), insulin resistance, hyperglycemia (elevated fasting blood glucose), abdominal obesity (increased waist circumference), dyslipidemia (unhealthy levels of blood fat), and low HDL (reduced high density lipoprotein cholesterol) as summarized in Table 1 [1]. A central component of MetS is visceral adiposity, which contributes to insulin resistance. If left untreated, MetS can lead to serious health conditions related to T2DM, cardiovascular disease, non-alcoholic fatty liver disease, cholesterol gallstones, asthma, sleep disturbances, or certain forms of cancer [4].

Hypertension

Hypertension is among the most prevalent chronic conditions worldwide and plays a critical role in MetS. In a review paper focused on vegetarian dietary patterns and MetS, it was found that dietary patterns placing emphasis on high intake of fruits and vegetables could reduce the risk of MetS through mechanisms that incorporate a combination of fiber, potassium, magnesium and phytochemicals that could potentially decrease blood pressure. Moreover, vegan dietary plans that replace processed meats, excess sodium, saturated fats, and added sugars with plant-based foods has been shown to improve blood pressure [43-47], highlighting the health-enhancing impact of plant-based diets.

Insulin Resistance

Insulin resistance, a hallmark of MetS, occurs in the context of impaired fasting glucose, glucose intolerance, or T2DM. Along with exercise and lifestyle modification, insulin resistance can be improved through diet changes [4]. High sugar foods, refined carbohydrates and grains, as well as processed and ultra-processed foods cause rapid spikes in blood glucose and excessive insulin secretion, which over time can cause cells to become less responsive to insulin [48,49], while also increasing inflammation and oxidative stress [50,51]—both of which are linked to further disease development.

Hyperglycemia

Hyperglycemia typically arises from inadequate insulin secretion, decreased peripheral glucose utilization, and increased hepatic glucose production, with insulin functioning as the central regulatory hormone [32]. Many hyperglycemia risks can be mitigated with changes to diet. Along with exercise, a nutrient dense diet rich in non-starchy vegetables, legumes, whole grains, and low saturated fat is recommended [10,52]. Fiber-rich vegetarian and vegan diets significantly reduce fasting glucose and glycated hemoglobin A1C (HbA1c), both of which are associated with improved insulin sensitivity [53].

Obesity

Adult obesity has become more prevalent with the age-standardized average BMI rising from 21 kg/m^2 in 1975 to 24 kg/m^2 in 2014 for men and 22.1 kg/m^2 to 24.4 kg/m^2 for women during the same timeframe [43], with values continuing to increase. The World Obesity Federation estimates that 800 million people are currently living with obesity, and there are at least 1 billion more people at risk of becoming overweight or obese [38]. Since the prevalence of MetS parallels obesity as well as diabetes, it should not be surprising that its rate is also increasing.

Abdominal Obesity

Visceral adipose tissue (VAT) is particularly pathogenic, associated with direct delivery of non-esterified fatty acids to the liver, promoting insulin resistance and metabolic dysfunction [16]. VAT correlates strongly with hypertension, dyslipidemia, and T2DM. Consumption of refined, high glycemic carbohydrates, like sweets and white bread, leads to elevated insulin secretion, facilitating the deposition of glucose and fatty acids into adipose tissue. This hypersecretion of insulin serves as the primary mechanism promoting fat accumulation, whereas dietary fat plays a secondary role in the progression of obesity [54].

Dyslipidemia

Dyslipidemia, characterized by abnormal blood lipid levels – including elevated triglycerides, total and low-density lipoprotein cholesterol (LDL), and lower high-density lipoprotein cholesterol (HDL)— is a major risk factor for cardiovascular disease (e.g. coronary artery disease). Diets high in saturated fats worsen dyslipidemia by altering lipid transport and clearance, leading to increased LDL cholesterol and triglycerides, decreased HDL cholesterol, and a higher cardiovascular risk profile [42,55-60]. Nutritional management focused on the adherence to diets rich in whole grains, vegetables, and fish [61], while avoiding trans fatty acids and increasing intake of oleic and alpha-linoleic acids [62] appears quite helpful.

Prevalence of MetS

The prevalence of MetS in the United States has increased from 37.6% in 2011-2012 to 41.8% in 2017-2018 [43] and may be even higher today. This trend was more pronounced in lower educated and socioeconomically disadvantaged populations [25] and varies by race/ethnicity [63]. Estimation of MetS in Canada are placed at 41.9% with Mexico having a prevalence of 28.9% and 44.4% for males and females, respectively. The UK Biobank showed that 24.5% of their population cohort had MetS. Outside of North America and Europe, increases have been seen as well. South Korea saw an increase from 27.1% to 33.2% in 2020. MetS has become an increasingly important health concern in both China and India with rates being 19.4% and 30%, respectively. A pooled analysis in Africa showed a prevalence of MetS being 21.02% [25].

Role of Nutrients in MetS

As highlighted under each of the metabolic risk factors, dietary intake has been implicated as a potential contributor, as well as treatment to multiple MetS factors. Herein, we focus briefly at how different macronutrients may affect MetS and its risk factors, then delve deeper into plant-based diets as a whole.

Protein/Amino Acids

Protein aids in weight management (lean mass preservation), improves appetite, and lowers fasting triglycerides [64]. Amino acids such as leucine, isoleucine, and valine are associated with improved diabetic parameters [65]. Comparing the benefits between animal vs plant protein, the Melbourne Collaborative Cohort demonstrated that higher plant protein intake was associated with a decreased risk of MetS incidence, and a higher total of animal protein intake was associated with an increased risk [66,67]. Additionally, a study on Korean households, with a focus on single person households, found that increased animal protein consumption was associated with an increased risk of MetS [67].

Fiber

Fiber can aid in the treatment of MetS by positively affecting blood glucose and lipid levels, while also improving digestive health [68]. In a study implementing caloric deficit, exercise, and increased fiber intake, investigators noted that fiber intake at the one-year follow-up was the main predictor of variation in the health outcomes of the intervention [69]. Additionally, in an inpatient feeding trial, researchers divided individuals into two groups; ultra-processed diet or unprocessed diet, both of which were allowed to be consumed *ad libitum*. Results demonstrated that those on the ultra-processed diet consumed 508 more calories per day and gained 0.9 kg during the two weeks [70]. Ultra-processed diets are often low in fiber content, and this may be at least partly responsible for the increased food intake—highlighting the importance of dietary fiber as a major consideration in the whole food plan, in particular for those seeking to lose weight through reduced caloric intake.

