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REVIEW ARTICLE

Menopause and Weight Gain

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Abstract

The burden of obesity in menopausal women is on the rise, and addressing this issue is crucial for public health. Weight gain during menopause is a gradual process primarily attributed to chronological aging and changes in body composition due to the cessation of ovarian function. It is associated with adverse metabolic and psychological effects, making it a significant public health concern. The factors contributing to weight gain during menopause are hormonal shifts, aging, sleep deprivation, disturbances in circadian rhythms, vitamin D deficiency and various lifestyle factors, including physical inactivity and dietary habits. This increased weight, particularly when accompanied by abdominal fat, elevates the likelihood of type II diabetes, metabolic syndrome, heart disease and stroke. Moreover, postmenopausal obesity independently increases the risk of various cancers and systemic health complications. Addressing menopausal weight gain necessitates a holistic approach, including hormone replacement therapy, diet, exercise tailored to individual needs and behavioural support.

Keywords: Menopause, Weight, Estrogen, Obesity, Hormones.

Introduction

Natural menopause is characterized as the permanent discontinuation of menstrual cycles resulting from the decline in ovarian follicular activity. Moreover, natural menopause is recognized to have transpired after an uninterrupted span of 12 months marked by amenorrhea, wherein no discernible underlying pathological or physiological causes can be identified (WHO, 1996). Conversely, induced menopause is defined as the termination of menstrual cycle following specific interventions such as the surgical removal of both ovaries (i.e., oophorectomy) or the deliberate suppression of ovarian function through medical procedures like chemotherapy or irradiation (Ambikairajah *et al.,* 2022).

The menopausal transition denotes the period of perimenopause preceding the final menstrual period. It signifies a transitional phase from reproductive cycles characterized by fertility and well-defined hormonal patterns to the postmenopausal stage characterized by diminished levels of estrogen and progesterone, alongside elevated levels of gonadotrophins, specifically leutotrophin or luteinizing hormone (LH) and follicle-stimulating hormone (FSH) (Sherman, 2005; Bruce and Rymer, 2009).

The term 'perimenopause' is defined as commencing when the initial clinical indicators of impending menopause manifest, with the most prevalent sign being the onset of menstrual cycle irregularities. Perimenopause concludes one year after the occurrence of the last menstruation (Fig. 1). Within the context of perimenopause, the term 'menopause transition' refers to the phase that precedes the final menstrual period, characterized primarily by irregularities in the menstrual cycle (Sherman, 2005). The term 'postmenopause' is formally defined as the period commencing from the occurrence of the final menstrual period (FMP), irrespective of whether menopause arises from natural biological processes or is induced by external factors. The designation 'premenopause' encompasses the entirety of the reproductive phase leading up to the FMP. The concept of 'climacteric' encompasses not only the transitional phase but also the indeterminate span following the FMP. The etymology of the term 'climacteric' derives from the Latin word 'climactericus,' signifying a precarious or critical phase in the course of life that encompasses perimenopause but extends over a variable and extended period both preceding and succeeding perimenopause. It serves as the demarcation of the transition from the reproductive state to the non-reproductive state (Ambikairajah *et al.*, 2022).

Women experiencing consistent menstrual cycles are categorized as pre-menopausal individuals, also denoted as women prior to the menopausal transition (PTMT). The average age at which Indian women

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typically reach menopause stands at 46.2 years, a figure notably lower than that observed in their Western counterparts, who typically experience menopause around the age of 51 years. It is worth noting that there exists a correlation between the onset of menopause and various socio-economic factors, including social and economic status, marital status, and the number of pregnancies (Ahuja, 2016).

Menopause constitutes a pivotal juncture in life of a woman, marked by a series of notable physiological and psychological transformations. A notable among these changes is the propensity for increased body mass and alterations in the distribution of fatty tissue, heightening the susceptibility to menopausal symptoms and metabolic disorders, as elucidated by Chopra *et al*. (2021) and Ambikairajah *et al*. (2022). Furthermore, the intensity of menopausal symptoms is notably heightened in individuals classified as obese when contrasted with their non-obese counterparts. Remarkably, evidence suggests that clinically significant weight loss yields marked improvements in these symptoms, particularly with regard to hot flashes, mood disturbances (Chopra *et al*. 2021).

Moreover, the majority of weight gain during menopause tends to manifest in the peri-abdominal region, leading to an observable rise in the incidence of cardiovascular disease. This cardiovascular disease pattern becomes increasingly akin to that seen in older men, despite its lower prevalence among women at younger ages (Fenton, 2021; Ambikairajah *et al*. 2022).

