Report of the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) on nutritional risks for women during menopause, perimenopause and postmenopause

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Working group

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Abstract

Menopause is the time when a woman transitions from the reproductive stage of life to the non-reproductive state. It is characterised by significant hormonal changes, which can affect a woman's physical, emotional, mental and social well-being. This transition also includes peri-menopause (the stage before menopause) and post-menopause (the phase after the menopause).

According to the most recent data from the National Institute of Statistics (INE), in Spain women aged 50 or over (which is the usual age of onset of natural menopause) account for approximately

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half the female population. The World Health Organization (WHO) believes that support for women's social, psychological and physical health during the menopausal transition and after menopause, should be an integral part of health care, in order to promote women's healthy ageing and a good quality of life before, during and after menopause.

The Scientific Committee of the Spanish Agency for Food Safety and Nutrition (AESAN) has studied the factors that influence the age of onset and symptomatology of the menopause and has evaluated the nutritional risks that women present during the menopausal and post-menopausal transition, including obesity and its associated complications, vascular risk, osteoporosis and sarcopenia. The Committee has concluded that adopting a healthy diet, in which certain nutrients acquire special relevance at this stage of life, avoiding toxins such as tobacco and alcohol and performing physical activity on a regular basis, can influence these factors and help mitigate these risks and improve quality of life.

Key words

Menopause, nutritional risks, woman, healthy diet, physical activity.

Suggested citation

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1. Introduction

Menopause is the time when a woman transitions from the reproductive stage of life to the non-reproductive state. It is characterised by significant hormonal changes, which can affect a woman's physical, emotional, mental and social well-being. This transition also includes the peri-menopause (the stage before menopause) and post-menopause (the phase after the menopause). The date of menopause is determined retrospectively when a woman presents with 12 months of amenorrhoea, or lack of menstruation, and there is no specific pathological cause. Although there are individual differences, menopause usually occurs around 50 years of age, according to the Basic Manual of Menopause, prepared by the Spanish Association for the Study of Menopause (AEEM, 2020). During this stage, there can be changes in body composition, weight gain, decreased bone mineral density and increased cardiovascular risk, and, during this period, common symptoms can occur, such as hot flushes and sleep disorders (Casper, 2024) (NHS, 2024) (WHO, 2024).

The global population of menopausal, peri-menopausal, and post-menopausal women is increasing. In 2021, women aged 50 and over made up 26 % of the entire global female population, whereas, 10 years earlier, this figure was only 22 % (WHO, 2024). In Spain, in January 2025, the group of women aged 50 or over made up approximately 50 % of the entire female population (INE, 2025a). In addition, women's life expectancy has increased in recent decades (WHO, 2024). Due to these data, the World Health Organization believes that support for women's social, psychological and physical health during and after the menopause should be an integral part of health care, in order to promote healthy ageing in women and a good quality of life before, during and after the menopause (Hickey et al., 2024) (WHO, 2024).

It has been demonstrated that a woman's state of health when entering the peri-menopausal stage is highly conditioned, not only by their previous clinical and reproductive history, but also by environmental factors and their lifestyle (WHO, 2024). With regard to lifestyle, it has been proven that adopting a healthy diet and regular physical activity can help alleviate some symptoms of the menopause, as well as reducing the risk of the onset of some of the health problems related to it, such as osteoporosis, cardiovascular disease and being overweight or obese (Sayón-Orea et al., 2015) (Silva et al., 2021) (Erdélyi et al., 2023) (NHS, 2024) (Wylenzek et al., 2024). In 2022, the Spanish Agency for Food Safety and Nutrition (AESAN) published its recommendations for health, a sustainable diet and physical activity, based on the report that the Scientific Committee prepared that same year on these recommendations and which were aimed at the general population, both adult men and women, excluding special populations (AESAN, 2022a, b). In other countries, such as Canada (Yuksel et al., 2021), France (ANSES, 2019) and the United Kingdom (NHS, 2024), recommendations have been established for this population group, in order to reduce the specific risks that arise during these life stages.

For all the above reasons, the Scientific Committee of the AESAN was asked to carry out an assessment of the nutritional risks presented by women going through the menopausal, peri-menopausal and post-menopausal stages, in order to both prevent possible health risks in this population group and to improve their general well-being, and thus be able to establish a series of dietary and physical activity recommendations for women during these stages of life.

2. General aspects of the menopause

2.1 Concept and terminology

The concept and definition of menopause and its phases have changed over time (Ambikairajah et al., 2022). In colloquial language, in the media and even in a healthcare environment, imprecise terminology is sometimes used that can be misleading. This section includes the currently-accepted definitions of the woman's stages of reproductive life (Lumsden et al., 2025).

Most of the information about the symptomatology and hormonal changes that occur at this stage is based on longitudinal studies. One of the most relevant is the Study of Women's Health Across the Nation (SWAN), which started in 1996 and evaluated 3000 women between 45 and 52 years old for 15 years (El Khoudary et al., 2019). In 2001, a consensus document was published (STRAW, Stages of Reproductive Ageing Workshop) on reproductive life stages in women (Soules et al., 2001), which was subsequently updated in 2012 (Harlow et al., 2012), and is the basis of the classification currently used (Lumsden et al., 2025). Table 1 lists the different phases of reproductive life in women, focussing in particular on the menopausal transition.

MENOPAUSE
(Last menstrual period)

Table 1. Stages of menopause (STRAW criteria)

Stages	-5	-4	-3	-2	-1	+1	+2
Terminology	Reproductive Phase			Menopausal transition		Post-menopause	
	Early	Peak	Late	Early	Late *	Early *	Late
Menstrual cycles	Variable to regular	Regular	Regular	Peri-menopause: Variable cycle length (>7 days difference from normal)	Peri-menopause: 2 or more missed cycles and ≥60 days of amenorrhoea	‡	None
Endocrine changes	Normal FSH	Normal FSH	Elevated FSH	Elevated FSH	Elevated FSH	Elevated FHS	Elevated FHS
Stage duration	Variable			Variable		(a) 4 years (b)	Until death

* Stages most likely to be characterized by vasomotor symptoms.

‡ Amenorrhoea for one year or more.

Within the STRAW criteria, menopause occupies a central position in the classification system and is designated as the point zero (0). Five stages precede the Last Menstrual Period (LMP) (–5 to –1) and two follow it (+1 to +2). Stages –5 to –3 comprise the Reproductive Interval; stages –2 to –1 reflect the Menopausal Transition; and stages +1 to +2 define Post-menopause (Soules et al., 2001).

The menopausal transition (–2 to –1) begins with a variation in the length of the menstrual cycle and an increase in follicle stimulating hormone (FSH). This transition ends with the LMP. Early post-menopause (+1) is defined as the first 5 years after LMP and is subdivided into two segments: (a) the first 12 months after LMP and (b) the following 4 years. Late post-menopause (+2), however, is varies in duration which can extend until the woman's death. Finally, the STRAW criteria define peri-menopause (–2 to +1a) as the period ending 12 months after LMP.

Source: (Lumsden et al., 2025. Adapted from Ambikairajah et al., 2022 and Soules et al., 2001).

Natural menopause is defined as the absence of menstruation for more than 1 year. In Europe, it usually occurs, approximately, in women aged 50-51 years (Schoenaker et al., 2014). Menopause can occur suddenly, with an abrupt interruption of menstruation, or be a more gradual process. It is associated with characteristic hormonal changes including elevated levels of Follicle Stimulating Hormone (FSH) (Lumsden et al., 2025). The Basic Menopause Manual, published by the Spanish Association for the Study of Menopause (AEEM, 2020), states that the natural age of menopause in Spain is approximately 50 years old.

Peri-menopause is a transitional phase during which ovarian function declines, leading to a decrease in oestrogen levels. It is usually accompanied by the onset of climacteric symptoms and can last between 2 and 4 years, concluding 1 year after menopause. This term is often used interchangeably with "menopausal transition", although its exact definition may vary, as the STRAW criteria do not include the year after menopause within peri-menopause. Detailed stages of perimenopause are best described by the STRAW criteria (Table 1). A woman is considered to have reached post-menopause when 1 year has elapsed since her last menstrual period (Lumsden et al., 2025).

Early-onset menopause is defined as occurring from the age of 40 and before the age of 45. Premature Ovarian Failure (POF) is defined as the onset of the menopause before the age of 40, accompanied by the absence of menstruation (amenorrhoea) or menstrual irregularity for 4 to 6 months, together with hormonal changes (low levels of oestradiol and elevated gonadotropins) (Santoro et al., 2021) (Lumsden et al., 2025).

2.2 Epidemiology

According to data from the Spanish National Institute of Statistics (INE), there are more than 25 million women residing in Spain; of them, approximately half are 50 years of age or older (INE, 2025a), with an age range for peri-menopause between 45 and 54 years. Life expectancy at birth for women in Spain is 86.3 years, according to the INE (2025b), meaning that at least one third of a woman's life is spent in the postmenopausal period.

Table 2 shows data on the distribution of women living in Spain, by age group, aged 45 and over (as of 1 January 2025) (INE, 2025a).

Table 2. Population of women residing in Spain in January 2025 (age ≥45 years)

Age range	Resident population (no. of people)
45 to 49 years old	2 032 474
50 to 54 years old	1 969 968
55-59 years old	1 862 894
60-64 years old	1 714 638
65 to 69 years old	1 489 076
70-74 years old	1 234 885
75-79 years old	1 118 942
80 to 84 years old	854 868
85-89 years old	567 666
90 and older	470 223

Source: (INE, 2025a).

2.3 Physiology

2.3.1 Hormonal changes during the menopause

Hormonal regulation of sexual and reproductive function in women is very complex, and involves the hypothalamus, pituitary gland and ovaries, through tightly regulated control mechanisms (Santoro et al., 2017) (Gatenby and Simpson, 2024). Regulation is initiated in the hypothalamus, which secretes Gonadotropin-Releasing Hormone (GnRH) in the form of pulses, which stimulate the secretion of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) in the pituitary gland. FSH stimulates the growth and development of ovarian follicles and also acts on ovarian granulosa cells, which convert androgens into oestradiol and stimulate the secretion of the hormone Inhibin B. This latter hormone exerts negative feedback on FSH secretion, leading to decreases secretion. LH, in contrast, stimulates ovarian androgen production, which is subsequently converted into oestradiol. Its secretion peaks around the mid-menstrual cycle.

The menstrual cycle is classically divided into two phases: the follicular phase, in which the growth of ovarian follicles occurs, and the proliferation of the endometrium, which ends with ovulation or expulsion of the egg. The remaining ovarian tissue in the place of the follicle becomes the "corpus luteum", which secretes oestradiol and progesterone, that prepare the endometrium for the eventual implantation of the embryo. In the absence of fertilisation and implantation, the function of the corpus luteum declines; the decrease in the action of ovarian hormones on endometrial cells results in menstruation and the beginning of a new cycle.

As women age, there is an alteration in the timing of the secretion of the hypothalamic hormone GnRH, which in turn impacts the regulation of FSH and LH secretion in the hypothalamus. At the ovarian level, there is a decrease in the hormone Inhibin B, which decreases the ovarian "brake" on the secretion of FSH and LH, leading to a progressive increase. The decrease in the number of ovarian follicles leads to anovulatory cycles and a progressive decrease in oestrogen levels.

The levels of male sex hormones, such as testosterone, are not significantly changed during the menopausal transition. For this reason, lowering oestrogen levels increases the testosterone/oestradiol ratio and can lead to symptoms of hyperandrogenism in some women (Talaulikar, 2022).

Oestrogens exert their effects through three main receptors: ERα (ESR1), ERβ (ESR2), and GPER1, activating signalling pathways such as MAPK, PI3K/Akt, and eNOS (Fuentes et al., 2019). The differential distribution of these receptors explains the wide variety of physiological effects of oestrogens on the urogenital system, metabolic homeostasis, connective tissue, and the nervous system, among others. Oestrogen deficiency explains most of the symptoms associated with the menopause.

2.3.2 Changes in body composition

Human body composition changes with age. In women, these changes become more apparent as a result of the menopause. Overall, a progressive decrease in muscle mass and bone mass is evident, with an increase in the percentage of fat, with additional changes in the distribution of adipose tissue.

The longitudinal study Changes in body composition and weight during the menopause transition, analyses how the menopausal transition affects body composition and weight, regardless of chronological ageing (Greendale et al., 2019). Using data from the SWAN study, it was observed,

around the time of the last menstruation (DLM, Date of Last Menstruation), an increase in fat mass accelerates and a decrease in lean mass (a phenomenon that stabilises 2 years after the last menstrual period). Body weight (b.w.) and Body Mass Index (BMI) increase steadily before and during the menopausal transition, but do not accelerate in this period, and then stabilise in the post-menopausal period. This study also observed that changes in body composition were different depending on ethnic groups and geographic location. Thus, the effect was more marked in women identified as Caucasian and black, while women of Eastern ethnicity showed different patterns, such as the absence of fat increase or even a decrease in fat and weight when they were post-menopausal. Being older at the date of last menstruation attenuated these changes. The findings support that TM adversely impacts body composition, although this effect is not necessarily reflected in total weight, suggesting that BMI may be a limited useful tool for assessing metabolic risk in middle-aged women.

2.4 General symptomatology

It is estimated that up to 80-90 % of women experience some symptoms during the menopausal transition, and, approximately, one third of these symptoms have a significant impact on their daily quality of life (Gatenby and Simpson, 2024). Table 3 lists the most frequent symptoms.

Table 3. General symptomatology of women during menopause

Symptom Group	Typical symptomatology
Vasomotor symptoms	Hot flushes
	Night sweats
Psychological and cognitive	Low mood
	Anxiety
	Sleep disorders
	Difficulty concentrating
Urogenital	Urgency, urinary incontinence
	Nocturia, pollakiuria
	Increased risk of UTIs
	Vaginal dryness, genital pruritus
	Dyspareunia, pain/discomfort during sexual intercourse
	Decreased libido
Others	Fatigue
	Headache, migraines
	Muscle and joint pain
	Palpitations

Source: Adapted from Gatenby and Simpson (2024).

The appearance of symptoms related to the menopause can vary considerably between women and also in relation to different ethnic groups. As an example, in women identified as ethnic Caucasian, vasomotor symptoms, such as hot flushes or night sweats, are more frequent; however, these symptoms are less frequent in Asian women. Women who have an iatrogenic menopause, with a cessation of

ovarian function induced by surgery or medical treatments, usually have symptoms of greater intensity (Lumsden et al., 2025).

Symptoms associated with peri-menopause and menopause are commonly grouped into three main categories: vasomotor, psychological and urogenital.