Carbohydrates

The separation of carbohydrate intake from weight loss/body weight is challenging since they often appear related, and both impact factors of MetS [71]. To determine if carbohydrate intake is independent of weight loss, Hyde et al. performed a study in obese individuals with a confirmed diagnosis of MetS [72]. Participants were placed on one of three maintenance diets for 4 weeks: low, moderate, and high carbohydrate with protein constant and fat exchanged isocalorically in all three diets [72]. Results showed that even though body mass was maintained, the low-carbohydrate diet improved fat oxidation and was more effective in reversing high triglycerides, decreased HDL, and elevated LDL along with decreasing plasma total saturated fat, despite this diet containing 2.5 times more saturated fat. Therefore, high consumption of carbohydrates may contribute to MetS.

Fats

Like other macronutrients, dietary fats can also alter an individual's risk of MetS, with consumption of certain fats putting individuals at greater risk. Specifically, saturated fatty acids (SFAs) have been associated with both CVD and MetS [73]. Modifying dietary intake away from SFAs toward monounsaturated fatty acids (MUFAs) or polyunsaturated fatty acids (PUFAs) has been shown to decrease those risks. Clifton emphasizes that replacing carbohydrates with PUFAs can lower fasting insulin levels, suggesting that the types of fat consumed can modify insulin sensitivity and thereby influence the development of MetS [74]. In terms of blood pressure, a meta-analysis found that diets rich in carbohydrates resulted in significantly higher systolic blood pressure (SBP) and diastolic blood pressure (DBP), and that the low carbohydrate diet with higher fat intake lowered SBP, as did a diet where MUFAs replaced carbohydrates [75-77].

How Metabolic Syndrome is Impacted by a Plant-Based Diet

Background

Plant-based diets have been increasingly recognized for their role in improving health outcomes, particularly those related to MetS. Characterized by a high consumption of fruits, vegetables, whole grains, legumes, and nuts [6], these diets have long been known to offer a nutrient-dense approach that may help reduce the risk and severity of MetS [6]. Plant-based diets typically involve reducing or eliminating the consumption of animal products and include variations such as the Mediterranean, vegan, vegetarian, flexitarian (semi-vegetarian), and whole-food plant-based regimens [37]. These diet patterns along with interventions discussed below are associated with a reduced risk of CVD, T2DM, and hypertension. They also contribute to lower morbidity and mortality rates and improved lipid profiles, including reductions in LDL, total cholesterol, and triglycerides, as well as increases in HDL [71,72]. As an example, an interventional cohort study involved a 30-day low-fat, plant-based diet and demonstrated significant improvements in BMI, blood pressure, lipid profiles, and fasting plasma glucose, resulting in a measurable reduction in MetS risk factors [73].

Indeed, there is considerable evidence demonstrating the benefits of a plant-based diet to counteract MetS. While plant-based diets are linked to decreased body weight, BMI, and central adiposity (weight circumference) [8,74]; they also improve inflammatory responses [37,46]. That said, individuals adhering to vegetarian diets may exhibit lower blood and muscle concentrations of creatinine and carnitine due to reduced dietary intake of animal protein [8], which may be a concern of some. In contrast, omnivorous diets are associated with higher levels of vitamin D and iron - particularly heme iron, which is more bioavailable and may contribute to greater bone mineral density [8]. Additionally, one of the primary concerns with plant-based diets is the potential for nutrient deficiencies such as amino acids, omega-3 fatty acids, vitamin B12, iron, zinc, iodine, vitamin D, and calcium. Therefore, it may be premature to suggest that plant-based diets are best for all. Rather, consumption of high quantities of "clean" plant-based

Table 2: Plant-based diet comparisons to other plant-based and non-plant based diets on MetS.

