

Dietary Intervention of Chronic Diseases in Menopause

Subjects: Others

Contributor: Aliz Erdélyi, Erzsébet Pálfi, László Túű, Katalin Nas, Zsuzsanna Szűcs, Marianna Török, Attila Jakab, Szabolcs Várbíró

Menopause is associated with an increased prevalence of obesity, metabolic syndrome, cardiovascular diseases, and osteoporosis. These diseases and unfavorable laboratory values, which are characteristic of this period in women, can be significantly improved by eliminating and reducing dietary risk factors. Changing dietary habits during perimenopause is most effectively achieved through nutrition counseling and intervention. To reduce the risk factors of all these diseases, and in the case of an already existing disease, dietary therapy led by a dietitian should be an integral part of the treatment.

Keywords: menopause ; perimenopause ; dietetics ; cardiovascular risk ; healthy lifestyle ; nutritional status ; medical nutrition therapy ; healthy eating guidelines

1. Introduction

During menopause, the risk and occurrence of several chronic diseases increases in connection with the decrease in estrogen levels; therefore, the dietary therapy should be an integral part of the treatment and the nutritional intervention is an essential element of the prevention of chronic diseases ^[1].

2. Lipids Metabolism Disorders in Menopause

During perimenopause and menopause, the risk of cardiovascular diseases (CVD) increases with the decrease in estrogen levels ^[2]. It is a well-known fact that the population of women of reproductive age have a lower cardiovascular risk than the male population of the same age due to the protective effect of estrogen on the cardiovascular system ^[3]. In the presence of estrogen, the lipid profile is more favorable; the cholesterol level, LDL cholesterol fraction, and triglyceride level are also lower. With the onset of menopause, lipid parameters tend to deteriorate rapidly, the elasticity of blood vessels decreases, and the blood supply to the organs deteriorates. The increases in cholesterol levels after the onset of menopause already result in cholesterol values exceeding those of men of the same age group. In a few years, the worsening trend of LDL cholesterol and triglyceride levels catches up with, and even surpasses, that of the male contemporaries ^[4].

The risk of central obesity in menopausal women is five times higher than before menopause ^[5]. Epidemiological studies have shown that central obesity, dyslipidemia, glucose intolerance, and hypertension are the most common risk factors for CVD in menopausal women. The incidence of metabolic syndrome in postmenopausal women is 2–3 times higher than before menopause ^[6].

Estrogen exerts its protective effect before menopause by the following: acting on estrogen receptor alpha, estradiol increases the release of vasoactive compounds promoting vasodilation, nitric oxide, and prostacyclin, and shifts the renin-angiotensin axis towards the production of angiotensin 1–7 ^[7]. Estradiol also plays a role in the regulation of the vascular system with local anti-inflammatory effects and epigenetic modifying effects ^[7]. With the development of estrogen deficiency, the cardiovascular risk increases significantly. The increase in the risk is also influenced by the rate at which estrogen deficiency develops. In general, the greater the decrease in estradiol levels and the faster the rate of change, the greater the increase in cardiovascular risk ^[7]. The dietary treatment of cardiovascular diseases should aim to maintain and achieve a normal nutritional status, treat high blood pressure (one of the most important risk factors of which is currently the high salt intake), and manage unfavorable lipid profile changes. Strict adherence to a healthy diet can reduce the risk of cardiovascular death by 14–28% ^[8]. In the 2021 ESC Guidelines on Cardiovascular Disease Prevention in Clinical Practice (European Society of Cardiology, ESC), a Grade I/B recommendation is formulated; a balanced diet can be recommended to everyone to prevent cardiovascular diseases ^[9].

The fatty acid composition (quality) of the diet is more important than its total amount (grade B recommendation). The intake of saturated fatty acids (SFAs) may not exceed 10 E%. It is recommended to be achieved by replacing SFAs with

polyunsaturated fatty acids (PUFAs) in the diet. Dietary intake of omega-3 fatty acids, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), is extremely important (grade A recommendation). The fatty acid composition of the diet (saturated fatty acids, SFAs; trans-fatty acids, TFAs) affects serum cholesterol levels more than dietary cholesterol intake (grade B recommendation). In addition to all this, a dietary fiber intake of 30–45 g/day is recommended, mainly by consuming whole grains. It is recommended to consume at least 400 g of vegetables and fruits per day following WHO guidelines ^[10].

In the 2021 recommendation of the American Heart Association (AHA), balancing energy consumption is a priority. The guidelines encourage the consumption of fruits and vegetables in fresh, frozen, canned, and dried forms. Replacing refined grains with whole grains is associated with a lower risk of coronary heart disease. A higher intake of legumes and nuts and the consumption of 2–3 servings of fish per week are associated with a reduction in the risk of cardiovascular diseases. Liquid vegetable oils are recommended instead of tropical oils (coconut, palm, and palm kernel), animal fats (butter and lard), and partially hydrogenated fats. Saturated and trans fats (animal, dairy, and partially hydrogenated fats) should be replaced with non-tropical liquid vegetable oils. Evidence supports the cardiovascular benefits of dietary unsaturated fats, particularly polyunsaturated fats, primarily from vegetable oils ^[8].

Similar principles are implemented in the menopause diet recommendations of the British Dietetic Association. Considering the special target group, it recommends consuming at least four to five servings of unsalted nuts, seeds, and legumes per week and avoiding refined sugars, such as sweets, cakes, and soft drinks. It highlights the heart-friendly nature of oats, whole grains, and whole wheat bread, as well as legumes such as lentils, chickpeas, and beans, in addition to being excellent sources of fiber ^[11]. Individualized lifestyle changes are recommended for all patients with hypertension or with elevated but still normal blood pressure. The main elements of these lifestyle changes are weight control, reducing alcohol and salt consumption, and increasing calcium, potassium, and magnesium intake ^[10].

