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How Can Consuming a Plant-Based Diet Reduce the Risk of Cardiovascular Disease in Postmenopausal Women?

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Abstract

Despite the fact that women suffer higher rates of cardiovascular events after menopause, there exists a significant underrepresentation of women—especially postmenopausal women—in cardiovascular clinical trials to date. Fortunately, current evidence reveals that cardiovascular events in the general population are largely preventable through modifiable lifestyle factors, with dietary intervention being one of the most important (Amiri et al., 2022). As the impact of whole-diet interventions on cardiovascular risk factors is further explored, it has been determined that a plant-based dietary pattern may favorably influence the prevention of cardiovascular events in postmenopausal women (Barańska et al., 2021). Evidence also reveals that certain phytochemicals which are provided in bulk by a plant-based diet, such as phytoestrogens, may be particularly beneficial to the health of the postmenopausal population (Barańska et al., 2021). This comprehensive literature review will attempt to evaluate exactly how a plant-based diet can reduce the risk of cardiovascular disease in postmenopausal women by examining relevant clinical trials, identifying and explaining the beneficial effects of various cardioprotective phytochemicals, and considering how popular plant-based diets like the Mediterranean Diet

are conducive to heart health. As early as 2006, Chin-Hua Fu et al. established that a plant-based diet may be a natural and effective approach to reducing the risk of cardiovascular disease in postmenopausal women (Fu et al., 2006). This review concludes that more well-designed controlled clinical trials should be conducted with this population to achieve more conclusive results regarding the most effective diet for cardiovascular risk reduction in postmenopausal women.

Key Words: plant-based diet, cardiovascular disease, postmenopause, antioxidants, phytoestrogens, isoflavones, diet, intervention

Cardiovascular Disease Defined

What is cardiovascular disease and how can it be prevented?

Cardiovascular Disease (CVD) can be defined as a group of disorders of the heart and blood vessels such as coronary heart disease, congenital heart disease, and cerebrovascular disease (WHO, 2021). Despite the fact that cardiovascular disease (CVD) is the leading cause of death not only in the United States but across the globe, many people do not know that most CVDs can be prevented. One's risk of developing any of these CVDs can be reduced by addressing behavioral risk factors

such as tobacco use, physical inactivity, and alcohol abuse, as well as by eating more fruits and vegetables (WHO, 2021). Alongside these behavioral risk factors are other underlying determinants of CVD, such as poverty, stress, genetics, and population aging (WHO, 2021). Unfortunately, some populations are more at risk for developing CVD than others. Therefore, it is crucial to understand these risk factors as well as strategies for preventing CVDs.

Cardiovascular Disease and Postmenopause

What is the relationship between cardiovascular disease and postmenopause?

Chronic diseases are the leading causes of morbidity and mortality worldwide, and aging is one of the greatest risk factors (Amiri et al., 2022). Cardiovascular diseases are one category of chronic disease, and they affect both men and women. About 6.6 billion American women are affected by coronary artery disease (CAD) every year (Louis et al., 2019). As most women age, they experience physiological manifestations resulting from menopause which can lead to long-term chronic diseases such as CVD (Amiri et al., 2022). In fact, women tend to suffer higher rates of coronary artery disease after age 50 due to the hormonal changes brought on by menopause (Fu et al., 2006). Menopause typically occurs as a natural process in women and can be reflected by reduced secretion of progesterone and estrogen hormones (Amiri et al., 2022); however, women who have their ovaries surgically removed due to cancer, cysts, endometriosis, or other pathologies also experience the physiological effects of menopause. Unfortunately, even though menopause is a natural part of a woman's life and the consequent symptoms affect their health and quality

of life, the relationship between menopause and CVD has only recently gained momentum in the scientific literature (Amiri et al., 2022). In addition, most studies conducted thus far have only investigated the effects of supplements, nutrients, or isolated single foods on menopausal health issues in postmenopausal women rather than the impact of a whole diet on cardiovascular risk factors in this population (Amiri et al., 2022). What's more, the populations of such studies which evaluate the connection between diet and cardiovascular diseases are also predominantly male, whether they be human or animal subjects. This neglect has left a significant gap in our knowledge of gender differences in cardiovascular health as well as the effects of hormonal changes on heart health.

Cardiovascular Disease Risk Factors for Postmenopausal Women

For postmenopausal women, what are the risk factors for cardiovascular disease?