Vasomotor symptoms are the most frequent at this stage and can appear very early, even up to 15 years before the cessation of menstruation. They are usually manifested as "hot flushes", in which there is a sensation of heat, sweating and facial redness, which can be very annoying. They have a major impact on quality of life and even self-esteem, especially if they occur in the work environment or when in the company of other people. Night sweats are also very common and interfere with sleep. The pathophysiology of these conditions is complex and not entirely known (Gatenby and Simpson, 2024).

Psychological and cognitive symptoms are well documented. Women sometimes report difficulty in concentrating, finding words. On the other hand, it is common for them to present with asthenia, apathy, low mood, anxiety or irritability (Monteleone et al., 2018). The aetiology of these conditions is probably multifactorial.

Genitourinary symptoms are also commonly observed, although sometimes they are not actively reported by women or are not directly identified as related to menopause (Angelou et al., 2020). They occur later, even years after the last menstruation, when the fall in oestrogen levels is evident. Oestrogenic deficiency involves functional and structural changes in multiple systems. Oestrogen receptors are present in organs and apparatus other than the genitorurinary system, but these are highly sensitive, and the incidence of symptoms increases with time after the menopause. Women often report symptoms such as dryness, itching or vaginal irritation, which can also be associated with incontinence, pollakiuria, nocturia or dysuria. This set of symptoms is currently defined as Genitourinary Menopause Syndrome (GMS). Associated with these symptoms, and as a consequence of the atrophy of the vaginal mucosa, discomfort or pain may appear with sexual intercourse (dyspareunia). In the sexual sphere, many women describe a decrease in libido, which also has a multifactorial origin, influenced by physical and psychological factors.

All these symptoms, which can persist for several years after the cessation of ovarian function, significantly affect the quality of life of women in these stages.

2.5 Factors influencing the age of onset and symptomatology of the menopause

The age at which menopausal transition occurs ranges from 45 to 55 years. In Spain, the average age is approximately 50 years. Various studies have evaluated the factors that influence both the age of onset and the symptomatology of the menopause (Mishra et al., 2019).

Some studies have observed that the age at which menopause occurs influences, in part, the risk of developing long-term complications (El Khoudary, 2020). Early loss of ovarian function prolongs the time of exposure to low oestrogen levels, with important metabolic and psychological repercussions. Natural menopause at a later age is associated with increased longevity and a lower risk of cardiovascular disease, osteoporosis, and fractures; however, there is an increased risk of breast

and endometrial cancer (Gold, 2011). This fact may be due to women being exposed for a longer time to the effects of oestrogen (Daan and Fauser, 2015). On the other hand, a later age of menopause is associated with a lower risk of neurodegenerative diseases (Breeze et al., 2024).

A study conducted in Australia (Pant et al., 2025) included 46 238 women, without cardiovascular disease, with an average age of 61.1 ± 8.2 years, in whom information on the age of onset of the menopause was available. After a period of 15 years, the adjusted Odds Ratio (OR) of cardiovascular disease was higher in women with premature menopause (40-44 years) (OR: 1.36; 95 % CI (95 % Confidence Interval): 1.17-1.59; p<0.0001) and early menopause (<40 years) (OR: 1.15; CI 95 %: 1.03-1.28; p= 0.013), compared to women in whom the menopausal onset age of between 50 and 52 years. Interestingly, in this study it was observed that a healthy lifestyle reduced the risk of cardiovascular disease by 23 %; in women with premature menopause this decrease was 52 %.

A prospective observational study in 204 224 women with a median follow-up of 12.6 years assessed the relationship between the menopause onset age and stroke (Tschiderer et al., 2023). It was observed that menopause at an earlier age was associated with an increased risk of stroke; however, no association was found between the menopause age conditioned by genetic factors and stroke, suggesting that there is no causal relationship and that lifestyle-related factors may be more relevant than biological factors.

Both the age of menopause and the symptoms of this stage of life are influenced by various factors that are summarized below.

2.5.1 Biological factors

The age of onset of menopause is mainly influenced by genetic factors, with heritability varying between 31 and 63 %, although it depends on the population evaluated. The genetic component explains approximately 50 % of the variability in the age of menopause. Family and twin studies demonstrate high heritability, with higher concordance between monozygotic than dizygotic twins. Having a family history of early or premature menopause multiplies the risk of presenting it by six (Cramer et al., 1995). In addition, being the daughter of a multiple pregnancy increases the risk by 50 %. The presence of genetic variants in genes related to DNA repair, immune function and hormonal regulation (such as EXO1, FSHB or BRCA2 genes) is also associated with early menopause (Xu et al., 2023).

Genetic variants related to the menopause onset age have been identified. However, only 2.5-4 % of the described heritability can be explained by these genetic variants. A meta-analysis of 22 Genome-Wide Association Studies (GWAS), which included nearly 40 000 women of European descent, confirmed four previously established age-related genes of natural menopause, located on chromosomes 5, 6, 19, and 20 (Stolk, 2012).

2.5.2 Geographical and socio-cultural factors

Several studies have evaluated differences in the menopause onset age in different countries. A systematic review evaluated the age at the menopause and associated symptoms, among women from Europe, North America, Latin America and Asia (Palacios et al., 2010). This study observed

that the average age of the menopause in Europe is between 50.1 and 52.8 years; in North America, between 50.5 and 51.4 years; in Latin America, between 43.8 and 53 years; and in Asia, between 42.1 and 49.5 years. The frequency of vasomotor symptoms varied widely by geographic region, selection criteria, and method of symptom identification. The prevalence of such symptoms was between 74 % of women in Europe, 36-50 % in North America, 45-69 % in Latin America and 22-63 % in Asia. The study also observed differences according to ethnicity in the same geographical region and that women in a worse socioeconomic situation presented a significantly earlier menopause (Palacios et al., 2010). A meta-analysis that included 46 studies, in 24 countries on different continents, observed an average menopause age of 48.8 years, which varied between 46 and 52 years. Geographic location explained 68.5 % of the variations in the menopause onset age, it being earlier in the countries of Africa, Latin America, Asia and the Middle East (with the exception of Japan and Taiwan), compared to Europe, Australia and the United States (Schoenaker et al., 2014). Lower educational attainment and smoking, in agreement with the findings of this study, were also associated with the onset of the menopause at an earlier age.

2.5.3 Reproductive factors

The age of first menstruation (menarche) and the number of pregnancies are important determinants related to the age of menopause. The InterLACE study, which collected data from more than 50 000 menopausal women from nine studies conducted in different countries, observed that women with an early menarche (≤11 years) have almost twice the risk of premature menopause than women with menarche at age 13 or older (Mishra et al., 2017). Other studies, such as the Nurses' Health Study II in the United States (Whitcomb, 2018), the China Kadoorie Biobank (Wang et al., 2018) or the UK Biobank (Ruth et al., 2016) have observed similar results.

Nulliparity is also associated with an increased risk of early menopause, while multiparity appears to exert a protective effect (Mishra et al., 2017). The characteristics of the menstrual cycle in youth are also a predictor ovarian ageing. Short (<25 days) and regular cycles correlate with decreased ovarian reserve (Whitcomb et al., 2018).

The use of Oral Contraceptives (OC) is not related to early menopause, before the age of 45 (Langton et al., 2021). In a prospective study, based on the Nurses' Health Study II cohort, the association between the use of oral contraceptives and the risk of early natural menopause was evaluated in more than 106 000 American women followed between 1989 and 2017. The results showed that the use of oral contraceptives, regardless of the duration, type or time of onset, was not associated with an increased risk of early menopause, after adjusting for factors such as smoking, BMI, parity and breastfeeding duration.

2.5.4 Lifestyle-related factors

There are several studies relating lifestyle to the age of onset of menopause and associated symptomatology.

Smoking is undoubtedly the factor that has been most associated with the early onset of menopause and with more relevant symptoms (Willett, 1983). Tobacco and its components behave as

hormone function modifiers and have an anti-oestrogenic effect. Smoking advances the age of menopause by almost 1 year (-0.94, 95 % CI: -1.36, -0.52) (Schoenaker et al., 2014) and increases the risk of hot flushes (Jenabi and Poorolajal, 2015). A meta-analysis including eight studies (27 054 women) found that even former smokers had a 30 % higher risk of hot flushes than those that had never smoked (OR: 1.31; CI 95 %: 1.22-1.41). In women smokers the risk doubles with an OR of 1.97 (95 % CI: 1.81-2.14). A subcohort of the prospective EPIC-Spain study evaluated 12 562 pre-menopausal women from different regions of Spain, with a follow-up of 3 years (Lujan-Barroso et al., 2018). After a median of 3 years of follow-up, 1166 women reached post-menopause. Earlier menopause was observed in current smokers (Hazard Ratio (HR): 1.29; CI 95 %: 1.08-1.55). Smoking has also been linked to an increased risk of hot flushes (Avis et al., 2018). In the study by Whiteman et al., conducted on 1087 women between the ages of 40 and 60, this risk is almost doubled: it was observed that, compared to non-smoking women, smokers had a higher risk of both moderate and severe hot flushes, with an OR of 1.9 (95 % CI: OR of 1.9 (CI 95 %: 1.3-2.9), and daily hot flushes (OR: 2.2; CI 95 %: 1.4-3.7). Among smokers, the risk of hot flushes increased with the amount of tobacco consumed (Whiteman et al., 2003). Similarly, it is well known that smoking increases the risk of both vascular disease and osteoporosis (Messner and Bernhard, 2014) (Hou et al., 2023).

Alcohol promotes vasomotor symptoms in menopause. Compared to abstainers, consumption of <10, 10-19, 20-39, and ≥40 g/day of alcohol showed an OR (95 % CI) of presenting vasomotor symptoms of 1.42 (1.02-1.99), 1.99 (1.27-3.12), 2.06 (1.19-3.57), and 3.52 (1.72-7.20), respectively (trend p<0.01) (Kwon et al., 2022). Yet its deleterious effect on osteoporosis and sarcopenia is well known (Kwon et al., 2017).

Regarding the time of menopause onset and its relationship with diet, in a study published by Dunneram et al. (2018) found a relationship between the type of food that women usually eat and the age at which the menopausal stage begins. Specifically, it was observed that women who regularly ate portions of refined pasta and rice began this stage earlier, while women whose diet focused more on fish, beans and other legumes did so at a later age. In addition, it was observed that each daily serving of oily fish, beans and other legumes that a woman ate was associated with an average delay of 3.3 years in the onset of menopause, and, for each additional serving of refined pasta and rice that a woman consumed per day, menopause was advanced by an average of 1.5 years. The researchers also noted that higher intake of vitamin B6 and zinc appeared to delay the onset age of the menopause: 0.6 and 0.3 years, respectively. But it was also observed that the vegetarian women in the study reached menopause at an earlier age than the meat-eaters.

Obesity, a multifactorial disease, influenced by biological and environmental factors, is also related to inadequate nutrition and a sedentary lifestyle, so it is difficult to differentiate the direct effect of excess adiposity from the effect of factors that favour its development. Malnutrition, on the other hand, is more frequent in women with chronic diseases and nutrient deficiencies. A meta-analysis that included nine studies (313 482 women) observed that a lower BMI is associated with an increased risk of early menopause 1.08 (95 % CI: 1.03-1.14; p<0.01) (Tao et al., 2015). A combined analysis of eleven prospective studies from the InterLACE consortium (24 196 women) found that underweight women were more than twice as likely to experience early menopause, and this risk

remained even after adjustment for smoking. In this study, compared to women with a normal BMI (18.5-24.9 kg/m²), underweight women were at higher risk of early menopause (Relative Risk Ratio (RRR): 2.15; CI 95 %: 1.50-3.06), while overweight (1.52; 1.31-1.77) and obese (1.54; 1.18-2.01) women showed an increased risk of late menopause.

Finally, it should be noted that the menopause onset age is advanced in women with a higher perceived level of stress (Bae et al., 2018) and unfavourable social and personal circumstances (Mishra et al., 2019).

2.5.5 Environmental factors: endocrine disruptors

Climate change and those derived from human activity, with increased pollution, among other factors, can negatively impact reproductive function (Evangelinakis et al., 2024) (Shrivastava et al., 2025). Rising average and extreme temperatures can modulate the onset and severity of vasomotor symptoms (VMS), especially hot flushes and night sweats, due to increased sensitivity of the thermo-regulatory system. Epidemiological studies indicate that there are variations in the frequency of hot flushes according to seasonality and geography, with peaks in warm months (Cucinella et al., 2023).

However, endocrine disruptors can interfere the delicate hormonal balance that regulates the gonadal axis and reproductive function, including menopause (Armeni, 2023) (Levine and Hall, 2023). A relationship has been observed between exposure to some disruptors and an earlier age of menopause, decreased ovarian reserve, as well as an increase in associated symptomatology (Ding et al., 2022) (Inman and Flaws, 2024). On the other hand, endocrine disruptors can increase the risk of obesity, diabetes and cardiovascular disease (AESAN, 2023) (Armeni, 2023).

One study has evaluated whether exposure to organophosphate esters (OPEs), which are compounds with known endocrine-disrupting activity, especially the urinary metabolite bis(2-chloroethyl)phosphate (BCEP), is associated with early menopause and premature ovarian failure in adult women (Zhanh et al., 2024). To this end, a cross-sectional analysis of 2429 women participating in NHANES 2011-2020 was carried out, measuring five metabolites of OPE in urine and reproductive function data. Elevated BCEP levels were associated with the menopause being, approximately, 1 year earlier and a 91 % increased risk for premature ovarian failure, which was consistent after multiple adjustments. No significant associations were observed for the other metabolites tested.

This is therefore a relevant aspect, although more studies are needed to define the real impact of these environmental factors and how they influence different people, according to individual susceptibility.

3. Women during menopause: nutritional considerations

3.1 Role of nutrients in menopause

During menopause, in addition to hormonal changes, nutritional status of certain nutrients are affected, such as calcium, vitamin D, iron and proteins, among others, which are essential at this stage, not only to maintain a woman's health, but also to mitigate the risk of complications that may arise during this period. The following sections outlines the most relevant nutrients at this stage of a woman's life.