According to the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH) guidelines, important elements of lifestyle modification are to reduce salt intake to less than 5 g per day (1A) while eating vegetables, fresh fruit, fish, seeds, non-saturated fatty acids (olive oil), and low-fat dairy products and avoiding red meat (Grade 1A recommendation) ^[12]. In the dietary prevention of cardiovascular diseases, the following should be emphasized in menopause:

- (a) Body weight control in menopause is recommended with energy intake corresponding to body composition measurements;
- (b) Salt consumption should be as close as possible to 5 g/day, preferring green and dried vegetable spices for seasoning;
- (c) The daily recommended intake of vegetables and fruit is 5 portions (500 g/day, of which 300–400 g of vegetables and 200–100 g of fruit): 3–4 portions of vegetables, 1–2 portions of fruit ^{[13][14][15][16][17][18][19][20]}.

3. Carbohydrate Metabolism Disorders in Menopause

Metabolic changes during the menopausal transition include an increase in the proportion of adipose tissue, an increase in visceral fat, and a decrease in energy expenditure ^[21]. In addition, there is an impairment of insulin secretion and insulin sensitivity, as well as an increase in the risk of T2DM ^[22].

The changes affecting carbohydrate metabolism during menopause are the following ^[23]:

- In the absence of estrogen, the insulin secretion of the pancreatic beta cells decreases;
- Decreased insulin sensitivity in the muscles results in a decrease in glucose uptake;
- As a result of deteriorating insulin sensitivity in the liver, gluconeogenesis and lipogenesis increase, triglyceride accumulation increases, VLDL production increases, and insulin clearance decreases;
- As a result of the reduced insulin effect on adipose tissue, lipolysis increases, the size of fat cells increases, and inflammatory mediators accumulate;
- The resulting metabolic changes lead to the development of metabolic syndrome.

Therefore, the risk of developing a carbohydrate metabolism disorder is related to the presence or absence of sex hormones (menopause). A correlation can also be observed with the date of menopause. A large Chinese study revealed

a clear correlation between the date of menopause and the risk of diabetes. The risk of developing a carbohydrate metabolism disorder was the lowest with menopause occurring between the ages of 45 and 49. Menopause at both younger and older ages was associated with an increased risk of diabetes. Menopause occurring before the age of 40 had the highest risk [24]. The risk of developing diabetes was increased by weight gain and unfavorable changes in body composition (adiposity) [25]. Based on these, it can be said that menopause is associated with an increased risk of T2DM. Lifestyle intervention, including diet and exercise, is the cornerstone of diabetes prevention and management [26].

According to the American Academy of Nutrition and Dietetics, for adults with prediabetes or type 2 diabetes, dietary therapy administered by a registered dietitian improves the effectiveness of medical treatment and longevity. Dietary therapy is more cost-effective, successful, and essential for prediabetes and obesity, and in preventing the progression of type 2 diabetes [27]. Lifestyle interventions, including dietary changes and regular exercise, aimed at moderate weight loss (5%) are the mainstay of treatment [28].

In perimenopause and menopause, if there is no impaired fasting glycaemia (IFG), impaired glucose tolerance (IGT), or T2DM present, it is important to achieve and maintain adequate nutritional status and body composition, as well as ensure energy, nutrient, and fluid requirements appropriate to age, nutritional status, physical activity, and diseases. Treatment of overweight/obesity is of particular importance in prediabetes and diabetes. Its elimination/reduction reduces the transition of pre-diabetes conditions to diabetes, reduces insulin resistance, improves glycemic control, reduces the number and dose of blood sugar-lowering drugs used in already existing diabetes, and reduces the cardiovascular risk accompanying these conditions. In the case of weight reduction, the daily energy intake is 500–700 kcal less than the requirement, but it cannot be lower than the BMR [29]. The daily recommended amount of carbohydrates in the diet should be at least 120 g, which is rich in vegetable fibers, vitamins, and minerals, contains only the necessary amount of added sugar, and is low in fat and salt. The WHO directive sets the recommended added sugar intake at no more than 10% of the daily energy intake, but an intake of less than 5% per day would have additional benefits in achieving a healthy lifestyle [30]. Based on the energy needs of an average adult woman, which means 2000 kcal, this is 200 kcal or approximately corresponds to a maximum of 50 g of sugar. Taking a ratio of 5%, this is 100 kcal, i.e., approximately 25 g of sugar [30]. Taking into account the reduction of the daily energy requirement, in the case of 1600 kcal, this means only 40 g and 20 g of added sugar corresponding to 160 and 80 kcal, respectively. This requires taste adjustment and better utilization of the natural sugar content of fruits and dairy products rather than replacing the missing amount or sweet taste with intense sweeteners and sugar substitutes.

Eating carbohydrates with a low glycemic index and rich in fiber has a health-protective effect. Regarding carbohydrate sources, preference should be given to vegetables, whole-grain foods, fruits, and dairy products without added sugar. Increasing the fiber content is beneficial since it slows down the absorption of carbohydrates. In addition, due to fibers' satiating value, they improve the feeling of satiety and bowel function. Regarding fiber intake, the European guideline recommends an intake of over 25 g per day, 35–45 g for cardiovascular prevention [9][20]. The European Food-Based Dietary Guidelines (FBDG) recommend a minimum intake of sugar and fiber of 30 g [13][14][15][16][17][18][19][20]. A high-fiber diet has been shown to reduce the risk of obesity and has a protective effect against different diseases such as coronary heart diseases, intestinal malignancies, and type 2 diabetes.