This comprehensive review aims to summarize the existing knowledge concerning alterations in weight, body shape, and body composition during the menopausal phase and its impact on women in perimenopausal age group. For this, we conducted a thorough search across electronic databases, including NLM/PubMed, Google Scholar, Wiley Online Library, and Ministry of Health and Family Welfare survey reports, utilizing various keywords such as obesity, weight gain, menopause, post-menopause, middle-aged women, and hormones. The inclusion criteria comprised studies from 2003 onward to ensure the incorporation of the most recent evidence on the subject.

Burden of Obesity in Menopausal Women

Global obesity, commonly referred to as 'Globesity,' constitutes a significant and escalating public health concern in both developed and developing nations, exhibiting a pronounced upward trend over the last four decades. Obesity has garnered recognition as a global epidemic of the twenty-first century. It represents a severe, multifaceted, and persistent medical condition with substantial adverse effects on individual well-being and overall quality of life, while also imposing a substantial societal burden (Khandelwal, 2020).

The issue of obesity is experiencing a worrisome surge, with a notably higher prevalence among women compared to men. This discernible gender gap can primarily be ascribed to variations in age-specific reproductive phases, encompassing gestation, lactation, and menopause, which are exclusive to the female population. The notable rise in the prevalence of obesity among women in their middle age aligns with the commencement of the menopausal stage (Table 1).

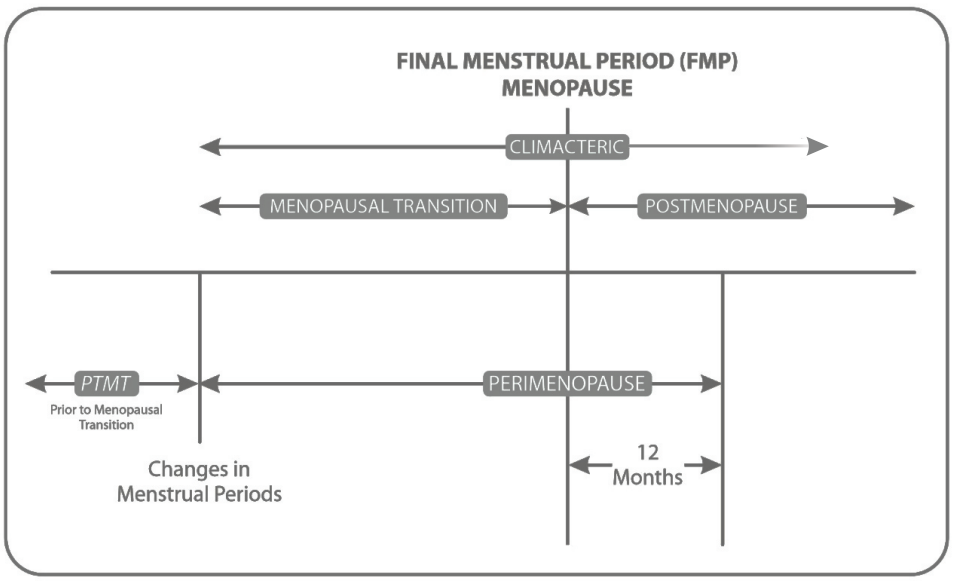

Fig. 1. Diagrammatic representation of terminology used in describing menopause stages

Table 1. Prevalence of Obesity in peri and postmenopausal women

Study	Study Design	Results
International Institute for Population Sciences and ICF, 2021	NFHS-5 (2019-21), Nation based study (India)	Overall rates of central obesity of 40% noted among women across the 22 states and union territories examined, with 56.7% of women in the age group of 40–49 years.
National Center for Health Statistics (US), 2019.	NCHS, 2018 Nation based study (US)	Rates of overweight and obesity were high with age for women 20 years and older, with 70% of women of perimenopausal age with overweight or obesity. The incidence reached a peak of 76% then declined after the age of 75 years.
Zhu *et al*., 2018	Pooled analysis of 11 international studies	39% of women in perimenopausal phase were categorized as overweight or obese.
International Institute for Population Sciences and ICF, 2017	NFHS-4 (2015-16), Nation based study (India)	The proportion of women classified as overweight or obese increased from a meagre 4 per cent in early years to a substantial 34 per cent in the midlife and old age.
North American Menopause Society and Nams, 2014	Population Based study (US)	Nearly two-thirds of women aged 40 to 59 years and about three-fourths of women 60 years and older were overweight of which almost half were obese in the United States.
Flegel *et al.,* 2010	Analysis of National Health and Nutrition Examination Survey (NHANES- 2008)	The incidence of obesity in the United States among women between 40 and 65 years was calculated as 65%, and among women over the age of 65 as almost 74%.
Sowers *et al.,* 2007	SWAN (Study of Women's Health Across the Nation), A 6-year longitudinal study (Michigan)	A 6% increase in waist circumference with 10% increase in body fat with a 1% decrease in skeletal muscle mass around the final menstrual period.