Components of MetS	Diet	N	Key MetS Findings	Reference
MetS risk factors, oxidative status, and microinflammation with diets (observational)	Veg Omn	90 46	MetS risk factors were comparable between diets. Vegetarian diet was associated with less microinflammation (C-reactive protein, leukocytes, and neopterin).	[81]
Risks of MetS with Veg diets (retrospective)	Non-Veg Pesco-Veg LOV Vegan	85319 2461 4313 1116	With mean follow-up of 3.75 years, the incidence rate of MetS was 227 (non-Veg), 239 (Pesco-Veg), 222 (LOV), and 393 (Vegan)	[82]
Associated factors of MetS to Malaysian Vegetarians (cross-sectional)	LOV OV LV VEG	33 6 37 20	MetS prevalence was 24.2% (LOV 32.6%, OV 25.0%, LV 19.2%, VEG 13.3%), which was lower than that of the general Malaysian population. 35.6% of subjects were overweight/obese.	[78]
MetS and hypertension risks for different Veg diets in elderly Taiwanese (cross-sectional)	Veg Vegan OV LV LOV Omn	**269** 83 7 122 57 **802**	MetS rates were 39.4% (Omn), 48.4% (OV/LV), 57.8% (vegan). MetS rates were also calculated for part-time veg (52.6%) and consistent veg (43.9%). MetS as well as hypertension were not significantly different between Veg and Omn.	[83]
MetS risk with dietary patterns (Adventist Health Study 2; cross-sectional)	 Veg Semi-Veg Non-Veg Vegan LOV Pesco-Veg Semi-Veg Non-Veg	**773** 35% 16% 49% 7.7% 29.2% 9.9% 5.4% 47.7%	MetS rates were 25.2% (Veg), 37.6% (semi-Veg), and 39.7% (Non-Veg). Veg/semi-Veg had better metabolic measures and 0.44 times the odds of having MetS compared to Non-Veg	[84] [85]
MetS risk with dietary patterns in South Asians without CVD in the United States (MASALA; cross-sectional)	Western Vegetarian	59 91	MetS rates were not reported; metabolic risk factors were. Vegetarian diet was associated with lower HOMA-IR (p=0.05) and HDL (p=0.09) and was considered to have better CVD risks.	[86]
MetS risk with dietary patterns in Black 7th Day Adventists (Adventist Health Study 2; cross-sectional)	Veg/Vegan Pesco-Veg Non-Veg	**592** 95/59 80 366	MetS rates were not reported; metabolic risk factors were. Veg/Vegan had a 44% lower odds of hypertension, 50% odds of diabetes as well as (in 1 cohort) lower BMI and waist circumferences compared to Non-Veg.	[87]
Metabolic profile comparisons for matched Veg and Non-Veg: (MJ Health Screening database; cross-sectional)	Veg Non-Veg	8183 40,915	MetS rates were not reported; metabolic factors were. Veg had significantly lower metabolic measures including waist circumferences, BMI, blood pressure, fasting glucose, total cholesterol, LDL, and HDL.	[13]
Metabolic profile comparisons for matched Veg and Non-Veg: (MJ Health Screening database; longitudinal)	Vegan LV LOV Omn	159 173 624 4778	The risk factors for the following were decreased per year on diet compared to the Omn diet. For vegan, obesity risk decreased by 7%. For LV, risks of elevated SBP and elevated glucose decreased by 8 % and glucose by 7%, respectively. For LOV, increased abnormal HDL by 7 % although TC:HDL was lower.	[103]
MetS risk in elderly Indians in care-homes (cross-sectional)	Veg Non-Veg	76 38	MetS rates were 39.5% for Veg and 43.4% for Non-Veg. Diet was not significantly associated with MetS.	[88]
Cardiometabolic risk in Asian Indians in the United States (cross-sectional)	Veg Non-Veg	328 546	MetS rates were 38.7% for Veg and 38.3% for Non-Veg Veg had an adjusted odds ratio for MetS of 0.89 compared to non-Veg. Veg were less likely to have diabetes or be obese than Non-Veg.	[89]
MetS risk associated with early adult life vegetarian status (Add Health; retrospective)	Veg Non-Veg	347 347	MetS rates not reported, components (hyperlipidemia, hypertension, truncal obesity) only. Veg status was not associated to MetS risk.	[90]
MetS risk with vegetarian diet in urban Indians in Delhi (cross-sectional)	Veg Non-Veg	200 200	MetS rates were 47.5% for Veg and 47% for Non-Veg. No significant effect was found for MetS and diet.	[91]
CVD risk with diet (cross-sectional)	Vegan Flex Omn	33 32 29	MetS scores were used, but all diets were found to be at low risk for CVD. Flex had lowest risk. Vegans were also significantly better than Omn based on BMI (p=0.012) and waist circumference (p=0.027). Vegans had lower fasting glucose than Omn and Vegans/Flex had lower LDL than Omn.	[92]

Veg: vegetarian, Omn: omnivore BV: Breakfast-vegetarian, NV: non-vegetarian, LOV: Lacto-ovo-vegetarian, CVD: Cardiovascular Disease, MASALA: Metabolic Syndrome and Atherosclerosis in South Asians Living in America, HOMA-IR: Homeostatic Model Assessment of Insulin Resistance, HDL: high-density lipoproteins, BMI: Body Mass Index, LDL: low-density lipoproteins, Flex: Flexitarian, ZJNHS: 2024 Zhejiang Nutrition and Health Survey.

foods, coupled with small amounts of high-quality animal proteins may be most appropriate but more research is needed to more fully elucidate what the "ideal" dietary plan may be. At the present time, what can be stated with confidence is that there is not one particular diet plan that appears best for all individuals.

Plant-based diets range in their inclusion/exclusion of animal products. A vegan diet excludes all animal products, but instead focuses on vegetables, fruits, whole grains, legumes/beans, nuts, and seeds, whereas a lacto-ovo-vegetarian diet includes some animal products such as cheese and various dairy products, and a pescatarian diet includes fish and seafoods. Each approach has it's merits and are discussed throughout the remainder of this paper—with a particular focus on their association with religious and cultural practices and how these approaches may influence MetS.

Methods

To identify relevant articles to consider, a PubMed search was conducted during the months of August and September 2025. We used a combination of the terms vegan/vegetarian/plant-based and MetS to identify research studies focused on differences in the incidence of MetS between plant-based diets and other diet types. The search resulted in an initial 208 entries. Of these, six entries were excluded for not being in English, one was excluded as it was a correction, one was excluded as it revealed vegetarian-based diet only during breakfast, and 162 entries were excluded due to relevance. Remaining studies of merit are described in Table 2. Results from clinical trials are described in Table 3. These findings were later used to assess the merits of plant-based religious and ethnic diets in Sections 5 and 6.

Relevant Clinical Studies

As observed in Table 2, many clinical and cross-sectional studies have focused on how different diets, including plant-based and omnivore, are associated with MetS and metabolic risk factors. In a 2018 study of Malaysian vegetarians, it was found that the prevalence of MetS was lower in vegetarians (24.2%) than the prevalence of MetS in the majority of the Malaysian population (42.5%) [78]. Picasso and colleagues performed a meta-analysis and found that MetS was not associated with a vegetarian diet but was with an omnivorous diet [79]. Further, a vegetarian diet was associated with lower blood pressure, fasting glucose, waist circumference, and HDL compared to an omnivorous diet, although the risk of bias was high for many studies, and authors cautioned that further research is needed. Almuntashiri and colleagues reviewed longitudinal studies to evaluate plant-based diets and disease risk [80]. Their analysis found that plant-based diets demonstrated lower risk of MetS, as well as metabolic risk factors such as T2DM, obesity, and cardiovascular health (cholesterol and blood pressure).

