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Review article
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Health Benefits of Vegetarian and Mediterranean Diets: Narrative Review

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Diet is an important lifestyle factor influencing disease risk. Vegetarian and Mediterranean diets have their proponents and are promoted for various potential health benefits. Over the years, numerous cross-sectional and cohort studies and randomized clinical trials have been conducted to elucidate the relationship between the Mediterranean and vegetarian diet and cardiovascular, cancer, diabetes, and other disease risks. More recently, research has been conducted to compare both diets directly. In this narrative review, we discuss the effects of vegetarian and Mediterranean diets on lipid profile, blood pressure, inflammation markers, body weight, risk of cardiovascular disease, cancer, diabetes mellitus, metabolic syndrome, and chronic kidney disease, as well as their associations with gut microbiota and mental health. The paper also discusses the studies comparing vegetarian and Mediterranean diets and their health effects. It provides further evidence that both diets can be beneficial and advocates their promotion, especially in Westernized populations plagued by various chronic lifestyle-associated diseases. At the same time, the Mediterranean dietary model may appear to be a superior public health strategy, less prone to the risk of nutritional deficiencies and less challenging in implantation on a broader scale. However, further studies based on cross-over design and long-term observations are recommended to thoroughly compare vegetarian and Mediterranean diets and draw more firm conclusions on their effects on health.

INTRODUCTION

Diet, among other lifestyle factors, is known to significantly influence disease risk, including cancer, metabolic disorders, and cardiovascular diseases. The awareness of this association leads to a growing interest in diets that offer specific health benefits. However, these benefits require scientific evaluation not only in observational research but also through clinical trials. The latter study design is considered the gold standard for evaluating particular treatments, including dietary interventions, and can provide a causal relationship between diet, health benefits, and disease risk in humans [Lucey *et al.*, 2016; Mirmiran *et al.*, 2021; Staudacher *et al.*, 2022; Yao *et al.*, 2013]. The number of such studies in recent years is growing, enabling meta-analyses and comparing different diet interventions [Ge *et al.*, 2020]. However, similarly to the comparisons of the efficacy of various vaccines or other medical treatments, a direct comparison of health benefits related to particular diets should be made upon analyzing randomized controlled clinical trials involving the same group of volunteers. The number of such studies is still limited, although systematically increasing in recent years [Burrows *et al.*, 2022; Mellor *et al.*, 2022; Watson *et al.*, 2015, 2018].

Particular attention is given to the health benefits of Mediterranean and vegetarian diets, which show some similarities but also distinctive differences (Table 1). The former dietary pattern is predominantly characterized by the consumption of plant-derived foods such as fruits, vegetables, beans, cereals, nuts, and seeds, with olive oil used as a primary source of fat, moderate amounts of dairy foodstuffs, principally cheese and yogurt, moderate consumption of fish and seafood, and low consumption of meat, with avoidance or notably low intake of red meat [Davis *et al.*, 2015].

Traditionally embraced by the populations of Greece, Italy and Spain, the Mediterranean diet pattern has also been promoted outside the Mediterranean region in the hope that it may benefit Westernized populations plagued by various chronic diseases, many of which are associated with lifestyle factors, including diets [Sotos-Prieto *et al.*, 2022]. Despite these efforts, adherence to the Mediterranean diet in non-Mediterranean countries remains low [da Silva *et al.*, 2009]. Moreover, recent studies show that adherence to this diet in the Mediterranean region is only moderate and has decreased

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TABLE 1. Comparison of main characteristics of the vegetarian and Mediterranean diets.

	Vegetarian diet	Mediterranean diet
Main protein sources	Legumes, nuts; in some variations: fish, seafood, eggs, dairy	Legumes, nuts, fish, seafood, poultry, dairy
Typical protein intake	70 g/day (lacto-ovo-vegetarians) 64 g/day (vegans) [Mariotti & Gardner, 2019]	70 g/day [Tosti *et al.*, 2018]
Main carbohydrates sources	Cereals, fruits, vegetables, sweets	Cereals, fruits, vegetables, sweets
Main fat sources	Vegetable oils, nuts	Olive oil, nuts
Excluded products	Meat (and all animal-derived products in case of a vegan diet)	–
Methods of thermal processing	All; preferably raw fruits and vegetables	Avoidance of frying; preferably raw fruits and vegetables
Health risks	Calcium, iron, vitamin D_3, and B_{12} deficiencies	–
Distinguishing features	No meat consumption	Focusing on local products; olive oil as the main source of fat

over the decades [Obeid *et al.*, 2022; Veronese *et al.*, 2020]. Contrary to this, the interest in vegetarian diets appears to increase in high-income countries, as reflected by increasing interest in sales of plant-based alternatives to animal-derived products [Choudhury *et al.*, 2020; Paslakis *et al.*, 2020]. It is estimated that approximately 5% of Europeans may adopt vegetarian diets, compared to 8% of South Americans, over 15% of African and Middle East populations, and nearly 20% of Asians [Hargreaves *et al.*, 2021].

On the other hand, India, often perceived as a household with the largest population of vegetarians (estimated at 30–40% of the population), is currently experiencing the highest growth rates for meat consumption in the world [Arora *et al.*, 2020; Shridhar *et al.*, 2014]. Vegetarianism is characterized by total abstention from consuming meat. There are different variations of this diet that include eggs (ovo-vegetarianism), dairy (lacto--vegetarianism), or both (lacto-ovo-vegetarianism), or exclude them and any other animal-derived products, *e.g.*, honey (veganism) [Fontes *et al.*, 2022]. A diet such as flexitarianism, which limits but does not entirely exclude meat, is regarded as semi-vegetarianism. In addition, some individuals adhere to pesco-vegetarianism, which excludes all meats except fish [Wozniak *et al.*, 2020]. Although the motivations for transitioning to vegetarianism can be ethically- and environmentally driven, some individuals choose this dietary pattern for health-associated reasons [Dinu *et al.*, 2017; Rosenfeld, 2019; Rosenfeld & Burrow, 2017]. However, ceasing meat consumption or switching to a diet low in meat appears to be a challenge for many people [Macdiarmid *et al.*, 2016; O'Keefe *et al.*, 2016; Tucker, 2014].

Considering that vegetarian and Mediterranean diets both focus on plant-based foods but take a different approach regarding meat products, it is pivotal to understand their effects, separately and jointly, on health outcomes. It is particularly important given that both diets are gaining attention in some regions and populations, leading to public discussion on the superiority of one diet over another. Considering the discussion on dietary interventions as a non-pharmaceutical approach to decrease the risk of disease, summarizing the health benefits of both diets and comparing them may be beneficial for dieticians who work in the promotion of diets in various risk groups.

The objective of this narrative review was to present existing evidence on the potential associations between the Mediterranean and vegetarian diets and human health and to preliminary compare these diets. To this end, we have searched PubMed and Google Scholar databases using the following keywords: "Mediterranean diet", "vegetarian diet", "vegan diet", "plant-based diet", and "health". Peer-reviewed papers related to the search terms were assessed by titles, abstracts, and article content. We have preferentially selected meta-analyses and systematic reviews, if available. If not, other types of papers (observational and interventional studies) were included. Only English-language articles published between 2012–2022 were chosen to elicit the latest trends. The selected papers were categorized to construct subsequent review sections discussing the established effects of each diet on the lipid profile, blood pressure, inflammation markers, overall cardiovascular risk, as well as the risk of cancer, diabetes mellitus, metabolic syndrome, and chronic kidney disease, and associations with gut microbiome and mental health. We have included these effects and health conditions as they are the most studied in relation to diet. At the same time, they pose significant challenges to public health, with a need to seek non-pharmaceutical interventions that could decrease the associated morbidity and mortality. Separately, we have also selected the available studies designed to compare both diets regarding cardiovascular parameters, kidney function, metabolic profile, gut microbiome, and pain in rheumatoid arthritis. The exact metabolic and molecular mechanisms of how these two diets can affect different aspects of human health are not fully elucidated and remain subject to study (*e.g.*, see [Allen & Locasale, 2021; Tosti *et al.*, 2018] for reviews on this matter). Based on the conducted review, the present paper provides a base for promoting Mediterranean and vegetarian diets in different populations and groups of patients to benefit their health.

VEGETARIAN DIET AND HUMAN HEALTH

Vegetarian diet and lipid profile

The relationship between a vegetarian diet and lipid management has not been fully elucidated. Two meta-analyses

[Wang *et al.*, 2015; Yokoyama *et al.*, 2017] demonstrated the overall effect of a vegetarian diet on lowering the level of total cholesterol, low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol and revealed no association with triglyceride levels. One of the meta-analyses involved 11 trials and a total of 832 participants from 28 to 56 years of age [Wang *et al.*, 2015]. The duration of the vegan, lacto-ovo-vegetarian, or lacto-vegetarian diet intervention ranged from 3 weeks to 18 months. Five studies involved participants with higher cardiovascular risk factors, such as obesity or type 2 diabetes. In three studies, participants were also in lipid-lowering therapy, which may have interfered with the results. Using omnivorous diets as comparators, vegetarian diets resulted in significant reductions in total cholesterol (–0.36 mmol/L), LDL cholesterol (–0.34 mmol/L), and HDL cholesterol (–0.1 mmol/L). However, there was no meaningful change in triglyceride levels (–0.04 mmol/L) [Wang *et al.*, 2015].

The second meta-analysis involved 49 studies (lasting more than 4 weeks) conducted on a total of 11,627 participants from 21 to 72 years of age [Yokoyama *et al.*, 2017]. Compared to omnivorous diet, the 30 observational studies and 19 clinical trials of vegetarians revealed reductions in total cholesterol concentration by 29.2 mg/dL and 12.5 mg/dL respectively, LDL cholesterol by 22.9 mg/dL and 12.2 mg/dL, and HDL cholesterol by 3.6 mg/dL and 3.4 mg/dL. In contrast, no significant effect of vegetarianism on triglyceride levels was observed [Yokoyama *et al.*, 2017]. The significant reduction in total serum concentrations of cholesterol and LDL cholesterol (–28.2 and –21.3 mg/dL, respectively, in vegetarians and vegans compared to omnivores was also demonstrated by the meta-analysis of 86 cross-sectional trials. A vegan diet was also associated with lowered levels of total cholesterol and LDL cholesterol, *i.e.*, –31.0 mg/dL and –22.9 mg/dL, respectively [Dinu *et al.*, 2017]. In contrast to Wang *et al.* [2015], the lowered concentrations of triglycerides in individuals adhering to a vegetarian but not vegan diet amounted to –11.4 mg/dL as compared to omnivores.

Another meta-analysis of 12 cross-sectional and cohort studies (1,300 participants) found that vegetarian diets followed for at least six months in four developing countries effectively reduced plasma triglyceride concentrations (standardized mean difference, SMD=–4.06 mmol/L). In contrast, vegetarians in eight developed countries showed a slight decrease in triglyceride levels (–0.31 mmol/L) compared to omnivores [Zhang *et al.*, 2013]. Contrary to the 2015 and 2017 publications, the 2014 meta-analysis, including 12 observational studies, demonstrated no difference in HDL cholesterol levels between vegetarians and omnivores (SMD=0.02 mmol/L) [Zhang *et al.*, 2014]. Lacto-ovo-vegetarianism, lacto-vegetarianism, and ovo-vegetarianism were the dietary models examined. The participants (n=4177, age group 30–52 years; 2,191 vegetarians, 1,986 omnivores) had no family history of vascular diseases (such as myocardial and cerebrovascular infarction, angina pectoris, and others), hyperlipoproteinemia, dyslipidemia, and other related diseases. There appeared to be no change in HDL cholesterol levels among vegetarians and omnivores even after the cultural conditions were considered (Asia, Latin and North America, and Europe). The authors of the meta-analysis indicated that information on blood pressure, weight, insulin, or diabetes could not be obtained for all studies, which limited any further analysis [Zhang *et al.*, 2014].

In general, the studies show the beneficial effect of vegetarian diets, including vegan, on lipid profiles encompassing mostly total cholesterol and LDL cholesterol levels. To some extent, the reduction in triglyceride concentrations was also found, but the findings in this regard are inconclusive and require further studies. Nevertheless, lipid profile is helpful in the determination of approximate cardiovascular risk, and its impairment is often seen in obesity. Interventional studies are required to understand the extent to which a vegetarian diet can lower the lipid profile in already diseased patients.

Vegetarian diet and blood pressure

Two meta-analyses have confirmed the beneficial hypotensive properties of vegetarian diets. The first, published in 2014, included 39 publications [Yokoyama *et al.*, 2014]. In six studies, a proportion of the participants were using antihypertensive medication; in twenty-two, the vegetarian dietary model was followed for more than one year. Seven of the works examined the impact of veganism, three focused on lacto-vegetarianism, fourteen on lacto-ovo-vegetarianism, and fifteen examined the diverse types (veganism, lacto-vegetarianism, lacto-ovo-vegetarianism, pesco-vegetarianism, and/or semi vegetarianism). The analysis of 7 controlled clinical trials (311 subjects aged 38–54), with a duration of six weeks or more, revealed that in comparison with a traditional diet, vegetarian diet consumption was associated with a decrease in mean systolic blood pressure by 4.8 mmHg (–6.6 to –3.1 mmHg) and diastolic blood pressure by 2.2 mmHg (–3.5 to –1.0 mmHg). The analysis of 32 observational studies (21604 participants aged 28 to 68 years) indicated that compared to an omnivorous diet, mean systolic blood pressure in individuals on a vegetarian diet decreased by 6.9 mmHg (–9.1 to –4.7 mmHg) and diastolic blood pressure decreased by 4.7 mmHg (–6.3 to –3.1 mmHg) [Yokoyama *et al.*, 2014].

The second meta-analysis, published six years later, including 15 randomized controlled trials with intervention periods ranging from 3 to 74 weeks, examined veganism (10 publications) and lacto-ovo vegetarianism (5 papers) [Lee *et al.*, 2020]. Adults were the participants in fourteen papers, and one paper involved children. Eight studies focused on diabetics, and seven on non-diabetics. Compared with an omnivorous diet, vegetarian diet consumption lowered systolic blood pressure by an average of 2.66 mmHg (–3.76 to –1.55) and diastolic blood pressure by 1.69 mmHg (–2.97 to –0.41). Subgroup analysis indicated that veganism reduced systolic blood pressure (–3.12 mmHg) more than lacto-ovo vegetarianism (–1.75 mmHg). A decrease in diastolic blood pressure was observed with the former diet (–1.92 mmHg), while no change was demonstrated for the latter. The authors reported the substantial heterogeneity of the studies used and noted that most were conducted in the USA. Despite the limitations, both meta-analyses suggest that vegetarian diets (mainly vegan diets) [Lee *et al.*, 2020] may be an effective non-pharmacological strategy to lower blood pressure [Lee *et al.*, 2020; Yokoyama *et al.*, 2014].

Vegetarian diet and body weight

The meta-analysis on the impact of a vegetarian diet on weight loss confirms its effectiveness in this regard [Huang *et al.*, 2016]. It included 12 randomized controlled trials involving 1,151 subjects from 18 to 82 years and examined the impact of a vegan diet (in 8 studies) and a lacto-ovo-vegetarian diet (in 4 studies). Obese or overweight participants were monitored for 8 weeks to 2 years. Subjects on vegetarian diets had significantly greater weight loss (2.02 kg on average) than those from the non-vegetarian groups. Compliance with the vegan diet resulted in more significant weight loss (–2.52 kg) than with the lacto-ovo vegetarian diet (–1.47 kg). Furthermore, weight loss was greater in subjects with <1 year of intervention (–2.05 kg) than in those with ≥1 year of intervention (–1.13 kg) [Huang *et al.*, 2016]. This indicates the beneficial effect of a vegetarian diet on weight reduction compared to non-vegetarian dietary practices. However, the attenuation observed after one year of adherence to a vegetarian diet requires further elucidation in future research and postulates a need to pursue more long-term studies.

