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REVIEW ARTICLE



# The role of lifestyle medicine in menopausal health: a review of non-pharmacologic interventions

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**ABSTRACT**

**Objective:** Menopause, typically occurring between ages 45 and 55 years, is a natural life stage marked by hormonal changes that can affect the symptom burden, quality of life and chronic disease risk. While not a disease, the transition often requires individualized, holistic care. Lifestyle medicine – encompassing healthy eating, physical activity, mental well-being, avoidance of risky substances, restorative sleep and healthy relationships – offers a promising non-pharmacological strategy to optimize health during this period.

**Method:** A systematic literature search was conducted in PubMed, Embase, Scopus and Web of Science (January 2000–December 2024) using the following keywords and combinations: 'menopause', 'lifestyle medicine', 'healthy eating', 'physical activity', 'mental wellbeing', 'avoidance of risky substances', 'restorative sleep', 'healthy relationships', 'weight management', 'chronic disease prevention', 'health equity and access' and 'general health frameworks'. Peer-reviewed human studies in perimenopausal, menopausal or postmenopausal women evaluating one or more lifestyle medicine pillars were included. Data were extracted on study design, population, interventions, outcomes and main findings.

**Results:** Lifestyle medicine interventions were associated with reductions in vasomotor symptoms, improved sleep quality, enhanced mental well-being, healthier weight regulation, and reduced cardiometabolic and osteoporosis risk. Multidisciplinary, person-centered approaches improved adherence and patient-reported outcomes. Strategies were cost-effective, adaptable and beneficial for long-term disease prevention across diverse populations.

**Conclusion:** Lifestyle medicine offers a foundational, evidence-based framework for equitable menopause care. Integrating these strategies into clinical guidelines and public health policy can improve quality of care, empower women to manage their health and reduce disparities in access. Collaborative action among healthcare providers, policymakers and communities is essential to maximize impact.

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Menopause; lifestyle medicine; healthy eating; physical activity; sleep; healthy relationships; weight management; chronic disease prevention

## Introduction

Menopause, naturally occurring between 45 and 55 years of age, describes a point in time when the last menstrual period occurs. Prior to this, when women begin encountering fluctuations of sex hormones, is defined as the menopausal transition or perimenopause. The average duration of perimenopause is around 4 years but a certain degree of variability depending on age at onset and other individual factors may be found [1,2]. Thereafter, when the ovaries finally stop releasing estrogens, women are postmenopausal for almost 40% of their life with an overlap between reproductive aging, chronological aging and other aging-related risk factors overall affecting major chronic diseases and disabilities [3].

Menopause is not a disease state but changes associated with menopause can increase the risk of chronic disease. Its model of care should follow a biopsychosocial approach and decision-making relying on evidence-based information [4]. Indeed, every woman requires her individual need for care based on possible bothersome symptoms associated with menopause, risk factors for chronic disease, and intrapersonal and environmental aspects, influencing their quality of life

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and health profile [5]. Menopause may also occur ahead of the usual time, being premature (<40 years of age) or early (between 40 and 44 years), either spontaneously or induced by iatrogenic procedures for benign or malignant conditions. In this case, decision-making regarding symptom management and choice of interventions should consider the evidence for a higher risk of morbidity and mortality when women enter menopause prematurely [6].

Ethical management of menopause should empower both women and healthcare providers to share decision-making in developing tailored strategies to alleviate symptoms and/or optimize health, thus fostering equitable care and fighting the stigma surrounding this life transition [4,7]. The full options include hormonal or non-hormonal therapies, or lifestyle and behavioral approaches, alone or in combination, based on individual needs, preferences and access, considering the risk–benefit profile of each woman [8].

The aim of this White Paper is to underscore the importance of lifestyle principles in empowering women to embrace their menopausal transition and optimize health and well-being into menopause. The goal of lifestyle medicine is to maintain optimal health and to prevent, treat and even reverse chronic illness across all life stages by targeting the pathophysiological bases [9]. Education and evidence-based person-centered behavioral interventions addressing the six pillars of lifestyle medicine – healthy eating, physical activity, mental well-being, avoidance of risky substances, restorative sleep and healthy relationships – offer a worldwide promising non-pharmacological approach to menopause care [3]. Indeed, lifestyle as medicine integrates multidisciplinary competencies and is a cost-effective strategy to improve symptoms and health outcomes in women under several circumstances and conditions. It also contributes to self-empowerment [10], in particular to regulate body weight [11] and to manage the cardio-metabolic transition associated with menopause [12].

Here, we report a review of the available evidence on the role of the six pillars of lifestyle medicine in improving symptomology of menopause, quality of life and common risk factors for chronic diseases.

## Methods

A comprehensive literature search was conducted to identify studies evaluating the role of lifestyle medicine interventions in menopause care, symptom management and chronic disease prevention. The search strategy included the following keywords and their combinations: 'menopause', 'lifestyle medicine', 'healthy eating', 'physical activity', 'mental wellbeing', 'avoidance of risky substances', 'restorative sleep', 'healthy relationships', 'weight management', 'chronic disease prevention', 'health equity and access' and 'general health frameworks'.

The search was performed across the PubMed, Embase, Scopus and Web of Science databases, primarily covering literature published from January 2000 to December 2024. Search terms were applied to titles, abstracts and keywords, and Boolean operators (AND/OR) were used to refine results. References of relevant articles were also screened to identify additional eligible studies.

Inclusion criteria were: peer-reviewed articles; human studies involving women in perimenopause, menopause or postmenopause; studies assessing at least one of the six pillars of lifestyle medicine – healthy eating, physical activity, mental well-being, avoidance of risky substances, restorative sleep and healthy relationships – or related domains such as weight management, chronic disease prevention and health equity; and randomized controlled trials (RCTs), cohort studies, cross-sectional studies, systematic reviews or meta-analyses. Exclusion criteria included: non-English language publications; studies without original data (except systematic reviews or meta-analyses); and animal or preclinical studies.

## Healthy eating

Adopting a health-promoting diet is a cornerstone of lifestyle-based disease prevention. Malnutrition, encompassing both undernutrition and obesity, has been recognized as a major global health threat [13], prompting coordinated efforts by international bodies such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) [14]. In the USA alone, suboptimal dietary patterns are estimated to contribute to an annual cardiometabolic burden of approximately US$50.4 billion [15]. Addressing this challenge requires achieving three interrelated goals: defining the parameters of a healthy diet; ensuring its global accessibility; and aligning it with the sustainability of food systems. Accordingly, a universally applicable 'reference diet' must not only be nutritionally adequate and culturally acceptable but also environmentally sustainable, consistent with both the United Nations Sustainable Development Goals and the Paris Agreement. The overarching principles of such a diet include the preferential consumption of plant-based foods (e.g. vegetables, fruits and unsaturated oils) and the reduced intake of red and processed meats, as well as a reduction in added sugars [16]. This paradigm underlies the framework of the 'Great Food Transformation', an initiative aimed at reconciling global population growth with dietary standards that safeguard planetary health [17].