It is anticipated that by the year 2026, around 401 million Indian women who are in the perimenopausal stage will face an increased susceptibility to developing menopause induced obesity. At this stage, women who are obese confront the dual challenge of enduring menopausal symptoms while contending with the metabolic complications associated with adiposity throughout their remaining life. The weight gain experienced during this phase can, in part, be attributed to middle-aged women's limited awareness of their own health concerning problems, often prioritizing the well-being of other members of the family over their own. Given the substantial numbers of menopausal women affected and the resulting impact on the overall years of healthy living lost to obesity and its associated implications, this problem becomes a matter of significant public health concern (Chopra *et al*., 2021).

Weight Gain at Menopause

Experiencing weight gain is a prevalent occurrence among women during the perimenopausal and postmenopausal phases. A substantial majority, approximately two-thirds, of women aged between 40 and 59 years have a body mass index (BMI) exceeding 25 kg/m2, as indicated by Kapoor *et al*. in 2017. On average, within a span of over 5 years, women in this age bracket tend to gain approximately 2.1 ± 5.1 kg of weight. Other research studies have proposed an even higher weight gain of around 4.0 ± 4.6 kg during a similar timeframe.

A well-established characteristic of the menopausal transition is the progressive year-on-year weight gain, which has the potential to substantially elevate the prevalence of overweight and obesity. Concurrently, there are quantitatively smaller but nevertheless noteworthy reductions in lean tissues, primarily involving bone and muscle (Simpson *et al*. in 2022).

On average, women typically experience an annual weight gain of approximately 0.5 to 0.7 kg during the midlife period (50-60 years of age). This weight gain is observed regardless of their original body size or racial/ethnic background (Davis *et al.,* 2012; Kapoor *et*

al., 2017). Existing evidence predominantly suggests that alterations in weight are a consequence of chronological aging rather than solely attributable to the menopause itself, whereas shifts in body composition and fat distribution are primarily linked to the cessation of ovarian function. Furthermore, weight gain and an elevated body mass index (BMI) during the menopausal transition have been associated with heightened levels of anxiety, depression, and diminished life satisfaction (Naser *et al*., 2022).

Postmenopausal women undergo significant alterations in their body fat distribution, exhibiting a pronounced inclination toward central fat deposition, often characterized as an android pattern. This contrast is particularly noticeable when compared to premenopausal women of similar age and BMI, who typically have fat concentrated in the lower body (gynoid obesity). These changes not only cause physical discomfort and body image concerns but also elevate the risk of experiencing cardiovascular events, type 2 diabetes mellitus (T2DM), and metabolic disruptions (Kapoor *et al*., 2017). The development of obesity during the menopausal period seems to be a complex process influenced by a combination of both modifiable and non-modifiable factors.

Factors Contributing to Weight Gain At Menopause

Hormonal shift

Female sex hormones play a crucial role in women's health throughout their entire life span. However, during the transition into menopause, substantial hormonal changes occur due to the degeneration of the ovaries. These hormonal shifts are characterized by a notable increase in serum follicle-stimulating hormone (FSH) levels and a rapid decline in estradiol levels. These changes coincide with the accretion of adipose tissue and a fall in bone density (Liu *et al.,* 2023).

In the premenopausal phase, estrogen is primarily secreted by the ovaries, and its level fluctuates between 40 and 400 pg/mL through the different phases of menstrual cycle. Post-menopause, these levels plummet to less than 20 pg/mL, as the estrogen production is stopped by the ovaries (Khoudary *et al*., 2019, Taylor *et al*., 2019). The decline in estrogen levels contributes to a fall in lean body mass and accumulation of fat, predominantly in central body areas (Kodoth *et al*.,2022). Table 2 is a collection of some research works carried out to increase the understanding on role of hormones in bringing about the changes in weight and body composition of women in midlife.