To elaborate further, menopause can be defined as the permanent cessation of menstrual cycles following the loss of ovarian follicular activity (Silva et al., 2021). As previously mentioned, women tend to suffer higher rates of coronary artery disease after age 50 due to the hormonal changes brought on by menopause. Epidemiological studies have reported that, compared to age-matched men and premenopausal women, postmenopausal women have higher arterial blood pressure, increased atherosclerosis, and disturbed activity of cardiac autonomic functions, each of which are risk factors for CVD (Fu et al., 2006). In women over 50 years of age, CVD accounts for over one-third of total deaths, making it the number one cause of morbidity

and mortality for this population (Barańska et al., 2021). Prior to menopause, cardiovascular disease is relatively infrequent. This suggests that female hormones and metabolism offer cardiovascular protection (Barańska et al., 2021). Therefore, it is important to note that the reduced risk of premenopausal women is associated with the cardioprotective properties of estrogen (Louis et al., 2019). Among other unpleasant side effects which women experience during natural menopause or after a bilateral ovariectomy, some more serious health effects caused by estrogen deficiency include various metabolic syndrome features, including accumulation of fat mass in the abdominal compartment, transition to a more atherogenic lipid profile, hyperinsulinemia, insulin resistance, and glucose intolerance (Barańska et al., 2021). Not only are these effects associated with an increased risk of coronary heart disease (CHD), but they are also related to an increased risk of stroke and other atherosclerotic vascular diseases, including peripheral arterial disease, atherosclerotic aortic disease, and carotid artery disease (Barańska et al., 2021) as well as osteoarthritis, diabetes, cancers, and chronic kidney diseases (Amiri et al., 2022). What's more, after a woman goes through menopause, plaque ruptures become more frequent every decade (Louis et al., 2019). A plaque rupture occurs when plaque, a buildup of cholesterol and other substances attached to the wall of a blood vessel, breaks off the vessel wall and enters the bloodstream. These ruptures are a common cause of coronary thrombosis, or blood clotting within the vessels of the heart, but, interestingly, they are less frequent in premenopausal women (Louis et al., 2019). Undoubtedly, menopause and its consequential effects must not be overlooked or underestimated.

Aside from the hormonal changes which women experience during menopause—a somewhat inescapable risk factor for CVD—, there are other lifestyle behaviors that can be modified and controlled to improve a woman's cardiovascular health outcome. Diet is arguably one of the most important of these factors. Diets that include large amounts of meat—especially red and processed meat—as well as other animal-based foods, such as eggs, are higher in dietary cholesterol intake and are consequently associated with a modestly higher risk of incident CVD and all-cause mortality (Chen et al., 2021). It has been reported that, compared to men, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) levels are better predictors of cardiovascular disease risk in women, so it is especially crucial for this population to be mindful of dietary cholesterol intake (Huang et al., 2014). Furthermore, data from the Nurse's Health Study—a series of prospective studies which examine epidemiology and the long-term effects of nutrition, hormones, and environment on health and disease development—shows that higher red meat consumption is associated with higher concentrations of C-reactive protein (CRP) in plasma, which is an established risk factor for cardiovascular disease (Wang et al., 2021). For postmenopausal women who already have hormone-related risk factors to be concerned about, it is prudent for this population to be mindful of the impact of modifiable risk factors such as diet on heart health.

Cardiovascular Disease and Diet

What are the effects of diet on cardiovascular health?

We are what we eat. In many ways, this familiar statement is true. Dietary cholesterol, which is derived only from animal products, tends to “stick around” in our

arteries with other fats, contributing to cardiovascular disease. Both unprocessed and processed red meats, including beef, pork, and lamb, are high in saturated fat, cholesterol, L-Carnitine, and phosphatidylcholine, which is found abundantly in eggs (Sikand et al., 2020). Each of the aforementioned substances is linked to an increased risk of CVD (Sikand et al., 2020). It should be noted that the more processed meat is, particularly if it is red processed meat, the stronger the CVD risk, and consuming processed meats frequently, or multiple times per week, also increases one's CVD risk (Sikand et al., 2020). One meta-analysis of 20 different studies and 1,218,380 participants examined processed and unprocessed red meat intake as they relate to coronary heart disease (CHD), and the authors determined that processed red meats are associated with a 42% increased risk of CHD per each 50-gram serving per day (Sikand et al., 2020). The 2019 American College of Cardiology (ACC) and American Heart Association Guideline on the Primary Prevention of Cardiovascular Disease cites studies to confirm the benefits of plant-based protein as opposed to animal-based protein, and they determined that choosing plant-based protein sources is a prudent method to minimize cholesterol intake (Sikand et al., 2020). Although some ongoing research has suggested that saturated fats may not be as detrimental to cardiovascular health as once thought, the American Heart Association still recommends eating foods with unsaturated fat when possible (Moll, 2022). Compared to the saturated fat found in meat, the unsaturated fats found in plant-based sources may be more conducive to health, helping to keep our hearts, hair, skin, and nails healthy, among other parts of the body (Ravisankar et al., 2015). For example, heart-healthy diets such as the Mediterranean Diet (MD), which