Implementing a global reference diet, however, necessitates overcoming significant barriers. Key challenges include reconciling dietary recommendations with regional food cultures, accommodating diverse agricultural systems and adapting to resource constraints exacerbated by climate change, such as water scarcity and limited financial infrastructure.

### *Diet and health outcomes*

The evidence base linking dietary intake to health outcomes remains constrained by methodological limitations, including the retrospective nature of many studies, imprecise dietary assessment tools and the need for sufficiently powered sample sizes. Nevertheless, recent advances in data science and the availability of large, well-characterized cohorts with biobank integration are enhancing the robustness of findings. For example, aggregated analyses of 36 studies based on the

UK Biobank indicate that healthier dietary patterns are associated with reduced risks of cardiovascular disease, colorectal cancer and type 2 diabetes mellitus [18]. Conversely, a comprehensive umbrella review reported that higher consumption of ultra-processed foods correlates with increased incidence of cardiometabolic and psychiatric disorders, as well as higher all-cause mortality [19]. For midlife women, glucose, blood pressure and nicotine exposure are critical components of associated risks and poor midlife sleep quality may uniquely contribute to future event risk [20].

### *Dietary patterns*

Although a wide array of dietary patterns exists, high-quality evidence supporting their long-term health effects remains limited for many. Among these, the Mediterranean diet (MedDiet) has emerged as the most extensively studied and widely endorsed dietary model. Its strengths include long-standing cultural acceptance across Mediterranean countries [21], resilience in low-resource settings, as demonstrated during historical periods of scarcity, and robust cardiometabolic benefits suggested by early epidemiological research [22]. Adherence to the MedDiet can have beneficial impacts on menopausal women's health, including improvement in mood and depression symptoms and reductions in weight, blood pressure, the blood ω6:ω3 ratio, triglycerides, total cholesterol and low-density lipoprotein (LDL) levels [23,24].

While no strict consensus definition exists, the MedDiet is broadly characterized by high intake of vegetables, fruits, olive oil, nuts and fish, with limited consumption of red meat. To operationalize this pattern, food-frequency pyramids were developed [24] and later refined [25], enabling the development of adherence scores that facilitate epidemiological investigation into disease risk reduction [26].

A related dietary pattern is the Dietary Approaches to Stop Hypertension (DASH) diet, developed through a US National Heart, Lung, and Blood Institute-led initiative [27]. The DASH diet closely parallels the MedDiet in food group composition, with an important variant, the DASH-Sodium diet, incorporating sodium restriction. This modification has shown slightly superior efficacy in blood pressure reduction [28,29].

Intermittent fasting has also garnered substantial interest as a metabolic intervention [30]. Common approaches include alternate-day fasting and the 5:2 protocol, which involves fasting on 2 days of the week with normal eating patterns on the remaining 5 days. Vegetarian and vegan diets, although distinct, share compositional similarities with both the MedDiet and DASH patterns, particularly in their emphasis on plant-based food sources [31]. Studies on the effect of intermittent fasting among menopausal women are scarce.

### *Dietary interventions and health*

Data on the effects of various dietary interventions on midlife health are limited. Generally, evidence from RCTs supports the protective role of the MedDiet against cardiovascular disease [32], along with favorable effects on intermediate cardiometabolic markers including blood pressure, lipid profiles, insulin sensitivity and metabolic syndrome (MetS) components. Additional findings suggest potential benefits for cognitive function, psychological well-being, certain malignancies and overall survival [22]. The DASH diet yields comparable improvements in intermediate cardiovascular endpoints [33].

Intermittent fasting has been associated with improvements in blood pressure, lipid metabolism and insulin resistance [30]. While no major safety concerns have emerged, limitations include uncertainty regarding long-term adherence and whether outcomes parallel those of traditional caloric restriction [34,35].

The cardiovascular and broader health benefits of plant-based diets are supported by prospective observational studies, which also indicate potential protective effects against cancer and neurodegenerative conditions [31].

### *Additional health impacts of diet*

Evidence suggests that the MedDiet contributes to reductions in overall and central obesity [36], with weight loss outcomes comparable to those observed in hypocaloric vegetarian diets [37]. These effects may be enhanced by regular physical activity [38] and the predominant use of olive oil as a dietary fat [39].

Nutrition is also fundamental to skeletal health. Adequate calcium and vitamin D intake is essential, particularly in postmenopausal women. Current guidelines recommend daily calcium intakes of 700–1200 mg for women aged ≥50 years [40]. Given the age-related decline in cutaneous synthesis of vitamin D and the potential dermatological risks of sun exposure, dietary sources, such as oily fish and egg yolks, are recommended. Although optimal vitamin D intake remains debated, existing guidance proposes 400–600 IU/day for older adults, increasing to 800–1000 IU in individuals with limited sunlight exposure [41]. Fortified products, including dairy and cereals, may be used to help achieve these targets.

The relationship between diet and menopausal vasomotor symptoms (VMS) has also been explored. Small-scale studies suggest that diets rich in fruits and vegetables may alleviate VMS [42,43]. Larger investigations, such as the Australian Longitudinal Study on Women's Health, a 9-year observational prospective cohort of 6040 women [44], and the randomized Women's Health Initiative (WHI) Dietary Modification Trial [45], have reported only modest benefits. Evidence of the efficacy of soy foods in improving menopausal symptoms is limited due to the small number of trials reporting conflicting results [46].

## Physical activity

During menopause, an increase in central adiposity is linked to a 40% reduction in physical activity [47] and animal studies have demonstrated that despite minimal change or a reduction in overall energy intake, a reduction of energy expenditure contributes strongly to the development of central adiposity [48]. The reduction in energy expenditure is

hypothesized to be related to reduced physical activity contributing to a loss of lean mass and reduced resting metabolism [49] compounded by the loss of estrogen during this transition period. As estrogen helps reduce reactive oxygen species (ROS) and NF-κB, a transcription factor important for regulating other inflammatory markers, a loss of estrogen with menopause may lead to higher levels of inflammation [50,51]. The decline in estrogen levels during menopause has also been correlated to an increased level of vasoconstrictive prostaglandins and reduction of nitric oxide (NO) and prostacyclin (PGI2) leading to higher resting vascular tone and reduced function [52] as well as a loss of cardio-protection that estrogen confers through regulation of lipid metabolism, increased angiogenesis, promotion of endothelial function and reduction of fibrosis [53]. Finally, the loss of estrogen has been connected to an increase in visceral adiposity [54].