3.1.1 Macronutrients

3.1.1.1 Proteins

Daily consumption of protein-rich foods is essential for the maintenance of muscle mass, strength and physical function, all of which are essential during the post-menopausal stage (Mangano et al., 2017). Proteins are macronutrients found in muscles, bones, skin, hair and virtually every other part of the body or tissue and constitute the enzymes that drive many chemical reactions or the haemoglobin that carries oxygen in the blood. They are made up of 20 amino acids, 9 of which (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine), known as essential amino acids, must come from food. Sources of plant-based protein in the diet are legumes, nuts, whole grains, and soy-based foods. Sources of animal-based protein include fish, eggs, milk and dairy products, and meat. The proteins of the different food groups vary in terms of their amino acid profile and digestibility; thus, proteins of animal origin are considered to be of high quality, due to their high content of essential amino acids and the fact that they are rapidly digested and absorbed. Plant-based proteins can also be of high quality, as is the case for some legumes such as chickpeas, some white beans and soy, although this is not the case for most legumes and other sources of plant proteins. This limitation can be overcome with combinations of different plant protein sources complementary in amino acids. However, the consumption of protein foods involves the intake of other nutrients, which can determine their overall effects on health. In addition, it has been observed that the consumption of protein foods of plant origin, in substitution of protein foods of animal origin, is associated with a lower risk of developing cardiovascular diseases (Bernstein et al., 2010, 2012) and with a lower risk of developing frailty, cognitive impairment or premature mortality (HSPH, 2019a) (Huang et al., 2020) (AESAN, 2022b) (Struijk et al., 2022a, b) (Yeh et al., 2022) (Erdélyi et al., 2023) (Yang et al., 2025).

3.1.1.2 Omega-3 fatty acids

Omega-3 fatty acids are a class of polyunsaturated fatty acids, beneficial for cardiovascular health and that may help reduce inflammation, but that the body cannot synthesize, so they must be ingested through diet. Foods rich in omega-3 include certain fish and seafood; some vegetable oils, such as olive oil; nuts (especially nuts); flax seeds and green leafy vegetables (HSPH, 2019b) (AESAN, 2022b). What makes omega-3 fatty acids special is the part they play in the formation of cell membranes throughout the body and in the function of the cell receptors of these membranes. They also provide the starting point for making hormones that regulate blood clotting, the contraction and relaxation of artery walls, and inflammation. In addition, they can bind to cell receptors that regulate gene function. Because of all these effects, omega-3 fatty acids can help prevent heart and cerebrovascular diseases, can help manage autoimmune diseases, such as lupus and rheumatoid arthritis, and can play protective roles against cancer and other conditions. A deficiency in omega-3 fatty acids can increase the risk of vascular disease and cognitive impairment (HSPH, 2019b) (Ko and Kim, 2020) (Wylenzek et al., 2024).

3.1.2 Dietary fibre

Fibre is a class of carbohydrate that cannot be digested by intestinal enzimes. Although most carbohydrates are broken down into glucose molecules, fibre is not broken down.

During the menopausal transition, a series of metabolic changes occur, including an increase in the proportion of adipose tissue, an increase in visceral fat and a decrease in energy expenditure (Lovejoy et al., 2008) (Erdélyi et al., 2023). In addition, impaired insulin secretion and sensitivity can occur, as well as an increased risk of type 2 diabetes *mellitus* (T2DM) (Paschou et al., 2019) (Erdélyi et al., 2023). There are also several pathologies or conditions whose risk may be increased in women during menopause and post-menopause, such as cardiovascular disease or some types of cancer.

It has been seen that dietary fibre intake can reduce the risk of the onset or development of these pathologies. Dietary fibre has been shown to reduce the risk of obesity, may help improve glucose metabolism, helping to control hunger and blood glucose level, and plays a beneficial role on the gut microbiome. It has also been shown to have a protective effect against different pathologies, such as cardiovascular disease, breast and colorectal cancer, and diabetes (Erkkilä et al., 2005) (Murphy et al., 2012) (Threapleton et al., 2015) (HSPH, 2022) (Erdélyi et al., 2023). According to some authors, increasing fibre intake may reduce the risk of developing metabolic syndrome: an increase of 10 g per 1000 kcal reduced the risk of metabolic syndrome by 0.1 units (Lepping et al., 2022) (Erdélyi et al., 2023). Fibre intake can also positively influence the bacterial flora, in a similar way to isoflavonoids and pre-, pro- and post-biotics (gut flora plays a role in oestrogen metabolism as bacteria with beta-glucuronidase activity can increase the level of biologically active oestrogen in the organism, which slows down the development of oestrogen deficiency and thus reduces the symptoms accompanying the menopause) (Zengul et al., 2021) (Erdélyi et al., 2023) (Singh et al., 2023).

The European Food Safety Authority (EFSA) establishes an adequate fibre intake of 25 g per day for the adult population (EFSA, 2010), although there are authors who recommend a daily intake of 30-45 g for menopausal women. On the other hand, it has also been seen that an excessive consumption of fibre, greater than 50 g/day, can have a negative effect since it can cause swelling, increase the binding and excretion of useful substances and lead to digestive problems (Erdélyi et al., 2023).

Dietary fibre can be ingested in the diet through high-fibre foods such as whole grain cereals and derived products, which prevent the rapid absorption of carbohydrates, which classifies these foods as having a low glycaemic index, unlike refined cereals, which, being made up only of the endosperm of the grain, have a greater nutritional composition of fast-digesting carbohydrates. In general, whole grains exert positive effects through several mechanisms of action: 1) by regulating glucose metabolism and lipid metabolism; 2) by decreasing inflammatory processes and endothelial dysfunction; 3) by restoring the diversity of the intestinal microbiota and increasing intestinal short-chain fatty acids; and 4) by acting on regulatory pathways associated with carcinogenic processes. The most recent scientific evidence supports the beneficial effect of whole grain cereal consumption, which decreases the risk of developing cardiovascular disease, type 2 diabetes, cancer and premature mortality (AESAN, 2022b) (HSPH, 2022) (Erdélyi et al., 2023).

In addition to whole grain cereals, other foods that are an important source of dietary fibre are whole fruits (with edible skin) and vegetables; legumes, whose fibre helps improve the lipid profile and increases the feeling of satiety; and nuts (AESAN, 2022b) (HSPH, 2022) (Erdélyi et al., 2023).
Dietary fibre is classified into two main types (HSPH, 2022):

1. Soluble fibre, which dissolves in water, and may help reduce blood glucose and cholesterol levels. Foods with soluble fibre include oats, chia seeds, nuts, beans, lentils, apples, and blueberries.
2. Insoluble fibre, which does not dissolve in water, and can help food move through the digestive system, promoting regularity and helping to prevent constipation. Foods with insoluble fibre include whole wheat products (especially wheat bran), quinoa, brown rice, legumes, green leafy vegetables such as kale, almonds, nuts, seeds, and fruits with edible skins such as pears and apples.

3.1.3 Micronutrients

3.1.3.1 Calcium and vitamin D

Calcium and vitamin D are crucial for maintaining bone health and, their deficiency, prevalent in post-menopausal women, is associated with loss of bone mass and with an increased risk of osteoporosis and bone fractures, risks to be taken into account due to the decrease in oestrogen levels during the menopause (Lerchbaum, 2014) (Ilesanmi-Oyelere et al., 2019) (DGA, 2020) (Devarshi et al., 2021) (DGAC, 2024) (Wylenzek et al., 2024).

Calcium is the most abundant mineral in the body and one of the main components of bones and teeth, however, the body cannot manufacture it on its own, so it is essential to consume foods rich in calcium to cover the daily needs of this mineral. As well as being crucial in the formation and maintenance of bones, it also plays other essential functions in the heart and other muscles as well as the nervous and vascular systems (blood pressure). Food sources that provide calcium are milk and dairy products (yoghurts, cheese); legumes (chickpeas, beans); nuts (almonds); chia seeds; vegetables such as kale or kale and fish such as sardines (with thorns) (Dennehy and Tsourounis, 2010) (Ilesanmi-Oyelere et al., 2019) (Erdélyi et al., 2023) (HSPH, 2023a) (Hendley, 2025).

Vitamin D, by contrast, is a fat-soluble vitamin that promotes the absorption of calcium and phosphorus, which are essential for the formation of bones, and can also reduce the growth of cancer cells, help control infections and reduce inflammation. Few foods naturally contain vitamin D, so many are fortified with this vitamin, such as milk and dairy products and cereals. Vitamin D3 (cholecalciferol) is produced, mainly, in the skin of humans and other animals by the action of the ultraviolet B (UVB) rays of the sun (hence its nickname as "the vitamin of the sun"), while vitamin D2 (ergocalciferol) is produced in plants, fungi and yeasts by solar irradiation. Foods that are a natural source of vitamin D3 include fatty fish (salmon, tuna, sardines), eggs and cheese. Some mushrooms contain vitamin D2 (Dennehy and Tsourounis, 2010) (Erdélyi et al., 2023) (HSPH, 2023b).

3.1.3.2 Iron

Although iron needs decrease after menopause due to the cessation of menstruation, it is still important for women's health in general and it is necessary to control and maintain adequate iron levels in order to prevent fatigue and anaemia related to iron deficiency (HSPH, 2023c) (Wylenzek et al., 2024). Food iron comes in two forms: heme and non-heme. Heme iron is only found in the liver and meat of animals such as beef, poultry, and fish products (clams, mussels). Non-heme iron is

found in foods of vegetable origin, such as legumes (lentils, soya beans); nuts; seeds and green leafy vegetables (spinach). Non-heme iron can also be found in animal meat (as animals consume plant foods with non-heme iron) (AESAN, 2022b) (HSPH, 2023c).

However, it is important to consider that iron overload is common in people with obesity, which occurs as a result of a metabolic change that favours absorption, which has relevant clinical consequences (Deugnier et al., 2017). In obese women, this change in iron metabolism is more evident after menopause, due to the cessation of menstruation.

3.1.3.3 Magnesium

Magnesium is naturally present in various foods and plays an important role in facilitating numerous enzymes in the body to carry out various chemical reactions such as the formation of proteins, the maintenance of bone mass and the regulation of blood glucose, blood pressure and muscle and nerve functions, so a severe deficiency of this mineral would lead to significant health problems. Magnesium is found in plant foods such as legumes; nuts; whole grains; seeds and dark green leafy vegetables; and also, in animal foods such as fish, poultry and beef (HSPH, 2023d).

3.1.3.4 Vitamins B6, B9 and B12

Vitamins B6 (pyridoxine), B9 (folate), and B12 (cobalamin) are important for cardiovascular health and cognitive function. Deficiencies in these vitamins can cause elevated levels of homocysteine, which is associated with an increased risk of heart disease and heart attack, as it can promote the formation of blood clots and excess free radicals, in addition to impairing the normal functioning of blood vessels.

Especially in pre-menopausal women, low levels of vitamin B6 have been shown to lead to a 2-3-fold increased risk of vascular disease. As for its role in cognitive function, elevated levels of homocysteine have been linked to a higher incidence of dementia, Alzheimer's disease and cognitive impairment, while, conversely, adequate levels of vitamin B6, B12 and folate are linked to better cognitive function (Verhoef et al., 1999) (Wiacek et al., 2013) (Agnew-Blais et al., 2015) (Keller et al., 2019) (Raczkiewicz et al., 2024) (Wylenzek et al., 2024). In some epidemiological studies it has even been observed that a high intake of foods with vitamin B6 and, therefore, high levels of this vitamin in the blood, were significantly associated with a lower risk of all types of cancer, especially gastrointestinal cancer (Wei et al., 2005) (Lee et al., 2009) (Zhang et al., 2013) (Mocellin et al., 2017) (Rutjes et al., 2018) (HSPH, 2023e).

Something similar happens with folate since it is believed that it can play an important role, both in the suppression of some types of incipient cancer, and in the progression of established cancers, if high doses of folic acid are used; and some observational studies have shown that people who ingest higher than average amounts of folate through diet or folic acid supplements, for 15 years or more, have less risk of colon and breast cancer (Giovannucci et al., 1998) (Zhang et al., 1999) (Sanjoaquin et al., 2005) (Cole et al., 2007) (Ericson et al., 2007) (Ferrari et al., 2007) (Larsson et al., 2007) (Mason et al., 2007) (Ulrich, 2007) (Zhang et al., 2008) (Hu et al., 2016) (Buja et al., 2020) (HSPH, 2023f).

B vitamins are present in various foods of plant and animal origin, such as dark green leafy veg-

etables (spinach, Brussels sprouts, broccoli, lettuce); fruits such as bananas, oranges or melons; legumes such as chickpeas, beans or soya beans; nuts; milk and dairy products; fish such as tuna and salmon; eggs; liver; and poultry meat (AESAN, 2022b) (HSPH, 2023e, f, g).

3.1.3.5 Vitamins with antioxidant function: vitamin C and vitamin E

Vitamins C and E, together with other antioxidants, help combat oxidative stress, which increases during menopause and may contribute to the development of cardiovascular and neurodegenerative diseases (Wiacek et al., 2013) (Wylenzek et al., 2024).

Vitamin C is involved in the control of infections and wound healing, and is a powerful antioxidant capable of neutralising harmful free radicals. It is also necessary in the manufacture of collagen, a protein essential for maintaining healthy skin, tendons, ligaments and blood vessels, as well as for repairing wounds and forming scar tissue; it also helps keep bones, cartilage and teeth strong and increases the body's ability to absorb iron from plant-based foods. Vitamin C is available in foods such as citrus fruits (oranges, lemons, grapefruits); peppers; strawberries; cruciferous vegetables (broccoli, cauliflower, Brussels sprouts) and potatoes (HSPH, 2023h).

The main function of vitamin E is also to act as an antioxidant, eliminating free radicals, which can damage cells. It also improves the function of the immune system and prevents the formation of arterial clots. Vitamin E is found in vegetable oils, such as olive oil; nuts; seeds; whole grains; fruits and vegetables (IOM, 2000) (Dennehy and Tsourounis, 2010) (Ko and Kim, 2020) (AESAN, 2022b) (Erdélyi et al., 2023) (HSPH, 2025) (Restivo, 2025).

Deficiency of these antioxidants, in addition to increasing oxidative stress, can cause, in the case of vitamin C deficiency, the appearance of symptoms related to the loss of collagen, which weakens connective tissue, generating the appearance of spots on the skin caused by haemorrhages due to broken blood vessels, bleeding gums, loss of teeth or hair loss, as well as anaemia, caused by the decrease in the absorption of non-heme iron; in the case of vitamin E, its deficiency can cause decreased immune function, retinopathy and damage to peripheral nerves, especially hands and feet, which can cause weakness and pain (Wiacek et al., 2013) (Wylenzek et al., 2024) (HSPH, 2023h, 2025).

3.1.4 Recommendations for adequate nutrient intake in women during menopausal and post-menopausal transition

EFSA has established the Adequate Intake (AI) values for nutrients, that is, the average level of intake of a nutrient that, on the basis of observations or experiments, is considered adequate to the needs of the population, as well as the Nutrient Reference Intake for the Population (NRI) values, understood as the levels of nutrient intake that cover the daily needs of almost all people in a healthy population. For the adult female population aged 40 years or older, the AI and NRI values for nutrients considered important in women during the stages of menopause, peri-menopause and post-menopause are shown in Table 4.