Not all plant-based diets are equal in their protective qualities towards MetS. In a study of obese Iranian adults, a direct significant association was found between an *unhealthy* plant-based diet and odds of hyperglycemia, reiterating the need to greatly reduce all processed foods [93]. Many studies employ plant-based diet indices (PDIs), developed from food frequency questionnaires, to determine how differences in diet within a population are correlated to health effects. These indices can include positive and negative food factors that indicate how strongly or weakly a subject adheres to a specified plant-based diet. In 2024, Nikparast and colleagues conducted a meta-analysis on nine cross-sectional studies utilizing these indices [94]; many of which are included in Table 3. Researchers found that higher adherence to a healthful PDI (hPDI) resulted in lower risk of MetS. In addition, elevated fasting blood glucose and obesity were both decreased with PDI and hPDI. Further, higher adherence to an unhealthful PDI (uPDI) resulted in a higher risk of MetS as well as obesity, hypertriglyceridemia, low HDL, and elevated fasting blood glucose. These findings highlight that eating a healthy plant-based diet rich in fruits, grains, nuts, legumes, and vegetables compared to diets that incorporate less plant-based foods and more animal-based/processed foods can alter the risk of MetS. Many of these studies also found that the impact of the diet was stronger in women than in men.

Cultural Foundations of Plant-Based Diets

Methodology Search

Articles specific to cultural and religious dietary and plant-based practices among Japanese, Mediterranean, Nordic, Seventh Day Adventist, Buddhist, Christian Orthodox, Christian Daniel Fast, and Hindu/Jainism were initially identified via a review of two main articles. Subsequently, an additional search was carried out during September 2025 using various combinations of relevant keywords including: "MetS and plant-based diet" or "plant-based diet, metabolic syndrome and religion" or "plant-based diet and metabolic syndrome" or "hypertension and plant based diet" or "dyslipidemia and plant based diet" or "insulin resistance and plant based diet" or "obesity and plant based diet" or "cardiovascular disease and plant based diet" or "diabetes and plant based diet" or "religion and plant based diet" or "cultural fasting and cultural practices and plant based diet" or "religious practices and plant based diet". The listed religion/tradition associated dietary practices were searched individually with MetS and risk factors of MetS (hypertension, insulin resistance, hyperglycemia, abdominal obesity, and dyslipidemia. Additional references were identified when reading the relevant articles.

History and Tradition

Plant-based diets have long shaped cultures by influencing dietary behaviors, ethics, and environmental sustainability. Understanding these cultural traditions supports respectful, inclusive, and sustainable dietary recommendations [20]. Many cuisines, such as Indian, Mediterranean, Latin American, Asian and African traditionally emphasize plant-based staples including legumes, whole grains, vegetables, herbs, spices [21,22].

The Mediterranean diet, first described by Ancel Keys – features whole and unrefined grains, fruits, colorful vegetables, olive oil, nuts, seeds, low-fat fermented dairy, limited seafood and eggs [108]. Latin American diet centers on fruits, vegetables, unprocessed cereal, whole grains, legumes, and seafood [22,55]. Asian traditions highlight soy, legumes, seasonal vegetables, fermented foods, nuts, and medicinal plants with meat as a minor component. Indian diets emphasize whole grains, seasonal produce, dairy, rice and limited meat [22,109]. African cuisines – shaped by Africa, the Caribbean and Americas - feature beans, grains, root and leafy vegetables, nuts, spices, and modest use of fish or meat [22]. Together, these global cuisines rely on plant-based staples as dietary foundations, with a relatively low contribution of meat. Religious dietary practices also influence health and culture. Understanding such practices helps healthcare providers better care for their patients and deliver culturally sensitive guidance

Table 3: Clinical trials of plant-based diets and the impact on MetS.

Study Purpose	Diet	N	Key Findings	Reference
MetS and dietary patterns in Iranians with impaired glucose tolerance	Diet Patterns: Western, Prudent, Vegetarian, High-fat dairy, and Chicken and Plant	425	MetS prevalence not reported; risks of metabolic syndrome factors assessed for diet patterns. Western pattern was associated with increased risk of MetS, triglycerides, and blood pressure. Prudent pattern was associated with lower HDLs. Vegetarian pattern had a lower risk of abnormal fasting blood glucose levels.	[95]
Development of MetS among South Koreans without MetS or related chronic disease that consumed plant-based diets longitudinally	Plant-based diets evaluated by indices: uPDI, PDI, hPDI, and PVG	5646	2,583 participants developed MetS over 8-year median follow-up. Less-healthy plant diets (according to uPDI) have higher risk of MetS. Adhering to a healthy diet (according to PDI) lowers risk of high fasting glucose. No association was found for MetS and hPDI or PVG.	[96]
Association of plant-based diet composition and MetS among Iranian older adults	Diets evaluated by indices: uPDI, PDI, and hPDI	178	MetS prevalence was 53.4%. No studied index was associated with MetS risk.	[97]
Association of plant-based diet composition and MetS prevalence in South Koreans (KNHANES data)	Plant-based diets evaluated by indices: uPDI, PDI, and hPDI	14,450	MetS prevalence was 23.3%. While healthy (PDI and hPDI) diets did not decrease MetS risk, highest quintile of uPDI was associated with increased risk compared to lowest quintile. Diet-based difference in sexes were observed.	[98]
Association of plant-based diet composition on MetS prevalence and metabolomics in adults in Copenhagen	Diets evaluated by indices: uPDI, PDI, and hPDI	676	MetS prevalence was 10.8%. Top tertile of hPDI was less at risk for MetS than bottom tertile. Top tertile of uPDI was more at risk of MetS than bottom tertile.	[99]
Association of plant-based diet composition and MetS among obese Iranians	Diets evaluated by indices: uPDI, PDI, and hPDI	347	40.82% of participants had MetS. No studied index was associated with MetS risk. Odds of hyperglycemia was associated with uPDI.	[93]
Association of plant-based diet on MetS with adropin, atherogenic index of plasma, and MetS in Iranian adults	Diets evaluated by indices: uPDI, PDI, and hPDI	527	28.7% of participants had MetS. No association was found for MetS and PDI or hPDI. 3rd quartile of uPDI was associated with MetS.	[100]
Development of MetS among Chinese without MetS or related chronic disease that consumed plant-based diets over median follow-up of 5 years (CHNS)	Diets evaluated by indices: uPDI, PDI, and hPDI	10,013	9.61% developed MetS over 5-year median follow-up. Highest quintile of uPDI was associated with abdominal obesity compared to lowest quintile.	[101]
Association of plant-based diet composition on MetS in Iranians (PKCS)	Diets evaluated by indices: uPDI, PDI, and hPDI	2225	Women in highest tertile of hPDI had a lower risk of MetS.	[102]
Association of plant-based diet composition on MetS in Korean adults (KoGES)	LPBD HPBD	58,701	17.9% of men on LPBD, 17.0% of men on HPBD, 13.6% of women on LPBD, and 10.2% of women on HPBD had MetS. Low PBD was positively related to MetS risk.	[103]
MetS risk with dietary patterns in middle-aged Iranians (Shiraz Heart Study)	Diets evaluated by Vegan Western Carbohydrate	1675	MetS rate was 47.2%. Higher adherence to Vegan diet has a lower risk of MetS.	[104]
Cross-sectional associations of three French studies on plant-based diet composition on MetS risk (NutriNet-Santé-Santé, Esteban, and STANISLAS)	Diets evaluated by indices: uPDI and hPDI	16,358 1769 1565	MetS rates were 13.1%, 17.8%, and 24.3%. With adjustments, higher hPDI had lower risk of MetS. Higher uPDI in women had a higher risk of MetS.	[105]
MetS risk with plant-based diets in China (ZJNHS)	Diets evaluated by indices: uPDI, PDI, and hPDI	4695	MetS rate was 23.9%. Highest quintile with uPDI was associated with higher risk of MetS as well as abdominal obesity, increased blood pressure and fasting glucose. These effects of uPDI on MetS was greater in women.	[106]
Cardiovascular-Kidney-Metabolic Risk Factors with diet in individuals with advanced chronic kidney disease	Diets evaluated by healthful plant-based diet score	147	High adherence to healthful plant-based diet resulted in lower obesity/overweight and central obesity, but hypertension, hypertriglyceridemia, and hyperglycemia were not significantly different after model adjustments.	[107]