The progressive fall in ovarian follicular reserves, a characteristic feature of menopausal transition leads to a reduction in estrogen production, accompanied by a proportionate rise in androgen levels. Such hormonal disproportions disrupt the regulation of energy homeostasis, particularly in terms of hunger and satiety signals. Estrogen ordinarily exerts an inhibitory effect on hunger indicators, thus mitigating the propensity for excessive caloric intake. It is suggested that hormonal fluctuations during menopause may reduce estrogen's ability to control hunger-related hormones. Consequently, menopausal women may experience heightened hunger signals, which in turn promote increased food intake, ultimately contributing to weight gain (Chopra *et al*., 2021).

It has been established through studies done on animals that a deficiency in estrogen is linked to temporarily increased appetite (hyperphagia) and reduced impulsive physical activities, like fidgeting (Proietto, 2017). Such alterations were reverted by the administration of estrogen replacement therapy (Stubbins *et al*., 2012; Fenton, 2021). Empirical evidence from human studies has corroborated a noteworthy decline in impulsive physical activity, but no significant alteration in energy consumption has been observed (Gavin *et al*., 2018). Over the menopausal transition, there is a substantial increase in waist circumference, a trend that holds true across various ethnic groups. The reduction in estradiol levels, which appears to be a pivotal initiator for these changes, also has implications for resting and total energy expenditure. Investigations exploring the impact of ovarian ablation through the use of a GnRH (Gonadotropin-releasing hormone) antagonist have revealed that rectifying the resultant estrogen deficiency preserves lean body mass and basal metabolic rate, thereby preventing the deposition of visceral and abdominal subcutaneous fat. It is noteworthy that women receiving estrogen supplementation also exhibited a higher level of physical activity compared to those experiencing estrogen deficiency (Gavin *et al*., 2018; Fenton, 2021).

Decline in physical activity and age factor

Chronological aging stands out as a prominent non-modifiable factor associated with weight gain. Literature has provided substantial evidence that perimenopausal women typically exhibit a yearly weight gain of around one pound. However, the extent of weight accretion varies considerably, with approximately 20% of females experiencing an increase of 10 pounds or more during this transitional phase. Although a conclusive correlation between alterations in hormonal status and the increase in body weight remains elusive, it appears to

Table 2. Hormonal regulation of weight gain at menopause

Study	Study Design	Major findings
Liu *et al.,* 2023	1329 Chinese women of 35 -60 years of age	• Elevated serum FSH and LH level at menopause were associated with an increased Fat Mass Index (FMI) but a decreased Fat Free Mass Index (FFMI) in menopausal women
Veldhuis-Vlug *et al.,* 2021	238 postmenopausal women and 245 men participating in AGES-Reykjavik Longitudinal Study, Iceland	• Older postmenopausal women with higher FSH levels had higher bone marrow adiposity, but lower bone mineral density and lower fat and lean mass, independent of estradiol and testosterone levels
Khoudary *et al.,* 2019	9-year-long Melbourne Women's Midlife Health Project with 438 native Australian women with 45–55 years of age	• A strong association between CVD risk because of obesity • Increased FSH levels and depressed estradiol amongst selected population
Cui *et al.,* 2018	Ovariectomized mice	• After ovariectomy, levels of estrogen and FSH varied and an increase in lipid deposition and feed consumption occurred
Rebouças *et al.,* 2016	Ovariectomized rats	• Estradiol affected food intake and, consequently, body weight gain. • Ovariectomy induced an increase in neuropeptide Y (NPY) expression, an appetite stimulating peptide
Liu *et al.,* 2015	Ovariectomized rats	• FSH receptor signalling could raise adipocyte lipid generation and leptin levels and reduce adiponectin thus promoted fat accumulation
Nestor *et al.,* 2014	Ovariectomized rats	• Estrogens were involved in central regulation of energy balance, and act on the CNS to reduce appetite by controlling activity of ghrelin – an appetite stimulator derived mainly from the stomach
Nakamura *et al.,* 2014	69 women undergoing menopausal transition	• Statistically significant changes in adipokines and inflammatory markers associated with alterations in abdominal fat • A greater increase in visceral adiposity, contributing to an unfavorable metabolic profile in postmenopausal women
Stubbins *et al.,* 2012	Male and female mice	• Oophorectomy of mice resulted in obesity, inflammation of fatty cells, and onset of hepatic steatosis • Supplementation with estradiol effectively shielded the animals from oxidative stress, fatty liver and insulin resistance
Sutton-Tyrrell *et al.,* 2010	3302 women (42 –52 years), undergoing menopausal transition (SWAN-US)	• Menopause was asociated with increase in FSH and reduction in circulating estradiol with maintained levels of androgen leading to adipose tissue accumulation in the abdominal area • There was also an increase in total visceral adipose tissue

exhibit a strong connection with the advancing age and decreased energy expenditure Increasing the physical activity among post-menopausal women who had a sedentary lifestyle has shown promise in reducing adiposity and lowering the risk of breast cancer for some individuals. In women maintaining a normal weight status, the peri-to-postmenopausal period offers opportunities for mitigating weight gain through heightened physical activity and sustained dietary adjustments (Knight *et al*., 2021).