will be defined later in this review, are typically high in polyunsaturated and monounsaturated fats (Sikand et al., 2020). Both monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) are considered “good fats,” because consuming them in replace of saturated fats can improve cholesterol, decrease inflammation, and stabilize heart rhythms (Moll, 2022). The main difference between MUFAs and PUFAs is their molecular structure. MUFAs have only one carbon-to-carbon double bond in their molecular structure, while PUFAs have more than one double bond in their carbon structure (Moll, 2022). Monounsaturated fats are provided by plant foods such as peanut butter, avocados, and olives, and polyunsaturated fats can be obtained from similar foods such as seeds, nuts, and cooking oils (Moll, 2022). In essence, some foods possess greater nutritional value than others, and what we eat can either promote health or pollute it. It is a double-edged sword, but fortunately, the world has discovered that some of our leading causes of death and chronic diseases can be alleviated by a plant-based diet.

Postmenopause Dietary Intervention

What is the importance of diet during the postmenopausal period?

Food is medicine. Proper nutrition is a key factor to the good health of any individual; however, one can argue that it is especially important during certain stages of life, such as during the postmenopausal period when CVD risk rises. Nutritional habits concern all women, they can be modified, and they have a significant impact on both longevity and quality of life (Silva et al., 2021). As a modifiable lifestyle factor, diet is a crucial primary prevention method for cardiovascular events (Amiri et al., 2022). The Mediterranean Diet (MD) is a great example of

a plant-based diet that may help in the primary prevention of bone, metabolic, and cardiovascular diseases in the postmenopausal period (Silva et al., 2021). The MD revolves around the use of plant foods that have anti-inflammatory and antioxidant properties. This diet's focus on plant foods has been associated with a small but significant decrease in blood pressure, reduction of fat mass, and improvement in cholesterol levels—all three of which are conducive to heart health (Silva et al., 2021). In order to understand why plant foods are so beneficial to cardiovascular health, the various components of plant foods must also be examined. Evidence exists to support the cardiovascular benefits of specific plant compounds such as antioxidants, phytoestrogens, and isoflavones in postmenopausal populations.

The Plant-Based Diet Defined

What is a plant-based diet? What are some other similar diets?

In a world inundated by fad diets, strict regimens, and “quick fixes,” people seem to forget the simple instruction we are given as children: eat your fruits and vegetables! There is no doubt that fruits, vegetables, and other plant foods offer beneficial, and often vital, nutrients to the human body, and, as the western world has grown ever more conscious about health and longevity, plant-based diets have grown in popularity. Not to be confused with a completely vegan or whole-food plant-based diet, the original plant-based diet refers specifically to one's diet alone and may or may not include animal products and processed foods (Melina et al., 2016). By contrast, veganism is not simply a diet but a way of living in which one excludes all animal products from their diet and avoids all other forms of animal exploitation and cruelty

(Petre, 2022). The key distinction to be made between the original plant-based diet and a whole-food plant-based diet (WFPB diet) is that a WFPB diet not only emphasizes plant foods, but it also focuses on minimally processed foods (Kubala, 2018). A plant-based diet may include whole, or unprocessed, plant foods such as fresh kale, soybeans, and almonds, but it may also include minimally processed versions of plant foods such as peanut butter, tofu, and hummus. It may also include, in moderation, small amounts of meat, seafood, eggs, and dairy products (Melina et al., 2016). Any of the nine variations of a vegetarian diet may fall under the umbrella term of “plant-based” whether they include animal-based foods or not. For example, lacto-ovo-vegetarians avoid meat and fish, yet they choose to consume dairy and eggs.

The Plant-Based Diet Benefits

How might a plant-based diet be beneficial to cardiovascular health?

One may ponder: what are the effects of a plant-based diet on cardiovascular disease? This is a question that will be answered in depth later in this review; however, there are a few general reasons why one should adhere to the aforementioned advice to eat fruits and vegetables. To begin, plant foods such as vegetables, fruits, whole grains, legumes, soy products, nuts, and seeds contain fiber, vitamins, minerals, and phytochemicals which help to lower total cholesterol (TC) levels as well as “bad” cholesterol—low-density lipoprotein cholesterol (LDL-C) (Melina et al., 2016). Furthermore, these plant foods also help to improve serum glucose control, or blood sugar, and consequently avoid the negative effects of hyperglycemia, or high blood sugar (Melina et al., 2016). Each of these factors, among others, ultimately contributes to the

reduction of many chronic diseases, including heart disease. It has been determined that those who eat fewer animal products and more plant foods, such as vegetarians and vegans, are at reduced risk of ischemic heart disease, type 2 diabetes, hypertension, certain types of cancer, and obesity (Melina et al., 2016). This review will further elaborate on how a plant-based diet may improve the cardiovascular health of postmenopausal women specifically later in the discussion.