While the extent to which intentional physical activity impacts weight loss is debated across multiple studies [55,56], studies have shown that physical activity has cardiovascular and body composition benefits as well as benefits for menopausal symptoms, particularly VMS of hot flashes and night sweats by increasing hypothalamic β-endorphins to help stabilize thermoregulation [51,57–60]. Furthermore, quality of life has been shown to improve during menopause and post menopause with physical activity [58,59]. Therefore, exercise could help mitigate some effects experienced with the loss of estrogen during and after menopause. Overall, physical activity helps reduce inflammation in adipose tissue and skeletal muscles by increasing antioxidants such as superoxide dismutase, glutathione peroxidase, glutathione reductase and catalase [51,61]. It also improves fat cell metabolism [49] and has been shown to affect body composition to reduce the android to gynoid fat mass ratio [62]. Physical activity has also been demonstrated to improve bone density in postmenopausal women [63,64].

However, the extent to which physical activity improves cardiovascular health, body composition and VMS depends on the intensity and type of exercise. For example, some studies show that higher intensity and longer duration of exercise correlates with a higher reduction in total fat mass and waist circumference although no significant difference in weight loss was noted [55,63]. Additionally, there are conflicting studies that report either no effect in endothelial function or some improvement in early and late postmenopausal women who participate in physical activity [64–67], and rather that the impact of improvement in endothelial function in relation to physical function is hypothesized to be related to the level of estrogen bioavailability, which may be correlated to certain types of exercises [64,65].

### *Types of physical activity*

Aerobic exercise, also known as cardiovascular or endurance exercise, involves rhythmic activities that increase the heart rate and breathing for extended periods. Aerobic exercise in adults has been well established to benefit body composition and cardiovascular health by reducing body fat, increasing bone mineral density (BMD), decreasing blood pressure and resting heart rate, and increasing cardiac output [68–71]. In women transitioning through menopause and who are postmenopausal, aerobic exercise helps with menopausal symptoms and improves muscle strength, flexibility and skeletal muscle mass. An RCT comparing sedentary women who newly started 50-min aerobic exercise sessions four times per week for 6 months compared to sedentary women who did not exercise showed that after 6 months of aerobic exercise, women reported improved mental health, physical function and improvement in physical role limitations, and had slight improvement in sleep [59]. A systematic review and meta-analysis examining the effects of a walking intervention in perimenopausal and postmenopausal women showed statistically significant improvements in body mass index (BMI) (–0.33 kg/m$^2$, 95% confidence interval [CI] – 0.62 to –0.04 kg/m$^2$), body weight (–1.14 kg, 95% CI –1.86 to –0.42 kg) and body fat percentage (–2.36%, 95% CI –3.21% to –1.52%) compared to women who did not exercise [72]. Aerobic exercise may also improve vascular health by improving flow-mediated dilation (FMD), which is the endothelium-mediated vasodilatory capacity of a vessel in response to change in blood flow [50]. In a prospective study examining the effects of different levels of aerobic exercise on sedentary postmenopausal women with obesity, FMD improved in postmenopausal women with obesity and elevated blood pressure after 6 months of aerobic exercise [73]. Furthermore, a review article examining the therapeutic role of exercise during menopause suggested that aerobic exercise improved vascular health by improving endothelial function, arterial stiffness and estrogen bioavailability particularly in the early postmenopausal stage [52]. However, multiple studies suggest that the greatest improvement in FMD is seen in women with a higher degree of cardiovascular risk; women who had low cardiovascular risk may have minimal or no significant changes to FMD with aerobic exercise regardless of intensity of aerobic exercise [64,73–75].

Resistance training, also known as strength or weight training, involves using resistance to build muscle strength, endurance and/or size. Examples of resistance training include body weight exercises, free weight exercises, resistance band exercises, yoga and tai chi. Resistance training in adults has been shown to reduce the resting heart rate and blood pressure, and to strongly impact body composition by increasing lean body mass and BMD, and reducing sarcopenia in older patients [68,69,71,76]. In postmenopausal women, one RCT showed that the combined use of resistance bands with agility and balance exercise improved cholesterol, high-density lipoprotein (HDL) and body composition [77]. Multiple studies have demonstrated that resistance training may reduce inflammation by reducing skeletal muscle expression of TNF-α, a cytokine that impairs insulin signaling and contributes to insulin resistance in skeletal muscles and adipose tissues [51,78–80]. Postmenopausal women with age-related loss of muscle strength who participated in tai chi for 12 weeks demonstrated improvement in physical function evaluated through hand grip strength ($p = 0.04$), chair–stand test ($p = 0.02$), alternate-step test ($p = 0.002$), one-leg stance test ($p = 0.05$), decrease in BMI ($p = 0.005$) and overall body weight ($p = 0.004$), systolic and diastolic blood pressure ($p = 0.001$ and $p = 0.005$, respectively) and general health

perception ($p = 0.01$) [81]. Yoga, a type of resistance exercise focusing on flexibility, balance and mental relaxation, demonstrated significant improvement in VMS, sleep quality, stress and psychosocial symptoms, and had antioxidant benefits in multiple studies but had limited impact on hormone levels [82–84]. Furthermore, the discontinuation of high-intensity resistance training led to an increase in VMS [57]. However, one RCT suggested that resistance training, while helpful for physical function, body composition and short-term VMS, such as hot flashes and night sweats, had little impact on long-term cardiovascular health and long-term symptom reduction beyond 2 years [85]. There are also conflicting data about the long-term impact of vascular health with resistance training – there is mixed evidence about the impact on arterial stiffness and endothelial function [52,74,86].

While aerobic exercise and resistance exercise independently have benefits for body composition, bone health and cardiovascular health, multi-component exercises combining muscle strengthening, balance and aerobic exercise are highly beneficial as well. Multi-component exercises have been shown to improve VMS and improve muscle strength, cardiorespiratory fitness, flexibility and agility [87–89]. HIIT exercises, or high-intensity interval training, which commonly are combinations of aerobic and resistance exercises, have been shown to lead to higher weight loss and increase or maintenance of lean mass [56,90] as well as an improvement in intracranial artery velocity and reactivity to carbon dioxide exposure in postmenopausal women [91]. Furthermore, multi-component exercise had the highest level of reduction of inflammatory cytokines compared to aerobic exercise or resistance training alone [92], and a separate meta-analysis indicated that multi-component exercise improved brachial–ankle pulse wave velocity [93].