In the case of an already existing carbohydrate metabolism disorder, the adjustment of the diet is based on the energy and nutrient intake required to achieve or maintain normal body weight and on a defined amount and altered composition of carbohydrate intake [31]. This also includes determining the frequency and timing of meals. The individualized diet promotes the preservation of health as fully as possible with particular regard to the achievement and maintenance of individual goals related to nutritional status, provision of individual glycemic target values, and prevention or delay of complications. Establishing a daily eating schedule is an important criterion. A diet divided into several parts per day with defined carbohydrate content helps to limit the blood-sugar-raising effect of meals [31]. Efforts should be made to exclude added sugars from the diet. Taking into account the amount of fast-absorbing carbohydrates found in milk, fruits, and fermented (acidified) natural products and the time of consumption, they can be included in the diet [32]. In the case of already developed T2DM, adequate dietary therapy is an integral part of the toolset of treatment and self-management. Learning it under the guidance of an experienced dietitian can result in a 0.3–1.0% HbA1c reduction in type 1 diabetes and 0.5–2.0% in type 2 diabetes [33].

Most people with type 2 diabetes are overweight. In addition to ensuring the ratio of dietary components and aspects of healthy nutrition, it is necessary to limit energy intake in these cases. In addition to improving glycemic control, continuous and non-forced weight loss can contribute to regulating blood pressure and blood fat levels. In all stages of type 2 diabetes, it is fundamentally important to be aware of the energy content of food and follow and calculate carbohydrate intake. Regarding carbohydrate sources, preference should be given to vegetables, whole-grain foods, fruits, and dairy

products, while foods and beverages containing added fat, sugar, or salt should be avoided. The dietary fiber ratio for people living with diabetes must be at least the same as the amount recommended for non-diabetic patients. Incorporating 30 to 50 g of dietary fiber into the daily carbohydrate intake is recommended. Increasing the fiber content is beneficial since it slows down the absorption of carbohydrates. In addition, due to its satiating value, it increases the feeling of satiety and improves bowel function [34].

Increasing fiber intake reduces the risk of developing metabolic syndrome. An increase in fiber intake of 10 g per 1000 kcal reduced the risk of metabolic syndrome by 0.1 unit [35]. By increasing fiber intake, the composition of the intestinal flora changes. The changes have a positive effect on metabolism, insulin sensitivity, and insulin secretion. The increased fiber intake can have a positive influence on bacterial flora similar to isoflavonoids (e.g., soy), pre-, pro-, and postbiotics [36]. The intestinal flora also play a role in estrogen metabolism. Bacteria with beta-glucuronidase activity can increase the level of biologically active estrogen in the body, thus slowing the development of estrogen deficiency and reducing the symptoms accompanying menopause. Based on previous research, the functioning of intestinal bacteria with beta-glucuronidase activity in addition to a diet rich in fiber does not represent an increased risk of breast cancer [37]. When formulating a fiber-rich diet, gradualness is important so the body can adapt to the changed diet. Excessive fiber intake, consuming more than 50 g of fiber per day, may have a negative effect because it may cause bloating, increase the binding and excretion of useful substances, and entail digestive problems. In each case, it is advisable to determine the dietary ratio of fats and the composition of foods containing fats on an individual basis, taking into account the cardiovascular risk. In diabetes complicated by dyslipidemia, it may be beneficial to consume 1.6–3.0 g of plant stanols and sterols per day. The sterols found in plants reduce the absorption of dietary cholesterol by binding to their receptors. The consumption of foods enriched with phytosterols is, therefore, favorable by reducing the total and LDL cholesterol levels of the serum. Natural ingredients should be preferred over foods and beverages containing added sugar. If necessary, energy-free and low-energy sweeteners can be used to replace added sugar, as they can reduce daily carbohydrate and energy intake [32].

The organizations performing scientific evaluation and risk assessment (EFSA in Europe and FAO/WHO JECFA on a global level) determined the acceptable daily intake (ADI) amounts regarding intensive sweeteners and sugar alcohols [38]. All additives approved before 20 January 2009 must be re-assessed. EFSA is conducting a consultation on assessing consumer exposure to sweeteners to develop a protocol. Even for the amount of sweeteners used to replace sugar, the recommended maximum is approximately 5% to 10% of the total daily energy intake, similar to that recommended in prevention [20].

4. Bone Metabolism Changes in Menopause

Osteoporosis is a chronic, progressive health problem that affects most women during menopause and has serious consequences. Osteoporosis is particularly common during this period in those with low serum vitamin D levels [39]. The average annual rate of bone loss during menopause, beginning 1–3 years before menopause and lasting 5–10 years, is approximately 2% resulting in an average 10–12% decrease in bone mineral density (BMD) in the spine and hip.

Among nutritional factors, bone health can be adversely affected by abnormal nutritional status (overweight, obesity, malnutrition, or sarcopenia), vitamin D deficiency, hypercalciuria, and malabsorption disorders (e.g., celiac disease, inflammatory bowel diseases, gastrectomy, chronic liver diseases, or gastrointestinal malignancies).

A distinction must be drawn between osteoporosis (low BMD) and risk factors for fractures. The causes of low BMD are menopause itself, age, genetic predisposition, abnormal nutritional status, other diseases, and medications that affect bone absorption and metabolism. Risk factors for bone fractures are low BMD, previous fractures, multiple fractures occurring in the family, old age, frailty syndrome, and other diseases (e.g., those associated with dizziness and general weakness) [40].

Based on the above-mentioned factors, it is necessary to introduce lifestyle changes during this period to reduce the risk of fractures caused by osteoporosis, which include maintaining/achieving a healthy nutritional status and balanced nutrition focusing on adequate intake of vitamin D and calcium, regular exercise, smoking cessation, and stopping alcohol drinking [39][40].