Phytochemicals Defined

What are phytochemicals and how are they relevant to cardiovascular health?

Overall, the general consumption of fruits and vegetables is linked with various health benefits due to the many medicinal properties and extensive nutritional value of these foods (Altemimi et al., 2017), which is why many individuals have shifted their diet to be more plant-based. There are various bioactive compounds—nutrients and non-nutrients that can produce physiological effects beyond their classical nutritional properties (Betim et al., 2022)—found in plant foods that are nutritionally valuable. The term “phytochemicals” serves as an umbrella term for such compounds. Some subcategories include flavonoids and phenolic acids (Thiede et al., 2016). It is important to note that the phytochemicals found in fruits and vegetables may protect against free radical damage since they act as natural antioxidants (Altemimi et al., 2017). The National Institutes of Health (NIH) define free radicals as highly unstable molecules that are naturally formed when you exercise and when your body converts food into energy, but other environmental factors such as cigarette smoke, sunlight, and air pollution also promote the formation of free radicals (Chun et al., 2013). Antioxidants

are a type of bioactive compound that functions to inhibit or delay the oxidation of molecules and consequently help prevent the development of certain cancers (Altemimi et al., 2017). Some examples of plant foods that contain high concentrations of antioxidants include berries, nuts, and even dark chocolate (Raman, 2022). Recent research has declared that the consumption of various phytochemicals in the diet has numerous beneficial effects including, but not limited to, inhibition of lipid oxidation, lipid-lowering effects, hypoglycemic- and insulin-lowering effects, antioxidant activity, anti-inflammatory activity, and anti-proliferative or apoptotic cell death activity (Thiede et al., 2016).

Antioxidants Defined

What are antioxidants and how are they relevant to cardiovascular health?

As previously mentioned, antioxidants function to inhibit or delay the oxidation of molecules, which is important to prevent not only the development of cardiovascular diseases but also certain cancers and Alzheimer’s Disease, among others (Altemimi et al., 2017). Oxidation, or oxidative stress, is caused by free radicals in the body, and it can lead to cell damage which contributes to the development of CVD (Chun et al., 2013). Relevant research demonstrates that consuming antioxidants, preferably from plant foods such as fruits and vegetables, can counteract oxidative stress (Chun et al., 2013). This is vital for the postmenopausal population, because not only does decrease estrogen availability increase a woman’s risk of CVD, but it is also accompanied by increased oxidative stress (Bourgonje et al., 2020). One should note that estrogen itself is a naturally occurring antioxidant in the human body (Bourgonje et al., 2020). Furthermore,

oxidative stress typically increases with age (Bourgonje et al., 2020). Although current research studies have not yet concluded whether low estrogen levels have a pro-oxidant effect, high levels of estrogen provided by hormone replacement therapy in postmenopausal women may protect against age-related oxidative stress due to the antioxidant nature of estrogen (Bourgonje et al., 2020).

Antioxidants Literature Review

What are some of the best dietary sources of antioxidants and how do they function to improve cardiovascular health in women?

The various health benefits of plant-based diets, such as the Mediterranean Diet (MD), are noteworthy with respect to the postmenopausal period. The focus of the MD on plant foods encourages greater consumption of antioxidant-rich fruits and vegetables along with reduced consumption of saturated animal fats, as compared to the typical Western diet. The significance of this key characteristic lies in the cardioprotective value of antioxidants and polyphenols. Evidence from observational studies and randomized trials which investigate nutrition in postmenopausal women explain that the polyphenols found in plant-based foods such as extra virgin olive oil, whole grain cereals, nuts, legumes, vegetables, red wine, and fruits have both antioxidant and anti-inflammatory properties that have been observed to decrease LDL cholesterol as well as both systolic and diastolic blood pressure (Silva et al., 2021). The reductions in LDL cholesterol and blood pressure associated with MD are linked to reduced risk of CVD and death among various female populations, including postmenopausal women; however, more evidence is required to draw conclusions for the postmenopausal population (Silva

et al., 2021). Resveratrol (RVT) is just one powerful antioxidant found in many of the staple foods of the MD, including grapes and red wine (Khattar et al., 2022).

Phytoestrogens Defined

What are phytoestrogens and how are they relevant to cardiovascular health?