With various types of exercises, adding menopause hormone therapy (MHT) has varied effects. One double-blinded RCT showed that adding transdermal estrogen therapy to resistance training led to a smaller reduction in total (−1.1% vs. −5.6%) and visceral adiposity (−6.8% vs. −18.6%) compared to resistance training alone, but had a higher level of improvement in metabolic markers such as LDL (−0.07 vs. 0 mmol/l), blood glucose (−0.36 vs. −0.16 mmol/l) and Hemoglobin A1C (HbA1C) (−2.53% vs. −1.25%) compared to resistance training alone [94]. Another study suggested that adding long-term MHT for more than 10 years in the form of transdermal or oral estrogen, estradiol or estrogen/progesterone combinations helped improve or maintain arterial compliance with aerobic exercise [95]. There are also mixed data about the impact of combined MHT with exercise and the overall impact on muscle performance and cardiorespiratory fitness. One case–control study demonstrated that the combination of MHT and exercise led to improved muscle performance, composition and exercise capacity in sedentary postmenopausal women [96]. Another study showed that cardiorespiratory fitness was not affected by MHT use in moderately active postmenopausal women [97].

In summary, body composition and vascular health with menopause and postmenopause can strongly be affected due to estrogen loss, reduced estrogen bioavailability and the reduction of energy expenditure. Different types of physical activity have different benefits for females who are perimenopausal or postmenopausal. Resistance training, including yoga and tai chi, strongly benefits limited reduction or preservation of lean body mass and VMS. Aerobic exercise may have stronger effects to improve vascular health; however, multi-component exercise combining aerobic and resistance exercises has benefits of both individual types of exercises. Consistent aerobic or resistance exercise for at least 3–4 months has been demonstrated to lower insulin levels, BMI, percentage of body fat and waist circumference in 6–12 months in postmenopausal women [98]. Furthermore, there are mixed data about the effect of MHT with exercise on the impact on muscle and cardiorespiratory fitness. The current recommendations for physical activity in adults per the American Heart Association is 75–150 min of vigorous intensity aerobic activity or 150–300 min of moderate intensity aerobic activity and at least 2 days of strength or resistance training weekly [70]. Similarly, the International Menopause Society (IMS) recommends at last 150 min of moderate-intensity aerobic activity and 2 days or more of strength or resistance exercise weekly [99,100]. While menopause is itself a natural life process in women, the consequences of estrogen loss can have major long-term impacts in women that may be somewhat mitigated with physical activity.

## Mental well-being

### *Stress and menopause*

Midlife can be a stressful period for many women due to a combination of factors such as life events, physical changes, changes in health status as well as the need to care for children and older parents at the same time. The menopause transition in midlife results in physical, metabolic changes and psychological changes, which leads to greater perceived stress [101,102]. Several studies have also found that stress is associated with menopausal symptoms as well as increased frequency of VMS [103,104]. High levels of job-related stress, less job control and fitness are significantly associated with menopausal symptoms while higher mindfulness and lower stress correlated with lower menopausal symptom scores [101,104].

One effective solution that has been shown to improve the quality of midlife women experiencing menopausal symptoms is stress management programs that incorporate cognitive-based therapy and relaxation techniques. Such programs have shown to be highly effective in significantly improving women's ability to cope with stress, reduce VMS [105] as well as reduce stress and menopausal symptoms [106].

The COVID-19 pandemic led to an acceleration of development of mobile health (mHealth) solutions due to lockdowns and travel restrictions imposed by various countries. In a systematic review and meta-analysis, mHealth solutions were found to improve self-reported stress outcomes and physiological measures outcomes [107]. Studies conducted specifically in midlife women are scarce; however, studies among the general population that used muscle and

breathing relaxation, meditation strategies, personalized guidance, experimental usage settings and measured acute stress responses demonstrated significantly positive results. Further analysis of specific physiological systems also revealed improvement for autonomic and cardiac outcomes. The significant effects observed across both psychological and physiological outcomes support the efficacy and potential of mHealth apps for the self-management of stress responses in the broader population. This illustrates the feasibility for self-management of stress using mHealth solutions, which will lead to greater accessibility to limited and sometimes expensive healthcare resources.

With the release of ChatGPT, a generative artificial intelligence (AI) chatbot released in November 2022, and the release of Chinese AI company Deepseek on 20 January 2025, chatbot development has greatly accelerated [108]. In a systematic review and meta-analysis, Li et al. found that AI conversational agents significantly reduce symptoms of depression and distress, with greater effect seen in those employing generative AI (compared to rule-based responses), using multi-modal or voice-based conversational agents or delivering interventions via mobile applications and instant messaging platforms with target groups that are clinical/subclinical or older. The quality of human–AI therapeutic relationships, content engagement and effective communications shaped the user experience [109].

With the rapid increase in chronic diseases such as obesity and diabetes mellitus linked to lifestyle, the utilization of mHealth to tackle this chronic disease epidemic is critical in reducing the burden on healthcare systems worldwide. A systemic review and meta-analysis conducted on weight management interventions that utilized mHealth for lifestyle self-monitoring showed a moderate decrease in weight and higher adherence to behavioral interventions compared to other interventions [110]. Smartphones were the most effective mHealth approach to achieving weight management in subgroup analysis. Lifestyle mHealth self-monitoring achieved greater effect in behavioral weight management interventions compared to usual care in the short term (less than 6 months). While studies focusing specifically on menopausal women are lacking, generally mHealth self-monitoring also showed higher adherence than paper recording at any time and any other interventions at 6 and 12 months [111].

The recent rapid increase in the availability of affordable consumable wearable trackers allows more consumer-generated physical and physiological parameters to be easily collected. This provides opportunities for healthcare professionals to better monitor the activity and health of their patients. Wearable fitness trackers were shown to improve motivation for physical activity and self-efficacy for exercise as users felt a sense of accountability when wearing the fitness tracker. Users of wearable fitness trackers also reported beneficial effects in improving motivation for physical activity over 13 months compared to non-users [111]. As such, AI has the potential to aid in menopause and post-reproductive health management in many ways, such as the assessment of comorbidities, assessment of the risk of long-term conditions, symptom tracking and aiding in selection of the best treatment [108].

Wearable fitness trackers also appear to be an effective means of supporting more autonomous motivation in adults. The effects of allowing users to set their own goals lead to better outcomes as compared to a fixed daily number of steps goal where, if this is perceived as unattainable for those with low baseline activity, it could lead to negative impact as it creates a sense of failure [111].

Combining behavioral interventions like self-determination theory-based motivational interviewing and wearable fitness trackers appears promising in increasing physical activity [111].

Sleep, being an important lifestyle factor for health outcomes, can also be tracked objectively by many of the wearable trackers. Consumer sleep trackers have made tracking sleep, an important part of lifestyle changes that have effects on one's health, possible. Lee et al. evaluated 11 wearable, nearable and airable consumer sleep trackers and found them useful for tracking sleep and sleep quality despite the limitations in tracking various sleep parameters by the various devices. Insights into sleep could allow clinicians to provide timely and appropriate advice on lifestyle changes that can improve sleep duration and sleep quality [112].