MetS: Metabolic Syndrome, LOV: Lacto-ovo-vegetarian, OV: Ovo-vegetarian, LV: Lacto-vegetarian, VEG: Vegan, PDI: Overall plant-based diet index, hPDI: Healthful plant-based diet index, uPDI: unhealthful plant-based diet index, PVG: pro-vegetarian diet index, KNHANES: Korean National Health and Nutrition Examination, CHNS: China Health and Nutrition Survey, PKCS: Persian Kavar cohort study, KoGES: Korean Genome and Epidemiology Study, LPBD: Low Plant-Based Diet, HPBD: High Plant-Based Diet.

Note: Many key findings are provided for corrected models with consideration of confounding factors such as age, sex, physical activity, etc.

[110]. The various cultural practices have many similarities to the adopted religious practices, which often limit the intake of certain animal proteins. Additionally, many of these dietary plans result in favorable health outcomes. For example, the Mediterranean diet, though not tied to a specific faith, reflects the shared heritage of Christianity, Judaism, and Islam [111] and yields improved overall health. The Nordic diet improves lipid profiles, blood pressure, and inflammation biomarkers through foods rich in omega-3s, β-carotene and whole grains [112]. Vegetarianism among Hindus and Buddhists is linked to reduced obesity, cardiovascular disease, and T2DM [110]. Finally, Christian fasting traditions, such as Lent, as well as the Daniel Fast model [23] have been shown to enhance metabolic health, insulin sensitivity, and reduce inflammation. Table 4 summarizes the various cultural and religiously motivated diet plans.

Japanese Diet

Japan has the world's longest life expectancy (81.1 years for men and 87.1 years for women), likely influenced by the dietary pattern of the Japanese people [113]. The Japanese diet is characterized by high consumption of rice, miso soup, seaweed, soy products, pickles, green and yellow vegetables, fish, and green tea, with limited intake of red meat [113,123]. In a study of 92,969 adults aged 45-74 years followed for a median of 18.9 years, a higher Japanese Diet Index (JDI8) score was significantly associated with a lower risk for all-cause and CVD mortality [113].

Low energy density foods common in this diet promote satiety, reduce caloric intake, improve lipid profiles, and lower cardiovascular risk [124]. Diets rich in fiber, vegetables and soy protein similarly support lower obesity rates, improved glucose regulation, and reduced risk of MetS [123]. Among Japanese older adults, MetS was linked to lower intake of vitamin B6 and fiber in men, and lower intake of calcium/dairy intake and higher cereal consumption in women [125].

In a 2017 study, 33 middle-aged men who received nutrition education on the Japanese diet showed improvement in at least one cardiovascular risk factor (body weight, LDL cholesterol, and triglycerides) after 6 weeks, with 91% showing overall benefit [126]. These findings suggest that the Japanese diet contains a higher proportion of protective, minimally processed foods for metabolic health [94].

While the above findings are encouraging, we must remember that not all plant-based diets have equal benefits. That is, the focus must be on consumption of unprocessed whole foods if the aim is to improve metabolic health. This may include small quantities of lean animal proteins, such as fish, as found in the Japanese diet. Moving forward, we need to develop more refined dietary assessment tools that can distinguish between healthy and unhealthy plant-based patterns, as many people erroneously believe that if they are consuming a diet devoid of meat, they are eating a healthy diet. While this is true is some cases, it is certainly not ubiquitous. Furthermore, future study of plant-based diets, including the Japanese diet, should explore the long-term sustainability of such plans and the broader cardiovascular outcomes, including effects on inflammation and atherosclerosis.

Mediterranean Diet

This Mediterranean diet may combat MetS components through its high content of fiber, omega-3 and 9 fatty acids, complex carbohydrates, antioxidants, minerals, vitamins, and polyphenols [14]. This dietary pattern emphasizes frequent intake of olive oil, vegetables, fruits, legumes and whole grains; moderate consumption of fish, red wine and dairy; and limited intake of poultry, red meat, and processed meats. These dietary patterns collectively reduce inflammation, improve insulin sensitivity, lower LDL cholesterol, raise HDL cholesterol, and reduce blood pressure [14]. While the Mediterranean diet's role in promoting longevity and preventing cardiovascular disease is well established, few studies have examined its impact on all-cause

Table 4: Variations of diets for purposes of improving health or adherence to cultural or religious practices.