Table 4. Adequate Intake (AI) and Nutrient Reference Intake Values (NRI), of nutrients, for the adult female population (≥40 years)

	AI	NRI	Reference
Minerals			
Calcium	-	950 mg/day	(EFSA, 2015a)
Iron	-	11 mg/day	(EFSA, 2015b)
Magnesium	300 mg/day	-	(EFSA, 2015c)
Vitamins			
Vitamin A	-	650 µg ER/day [1]	(EFSA, 2015d)
Vitamin B6	-	1.6 mg/day [2]	(EFSA, 2016a)
Vitamin B12	4 µg/day	-	(EFSA, 2015e)
Vitamin C	-	95 mg/day	(EFSA, 2013)
Vitamin D	15 µg/day [3]	-	(EFSA, 2016b)
Vitamin E	11 mg/day [4]	-	(EFSA, 2015f)
Folate	-	330 µg EFD/day [5]	(EFSA, 2014)
Fatty acids			
Alpha-linolenic acid (AAL)	0.5 % E	-	(EFSA, 2010b)
Eicosapentaenoic acid (EPA) Docosahexaenoic acid (DHA)	250 mg/day EPA + DHA	-	
Linoleic Acid (AL)	4 % E	-	
Proteins	-	0.83 g/kg b.w./day	(EFSA, 2012)
Dietary fibre	25 g/day	-	(EFSA, 2010a)

[1] Values correspond to vitamin A in the form of retinol, retinyl esters and provitamin A carotenoids. RE= retinol equivalent. Pro-vitamin A carotenoids have lower bioavailability than retinol. To account for these differences, REs defined as 1 µg RE= 1 µg of retinol= 6 µg β-carotene= 12 µg of other carotenoids with provitamin A activity have been introduced.

[2] NRIs correspond to vitamin B6 in the form of pyridoxine, pyridoxal, pyridoxamine and their phosphorylated forms.

[3] AIs correspond to vitamin D in the form of ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3). The AI configuration of vitamin D means minimal cutaneous synthesis of vitamin D. In the presence of endogenous synthesis of vitamin D, the need for vitamin D in the diet is lower, or may even be zero.

[4] The AIs of vitamin E refer only to α-tocopherol, which is the physiologically active form. Other tocopherols and tocotrienols do not contribute to the vitamin E requirement.

[5] Maximum tolerable intake (ML) levels correspond to folate and folic acid in the diet. DFE: dietary folate equivalents. Natural food folates have a lower bioavailability than folic acid. DFE has been introduced to account for these differences. For combined intakes of dietary folate and folic acid, DFEs can be calculated as follows: µg DFE= + µg of dietary folate + (1.7 x µg folic acid).

AI: Adequate nutrient intake; NRI: Nutrient Reference Intake for the Population; % E: percentage of energy intake; bw: body weight.

Source: (EFSA, 2010a, b, 2012, 2013, 2014, 2015a, b, c, d, e, f, 2016a, b, 2024).

3.1.5 Studies on the adequacy of nutrient intake for women's dietary recommendations during menopause

Several studies have analysed the eating habits and nutritional status of women during menopause, peri-menopause and post-menopause, highlighting the importance of following a healthy diet,

which prevents the appearance of deficits of fundamental nutrients during these stages (Xi et al., 2017) (Beezhold et al., 2018) (Dunneram et al., 2019) (Flor-Alemany et al., 2020a).

Vitamin D deficiency is highly prevalent at these stages as more than 80 % of post-menopausal women have insufficient levels of vitamin D, which can negatively affect bone mineral density, increasing the risk of osteoporosis and fractures (Fan et al., 2013) (Quesada-Gómez et al., 2013) (Olmos et al., 2016) (Olza et al., 2017a) (Vazquez-Lorente et al., 2020).

The same goes for calcium intake, which is also insufficient in a high proportion of post-menopausal women; many of whom do not reach the recommended daily levels, which also contributes to loss of bone density and the risk of osteoporosis (Fan et al., 2013) (Ortega et al., 2013) (Quesada-Gómez et al., 2013) (Olmos et al., 2016).

Magnesium intake is frequently low, with 79 % of the population falling short of the recommended levels (Olza et al., 2017b).

Intake of vitamins A, C, and E is below recommended levels in a large proportion of the population, which can affect overall health and increase the risk of chronic diseases (Olza et al., 2017a, b). These nutritional deficiencies underline the importance of following a healthy, varied and balanced diet to improve nutritional status and reduce the risks associated with menopause.

In the study carried out by Ortega et al. (2013), in a representative sample of the Spanish female population (n= 547), aged 17 to 60 years, in which 108 women of menopausal age were included, a questionnaire was carried out using a "Food Consumption Registry", for 3 consecutive days, in which the participants had to note the weight of the food and drinks consumed. It was observed that the intake of calcium and vitamin D was lower than that recommended by the Institute of Medicine (IOM, 2011) in this population group, and only 3.7 % of the women undergoing the menopause had adequate intakes of both nutrients. Specifically, calcium intake was lower than recommended in 79.6 % of them and 85.2 % of the women did not reach the recommended intake for vitamin D, which can have a detrimental effect on bone density, increasing the risk of osteoporosis or bone fractures. The authors considered it an urgent need to establish measures aimed at protecting the bone health of the Spanish female population.

Based on the fact that post-menopausal women are at risk of suffering numerous micronutrient deficiencies, including vitamin D, in 2020, Vázquez-Lorente et al. evaluated the influence of magnesium intake on vitamin D levels in a population of post-menopausal women in the province of Granada (Spain). They included 52 healthy post-menopausal women aged between 44 and 76 years, who were divided into two randomised groups, placebo and magnesium (500 mg/day), and who were treated for 8 weeks. Nutrient intake was assessed by questionnaires based on 72-hour recall and it was observed that more than 80 % of the women participating in the study had a baseline vitamin D deficit and that the administration of magnesium produced a significant increase in the levels of this vitamin in the intervention group versus the control group ($p<0.05$).

In relation to women's bone health during menopause, a study conducted by Roncero-Martín et al. (2021) investigated the relationship between plasma levels of fatty acids and bone parameters in post-menopausal Spanish women. The study included 301 women with a median age of 59 years, who underwent extensive screening by densitometry and whose plasma levels of fatty acids were mea-

sured. The study concluded that higher plasma levels of omega-3 polyunsaturated fatty acids were significantly associated with improved bone mineral density in post-menopausal women, suggesting a protective role of these omega-3 fatty acids against osteoporosis (Roncero-Martín et al., 2021).

A recently-published study by Wylenzek et al. (2024) provided a comprehensive review of the impact of nutritional deficiencies on the morbidity of post-menopausal women. The review analysed 90 observational studies in order to assess the relationship between deficiencies of vitamins B6, B12, D, iron, omega-3 fatty acids and lycopene, and the risk of various morbidities in post-menopausal women. The results indicated that deficiencies of these nutrients were associated with increased vulnerability to cardiovascular and cerebrovascular events, metabolic diseases, osteoporosis, obesity, cancer and neurodegenerative diseases, such as Parkinson's disease, Alzheimer's disease, depression, cognitive impairment, dementia and stroke. They highlighted the benefit of vitamins B6, B12 and D in relation to the improvement of cardiovascular and cerebrovascular diseases, neurological symptoms, metabolic risk and osteoporosis. The results also indicated the benefit of adequate iron levels on climacteric symptoms, as well as on the reduced risk of cardiovascular diseases, including heart or liver failure, and the reduced risk of breast cancer and osteoporosis, and the beneficial effect of omega-3 fatty acids on the immune system and cognitive performance, as well as on the prevention of osteoporosis and cardiovascular and cerebrovascular diseases. Among the benefits of lycopene, they highlighted that it eliminates free radicals, relieves oxidative stress, benefits bone health, prevents post-menopausal osteoporosis and hypertension, and decreases the risk of certain types of cancer. The authors concluded that maintaining optimal serum levels of these nutrients through an adequate diet (intake of fruits, vegetables and healthy fats), or an adequate food supplement, was essential to reduce the risk of these morbidities and improve the health-related quality of life in women during the menopausal transition and after the menopause. In addition, they emphasized the need for studies to make appropriate recommendations to women during these stages of life.

Devarshi et al. (2021) evaluated the estimated total intake of nutrients, from food and food supplements, and compared it to the recommendations established for the same nutrients in menopausal American women (40-65 years), as well as the relationship between self-reported intake by study participants and biomarker levels of nutritional status. The results of the study showed significant deficiencies in nutrient intake compared to the estimated average needs. Specifically, a considerable percentage of women had a lower-than-recommended intake of calcium, magnesium and vitamins A, B6, C, D and E. Specifically, more than 97 % of menopausal women had a lower-than-recommended intake of vitamin D. The study also showed that the consumption of food supplements helped to partially cover these nutrient deficiencies. In addition, women in the lower categories of biomarkers for folate, vitamins D and B12, and omega-3 docosahexaenoic fatty acid (DHA) were observed to have significantly lower intakes of these nutrients as compared to those in the higher categories of biomarkers. The authors concluded that there is a critical need for specific dietary guidance to ensure adequate nutrient intake and improve nutritional status during these life stages, as considerable percentages of menopausal women did not reach recommended nutrient intakes.

In a study by Sayón-Orea et al. (2015) on the relationship between adherence to a Mediterranean-style diet, symptoms during menopause and being overweight or obese in Spanish women being peri-menopausal or post-menopausal, it was observed that greater adherence to the Mediterranean diet was associated with fewer menopausal symptoms and, conversely, with being overweight/obese, therefore, a high adherence to a Mediterranean-style diet and a BMI of 25 kg/m^2, or lower, could improve the quality of life of women in these stages.

The FLAMENCO Project, prepared by Flor-Alemany et al. (2020a), also explored the association of eating habits and adherence to a Mediterranean-style diet with menopausal symptoms. The study was carried out with 198 women from the province of Granada (Spain), aged between 45 and 60 years, and who were given a questionnaire on the frequency of their food consumption and eating habits. Of the total participants, 172 women with an average age of 52.5 ± 4.2 years were chosen for the analysis. Adherence to the Mediterranean-style diet was assessed using the Mediterranean diet score (Panagiotakos et al., 2006) and it was observed that a higher consumption of soy and vegetable drinks was associated with fewer menopausal symptoms, while a higher consumption of poultry and skimmed dairy products was associated with worse symptoms. However, based on the results of this study, no strong evidence was found to support the idea that a change in diet could change menopausal symptoms.

Another study by García-Arenzana et al. (2012) analysed the quality of diet among Spanish women during peri-menopause and post-menopause, from seven autonomous communities participating in breast cancer screening programmes (3584 women aged 45 to 68 years). Socio-demographic, reproductive, and lifestyle data were obtained through responses to a questionnaire (interview), which included two menopause-specific questions. Dietary intake was estimated with the help of a 117-item semi-quantitative Food Frequency Questionnaire (FFQ), similar to that used by Willett et al. (1985), adapted and validated for use in the Spanish adult population (Vioque, 2006) (Vioqueet et al., 2007). The data reflected better diet quality among ex-smoking women than among non-smoking women; similarly, better diet quality indicators were observed among post-menopausal women and those suffering from osteoporosis. These associations could reflect the concern for health felt by women who have stopped smoking due to a conscious decision in favour of a healthier life and a greater awareness of the importance of a healthy diet, after suffering the physiological changes of menopause or, alternatively, after being diagnosed with a disease such as osteoporosis, whose evolution is influenced by diet. The results of the study also showed that there were significant differences in the quality of the diet of these women based on their socio-demographic characteristics and lifestyles, and, specifically, women under 50 with a low level of education and a modest socio-economic level, had a less healthy dietary pattern and a higher prevalence of smoking, as well as a sedentary lifestyle. The authors highlighted the importance of promoting health campaigns that include promoting a healthy diet, along with physical activity recommendations, in this group of women (García-Arenzana et al., 2012).

3.1.6 Consumption of food supplements during menopause

Hormone therapy is used as a method to relieve the first symptoms of menopause. The basis of this treatment is the application of oestrogens, alone or in combination with progestogens, but it may be

associated with side effects and risks such as strokes, thromboembolic events, breast cancer and vascular diseases, so women following this hormone therapy should be continuously monitored. It should be noted that many women have other types of contraindications or prefer a non-hormonal approach for the management of these symptoms, so the use of alternative and complementary therapies has expanded (Palacios et al., 2023).

There are numerous preparations are available on the market to manage symptoms during the menopause, under the name of food supplements, which include a heterogeneous amount of nutrients and bioactive compounds, many of them traditionally used for treating those symptoms (Rubio et al., 2023).

Among the ingredients in these food supplements, some nutrients whose intake is especially important for post-menopausal women stand out, such as calcium and vitamin D, which among their recognised health properties is that they contribute to reduce bone demineralisation in this group of women, and vitamin B6, which helps regulate hormonal activity (EU, 2012, 2014) (AESAN, 2025). Menopausal women can also consume food supplements containing other vitamins and minerals such as iron, magnesium, folate, vitamin B12 or vitamin E, based on their health properties.

In addition to containing nutrients, there are food supplements that contain some medicinal plants such as soya bean (*Glycine max*); black cohosh (*Cimicifuga racemosa*); hops (*Humulus lupulus*); L-tryptophan; sage (*Salvia officinalis*); evening primrose (*Oenothera biennis*); hypericum (*Hypericum perforatum*) or chasteberry (*Vitex agnus-castus*), and their corresponding active components, with different mechanisms of action (Navarro et al., 2022) and these are often consumed by women during the peri-menopausal and post-menopausal stages to relieve some of the common symptoms.

Among these bioactive components are phytooestrogens, which are substances of plant origin that have oestrogenic activity. Soy (*Glycine max*) is rich in a type of phytooestrogens called isoflavones, which is why it has been widely used in the treatment of menopause symptoms. Consumption of isoflavones or soy foods is associated with a reduction in vasomotor syndromes, even after considering the placebo effect. These compounds are used, not only in the treatment of these symptoms, but also in that of other physiological changes associated with the menopause so, for example, isoflavone preparations will have the added value of their action on glucose homeostasis, bone health and oxidative stress (AESAN, 2007). However, an oestrogenic effect associated with the consumption of soy isoflavones does not seem to have been demonstrated (Viscardi et al., 2025). Another plant used as an ingredient in these food supplements is hops (*Humulus lupulus*), which also contains phytooestrogens, including prenylnaringenin, one of the phytooestrogens with the highest oestrogenic activity. It should be noted that some authors point out adverse effects of phytooestrogens on health that depend on the stage of life when they are ingested or if there is any hormone-dependent pathology or family history of it, so a more detailed study of the risk that the consumption of these compounds may have in certain women experiencing the menopause would be necessary.