Phytoestrogens are a class of plant-derived compounds, or phytochemicals, that have pro-estrogenic effects (Louis et al., 2019). Collectively, phytochemicals from plant foods are beneficial to one's general health. However, there may be specific phytochemicals, such as phytoestrogens, that directly influence female health in the postmenopausal period. Soybeans are known to be particularly rich in phytoestrogens, and they have been associated with favorable metabolic effects on the cardiovascular system in postmenopausal women (Su et al., 2011). Phytoestrogens may be associated with a reduced risk of CVD due to the cardioprotective effects of estrogen; however, their effect is mostly dependent upon their bioavailability within the human body. Bioavailability can be defined as "the extent a substance...becomes completely available to its intended biological destination(s)" (NIH, 2021), which, once again, can largely determine the effectiveness of the substance in its reaction with the human body. One specific cardioprotective effect of high phytoestrogen intake that has been observed in postmenopausal women is decreased arterial stiffness which consequently decreases one's risk of experiencing cardiovascular events (Su et al., 2011).

Phytoestrogens Literature Review

What are the effects of individual phytoestrogens in reducing cardiovascular risk factors?

As previously stated, there may be specific phytochemicals that directly influence female health in the postmenopausal period. Resveratrol (RES), previously identified as an antioxidant, can also be categorized as a phytoestrogen and is found in plant foods such as grapes, peanuts, plums, and blueberries, as well as in foods derived from plants including wine and dark chocolate (Regan, 2022). Resveratrol has been classified as a phytoestrogen due to its capacity to bind to and modulate estrogen receptor signaling (Louis et al., 2019). In other words, it has estrogen-like properties and behaviors. Animal studies with rats have demonstrated promising results regarding the efficacy of resveratrol in reducing cardiovascular risk factors; however, further research must be completed with human subjects before any definite conclusions can be made about human health. In one study with both male and female rats, RES metabolism was more efficient in female liver microsomes, when compared with male liver microsomes (Louis et al., 2019), which may offer insight into potential sex-related differences in bioavailability. As applied to RES, sex-dependent bioavailability data is not currently available for humans, let alone women specifically. Thus far, male subjects have been preferred by researchers for animal studies to avoid any inaccuracies caused by cyclical hormonal fluctuations in females (Louis et al., 2019). This has created a bias that has finally been raised as a concern by the research community. There are a few existing studies with female animal subjects which have reported the beneficial effects of resveratrol, but research is still inadequate (Louis et al., 2019). Because of this lack

of research, few conclusions can be made regarding the bioavailability of RES in humans; yet “several clinical trials are underway testing [the] cardioprotective properties [of RES]” (Louis et al., 2019).

Although minimal, the research that exists to explore the beneficial effects of RES in humans is promising. Most published studies indicate that the bioavailability of RES in humans is low, so RES trial dosages are often exceedingly generous in hopes of increasing absorption; however, both low and high supplemental doses of RES in humans have been reported to be beneficial (Raj et al., 2021). To date, the appropriate dosage remains questionable. Furthermore, whether RES should be utilized strictly as an agent of primary prevention rather than tertiary is also controversial (Gal et al., 2021). Nevertheless, there have been a few instances thus far where “...the administration of RES in double-blind, randomized, placebo-controlled clinical trials showed a decreased expression of endothelial cell ICAM, VCAM, and IL-8 as well as of inflammatory markers” (Carrizzo, et al., 2020). To clarify, RES successfully reduced the presence of the aforementioned molecules which stimulate plaque formation and consequently narrow the arteries. Thus, decreased expression of such molecules is beneficial to cardiovascular health. Another double-blinded, placebo-controlled, randomized clinical study of only three months demonstrated that resveratrol treatment in 40 post-MI patients including 26 men and 14 women was able to improve systolic function, and diastolic function as well as endothelial function, red blood cell deformability, LDLC and platelet aggregation (Raj et al., 2021), each of which is conducive to improved heart health. As we have established, human clinical trials concerning the effects of RES supplementation

on cardiovascular risk are few. Equivalent clinical trials with strictly female populations are even fewer, and those focused on postmenopausal women are close to none. In summation, the cardiovascular benefits of RES have not been entirely confirmed in humans, and the exact mechanisms of RES are still unclear and partly controversial (Gal et al., 2021); yet current evidence is promising.

Soy Protein and Isoflavones Literature Review

What are the cardiovascular benefits of soy protein as compared to animal protein on cardiovascular health in the postmenopausal population?

Isoflavones are another type of phytochemical, falling under the more specific category of “flavonoids.” Flavonoids make up the largest class of phytochemicals and possess certain cardioprotective functions such as improved endothelial function, decreased blood pressure, and improvements in lipid and insulin resistance (Thiede et al., 2016). Some of the best food sources of isoflavones include soybeans and soy-based products (Thiede et al. 2016). Soy-based products may include tofu and tempeh—which are especially popular in Eastern countries such as Taiwan (Su et al., 2011)—or other more processed meat alternatives. Not dissimilar to a plant-based diet, soy food, and its protein and isoflavone content has received widespread attention for their potential role in CVD risk improvement: In 1999, the FDA concluded that including soy protein in a diet low in saturated fat and cholesterol may reduce the risk of CHD by decreasing blood cholesterol levels (Barańska et al., 2021). Furthermore, a review of “114 meta-analyses and systematic reviews indicates soy-derived isoflavones are particularly

beneficial for reducing cancer and CVD risk in women” (Wang et al., 2021).