5. Cancer Prevention during Perimenopause and Menopause

In connection with female hormonal changes during perimenopause, the risk of developing hormone-sensitive breast cancer may increase, so in this period, in addition to the previously mentioned diseases (CVD, IR, T2DM, and

osteoporosis), tumor prevention lifestyle changes (exercise, nutrition, avoidance of alcohol, tobacco, and coffee) are also important.

During menopause, an increase in body weight, including visceral fat weight, is characteristic, which not only increases the risk of CVD but also the risk of IR and, through this, the development of tumors [39].

The most common cancer in women during menopause is breast cancer, for which the three leading risk factors are overweight (or obesity), regular alcohol consumption, and a sedentary lifestyle. A weight gain of 20 kg in adulthood doubles the risk of breast cancer. Regular alcohol consumption and a sedentary lifestyle in both the pre- and postmenopausal periods increase the risk of developing breast cancer [41]. Maintaining and achieving a normal nutritional status and body composition are also paramount in reducing the risk of cancer. In particular, the goal is to maintain and achieve a normal range of fat-free mass, and skeletal muscle mass. In addition to following the guidelines of a balanced diet, the regular inclusion of cruciferous vegetables in the diet (cabbage, broccoli, cauliflower, radishes, and canola) and the consumption of at least half a kg of vegetables and fruits should be highlighted.

In the case of an already developed breast cancer, the focus is on maintaining normal nutritional status and skeletal muscle mass. In addition to cancer treatments, the diet is the same as the IR diet. In case of adequate energy intake or overweight or obesity, a 500–700 kcal less energy intake and a fat intake of 30–35% of energy are recommended, most of which consists of monounsaturated and polyunsaturated fatty acids, i.e., vegetable fats. Tumor size can be reduced with an optimized energy intake or in the case of obesity or overweight, with a 5–10% reduction in body weight [41].

6. The Role of Micronutrients in Menopause

Most of the vitamin D requirement is synthesized endogenously in the summer months. However, when there is not enough UV-B radiation, dietary vitamin D intake is also important (e.g., in Central Europe from October to March, or if someone does not spend enough time outdoors, uses sun protection creams, or wears clothing that fully covers the skin). With ageing, the rate of hydroxylation of vitamin D precursors in the body decreases, so the importance of exogenous vitamin D intake increases with age [42][43].

Vitamin D is a fat-soluble vitamin. Its sources are egg yolks, dairy products, offal, and foods supplemented with vitamin D. About 80% of dietary vitamin D is absorbed in the small intestine. If UV-B radiation is insufficient, routine dietary supplementation is required. Vitamin D supplementation is especially important for infants, young children, and the elderly population. Vitamin D preparations should be taken with meals [20]. Clinical studies have proven that osteoporosis treatments only achieve their effectiveness with adequate vitamin D supplementation (more than 1000 IU per day). Without vitamin D supplementation, the fracture risk reduction effect of osteoporosis therapies can decrease by up to 30%. From October to March in Central Europe, the UV-B radiation is so low that not enough vitamin D can be synthesized in the skin. Therefore, continuous vitamin D supplementation is recommended in these months for preventive purposes with a dose of 2000 IU per day. For people who do not have permanent access to sunlight, a year-round supplementation is recommended [44].

The calcium requirements can be covered by a balanced diet. In the case of a diagnosed deficiency, the appropriate intake can be ensured primarily by modifying the diet. Routine calcium supplementation is not recommended due to its cardiovascular risk [40]. The absorption of calcium is primarily influenced by vitamin D status, but it can be improved by the acidic components of dairy products and food matrix. Dairy products contain the most easily absorbable calcium, but consumption of mineral waters with high mineral content or hard water also contributes to ensuring the need. Regular consumption of soft-boned fish (eaten with bones), such as canned sardines, pickled herring, and anchovy, as well as oilseeds and foods supplemented with calcium, also contribute to calcium intake [45].

In addition to insufficient vitamin D status, the factor inhibiting calcium absorption and utilization is a diet rich in protein, dietary fiber, and phytates [20]. Supplements should only be used if a calcium deficiency can be diagnosed. The recommended daily calcium intake (recommended dietary allowance, RDA) for menopausal women (from the age of 51) is 1000–1200 mg [40]. The calcium intake recommended by the European Food Safety Authority (EFSA) is 950 µg over the age of 25 [20].

The protein intake should be 0.8 g/kg body weight/day following a balanced diet, and 1–1.2 g/kg body weight/day protein intake is recommended for those who exercise regularly and in case of weight loss, half of which should come from vegetable sources. A diet rich in protein (1.5–2 g/kg body weight/day) increases the risk of fractures [40].

Vitamin C is necessary for bone formation due to its role in collagen formation. Its absorption is about 80% if the daily intake is 100 mg/day. RDA is 100 mg/day, which can be provided through diet. Its sources are freshly eaten vegetables and fruits, especially peppers, currants, citrus fruits, and sauerkraut [20].

All menopausal women, not just those at risk of fracture, should be encouraged to adopt a bone-friendly lifestyle. This includes optimizing calcium and vitamin D status, getting adequate physical activity, and avoiding smoking and alcohol [46]. Prevention of osteoporosis begins in childhood and adolescence, as this is the age when peak bone mass is formed. The two pillars of prevention are maintaining adequate calcium and vitamin D status, as well as regular exercise. According to the American guideline, phytoestrogens, including isoflavonoids, can only have a mild effect on estrogen deficiency, thus, on the loss of bone minerals; therefore, they do not prevent the development of osteoporosis [40].