Vegetarian diet and inflammation biomarkers

Three meta-analyses examining the effect of a vegetarian diet on inflammatory biomarkers confirm its key role in improving C-reactive protein (CRP) levels, whereas one of the analyses indicated a 2-year minimum intervention time [Craddock *et al.*, 2019; Haghighatdoost *et al.*, 2017; Menzel *et al.*, 2020]. The meta-analysis of 30 (cross-sectional or cohort) observational studies aimed to determine the association between vegetarianism and inflammatory and immunological markers (CRP, tumor necrosis factor α, fibrinogen, natural killer (NK) cells, leukocytes, lymphocytes, thrombocytes, interleukins, and immunoglobulins) [Craddock *et al.*, 2019]. The dietary models evaluated with an intervention period of 4 to 54 weeks involved lacto-ovo-vegetarianism (8 publications), lacto-vegetarianism (2), veganism (5), and a combination thereof. Participants included in two studies had chronic diseases: in one, patients were on dialysis; in the other, patients had cardiovascular disease and/or diabetes. Research on adult volunteers, with the exception of 1 study involving 2- to 18-year-old individuals, was conducted in Asia, Africa, North and South America, and Europe. As indicated, in comparison with the participants adhering to non-vegetarian dietary patterns, individuals on a vegetarian diet had lower levels of CRP (–0.61 mg/L), fibrinogen (–0.22 g/L), and a lower total leukocyte count ($-0.62\times10^3/\mu$L), thus suggesting a beneficial impact of vegetarianism on inflammation biomarkers [Craddock *et al.*, 2019].

These conclusions contradict the results of a meta-analysis published two years earlier, which reported no differences in high-sensitivity CRP levels while maintaining a vegetarian and non-vegetarian diet for less than two years. In addition, when compared to an omnivorous diet, vegetarianism was associated with increased levels of interleukin-6 (0.21 pg/mL), which has a dual role: proinflammatory as cytokine and anti-inflammatory as myokine [Haghighatdoost *et al.*, 2017]. As explained by Craddock *et al.* [2019], this is due to the inclusion of research on individuals treated with statins (reducing inflammation), which significantly altered the results. Moreover, the papers where participants consumed lesser amounts of meat in vegetarian groups, or the diet was not sufficiently described were also included in the meta-analysis conducted by Haghighatdoost *et al.* [2017]. Another meta-analysis (21 cross-sectional studies) evaluating the association of veganism and vegetarianism with biomarkers of inflammation was published in 2020 [Menzel *et al.*, 2020]. The vegan diet adoption ranged from 1 year to 20 years and the vegetarian diet from 1 year to 25 years. Most studies (12) were conducted in Asia, followed by Europe (6) and South America (3). The research focused on the following biomarkers: CRP, tumor necrosis factor α, interleukin-6, interleukin-18, interleukin-1 receptor antagonist, selectin E, intercellular adhesion molecule, monocyte chemoattractant protein-1, adiponectin, omentin-1, and resistin. The meta-analysis indicated that veganism, compared to an omnivorous diet, reduced CRP levels (mean difference, MD=–0.54 mg/dL) more than vegetarianism (–0.25 mg/dL). It was observed that the association between the vegetarian pattern and CRP was significantly stronger in patients with renal impairment (–3.91 mg/L). However, no significant changes were observed for the other inflammatory biomarkers [Menzel *et al.*, 2020].

Considering that inflammatory biomarkers, such as CRP, are associated with the pathogenicity of chronic diseases, such as type 2 diabetes and cardiovascular diseases, further investigations, including dietary interventional studies, are required to understand the effect of vegetarianism on reducing inflammation in specific groups of patients.

Vegetarian diet and cardiovascular disease

The impact of a vegetarian diet on cardiovascular disease (CVD) risk and mortality has been repeatedly examined [Matsumoto *et al.*, 2019; Pawlak, 2015; Petermann-Rocha *et al.*, 2021; Vahid *et al.*, 2022]. According to the analysis of 10 prospective cohort studies, the risk of ischemic heart disease morbidity and/or mortality in participants on a plant-based diet was reduced by 25%, although not for all cerebrovascular and cardiovascular diseases [Dinu *et al.*, 2017].

In 2021, two meta-analyses examining the impact of vegetarianism on CVD prevalence proved the key role of consumed plant-based food quality [Gan *et al.*, 2021; Quek *et al.*, 2021]. One analysis included 10 studies (9 cohorts) and a total of 698,707 participants, including 137,968 individuals with CVD, 41,162 with coronary heart disease (CHD), and 13,370 with stroke [Gan *et al.*, 2021]. As revealed, the strictest adherence to vegetarian diets (as measured by the plant-based diet index, PDI) remained associated with a lower risk of CVD (relative risk, RR=0.84) and CHD (RR=0.88), although not with stroke (RR=0.87). Similarily, the meta-analysis of seven prospective cohort studies, encompassing 29,705 individuals adhering to a vegetarian diet, did not find an association with the risk of stroke compared to non-vegetarians [Lu *et al.*, 2021].

It has also been reported that eating an unhealthy plant-based diet (rich in refined grains, sweets, and sweetened beverages) may increase CVD risk (RR=1.13) [Gan *et al.*, 2021]. The second meta-analysis included thirteen prospective cohort studies (410,085 participants; 78,671 vegans and vegetarians) and demonstrated that greater compliance with

a vegetarian diet appeared to be significantly associated with a lower risk of CVD morbidity (RR=0.90) and cardiovascular mortality (RR=0.92) [Quek *et al.*, 2021]. Unhealthy plant-based diets (by PDI) increased the risk of cardiovascular mortality (RR=1.05) but did not affect the volume of CVD morbidity. A healthy vegetarian diet was associated with reduced CVD incidence (RR=0.87), although no association with mortality was demonstrated. Overall, vegetarians, compared with individuals following an omnivorous dietary pattern, had a significantly lower prevalence of CVD (RR=0.81) but with similar mortality rates from CVD [Quek *et al.*, 2021].

The above-reviewed data confirm that a vegetarian diet may decrease cardiovascular risk; however, the quality of the plant-based products consumed is essential. It is also crucial for individuals adhering to vegetarian diets to improve their intake of B_{12} vitamin since its deficiency has been associated with elevated plasma levels of homocysteine, an independent risk factor for CVD [Feng *et al.*, 2020; Meleady & Graham, 1999; Obersby *et al.*, 2013]. Such deficiency can be prevented by supplementation of B_{12} vitamin or increased consumption of B_{12}-fortified foods [Damayanti *et al.*, 2018].

Vegetarian diet and cancer risk

The results of three meta-analyses focused on assessing the impact of a vegetarian diet on cancer risk are inconclusive. The first analysis included seven papers in which lacto-ovo-vegetarianism or veganism was the considered dietary model [Huang *et al.*, 2012]. A total of more than 124,000 participants from 10 to 90 years of age were under observation for 10 to 23 years. It has been reported that vegetarians had an 18% lower cancer morbidity than non-vegetarians [Huang *et al.*, 2012]. The subsequent meta-analysis also demonstrated a positive impact of the discussed diet on cancer risk. It included 86 cross-sectional surveys and 10 prospective cohort trials [Dinu *et al.*, 2017]. The analysis revealed a significant decrease in cancer risk compared to an omnivorous diet. Compliance with a vegetarian diet resulted in an 8% reduced risk and a 15% reduced risk with a vegan diet. However, no significant association was demonstrated for specific cancer types [Dinu *et al.*, 2017]. Likewise, in a study focusing on breast, colorectal, and prostate cancers, vegetarian diets had no significant impact on reducing the risk of the variations mentioned above of oncological diseases compared to a non-vegetarian diet [Godos *et al.*, 2017]. This meta-analysis included nine studies conducted on six cohorts. Among approximately 687,000 participants, there were 3,441 cases of breast cancer, 4,062 cases of colorectal cancer, and 1,935 cases of prostate cancer. However, during the analysis, a lower risk of colorectal cancer was noted with semi-vegetarian (–14%) and pesco-vegetarian (–33%) diets compared to a non-vegetarian pattern [Godos *et al.*, 2017].

Although there is evidence that vegetarian diets may beneficially impact cancer risk, further studies, including long-term observations, are required to understand their association with specific cancer types.

Vegetarian diet and type 2 diabetes mellitus risk

A meta-analysis of two cohort studies and twelve cross-sectional studies on the impact of a vegetarian diet on type 2 diabetes risk was published in 2017 [Lee & Park, 2017]. The combined odds ratio for diabetes in vegetarians *vs*. nonvegetarians was 0.726. Subgroup analyses suggested vegetarians were less likely to suffer from diabetes than omnivores. It has been estimated that individuals on a vegetarian diet were 27% less likely to develop diabetes than those on a traditional diet. Compared to four studies conducted in Southeast Asia, lower risks were observed in three studies conducted in the Western Pacific region and seven in Europe and North America. The meta-analysis suggests that a vegetarian diet may protect against diabetes by, among other things, increasing insulin sensitivity (especially in vegans) and lowering intramuscular lipid levels, which affect insulin resistance. The authors confirm the need for further research on the type of vegetarianism and diet duration in relation to diabetes risk [Lee & Park, 2017].

Moreover, numerous research papers have confirmed the beneficial influence of vegetarianism on individuals with diabetes. In the meta-analysis involving nine clinical trials (a total of 664 subjects), an association has been observed between vegetarian diet consumption (for at least three weeks) and glycemic control, along with other cardiometabolic risk factors [Viguiliouk *et al.*, 2019]. As demonstrated, this diet significantly reduced HbA1c (MD=–0.29%), fasting blood glucose (MD=–0.56 mmol/L), LDL cholesterol (MD=–0.12 mmol/L), non-HDL cholesterol (MD=–0.13 mmol/L), body weight (MD=–2.15 kg), body mass index (BMI) (MD=–0.74 kg/m^2), and waist circumference (MD=–2.86 cm) [Viguiliouk *et al.*, 2019]. The last three parameters were also analyzed in the 2021 meta-analysis of seven studies that examined the impact of plant-based diets on body weight in adults with type 2 diabetes and compared it to a regular meat diet [Austin *et al.*, 2021]. Studies included a vegan diet and one considered a lacto-vegetarian diet. Body weight, BMI, and waist circumference were measured in a total of 353 participants. Significant reductions in average differences in body weight, BMI, and waist circumference were found for plant-based diets *vs*. regular meat diet. Plant-based diet adoption by individuals with type 2 diabetes resulted in a 5.1% reduction in average body weight, a 5.4% reduction in BMI, and a 4.3% reduction in waist circumference. Dietary interventions without restricting energy intake also resulted in a significant reduction in body weight. Regardless of caloric content, plant-based diets have proved to be effective in reducing central adiposity in individuals with type 2 diabetes mellitus [Austin *et al.*, 2021]. Furthermore, adherence to a vegetarian diet was beneficial for diabetic patients to lower LDL cholesterol and non-HDL cholesterol, and also to ensure glycemic control [Viguiliouk *et al.*, 2019]. The existing evidence indicates that implementation of vegetarian diet can potentially represent cost-effective and low-risk interventions in type 2 diabetes mellitus.

Vegetarian diet and chronic kidney disease

To the best of our knowledge, there is no meta-analysis testing the effect of a plant-based diet on chronic kidney disease (CKD). Only one meta-analysis focused on selected biomarkers associated with kidney impairment. It was demonstrated, considering four available studies, that compared to

an omnivorous diet, adherence to vegetarianism was associated with lower CRP levels (–3.9 mg/L) [Menzel *et al.*, 2020].

In addition to this meta-analysis, there is one randomized controlled trial, two cross-over studies, and one cross-sectional study that tested vegetarianism's effect in the groups of non-dialyzed patients with CKD [Valim *et al.*, 2022]. A prospective, randomized, controlled trial of 207 participants showed that a very-low-protein vegetarian diet (VLPD; 0.4 g/kg/day) combined with amino acid ketoanalogues supplementation was more beneficial than a traditional low-protein diet (LPD; 0.6 g protein/kg/day) [Garneata *et al.*, 2016]. After 15 months of complying with dietary recommendations, 42% of patients in the LPD group reached the endpoint (initiation of renal replacement therapy or a >50% reduction in initial estimated glomerular filtration rate, eGFR), while in the vegetarian group, 13% patients did. Initiation of renal replacement therapy was more required in the first group (30%) than in the second group (11%). After adjusting for relevant variables (eGFR, body mass index, CPR, and angiotensin-converting enzyme inhibitor), a VLPD combined with amino acid ketoanalogues supplementation appeared to be associated with a lower probability of reaching the endpoint [Garneata *et al.*, 2016].

The other three studies (one cross-sectional study and two cross-over trials) did not show differences in renal function (measured parameters: eGFR or creatinine clearance) with vegan and meat-based diets [Chang *et al.*, 2018; Moe *et al.*, 2011; Soroka *et al.*, 1998]. However, two of these studies (both cross-over design studies) included a very small sample size of only 8–9 participants; therefore, the meaning results may be limited [Moe *et al.*, 2011; Soroka *et al.*, 1998; Valim *et al.*, 2022].

In summary, more studies on larger sample sizes and prolonged observation periods are required to draw final conclusions on vegetarian diets' role in CKD.

Vegetarian diet and gut microbiome

Research shows that the composition of the gut microbiota is different in individuals on a plant-based and omnivorous (meat-containing) diet. In one study, 268 non-diabetic volunteers (41 to 58 years old) were assessed for the effect of practicing vegetarianism for at least one year (66 people in the vegetarian group, 102 in the lacto-ovo vegetarian group and 100 in the omnivorous group) on gut bacteria counts [Franco-de-Moraes *et al.*, 2017]. Most of the studied population were women (54.2%) and 41.4% of the participants were overweight. The taxonomic composition and phylogenetic structure of the microbiota were obtained through the analysis of the 16S rRNA gene. Clinical, biochemical, and circulating inflammatory markers were compared. *Firmicutes* and *Bacteroidetes* were the most abundant bacterial types, with no differences in abundance between normal-weight and overweight subjects. Strict vegetarians had lower percentages of *Firmicutes* and *Bacteroidetes* than lacto-ovo vegetarians and omnivores.

Furthermore, a higher *Prevotella* abundance and *Prevotella*/*Bacteroides* ratio were noted in subjects on vegetarian diets than in the other groups. Both strict vegetarians and lacto-ovo vegetarians had a higher percentage of *Faecalibacterium* compared to omnivores, where excessive amounts of *Succinivibrio* and *Halomonas* from the Proteobacteria cluster were noted. Compared to the vegetarian groups, the latter group showed higher values of anthropometric data, insulin, insulin resistance index, and a worse lipid profile. Inflammatory markers exhibited a successive increase. Such findings suggest that the consumption of animal foods may trigger systemic inflammation and insulin resistance-dependent metabolic disorders [Franco-de-Moraes *et al.*, 2017].

A randomized cross-over study examining the effects of a vegetarian diet on, among other things, microbiota composition in individuals with ischemic heart disease was published in 2020 [Djekic *et al.*, 2020]. Participants (31 subjects; 29 men 63 to 70 years old), divided into two groups (vegetarian diet and omnivore diet), underwent a 4-week intervention. After a washout period (4 weeks), the groups swapped the isocaloric diets. Analysis showed that none of the dietary models affected the abundance or composition of the gut microbiota at the cluster level, while changes occurred in the abundance of several types of bacteria from the *Ruminococcaceae*, *Lachnospiraceae*, and *Eggerthellaceae* families. In vegetarian diet participants, the predominant *Ruminococcaceae* bacterial genera were associated with reduced oxidized LDL cholesterol levels and, subsequently, lower cardiometabolic risk. In addition, compared to the meat-eaters, the vegetarian group exhibited reduced fecal microbial taxa and plasma metabolites, associated with a lower risk of metabolic diseases, including cardiovascular diseases [Djekic *et al.*, 2020].