In one systematic review which evaluated the impact of soy protein containing isoflavones and soy isoflavones extract on lipid profile in postmenopausal women, as compared with placebo or protein of milk, casein, or isolated soy protein with or without trace isoflavone content, the authors concluded that consuming soy and isoflavones may favorably influence the prevention of cardiovascular events in postmenopausal women due to its effects on lipid metabolism (Barańska et al., 2021). The same report conducted a meta-analysis of randomized controlled trials. Over 2,300 postmenopausal women took part in the analysis studies that this report evaluated, making these results more credible compared to other studies with very few participants. The meta-analysis demonstrated that consuming soy protein that contains isoflavones and soy isoflavone extract is associated with various cardioprotective changes including a significant decrease in serum total cholesterol (TC), increase of HDL cholesterol (HDL-C), albeit linked with insignificant reduction in LDL cholesterol (LDL-C) and triacylglycerol (TAG) (Barańska et al., 2021). When compared to the control group, these changes revealed that soy protein and/or isoflavones were more effective in changing the lipid profiles of older women (Barańska et al., 2021). Therefore, the consumption of soy should be promoted as part of a heart-healthy diet; for, the research suggests that the isoflavones within soy, or even soy isoflavone extract, have the ability to modulate an individual's lipid profile and consequently help to prevent cardiovascular events (Barańska et al., 2021). To conclude, this systematic review and meta-analysis clearly demonstrate that soy isoflavones significantly contribute to the correction of

lipid profiles in postmenopausal women; however, further studies based on greater amounts of research material as well as more specific doses of isoflavones are essential in determining how isoflavones can benefit lipid metabolism and consequently lower the risk of cardiovascular disease in postmenopausal women (Barańska et al., 2021).

Another narrative review reported similar results, concluding that higher isoflavone dietary intake may be associated with a lower risk of subclinical CVD (Silva et al., 2021). The review also supports that the beneficial effects of isoflavones can be attributed to their anti-inflammatory and antioxidant properties; however, as the first systematic review discussed, this narrative review concludes that further research is warranted and the effects of isoflavones remain to be evaluated over a longer period of time (Silva et al., 2021).

In a 2021 prospective cohort study of 38 European American and African American omnivorous females matched by both age and BMI, the replacement of animal-based foods with soy-based foods led to an over 20% reduction in blood levels of C-reactive protein (CRP), which is an established risk factor for cardiovascular disease (Wang et al., 2021). This was measured by the enzyme-linked immunosorbent assay (ELISA). The data from this study allowed researchers to conclude that adopting a vegetarian or plant-based diet may rapidly promote improvements in fatty acid metabolism, allowing the body to better oxidize fats for energy homeostasis rather than store them (Wang et al., 2021).

Whole Diet Interventions Literature Review

What are the benefits of whole diet interventions as opposed to individual phytochemicals on the cardiovascular health of postmenopausal women?

Thus far, it has been established that certain phytochemicals which exist in plant foods may play a promising role in the reduction of cardiovascular risk, particularly in postmenopausal women. With this, the importance of other dietary components along with one's diet as a whole should not be undervalued. As previously mentioned, the majority of studies conducted thus far have only investigated the effects of supplements, nutrients, or isolated single foods on menopausal health issues in postmenopausal women rather than the impact of a whole diet on cardiovascular risk factors in this population (Amiri et al., 2022). It is critical to also analyze how whole-diet interventions, especially plant-based diets, impact heart health.

The Vegetarian Diet vs. The Omnivore Diet

One 2006 study from the American Journal of Cardiology followed and compared 35 vegetarians and 35 omnivores, all of whom were healthy postmenopausal women without hormone replacement therapy (HRT). The authors hypothesized that a long-term vegetarian diet may positively influence cardiovascular functions in healthy postmenopausal women (Fu et al., 2006). The participants of the study, both vegetarian and omnivorous postmenopausal women, were recruited from the health checkup department of Tzu Chi Dalin General Hospital (Fu et al., 2006). In Chinese society, vegetarianism originates from the Buddhist's teaching of "no killing" and has been practiced for centuries (Fu et al., 2006). To reiterate, a vegetarian diet excludes all meat and fish but may include some animal products such as eggs and dairy products. An omnivorous diet includes both plant foods and animal-derived foods. The vegetarian subjects in this study had been vegetarian for 2 to 35 years, and they