Diet	Description
Japanese	High intake of rice, miso soup, seaweeds, pickles, green and yellow vegetables, fish, and green tea; low intake of beef and pork [113].
Mediterranean	Olive oil, vegetables, fruit, nuts, legumes, and unprocessed cereals. Fish, red wine, dairy in moderation. Poultry, red meat, and processed red meat on a rare basis [14].
Nordic	Fruits, vegetables, berries, legumes, low-fat dairy products, and whole grains are predominant. Fatty fish (salmon, mackerel, and herring) are sources of fat and omega-3 fatty acids. Rapeseed oil is the primary source of healthy fat and there is a reduced intake of red meat, sugar, and processed foods [12].
Seventh Day Adventist	Traditionally, vegan or vegetarian diets may include fruits, vegetables, legumes, nuts, seeds, whole grains, eggs, and low-fat dairy. Pesco-vegetarian and semi-vegetarian diet options include "clean" meats such as fish or poultry [114,115].
Buddhist	Fruits, vegetables, grains, beans, lentils, nuts, seeds, dairy, and soy products. Avoid meat, poultry, fish, and alcohol. Some traditions may also restrict onions, garlic, leeks, shallots, and scallions [116].
Christian Orthodox	Periodic vegetarianism, fasting rituals are practiced during Nativity (40 days before Christmas), Lent (48 days preceding Easter), and the 15 days preceding the Assumption of Mary [117].
Christian Daniel Fast	Strict vegan styles diet that excludes meat, dairy, eggs, processed foods, caffeine, alcohol, refined grains, and added sugars. Ad libitum intake of whole grains, nuts, seeds, fruits, vegetables, healthy oils, beans, and legumes [118,119].
Hindu/Jainism	44% of Hindus report vegetarianism versus 39% restricting intake of animal meat in some way [120]. >4 servings per day of milk/dairy products and >2 servings per day of pulses and legumes [121]. Jains restrict root vegetables, certain fruits, and fermented foods, with rigid rules on food freshness, timing and preparation to minimize harm to living beings [122].

or cardiovascular mortality in individuals with MetS [127]. In a 2020 systematic review of 84 studies, Papadaki et al. found that although the diet did not lower MetS incidence, it significantly improved 18 of 28 associated risk factors compared to control diets [128]—findings that are certainly promising as related to overall health.

There is a plethora of studies on the Mediterranean diet and its impact on metabolic factors; however, limitations to consider include the potential for high fat content which may prove problematic for some, as well as potential nutritional gaps in calcium, vitamin D and vitamin B12, if not consuming food sources rich in these nutrients. While this dietary pattern has multiple benefits and may be followed by many, like other diet plans discussed, improvement in MetS risk factors will only occur if adherence to the dietary plan is maintained over time. Individuals considering the adoption of such a plan need to carefully consider their ability to adhere to the plan long-term. If it appears too stringent or not compatible with their lifestyle, they should consider an alternative plan, so as to not become discouraged at their lack of compliance.

Nordic Diet

The Nordic diet common in Denmark, Sweden and Finland, emphasizes fruits, vegetables, berries, legumes, low-fat dairy, and whole grains while limiting red meat, sugar, and processed foods. Recommended macronutrient distribution is 25-40% fat, 45-60% carbohydrates, and 10-20% protein [129]. Fatty fish (e.g. salmon, mackerel, herring) and rapeseed oil are key sources of fat (including omega-3 fatty acids), and support cardiovascular and metabolic health [12]. Fish consumption is inversely associated with MetS risk [130], and pescatarians show lower obesity rates and reduced hypertension compared with omnivores, though cholesterol benefits may be BMI-dependent [85,87,131]. Pescatarian and semi-vegetarian diets have also been linked to lower diabetes risk [114].

Higher adherence to the Nordic diet among individuals with T2DM has been associated with improved cardiovascular outcomes, including reductions in obesity, LDL cholesterol, and blood pressure. Wozniak et al. also reported lower prevalence of hypertension and hypercholesterolemia among pescatarians compared to omnivores, although the cholesterol benefits were largely explained by BMI differences and became insignificant [131]. Similarly, benefits to hypertension were not observed after BMI adjustment in the Adventist Health Study 2 [85], leaving it unclear as to whether vegetarian or vegan diets confer a greater advantage over that of pescatarian diets. Several interventional trials have further demonstrated the metabolic benefits of the Nordic diet in individuals at risk for MetS [132-134]. A 12-week isocaloric intervention reduced diastolic and mean arterial pressure [135], while an 18–24-week study improved lipid profiles without affecting insulin sensitivity or blood pressure [136,137]. Additional research reported transient lipidomic modifications, including increased antioxidative plasmalogens and reduced ceramides linked to insulin resistance [138]. In a separate 6-week ad libitum intervention, the Nordic diet also improved lipid levels compared with a Western diet in subjects with hypercholesterolemia [134]. Importantly, these cardiometabolic improvements occurred without strict caloric control, demonstrating the public health relevance of culturally familiar dietary patterns that promote health through food quality rather than energy limitation. From a behavioral perspective, the diet's flexibility may enhance long-term adherence. Most recently, a 2022 randomized 24-week trial demonstrated improvements in glucose metabolism, low-grade inflammation, blood lipids, waist circumference, and blood pressure, even in the absence of weight loss [139]. Collectively, these findings support the Nordic diet as a viable and adaptable dietary pattern for improving metabolic health across diverse populations.

Religiously Motivated Plant-Based Diets

Seventh Day Adventists

Adhering to a healthy lifestyle is important to individuals within the Seventh Day Adventist faith. One of the 28 fundamental beliefs states: "Along with adequate exercise and rest, we are to adopt the most healthful diet possible and abstain from the unclean foods identified in the Scriptures." While the exact diet is not detailed within their belief statement, the majority of church members across the world consume a plant-based diet. For example, in 2018, 5% of church members reported following a vegan, 14% vegetarian, 11% pescatarian, and 32% flexitarian (eating one serving of meat or less per week) [140].