Differences in gut microbiota composition between vegetarians and omnivores were also demonstrated in a 4-week randomized controlled trial including healthy individuals (53 subjects; 33 women, 20 men), 18 to 60 years of age. The participants were divided into two groups: vegan and omnivore. As in other publications, stool samples were analyzed using 16S rRNA gene amplicon sequencing. It was shown that, in contrast to the omnivore group, the vegetarian group had a decrease in *Roseburia* and *Faecalibacterium* abundance and an increase in *Coprococcus*. These three types of bacteria may be associated with mental and physical health; hence, further research is recommended [Kohnert *et al.*, 2021]. The available data clearly show that different subtypes of vegetarian diets affect the abundance of other bacteria in the gut microbiota, resulting in improved physical and mental health.

Vegetarian diet and mental health

The effects of a vegetarian diet on mental health and the risk of depression have been analyzed numerous times in various populations, but the results of existing studies are inconsistent [Bègue & Shankland, 2022; Hopwood, 2022; Jin *et al.*, 2021; Lee *et al.*, 2021; Shen *et al.*, 2021]. The meta-analysis of thirteen observational or interventional studies (17,809 individuals) evaluated the association of vegetarianism and veganism with mental health and cognitive functions [Iguacel *et al.*, 2021]. It was demonstrated that vegans/vegetarians were more likely to suffer from depression (odds ratio, OR=2.1) but had lower anxiety levels (MD=–0.85) than those on a traditional diet. Subgroup analyses of anxiety showed higher risk in participants younger than 26 years and studies of higher quality. However, the heterogeneity of

the studies was considerable, although subgroup analyses showed numerous differences. The meta-analysis found no significant association between diet and depression, stress, mood, or cognitive impairment [Iguacel *et al.*, 2021].

Another meta-analysis of 13 studies (43,728 participants; 5,436 vegetarians and 38,292 non-vegetarians) found that vegetarians had higher depression scores (according to the PHQ-9 patient health questionnaire) than non-vegetarians [Ocklenburg & Borawski, 2021]. However, the authors stated that due to the considerable heterogeneity of publications, further empirical studies are needed before any definitive conclusions can be formed. Another meta-analysis (thirteen papers, including four cohort studies and nine cross-sectional studies) published in 2022 examined the association of vegetarianism with depression, anxiety, and stress symptoms in adults [Askari *et al.*, 2022]. Ten studies indicated no association of the dietary model in question with the incidence of depression. Four publications has suggested that adherence to a vegetarian diet is not associated with anxiety. Due to insufficient data, the authors could not collect stress scores; thus, the main conclusion of the meta-analysis was an indifferent effect of a vegetarian diet on depression and anxiety [Askari *et al.*, 2022].

Given the conclusions of the above-discussed link between a vegetarian diet and mental health, there is a need to pursue further studies. Importantly, there is a need to conduct studies on different populations before a generalization of the effect can be outlined. Moreover, some authors suggest that future research should also consider the effect of experimental diet manipulation on mental health outcomes [Lavallee *et al.*, 2019]. Last but not least, there are numerous confounding factors when testing the effect of any diet on mental health that need to be taken into account, *e.g.*, age, gender, socioeconomic status, education, physical activity, genetic predisposition, smoking, chronic health issues, environmental background (*e.g.*, trauma levels) [Alzahrani *et al.*, 2022; Sheldon *et al.*, 2021]. Controlling them all may be highly challenging when testing the effect of a particular diet.

MEDITERRANEAN DIET AND HUMAN HEALTH

Mediterranean diet and lipid profile

A cohort study of 4,740 participants 35–70 years of age examining the association between the Mediterranean diet and blood lipid levels in Iranian adults was published in 2021 [Panbehkar-Jouybari *et al.*, 2021]. After a four-year observation, the HDL cholesterol level in these subjects significantly increased (52.8±12.3 for the third *vs.* 51.6±11.6, first tercile). Furthermore, strict compliance with Mediterranean diet was associated with decreased LDL to HDL cholesterol ratio (OR=0.85), which promoted proper lipid metabolism. However, no alterations were observed in total cholesterol, LDL fraction, or triglyceride levels [Panbehkar-Jouybari *et al.*, 2021]. In the same year, a randomized cross-over study was published. It aimed to evaluate the effects of short-term (4-week) use of a caloric-restricted Mediterranean diet *vs*. a traditional caloric-restricted diet on lipid profile and other metabolic parameters in South Koreans with hypercholesterolemia [Son *et al.*, 2021]. After a two-week washout period, participants, randomly assigned to the caloric-restricted Mediterranean diet group or the control diet group (92 subjects), exchanged diets. It was shown that even after accounting for age, gender, changes in total energy intake, alcohol intake, smoking, and changes in physical activity; the caloric-restricted Mediterranean diet group significantly decreased total cholesterol levels and LDL and HDL cholesterol levels, thereby supporting the treatment of dyslipidemia. In addition, it has also been shown that the diet used had a beneficial effect on reducing the risk of cardiovascular diseases by decreasing anthropometric parameters, decreasing levels of white blood cells, fasting glucose, fasting insulin, homeostatic model assessment for insulin resistance (HOMA-IR) index, and hepatic steatosis index (FLI), regardless of energy intake, physical activity, and changes in body weight reduction [Son *et al.*, 2021].

Another cross-sectional study on the effect of the Mediterranean diet on lipid metabolism in subjects with familial hypercholesterolemia was conducted on Brazilian residents (n=92) and Spanish residents (n=98) [Antoniazzi *et al.*, 2021]. As shown, the majority of Brazilian residents (83.7%) had low adherence to the Mediterranean diet, which was associated with their higher LDL cholesterol levels than in the Spanish group: 179 (135–250) and 161 (133–193) mg/dL. After adjusting for socioeconomic parameters, caloric and fatty acid intake, and lipid-lowering pharmacological therapies, a significant association was reported between high adherence to the Mediterranean diet and lowering of LDL cholesterol, thus a beneficial effect on familial hypercholesterolemia [Antoniazzi *et al.*, 2021].

One multi-ethnic cohort study also examined the effects of the Mediterranean diet on the lipid profile of individuals from less-developed ethnic minorities [Zhang *et al.*, 2022]. As demonstrated, adherence to the Mediterranean diet (as measured by the alternative mediterranean diet scale – AMED) was negatively associated with total cholesterol, LDL, and HDL fraction levels. Comparing the highest quintiles with the lowest AMED scores, total cholesterol levels decreased by 0.082 (–0.092 to –0.049) mmol/L, LDL cholesterol by 0.030 (–0.048 to -0.012) mmol/L, and HDL cholesterol by 0.0275 (–0.036 to –0.019) mmol/L. Despite the absence of changes in triglyceride levels, the Mediterranean diet was found to effectively improve lipid metabolism in underdeveloped ethnic minorities [Zhang *et al.*, 2022].

Mediterranean diet and blood pressure

Many studies have demonstrated that the Mediterranean diet lowers blood pressure [Ahmed *et al.*, 2020; Dai *et al.*, 2022; Jennings *et al.*, 2019; Magriplis *et al.*, 2020; Septiadi *et al.*, 2021]. The meta-analysis encompassing six randomized controlled trials compared the Mediterranean diet with low-fat diets [Nissensohn *et al.*, 2016]. As shown, adherence to the Mediterranean diet for at least one year resulted in reduced systolic (–1.44 mm Hg) and diastolic (–0.70 mm Hg) blood pressure. However, due to the small number of studies included in the meta-analysis and their large heterogeneity, the authors did not have sufficient evidence to support the blood-pressure-lowering effects of the Mediterranean diet [Nissensohn *et al.*, 2016]. As many as three meta-analyses

(evaluating the association between the Mediterranean diet and blood pressure) were published in 2021 [Bakaloudi *et al.*, 2021; Cowell *et al.*, 2021; Filippou *et al.*, 2021]. One of these analyses, involving 19 randomized controlled trials (4,137 participants), showed that Mediterranean diet interventions reduced systolic and diastolic blood pressure by an average of 1.4 mmHg and 1.5 mmHg, respectively, compared with the control group [Cowell *et al.*, 2021]. As shown in the meta-regression, longer study duration and higher baseline systolic blood pressure were associated with more significant decreases in response to the Mediterranean diet. In the same publication, the meta-analysis of 16 observational studies (59,001 participants) showed that with higher adherence to the Mediterranean diet, the probability of developing hypertension was 13% less than at a lower [Cowell *et al.*, 2021].

Another meta-analysis of 54 observational studies noted that compared with the low adherence to the Mediterranean diet, greater adherence lowered systolic blood pressure (SMD=–0.08; –0.15 to –0.02) but did not significantly affect diastolic blood pressure (SMD=–0.07; –0.13 to 0.00) [Bakaloudi *et al.*, 2021]. These findings may be related to normal levels (<90 mmHg) of mean diastolic pressure in all study participants.

The other meta-analysis encompassed 35 randomized controlled trials (13,943 participants). It demonstrated that, compared with the usual diet and other intervention diets, the Mediterranean diet reduced systolic blood pressure by 1.5 mmHg and diastolic blood pressure by 0.9 mmHg [Filippou *et al.*, 2021]. Compared with the usual diet alone, the Mediterranean diet still caused both blood pressures to fall. However, the association disappeared when comparing the Mediterranean diet to all other intervention diets or a low-fat diet alone. Additionally, more significant reductions in diastolic blood pressure were observed in subjects with mean baseline systolic blood pressure ≥130 mmHg. It was noted that both systolic and diastolic blood pressure were lowered more in interventions with a mean follow-up period of ≥16 weeks [Filippou *et al.*, 2021].

Mediterranean diet and body weight

Two meta-analyses have shown that following a Mediterranean diet may support weight loss [Esposito *et al.*, 2011; Lotfi *et al.*, 2022]. The first analysis included 16 randomized controlled trials and 3,436 participants (1,848 with a Mediterranean diet and 1,588 with a control diet – in most studies, represented by a low-fat diet, but also high-carbohydrate, prudent or high-saturated fat diets) [Esposito *et al.*, 2011]. As shown, Mediterranean diet subjects had greater weight loss (–1.75 kg; –2.86 to –0.64 kg) and BMI (–0.57 kg/m^2; –0.93 to –0.21 kg/m^2), compared with the control group. Moreover, the weight loss was greater when following the Mediterranean diet with energy restriction (–3.88 kg; –6.54 to –1.21 kg), increased physical activity (–4.01 kg; –5.79 to –2.23 kg), and intervention longer than 6 months (–2.69 kg; –3.99 to –1.38 kg). What is important, none of the studies showed significant weight gain when following the Mediterranean diet, thus confirming the lack of negative effects of the substantial amounts of olive oil used in the Mediterranean diet [Esposito *et al.*, 2011].

The second meta-analysis included seven prospective cohort studies with a total of several hundred thousand participants [Lotfi *et al.*, 2022]. As shown, adherence to the Mediterranean diet was strongly associated with a 9% reduced risk of overweight and/or obesity (RR=0.91) only for studies on overweight and obesity (RR=0.92) and not for articles focusing only on obesity (RR=0.68). In addition, the analysis of 6 publications proved a risk reduction (RR=0.98) of overweight and/or obesity of 2% per 1 Mediterranean Diet Score (MDS). Each unit increase in the MDS was associated with a reduction in weight gain of 0.04 kg over five years [Lotfi *et al.*, 2022]. In summary, available meta-analyses suggest that the Mediterranean diet may support weight loss in adults.

Mediterranean diet and inflammation biomarkers

A meta-analysis of seventeen (lasting at least 12 weeks) randomized controlled trials on a total of 2,300 subjects evaluated the association of the Mediterranean diet with inflammation in adults [Schwingshackl & Hoffmann, 2014a]. Adherence to Mediterranean diet was shown to significantly increase adiponectin levels (weighted mean difference =1.69 μg/mL) and decrease high-sensitivity C-reactive protein (hs-CRP; –0.98 mg/L), interleukin-6 (–0.42 pg/mL), and intercellular adhesion molecule-1 (–23.73 ng/mL). The analysis results prove that adherence to the Mediterranean diet decreases inflammation and improves endothelial function [Schwingshackl & Hoffmann, 2014a].

The more recent meta-analysis, encompassing 13 publications (eight cross-sectional studies, three randomized clinical trials, 1 quasi-experiment, and 1 cohort study), examined the effect of the Mediterranean diet on inflammation in older people (≥65 years) [Wu *et al.*, 2021]. Two randomized controlled trials demonstrated that greater adherence to the Mediterranean diet among the elderly was associated with a decrease in CRP (–0.54 and –0.34 mg/dL) and interleukin 6 (–1.6 and –0.2 pg/mL). In contrast, in a 3-year cohort study, only a decrease in CRP values was noted (–0.10 pg/mL).

The meta-analysis of 5 cross-sectional studies also demonstrated that the Mediterranean diet significantly decreased CRP levels (SMD=–0.26). Data on other inflammatory markers varied in the included publications; thus, no significant correlations were found [Wu *et al.*, 2021].

Mediterranean diet and cardiovascular disease

The impact of the Mediterranean diet on cardiovascular risk and mortality associated with lipid and blood pressure was examined in five major meta-analyses. One of them included six studies and a total of 10,950 participants (477 major cardiovascular events, 693 deaths, 315 cardiovascular deaths) [Bloomfield *et al.*, 2016; Chen *et al.*, 2019; Liyanage *et al.*, 2016; Mayr *et al.*, 2018; Tang *et al.*, 2021]. As shown, adherence to the Mediterranean diet decreased the risk of major cardiovascular events (RR=0.63), coronary events (RR=0.65), stroke (RR=0.65), and cardiac failure (RR=0.30) but was not associated with mortality from cardiovascular causes (RR=0.90) or any causes (RR=1.00). After excluding a large (1,000 participants) study with non-integral data, there was still evidence of a significant association of the Mediterranean diet with cardiovascular events

(RR=0.69) and stroke (RR=0.66), although positive effects for coronary events (RR=0.73) and heart failure (RR=0.25) disappeared [Liyanage *et al.*, 2016].

In the second meta-analysis, two publications on primary prevention demonstrated no difference in mortality from any cause between subjects using the Mediterranean diet and other groups. At the same time, one study showed that the Mediterranean diet decreased the incidence of major cardiovascular events (hazard ratio=0.71) [Bloomfield *et al.*, 2016]. In one of the three publications on secondary prevention, adherence to the Mediterranean diet without fat intake restrictions appeared to decrease the risk of recurrent myocardial infarction and cardiovascular death [Bloomfield *et al.*, 2016].

The third meta-analysis, focusing on stroke-related data, included twenty prospective cohort studies encompassing 682,149 participants (16,739 stroke cases) [Chen *et al.*, 2019]. The RR for each 4-point increase in the MDS was 0.84 for all studies, 0.76 for studies on Mediterranean populations, and 0.86 for those on other populations. Adherence to the Mediterranean diet was associated with a lower risk of ischemic stroke (RR=0.86) and hemorrhagic stroke (RR=0.83). The data suggest that regardless of residence, the Mediterranean diet reduced the risk of both strokes [Chen *et al.*, 2019]. The most recent meta-analysis, including 7 cohort studies (37,879 participants with a history of CVD), found that the pooled RR for each 2-unit increment of the MDS was 0.85 for all-cause mortality and 0.91 for cardiovascular mortality [Tang *et al.*, 2021]. Moreover, according to the subgroup analysis for all-cause mortality, the association was stronger in trials of shorter duration (RR=0.75) and Mediterranean regions (RR=0.76) than in non-Mediterranean areas (RR=0.95). Thus, the meta-analysis proved that adherence to a Mediterranean diet improved survival in people with a history of CVD [Tang *et al.*, 2021].