B vitamins also play an important role in menopause. They play a fundamental role in the processing of carbohydrates and the functioning of the nervous system [47][48]. Adequate B vitamin intake significantly reduces the serum homocysteine level and, in parallel, the risk of stroke [49]. High homocysteine levels have also been associated with osteoporosis and increased risk of bone fractures [50][51][52][53][54][55][56].

In the prevention and treatment of cognitive dysfunction and cognitive decline, which are common complaints in menopause, an *adequate supply of B vitamins* is extremely important [57][58][59][60][61][62][63]. A balanced B-vitamin intake, therefore, plays an important health-preserving role in menopause. A microbiome with the appropriate biodiversity and composition also contributes to this [64][65].

7. Soy and Phytoestrogens and Menopause

During perimenopause, women in question try many dietary practices. Perhaps the most common and at the same time the most controversial one is the consumption of soy and other phytoestrogens in the diet or as dietary supplements. Many studies for and against the topic can be read. While the isoflavone content of soy can have a positive effect on the strength and frequency of symptoms, phytoestrogens can have a negative effect on the treatment of hormone-sensitive breast tumors.

Menopausal hot flashes are rarer in countries where regular soy consumption is a part of the diet. The isoflavone content of soy foods may be effective in reducing menopausal symptoms. One study recommended 20 mg/day of soy isoflavones supplementation during perimenopause for symptom reduction. This corresponds to 400 mL/day of soy drinks or 80 g/day of other soy products (tofu, tempeh, or fermented soy products) [66]. According to another study, intake of more than 42 mg/day of soy isoflavones may have a tumor-reducing effect [67]. According to a third publication, regular soy consumption does not increase the risk of developing breast cancer [68]. However, the effectiveness of anti-estrogen therapy (e.g., Tamoxifen) can be reduced by regular soy consumption (examined substance: Genistein). However, according to an Asian population-level study (a study of isoflavones), consuming 10–15 g of soy protein (equivalent to 250 mL of soy drink) with a balanced diet and a healthy lifestyle can be safe even in these cases [41][69][70][71].

In summary, it can be said that there is no consensus among the scientific community on the effect of dietary soy on breast cancer and its treatment. It is important to point out that the above safe intake applies only to soy foods included in the diet and not soy isoflavones taken as dietary supplements [72].

References

1. Ojo, O. Nutrition and Chronic Conditions. *Nutrients* 2019, 11, 459.
2. Raj, A.; Chakole, S.; Agrawal, S.; Gupta, A.; Khekade, H.; Prasad, R.; Lohakare, T.; Wanjari, M. The Impact of Menopause on Cardiovascular Aging: A Comprehensive Review of Androgen Influences. *Cureus* 2023, 15, e43569.
3. Mishra, S.R.; Chung, H.F.; Waller, M.; Mishra, G.D. Duration of estrogen exposure during reproductive years, age at menarche and age at menopause, and risk of cardiovascular disease events, all-cause and cardiovascular mortality: A systematic review and meta-analysis. *BJOG* 2021, 128, 809–821.
4. Anagnostis, P.; Stevenson, J.C.; Crook, D.; Johnston, D.G.; Godsland, I.F. Effects of menopause, gender and age on lipids and high-density lipoprotein cholesterol subfractions. *Maturitas* 2015, 81, 62–68.
5. Silva, T.R.; Oppermann, K.; Reis, F.M.; Spritzer, P.M. Nutrition in Menopausal Women: A Narrative Review. *Nutrients* 2021, 13, 2149.