Amongst the different Seventh Day Adventist research studies on various aspects of human health and wellbeing, two large health studies (Adventist Health Study 1 and 2) aid in the understanding of how variations in diet amongst their members are associated with various health risks, including MetS. Adventists (>30 years) were found to have lower adjusted prevalence rates for high total cholesterol, LDL cholesterol, obesity, abdominal adiposity, hypertension, cancer risks, and cardiovascular disease in all vegetarian groups compared to non-vegetarians [85,110]. In addition, a lower risk has been noted for T2DM. One potential concern, as found in all plant-based diets compared to omnivorous diets, is that vegetarian diets have been linked to adverse effects on one-carbon metabolism, including reduced levels of vitamin B12 and elevated homocysteine concentrations [141]. However, research does reveal that Adventists who consume fortified foods and supplements rarely show deficiency [142,143].

Buddhist

Contrary to the Western view of vegetarianism as a lifestyle choice adopted in adulthood, vegetarianism in India is a way of life from birth for nearly one-third of the population. Rooted in the religious teachings of Hinduism, Jainism, and Buddhism, it extends beyond *ahimsa* (non-violence) to embody an ethical and mindful approach to eating [89]. The Buddhist diet typically includes fruits, vegetables, grains, legumes, nuts, seeds, dairy, and soy products, while avoiding meat, poultry, fish, and alcohol. Some traditions also restrict pungent foods such as onions and garlic. Much of the literature centers on Buddhist monks, whose meals are often high in carbohydrates and low in protein, and are donated by lay devotees during morning alms rounds [116,144]. Among Thai monks, MetS prevalence ranges from 13% to 20.8% [116], which is much lower than what is observed in typical society and by those adhering to a traditional dietary plan. Physical activity is limited to walking meditation, alms rounds, and temple cleaning [116,144]. As noted elsewhere throughout this paper, a well-planned vegetarian diet can lower the risk of MetS and its components. Tibetan Buddhists, for example, exhibit a 38% lower prevalence of hypertension compared with non-Buddhists [145]. Similarly, the Tzu Chi Health Study found lower ischemic and hemorrhagic stroke risk among vegetarian Tzu Chi commissioners compared to omnivores [146]. Overall, Buddhist vegetarians show reduced diabetes risk, improved metabolic profiles, and less central adiposity and insulin resistance than omnivores [147]. However, potential drawbacks include low protein intake and muscle loss in monks (in particular in those practicing time-restricted eating), and vitamin B12 deficiency among strict vegetarians, which may impair muscular, cardiovascular, and neurological health if unaddressed [146,147].

Christian Orthodox

Normal diet restrictions vary for Orthodox Christians depending on the day of the week and the time of the year. Generally, adherents refrain from meat, fish, eggs, milk, dairy products and olive oil every Wednesday and Friday, as well as during fasting periods such as Nativity, Lent, and Assumption of Mary [117]. Potential benefits related to MetS from this diet may include those observed with periodic fasting, as well as semi-vegetarian diets with decreased meat consumption. These periods of energy restriction and partial vegetarianism promote a diet rich in fruits, vegetables, legumes, and whole grains, with a limited intake of animal fats and processed foods. These patterns may favorably influence metabolic health by lowering caloric and saturated fat intake, improving insulin concentrations, and enhancing lipid metabolism – mechanisms also observed in intermittent fasting and Mediterranean dietary models [148,149].

In a study from Thessaloniki, Greece, long-term Orthodox fasters (>12 years) reported lower consumption of red and processed meats and fried foods, and higher intake of seafood, soy products, and plant-based foods compared to non-fasters [148]. While this study had limitations, it found no direct association between fasting and MetS prevalence. The observed dietary pattern reflects established cardioprotective behaviors. Other investigations have shown reductions in total and LDL cholesterol and fasting glucose during fasting periods, with only partial rebound afterwards, suggesting cumulative metabolic benefits [148]. A 2021 review concluded that Orthodox fasting shares key components with the Mediterranean diet, and when combined with physical activity, may decrease overall MetS scores [149]. Variations in adherence, food customs and lifestyle factors such as avoiding alcohol likely mediate these effects.

Collectively, Christian Orthodox fasting represents a culturally embedded model of intermittent, plant forward eating that aligns with evidence-based strategies for MetS prevention and management [149]. Similarly, other faith-based dietary patterns demonstrate how religiously motivated food practices can influence metabolic risk through recurring periods of restriction, food selection, and lifestyle behaviors. Together, these studies underscore the potential of culturally rooted dietary practices to serve as preventative strategies against MetS and related chronic conditions. They also emphasize the importance of integrating culturally sensitive approaches into public health nutrition interventions and the call for further longitudinal research to explore the long-term health impacts of religious fasting models.

Daniel Fast

The Daniel Fast (DF), a biblically inspired (Daniel 1:8-20), plant-based and purified dietary pattern, has been shown to improve various markers of metabolic health. Traditionally lasting 21 days, although shorter and longer periods have been observed [150], the DF is a strict vegan diet that excludes meat, dairy, eggs, processed foods, caffeine, alcohol, refined grains, added sugars, flavorings, and dyes. It allows ad libitum intake of whole grains, nuts, seeds, fruits, vegetables, healthy oils, beans, and legumes [118,119], without restriction on when food can be consumed—which enhances long-term compliance to the plan.

Trepanowski and Bloomer highlighted the overall benefits of the DF in a review on religiously motivated fasting plans [150]. From research on the risk of MetS with vegan and vegetarian diets compared to omnivore diets, it would be expected that the DF diet would also provide some protection against metabolic risk factors. The clinical studies certainly support this, using both the traditional strict vegan approach, as well as the modified version which allows for small amounts of animal protein (3 to 4 ounces) and skim milk (8 ounces) [23,119]. Additionally, the modified version demonstrates higher adherence, suggesting that it may be a more realistic long-term dietary strategy for some individuals.

Comparative studies in both animals [151-153] and humans [119,154] further support the DF's health benefits with improvements to metabolic risk factors noted. In a human study, the DF diet resulted in a 33% drop in fasting blood insulin, and SBP declined by approximately 7 mmHg. The traditional DF also led to a 20% reduction in total and LDL cholesterol, compared to a 10% reduction in the modified DF group [154]. In a 6-month trial, both traditional and modified DF participants experienced 5 to 8% reductions in body mass, even under ad libitum feeding conditions [119].