The 2018 meta-analysis, including 11 studies, examined the effects of an olive oil-rich Mediterranean diet on inflammation in patients with coronary heart disease (CHD) [Mayr *et al.*, 2018]. Five clinical trials showed a slight reduction in CRP levels following adherence to the Mediterranean diet, and two noted a significant decrease. The random-effects model meta-analysis of four controlled trials did not prove any significant difference between the Mediterranean diet and low-fat diets in the final mean CRP levels.

Conversely, four observational studies showed a significant association between the Mediterranean diet and reductions in proinflammatory cytokines. Nevertheless, in most studies, the effect of the Mediterranean diet on inflammation in individuals with CHD was insignificant; thus, the effect of this diet cannot be conclusively determined [Mayr *et al.*, 2018]. In addition, a recent randomized controlled trial examined the association between long-term Mediterranean diet use by individuals with CHD and kidney function [Podadera-Herreros *et al.*, 2022]. Participants from the CORDIOPREV trial (n=1,002), were randomly assigned to the Mediterranean diet group or low-fat diet consumption group and underwent a 5-year dietary intervention. Kidney function was assessed at the beginning and at the end of the study by the determination of serum creatinine-based estimated glomerular filtration rate (eGFR). By distinguishing between participants with type 2 diabetes mellitus and healthy participants, multiple linear regression analysis showed that Mediterranean diet use was associated with a smaller decrease in eGFR than a low-fat diet in patients with type 2 diabetes mellitus and in the general population. However, no significant difference in eGFR was observed between the two dietary models in subjects without type 2 diabetes mellitus. Moreover, such an effect of the Mediterranean diet was observed in participants with mild eGFR impairment. Data suggest that long-term use of the Mediterranean diet may preserve kidney function in individuals with CHD and type 2 diabetes mellitus, especially in patients with mild eGFR impairment [Podadera-Herreros *et al.*, 2022]. It may therefore be concluded that the Mediterranean diet provides clinical benefits in preventing secondary cardiovascular diseases.

Mediterranean diet and cancer risk

According to research, the Mediterranean diet may reduce the risk of selected cancers [Gioxari *et al.*, 2021; Männistö *et al.*, 2021; Montano *et al.*, 2022; Schulpen & van den Brandt, 2021; Tayyem *et al.*, 2022]. In a pooled analysis of 3 Italian case-control studies, including 5,079 women (1,411 diagnosed with endometrial cancer and 3,668 in the control group) the 9-item MDS used showed that high adherence to this diet *vs*. low adherence was associated with a 57% reduction in endometrial cancer risk (OR=0.43) [Filomeno *et al.*, 2015]. The OR for an increment of one MDS unit, or one Mediterranean diet component, was 0.84. The findings suggest that a Mediterranean diet has a beneficial role in preventing endometrial cancer [Filomeno *et al.*, 2015]. The meta-analysis encompassing six studies (3,986 women; 2,321 with diagnosed breast cancer and 1,665 in the control group) evaluated the association between the Mediterranean diet and breast cancer (estrogen/progesterone receptor subtypes: ER/PR) in postmenopausal women [van den Brandt & Schulpen, 2017]. As shown, high adherence to the Mediterranean diet was associated with a 23% reduction in ER–PR– and ER– breast cancer risk by 27%, whereas for ER+, this relationship was not statistically significant, indicating a positive effect of the Mediterranean diet on specific breast cancer subtypes only [van den Brandt & Schulpen, 2017].

Another meta-analysis of 10 observational studies (33,451 prostate cancer cases) examined the effect of the Mediterranean diet on prostate cancer risk [Cheng *et al.*, 2019]. The RR was 0.95 in general for prostate cancer, 0.93 for advanced stage, and 0.92 for its lethal form. The results suggest that the Mediterranean diet is not associated with prostate cancer risk [Cheng *et al.*, 2019].

The meta-analysis of 21 cohort studies and 12 case-control studies (just under 1.5 million participants) evaluating the impact of the Mediterranean diet on various cancers was published in 2014 [Schwingshackl & Hoffmann, 2014b]. As shown, the highest adherence to the Mediterranean diet resulted in a 4% reduction in prostate cancer risk, a 14% reduction in colorectal cancer risk, a 56% reduction in laryngeal cancer risk, and a 10% reduction in cancer mortality risk. An association of the Mediterranean diet with breast, stomach, and pancreatic cancer was not observed [Schwingshackl & Hoffmann, 2014 b].

Conversely, a recent meta-analysis of 117 studies (encompassing a total of over 3 million participants) showed that the highest adherence to the Mediterranean diet reduced cancer mortality by 13% (based on eighteen cohort studies) and mortality from any cause among cancer survivors by 25% (based on eight cohort studies) [Morze *et al.*, 2021]. Furthermore, higher adherence to the Mediterranean diet resulted in a lower risk of breast cancer (by 6%; twenty-three observational studies), bladder cancer (by 13%; four observational studies), respiratory cancer (by 16%; five cohort studies), colorectal cancer (by 17%; seventeen observational studies), stomach cancer (by 30%; 7 observational studies), liver cancer (by 36%; four observational studies), and head and neck cancer (by 54%; nine observational studies). The association between the Mediterranean diet and the incidence of blood, esophageal, pancreatic, and prostate cancers was not observed, which is a finding consistent with the results of previous publications [Morze *et al.*, 2021].

Mediterranean diet and type 2 diabetes mellitus

In 2015, a large meta-analysis was published, including five randomized controlled clinical trials (lasting at least six months) and eight meta-analyses [Esposito *et al.*, 2015]. Meta-analyses showed that higher adherence to the Mediterranean diet was associated with a 19% [Schwingshackl *et al.*, 2015] and 23% reduction in type 2 diabetes risk, thus recommending the Mediterranean diet for the prevention of type 2 diabetes [Esposito *et al.*, 2015; Koloverou *et al.*, 2014]. The meta-analysis of 3 long-term clinical trials showed that the overall effect for HbA1c was –0.47% (–0.56 to –0.38), confirming the beneficial effect of the Mediterranean diet on glycemic control compared with traditional or low-fat diets. In addition, four other meta-analyses of randomized clinical trials also demonstrated lower HbA1c levels (–0.3% to –0.47%) in type 2 diabetes patients using the Mediterranean diet [Esposito *et al.*, 2015].

The meta-analysis published five years later included as many as 41 articles (3 randomized clinical trials and 38 prospective cohort studies) [Becerra-Tomás *et al.*, 2020]. The analysis of randomized controlled trials showed a beneficial effect of the Mediterranean diet on the prevalence of cardiovascular disease (RR=0.62) and myocardial infarction (MI; RR=0.65), whereas prospective cohort studies comparing the highest and lowest adherence to the Mediterranean diet proved an inverse association with CVD mortality (RR=0.79), coronary heart disease (RR=0.73), CHD mortality (RR=0.83) stroke incidence (RR=0.80), stroke mortality (RR=0.87), and MI incidence (RR=0.73). The above data suggest that the Mediterranean diet is highly beneficial in preventing CVD in individuals with type 2 diabetes [Becerra-Tomás *et al.*, 2020].

Mediterranean diet and chronic kidney disease

A meta-analysis of four studies (8,467 participants) which was published in 2020, assessed the association between adherence to the Mediterranean diet (assessed by standardized food frequency questionnaires) and prevention of chronic kidney disease [Hansrivijit *et al.*, 2020]. In all included articles, an index of the adopted diet's similarity to the Mediterranean diet was used (mean MDS=3.8±0.3). With the mean follow-up duration of 20.6±7.0 years, the pooled OR for CKD was 0.901 for each 1-point increment of MDS. The incidence of CKD equaled 0.026 events per person-year. Furthermore, the male sex was associated with the incidence of chronic kidney disease in an adjusted meta-regression analysis. However, there was no significant association between chronic kidney disease incidence and age, ethnicity, smoking, comorbidities, kidney function, and total daily energy intake. Adherence to the Mediterranean diet with a 1-point increase in MDS was associated with a 10% lower risk of chronic kidney disease. However, there were insufficient data for patients on dialysis or with preexisting chronic kidney disease [Hansrivijit *et al.*, 2020].

Mediterranean diet and gut microbiome

Mediterranean diet is characterized by high fiber intake, which is known to shift *Bacteroidetes* populations and maintain a reduced *Firmicutes* population, overall resulting in higher levels of short-chain fatty acids (SCFAs) in the gut [Haro *et al.*, 2017; Nagpal *et al.*, 2019]. A meta-analysis of seventeen studies was published in 2021 to determine whether the Mediterranean diet can prevent cancer and inflammatory bowel disease by modulating gut microflora [Illescas *et al.*, 2021]. The Mediterranean diet was compared with different dietary models, including the Paleolithic diet and the Western diet. Analysis of 1,563 stool samples showed that the microbiota of patients following the Mediterranean diet was enriched with beneficial bacteria promoting an anti-inflammatory environment (*Verrucomicrobia*, *Bacteroidetes*, *Actinobacteria*), whereas the bacterial community was reduced in those with inflammatory bowel disease, colonic adenocarcinoma, and colorectal cancer. An inverse relationship was also observed, with a decrease in the abundance of bacteria with pro-inflammatory properties (*Proteobacteria*, *Euryarchaeota*, *Fusobacteria*) in the Mediterranean diet and an increase in inflammatory bowel disease, colonic adenocarcinoma, and colorectal cancer. Moreover, subjects on the Mediterranean diet increased the abundance of *Akkermansia*, regarded as a marker of a healthy gut, and decreased that of *Fusobacterium*, a pathogenic bacterium associated with colorectal cancer and inflammatory bowel disease (IBD) [Illescas *et al.*, 2021]. Thus, the findings suggest that incorporating Mediterranean diet principles into lifestyle may prevent intestinal cancer.

Mediterranean diet and mental health

Of the twenty-two studies included in the 2013 meta-analysis, nine examined the effect of the Mediterranean diet on the risk of depression [Psaltopoulou *et al.*, 2013]. As shown, high and moderate adherence to the Mediterranean diet was significantly associated with a reduced risk (RR=0.68; 0.54–0.86). The protective effects of high adherence seemed independent of age, whereas the beneficial effects of moderate adherence to the Mediterranean diet reducing the risk of depression seemed to disappear with age [Psaltopoulou *et al.*, 2013]. A meta-analysis, published six years later, included a total of fourteen observational studies (four cohort and nine clinical-control studies) on a total of 56,043 participants [Shafiei *et al.*, 2019]. Analysis of the cohort studies, despite

the lack of heterogeneity, showed no significant association between adherence to a Mediterranean diet and risk of depression (RR=0.95; 0.79–1.16), whereas the cross-sectional studies found a 28% reduction in the risk (RR=0.72; 0.60–0.87). Given the use of food frequency questionnaires, the above differences in findings may be due to the misclassification of participants in some studies [Shafiei *et al.*, 2019]. Similarly as in the "Vegetarian diet and mental health" subsection, discussing the potential association between a vegetarian diet with mental health, one should note that there are numerous confounding factors and controlling them all, when testing the effect of diet [Alzahrani *et al.*, 2022; Sheldon *et al.*, 2021].

COMPARISON OF HEALTH BENEFITS OF VEGETARIAN AND MEDITERRANEAN DIETS

This section discusses the research allowing for direct comparison of the vegetarian and Mediterranean diets. It should be highlighted that the number of such investigations is limited. Therefore, more research, preferentially based on randomized cross-over studies in various populations, is encouraged in the future. The comparison of both diets discussed in subsequent subsections is summarized in Table 2.

TABLE 2. Comparison of health effects of vegetarian and Mediterranean diets emerging from comparative studies.

	Vegetarian diet	Mediterranean diet
Body weight control	↓	↓
Total cholesterol	↓↓	↓
Low-density lipoprotein cholesterol	↓↓	↓
Triglycerides	↓	↓↓
Blood pressure	↓	↓↓↓
Glycemic control	↓	↓↓
Total cancer risk	?	↓

Cardiovascular disease prevention

A randomized cross-over study performed as a part of the CARDIVEG Study examined the effect of the lacto-ovo vegetarian and Mediterranean diet on cardiovascular disease prevention [Sofi *et al.*, 2018]. Participants included overweight omnivores, at low or intermediate cardiovascular risk, with at least one additional risk factor (*i.e.*, abdominal obesity, high total cholesterol, high LDL cholesterol, high triglycerides, fasting glucose), and not on medications [Sofi *et al.*, 2016]. Subjects (118 individuals) were randomly divided into two groups (vegetarian diet $n=60$; Mediterranean diet $n=58$). Each dietary intervention phase lasted three months. After phase 1, the groups exchanged diets. Both low-calorie diets resulted in significant reductions in cardiovascular risk. A total of 81 subjects achieved the target values recommended by the European Society of Cardiology. Among them, 16 subjects in the lacto-ovo vegetarian group achieved target values for total cholesterol, 17 for LDL cholesterol, 6 for triglycerides, and 14 for BMI (body mass index). Meanwhile, from the Mediterranean diet group, target values for total cholesterol were achieved only by 7 participants, 6 for LDL cholesterol, 8 for triglycerides, and 10 for BMI. A low-calorie vegetarian diet was more effective in lowering total cholesterol and low-density lipoprotein levels, while a low-calorie Mediterranean diet led to greater reductions in triglyceride levels in overweight individuals [Sofi *et al.*, 2018].

Blood pressure in hypertension

The meta-analysis, involving 67 randomized trials and over 17,000 participants, estimated the effects of thirteen different (lasting at least 12 weeks) dietary interventions (including the Mediterranean and vegetarian diets) on blood pressure in individuals with hypertension and prehypertension [Schwingshackl *et al.,* 2019]. The Mediterranean diet ranked third as one of the most effective diets in reducing systolic and diastolic blood pressure. Although the vegetarian diet has not been distinguished in any way, the authors have found that an effective way to control blood pressure in populations with hypertension and prehypertension is to consume plenty of vegetables, fruits, grains, legumes, nuts, seeds, dairy products, and to follow a low intake of red meat, sugar-sweetened beverages, and sodium [Schwingshackl *et al.*, 2019]. This dietary pattern, with the exception of meat consumption, is consistent with both types of the discussed diets.

Cancer mortality

A meta-analysis examining the effect of vegetarian and Mediterranean diets on cancer mortality was published in 2020 [Molina-Montes *et al.*, 2020]. All papers included in the meta-analysis studied populations ranging from a few to several hundred thousand. Of the 13 articles, 5 focused on vegetarian/vegan diets and 8 on Mediterranean diets. The results indicated that the vegetarian/vegan diet did not exhibit significant preventive potential for overall cancer mortality compared with a non-vegetarian diet. However, the association between adherence to the Mediterranean dietary model and cancer mortality reached statistical significance. Nevertheless, none of the studies accounted for the influence of prognostic factors. Therefore, further analysis is needed to determine dietary guidelines for cancer survivors [Molina-Montes *et al.*, 2020].

Body weight control

One study simultaneously evaluated the effect of low-calorie lacto-ovo vegetarian and Mediterranean diets on weight loss [Sofi *et al.*, 2018]. A significant reduction occurred in both groups. The average weight reduction was –1.88 kg in the vegetarian group and –1.77 kg in the Mediterranean diet group. The decrease in BMI equaled –0.64 kg/m^2 in the vegetarian group and –0.67 kg/m^2 in the Mediterranean diet. In contrast, the reduction in fat mass reached –1.23 kg in the first group and –1.46 kg in the second group. The study confirms the beneficial effects of both vegetarian and Mediterranean diets in reducing body weight, BMI, and fat mass in overweight individuals. Given the comparable results, none of the diets could be determined as more effective [Sofi *et al.*, 2018].