The use of black cohosh (*Cimicifuga racemosa*) as an ingredient of food supplements is justified according to data from *in vitro* studies and animal models, which show that the extracts of this plant act on different dopaminergic, serotonergic and noradrenergic neurotransmission systems

all involved in the onset of hot flushes, as well as on the μ opioid receptors. It should be borne in mind that a relationship has been described between the consumption of black cohosh and liver disorders, although more recent data seem to indicate that there is no cause-and-effect relationship between the consumption of food supplements that have this plant as an ingredient and these pathologies (AESAN, 2022c).

Other ingredients in food supplements that are used to relieve the symptoms of menopause are L-tryptophan, as a precursor of serotonin that improves mood thanks to its serotonergic mechanism, minerals such as magnesium, B vitamins and vitamin D that reduce neuropsychiatric symptoms and contribute to the maintenance of bone health, among others. However epidemiological studies are needed to demonstrate their effectiveness in the treatment of these symptoms and their effect on the health of women who take supplements that contain them.

In conclusion, we can say that there are many food supplements with different nutrients and bioactive compounds that are used to relieve the symptoms of menopause. However, in the absence of studies with an adequate methodological design that analyse the efficacy and safety of the consumption of this type of supplement, it cannot be ruled out that they, at the doses and types of extract that are currently available on the market, are related to some type of adverse effect and, therefore, a more exhaustive study of the possible health effects of the consumption of these supplements by women during peri-menopause, menopause and post-menopause must be carried out.

3.2 Changes in gastrointestinal physiology

Decreased oestrogen may induce changes in intestinal motility, gastric secretion, and intestinal mucosal permeability. Some studies have observed a reduction in the secretion of hydrochloric acid (hypochlorhydria) in women during the menopause, which affects the solubilisation of minerals and the activation of digestive enzymes. In addition, changes in the composition of the intestinal microbiota that could interfere with nutrient absorption have been reported.

3.2.1 Impact on nutrient absorption

3.2.1.1 Absorption of iron and vitamin B12

During the menopause, oestrogen depletion causes systemic physiological disturbances, including those affecting the gastrointestinal system. During menopause, the absorption of micronutrients that are critical at this stage, such as iron and vitamin B12, can be modified. Lower gastric acidity, changes in intestinal motility, reduction of intrinsic factor, and alterations in the intestinal microbiota are some of the factors involved. These changes may contribute to nutritional deficiencies, particularly in women on restricted diets or who have gastric conditions. Clinical follow-up and nutrition education are critical to prevent the anaemias and neurological disorders associated with these deficiencies.

a. Absorption of iron

Dietary iron exists in heme (from animal sources) and non-heme (from vegetable sources) forms, the latter being more dependent on gastric acidity and active transport in the small intestine. During the menopause, hypochlorhydria reduces the solubility of non-heme iron, re-

ducing its absorption. The lower frequency of menstruation can also reduce iron loss, which may mask subtle deficiencies. Chronic low-grade inflammation and increased hepcidin, a peptide hormone that acts as the main regulator of iron metabolism in the body, could also contribute to reduced transport of iron. Iron deficiency can manifest itself as iron-deficiency anaemia, fatigue, or in immunological disorders. Obesity, on the other hand, can increase iron absorption, mediated by a change in the action of hepcidin, which is associated with an increased risk of metabolic diseases (Waldmann et al., 2005) (Rah et al., 2025).

b. Absorption of vitamin B12

Vitamin B12 requires gastric acid to get rid of food proteins and the intrinsic factor for its absorption in the ileum. Post-menopausal hypochlorhydria may reduce its bioavailability, especially in women with atrophic gastritis or taking Proton Pump Inhibitors (PPIs). Subclinical B12 deficiencies are associated with cognitive impairment, depression, and megaloblastic anaemia, and are common in women over 50. Vitamin B12 deficiency can induce neurological symptoms that are reversible if detected early.

Timely nutrient screening and supplementation are essential, especially in women on vegetarian diets, who have gastric disorders or are taking pharmacological treatments over a prolonged period (Allen, 2009).

The gastrointestinal changes induced by menopause affect the absorption of iron and vitamin B12, which can lead to significant nutritional deficiencies. Periodic nutritional assessment in women during the menopause is recommended, supplemented by dietary interventions, appropriate supplementation, and individualised clinical follow-up (Chen et al., 2019).

3.2.2 Importance of nutrient interactions. Fibre and divalent cations

During the menopause, women experience significant physiological changes that affect the metabolism and absorption of essential nutrients. Among them, the divalent cations calcium (Ca^{2+}), magnesium (Mg^{2+}) and iron (Fe^{2+}) play a crucial role in the prevention of osteoporosis, anaemia and cardiovascular dysfunction. Dietary fibre, while providing multiple health benefits, can interfere with the bioavailability of these minerals. The available evidence indicates that phytates and oxalates present in foods rich in fibre can reduce mineral absorption, especially in unbalanced diets.

Fibre, particularly in its insoluble form and rich in chelating compounds, can reduce the bioavailability of these minerals, generating a relevant nutritional conflict for this population.

- Fibre-calcium interactions: calcium is critical in the prevention of post-menopausal osteoporosis. However, insoluble fibre, especially fibre that is rich in phytates and oxalates, can form complexes with calcium in the intestine, preventing its absorption. Weaver et al. (2013) reported that diets with a high phytate load reduce calcium absorption by 20 to 30 % in post-menopausal women. Heaney et al. (2001) demonstrated that some fermentable fibres, such as inulin, can increase calcium uptake by improving the acidic environment of the colon.
- Fibre-magnesium interactions: magnesium is essential for hormone synthesis, muscle relaxation, and cardiovascular function. Although less studied than calcium, the bioavailability of magnesium can also be affected by excessive consumption of phytate-rich fibre. Schuchardt

and Hahn (2017) noted that diets with a high proportion of whole grains can compromise magnesium absorption, although to a lesser degree than calcium. Some fermentable soluble fibres could have a neutral or positive effect by favouring the acidic intestinal environment.

- Interactions between fibre and iron: iron, particularly in its non-heme form present in vegetables, is highly susceptible to inhibitors such as phytates, tannins and some insoluble fibres. Hurrell (2003) found that a diet rich in phytates can reduce the absorption of non-heme iron by up to 70 %. Teucher et al. (2004) explained that the bioavailability of iron can be partially recovered with the consumption of vitamin C and other enhancing substances.

The body of evidence suggests that interactions between dietary fibre and divalent minerals are highly dependent on fibre type, overall dietary composition, and individual physiological conditions. In women experiencing the menopause, these interactions are particularly important due to the high prevalence of bone demineralisation, fatigue and digestive problems.

Dietary fibre can interfere with the absorption of calcium, magnesium, and iron, especially when consumed in unprocessed form and rich in phytates and oxalates. These interactions may exacerbate nutritional risks in women during the menopause, including osteoporosis, sarcopenia, and anaemia.

3.2.3 Importance of the interaction between alcohol and nutrients

Alcohol is the drug with the highest prevalence in Spain and has a normalised consumption in our society. According to data from the Survey on Alcohol and Drugs in Spain (EDADES, 2024), 93.4 % of women aged 45-55 had consumed alcoholic beverages at some point in their lives, 72.2 % in the last 12 months, 57.8 % in the last month and 6.6 % daily over the last month. In women between the ages of 56 and 65, the latter percentage rises to 7.3 %. Although, in general, the intake of alcoholic beverages is higher in men, it should be noted that its deleterious effect on health is greater in women (Erol and Karpyak, 2015).

Alcohol favours the development of malnutrition and micronutrient deficiency, in part due to ethanol's effect on the intestine's ability to absorb essential nutrients, including glucose, amino acids, lipids, minerals, and vitamins (Lieber, 2000) (Butts et al., 2023). Alcohol also interacts with the conversion of some vitamins to active forms or liver storage.

Alcohol modifies the absorption of nutrients, acting through different mechanisms, including morphological changes in the intestinal villi, alteration in intestinal motility, changes in the microbiota, increased permeability and increased oxidative stress and local inflammatory response (Butts et al., 2023). Water-soluble vitamins, such as thiamine or folate, are especially relevant. Alcohol also interacts with the absorption of calcium, phosphorus, magnesium and zinc and increases the renal elimination of some of these elements (Skalny et al., 2018) (Vanoni et al., 2021) (Ito et al., 2024).

The interaction between alcohol and nutrients acquires a special significance during the menopause and post-menopause, due to the role that these nutrients play in bone, muscle and cardio-metabolic health.

3.3 Nutritional risks to women during the menopausal and post-menopausal transition

3.3.1 Obesity and its complications

Although obesity is a recognised cause of comorbidities, such as diabetes, hypertension and dyslipidaemia, the way these diseases affect women is of particular concern after the menopause (Gianini et al., 2019) (Palacios et al., 2024) (Ayesh et al., 2025). The cardiovascular risks associated with obesity differ significantly between men and women, mainly due to hormonal, metabolic and structural differences. Women tend to accumulate more subcutaneous fat during their reproductive years, but this is transferred to intra-abdominal fat after menopause, which increases their risk of cardiovascular disease (Valencak et al., 2017). Obesity treatment strategies that do not take these sex-specific variations into account may be less effective in women.

Obesity rates vary significantly across age groups, with middle-aged and post-menopausal women having higher rates compared to younger age groups, with rates above 40 % in high-income countries. In Spain, according to the last health survey by the INE in 2023, this trend is related to metabolic and hormonal changes (INE, 2023). Post-menopausal women are especially vulnerable due to the fall in oestrogen levels, which causes an increase in intra-abdominal fat, associated with an increased risk of metabolic syndrome (Nappi et al., 2022). In younger women, although obesity rates are increasing, they tend to remain lower than in older women, with lifestyle-related factors, such as unhealthy dietary patterns and sedentary behaviour contributing to a steady increase. This pattern suggests the need for early-intervention strategies targeting younger age groups before the onset of more serious health risks associated with obesity later in life.

Elderly or post-menopausal women appear to offer greater resistance to weight loss. A meta-analysis conducted by Thomson et al. (2020) compared changes in weight, fat mass, and lean mass in premenopausal versus post-menopausal women in dietary weight-loss trials. Seven studies were included (10 interventions, n= 791). As a result of the meta-analysis, there were no statistically significant differences between pre-menopausal and post-menopausal women for weight change (0.58 kg (95 % CI: -0.12 to 1.28), n= 7 interventions), fat mass (0.73 kg (-0.25 to 1.70), n= 6 interventions) or lean mass (-0.56 kg (-1.48 to 0.36), n= 4 interventions). However, a statistically significant difference was observed in a subgroup for the change in fat mass between the groups of women going through the menopause, being lower in women who were in the post-menopausal stage than in the pre-menopausal stage when comparing diet-only interventions (1.28 kg (0.23 to 2.33), n= 4 interventions) versus diet and exercise (-0.09 kg (-0.51 to 0.32), n= 2 interventions).

Despite these results, it is important to note that, given the small number of studies, short duration of intervention in most publications (≤ 6 months) and unclear retention rates in pre-menopausal *versus* post-menopausal groups of women in some publications, differences between menopausal groups of women should be examined in existing and future trials in which appropriate data have been collected.

3.3.1.1 Obesity and cancer

Research carried out in the last decade shows the association between obesity and several types of cancers, including breast cancer. A recent systematic review and meta-analysis has evaluated

the effect of obesity on breast cancer risk in women, before and after the menopause (Dehesh et al., 2023). After analysing 102 articles, the combination of all of them, they found that the combined OR (Odds Ratio) of the association between obesity and breast cancer in pre-menopausal women was 0.93 (CI: 0.85-1.1; I^2= 65.4 %), and for post-menopausal women, OR= 1.26; CI: 1.19-1.34; I^2= 90.5 %. This therefore indicates that the likelihood of developing breast cancer increases in post-menopausal women who are obese. Surprisingly, the study showed that obesity could have a protective role in breast cancer among pre-menopausal women, but this relationship is only statistically significant in European women. Studies conducted in Spain have also observed a higher prevalence of breast cancer in women with obesity (Crujeiras et al., 2012).

The Mediterranean diet exerts a protective effect for the development of breast cancer, especially in women after the menopause (González Palacios et al., 2023), in addition to improving quality of life and mortality. The Mediterranean diet has anti-inflammatory and antioxidant effects. It can also influence gene regulation and produce hormonal changes and changes in the intestinal microbiota (Reytor-Gonzalez et al., 2025).

However, obesity also increases the risk of other types of hormone-sensitive tumours, such as endometrial cancer, the incidence of which is increasing (Crosbie et al., 2022).

3.3.1.2 Obesity and risk of fractures

Obesity is associated with an increased risk of fractures in general, although, especially, of vertebral fractures in post-menopausal women, however, it is a protective factor for pelvic fractures. A recent meta-analysis which included eight cohort studies of 671 532 post-menopausal women and 40 172 fractures (Liu et al., 2023a), shows that obesity in women at this stage is associated with an increased risk of fractures of any type (Relative Risk (RR)= 1.18; 95 % CI: 1.09-1.28; I^2= 86.3 %; p= 0.000). Subanalyses for each fracture focus indicated that obesity was associated with an increased risk of vertebral fracture in post-menopausal women (RR= 1.154; 95 % CI: 1,020-1,305; I^2= 94.5 %; p= 0.023) but reduced the risk of pelvic fracture (RR= 0.575; 95 % CI: 0.470-0.702; I^2= 0.0 %; p= 0.000). There are no statistically significant differences in the risk of obesity-associated hip and humerus fractures in post-menopausal women.

3.3.1.3 Hepatic steatosis

Metabolic-Associated Steatotic Liver Disease (MASLD), or metabolic hepatic steatosis, is a prevalent multifactorial systemic metabolic disorder, currently recognised as the most prevalent chronic liver disease worldwide. Female susceptibility to MASLD varies by menstrual status, influenced by genetic factors, age, menopausal status and physical activity. Post-menopausal women, who experience significant oestrogen depletion, are particularly vulnerable to metabolic imbalances, which increases their risk of MASLD, disease progression, liver fibrosis, insulin resistance, and adverse cardiovascular events, compared to pre-menopausal women and men of the same age (Ren et al., 2025).

3.3.2 Cardiovascular risk

The fall in the concentration of oestrogen during the menopause causes a deterioration of endothelial and vascular function and an increase in systemic inflammation, further intensifying the athero-

sclerotic process. In addition, the transition to menopause comes with the accumulation of several risk factors for cardiovascular disease (CVD), such as abdominal adiposity, atherogenic dyslipidaemia, insulin resistance, and high blood pressure (Anagnostis et al., 2020).