did not eat any meat nor any fish due to their religious beliefs; however, some occasionally consumed eggs and milk (ovo-lactovegetarians) in small amounts (Fu et al., 2006). The 35 omnivores served as the age-matched control group. It is important to note that none of the women drank alcohol, smoked, or took drugs reported to influence cardiovascular function, so the effects observed should mainly be reflective of dietary factors (Fu et al., 2006). In addition, to rule out patients with existing systemic diseases, arrhythmias, and other pathologies, researchers recorded the complete medical history of each patient, took detailed screening questionnaires, performed physical and neurologic examinations, and did laboratory tests (Fu et al., 2006). The results of the study demonstrated that the vegetarian subjects, especially those who had been vegetarian for 2 or more years, had better baroreflex sensitivity, more optimal blood pressure, and favorable lipid concentrations compared to the omnivorous subjects (Fu et al., 2006). The vegetarians also had lower total cholesterol, lower LDL cholesterol, and lower fasting blood glucose levels than the omnivores (Fu et al., 2006). These findings are significant; the effects of vegetarian diets demonstrated in the study—reduced blood pressure, reduced cholesterol, improved baroreflex sensitivity—may serve as a natural and effective approach to reducing the risk of cardiovascular disease in postmenopausal women (Fu et al., 2006). Although this research study was conducted over a decade ago, the results are supported by more recent studies and provide insight into the mechanisms linking vegetarian diets and cardiovascular health. Nevertheless, additional exploration with respect to the relationship between whole diet interventions and the cardiovascular health of postmenopausal women is warranted.

The Mediterranean Diet

The Mediterranean Diet (MD) has become a very popular choice for those seeking to change their dietary habits as a way of improving their overall health—and for good reason. In terms of reducing the risk of CVD morbidity, mortality, and cardiovascular events, the MD is comparable to not only lifestyle interventions such as physical activity but also modern pharmacological and surgical interventions such as aspirin, antihypertensives, and statins (Hernández-Angeles et al., 2016). The Mediterranean Diet is high in fruits, vegetables, whole grains, legumes, unsalted nuts and seeds, and olive oil. It is low to moderate in fish, skinless poultry, low-fat dairy products, and red wine (in individuals consuming alcohol) and low in red meat (Sikand et al., 2020). As previously noted, the focus of the MD on plant foods encourages greater consumption of antioxidant-rich fruits and vegetables along with reduced consumption of saturated animal fats, as compared to the typical Western diet. In one meta-analysis study of randomized controlled trials, diets such as the MD which can be considered low-fat have been efficacious in lowering the concentrations of TC, HDL-C, and LDL-C, likely because low-fat vegetarian diets have been shown to improve both glycemic and lipid control, among other factors (Huang et al., 2014). Although the MD is considered “low-fat,” it is relatively high in beneficial fats such as MUFAs and PUFAs as well as polyphenols, flavonoids, phytosterols, and fiber—all of which contribute to reduced risk of CVD and diabetes (Sikand et al., 2020). With the knowledge we have regarding the impact of diet on cardiovascular health and the evidence which demonstrates the beneficial effects of the MD on cardiovascular disease markers, it is suggested that postmenopausal women—who are at

increased risk of cardiovascular disease—can benefit from the Mediterranean Diet as well as other plant-based diets that emphasize plant foods.

Conclusion

What does the evidence suggest overall about the importance of dietary intervention as it pertains to the cardiovascular health of postmenopausal women?

The opportunity for improving health by improving diet is great. There is an undeniable link between nutrition and health that must not be overlooked, especially when evidence exists to support the role of plant foods in disease prevention. When considering the cardiovascular health of postmenopausal women, diet should be a fundamental component of both prevention and treatment. Diet is an inseparable part of one's lifestyle, and it has the power to control the risk factors of cardiovascular disease (Amiri et al., 2022). The detrimental effects of menopause on cardiovascular health exemplify the need to pay exclusive attention to women and identify ideal treatment methods for both alleviating risk factors and reducing cardiovascular mortality within the postmenopausal population (Amiri et al., 2022). Literature confirms that modifying one's diet to include more plant foods and fewer animal products is a promising solution for not only postmenopausal women but also the general population (Amiri et al., 2022).

A common misconception surrounding plant-based diets is that they are not nutritionally adequate and cannot fully provide the micronutrients and macronutrients required by the human body. However, the Academy of Nutrition and Dietetics (AND) asserts that appropriately planned plant-based diets, including vegan diets, are healthful, nutritionally adequate, and may

provide health benefits for the prevention and treatment of certain diseases (Melina et al., 2016). The Academy also affirms that plant-based diets are appropriate for all stages of the life cycle, including pregnancy, lactation, infancy, childhood, adolescence, older adulthood, and for athletes (Melina et al., 2016). When properly followed, plant-based diets easily provide adequate quantities of plant proteins, vitamins, and minerals as well as beneficial phytochemicals such as plant sterols, polyphenols, and flavonoids (Daneshzad et al., 2021). As we have established, plant-based diets have the added benefit of being low in salt, fat, animal products, oils, processed foods, cholesterol, and sugar which help to prevent CVD and control CVD risk factors (Daneshzad et al., 2021).