Type 2 diabetes mellitus

Type 2 diabetes mellitus is the most common type of diabetes worldwide and appears to increasingly affect also younger

populations [Bellary *et al.*, 2021; Lawrence *et al.*, 2021]. Network meta-analysis was published in 2019, examining the effects of, among others, vegetarian and Mediterranean diets on blood lipid control in patients with type 2 diabetes [Neuenschwander *et al.*, 2019]. Fifty-two randomized controlled trials on adults with type 2 diabetes, with an intervention period ≥12 weeks and comparing dietary approaches for LDL cholesterol, HDL cholesterol, or triglycerides were included. It was shown that of the nine dietary approaches, the vegetarian diet was most effective in lowering LDL cholesterol levels compared to the control diet. Conversely, the Mediterranean diet favorably raised HDL cholesterol and lowered triglyceride levels compared to the control diet [Neuenschwander *et al.*, 2019]. Researchers assessing the effects of both diets on CVD prevention in overweight individuals reached similar conclusions [Sofi *et al.*, 2018]. Therefore, this implies that the diets similarly affect the lipid profile in healthy individuals and those with type 2 diabetes. However, a 2019 meta-analysis recognized the Mediterranean dietary model as the most effective dietary approach for the full control of diabetic dyslipidemia (79% according to the surface under the cumulative ranking curve (SUCRA) score) [Neuenschwander *et al.*, 2019].

Several studies have also reported the positive effects of Mediterranean and vegetarian diets on glycemic control in people with type 2 diabetes. A network meta-analysis of 56 studies comparing nine dietary approaches (including the two mentioned above) evaluated their effects on blood glucose levels in 500 people with type 2 diabetes [Schwingshackl *et al.*, 2018]. Considering HbA1c lowering, the surface under the cumulative ranking (SUCRA) score ranked Mediterranean diet (80%) as the second-best diet compared to the control group, and vegetarianism (60%) ranked fourth. The network analysis also indicated that the Mediterranean diet was the best dietary approach to reduce fasting glucose levels compared to a control diet (88%), followed by a vegetarian diet in the third place (63%). The authors' main conclusion is that the Mediterranean diet is the most effective dietary approach for improving glycemic control in patients with type 2 diabetes [Schwingshackl *et al.*, 2018]. However, both dietary approaches are considered beneficial for diabetics since they feature an abundance of vegetables, fruits, grains, and cereals – and therefore fiber – which positively affects blood glucose levels [Benson & Hayes, 2020].

A randomized controlled cross-over study in overweight/obese individuals with type 2 diabetes examined the effects of the diets in question in terms of hunger and satiety perception [Di Mauro *et al.*, 2021]. The Mediterranean and high-fiber vegetarian diets were compared. Participants (12 subjects; 5 women, 7 men), aged 54–72 years, consumed two types of isocaloric meals during two visits with trial investigators. Appetite, glucose, insulin, and gastrointestinal hormone levels were assessed during the appointments. Measurements were taken at fasting and every 30 min for 3.5 h after meal consumption. Glucagon-like peptide 1 and oxyntomodulin concentrations were significantly higher after the Mediterranean diet compared to the high-fiber vegetarian diet.

In addition, consumption of the Mediterranean meal was associated with a lower glycemic profile compared to a high-fiber vegetarian meal. However, there were no significant changes in self-reported scores on the visual analogue scale or insulin trend. In conclusion, in overweight/obese and type 2 diabetes participants, the Mediterranean diet was more effective than the high-fiber vegetarian diet in postprandial plasma glucose homeostasis and glucagon-like peptide 1 and oxyntomodulin release. However, the small number of participants must be considered [Di Mauro *et al.*, 2021].

Gut microbiome

The cardiovascular prevention with vegetarian diet (CARDIVEG) study examined the effects of low-calorie Mediterranean and vegetarian diets on gut microbiome composition and SCFA production [Pagliai *et al.*, 2020]. Omnivorous subjects (16 women and 7 men) with low to moderate cardiovascular risk were randomly assigned to the Mediterranean and vegetarian groups. After three months of dietary intervention, the groups exchanged. Next-generation 16S rRNA sequencing and SCFA analysis were performed on participants' stool samples. As the analysis showed, adherence to the Mediterranean diet affected the abundance of *Enterorhabdus*, *Lachnoclostridium*, and *Parabacteroides* strains, while a vegetarian diet significantly affected the abundance of *Anaerostipes*, *Streptococcus*, *Clostridium sensu stricto*, and *Odoribacter*. However, microbiome composition did not change significantly in either of the groups. A comparison of the mean variation of each SCFA between Mediterranean and vegetarian diets showed an opposite and statistically significant trend for propionic acid (+10% vs –28%, respectively, $p=0.034$).

In addition, changes in SCFAs were negatively correlated with changes in some inflammatory cytokines (vascular endothelial growth factor, monocyte chemoattractant protein-1, interleukin-17, interferon gamma-induced protein-10 and interleukin-12) [Pagliai *et al.*, 2020]. Correlation analyses showed a potential relationship between changes in strain types and changes in clinical and biological parameters. It was noted that with a Mediterranean diet, there were changes in the production of short-chain fatty acids, supporting their role in modulating the inflammatory response. However, short-term use of a Mediterranean or vegetarian diet did not result in major changes in the gut microbiota composition. It is suggested that such dietary interventions should last for more than three months, and it would be worthwhile to conduct the study on a greater sample size.

Metabolic profile

The recent study published in 2021 aimed to evaluate the effects of long-term vegetarian and Mediterranean dietary patterns on metabolic profile and salivary microbiota composition [Daniele *et al.*, 2021]. Participants (42 subjects; 20 men, 22 women) approximately 38 years of age completed a questionnaire assessing dietary habits for at least two years. Information from medical history, saliva sample analysis, and basal metabolic rate and respiratory rate values were used to assess the metabolic profile. It was shown that individuals on the Mediterranean diet had a higher species diversity of oral bacteria and a better metabolic profile compared to the vegan diet. Participants in the Mediterranean dietary patterns group had higher percentages of *Subflava* and *Prevotella* species, lower carbohydrate consumption and higher lipid intake than

individuals on the vegetarian diet. Followers of the Mediterranean diet achieved higher basal metabolic and lower respiratory rates. It was observed that *Prevotella* abundance was inversely related to the respiration rate and carbohydrate consumption, whereas *Subflava* abundance was positively correlated with basal metabolic rate.

Furthermore, *Lactobacillus* abundance, inversely related to the presence of *Subflava* in the Mediterranean diet group, was associated with decreased basal metabolic rate. The study proved the association of macronutrient consumption with metabolic profile and oral microbiota. It also confirmed the positive effect of the Mediterranean diet on basal metabolic rate and the abundance of microbial species associated with better protein, carbohydrate, and lipid metabolism. The analysis suggests that long-term adherence to the Mediterranean diet, with high contents of protein and lipids, is associated with higher oral microbial diversity and, therefore, a better metabolic profile compared to veganism [Daniele *et al.*, 2021].

Kidney function

In 2020–2-21, a randomized cross-over study was conducted as a part of the CARDIVEG Study to evaluate the effects of a lacto-ovo vegetarian diet versus the Mediterranean diet on kidney function in healthy individuals at medium to low cardiovascular risk [Dinu *et al.*, 2021]. Participants (107 subjects; 82 women, 25 men) aged 21–75 years were assigned to a lacto-ovo vegetarian or Mediterranean diet group for three months, and then switched the diets. The analysis included confounding variables such as age, sex, weight, physical activity, alcohol consumption, smoking, hypertension, LDL cholesterol, and glucose levels. As shown, adherence to the lacto-ovo vegetarian diet decreased creatinine levels by 5.3%, blood urea nitrogen by 8.7%, and urea by 5.8%. In contrast, the eGFR increased by 3.5%. Clinically significant improvement in the above parameters may positively affect the protection of renal function, at least with a short-term vegetarian diet. In the Mediterranean diet group, no significant changes were observed in the parameters considered. However, the study covered a period of three months; thus, the effect of dietary intervention with this diet for a longer time was not evaluated [Dinu *et al.*, 2021].

Pain in rheumatoid arthritis

A recent meta-analysis of seven randomized controlled trials (326 participants in total) was published to examine the effect of potentially anti-inflammatory diets (including, among others, vegetarian and Mediterranean) on pain in rheumatoid arthritis [Schönenberger *et al.*, 2021]. Visual analogue scale (VAS), CRP level, erythrocyte sedimentation rate, health assessment questionnaire, disease activity score-28 for rheumatoid arthritis (DAS28), number of tender/swollen joints, body weight, and BMI were used for the assessment. It was noted that better outcomes were achieved in dietary interventions lasting more than three months. Subgroup analysis showed that the Mediterranean diet tended to have a greater effect on pain reduction than the vegetarian diet. However, the former dietary interventions were only evaluated in two papers. Nevertheless, the authors of the meta-analysis conclude that anti-inflammatory diets, including vegetarian and Mediterranean diets, decrease pain in rheumatoid arthritis compared to traditional diets [Schönenberger *et al.*, 2021]. However, as indicated the risk of bias was high, while the evidence was very low, advocating further studies to understand the role of vegetarian and Mediterranean diets in rheumatoid arthritis and comparison of outcomes of their implementation.

FUTURE RESEARCH PROSPECTS AND CHALLENGES

Several gaps and challenges must be addressed in future assessments of the health benefits of vegetarian and Mediterranean diets, as well as their implementation as non-pharmaceutical methods of disease prevention.

1. As stated by the Academy of Nutrition and Dietetics, the vegetarian diet, including vegan, can provide health benefits if appropriately planned [Melina *et al.*, 2016]. However, unbalanced plant-based diets can be harmful and lead to nutritional deficiencies, weight gain, increase in triglyceride and glucose levels [Sabaté, 2003]. Therefore, epidemiological studies should attempt to distinguish individuals adhering to a vegetarian diet based on how well it is planned. This is particularly important given the fact that some plant-based products fall into the category of ultra-processed food [Gehring *et al.*, 2021; Ohlau *et al.*, 2022].
2. There is a need to distinguish and define different types of vegetarianism when testing its health effect and comparing it to other diets, *e.g.*, the Mediterranean diet. A vegetarian diet includes individuals restricting meat consumption but eating eggs (ovo-vegetarianism), dairy (lacto-vegetarianism), both (lacto-ovo-vegetarianism), and avoiding consumption of any animal-derived products (veganism). However, there appears to be an increased interest in flexitarianism, which assumes a primary focus on plant foods with the occasional inclusion of meat products (and can be regarded as semi-vegetarianism). The effects of this practice require further assessment [Derbyshire, 2017].
3. There are numerous confounding variables when addressing the health benefit of diet, encompassing age, BMI, physical activity, smoking, alcohol consumption, biochemical markers, clinical background, and genetic predispositions, while adjustment for all of them may often be a challenging or impossible task.
4. Some health effects of each diet are evidenced in a small sample size, advocating further research to provide additional data and improve the strength of evidence. Numerous studies include healthy subjects, and there remains a need to test whether specific diets can exert similar beneficial effects in individuals with active disease.
5. Pursuing cross-over interventional trials comparing the effects of vegetarian and Mediterranean diets in different groups is encouraged. This particularly concerns the studies designed to directly compare the effects of these diets on cardiovascular markers, gut microbiome, metabolic profile, kidney function, and course of autoimmune diseases.
6. Considering that a shift in diet may not produce immediate effects, there is a need to pursue long-term interventional trials for vegetarian and Mediterranean diets. This

is important to understand whether the effects evidenced so far are persistent or can attenuate over time (*e.g.*, years of adherence to a specific diet).

7. Implementation of diets, such as vegetarian or Mediterranean, in selected populations may be faced with several obstacles that include economic factors, difficulties in the availability of certain food products, additional time and effort to prepare meals adhering to a particular diet [Bonaccio *et al.*, 2016; Middleton *et al.*, 2015]. The broader implementation of vegetarian or Mediterranean diets in some populations, *e.g.*, the Western world, may also be challenging since both require limitation or complete abstinence from meat [Fehér *et al.*, 2020].

CONCLUSIONS

Both vegetarian and Mediterranean diets exhibit various health-beneficial effects. Both diets are beneficial for lipid management, reduce cardiovascular risk, promote weight loss, and improve glycemic control in patients with type 2 diabetes. However, in most studies, the Mediterranean diet shows a higher health-promoting potential than the vegetarian diet, particularly regarding triglyceride levels, control of glycemia and blood pressure, and total cancer risk. Additionally, adherence to the Mediterranean diet is related to a lower risk of nutritional deficiencies than vegetarianism. At the same time, adherence to the Mediterranean diet does not require complete exclusion of meat products which can be less challenging, contrary to the vegetarian diet. Hence, as long as vegetarian diets can provide numerous health benefits, the Mediterranean dietary model may preliminarily appear superior in public health strategies aiming to decrease the burden of various chronic diseases in which lifestyle factors play a significant role. More studies, primarily based on cross-over design and conducted on different populations and risk groups, are required to fully understand the difference in health outcomes between those two diets and draw definitive conclusions.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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REFERENCES

1. Ahmed, F.S., Wade, A.T., Guenther, B.A., Murphy, K.J., Elias, M.F. (2020). Adherence to a Mediterranean diet associated with lower blood pressure in a US sample: Findings from the Maine-Syracuse Longitudinal Study. *Journal of Clinical Hypertension*, *22*(12), 2276–2284. https://doi.org/10.1111/jch.14068
2. Allen, A.E., Locasale, J.W. (2021). Metabolomics: insights into plant-based diets. *EMBO Molecular Medicine*, *13*(2), art. no. e13568. https://doi.org/10.15252/emmm.202013568
3. Alzahrani, F., Alshahrani, N.Z., Abu Sabah, A., Zarbah, A., Abu Sabah, S., Mamun, M.A. (2022). Prevalence and factors associated with mental health problems in Saudi general population during the coronavirus disease 2019 pandemic: A systematic review and meta-analysis. *PsyCh Journal*, *11*(1), 18–29. https://doi.org/10.1002/pchj.516
4. Antoniazzi, L., Arroyo-Olivares, R., Bittencourt, M.S., Tada, M.T., Lima, I., Jannes, C.E., Krieger, J.E., Pereira, A.C., Quintana-Navarro, G, Muñiz-Grijalvo, O., Díaz-Díaz, J.L., Alonso, R., Mata, P., Santos, R.D. (2021). Adherence to a Mediterranean diet, dyslipidemia and inflammation in familial hypercholesterolemia. *Nutrition, Metabolism and Cardiovascular Diseases*, *31*(7), 2014–2022. https://doi.org/10.1016/j.numecd.2021.04.006
5. Arora, R.S., Brent, D.A., Jaenicke, E.C. (2020). Is India ready for alt-meat? Preferences and willingness to pay for meat alternatives. *Sustainability*, *12*(11), art. no. 4377. https://doi.org/10.3390/su12114377
6. Askari, M., Daneshzad, E., Darooghegi Mofrad, M., Bellissimo, N., Suitor, K., Azadbakht, L. (2022). Vegetarian diet and the risk of depression, anxiety, and stress symptoms: a systematic review and meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*, *62*(1), 261–271. https://doi.org/10.1080/10408398.2020.1814991
7. Austin, G., Ferguson, J.J.A., Garg, M.L. (2021). Effects of plant-based diets on weight status in type 2 diabetes: A systematic review and meta-analysis of randomised controlled trials. *Nutrients*, *13*(11), art. no. 4099. https://doi.org/10.3390/nu13114099
8. Bakaloudi, D.R., Chrysoula, L., Leonida, I., Kotzakioulafi, E., Theodoridis, X., Chourdakis, M. (2021). Impact of the level of adherence to the Mediterranean Diet on blood pressure: A systematic review and meta-analysis of observational studies. *Clinical Nutrition*, *40*(12), 5771–5780. https://doi.org/10.1016/j.clnu.2021.10.002
9. Becerra-Tomás, N., Blanco Mejía, S., Viguiliouk, E., Khan, T., Kendall, C.W.C., Kahleova, H., Rahelić, D., Sievenpiper, J.L., Salas-Salvadó, J. (2020). Mediterranean diet, cardiovascular disease and mortality in diabetes: A systematic review and meta-analysis of prospective cohort studies and randomized clinical trials. *Critical Reviews in Food Science and Nutrition*, *60*(7), 1207–1227. https://doi.org/10.1080/10408398.2019.1565281
10. Bègue, L., Shankland, R. (2022). Is vegetarianism related to anxiety and depression? A cross-sectional survey in a French sample. *Journal of Health, Population, and Nutrition*, *41*(1), art. no. 18. https://doi.org/10.1186/s41043-022-00300-2
11. Bellary, S., Kyrou, I., Brown, J.E., Bailey, C.J. (2021). Type 2 diabetes mellitus in older adults: clinical considerations and management. *Nature Reviews Endocrinology*, *17*(9), 534–548. https://doi.org/10.1038/s41574-021-00512-2
12. Benson, G., Hayes, J. (2020). An update on the Mediterranean, vegetarian, and DASH eating patterns in people withtype 2 diabetes. *Diabetes Spectrum*, *33*(2), 125–132. https://doi.org/10.2337/ds19-0073