Likewise, low oestrogen levels after menopause are related to altered vascular function, increased inflammation, and positive regulation of other hormonal systems, such as the renin-angiotensin-aldosterone system, the sympathetic nervous system, and reduced nitric oxide-dependent vasodilation. A healthy brain system is sensitive to the vasodilatory properties of oestrogens, but this is reversed when vascular rigidity and atherosclerotic disease develop over time (Maas, 2021).

Numerous epidemiological studies have found an association between this period of life and increased cardiovascular risk. Early (EM) or premature (PM) menopause is also associated with an increased risk.

A study conducted in Australia with participants aged ≥45 years (n= 267 357) without prior cardiovascular disease showed that the likelihood of CVD was higher in women who are prematurely menopausal (OR: 1.36; 95 % CI: 1.17-1.59; p<0.0001) and those experiencing early menopause (OR: 1.15; 95 % CI: 1.03-1.28; p= 0.013) compared to menopausal women aged 50-52. Among all women, high adherence to a healthy lifestyle reduced the likelihood of CVD by 23 % (OR: 0.77; 95 % CI: 0.68-0.86; p<0.0001), and in prematurely menopausal women, the likelihood of CVD was 52 % (OR: 0.48; 95 % CI: 0.30-0.77) (Pant et al., 2025).

Liu et al. (2023b) recently conducted a meta-analysis with the aim of comprehensively evaluating the most reliable evidence on the relationship between menopausal age and the risk of cardiometabolic disease in the long term. 921,517 participants from 20 cohort studies published between 1998 and 2022 were considered. Compared to menopausal women aged 45 or older, women with PM or EM were at higher risk of type 2 diabetes (RR: 1.32, 95 % CI: 1.08-1.62; RR: 1.11, 95 % CI: 0.91-1.36, respectively), hyperlipidemia (RR: 1.21, 95 % CI: 1.05-1.39; RR: 1.17, 95 % CI: 1.02-1.33, respectively), coronary heart disease (RR: 1.52, 95 % CI: 1.22-1.91; RR: 1.19, 95 % CI: 1.07-1.32, respectively), stroke (RR: 1.27, 95 % CI: 1.02-1.58; RR: 1.13; 95 % CI: 0.97-1.32, respectively) and total cardiovascular events (RR: 1.36; 95 % CI: 1.16-1.60; RR: 1.14; 95 % CI: 0.97-1.35, respectively). No differences in hypertension were found between women with PM and EM (RR: 0.98; 95 % CI: 0.89-1.07; RR: 0.97; 95 % CI: 0.91-1.04, respectively). It was also observed that women with PM, but not those with EM, were associated with an increased risk of ischemic and haemorrhagic stroke.

Likewise, presenting vasomotor symptoms has been shown to increase the risk of CVD. A recent review has shown that frequent and/or persistent vasomotor symptoms are associated with adverse CVD risk factor profiles, worse peripheral vascular and underlying cerebrovascular health, and increased risk of clinical CVD events (Thurston, 2024). Therefore, early dietary and lifestyle interventions and medical treatments are necessary to decrease the risk of cardiometabolic disease in women experiencing early or premature menopause and those with vasomotor symptoms.

In Spain, several epidemiological studies have been conducted analysing the effect of the menopausal transition on cardiovascular health. A retrospective population cohort study evaluated the impact of lifestyle habits and chronic diseases on the risk of cardiovascular mortality in women over 50 at high vascular risk. This study developed a predictive model for menopausal women with

cardiovascular risk factors, using data from the 2011 Spanish National Health Survey that included a total of 5953 women aged ≥50. The study concluded that consumption of vegetables less than once per week (HR: 1.758), smoking (HR: 1.816), excess sleep (≥9 hours/day, RH: 1.809), or spend most of the time sitting as the main daily activity (HR: 2.757) were related to cardiovascular mortality in menopausal women (Quesada et al., 2022).

A retrospective cohort study used data from the 2011 Spanish National Health Survey and the National Registry of Deaths, focusing on women during menopause and post-menopause with no prior cardiovascular events, but with at least one major risk factor. Participants were followed for 10 years, assessing mortality from circulatory system diseases and other causes. Of the 21 007 women surveyed, 3057 women met the inclusion criteria. This study pointed to the significant influence of physical activity, consumption of legumes, perceived health and specific treatments on the risk of cardiovascular mortality in women at menopause (Lopez-Pineda et al., 2024).

In conclusion, the risk of CVD increases significantly in women in menopause due to hormonal and metabolic changes. It is critical to emphasise individualised risk assessment and management, incorporating regular cardiovascular testing and proactive management of risk factors such as hypertension, dyslipidaemia, and obesity. Personalized lifestyle interventions and, where appropriate, therapeutic strategies can mitigate these risks, thereby improving cardiovascular outcomes in post-menopausal women. Physicians and researchers need to understand the complex relationship between the menopause and cardiovascular health to promote better cardiovascular outcomes in menopausal women (Fassero and Coronado, 2025).

3.3.3 Osteoporosis

Osteoporosis is a metabolic bone disease in which there is a general decrease in skeletal strength, resulting in an increased risk of fractures (de Villiers, 2024). It is a very prevalent disease, with significant clinical, social and economic consequences. Following the guidelines of the WHO, it is diagnosed when there is a decrease in bone mineral density, evaluated by means of densitometry, below 2.5 standard deviations with respect to the mean of a reference population (WHO, 1994). It is a chronic and progressive disease, with important ramifications, but it can be prevented and treated. In Spain, the Clinical Practice Guide of the Spanish Society for Bone Research and Mineral Metabolism (SEIOMM) (Riancho et al., 2022) summarises the clinical characteristics, prevention and treatment of osteoporosis.

"Bone remodelling" is the process by which bone is destroyed (resorption) and regenerated (formation) in a continuous manner, to adapt to mechanical loads. This process is also part of the regulation of phosphocalcium metabolism. In osteoporosis there is an imbalance of this remodelling, which leads to a progressive change in the quantity and quality of bone. In post-menopausal osteoporosis, oestrogen deficiency is the main cause of this imbalance, in which there is a predominance of bone resorption over formation. In the first 5-7 years after menopause, approximately 12 % of bone mass is lost (2 % each year), which mainly affects the trabecular bone, increasing the risk of vertebral fractures (Karlamangla et al., 2018).

Several studies have been published on the prevalence of post-menopausal osteoporosis in Spain and the factors influencing its occurrence. In 2010, a study was published on a sample of

854 women over 50 (Sanfélix-Genovés et al., 2010). The average age of women was 64 (range: 50-87 years) The prevalence of all vertebral fractures was 21.4 % (95 % CI: 17.7-25.1) and 9.7 % (95 % CI: 6.7-12.7) for moderate or severe fractures. In women aged 50-54, the prevalence of lumbar and/or femoral osteoporosis was 16.2 % (95 % CI: 9.3-23.1) and osteopenia of 52.3 % (95 % CI: 42.9-61.6). In women aged 55-59, this prevalence increased (osteoporosis: 18.2 %, 95 % CI: 12.4-24.8) and osteopenia 53.8 % (95 % CI: 45.9-61.7). A study evaluating the prevalence of osteopenia and osteoporosis in Spain, carried out by the Spanish Society of Rheumatology (Gómez Vaquero et al., 2025) has been published recently. This is a prospective observational study, in 12 rural and urban localities, which has evaluated the bone mineral density and clinical characteristics of Spanish people identified as Caucasian and between 20 and 80 years old. Participants were selected by the Primary Care team, according to inclusion and exclusion criteria and the data were stratified by age, sex and BMI. The study includes 1522 participants (51.8 % male). Peak bone mass was reached between the ages of 20 and 39 in both sexes. In post-menopausal women, the prevalence of osteoporosis was 18.5 % and osteopenia was 56.2 %. For men over the age of 50, the prevalence of osteoporosis was 2.6 % and osteopenia was 52.4 %. A positive correlation was observed between bone mineral density and height, BMI and physical exercise, and a negative correlation with smoking.

The risk of developing post-menopausal osteoporosis depends on multiple factors, including lifestyle aspects such as dietary intake and nutritional status, activity, and toxic habits (e.g., alcohol, tobacco use) (Table 5). Early-onset menopause is associated with an increased risk of osteoporosis and fractures (Anagnostis et al., 2019).

Table 5. Factors that influence the risk of developing post-menopausal osteoporosis

Non-modifiable factors	Female sex
	Elderly
	Family history of fractures or osteoporosis
	Women identified as Caucasian or Asian
	Early menopause, early ovarian failure
Modifiable factors	Sedentary lifestyle, prolonged immobilisation
	Dietary factors: low calcium, vitamin D, protein intake; excessive sodium intake
	Low weight, malnutrition
	Smoking
	Excessive consumption of alcohol
Medical conditions, drugs	Hyperparathyroidism
	Hypercortisolism
	Hyperthyroidism
	Hypogonadism
	Digestive diseases, malabsorption
	Digestive surgery, bariatric surgery
	Inflammatory diseases
	Treatment with corticosteroids or other drugs

Table 5. Factors that influence the risk of developing post-menopausal osteoporosis	
Factors that favour falls	Neurological diseases
	Visual and auditory disorders
	Sarcopenia, decrease in muscle mass
	Some medications (e.g., sedatives)

Nutrition plays a key role in determining bone health (Ortega et al., 2021). Insufficient protein intake increases the risk of osteoporosis. The relevance of calcium and vitamin D, which are described in more detail elsewhere in this report, is also well known. However, other nutrients are also relevant. Magnesium is involved in bone physiology and mineralisation. Vitamin K is involved in the synthesis of bone proteins, such as osteocalcin. Vitamin C is involved in the synthesis of collagen, since it favours the hydroxylation of proline and lysine. However, excessive sodium intake or vitamin A poisoning can promote osteoporosis. Malnutrition increases the risk of osteoporosis and sarcopenia, in which muscle mass and strength decreases, and falls increase (Zanchetta et al., 2021). This clinical condition is called "osteosarcopenia" and has a higher risk of complications than either osteoporosis or sarcopenia alone. Importantly, a normal or high weight does not rule out a decrease in muscle mass.

People with obesity generally have increased bone mass, which occurs as a compensatory mechanism for increased body weight. However, and especially if there are metabolic complications such as type 2 diabetes, there may be an increased risk of fractures, due to the negative impact on bone physiology of low-grade inflammation (Martiniakova et al., 2024).

The main complication of osteoporosis is the risk of bone fractures. In post-menopausal women, the most frequent locations are the vertebrae and the radius; in contrast, in older people, a hip fracture is more likely. It is pertinent to draw attention to the fact that, in addition to osteoporosis, there are other factors that increase the risk of fractures, such as less strength and muscle mass, in the neuromuscular system, vision and balance, among others (Albrand et al., 2003). Adequate prevention and management of osteoporosis in peri-menopausal women can prevent future problems.

Maintaining healthy habits can prevent osteoporosis in women during the menopause. Physical activity and physical exercise are one of the most important factors, along with a proper diet that provides essential nutrients, and abandoning toxic habits. A Mediterranean-style diet may improve bone health (Andreo-Lopez et al., 2023).

3.3.4 Sarcopenia

Sarcopenia, characterized by progressive loss of muscle mass and function (Cruz-Jentoft et al., 2019), is a frequent syndrome in women during the menopause (Buckinx and Aubertin-Leheudre, 2022). Oestrogen signalling in the activation and proliferation of muscle satellite cells is mediated through the oestrogen receptor alpha (ERα) present in skeletal muscle, and activates various signalling pathways, including the IGF-1 pathway, nitric oxide signalling, or activation of the phosphatidylinositol-3-kinase/kinase B protein (Akt) pathway, which act positively on muscle satellite cells and promote protein synthesis. Hormonal decline, especially that of oestrogens, therefore,

plays a central role in female muscle physiology (Maltais et al., 2009). Physical inactivity, changes in body composition, and inadequate nutrition aggravate the condition. Smoking or alcohol intake also increases the risk of sarcopenia (Yuan and Larsson, 2023).

The consequences of sarcopenia range from loss of autonomy to an increased risk of falls, fractures and increased mortality (Cruz-Jentoft et al., 2019). The muscle dysfunction that occurs in sarcopenia favours insulin resistance and metabolic complications (Li, 2022). Decreased strength and muscle mass may therefore favour or increase the risk of many menopausal complications.

A multidisciplinary approach that combines resistance exercise, adequate protein intake, and endocrine evaluation can prevent or slow the progression of sarcopenia in women at this stage.

The prevalence of sarcopenia in post-menopausal women depends on the population evaluated and the diagnostic criterion that has been used and ranges from 12 to 24 % of post-menopausal women. Some studies base the diagnosis on the decrease in muscle mass, evaluated with different techniques and with different cut-off points. However, the most recognized clinical guidelines define sarcopenia as the decrease in muscle strength, usually evaluated by dynamometry, associated with a decrease in muscle disease, evaluated by validated techniques and with specific cut-off points (Cruz-Jentoft et al., 2019). Beaudart et al. (2017) report a prevalence of 13 % in women over 50, using European criteria. In Latin American countries, such as Brazil, the prevalence can reach 20 %, according to Diz et al. (2017).

In general, an acceleration in the loss of muscle mass is observed during the menopausal transition. Indeed, during this transition, Lean Body Mass (LBM) decreases by 0.5 % (an average annual absolute loss of 0.2 kg), while fat mass increases by 1.7 % per year (an average absolute increase of 0.45 kg) (Greendale et al., 2019). Compared to post-menopausal women, premenopausal women have a higher appendicular lean mass (ALM): 18.2 ± 2.2 *versus* 17.8 ± 2.1 kg, $p<0.001$) (Sipilä et al., 2020). Being in the post-menopausal stage is also associated with an increased risk of developing sarcopenia (OR: 2.99, 95 % CI: 1.38-6.51) (Monterrosa-Castro et al., 2019).

In post-menopausal women, significant differences in the prevalence of sarcopenia by age are also reported: 1.4 % in the 60-69 age group; 4.9 % in the 70-79 age group and 12.5 % in the ≥80 age group (Zanchetta et al., 2021). In younger post-menopausal women (57.8 ± 4.5 years), the proportion of presarcopenic, sarcopenic, and non-sarcopenic women is 11.8 %, 2.7 %, and 85.6 %, respectively (Orprayoon et al., 2021).

Nutritional and lifestyle factors influence the risk of sarcopenia in post-menopausal women. A sedentary lifestyle, low weight, inadequate treatments for obesity, some chronic diseases or some pharmacological treatments, such as corticosteroids, enhance a decrease in muscle mass. The nutritional factors that have been most related to the risk of sarcopenia are protein intake and some micronutrients, such as vitamin D (Abiri et al., 2019). Adequate protein intake is essential to preserve muscle mass and strength. Protein requirements are estimated to increase in the elderly, up to 1.1-1.3 g/kg b.w./day and highlights the relevant role of some essential amino acids, such as leucine (Agostini et al., 2018).