Technology advances have the potential to narrow the gap in accessibility of scarce healthcare resources, allowing greater access to those who are vulnerable to ensure greater equity in healthcare for all. Numerous studies have shown positive impact on lifestyle changes leading to reduced chronic disease burden and improvement in menopausal symptoms and mental wellness. Technology also has the potential to provide individualized management for patients with different profiles and needs, thereby increasing its effectiveness in behavioral lifestyle change.

## Avoidance of risky substances

### *Substance use*

Substance use is often considered to predominantly affect males and is often approached in a male-centric manner when researching factors and treatments [113]. This approach neglects that ovarian hormones may be a potential factor affecting both substance use and the physiological response to it. For example, women appear to be more vulnerable to the harmful effects of alcohol and tend to develop diseases related to alcohol earlier in life [114]. In addition, the female population is catching up and exceeding men in substance use, highlighting the importance of gender issues in substance abuse research [113,115]. The drug-using population of women is increasing, centering on those in perimenopausal or menopausal phases. Substance-abusing women may experience alcohol and illicit substance use, HIV/AIDS, hepatitis, psychological distress and negative life events. Additionally, substance use may increase the severity of menopause symptoms including hot and cold flushes, sweats, fatigue, loss of libido, menstrual irregularity, and mood and sleep disturbances. Overlapped with withdrawal symptoms, these may lead to severe discomfort. This is especially true for those with opiate withdrawal and methadone treatment with incorrect dosages. Women are particularly sensitive to

these symptoms, which in turn makes them at higher risk for relapse of substance abuse than those who may not currently be using substances [113].

There is evidence of an association between addiction and menopause [116]. There are limited data suggesting that negative mood symptoms of menopause may lead to more alcohol misuse and risk-taking behaviors [116]. In addition, studies have noted that circulating levels of ovarian hormones throughout the varying menstrual cycle phase can influence the central effects of stimulant drugs (such as amphetamines and cocaine) in women, with greater stimulating effects seen in the follicular phase as compared to the luteal phase [117]. However, studies have shown a modest, if any, effect on the response to other commonly abused drugs such as benzodiazepines, caffeine, marijuana, nicotine and opioids based on the menstrual cycle phase [117].

Smoking cessation is crucial for the onset of menopause and for general quality of life. During the transition from perimenopause to postmenopause, cardiovascular risks increase. For this reason, females should be inclined to reduce coronary heart disease risk factors [118]. The longer duration someone smokes has been suggested to be more influential than the number of cigarettes smoked per day, as it is associated with worse physical and menopausal symptoms as well as earlier onset of menopause [119]. More specifically, women who smoked for less than 10 years in total experienced less bothersome menopausal symptoms than those who smoked for 20–30 years [119]. Non-smokers had significantly better VMS and quality of life, which reinforces the notion that midlife women should be encouraged to quit smoking [119].

Data on women who quit smoking showed that they gained significantly more weight than non-smokers and continuous smokers. Additionally, they experienced a decrease in systolic blood pressure, signifying positive effects despite greater weight gain [119,120]. The potential for weight gain may hinder women who want to quit and make them more reluctant to engage. Weight gain in this form is not associated with negative changes in cholesterol risk factors like LDL or HDL [118].

### *Alcohol*

Consuming alcohol can interfere with hormonal balance and reproductive function by activating or inhibiting the neurohormonal axis or changing the metabolism of hormones in the liver. Specifically, alcohol increases estrogen levels by promoting the conversion of androgens to estrogen through increased aromatase activity, or by interfering with estrogen's metabolism and clearance from the blood. For this reason, it is crucial to understand disorders of the reproductive system in women who drink excessively and who experience dysfunction of the hypothalamus–pituitary–ovaries axis. The gonads are sensitive to alcohol and toxic influence [121]. Intake of alcohol has been suggested as a factor that affects the age at which menopause occurs. While alcohol consumption can be associated with an earlier onset of menopause, it can also be associated with a delayed onset of menopause [121]. Low consumption (broadly defined as more than one drink per week) and moderate consumption (broadly defined as three or fewer drinks per week) were associated with a later menopause onset compared to those who do not drink. However, the magnitude of this association is low and it is unclear whether alcohol consumption could potentially delay the onset of menopause.

Sex also plays a role in the effects of alcohol, although again the effects appear to be contradictory. Females may be more susceptible to the benefits of wine when the consumption rate is low to moderate compared to other beverages [122]. Up to 30 g of alcohol per day may be protective for cardiovascular disease and type 2 diabetes [122]. However, these findings are to be taken with caution because not all alcoholic beverages are equivalent in their ability to influence health [121]. In addition, alcohol intake is a known risk factor for other conditions mediated by estrogen levels such as breast cancer. Any perceived benefits of alcohol consumption do not outweigh the potential risks. National guidelines on alcohol consumption recommend no more that 10–20 g alcohol per day with alcohol-free days [27].

Alcohol use disorder (AUD) is a substance abuse disorder that is the cause of 85,000 deaths per year. Degrees of this disorder can be mild, moderate or severe, and consequences include liver damage like alcoholic hepatitis, hepatic steatosis, cirrhosis or hepatocellular carcinoma. The prevalence of AUD is steadily increasing in female populations. In women, risks of AUD can manifest as disruptions of hormonal balance leading to reproductive health issues. Alcohol intake can increase estradiol levels in the blood in premenopausal women and postmenopausal women undergoing estrogen therapies [122].

The menopause transition and the symptoms associated with it may lead to changes in behaviors. In terms of alcohol intake, this may appear as going from non-excessive drinking to excessive drinking during menopause [122]. Additionally, stress and depression experienced during menopause may trigger alcohol abuse or worsening abuse [114]. Women who are vulnerable to alcohol's negative impacts may have experiences that are emphasized with age. The relationship between AUD and menopause is intricate and there are mixed findings, but reducing alcohol intake is recommended.

Those who suffer from AUD tend to be more prone to related injuries. Their falls become more frequent and severe due to the onset of osteoporosis [114]. Indeed, lower BMD and increased osteoporotic fractures are observed in postmenopausal women who heavily consumed alcohol compared to postmenopausal women who were light drinkers [122].

Additionally, a study on biochemical markers of bone turnover in postmenopausal women displayed the possibility of moderate alcohol intake lowering this phenomenon [123]. Abstinence from any alcohol consumption leads to increased markers of bone turnover, while consumption reduces turnover markers. The research found no significant association between BMD at the patient's femoral neck or lumbar spine and alcohol consumption. However, moderate consumption does not yet have a standardized, universal definition. The amount of ethanol in drinks varies around the world; therefore, more research is needed to pinpoint how much alcohol is associated with the benefits and consequences of consumption [123].

## Restorative sleep

Sleep is a fundamental biological process that plays a key role in a variety of endocrine, metabolic, cognitive and emotional functions. Sufficient and restorative sleep is critical for the optimal functioning of all body systems, and poor sleep is linked to a broad range of adverse health conditions [124].