6. Ryczkowska, K.; Adach, W.; Janikowski, K.; Banach, M.; Bielecka-Dabrowa, A. Menopause and women's cardiovascular health: Is it really an obvious relationship? *Arch. Med. Sci.* 2023, 19, 458–466.
7. Novella, S.; Perez-Cremades, D.; Mompeon, A.; Hermenegildo, C. Mechanisms underlying the influence of oestrogen on cardiovascular physiology in women. *J. Physiol.* 2019, 597, 4873–4886.
8. Gardner, C.D.; Vadiveloo, M.K.; Petersen, K.S.; Anderson, C.A.M.; Springfield, S.; Van Horn, L.; Khera, A.; Lamendola, C.; Mayo, S.M.; Joseph, J.J.; et al. Popular Dietary Patterns: Alignment With American Heart Association 2021 Dietary Guidance: A Scientific Statement From the American Heart Association. *Circulation* 2023, 147, 1715–1730.
9. Visseren, F.L.J.; Mach, F.; Smulders, Y.M.; Carballo, D.; Koskinas, K.C.; Back, M.; Benetos, A.; Biffi, A.; Boavida, J.M.; Capodanno, D.; et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. *Eur. Heart J.* 2021, 42, 3227–3337.
10. Zwart, J.J.; Richters, J.M.; Ory, F.; de Vries, J.I.; Bloemenkamp, K.W.; van Roosmalen, J. Uterine rupture in The Netherlands: A nationwide population-based cohort study. *BJOG* 2009, 116, 1069–1080.
11. Martin, S.; Schneider, B.; Heinemann, L.; Lodwig, V.; Kurth, H.J.; Kolb, H.; Scherbaum, W.A. Self-monitoring of blood glucose in type 2 diabetes and long-term outcome: An epidemiological cohort study. *Diabetologia* 2006, 49, 271–278.
12. Williams, B.; Mancia, G.; Spiering, W.; Agabiti Rosei, E.; Azizi, M.; Burnier, M.; Clement, D.L.; Coca, A.; de Simone, G.; Dominiczak, A.; et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur. Heart J.* 2018, 39, 3021–3104.
13. Herforth, A.; Arimond, M.; Álvarez-Sánchez, C.; Coates, J.; Christianson, K.; Muehlhoff, E. A Global Review of Food-Based Dietary Guidelines. *Adv. Nutr.* 2019, 10, 590–605.
14. Daley, A.; Jolly, K.; Madigan, C.; Griffin, R.; Roalfe, A.; Lewis, A.; Nickless, A.; Aveyard, P. Public Health Research. In *A Brief Behavioural Intervention to Promote Regular Self-Weighing to Prevent Weight Regain after Weight Loss: A RCT*; NIHR Journals Library: Southampton, UK, 2019.
15. Camara, M.; Giner, R.M.; Gonzalez-Fandos, E.; Lopez-Garcia, E.; Manes, J.; Portillo, M.P.; Rafecas, M.; Dominguez, L.; Martinez, J.A. Food-Based Dietary Guidelines around the World: A Comparative Analysis to Update AESAN Scientific Committee Dietary Recommendations. *Nutrients* 2021, 13, 3131.
16. Springmann, M.; Spajic, L.; Clark, M.A.; Poore, J.; Herforth, A.; Webb, P.; Rayner, M.; Scarborough, P. The healthiness and sustainability of national and global food based dietary guidelines: Modelling study. *BMJ* 2020, 370, m2322.
17. Corrêa Rezende, J.L.; de Medeiros Frazão Duarte, M.C.; Melo, G.; Dos Santos, L.C.; Toral, N. Food-based dietary guidelines for children and adolescents. *Front. Public Health* 2022, 10, 1033580.
18. Food-Based Dietary Guidelines. Available online: <https://www.fao.org/nutrition/education/food-based-dietary-guidelines> (accessed on 2 February 2023).
19. The Hungarian Dietetic Association. The OKOSTÁNYÉR® New Dietary Guideline for the Healthy Adult Population. Available online: https://www.okostanyer.hu/wp-content/uploads/2021/11/2021_OKOSTANYER_ANGOL_felnott_A4.pdf (accessed on 12 February 2021).
20. European Food Safety Authority. Dietary Reference Values for nutrients Summary report. EFSA Support. Publ. 2017, 14, 98.
21. Lovejoy, J.C.; Champagne, C.M.; de Jonge, L.; Xie, H.; Smith, S.R. Increased visceral fat and decreased energy expenditure during the menopausal transition. *Int. J. Obes.* 2008, 32, 949–958.
22. Paschou, S.A.; Anagnostis, P.; Pavlou, D.I.; Vryonidou, A.; Goulis, D.G.; Lambrinoudaki, I. Diabetes in Menopause: Risks and Management. *Curr. Vasc. Pharmacol.* 2019, 17, 556–563.
23. Mauvais-Jarvis, F.; Manson, J.E.; Stevenson, J.C.; Fonseca, V.A. Menopausal Hormone Therapy and Type 2 Diabetes Prevention: Evidence, Mechanisms, and Clinical Implications. *Endocr. Rev.* 2017, 38, 173–188.
24. Wang, M.; Gan, W.; Kartsonaki, C.; Guo, Y.; Lv, J.; Chen, Z.; Li, L.; Yang, L.; Yu, M. Menopausal status, age at natural menopause and risk of diabetes in China: A 10-year prospective study of 300,000 women. *Nutr. Metab.* 2022, 19, 7.
25. Wainberg, M.; Mahajan, A.; Kundaje, A.; McCarthy, M.I.; Ingelsson, E.; Sinnott-Armstrong, N.; Rivas, M.A. Homogeneity in the association of body mass index with type 2 diabetes across the UK Biobank: A Mendelian randomization study. *PLoS Med.* 2019, 16, e1002982.
26. Slopian, R.; Wender-Ozegowska, E.; Rogowicz-Frontczak, A.; Meczekalski, B.; Zozulinska-Ziolkiewicz, D.; Jaremek, J.D.; Cano, A.; Chedraui, P.; Goulis, D.G.; Lopes, P.; et al. Menopause and diabetes: EMAS clinical guide. *Maturitas* 2018, 117, 6–10.
27. Briggs Early, K.; Stanley, K. Position of the Academy of Nutrition and Dietetics: The Role of Medical Nutrition Therapy and Registered Dietitian Nutritionists in the Prevention and Treatment of Prediabetes and Type 2 Diabetes. *J. Acad.*