Intake of alcoholic beverages increases the risk of sarcopenia in post-menopausal women (Kwon et al., 2017). In a systematic review (Hong and Bae, 2022), which included 19 studies, with 422 780

participants, of which 3826 had sarcopenia, it was observed that, in people under 65 years of age, alcohol significantly increased the risk of sarcopenia (OR: 2.62; 95 % CI: 1.22-5.62; I^2= 100 %). In a subsequent study, which evaluated four subcohorts of the NHANES III (National Health and Nutrition Examination Survey) based on ethanol intake, it was observed that the deleterious effect of alcohol is especially relevant in women (Yang et al., 2025).

On the other hand, smoking has also been shown to increase the risk of sarcopenia (Locquet et al., 2021).

In summary, prevention of sarcopenia is critical in women during the menopause and post-menopause transition. Physical activity and exercise, avoiding tobacco and alcoholic beverages and maintaining a healthy diet, adequate in essential nutrients, is essential for their prevention.

4. Dietary recommendations for women during menopause, peri-menopause and post-menopause

As discussed, hormonal changes during the menopausal transition and the post-menopausal stage increase the risk of bone loss, sarcopenia, and metabolic and cardiovascular alterations, among other effects. Aware of this, a large number of scientific organizations and societies, both national and international, have issued specific recommendations aimed at women at these stages. These guidelines highlight the importance of following a Mediterranean-style diet, or equivalent, that includes an abundance of foods of vegetable origin, fish and olive oil; reducing the consumption of processed meats and ultra-processed foods; and ensuring a sufficient intake of calcium and vitamin D. They also highlight the role of an adequate protein intake together with physical strength exercise to prevent sarcopenia.

The following is a summary of the dietary recommendations published by various institutions and scientific societies in Spain and other countries.

4.1 Dietary recommendations from Spanish scientific institutions and societies

In 2022, AESAN published a guide that includes sustainable dietary and physical activity recommendations for the Spanish population (AESAN, 2022a), based on a report prepared by the Scientific Committee of this agency (AESAN, 2022b) based on scientific evidence, from the point of view of a healthy and environmentally sustainable diet and the health benefits of physical activity. Although the recommendations of the AESAN are aimed at the general population, they are fully applicable to women during the menopause, since the nutrients and dietary patterns they promote coincide with those indicated by scientific societies, specific for this stage. In addition, by addressing the prevention of common chronic diseases, these recommendations reinforce, in a transversal way, bone, muscle and cardiovascular health, critical aspects in post-menopausal women. In this sense, they align with the most specific recommendations for women during the menopause and post-menopausal stage, such as: increasing the intake of fibre, vitamins and minerals through the consumption of at least 5 servings a day of vegetables and fruits, of which at least 3 are from vegetables (especially cruciferous and dark green leafy vegetables) and 2-3 from fruits (mostly citrus and

red fruits); include, in the diet, sources of calcium, vitamin D and proteins, such as dairy (maximum consumption of 3 servings a day, avoiding those with added sugars and high in salt, although, due to its high environmental impact. It is suggested to reduce the number of daily servings of dairy if other foods of animal origin are consumed); consuming between 3 and 6 servings of cereals a day, prioritizing whole grain cereals and whole grain products and minimising the consumption of foods made with refined flours; ensuring a sufficient protein intake through the intake of legumes (at least 4 servings a per week, until reaching the daily consumption), nuts (3 or more servings per week, up to a consumption of one serving per day), fish (3 or more servings per week), up to 4 eggs per week and a maximum consumption of 3 servings of meat per week, prioritising the consumption of poultry and rabbit meat and minimising the consumption of processed meat. This guide also recommends daily consumption of olive oil at all main meals of the day, and drinking as much water as necessary and, whenever possible, from the tap or bottled (AESAN, 2022a, b).

The Community of Madrid, on its website (CM, 2022, 2025), among the topics of interest in health, highlights the health of women in menopause and recommends women at this stage consume foods with high density of nutrients, taking special care with the intake of calcium (present in chickpeas, almonds, dried figs, dairy), magnesium, potassium, phosphorus, antioxidant vitamins and minerals, folates and vitamins B6, B12, K and D (through the intake of tuna, mackerel and salmon, as well as products with added vitamin D and highlighting that vitamin D in the diet must be complemented with exposure to sunlight daily), and proteins (especially legumes). It also recommends increasing the intake of dietary fibre (25-30 g/day) and complex carbohydrates (50-60 % total kcal); controlling the intake of total fat and saturated fat; consuming olive oil and foods rich in omega-3 fatty acids (fish and nuts); if necessary, taking calcium, vitamin D and folate supplements; moderate salt and alcohol intake; avoid smoking and limiting coffee consumption due to its relationship with calcium metabolism since caffeine, due to its diuretic effect, stimulates the elimination of this mineral in the urine.

The Menoguías (Menopause Guides) prepared by the AEEM include recommendations based on scientific evidence. Specifically, the Menopause Guide on hot flushes during menopause, points out that a Mediterranean-style diet, which ties in with weight control, has a beneficial effect on hot flushes, while the high consumption of fats and sugars can increase hot flushes. In addition, this guide recommends reducing alcohol consumption to prevent the onset or worsening of these symptoms (Fasero et al., 2023). Although the Menopause Guide indicates that there are no data to assess the role of omega-3 fatty acids in the treatment of vasomotor symptoms or on the loss of bone mass, there seems to be a trend towards them being beneficial to health (Alonso et al., 2016). On the other hand, the AEEM, the Menopause Guide recommends that women of post-menopausal age consume sufficient protein (1.0-1.2 g/kg b.w./day) in their diet, to maintain the function of the musculoskeletal system, in addition to reducing complications in case of osteoporotic fractures, and to follow an adequate diet, to maintain a healthy bone, which provides enough calories and the daily requirements of calcium and vitamin D necessary to maintain bone formation and, therefore, an optimal mineral density. It adds that the main foods rich in calcium are milk and other dairy products (cheese, yoghurt), nuts, green vegetables (Swiss chard, kale) and legumes; and the main foods rich in provitamin D, are liver, fatty fish, cod, oysters, eggs, milk and cheese (Presa et al., 2022). Lastly, the AEEM Menopause

Guide on menopause and obesity prepared by Comino et al. (2022), indicates that the comorbidities of obesity in menopause include abnormalities in cardiovascular, endocrine, gastrointestinal, dermatological, neurological, orthopaedic, psychosocial and pulmonary health, as well as increased risk of certain cancers and functional limitations, and concludes that a Mediterranean-style diet is the dietary strategy of choice due to the scientific evidence of its properties and its anti-inflammatory and sustainability characteristics. According to the authors, this diet is based on the predominance of foods of plant origin; nuts (preferably walnuts); more than 2 servings of vegetables per day; more than 3 servings of fruit per day; predominance of plant-based protein sources (3-4 servings of legumes per week); 3-4 servings of fish per week (white and blue) and extra virgin olive oil. It also includes the concept of "anti-inflammatory nutrition", which would encompass those dietary patterns with a high index of anti-inflammatory activity due to their richness in polyphenols, phytochemicals and anti-inflammatory micronutrients that would counteract the low-grade inflammation associated with excess adiposity. This anti-inflammatory diet is similar to the Mediterranean-style diet, is characterised by an absence of ultra-processed and refined foods; the abundant consumption of legumes, whole grains, vegetables, vegetables, fruit and nuts; low consumption of red meat and red meat products; predominance of protein from fish, poultry and eggs and virgin olive oil as cooking fat and dressing.

In 2019, the Spanish Society of Community Nutrition (SENC) published its Guide to healthy eating for primary care and citizen groups which refers to certain life stages such as the menopause, milk and its derivatives, in their different formats, are especially important as an essential source of high quality proteins; vitamins (A, D, B2 and B12) and calcium, a mineral of great importance for the prevention of osteoporosis (Aranceta-Bartrina et al., 2019).

In 2004, the Menopause and Post-menopause Working Group, composed of members of the Spanish Society of Gynaecology and Obstetrics (SEGO), the Spanish Society of Family and Community Medicine (semFYC), the SEEM and the Ibero-American Cochrane Centre, published a Clinical Practice Guide in Menopause and Post-menopause which included a series of dietary recommendations (Menopause and Post-menopause Working Group, 2004). It indicates that an increase in calcium intake during adulthood, and prior to menopause, has been shown to be beneficial for the prevention of osteoporosis, although, they point out, that the influence of a calcium-rich diet in post-menopause in the prevention of bone fractures is not entirely clear. They recommend vitamin D supplements to help prevent osteoporosis and the risk of fracture in women over 65 who are highly susceptible to fractures, as well as the combination of calcium and vitamin D supplements. They also recommend moderating alcohol and caffeine intake to help prevent osteoporosis and warn that phytooestrogens, both in the form of food supplements and in the diet, are not indicated in the treatment of vasomotor symptoms, nor is the intake of vitamin E for the same purpose.

4.2 Dietary recommendations from scientific institutions and societies in other countries

In 2020, the European Menopause and Andropause Society (EMAS) published a position paper on the effect of the Mediterranean diet on women's health during menopause, concluding that it can improve vasomotor symptoms, cardiovascular risk factors such as blood pressure, cholesterol, and

blood sugar, as well as mood and depression symptoms, and long-term adherence can improve cardiovascular risk and events, as well as mortality. It can also improve bone mineral density, prevent cognitive decline, and reduce the risk of breast cancer and all-cause mortality (Cano et al., 2020). This same society has recently published an article on its positioning regarding the effect of vitamin D on the health of post-menopausal women, in which it indicates that doses of vitamin D of 800-2000 IU/day (20-50 µg/day) can provide benefits in the prevention of bone fractures only when administered with calcium (1000-1200 mg/day), especially in elderly women and in those with severe vitamin D deficiency (Anagnostis et al., 2023).

The British Menopause Society (BMS) stresses that a proper diet and an active lifestyle remain the cornerstone of a healthy menopause, regardless of whether the woman, during this stage, uses hormone replacement therapy or not. The BMS points out that weight gain is one of the most common side effects of peri-menopause and menopause, affecting at least 50 % of women and that, as collected in the SWAN studies (SWAN, 2025) and Healthy Women's Study (Matthews et al., 1994), on average, women gain about 1.5 kg of weight per year during the menopausal transition, resulting in an average increase of 10 kg when reaching menopause, and warn that women should avoid those weight loss diets that advise a restricted diet without adequate intake of vitamins, minerals, fibre and proteins, that suggest eliminating entire categories of foods (for example, all dairy or all sources of carbohydrates) and promote that any specific food is capable of accelerating weight loss. It adds that there have been no high-quality studies evaluating the efficacy of popular diets such as the ketogenic diet (very low carbohydrate, moderate protein and high fat eating pattern), time-restricted eating (avoiding certain foods could cause women not to get important nutrients) or fasting for adequate weight loss in women during peri-menopause and menopause. However, the BMS does state that there is high-quality evidence that supports calorie-reduction diets accompanied by physical exercise, including strength or resistance exercise, as the route to achieve long-term weight control. It recommends structured mealtimes composed of foods from the main groups, increasing the consumption of fruits and vegetables and reducing the intake of sugar, salt and fat; they also recommend increasing the intake of micronutrients such as iron, calcium, folate and iodine; following the food group model of 1⁄4 protein, 1⁄4 carbohydrate and 1⁄2 fruit, vegetable or salad; eating slowly and setting weekly alcohol consumption limits. It points out that slow and steady changes are key to long-term successful and sustainable change, which will gradually alter the whole lifestyle in a favourable direction. The BMS document on nutrition and weight loss during menopause (BMS, 2023), includes a series of specific recommendations such as:

- On the intake of foods that are a source of carbohydrates:
  - It is essential for women experiencing menopause to eat carbohydrates, especially when their physical activity levels increase.
  - Exercising with insufficient carbohydrate intake will result in a loss of lean muscle mass, which will of course be counterproductive.
  - It is worth talking about low glycaemic index carbohydrates (whole wheat bread, rye or seeds; new potatoes; oats or couscous, for example), with those women who may be susceptible to insulin resistance or who experience cravings for sweets.

  - Carbohydrates should make up about a quarter of all food portions.
- On protein intake:
  - Protein helps increase satiety, and protein-rich foods can be a valuable source of important nutrients, such as iron and omega-3 fatty acids. Consuming a variety of these foods at lunch and dinner can reduce the need to take a protein supplement.
  - The protein portions should make up about a quarter of a meal.
- On calcium intake:
  - Women with satisfactory bone density need 700 mg of calcium a day, while women with osteopenia or osteoporosis need 1200 mg. The best source of calcium is milk and dairy products, and 2-3 servings a day provide adequate levels of calcium.
- On vegetarian and vegan diets:
  - A plant-based diet simply means using more plant foods along with moderate amounts of non-plant foods. Eating more plant-based foods is usually a very healthy and sensible choice, although there is no evidence that a vegetarian or vegan diet is healthier than a balanced diet that includes lean meat, fish, poultry, and dairy.
  - Women following a vegan diet should take special care to meet the requirements of certain nutrients, including calcium, iron, omega-3 fatty acids, and vitamin B12. For example, women who avoid milk and dairy products should ensure that the plant-based alternatives they consume are enriched with calcium, iodine, and vitamins B and D.
- On food supplements:
  - The only dietary supplement recommended for women in peri-menopause and menopause is a daily vitamin D supplement of 10 µg (or 400 IU). Additional supplements should only be taken when there is a clinical need.
- On relief of symptoms through nutrient intake:
  - It is very unlikely that the symptoms of menopause can be controlled by diet alone. Some foods, such as caffeine, alcohol, and spices, can increase hot flushes, and of course, they can also disrupt sleep.
  - There is limited evidence that consuming large amounts of foods containing phytooestrogens could help reduce hot flushes in some women, but not all.
  - During the menopause diet should clearly focus on eating well and consuming a variety of foods to support overall good health, especially cardiovascular and bone health.

The clinical practice guideline published by the Endrocrine Society (an international scientific society dedicated to the study of hormones and the clinical practice of endocrinology) indicates that, in order to reduce morbidity and mortality from cardiovascular disease and cancer, and maintain an adequate quality of life for women during the menopause, it is important to optimise diet and exercise to maintain an adequate weight, as well as offering advice on alcohol consumption and smoking cessation, and identifying and treating hypertension, glucose intolerance and dyslipidaemias. It adds that adequate intake of calcium and vitamin D, together with limiting alcohol consumption, can minimise bone loss and reduce the risk of falls and fractures (Stuenkel et al., 2015).