What are some of the limitations of this research?

Unfortunately, concrete evidence regarding the effectiveness of plant-based diets on the cardiovascular disease risk of postmenopausal women remains limited thus far. The significant underrepresentation of women—especially postmenopausal women—in cardiovascular clinical trials to date is the chief foundational limitation preventing this research from advancing. This underrepresentation has been discussed for several years, and the evidence is clear that CVD is a major health issue for older women since the development of CVD is higher after menopause; yet the underrepresentation persists (Amiri et al., 2022). What's more, evidence has demonstrated that, compared to men, women suffer a more aggressive form of coronary artery disease and are more susceptible to death from CVD (Amiri et al., 2022).

More well-designed controlled clinical trials must be conducted with postmenopausal women in order to adequately capture the dietary patterns of different

subpopulations as well. As we have established, one's sex can be a significant risk factor for certain chronic diseases such as CVD. Race is yet another risk factor that must be taken into consideration. African Americans remain a particularly understudied population with regard to plant-based dietary patterns despite the disproportionate burden of CVD risk factors and outcomes they experience (Weston et al., 2022). A 2021 study that compared European American and African American omnivorous females found that African American women are at higher risk for developing obesity and its associated cardiometabolic diseases (Wang et al., 2021). Evidence is also limited amongst various Asian populations despite their extensive history of consuming diets rich in plant foods (Kim et al., 2020).

Alongside limitations regarding population, research methods can also be limiting. For example, it is nearly impossible to blind participants to diet, especially for whole diet interventions (Amiri et al., 2022). Knowing which diet they have been assigned could influence how well or how poorly a participant adheres to said diet. Also, small sample sizes or few subjects may result in insufficient statistical power, thus limiting definitive conclusions (Barańska et al., 2021). In addition, most studies exploring dietary interventions investigate general, low-fat diets while research on more promising diets such as plant-based diets and the Mediterranean Diet are lacking (Amiri et al., 2022). Finally, the variability of a plant-based diet is also somewhat problematic. Cardiovascular risk may vary by “healthiness” of different plant-based diets; so, increased specificity within research is essential (Kim et al., 2020). For example, those who exclusively consume plant foods may likely have different outcomes than those who regularly include varying amounts of

animal-based foods in their diet. Furthermore, some plant foods may be considered healthier than others. A recent 2022 cohort study from PLOS Medicine attempted to account for this variability by using sample-based scoring methods for scoring differing plant-based diets. The authors compared an overall plant-based diet (PDI), a healthy plant-based diet (hPDI), and an unhealthy plant-based diet (uPDI) (Weston et al., 2022). Breaking down a plant-based diet in this way offers unquestionably better insight; however, the terms “healthy” and “unhealthy” are arguably still too ambiguous. The overarching solution to these limitations is further research—more specifically, well-designed controlled clinical trials conducted with postmenopausal women of various regions.

Which diet is the “best” diet for the postmenopausal population?

There is no denying the fact that increasing one's consumption of plant foods can foster good health, and, as research advances, it is becoming clearer that many of the bioactive phytochemicals found in plants may be just as effective as some pharmacological therapies in the treatment of chronic disease, including cardiovascular disease. However, a “one-size-fits-all” diet may not exist. The limitations of the current evidence concerning the relationship between diet and heart health should be noted to improve future research and find the most relevant diet for postmenopausal women (Amiri et al., 2022). This review has established that plant-based diets are associated with a reduction of cardiovascular risk factors and incident CVD; however, there is significant variation in the “healthiness” of different plant-based diets which must be explored in order to make any conclusions about the ideal diet for postmenopausal women (Kim et

al., 2020). As we explore further, we may find that more personalized nutrition strategies may be necessary across population subgroups (Wang et al., 2021). One might begin by reducing their consumption of meat and processed foods and increasing their consumption of fruits, vegetables, whole grains, nuts, seeds, and legumes.

Closing Remarks

This review concludes that more well-designed controlled clinical trials must be conducted with this population to achieve more conclusive results regarding the most effective diet for cardiovascular risk reduction in postmenopausal women. Despite the aforementioned limitations of current research, the available evidence is promising, and one should not underestimate the healing power of plants. As Thomas Edison declared: “The doctor of the future will no longer treat the human frame with drugs but will rather cure and prevent disease with nutrition” (Isaak et al., 2013).

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