13. Bloomfield, H.E., Koeller, E., Greer, N., MacDonald, R., Kane, R., Wilt, T.J. (2016). Effects on health outcomes of a Mediterranean diet with no restriction on fat intake: A systematic review and meta-analysis. *Annals of Internal Medicine*, *165*(7), 491–500. https://doi.org/10.7326/M16-0361
14. Bonaccio, M., Bes-Rastrollo, M., de Gaetano, G., Iacoviello, L. (2016). Challenges to the Mediterranean diet at a time of economic crisis. *Nutrition, Metabolism and Cardiovascular Diseases*, *26*(12), 1057–1063. https://doi.org/10.1016/j.numecd.2016.07.005
15. Burrows, T., Teasdale, S., Rocks, T., Whatnall, M., Schindlmayr, J., Plain, J., Latimer, G., Roberton, M., Harris, D., Forsyth, A. (2022). Effectiveness of dietary interventions in mental health treatment: A rapid review of reviews. *Nutrition and Dietetics*, *79*(3), 279–290. https://doi.org/10.1111/1747-0080.12754
16. Chang, C.-Y., Chang, H.-R., Lin, H.-C., Chang, H.-H. (2018). Comparison of renal function and other predictors in lacto-ovo vegetarians and omnivores with chronic kidney disease. *Journal of the American College of Nutrition*, *37*(6), 466–471. https://doi.org/10.1080/07315724.2018.1424588
17. Chen, G.-C., Neelakantan, N., Martín-Calvo, N., Koh, W.-P., Yuan, J.-M., Bonaccio, M., Iacoviello, L., Martínez-González, M.A., Qin, L.-Q., van Dam, R.M. (2019). Adherence to the Mediterranean diet and risk of stroke and stroke subtypes. *European Journal of Epidemiology*, *34*(4), 337–349. https://doi.org/10.1007/s10654-019-00504-7
18. Cheng, S., Zheng, Q., Ding, G., Li, G. (2019). Mediterranean dietary pattern and the risk of prostate cancer: A meta-analysis. *Medicine*, *98*(27), art. no. e16341. https://doi.org/10.1097/MD.0000000000016341
19. Choudhury, D., Singh, S., Seah, J.S.H., Yeo, D.C.L., Tan, L.P. (2020). Commercialization of plant-based meat alternatives. *Trends in Plant Science*, *25*(11), 1055–1058. https://doi.org/10.1016/j.tplants.2020.08.006
20. Cowell, O.R., Mistry, N., Deighton, K., Matu, J., Griffiths, A., Minihane, A.M., Mathers, J.C., Shannon, O.M., Siervo, M. (2021). Effects of a Mediterranean diet on blood pressure: a systematic review and meta-analysis of randomized controlled trials and observational studies. *Journal of Hypertension*, *39*(4), 729–739. https://doi.org/10.1097/HJH.0000000000002667
21. Craddock, J.C., Neale, E.P., Peoples, G.E., Probst, Y.C. (2019). Vegetarian-based dietary patterns and their relation with inflammatory and immune biomarkers: A systematic review and meta-analysis. *Advances in Nutrition*, *10*(3), 433–451. https://doi.org/10.1093/advances/nmy103
22. da Silva, R., Bach-Faig, A., Raidó Quintana, B., Buckland, G., Vaz de Almeida, M.D., Serra-Majem, L. (2009). Worldwide variation of adherence to the Mediterranean diet, in 1961–1965 and 2000–2003. *Public Health Nutrition*, *12*(9A), 1676–1684. https://doi.org/10.1017/S1368980009990541
23. Dai, S., Xiao, X., Xu, C., Jiao, Y., Qin, Z., Meng, J., Zuo, H., Zeng, P., Tang, D., Wu, X., Nima, Q., Quzong, D., Zhao, X. (China Multi-Ethnic Cohort Study Collaborative Group). (2022). Association of Dietary Approaches to Stop Hypertension diet and Mediterranean diet with blood pressure in less-developed ethnic minority regions. *Public Health Nutrition*, 1–11. https://doi.org/10.1017/S1368980022000106
24. Damayanti, D., Jaceldo-Siegl, K., Beeson, W.L., Fraser, G., Oda, K., Haddad, E.H. (2018). Foods and supplements associated with vitamin B12 biomarkers among vegetarian and non-vegetarian participants of the Adventist Health Study-2 (AHS-2) calibration study. *Nutrients*, *10*(6), art. no. 722. https://doi.org/10.3390/nu10060722
25. Daniele, S., Scarfò, G., Ceccarelli, L., Fusi, J., Zappelli, E., Biagini, D., Lomonaco, T., Di Francesco, F., Franzoni, F., Martini, C. (2021). The Mediterranean diet positively affects resting metabolic rate and salivary microbiota in human subjects: A comparison with the vegan regimen, *Biology*, *10*(12), art. no. 1292. https://doi.org/10.3390/biology10121292
26. Davis, C., Bryan, J., Hodgson, J., Murphy, K. (2015). Definition of the Mediterranean diet; A literature review. *Nutrients*, *7*(11), 9139–9153. https://doi.org/10.3390/nu7115459
27. Derbyshire, E.J. (2017). Flexitarian diets and health: A review of the evidence-based literature. *Frontiers in Nutrition*, *3*, art. no. 55. https://doi.org/10.3389/fnut.2016.00055
28. Di Mauro, A., Tuccinardi, D., Watanabe, M., Del Toro, R., Monte, L., Giorgino, R., Rampa, L., Rossini, G., Kyanvash, S., Soare, A., Rosati, M., Piccoli, A., Napoli, N., Fioriti, E., Pozzilli, P., Khazrai, Y.M., Manfrini, S. (2021). The Mediterranean diet increases glucagon-like peptide 1 and oxyntomodulin compared with a vegetarian diet in patients with type 2 diabetes: A randomized controlled cross-over trial. *Diabetes/Metabolism Research and Reviews*, *37*(6), art. no. e3406. https://doi.org/10.1002/dmrr.3406
29. Dinu, M., Abbate, R., Gensini, G.F., Casini, A., Sofi, F. (2017). Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*, *57*(17), 3640–3649. https://doi.org/10.1080/10408398.2016.1138447
30. Dinu, M., Colombini, B., Pagliai, G., Giangrandi, I., Cesari, F., Gori, A., Giusti, B., Marcucci, R., Sofi, F. (2021). Effects of vegetarian versus Mediterranean diet on kidney function: Findings from the CARDIVEG study. *European Journal of Clinical Investigation*, *51*(9), art. no. e13576. https://doi.org/10.1111/eci.13576
31. Djekic, D., Shi, L., Brolin, H., Carlsson, F., Särnqvist, C., Savolainen, O., Cao, Y., Bäckhed, F., Tremaroli, V., Landberg, R., Frøbert, O. (2020). Effects of a vegetarian diet on cardiometabolic risk factors, gut microbiota, and plasma metabolome in subjects with ischemic heart disease: A randomized, crossover study. *Journal of the American Heart Association*, *9*(18), art. no. e016518. https://doi.org/10.1161/JAHA.120.016518
32. Esposito, K., Kastorini, C.-M., Panagiotakos, D.B., Giugliano, D. (2011). Mediterranean diet and weight loss: Meta-analysis of randomized controlled trials. *Metabolic Syndrome and Related Disorders*, *9*(1), 1–12. https://doi.org/10.1089/met.2010.0031
33. Esposito, K., Maiorino, M.I., Bellastella, G., Chiodini, P., Panagiotakos, D., Giugliano, D. (2015). A journey into a Mediterranean diet and type 2 diabetes: a systematic review with meta-analyses. *BMJ Open*, *5*(8), art. no. e008222. https://doi.org/10.1136/bmjopen-2015-008222
34. Fehér, A., Gazdecki, M., Véha, M., Szakály, M., Szakály, Z. (2020). A comprehensive review of the benefits of and the bar-

riers to the switch to a plant-based diet. *Sustainability*, *12*(10), art. no. 4136. https://doi.org/10.3390/su12104136

35. Feng, Y., Kang, K., Xue, Q., Chen, Y., Wang, W., Cao, J. (2020). Value of plasma homocysteine to predict stroke, cardiovascular diseases, and new-onset hypertension: A retrospective cohort study. *Medicine*, *99*(34), art. no. e21541. https://doi.org/10.1097/MD.0000000000021541
36. Filippou, C.D., Thomopoulos, C.G., Kouremeti, M.M., Sotiropoulou, L.I., Nihoyannopoulos, P.I., Tousoulis, D.M., Tsioufis, C.P. (2021). Mediterranean diet and blood pressure reduction in adults with and without hypertension: A systematic review and meta-analysis of randomized controlled trials. *Clinical Nutrition*, *40*(5), 3191–3200. https://doi.org/10.1016/j.clnu.2021.01.030
37. Filomeno, M., Bosetti, C., Bidoli, E., Levi, F., Serraino, D., Montella, M., La Vecchia, C., Tavani, A. (2015). Mediterranean diet and risk of endometrial cancer: a pooled analysis of three italian case-control studies. *British Journal of Cancer*, *112*(11), 1816–1821. https://doi.org/10.1038/bjc.2015.153
38. Fontes, T., Rodrigues, L.M., Ferreira-Pêgo, C. (2022). Comparison between different groups of vegetarianism and its associations with body composition: A literature review from 2015 to 2021. *Nutrients*, *14*(9), art. no. 1853. https://doi.org/10.3390/nu14091853
39. Franco-de-Moraes, A.C., de Almeida-Pititto, B., da Rocha Fernandes, G., Gomes, E. P., da Costa Pereira, A., Ferreira, S.R.G. (2017). Worse inflammatory profile in omnivores than in vegetarians associates with the gut microbiota composition. *Diabetology and Metabolic Syndrome*, *9*(1), art. no. 62. https://doi.org/10.1186/s13098-017-0261-x
40. Gan, Z.H., Cheong, H.C., Tu, Y.-K., Kuo, P.-H. (2021). Association between plant-based dietary patterns and risk of cardiovascular disease: A systematic review and meta-analysis of prospective cohort studies. *Nutrients*, *13*(11), art. no. 3952. https://doi.org/10.3390/nu13113952
41. Garneata, L., Stancu, A., Dragomir, D., Stefan, G., Mircescu, G. (2016). Ketoanalogue-supplemented vegetarian very low-protein diet and CKD progression. *Journal of the American Society of Nephrology*, *27*(7), 2164–2176. https://doi.org/10.1681/ASN.2015040369
42. Ge, L., Sadeghirad, B., Ball, G.D.C., da Costa, B.R., Hitchcock, C.L., Svendrovski, A., Kiflen, R., Quadri, K., Kwon, H.Y., Karamouzian, M., Adams-Webber, T., Ahmed, W., Damanhoury, S., Zeraatkar, D., Nikolakopoulou, A., Tsuyuki, R.T., Tian, J., Yang, K., Guyatt, G.H., Johnston, B.C. (2020). Comparison of dietary macronutrient patterns of 14 popular named dietary programmes for weight and cardiovascular risk factor reduction in adults: systematic review and network meta-analysis of randomised trials. *BMJ*, *369*, art. no. m696. https://doi.org/10.1136/bmj.m696
43. Gehring, J., Touvier, M., Baudry, J., Julia, C., Buscail, C., Srour, B., Hercberg, S., Péneau, S., Kesse-Guyot, E., Allès, B. (2021). Consumption of ultra-processed foods by pesco-vegetarians, vegetarians, and vegans: Associations with duration and age at diet initiation. *The Journal of Nutrition*, *151*(1), 120–131. https://doi.org/10.1093/jn/nxaa196
44. Gioxari, A., Tzanos, D., Kostara, C., Papandreou, P., Mountzios, G., Skouroliakou, M. (2021). Mediterranean diet implementation to protect against advanced lung cancer index (ALI) rise: Study design and preliminary results of a randomised controlled trial. *International Journal of Environmental Research and Public Health*, *18*(7), art. no. 3700. https://doi.org/10.3390/ijerph18073700
45. Godos, J., Bella, F., Sciacca, S., Galvano, F., Grosso, G. (2017). Vegetarianism and breast, colorectal and prostate cancer risk: an overview and meta-analysis of cohort studies. *Journal of Human Nutrition and Dietetics*, *30*(3), 349–359. https://doi.org/10.1111/jhn.12426
46. Haghighatdoost, F., Bellissimo, N., Totosy de Zepetnek, J.O., Rouhani, M.H. (2017). Association of vegetarian diet with inflammatory biomarkers: a systematic review and meta-analysis of observational studies. *Public Health Nutrition*, *20*(15), 2713––2721. https://doi.org/10.1017/S1368980017001768
47. Hansrivijit, P., Oli, S., Khanal, R., Ghahramani, N., Thongprayoon, C., Cheungpasitporn, W. (2020). Mediterranean diet and the risk of chronic kidney disease: A systematic review and meta-analysis. *Nephrology*, *25*(12), 913–918. https://doi.org/10.1111/nep.13778
48. Hargreaves, S.M., Raposo, A., Saraiva, A., Zandonadi, R.P. (2021). Vegetarian diet: An overview through the perspective of quality of life domains. *International Journal of Environmental Research and Public Health*, *18*(8), art. no. 4067. https://doi.org/10.3390/ijerph18084067
49. Haro, C., García-Carpintero, S., Rangel-Zúñiga, O.A., Alcalá-Díaz, J.F., Landa, B.B., Clemente, J.C., Pérez-Martínez, P., López-Miranda, J., Pérez-Jiménez, F., Camargo, A. (2017). Consumption of two healthy dietary patterns restored microbiota dysbiosis in obese patients with metabolic dysfunction. *Molecular Nutrition and Food Research*, *61*(12), art. no. 1700300. https://doi.org/10.1002/mnfr.201700300
50. Hopwood, C.J. (2022). The link between vegetarian diet and depression might be explained by depression among meat-reducers. *Food Quality and Preference*, *102*, art. no. 104679. https://doi.org/10.1016/j.foodqual.2022.104679
51. Huang, R.-Y., Huang, C.-C., Hu, F.B., Chavarro, J.E. (2016). Vegetarian diets and weight reduction: a meta-analysis of randomized controlled trials. *Journal of General Internal Medicine*, *31*(1), 109–116. https://doi.org/10.1007/s11606-015-3390-7
52. Huang, T., Yang, B., Zheng, J., Li, G., Wahlqvist, M.L., Li, D. (2012). Cardiovascular disease mortality and cancer incidence in vegetarians: A meta-analysis and systematic review. *Annals of Nutrition and Metabolism*, *60*(4), 233–240. https://doi.org/10.1159/000337301
53. Iguacel, I., Huybrechts, I., Moreno, L.A., Michels, N. (2021). Vegetarianism and veganism compared with mental health and cognitive outcomes: a systematic review and meta-analysis. *Nutrition Reviews*, *79*(4), 361–381. https://doi.org/10.1093/nutrit/nuaa030
54. Illescas, O., Rodríguez-Sosa, M., Gariboldi, M. (2021). Mediterranean diet to prevent the development of colon diseases: A meta-analysis of gut microbiota studies. *Nutrients*, *13*(7), art. no. 2234. https://doi.org/10.3390/nu13072234
55. Jennings, A., Berendsen, A.M., de Groot, L.C.P.G.M., Feskens, E.J.M., Brzozowska, A., Sicinska, E., Pietruszka, B., Meunier,