The Daniel Fast's nutrient dense, high fiber composition supports reductions in blood pressure, body weight, and serum lipids, likely through a combination of lowering saturated fat and cholesterol intake while significantly elevating the intake of dietary fiber. However, the exclusion of animal products and fortified foods may compromise the intake of key nutrients such as vitamin B12, iron, zinc, calcium, vitamin D, and long chain omega-3 fatty acids, potentially being of concern over time. The inclusion of select dietary supplements, as considered in any plant-based dietary program, may be useful.

Hindu/Jainism

According to a 2021 Pew Research Center survey, 44% of Hindus in India identify as vegetarian and 39% limit animal meat intake, compared to 92% Jains [120]. In a study among Indian immigrants in the United States, nearly half reported lifelong vegetarianism; however, obesity and heart disease prevalence was similar to that of non-vegetarians and diabetes prevalence was higher. This pattern, termed "contaminated vegetarianism", reflects the high consumption of unhealthy foods and limited intake of fruits, vegetables, and protective nutrients [155,156] that can be found in some plant-based diets.

A study of 205 patients with MetS in Eastern India found that low fruit and vegetable intake, high meat consumption, and low physical activity were significantly associated with metabolic risk factors [121]. Conversely, consuming over 4 daily servings of dairy and 2 servings of pulses or legumes was protective against hypertension, while higher carbohydrate, saturated fat, and sodium intake correlated with increased risk.

In contrast, Jain dietary rules are more restrictive than Hindu practices. Jains avoid all animal products that include meat, fish, eggs, and honey. They also avoid root vegetables, fungi, yeast and fermented foods, and often limit foods with many seeds. While many consume dairy, an increasing number adopt veganism due to ethical concerns. Both religions promote vegetarianism, though Jainism emphasizes stricter principles of food purity, mindful preparation, and minimizing harm to living things [122]. As mentioned previously, poorly planned vegetarian diets may result in deficiencies in vitamin B12, iron, zinc, omega-3 fatty acids, and vitamin D, highlighting the need for targeted nutritional interventions, supplementation, or fortification strategies, particularly among populations with high rates of vegetarian adherence such as Hindus and Jains [155,156].

Religious practices unrelated to plant-based diets

While this section has focused on plant-based religious practices, other religious lifestyle practices such as fasting, physical activity, and meditation may also prevent MetS. For example, during Ramadan, Muslims practice time restricted feeding and often experience reductions in body weight, body fat, LDL, and total cholesterol [118,157], especially when meals emphasize nutrient dense foods like whole grains, cereals, legumes, fruits, vegetables eggs and limited meat and dairy [158,159]. However, consuming calorie dense, high fat and refined carbohydrate foods during non-fasting times can lead to weight gain, as shown in a cross-sectional study of 173 Saudi families who reported weight gain during Ramadan [158,160]. Similarly, fasting practices among Orthodox Christians may reduce risk of MetS. In one study, 23 overweight adults fasting during Holy Week demonstrated a decrease in body weight, waist circumference, waist-to-hip ratio, BMI, total body fat, as well as blood glucose, total cholesterol, and LDL cholesterol, although blood glucose and total and LDL cholesterol levels returned to pre-fasting levels after fasting cessation [117].

Yoga and meditation, rooted in Hinduism, Buddhism, and Jainism, have also shown benefits for MetS. A 2023 study of 84 climacteric women found a significant lower frequency of MetS after 24 weeks of yoga practice compared to controls [161]. In another 12-week yoga-based lifestyle intervention, oxidative stress was impacted with this plan more than a dietary intervention alone [162]. Meditation serves as a reliable stress-reduction strategy with neurological effects [163]. For obesity related aspects of MetS, it can meditation can promote mindful eating. In a study comparing mindfulness meditation training (MMT) with health training (HT), only the MMT group reported a reduction in food cravings, stress- and emotional-eating, and MRI findings suggested it may be able to counteract obesity-related neuronal activation patterns [164-167].

Conclusion

Metabolic syndrome (MetS), formerly known as Syndrome X, encompasses interrelated chronic conditions including hypertension, insulin resistance, hyperglycemia, abdominal obesity, and dyslipidemia. Plant-based diets, rich in fruits, vegetables, whole grains, legumes, nuts, and healthy oils offer a nutrient-dense strategy for improving or reducing MetS risk. Other preventive strategies include weight loss, regular physical activity, and dietary modification.

MetS prevalence is highest among African American and Hispanic populations, followed by Europeans, East Asians, South Asians, and Indigenous groups. Plant-based dietary patterns, influenced by cultural, ethical, and environmental factors, are associated with lower body weight, central adiposity, cholesterol, blood pressure, and blood glucose. The global rise in obesity linked to hypertension, diabetes, hypertriglyceridemia, and dyslipidemia disproportionately affects those with lower educational and socioeconomic status.

While plant-based diets vary, often permitting limited animal protein or dairy, adherence is guided by personal and cultural preferences, as well as an individual's religion. The Daniel Fast (DF) provides a spiritually rooted, evidence-based model consistent with DASH and Mediterranean patterns, and has been reported to lower blood lipids, blood pressure, body weight, inflammation, and insulin, while improving oxidative stress status. Modified DF versions that include small portions of meat or dairy may enhance long-term compliance. Similarly, adherence to other religiously motivated dietary plans appear helpful, as do approaches such as intermittent fasting/time-restricted feeding. Finally, the DASH and Mediterranean diets have demonstrated metabolic benefits.

Ultimately, metabolic health depends less on strict plant-based adherence and more on distinguishing between healthy from unhealthy dietary patterns, particularly regarding the elimination of processed food intake and consumption of a nutrient dense diet on most, if not all, days of the week. Religious and cultural dietary practices emphasizing whole foods, fasting, and lifestyle elements such as meditation and physical activity may further protect against MetS. Understanding long-term compliance and motivation remains critical for sustaining dietary benefits.

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