Restorative sleep is a term that refers to the quality of sleep that leads to improved daytime function, including alertness, mood, energy and overall well-being [125]. Although the term is frequently used, it remains variably defined and is seldom measured directly in research or clinical practice. The converse, non-restorative sleep (NRS), is characterized by the subjective feeling of being unrefreshed despite adequate sleep duration. While there are no standardized criteria for assessing restorative sleep, NRS is commonly assessed through proxy symptoms within broader sleep quality or insomnia questionnaires. The lack of consistency in definition and measurement of restorative sleep is a limitation in evaluating its impact on health outcomes [124]. While objective measurements such as actigraphy and polysomnography are valuable in research, self-report remains the most consistent and feasible approach for evaluating sleep quality in population studies [126].

Sleep-disordered breathing (SDB), including obstructive sleep apnea, becomes more prevalent after menopause and contributes to sleep fragmentation and poor sleep quality. Although distinct from NRS, SDB can lead to the subjective experience of NRS and shares many downstream health risks.

This section reviews the evidence linking restorative sleep and NRS to cognitive, bone, mental health, metabolic and cardiovascular outcomes in the menopause transition.

### *Cognitive health*

Cognitive complaints are common during menopause, and sleep disruption is increasingly recognized as a contributing factor, particularly through effects on executive function, attention and working memory. Sleep not only consolidates memories from before the sleep episode but also makes the brain more able to form new memories after the sleep episode [127].

Growing evidence indicates that, even in the absence of sleep disorders such as insomnia or obstructive sleep apnea, poor sleep quality is associated with cognitive impairment. In a study of healthy young adults, Tinajero et al. found that higher levels of NRS were associated with poorer performance on executive function tasks, increased fatigue and affective symptoms. These associations persisted after adjusting for age and total sleep duration, emphasizing the importance of sleep quality over quantity [128].

The menopausal transition is frequently accompanied by sleep disturbances and subjective cognitive complaints. A 2022 systematic review reported consistent associations between menopause-related sleep symptoms and reduced cognitive performance [129]. Although the loss of ovarian hormones may directly affect cognitive processes, indirect effects via disruption of sleep–wake cycles and circadian rhythms are also likely [130].

In the 2010 longitudinal data from the Study of Women's Health Across the Nation (SWAN) (involving 1903 midlife women), Greendale et al. demonstrated a transient decline in processing speed during late perimenopause. The learning rate on the Symbol Digit Modalities Test (SDMT) was 1.00 point lower during late perimenopause compared to premenopause ($p = 0.04$), but sleep disturbance did not account for this change in cognition [131].

However, in 2021 a SWAN analysis of 1126 postmenopausal women using actigraphy found that greater wake after sleep onset and sleep fragmentation were associated with slower processing speed. These associations were particularly evident among black women, suggesting potential racial differences in vulnerability [132]. Additionally, a 2018 SWAN analysis found that the cumulative number of visits at which sleep problems were reported predicted poorer cognitive and affective psychological well-being in later life [133].

The WHI study of more than 161,000 postmenopausal women in the USA investigated the link between sleep health and healthy aging. A systematic review of all 23 WHI articles examined sleep as a predictor of health outcomes. The results indicated that both short (≤6 h) and long (≥9 h) sleep duration were associated with a higher risk of cardiovascular disease, mortality and cognitive decline [134].

Data from the Japan Nurses' Health Study ($n = 12{,}507$) showed that 81.7% of women aged 50–54 years reported memory complaints, with 27.9% describing them as severe. Regression analysis indicated that short sleep duration (<6 h) and night-shift work were independently associated with higher prevalence of severe cognitive complaints in women aged 45–54 years [135].

While restorative sleep supports cognitive performance during menopause, sleep disturbances in midlife may also contribute to an elevated risk of later-life dementia [130]. Longitudinal studies reinforce this connection: self-reported short sleep (≤6 h) in midlife is associated with a 22–37% increased risk of incident dementia (hazard ratio (HR) 1.22–1.37), independent of cardiometabolic and mental health confounders [136]. Additionally, sleep fragmentation and reduced sleep efficiency, common in menopausal women, accelerate neuroinflammation and oxidative stress, further promoting neurodegenerative progression [137].

### *Bone health*

Emerging research suggests that poor sleep may increase fracture risk during and after menopause, through both direct effects on bone turnover and indirect pathways such as falls [138]. The SWAN cohort found that women reporting sleep disturbances three or more times per week had a 23% increased risk of any fracture and a 36% increased risk of non-traumatic fracture [138]. These associations were largely attenuated to no significance in the fully adjusted model, suggesting that shared factors – such as inflammation, frailty or comorbidities – may mediate the relationship between sleep and fracture risk. Sleep disturbances have been shown to be associated with a higher risk of recurrent falls in postmenopausal women and thereby fractures since most fractures occur because of a fall [139].

The WHI study found that both short (≤5 h) and long (≥9 h) sleep duration were associated with lower BMD at the total hip and whole body. These reductions were equivalent to approximately 1 year of physiological aging [139].

Other studies corroborate these findings. A 2022 prospective study in Indian postmenopausal women found that poor sleep quality predicted accelerated BMD decline and adverse changes in bone turnover markers over 2 years [140]. In the Netherlands Epidemiology of Obesity (NEO) study, poor sleep quality and later sleep timing – but not sleep duration –were associated with osteopenia and sarcopenia in midlife women, particularly in the premenopausal and perimenopausal group [141].

### *Mental health*

The relationship between sleep and emotional well-being becomes especially important during menopause, when vulnerability to mood disturbances increases. Sleep deprivation is known to heighten emotional reactivity, increase vulnerability to anxiety and depression, and impair social and executive functioning [142].

NRS has emerged as an independent predictor of depressive symptoms. In a cohort of 1196 adults (aged 18–64 years), NRS at baseline was associated with a 2.2-fold increased risk of incident depression over 2–3 years (odds ratio 2.2, 95% CI 1.4–3.5), after adjusting for other insomnia symptoms and comorbid conditions [143].

During the menopause transition, disturbed sleep contributes to depressive symptoms and the relationship is bidirectional. Insomnia and depression may reinforce one another, creating a self-perpetuating cycle [144].

The SWAN found that women with greater sleep disturbances had higher depressive symptom scores. Those who experienced fewer sleep problems over time showed greater improvements in mood [145]. A pooled analysis of longitudinal data from more than 20,000 women from the InterLACE consortium found that sleep disturbance largely accounted for the association between VMS and depressed mood [146].

The findings of the WHI study suggest that the presence of insomnia symptoms increases vulnerability to emotional impairment, even more strongly than that to physical impairment [147].