N., Caumon, E., Malpuech-Brugère, C., Santoro, A., Ostan, R., Franceschi, C., Gillings, R., O' Neill, C.M., Fairweather-Tait, S.J., Minihane A.-M., Cassidy, A. (2019). Mediterranean-style diet improves systolic blood pressure and arterial stiffness in older adults. *Hypertension*, *73*(3), 578–586. https://doi.org/10.1161/HYPERTENSIONAHA.118.12259

56. Jin, Y., Kandula, N.R., Kanaya, A.M., Talegawkar, S.A. (2021). Vegetarian diet is inversely associated with prevalence of depression in middle-older aged South Asians in the United States. *Ethnicity and Health*, *26*(4), 504–511. https://doi.org/10.1080/13557858.2019.1606166
57. Kohnert, E., Kreutz, C., Binder, N., Hannibal, L., Gorkiewicz, G., Müller, A., Storz, M.A., Huber, R., Lederer, A.-K. (2021). Changes in gut microbiota after a four-week intervention with vegan *vs.* meat-rich diets in healthy participants: A randomized controlled trial. *Microorganisms*, *9*(4), art. no. 727. https://doi.org/10.3390/microorganisms9040727
58. Koloverou, E., Esposito, K., Giugliano, D., Panagiotakos, D. (2014). The effect of Mediterranean diet on the development of type 2 diabetes mellitus: A meta-analysis of 10 prospective studies and 136,846 participants. *Metabolism*, *63*(7), 903–911. https://doi.org/10.1016/j.metabol.2014.04.010
59. Lavallee, K., Zhang, X.C., Michalak, J., Schneider, S., Margraf, J. (2019). Vegetarian diet and mental health: Cross-sectional and longitudinal analyses in culturally diverse samples. *Journal of Affective Disorders*, *248*, 147–154. https://doi.org/10.1016/j.jad.2019.01.035
60. Lawrence, J.M., Divers, J., Isom, S., Saydah, S., Imperatore, G., Pihoker, C., Marcovina, S.M., Mayer-Davis, E.J., Hamman, R.F., Dolan, L., Dabelea, D., Pettitt, D.J., Liese, A.D. (SEARCH Diabet Youth Study Grp). (2021). Trends in prevalence of type 1 and type 2 diabetes in children and adolescents in the US, 2001–2017. *JAMA*, *326*(8), 717–727. https://doi.org/10.1001/jama.2021.11165
61. Lee, K.W., Loh, H.C., Ching, S.M., Devaraj, N.K., Hoo, F.K. (2020). Effects of vegetarian diets on blood pressure lowering: A systematic review with meta-analysis and trial sequential analysis. *Nutrients*, *12*(6), art. no. 1604. https://doi.org/10.3390/nu12061604
62. Lee, M.F., Eather, R., Best, T. (2021). Plant-based dietary quality and depressive symptoms in Australian vegans and vegetarians: a cross-sectional study. *BMJ Nutrition, Prevention and Health*, *4*(2), 479–486. https://doi.org/10.1136/bmjnph-2021-000332
63. Lee, Y., Park, K. (2017). Adherence to a vegetarian diet and diabetes risk: A systematic review and meta-analysis of observational studies. *Nutrients*, *9*(6), art. no. 603. https://doi.org/10.3390/nu9060603
64. Liyanage, T., Ninomiya, T., Wang, A., Neal, B., Jun, M., Wong, M.G., Jardine, M., Hillis, G.S., Perkovic, V. (2016). Effects of the Mediterranean diet on cardiovascular outcomes—A systematic review and meta-analysis. *PLoS ONE*, *11*(8), art. no. e0159252. https://doi.org/10.1371/journal.pone.0159252
65. Lotfi, K., Saneei, P., Hajhashemy, Z., Esmaillzadeh, A. (2022). Adherence to the Mediterranean diet, five-year weight change, and risk of overweight and obesity: A systematic review and dose-response meta-analysis of prospective cohort studies. *Advances in Nutrition*, *13*(1), 152–166. https://doi.org/10.1093/advances/nmab092
66. Lu, J.-W., Yu, L.-H., Tu, Y.-K., Cheng, H.-Y., Chen, L.-Y., Loh, C.-H., Chen, T.-L. (2021). Risk of incident stroke among vegetarians compared to nonvegetarians: A systematic review and meta-analysis of prospective cohort studies. *Nutrients*, *13*(9), art. no. 3019. https://doi.org/10.3390/nu13093019
67. Lucey, A., Heneghan, C., Kiely, M.E. (2016). Guidance for the design and implementation of human dietary intervention studies for health claim submissions. *Nutrition Bulletin*, *41*(4), 378–394. https://doi.org/10.1111/nbu.12241
68. Macdiarmid, J.I., Douglas, F., Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite*, *96*, 487–493. https://doi.org/10.1016/j.appet.2015.10.011
69. Magriplis, E., Panagiotakos, D., Kyrou, I., Tsioufis, C., Mitsopoulou, A.-V., Karageorgou, D., Dimakopoulos, I., Bakogianni, I., Chourdakis, M., Micha, R., Michas, G., Ntouroupi, T., Tsaniklidou, S.-M., Argyri, K., Zampelas, A. (2020). Presence of hypertension is reduced by Mediterranean diet adherence in all individuals with a more pronounced effect in the obese: The Hellenic National Nutrition and Health Survey (HNNHS). *Nutrients*, *12*(3), art. no. 853. https://doi.org/10.3390/nu12030853
70. Männistö, S., Harald, K., Härkänen, T., Maukonen, M., Eriksson, J.G., Heikkinen, S., Jousilahti, P., Kaartinen, N.E., Kanerva, N., Knekt, P., Koskinen, S., Laaksonen, M.A., Malila, N., Rissanen, H., Pitkäniemi, J. (2021). Association between overall diet quality and postmenopausal breast cancer risk in five Finnish cohort studies. *Scientific Reports*, *11*(1), art. no. 16718. https://doi.org/10.1038/s41598-021-95773-2
71. Mariotti, F., Gardner, C.D. (2019). Dietary protein and amino acids in vegetarian diets – A review. *Nutrients, 11*(11), art. no. 2661. https://doi.org/10.3390/nu11112661
72. Matsumoto, S., Beeson, W.L., Shavlik, D.J., Siapco, G., Jaceldo-Siegl, K., Fraser, G., Knutsen, S.F. (2019). Association between vegetarian diets and cardiovascular risk factors in non-Hispanic white participants of the Adventist Health Study-2. *Journal of Nutritional Science*, *8*, art. no. e6. https://doi.org/10.1017/jns.2019.1
73. Mayr, H.L., Tierney, A.C., Thomas, C.J., Ruiz-Canela, M., Radcliffe, J., Itsiopoulos, C. (2018). Mediterranean-type diets and inflammatory markers in patients with coronary heart disease: a systematic review and meta-analysis. *Nutrition Research*, *50*, 10–24. https://doi.org/10.1016/j.nutres.2017.10.014
74. Meleady, R., Graham, I. (1999). Plasma homocysteine as a cardiovascular risk factor: Causal, consequential, or of no consequence? *Nutrition Reviews*, *57*(10), 299–305. https://doi.org/10.1111/j.1753-4887.1999.tb06902.x
75. Melina, V., Craig, W., Levin, S. (2016). Position of the Academy of Nutrition and Dietetics: Vegetarian diets. *Journal of the Academy of Nutrition and Dietetics*, *116*(12), 1970–1980. https://doi.org/10.1016/j.jand.2016.09.025
76. Mellor, R., Saunders-Dow, E., Mayr, H.L. (2022). Scope of use and effectiveness of dietary interventions for improving health-related outcomes in veterans: A systematic review. *Nutrients*, *14*(10), art. no. 2094. https://doi.org/10.3390/nu14102094

77. Menzel, J., Jabakhanji, A., Biemann, R., Mai, K., Abraham, K., Weikert, C. (2020). Systematic review and meta-analysis of the associations of vegan and vegetarian diets with inflammatory biomarkers. *Scientific Reports*, *10*(1), art. no. 21736. https://doi.org/10.1038/s41598-020-78426-8
78. Middleton, G., Keegan, R., Smith, M.F., Alkhatib, A., Klonizakis, M. (2015). Implementing a Mediterranean diet intervention into a RCT: Lessons learned from a non-Mediterranean based country. *The Journal of Nutrition, Health and Aging*, *19*(10), 1019–1022. https://doi.org/10.1007/s12603-015-0663-0
79. Mirmiran, P., Bahadoran, Z., Gaeini, Z. (2021). Common limitations and challenges of dietary clinical trials for translation into clinical practices. *International Journal of Endocrinology and Metabolism*, *19*(3), art. no. e108170. https://doi.org/10.5812/ijem.108170
80. Moe, S.M., Zidehsarai, M.P., Chambers, M.A., Jackman, L.A., Radcliffe, J.S., Trevino, L.L., Donahue, S.E., Asplin, J.R. (2011). Vegetarian compared with meat dietary protein source and phosphorus homeostasis in chronic kidney disease. *Clinical Journal of the American Society of Nephrology*, *6*(2), 257–264. https://doi.org/10.2215/CJN.05040610
81. Molina-Montes, E., Salamanca-Fernández, E., Garcia-Villanova, B., Sánchez, M.J. (2020). The impact of plant-based dietary patterns on cancer-related outcomes: A rapid review and meta-analysis. *Nutrients*, *12*(7), art. no. 2010. https://doi.org/10.3390/nu12072010
82. Montano, L., Maugeri, A., Volpe, M.G., Micali, S., Mirone, V., Mantovani, A., Navarra, M., Piscopo, M. (2022). Mediterranean diet as a shield against male infertility and cancer risk induced by environmental pollutants: A focus on flavonoids. *International Journal of Molecular Sciences*, *23*(3), art. no. 1568. https://doi.org/10.3390/ijms23031568
83. Morze, J., Danielewicz, A., Przybyłowicz, K., Zeng, H., Hoffmann, G., Schwingshackl, L. (2021). An updated systematic review and meta-analysis on adherence to mediterranean diet and risk of cancer. *European Journal of Nutrition*, *60*(3), 1561–1586. https://doi.org/10.1007/s00394-020-02346-6
84. Nagpal, R., Shively, C.A., Register, T.C., Craft, S., Yadav, H. (2019). Gut microbiome-Mediterranean diet interactions in improving host health. *F1000Research*, *8*, art. no. 699. https://doi.org/10.12688/f1000research.18992.1
85. Neuenschwander, M., Hoffmann, G., Schwingshackl, L., Schlesinger, S. (2019). Impact of different dietary approaches on blood lipid control in patients with type 2 diabetes mellitus: a systematic review and network meta-analysis. *European Journal of Epidemiology*, *34*(9), 837–852. https://doi.org/10.1007/s10654-019-00534-1
86. Nissensohn, M., Román-Viñas, B., Sánchez-Villegas, A., Piscopo, S., Serra-Majem, L. (2016). The effect of the Mediterranean diet on hypertension: A systematic review and meta-analysis. *Journal of Nutrition Education and Behavior*, *48*(1), 42–53.e1. https://doi.org/10.1016/j.jneb.2015.08.023
87. Obeid, C.A., Gubbels, J.S., Jaalouk, D., Kremers, S.P.J., Oenema, A. (2022). Adherence to the Mediterranean diet among adults in Mediterranean countries: a systematic literature review. *European Journal of Nutrition*, *61*(7), 3327–3344. https://doi.org/10.1007/s00394-022-02885-0
88. Obersby, D., Chappell, D.C., Dunnett, A., Tsiami, A.A. (2013). Plasma total homocysteine status of vegetarians compared with omnivores: a systematic review and meta-analysis. *British Journal of Nutrition*, *109*(5), 785–794. https://doi.org/10.1017/S000711451200520X
89. Ocklenburg, S., Borawski, J. (2021). Vegetarian diet and depression scores: A meta-analysis. *Journal of Affective Disorders*, *294*, 813–815. https://doi.org/10.1016/j.jad.2021.07.098
90. Ohlau, M., Spiller, A., Risius, A. (2022). Plant-based diets are not enough? Understanding the consumption of plant-based meat alternatives along ultra-processed foods in different dietary patterns in Germany. *Frontiers in Nutrition*, *9*, art. no. 852936. https://doi.org/10.3389/fnut.2022.852936
91. O'Keefe, L., McLachlan, C., Gough, C., Mander, S., Bows-Larkin, A. (2016). Consumer responses to a future UK food system. *British Food Journal*, *118*(2), 412–428. https://doi.org/10.1108/BFJ-01-2015-0047
92. Pagliai, G., Russo, E., Niccolai, E., Dinu, M., Di Pilato, V., Magrini, A., Bartolucci, G., Baldi, S., Menicatti, M., Giusti, B., Marcucci, R., Rossolini, G.M., Casini, A., Sofi F., Amedei, A. (2020). Influence of a 3-month low-calorie Mediterranean diet compared to the vegetarian diet on human gut microbiota and SCFA: the CARDIVEG Study. *European Journal of Nutrition*, *59*(5), 2011–2024. https://doi.org/10.1007/s00394-019-02050-0
93. Panbehkar-Jouybari, M. Mollahosseini M., Salehi-Abargouei, A., Fallahzadeh, H., Mirzaei, M., Hosseinzadeh, M. (2021). The Mediterranean diet and dietary approach to stop hypertension (DASH)-style diet are differently associated with lipid profile in a large sample of Iranian adults: a cross-sectional study of Shahedieh cohort, *BMC Endocrine Disorders*, *21*, art. no. 192. https://doi.org/10.1186/s12902-021-00856-w
94. Paslakis, G., Richardson, C., Nöhre, M., Brähler, E., Holzapfel, C., Hilbert, A., de Zwaan, M. (2020). Prevalence and psychopathology of vegetarians and vegans – Results from a representative survey in Germany. *Scientific Reports*, *10*(1), art. no. 6840. https://doi.org/10.1038/s41598-020-63910-y
95. Pawlak, R. (2015). Is vitamin B12 deficiency a risk factor for cardiovascular disease in vegetarians? *American Journal of Preventive Medicine*, *48*(6), e11–e26. https://doi.org/10.1016/j.amepre.2015.02.009
96. Petermann-Rocha, F., Parra-Soto, S., Gray, S., Anderson, J., Welsh, P., Gill, J., Sattar, N., Ho, F.K., Celis-Morales, C., Pell, J.P. (2021). Vegetarians, fish, poultry, and meat-eaters: who has higher risk of cardiovascular disease incidence and mortality? A prospective study from UK Biobank. *European Heart Journal*, *42*(12), 1136–1143. https://doi.org/10.1093/eurheartj/ehaa939
97. Podadera-Herreros, A., Alcala-Diaz, J.F., Gutierrez-Mariscal, F.M., Jimenez-Torres, J., de la Cruz-Ares, S., Arenas-de Larriva, A.P., Cardelo, M.P., Torres-Peña, J.D., Luque, R.M., Ordovas, J.M., Delgado-Lista, J., Lopez-Miranda, J., Yubero-Serrano, E.M. (2022). Long-term consumption of a mediterranean diet or a low-fat diet on kidney function in coronary heart disease patients: The CORDIOPREV randomized controlled trial. *Clinical Nutrition*, *41*(2), 552–559. https://doi.org/10.1016/j.clnu.2021.12.041
98. Psaltopoulou, T., Sergentanis, T.N., Panagiotakos, D.B., Sergentanis, I.N., Kosti, R., Scarmeas, N. (2013). Mediterranean diet, stroke, cognitive impairment, and depression: A meta-analysis. *Annals of Neurology*, *74*(4), 580–591. https://doi.org/10.1002/ana.23944