The North American Menopause Society (NAMS) issued its position on the management of osteoporosis in post-menopausal women (NAMS, 2021), recommending that all women during post-menopause, regardless of their bone mineral density, clinical risk factors or fracture risk, should be encouraged to adopt non-pharmacological measures and follow a balanced diet with adequate intakes of calcium and vitamin D, remain physically active and avoid lifestyle habits harmful to health, such as smoking, to promote both general health and bone health. Specifically, it recommends the daily intake of 1000-1200 mg of calcium and 400-800 IU of vitamin D3, as established by the scientific committee of the IOM. Regarding protein intake, they point out that studies on the relationship between protein intake and bone mineral density or fracture risk have yielded contradictory results, although they conclude that, in elderly people prone to falls and with weight loss, higher protein intake was associated with a lower frequency of falls.

The Society of Obstetrician and Gynaecologists of Canada (SOGC) collects a series of recommendations on nutrition for women during the peri- and post-menopause in a clinical practice guide published by Yuksel et al. in 2021. It states that a healthy diet during menopause can reduce the risk of future chronic diseases, promote weight control and improve energy levels and that, for women aged between 51 and 70, a healthy diet should include complex carbohydrates, proteins and healthy fats, as well as dietary fibre and calcium. In addition, it recommends a daily calcium intake of 1200-1300 mg, 800 IU of vitamin D and adequate protein intake, along with an active lifestyle, to avoid sarcopenia because, after menopause, the loss of lean muscle mass accelerates and protein requirements increase (Yuksel et al., 2021). They also point out that increasing fruit and vegetable consumption, and decreasing fat intake is associated with less subsequent decline in cognitive and physical function, including mental well-being, and that as energy requirements decline with age, it is recommended to reduce caloric intake and avoid simple sugars, especially if the goal is to maintain weight. On this, they warn that weight loss diets should be done prudently and combined with an active lifestyle and that certain research has shown that so-called mindless eating and an irregular diet contribute to overconsumption.

5. Physical activity and exercise in peri-menopause, menopause and post-menopause

5.1 Introduction

Physical activity and exercise exert a very favourable effect on health throughout the entire lifecycle, contributing to the maintenance of metabolic, musculoskeletal and psychological function. During peri-menopause and post-menopause, they acquire special relevance, as they can counteract the loss of muscle and bone mass, the adverse redistribution of adipose tissue and the increase in cardiovascular and metabolic risk.

The Ministry of Health and the AESAN, in addition to societies and clinical guidelines, recommend accumulating 150-300 minutes/week of moderate aerobic physical activity, or 75-150 minutes/week if it is vigorous, together with 2 or more weekly muscle strengthening sessions, in addition to reducing sedentary behaviours (AESAN, 2022a, b) (Ministry of Health, 2023).

This section describes the role of physical activity and/or exercise in controlling the risks women are subject to during the menopause and post-menopause.

5.2 General effects of physical activity during the menopausal transition

Physical activity is beneficial at any age, but in this period, it acquires special importance, since it conditions favourable changes in body composition, decreases the risk of chronic diseases specific to the post-menopause and improves the typical symptoms. Therefore, physical activity has been postulated as a highly effective tool, with preventive and therapeutic effects on general, cardiovascular and mental health (Fiuza-Luces et al., 2013).

Physical activity has a well-documented impact on physical and psychological health during the female climacteric (Wu et al., 2023) (Elavsky et al., 2024) (Trujillo-Muñoz et al., 2025). Furthermore, it has been observed that both regular physical activities, but especially physical exercise programs are associated with less menopausal symptomatology, including vasomotor symptoms (Aparicio et al., 2017a) (Baena-García et al., 2022).

5.3 Effects of physical exercise on body composition and metabolism

Physical exercise exerts a beneficial effect on body composition, contribuiting to the preservation of muscle mass and bone mineral density, and decreases adiposity (Chapman-Lopez et al., 2022) (Zhang et al., 2025). It can, therefore, help prevent obesity and its complications, sarcopenia and osteoporosis.

Marsh et al. (2023) observed that physical training and healthy dietary patterns after menopause are essential to mitigate visceral fat accumulation and preserve metabolic health. A meta-analysis by Bernal et al. (2025) demonstrated that physical exercise improves the lipid profile in peri- and post-menopausal women, reducing LDL cholesterol and triglycerides and increasing HDL cholesterol, after 12-16 weeks of combined training. In addition, aerobic exercise has been shown to reduce blood pressure and improve cardiorespiratory fitness in this population profile (Debray et al., 2023) (Li and Zhang, 2023) (Carpeggiani et al., 2025). In women who also have type 2 diabetes or metabolic syndrome, the combination of aerobic and strength exercise improves glycaemic control, and cardiovascular risk (Knowler et al., 2002) (Valenti et al., 2025). Interval aerobic training also improves arterial stiffness and endothelial function (Lyall et al., 2022) (Huynh et al., 2024).

5.4 Effects of physical exercise on bone health

As highlighted in previous sections, the loss of bone mass is a frequent consequence of oestrogenic decrease. Evidence shows that impact (e.g. jump-based), strength, or multi-component physical exercise helps to maintain Bone Mineral Density (BMD) and reduce the risk of osteoporotic fractures (Beck, 2022) (Hejazi et al., 2025).

Zhang et al. (2025) showed that physical exercise improves markers of bone remodelling (an increase in osteocalcin - a marker of bone formation and a decrease in CTX (C-terminal telopeptide of type I collagen) - a marker of bone resorption). A network meta-analysis (Xiaoya et al., 2025) observed that the combination of aerobic and strength exercise is the most effective strategy to improve lumbar BMD, while Zhao et al. (2025) specify that 2-3 sessions/week of progressive force achieve clinically relevant increases in the spine and hip.

In line with these recent reviews, Rosen and Lewiecki (2025) recommend combining load-bearing and muscle-strengthening exercise with adequate calcium and vitamin D intake, stressing that the benefits are lost by discontinuing the program.

5.5 Effects of physical activity and physical exercise on mental health, sleep, quality of life and specific symptomatology

Hormonal changes during menopause can be accompanied by mood swings, anxiety, and depression. Regular physical exercise significantly reduces depressive and anxiety symptoms, especially when interventions are supervised, of low-moderate intensity, and combine aerobic, strength, or yoga (Liu and Tang, 2025) (Yue et al., 2025). In addition, physical activity improves sleep quality and duration (Moilanen et al., 2012) (Corrêa et al., 2025) and sexual health (Carlelén-Fraile, 2020).

A meta-analysis by Corrêa et al. (2025) confirmed that physical activity improves sleep quality and duration in women with vasomotor symptoms, being more effective when based on exercise programs that include aerobic and strength components.

At the neuroendocrine level, exercise can modulate cortisol, oxytocin, and serotonin levels, which would explain some of its effects on mental health (Nguyen et al., 2020). In animal models, aerobic exercise has been observed to exert oestrogen receptor-mediated antidepressant effects (Zhou et al., 2022).

Baena-García et al. (2022) describe a possible positive effect of exercise on the reduction of vasomotor symptoms. However, the North American Menopause Society (NAMS, 2023) concludes that there is no strong evidence to recommend physical exercise as a specific treatment for vasomotor symptoms, although it acknowledges its overall benefits on physical and mental health.

In short, physical exercise is a safe, cost-effective and scientifically supported intervention to improve the health of women during peri-menopause and post-menopause. Although it does not replace specific treatments for certain specific symptoms such as hot flushes, it should be integrated as an essential component of public health and clinical care strategies in this population.

5.6 Practical recommendations for the design of physical exercise programmes

Below are some practical recommendations for designing physical exercise programs for women during peri-menopause, menopause and post-menopause:

- Frequency and intensity: 150-300 minutes/week of moderate physical exercise or 75-150 minutes/week of vigorous physical exercise or including at least 2 sessions/week of muscle strengthening.
- Useful methods:
  1. Aerobic (circuit training, through dances, cycling) → cardiovascular and metabolic benefits (Carpeggiani et al., 2025).
  2. Strength training → enhances lean mass and BMD (Zhao et al., 2025). Assess training based on micro-impacts (for example, jumps) to improve bone quality, although always with additional pelvic floor work.

3. Multicomponent (strength + flexibility + balance-coordination + aerobic) more comprehensive → effect on functionality, cardiometabolic profile, emotional state and quality of life (Coll-Risco et al., 2018, Aparicio et al., 2021, Baena-García et al., 2022, Marín-Jiménez et al., 2023 - FLAMENCO study).
4. Yoga or active stretching → reduces depressive and anxiety symptoms (Yue et al., 2025).

- Adherence: metabolic and bone benefits are lost upon discontinuation of exercise; continued and tailored programs should be encouraged (Rosen and Lewiecki, 2025).

5.7 The FLAMENCO project

In Spain, the FLAMENCO project (Fitness League Against MENopause COst) stands out, in which a multicomponent program of physical exercise (all types of physical workouts, including interval and strength aerobic training) was carried out for 16 weeks, in women aged 45 to 60 (Carbonell-Baeza et al., 2015). Table 6 summarises the main findings observed in this project, which also explored the influence of diet and other lifestyle factors on multiple dimensions of physical and mental health in the same sample of participants (n= 150) randomised in the exercise or control group. The overall results show significant improvements in quality of life, psychological well-being, body composition and cardiometabolic profile, with cost-effective evidence.

Table 6. Main findings of the FLAMENCO project

Reference	Key findings
Marín-Jiménez et al. (2023)	The exercise program improved health-related quality of life, especially in the domains of psychological well-being and physical limitations
Coll-Risco et al. (2022)	The exercise program did not globally modify adherence to the Mediterranean diet, although a slight increase in beer consumption was observed in the exercise group. This reinforces the need to accompany physical fitness programs with dietary monitoring
Baena-García et al. (2022)	The exercise program reduced menopausal symptoms (hot flushes, insomnia, irritability) and improved psychological well-being and relationship quality
Ruiz-Montero et al. (2021)	Physical fitness, assessed objectively, was associated with improved health-related quality of life. Body composition, fitness and lifestyle variables explained a significant proportion of the variability observed
Aparicio et al. (2021)	The exercise program increased positive effects and reduced negative effects and emotional distress, improving the overall well-being of the participants
Flor-Alemany et al. (2020a)	Eating chicken and skimmed dairy was associated with greater severity of menopausal symptoms, while soya drinks were associated with better scores
Flor-Alemany et al. (2020b)	Greater adherence to the Mediterranean diet was associated with better body composition and a healthier cardiometabolic profile, especially in non-smokers
Marín-Jiménez et al. (2020)	Lower levels of physical activity and longer sedentary time were associated with poorer quality of life and more menopausal symptoms. Better fitness was associated with a protective effect
Špacírová et al. (2019)	The exercise program developed was cost-effective from the perspective of the public health system

Table 6. Main findings of the FLAMENCO project

Reference	Key findings
Aparicio et al. (2019)	Self-perceived fitness, as assessed by the International Fitness Scale (IFIS), was associated with a better cardiometabolic profile and psychological well-being. Its use is proposed as a fast and low-cost tool in clinical practice
Coll-Risco et al. (2019)	The exercise program improved body composition (as assessed by dual energy X-ray absorptiometry, DXA), with significant reductions in total fat and android/gynoid distribution versus the control group, as well as less bone mineral density loss
Acosta-Manzano et al. (2019)	Reduced sedentary time and improved fitness were associated with greater numbers of ideal cardiovascular health components. Sedentary breakpoints were proposed (<460 minutes/day of sedentary time as the reference threshold for a healthy lifestyle in this population)
Coll-Risco et al. (2018)	The exercise program lowered LDL cholesterol (~10 mg/dl) and showed favourable trends in total cholesterol and diastolic pressure, evidencing modest cardiometabolic benefits
Aparicio et al. (2017a)	Higher physical activity levels and better physical condition were associated with less menopausal symptomatology; the more active participants had fewer vasomotor and psychological symptoms
Aparicio et al. (2017b)	Women with better physical condition and greater lean mass had higher bone mineral density, suggesting a protective role of muscle strength on bone health
Ruiz-Cabello et al. (2017)	Greater adherence to the Mediterranean diet was associated with a more favourable cardiometabolic profile (lower waist circumference, triglycerides and glucose) and better health related quality of life

Conclusions of the Scientific Committee

- The menopausal transition and post-menopause affect a significant percentage of the female population. Therefore, the nutritional health of this population group is a health and public health priority.
- Decreased oestrogen is the central pathophysiological factor that explains most of the adverse changes of this stage: changes in body composition (increased visceral fat, decreased muscle mass), accelerated loss of bone mass, and increased cardiometabolic risk.
- The age of onset of menopause (especially premature or early) conditions the risk, in the long term, of cardiovascular disease, osteoporosis and other problems; however, a healthy lifestyle can significantly mitigate this risk.
- A Mediterranean-style diet, avoiding toxins such as tobacco and alcohol, is associated with fewer menopausal symptoms, a better cardiometabolic profile, greater bone health, and a lower risk of certain cancers in the post-menopausal period.
- Some nutrients are especially relevant at this stage of life: proteins, calcium and vitamin D, magnesium, B vitamins or omega-3 fatty acids, among others, are essential to maintain bone and metabolic health and prevent sarcopenia.
- Insufficient intake of some nutrients, below the recommendations, is common in women in peri-menopause and post-menopause, especially in the case of vitamin D, calcium, magnesium

and vitamins A, C, E and B. Deficiency of these nutrients contributes to the risk of osteoporosis, sarcopenia and increased morbidity.

- Physical activity and regular physical exercise with a frequency of 150-300 minutes/week of moderate aerobic activity, or 75-150 minutes of vigorous activity, including ≥2 weekly sessions of strength training (assessing the incorporation of training based on micro-impact jumps, compensated with pelvic floor work) is a key intervention: it preserves muscle mass and bone quality, improves the cardiometabolic profile, mood, sleep and quality of life.
- Peri- and post-menopausal obesity increases the risk of metabolic syndrome, metabolic hepatic steatosis, hormone-dependent cancer, and fractures; weight loss should focus on a balanced diet and physical activity and exercise (including strength training) to preserve muscle mass and bone health.
- Calcium and vitamin D supplements may be indicated when there is a risk of deficiency of these nutrients. The use of other food supplements is frequent, but the evidence on their efficacy and safety is heterogeneous and requires individualised evaluation and further safety and efficacy studies.
- An integrated strategy, including nutritional and functional screening and assessment, cardiometabolic and bone health assessment, is needed to enable nutrition education and tailored structured exercise programs. Further research is needed to define specific recommendations as well as public health policies targeting this population group.

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