28. Paschou, S.A.; Marina, L.V.; Spartalis, E.; Anagnostis, P.; Alexandrou, A.; Goulis, D.G.; Lambrinoudaki, I. Therapeutic strategies for type 2 diabetes mellitus in women after menopause. *Maturitas* 2019, 126, 69–72.
29. Cooney, C.; Daly, E.; McDonagh, M.; Ryan, L. Evaluation of Measured Resting Metabolic Rate for Dietary Prescription in Ageing Adults with Overweight and Adiposity-Based Chronic Disease. *Nutrients* 2021, 13, 1229.
30. Guideline: Sugars Intake for Adults and Children; WHO: Geneva, Switzerland, 2015.
31. Cobiaci, L.J.; Scarborough, P.; Kaur, A.; Rayner, M. The Eatwell Guide: Modelling the Health Implications of Incorporating New Sugar and Fibre Guidelines. *PLoS ONE* 2016, 11, e0167859.
32. Cosentino, F.; Grant, P.J.; Aboyans, V.; Bailey, C.J.; Ceriello, A.; Delgado, V.; Federici, M.; Filippatos, G.; Grobbee, D.E.; Hansen, T.B.; et al. 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. *Eur. Heart J.* 2020, 41, 255–323.
33. Abdelsalam, S.E.; Ismaail, M.A.R.; Sultan, E.A.; Elsherif, O.E.; Salama, H.M.; Hassan, S.I. The outcome of medical nutrition therapy on glycemic control among type 2 diabetic patients. *Pan Afr. Med. J.* 2023, 45, 85.
34. Reynolds, A.N.; Akerman, A.P.; Mann, J. Dietary fibre and whole grains in diabetes management: Systematic review and meta-analyses. *PLoS Med.* 2020, 17, e1003053.
35. Lepping, K.; Adams-Campbell, L.L.; Hicks, J.; Mills, M.; Dash, C. Dietary fiber intake and metabolic syndrome in postmenopausal African American women with obesity. *PLoS ONE* 2022, 17, e0273911.
36. Singh, V.; Park, Y.J.; Lee, G.; Unno, T.; Shin, J.H. Dietary regulations for microbiota dysbiosis among post-menopausal women with type 2 diabetes. *Crit. Rev. Food Sci. Nutr.* 2023, 63, 9961–9976.
37. Zengul, A.G.; Demark-Wahnefried, W.; Barnes, S.; Morrow, C.D.; Bertrand, B.; Berryhill, T.F.; Fruge, A.D. Associations between Dietary Fiber, the Fecal Microbiota and Estrogen Metabolism in Postmenopausal Women with Breast Cancer. *Nutr. Cancer* 2021, 73, 1108–1117.
38. WHO. Joint FDA/WHO Expert Committee on Food Additives. Evaluations of the Joint FAO/WHO Expert Committee on Food Additives. Available online: <https://apps.who.int/food-additives-contaminants-jecfa-database/> (accessed on 23 August 2018).
39. Bussell, G. Menopause. In *Manual of Dietetic Practice*; Gandy, J., Ed.; Wiley Blackwell: Oxford, UK, 2019; pp. 85–87.
40. Management of osteoporosis in postmenopausal women: The 2021 position statement of The North American Menopause Society. *Menopause* 2021, 28, 973–997.
41. Harvie, M. Breast cancer. In *Manual of Dietetic Practice*; Gandy, J., Ed.; Wiley Blackwell: Oxford, UK, 2019; pp. 842–846.
42. Várbiro, S.; Takács, I.; Túú, L.; Nas, K.; Sziva, R.E.; Hetthéssy, J.R.; Török, M. Effects of Vitamin D on Fertility, Pregnancy and Polycystic Ovary Syndrome-A Review. *Nutrients* 2022, 14, 1649.
43. Agostini, D.; Gervasi, M.; Ferrini, F.; Bartolacci, A.; Stranieri, A.; Piccoli, G.; Barbieri, E.; Sestili, P.; Patti, A.; Stocchi, V.; et al. An Integrated Approach to Skeletal Muscle Health in Aging. *Nutrients* 2023, 15, 1802.
44. Takacs, I.; Dank, M.; Majnik, J.; Nagy, G.; Szabo, A.; Szabo, B.; Szekanecz, Z.; Sziller, I.; Toldy, E.; Tisler, A.; et al. Hungarian consensus recommendation on the role of vitamin D in disease prevention and treatment. *Orv. Hetil.* 2022, 163, 575–584.
45. Hodges, J.K.; Cao, S.; Cladis, D.P.; Weaver, C.M. Lactose Intolerance and Bone Health: The Challenge of Ensuring Adequate Calcium Intake. *Nutrients* 2019, 11, 718.
46. de Villiers, T.J.; Goldstein, S.R. Update on bone health: The International Menopause Society White Paper 2021. *Climacteric* 2021, 24, 498–504.
47. Nutrition Working, G.; O'Connor, D.L.; Blake, J.; Bell, R.; Bowen, A.; Callum, J.; Fenton, S.; Gray-Donald, K.; Rossiter, M.; Adamo, K.; et al. Canadian Consensus on Female Nutrition: Adolescence, Reproduction, Menopause, and Beyond. *J. Obstet. Gynaecol. Can.* 2016, 38, 508–554.e518.
48. Porter, K.; Hoey, L.; Hughes, C.F.; Ward, M.; McNulty, H. Causes, Consequences and Public Health Implications of Low B-Vitamin Status in Ageing. *Nutrients* 2016, 8, 725.
49. Homocysteine Studies, C. Homocysteine and risk of ischemic heart disease and stroke: A meta-analysis. *JAMA* 2002, 288, 2015–2022.
50. Dai, Z.; Wang, R.; Ang, L.W.; Yuan, J.M.; Koh, W.P. Dietary B vitamin intake and risk of hip fracture: The Singapore Chinese Health Study. *Osteoporos. Int.* 2013, 24, 2049–2059.