### *Metabolic health*

Restorative sleep is critical for maintaining metabolic homeostasis. Sleep disruption, including NRS, can affect glucose metabolism and lipid regulation through several biological pathways. Experimental studies in the general population have demonstrated that insufficient or poor-quality sleep contributes to insulin resistance, impaired glucose tolerance, increased sympathetic nervous system activity, elevated cortisol levels and altered appetite-regulating hormones (leptin and ghrelin) [148,149]. These mechanisms may promote central adiposity and contribute to the development of MetS.

Evidence from large population studies supports the association between NRS and metabolic dysfunction. In a Japanese cohort of more than 83,000 adults, NRS was independently associated with incident MetS (HR 1.12, 95% CI 1.08–1.16) and with its individual components, including obesity, hypertension and diabetes [148]. Similarly, longitudinal analyses in the Wisconsin Sleep Cohort found that reductions in restorative slow-wave and REM sleep were associated with progressive BMI gain over time, independent of sleep duration [149].

Among midlife and postmenopausal women, emerging data link poor sleep with adverse metabolic outcomes. In the SWAN, shorter sleep duration was associated with higher BMI cross-sectionally, although no prospective association with weight gain was found [150]. The findings observed in both the SWAN and the CARDIA sleep study indicate that short sleep duration does not contribute to weight gain in midlife [150,151].

The Korean Genomic Rural Cohort reported that midlife women (but not men) sleeping less than 6 h daily had nearly double the risk of MetS compared to those with longer sleep, after adjustment for menopausal status and other covariates [152]. Findings from the Sister Study echoed these patterns, showing that short sleep and insomnia symptoms were positively associated with prevalent MetS. Although still evident postmenopause, this study found stronger associations among premenopausal women. This reflected the findings from SWAN that the sleep–adiposity link may be weaker in midlife adults than in other age groups [153,154].

Further, studies in postmenopausal women have identified links between poor sleep quality and hyperinsulinemia, dyslipidemia and diabetes risk. For instance, poor subjective sleep quality was associated with higher insulin levels and lower HDL cholesterol in a Turkish postmenopausal cohort, while the WHI reported that both short sleep and SDB were associated with increased risk of treated diabetes over long-term follow-up [155–157].

Collectively, these findings suggest that non-restorative and disrupted sleep may contribute to adverse metabolic outcomes during the menopausal transition.

### *Cardiovascular health*

Sleep is now recognized as a key pillar of cardiovascular health, reflecting its importance in blood pressure regulation, autonomic function, heart rate variability, vascular function and metabolic processes [158–161]. NRS and disrupted sleep architecture may contribute to cardiovascular disease risk through pathways including sympathetic nervous system activation, elevated cortisol levels, systemic inflammation and endothelial dysfunction [158,161,162]. The American Heart Association's inclusion of sleep as one of 'Life's Essential 8' underlines its importance in cardiovascular health alongside diet and physical activity [163].

Evidence from the WHI links both short (≤6 h) and long (≥9 h) sleep duration, as well as poor sleep quality and insomnia symptoms, with elevated risk of coronary heart disease, stroke and cardiovascular mortality in postmenopausal women [134]. However, associations weakened after adjustment for conventional risk factors, suggesting that poor sleep

may act alongside other health and lifestyle variables to elevate cardiovascular risk.

Sleep disturbance may also influence subclinical atherosclerosis. In the SWAN, subjective sleep complaints were associated with greater aortic calcification, although not coronary artery calcification, suggesting early vascular effects of poor sleep in midlife women [164]. Similarly, poor sleep quality and insomnia symptoms have been associated with cardiovascular risk, independent of other factors [134].

SDB has been independently linked to increased risk of hypertension, heart failure and atherosclerosis [165–167].

Non-pharmacological strategies for optimizing sleep and achieving restorative sleep include strategies commonly referred to as sleep hygiene, such as maintaining a consistent sleep schedule, optimizing sleep environment to be cool, dark and quiet, avoiding stimulating activities before bed, limiting screen time and blue light exposure, engaging in regular physical activity during the day, limiting or avoiding caffeine and alcohol before bedtime, mindful eating and drinking habits (avoiding large meals and reducing fluid intake in the evening), and avoiding late afternoon naps. Cognitive Behavioral Therapy for Insomnia (CBT-I) is a structured, multicomponent treatment program that is effective, first line, for menopausal women with persistent sleep disturbance, with or without concurrent VMS [168].

## Healthy relationships

Healthy relationships, also referred to as social connection, are a key factor in healthy aging. Studies have consistently shown that higher levels of social support and engagement are associated with positive health benefits in middle-aged and older adults. These benefits include improved control of chronic medical conditions [169,170], decreased risk of coronary heart disease [171], diabetes [172] and osteoporosis [173], and lower overall risk of mortality [169,174–177]. One large prospective cohort study of women specifically showed that social integration was correlated with increased longevity [178]. In addition, research across diverse populations has demonstrated that strong social supports mitigate VMS related to menopause and improve overall quality of life [177–186].

In contrast, loneliness and social isolation are strongly associated with negative health outcomes. Older adults who lack social connections or who experience social stress have an increased risk of stroke [187], cardiovascular disease [188,189], MetS [190,191], multiple chronic medical conditions [192], disability [193], lower BMD [194] and higher all-cause mortality [195–198]. Collectively, this body of research underscores the importance of fostering and maintaining strong social connections as a critical determinant of health and well-being among menopausal women.

The quality of social relationships also plays a vital role. For instance, a prospective cohort study of Korean women found that the risk of osteoporosis is decreased in women who have large, intimate social support groups, whereas having a large, but less intimate, social network was associated with an increased risk of osteoporosis [173]. Similarly, two other studies of older adults found that having close friendships was significantly correlated with decreased mortality risk [199,200].

The mechanisms through which social connection improves long-term health is multifaceted. Studies show that social isolation is linked to diminished activity in older adults [201], while higher levels of perceived social support are linked to a higher objective physical activity level [202]. In a Canadian population, social isolation was tied to lower intake of healthy foods [203]. Social connectedness may also improve health and well-being by mitigating the risk of depression and anxiety. Large cohort and cross-sectional studies have shown that higher levels of social supports, and in particular positive romantic partnerships, are inversely associated with depressive symptoms in middle-aged and older adults [204–210]. Moreover, a review of studies in perimenopausal women illustrated the protective role of social support against depression and anxiety [211]. Thus, social connectedness may improve health by increasing positive health behaviors such as physical activity and healthy eating and by decreasing the risk of psychiatric comorbidities like depression and anxiety.

Intimate partner relationships, particularly heterosexual marital relationships, have been extensively studied in the context of menopause. Research has demonstrated that marital harmony and satisfaction with partner relationships is correlated with less severe menopausal symptoms [212–214] and improved health [199,200,212,215]. Spouses also seem to play an important role in women's quality of life and experience of menopause [216], and interventions aimed at educating partners of menopausal women may improve both relationship quality and well-being [217–219].