99. Quek, J., Lim, G., Lim, W.H., Ng, C.H., So, W.Z., Toh, J., Pan, X.H., Chin, Y.H., Muthiah, M.D., Chan, S.P., Foo, R.S.Y., Yip, J., Neelakantan, N., Chong, M.F.F., Loh, P.H., Chew, N.W.S. (2021). The association of plant-based diet with cardiovascular disease and mortality: A meta-analysis and systematic review of prospect cohort studies. *Frontiers in Cardiovascular Medicine*, *8*, art. no. 756810. https://doi.org/10.3389/fcvm.2021.756810
100. Rosenfeld, D.L. (2019). Ethical motivation and vegetarian dieting: The underlying role of anti-speciesist attitudes. *Anthrozoös*, *32*(6), 785–796. https://doi.org/10.1080/08927936.2019.1673048
101. Rosenfeld, D.L., Burrow, A.L. (2017). Vegetarian on purpose: Understanding the motivations of plant-based dieters. *Appetite*, *116*, 456–463. https://doi.org/10.1016/j.appet.2017.05.039
102. Sabaté, J. (2003). The contribution of vegetarian diets to health and disease: a paradigm shift? *The American Journal of Clinical Nutrition*, *78*(3), 502S–507S. https://doi.org/10.1093/ajcn/78.3.502S
103. Schwingshackl, L., Missbach, B., König, J., Hoffmann G. (2015). Adherence to a Mediterranean diet and risk of diabetes: a systematic review and meta-analysis. *Public Health Nutrition*, *18*(7), 1292–1299. https://doi.org/10.1017/S1368980014001542
104. Schönenberger, K.A., Schüpfer, A.-C., Gloy, V.L., Hasler, P., Stanga, Z., Kaegi-Braun, N., Reber, E. (2021). Effect of anti-inflammatory diets on pain in rheumatoid arthritis: A systematic review and meta-analysis. *Nutrients*, *13*(12), art. no. 4221. https://doi.org/10.3390/nu13124221
105. Schulpen, M., van den Brandt, P.A. (2021). Adherence to the Mediterranean diet and overall cancer incidence: The Netherlands Cohort Study. *Journal of the Academy of Nutrition and Dietetics*, *121*(2), 242–252. https://doi.org/10.1016/j.jand.2020.07.025
106. Schwingshackl, L., Chaimani, A., Hoffmann, G., Schwedhelm, C., Boeing, H. (2018). A network meta-analysis on the comparative efficacy of different dietary approaches on glycaemic control in patients with type 2 diabetes mellitus. *European Journal of Epidemiology*, *33*(2), 157–170. https://doi.org/10.1007/s10654-017-0352-x
107. Schwingshackl, L., Chaimani, A., Schwedhelm, C., Toledo, E., Pünsch, M., Hoffmann, G., Boeing, H. (2019). Comparative effects of different dietary approaches on blood pressure in hypertensive and pre-hypertensive patients: A systematic review and network meta-analysis. *Critical Reviews in Food Science and Nutrition*, *59*(16), 2674–2687. https://doi.org/10.1080/10408398.2018.1463967
108. Schwingshackl, L., Hoffmann, G. (2014a). Mediterranean dietary pattern, inflammation and endothelial function: A systematic review and meta-analysis of intervention trials. *Nutrition, Metabolism and Cardiovascular Diseases*, *24*(9), 929–939. https://doi.org/10.1016/j.numecd.2014.03.003
109. Schwingshackl, L., Hoffmann, G. (2014b). Adherence to Mediterranean diet and risk of cancer: A systematic review and meta-analysis of observational studies: Mediterranean diet and cancer risk. *International Journal of Cancer*, *135*(8), 1884–1897. https://doi.org/10.1002/ijc.28824
110. Septiadi, E., Rusman, A.A., Prawira, A.H., Anugrah, R.A., Rohman, N.M., Rais, M.A., Faradina, M.A., Nugraha, R.F. (2021). Decrease blood pressure on hypertensive patients with Mediterranean diet. In *Proceedings of the 12th Annual Scientific Meeting, Medical Faculty, Universitas Jenderal Achmad Yani, International Symposium on "Emergency Preparedness and Disaster Response during COVID 19 Pandemic" (ASMC 2021)*, Atlantis Press, Paris, France, pp. 21–23. https://doi.org/10.2991/ahsr.k.210723.005
111. Shafiei, F., Salari-Moghaddam, A., Larijani, B., Esmaillzadeh, A. (2019). Adherence to the Mediterranean diet and risk of depression: a systematic review and updated meta-analysis of observational studies. *Nutrition Reviews*, *77*(4), 230–239. https://doi.org/10.1093/nutrit/nuy070
112. Sheldon, E., Simmonds-Buckley, M., Bone, C., Mascarenhas, T., Chan, N., Wincott, M., Gleeson, H., Sow, K., Hind, D., Barkham, M. (2021). Prevalence and risk factors for mental health problems in university undergraduate students: A systematic review with meta-analysis. *Journal of Affective Disorders*, *287*, 282–292. https://doi.org/10.1016/j.jad.2021.03.054
113. Shen, Y.-C., Chang, C.-E., Lin, M.-N., Lin, C.-L. (2021). Vegetarian diet is associated with lower risk of depression in Taiwan. *Nutrients*, *13*(4), art. no. 1059. https://doi.org/10.3390/nu13041059
114. Shridhar, K., Dhillon, P.K., Bowen, L., Kinra, S., Bharathi, A.V., Prabhakaran, D., Reddy, K.S., Ebrahim, S. (2014). Nutritional profile of Indian vegetarian diets – the Indian Migration Study (IMS). *Nutrition Journal*, *13*(1), art. no. 55. https://doi.org/10.1186/1475-2891-13-55
115. Sofi, F., Dinu, M., Pagliai, G., Cesari, F., Gori, A.M., Sereni, A., Becatti, M., Fiorillo, C., Marcucci, R., Casini, A. (2018). Low-calorie vegetarian versus Mediterranean diets for reducing body weight and improving cardiovascular risk profile: CARDIVEG study (Cardiovascular prevention with vegetarian diet). *Circulation*, *137*(11), 1103–1113. https://doi.org/10.1161/CIRCULATIONAHA.117.030088
116. Sofi, F., Dinu, M., Pagliai, G., Cesari, F., Marcucci, R., Casini, A. (2016). Mediterranean versus vegetarian diet for cardiovascular disease prevention (the CARDIVEG study): study protocol for a randomized controlled trial. *Trials*, *17*(1), art. no. 233. https://doi.org/10.1186/s13063-016-1353-x
117. Son, D.-H., Kwon, Y.-J., Lee, H.S., Kim, H.-M., Lee, J.-W. (2021). Effects of a calorie-restricted Mediterranean-style diet on plasma lipids in hypercholesterolemic South Korean patients. *Nutrients*, *13*(10), art. no. 3393. https://doi.org/10.3390/nu13103393
118. Soroka, N., Silverberg, D.S., Greemland, M., Birk, Y., Blum, M., Peer, G., Iaina, A. (1998). Comparison of a vegetable-based (soya) and an animal-based low-protein diet in predialysis chronic renal failure patients. *Nephron*, *79*(2), 173–180. https://doi.org/10.1159/000045021
119. Sotos-Prieto, M., Del Rio, D., Drescher, G., Estruch, R., Hanson, C., Harlan, T., Hu, F.B., Loi, M., McClung, J.P., Mojica, A., Puglielli, D., Toong, K., Yangarber, F., Kales, S. N. (2022). Mediterranean diet – promotion and dissemination of healthy eating: proceedings of an exploratory seminar at the Radcliffe institute for advanced study. *International Journal of Food Sciences and Nutrition*, *73*(2), 158–171. https://doi.org/10.1080/09637486.2021.1941804

120. Staudacher, H.M., Yao, C.K., Chey, W.D., Whelan, K. (2022). Optimal design of clinical trials of dietary interventions in disorders of gut-brain interaction. *The American Journal of Gastroenterology*, *117*(6), 973–984. https://doi.org/10.14309/ajg.0000000000001732
121. Tang, C., Wang, X., Qin, L.-Q., Dong, J.-Y. (2021). Mediterranean diet and mortality in people with cardiovascular disease: A meta-analysis of prospective cohort studies. *Nutrients*, *13*(8), art. no. 2623. https://doi.org/10.3390/nu13082623
122. Tayyem, R., Al-Awwad, N., Allehdan, S., Ajeen, R., Al-Jaberi, T., Rayyan, Y., Bawadi, H., Hushki, A. (2022). Mediterranean dietary pattern is associated with lower odds of gastric cancer: A case-control study. *Cancer Management and Research*, *14*, 2017–2029. https://doi.org/10.2147/CMAR.S360468
123. Tosti, V., Bertozzi, B., Fontana, L. (2018). Health benefits of the Mediterranean diet: Metabolic and molecular mechanisms. *The Journals of Gerontology: Series A, 73*(3), 318–326. https://doi.org/10.1093/gerona/glx227
124. Tucker, C.A. (2014). The significance of sensory appeal for reduced meat consumption. *Appetite*, *81*, 168–179. https://doi.org/10.1016/j.appet.2014.06.022
125. Vahid, F., Chiriboga, D., Bohn, T., Hébert, J.R. (2022). Diet, inflammation, and cardiovascular disease. In J.R. Hébert, L.J. Hofseth (Eds.), *Diet, Inflammation, and Health*, Academic Press, San Diego, USA, pp. 367–472. https://doi.org/10.1016/B978-0-12-822130-3.00015-6
126. Valim, A., Carpes, L.S., Nicoletto, B.B. (2022). Effect of vegetarian diets on renal function in patients with chronic kidney disease under non-dialysis treatment: A scoping review. *Brazilian Journal of Nephrology*, *44*(3), 395–402. https://doi.org/10.1590/2175-8239-jbn-2021-0126
127. van den Brandt, P.A., Schulpen, M. (2017). Mediterranean diet adherence and risk of postmenopausal breast cancer: results of a cohort study and meta-analysis: Mediterranean diet and breast cancer. *International Journal of Cancer*, *140*(10), 2220–2231. https://doi.org/10.1002/ijc.30654
128. Veronese, N., Notarnicola, M., Cisternino, A. M., Inguaggiato, R., Guerra, V., Reddavide, R., Donghia, R., Rotolo, O., Zinzi, I., Leandro, G., Tutino, V., Misciagna, G., Caruso, M.G. (MICOL study group). (2020). Trends in adherence to the Mediterranean diet in South Italy: A cross sectional study. *Nutrition, Metabolism, and Cardiovascular Diseases*, *30*(3), 410–417. https://doi.org/10.1016/j.numecd.2019.11.003
129. Viguiliouk, E., Kendall, C.W.C., Kahleová, H., Rahelić, D., Salas-Salvadó, J., Choo, V.L., Blanco Mejia, S., Stewart, S.E., Leiter, L.A., Jenkins, D.J.A., Sievenpiper, J.L. (2019). Effect of vegetarian dietary patterns on cardiometabolic risk factors in diabetes: A systematic review and meta-analysis of randomized controlled trials. *Clinical Nutrition*, *38*(3), 1133–1145. https://doi.org/10.1016/j.clnu.2018.05.032
130. Wang, F., Zheng, J., Yang, B., Jiang, J., Fu, Y., Li, D. (2015). Effects of vegetarian diets on blood lipids: A systematic review and meta-analysis of randomized controlled trials. *Journal of the American Heart Association*, *4*(10), art. no. e002408. https://doi.org/10.1161/JAHA.115.002408
131. Watson, N.A., Dyer, K.A., Buckley, J.D., Brinkworth, G.D., Coates, A.M., Parfitt, G., Howe, P.R.C., Noakes, M., Dye, L., Chadwick, H., Murphy, K.J. (2015). A randomised trial comparing low-fat diets differing in carbohydrate and protein ratio, combined with regular moderate intensity exercise, on glycaemic control, cardiometabolic risk factors, food cravings, cognitive function and psychological wellbeing in adults with type 2 diabetes: Study protocol. *Contemporary Clinical Trials*, *45*(Part B), 217–225. https://doi.org/10.1016/j.cct.2015.11.001
132. Watson, N.A., Dyer, K.A., Buckley, J.D., Brinkworth, G.D., Coates, A.M., Parfitt, G., Howe, P.R.C., Noakes, M., Murphy, K.J. (2018). Comparison of two low-fat diets, differing in protein and carbohydrate, on psychological wellbeing in adults with obesity and type 2 diabetes: a randomised clinical trial. *Nutrition Journal*, *17*(1), art. no. 62. https://doi.org/10.1186/s12937-018-0367-5
133. Wozniak, H., Larpin, C., de Mestral, C., Guessous, I., Reny, J.-L., Stringhini, S. (2020). Vegetarian, pescatarian and flexitarian diets: sociodemographic determinants and association with cardiovascular risk factors in a Swiss urban population. *British Journal of Nutrition*, *124*(8), 844–852. https://doi.org/10.1017/S0007114520001762
134. Wu, P.-Y., Chen, K.-M., Tsai, W.-C. (2021). The Mediterranean dietary pattern and inflammation in older adults: A systematic review and meta-analysis. *Advances in Nutrition*, *12*(2), 363–373. https://doi.org/10.1093/advances/nmaa116
135. Yao, C.K., Gibson, P.R., Shepherd, S.J. (2013). Design of clinical trials evaluating dietary interventions in patients with functional gastrointestinal disorders. *American Journal of Gastroenterology*, *108*(5), 748–758. https://doi.org/10.1038/ajg.2013.77
136. Yokoyama, Y., Levin, S.M., Barnard, N.D. (2017). Association between plant-based diets and plasma lipids: a systematic review and meta-analysis. *Nutrition Reviews*, *75*(9), 683–698. https://doi.org/10.1093/nutrit/nux030
137. Yokoyama, Y., Nishimura, K., Barnard, N.D., Takegami, M., Watanabe, M., Sekikawa, A., Okamura, T., Miyamoto, Y. (2014). Vegetarian diets and blood pressure: A meta-analysis. *JAMA Internal Medicine*, *174*(4), 577–587. https://doi.org/10.1001/jamainternmed.2013.14547
138. Zhang, N., Xiao, X., Xu, J., Zeng, Q., Li, J., Xie, Y., Guo, B., Dai, S., Zhu, X., Lei, Y., Duojizhuoma, Yin, J., Zhao, X. (2022). Dietary Approaches to Stop Hypertension (DASH) diet, Mediterranean diet and blood lipid profiles in less-developed ethnic minority regions. *British Journal of Nutrition*, *128*(6), 1137–1146. https://doi.org/10.1017/S0007114521004013
139. Zhang, Z., Ma, G., Chen, S., Li, Z., Xia, E., Sun, Y., Yang, F., Zheng, N., Feng, X. (2013). Comparison of plasma triacylglycerol levels in vegetarians and omnivores: A meta-analysis. *Nutrition*, *29*(2), 426–430. https://doi.org/10.1016/j.nut.2012.07.016
140. Zhang, Z., Wang, J., Chen, S., Wei, Z., Li, Z., Zhao, S., Lu, W. (2014). Comparison of vegetarian diets and omnivorous diets on plasma level of HDL-c: A meta-analysis. *PLoS ONE*, *9*(3), art. no. e92609. https://doi.org/10.1371/journal.pone.0092609