51. Enneman, A.W.; Swart, K.M.; Zillikens, M.C.; van Dijk, S.C.; van Wijngaarden, J.P.; Brouwer-Brolsma, E.M.; Dhonukshe-Rutten, R.A.; Hofman, A.; Rivadeneira, F.; van der Cammen, T.J.; et al. The association between plasma homocysteine levels and bone quality and bone mineral density parameters in older persons. *Bone* 2014, 63, 141–146.
52. Gjesdal, C.G.; Vollset, S.E.; Ueland, P.M.; Refsum, H.; Drevon, C.A.; Gjessing, H.K.; Tell, G.S. Plasma total homocysteine level and bone mineral density: The Hordaland Homocysteine Study. *Arch. Intern. Med.* 2006, 166, 88–94.
53. McLean, R.R.; Jacques, P.F.; Selhub, J.; Fredman, L.; Tucker, K.L.; Samelson, E.J.; Kiel, D.P.; Cupples, L.A.; Hannan, M.T. Plasma B vitamins, homocysteine, and their relation with bone loss and hip fracture in elderly men and women. *J. Clin. Endocrinol. Metab.* 2008, 93, 2206–2212.
54. Tucker, K.L.; Hannan, M.T.; Qiao, N.; Jacques, P.F.; Selhub, J.; Cupples, L.A.; Kiel, D.P. Low plasma vitamin B12 is associated with lower BMD: The Framingham Osteoporosis Study. *J. Bone Miner Res.* 2005, 20, 152–158.
55. Yang, J.; Hu, X.; Zhang, Q.; Cao, H.; Wang, J.; Liu, B. Homocysteine level and risk of fracture: A meta-analysis and systematic review. *Bone* 2012, 51, 376–382.
56. Yazdanpanah, N.; Zillikens, M.C.; Rivadeneira, F.; de Jong, R.; Lindemans, J.; Uitterlinden, A.G.; Pols, H.A.; van Meurs, J.B. Effect of dietary B vitamins on BMD and risk of fracture in elderly men and women: The Rotterdam study. *Bone* 2007, 41, 987–994.
57. Corona, G.; Giuliani, C.; Parenti, G.; Colombo, G.L.; Sforza, A.; Maggi, M.; Forti, G.; Peri, A. The Economic Burden of Hyponatremia: Systematic Review and Meta-Analysis. *Am. J. Med.* 2016, 129, 823–835.e824.
58. Brown, B.; Huang, M.H.; Karlamangla, A.; Seeman, T.; Kado, D. Do the effects of APOE-epsilon4 on cognitive function and decline depend upon vitamin status? MacArthur Studies of Successful Aging. *J. Nutr. Health Aging* 2011, 15, 196–201.
59. Horvat, P.; Gardiner, J.; Kubinova, R.; Pajak, A.; Tamosiunas, A.; Schottker, B.; Pikhart, H.; Peasey, A.; Jansen, E.; Bobak, M. Serum folate, vitamin B-12 and cognitive function in middle and older age: The HAPIEE study. *Exp. Gerontol.* 2016, 76, 33–38.
60. Kado, D.M.; Karlamangla, A.S.; Huang, M.H.; Troen, A.; Rowe, J.W.; Selhub, J.; Seeman, T.E. Homocysteine versus the vitamins folate, B6, and B12 as predictors of cognitive function and decline in older high-functioning adults: MacArthur Studies of Successful Aging. *Am. J. Med.* 2005, 118, 161–167.
61. Moorthy, D.; Peter, I.; Scott, T.M.; Parnell, L.D.; Lai, C.Q.; Crott, J.W.; Ordovas, J.M.; Selhub, J.; Griffith, J.; Rosenberg, I.H.; et al. Status of vitamins B-12 and B-6 but not of folate, homocysteine, and the methylenetetrahydrofolate reductase C677T polymorphism are associated with impaired cognition and depression in adults. *J. Nutr.* 2012, 142, 1554–1560.
62. Morris, M.S. The role of B vitamins in preventing and treating cognitive impairment and decline. *Adv. Nutr.* 2012, 3, 801–812.
63. Morris, M.S.; Selhub, J.; Jacques, P.F. Vitamin B-12 and folate status in relation to decline in scores on the mini-mental state examination in the framingham heart study. *J. Am. Geriatr. Soc.* 2012, 60, 1457–1464.
64. Alrubaye, H.S.; Kohl, K.D. Abundance and Compositions of B-Vitamin-Producing Microbes in the Mammalian Gut Vary Based on Feeding Strategies. *mSystems* 2021, 6, e0031321.
65. Hossain, K.S.; Amarasena, S.; Mayengbam, S. B Vitamins and Their Roles in Gut Health. *Microorganisms* 2022, 10, 1168.
66. Taku, K.; Melby, M.K.; Kronenberg, F.; Kurzer, M.S.; Messina, M. Extracted or synthesized soybean isoflavones reduce menopausal hot flash frequency and severity: Systematic review and meta-analysis of randomized controlled trials. *Menopause* 2012, 19, 776–790.
67. Magee, P.J.; Rowland, I. Soy products in the management of breast cancer. *Curr. Opin. Clin. Nutr. Metab. Care* 2012, 15, 586–591.
68. Steinberg, F.M.; Murray, M.J.; Lewis, R.D.; Cramer, M.A.; Amato, P.; Young, R.L.; Barnes, S.; Konzelmann, K.L.; Fischer, J.G.; Ellis, K.J.; et al. Clinical outcomes of a 2-y soy isoflavone supplementation in menopausal women. *Am. J. Clin. Nutr.* 2011, 93, 356–367.
69. van Duursen, M.B.; Nijmeijer, S.M.; de Morree, E.S.; de Jong, P.C.; van den Berg, M. Genistein induces breast cancer-associated aromatase and stimulates estrogen-dependent tumor cell growth in in vitro breast cancer model. *Toxicology* 2011, 289, 67–73.
70. Guha, N.; Kwan, M.L.; Quesenberry, C.P., Jr.; Weltzien, E.K.; Castillo, A.L.; Caan, B.J. Soy isoflavones and risk of cancer recurrence in a cohort of breast cancer survivors: The Life After Cancer Epidemiology study. *Breast Cancer Res. Treat.* 2009, 118, 395–405.

71. Shu, X.O.; Zheng, Y.; Cai, H.; Gu, K.; Chen, Z.; Zheng, W.; Lu, W. Soy food intake and breast cancer survival. *JAMA* 2009, 302, 2437–2443.
72. Deli, T.; Orosz, M.; Jakab, A. Hormone Replacement Therapy in Cancer Survivors—Review of the Literature. *Pathol. Oncol. Res.* 2020, 26, 63–78.

Retrieved from <https://encyclopedia.pub/entry/history/show/120242>