As demonstrated, a robust body of evidence highlights the critical role of social connection in promoting healthy aging. For menopausal women, maintaining strong social support networks and nurturing healthy marital relationships can enhance quality of life, lower the risk of metabolic and cardiovascular disease, reduce the risk of osteoporosis and reduce the risk of mortality.

## Premature ovarian insufficiency

Premature ovarian insufficiency (POI) is characterized by a decline in ovarian function prior to the age of 40 years. This decline leads to low estrogen levels, which in turn cause disordered menstrual cycles with or without other symptoms of hypoestrogenism. POI is diagnosed when a woman experiences oligomenorrhea or amenorrhea for at least 4 months with evidence of elevated gonadotropins or a follicle stimulating hormone (FSH) level >25 IU [220]. Although POI is often used interchangeably with the term early menopause (EM), the two terms are in fact distinct. Recent guidelines define EM as the complete cessation of ovarian function, characterized by amenorrhea lasting more than 1 year, between the ages of 40–45 years [220]. This differs from POI, as women with POI may experience intermittent production of ovarian hormones and sporadic ovulation. POI can be idiopathic or iatrogenic, as discussed in the following. Lifestyle

medicine approaches as discussed through this article are important for those with or at risk of POI in order to delay or mitigate uncomfortable symptoms and the long-term consequences of this condition.

Recent studies suggest that the global prevalence of POI is significantly higher than previously estimated. In a meta-analysis by Golezar et al., the global prevalence of POI was estimated to be about 4%, which is greater than prior estimates of roughly 1% [221,222]. When combined with rates of EM, the total prevalence of conditions leading to early loss of ovarian function increases to about 12.2% [223]. While these global estimates help define the scope of the disease, it is important to note that the prevalence of POI and EM varies significantly across countries and ethnic groups [223,224].

There are several mechanisms that underlie the development of POI, but most frequently the etiology is unknown or idiopathic. In other cases, the causes can be categorized into two groups: iatrogenic and non-iatrogenic causes. Iatrogenic or acquired POI occurs when medical treatments damage the ovaries or disrupt ovarian function. This commonly occurs as a result of chemotherapy, radiation or surgery. Conversely, non-iatrogenic etiologies include inherited syndromes, systemic diseases or environmental exposures. X-linked or autosomal genetic disorders, such as Turner syndrome or Fragile X syndrome, are the most common inherited causes of POI. As such, women with POI are recommended to undergo genetic testing at the time of diagnosis. Even outside these known inherited disorders, it is hypothesized that genetics may play an important role in idiopathic POI. In a study by Vegetti et al., the researchers found that 4–30% of women with idiopathic POI had a family history of POI or EM [225]. For those individuals without a clear heritable syndrome, systemic conditions such as infectious, autoimmune and metabolic diseases should be ruled out as these conditions can also lead to POI. Lastly, there is also evidence that exposures such as cigarette smoke increase the risk of POI and EM [226,227].

Early diagnosis of POI is crucial due to its significant impacts on cardiometabolic, bone, neurologic, psychiatric and reproductive health. Evidence suggests that women with POI and those who undergo EM are at increased risk of developing chronic health conditions and multimorbidity compared to women who undergo menopause at a later age [228]. In fact, untreated POI and EM have been associated with higher mortality rates in several studies, highlighting the importance of recognizing this condition [229,230].

The increased risk of cardiometabolic disease is among the most serious health concerns and plays a major role in the increased morbidity and mortality seen within the population of women with POI. Several studies have demonstrated that women with POI are at increased risk of cardiovascular and cerebrovascular disease [230–234]. In a large review of observational studies, women who underwent natural or surgical menopause before the age of 40 years had a significantly increased risk of cardiovascular diseases [232]. This increased cardiovascular risk is likely explained in part by the metabolic changes observed in women with hypoestrogenism as seen in EM and POI, including increased risk of dyslipidemia, insulin resistance and central adiposity [235,236].

In addition to increased visceral adiposity, other changes in body composition have been observed in women with POI including decreased lean mass and altered bone health [237]. In studies comparing women with POI to those who experience menopause later in life, POI was associated with a higher incidence of low BMD and increased risk of osteoporosis [238].

Lastly, POI can affect several other aspects of women's well-being beyond reproductive and cardiometabolic health, including neurologic and psychiatric health, as well as general quality of life. Similar to women with menopause, women with POI can experience bothersome symptoms of low estrogen levels, including VMS, fatigue, urogenital discomfort, mood changes and disordered sleep. Prior research has demonstrated that POI can impact cognition and may be associated with an increased risk of dementia and Parkinson's disease [239–241]. In addition to these findings, POI can have a profound impact on women's mental health. Studies show that POI is associated with high levels of depression, anxiety and stress [242–244]. In particular, infertility and reproductive concerns are frequently sources of psychological distress within this population [245]. POI is associated with difficulty conceiving due to the low number of oocytes, leading to lower rates of ovulation.

Given the many health consequences, women with POI should receive comprehensive holistic care that addresses both the psychological and physiological risks of the condition. Establishing healthy lifestyle habits is critical to improving overall well-being and minimizing the health risks associated with this condition. The 2025 European Society of Human Reproduction and Embryology (ESHRE), American Society for Reproductive Medicine (ASRM), Centre for Research Excellence in Women's Health in Reproductive Life (CREWHIRL) and IMS Guidelines recommend that women with POI follow a heart-healthy diet, exercise regularly, maintain a normal body weight and avoid smoking to lower their cardiometabolic risk [220]. Additionally, regular exercise, specifically weight-bearing and resistance training, helps prevent muscle loss and optimize bone health, both key concerns in women with POI. The guidelines also suggest supplementation with calcium and vitamin D for women with POI who have low vitamin D, insufficient dietary calcium intake or evidence of low BMD. While the evidence behind these lifestyle interventions is limited in the specific POI population, there is sufficient evidence to support behavioral interventions as a means of improving outcomes in women who undergo menopause at a later age. As a result, it is reasonable to infer that these interventions may also benefit women with POI, but more targeted research is still needed [246].

## Conclusion

Menopause marks a significant physiological transition with far-reaching implications for women's long-term health and well-being. While not a disease, the menopausal transition can be accompanied by symptoms and health risks that warrant

personalized and holistic approaches to care. This White Paper has highlighted the growing body of evidence supporting lifestyle medicine as a foundational, non-pharmacological strategy to improve menopausal symptomatology, reduce chronic disease risk and enhance quality of life. By embracing the six pillars of lifestyle medicine – healthy eating, physical activity, mental well-being, avoidance of risky substances, restorative sleep and healthy relationships – women can be empowered to navigate menopause with resilience, autonomy and vitality. A biopsychosocial, evidence-based model of care not only honors the diversity of women's experiences but also promotes health equity and shared decision-making across the life course.

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