However, it is important to note that body changes appear to be predominantly influenced by menopausal status rather than solely by the aging process. In a comprehensive panel study conducted at Michigan as a part of SWAN (Study of Women's Health Across the Nation), involving more than 500 pre or perimenopausal women, notable findings included a 1 per cent fall in muscle mass with a concomitant increase of 6 per cent and 10 per cent in waist circumference and fat mass respectively over a six-year time-frame surrounding the final menses. Significantly, these results retained their statistical significance even after accounting for chronological age (Sowers *et al*., 2007). Lifestyle factors, considered to be modifiable risk factors contributing to the onset of obesity among women beyond their reproductive years, are closely tied to a lack of sufficient physical activity (Dubnov *et al*., 2003).

In a specific study involving 6079 Latin American females aged between 40 and 59 years, noteworthy findings emerged. Sedentary women, defined as those engaging in physical activity for less than three 30-minute sessions per week, exhibited a higher mean waist circumference and a greater prevalence of obesity compared to their non-sedentary counterparts. Furthermore, sedentary women, experienced intense menopausal symptoms, including hot flushes, insomnia, mental issues, sexual and urogenital issues, as assessed by their scores on the menopause rating scale (Blumel *et al*., 2016).

In a cross-sectional investigation examining interaction between menopausal stage and physical activity concerning fat distribution and body composition, it was noted that high-intensity activities, were generally linked to a thinner waist and decreased proportion of body fat. However, these associations were further influenced by factors such as education and perceived health (Sternfeld *et al*., 2005).

Sleep deprivation

Disturbances in circadian rhythms, sleep deficiency and irregular meal timings can also be significant contributors to weight gain (Davis *et al.,* 2012). Factors specific to menopause, along with stress, emotional elements, societal realities, cultural influences, lifestyle shifts, aging, and concurrent health conditions, can all play role in causing sleep disturbances (Society for Women's Health Research, 2017). Sleep can have a direct impact on the immune-metabolic processes and interact with other factors that contribute to immune metabolic dysfunction. Sleep problems associated with menopause may influence eating patterns, regulation of appetite and meal timings. Disruption in sleep owing to menopause is also intertwined with control of impulses, temper, thermoregulatory sensitivities and various elements associated with the body's ability to adapt metabolically in coping with nutritional stress. Reduced sleep and sleep disruptions have been linked to the deposition of visceral fat, as demonstrated in a research involving middle-aged women (Kravitz *et al*., 2018). Circadian timing plays a pivotal role in regulating numerous biological activities like sleep proclivity, appetite and eating patterns, hormone cycles, as well as the rhythmicity of carbohydrate and fat metabolism. Age-linked alterations in circadian rhythm and sleep may contribute to and interact with variations in total energy expenditure, resting energy expenditure, physical activity, nutrient intake and ultimately, conditions like sarcopenia and increased body fat (Fung *et al*., 2016).

Sleep disruption is also linked to weight increase among middle-aged women. Potential factors contributing to sleep disturbances in this demographic include night sweats, mood swings, sleep apnea, and the direct impact of decreased oestrogen levels. Prolonged sleep deficiency can cause heightened lethargy during the day and reduced physical activity. In a study involving over 68,000 women, it was observed that those who slept for 5 hours or less experienced greater weight gain compared to those who consistently slept for more than 7 hours each night (Patel *et al*., 2006; Kapoor *et al*., 2017). Restricted sleep may result in daytime fatigue, subsequently leading to decreased physical activity levels. Additionally, experimental research suggests that sleep deprivation can alter serum leptin and ghrelin levels, ultimately increasing hunger and appetite, thus causing obesity (Spiegel *et al*., 2004).

Vitamin D deficiency

The issue of vitamin D deficiency is highly prevalent during menopause. Menopausal women experience various issues contributing to vitamin D deficiency, including diminished skin thickness and a reduced ability to synthesize this vitamin. Additionally, there is a

fall in the absorption from gut and a decrease in the conversion of vitamin D into its active form in the liver and kidneys during this period (Patriota et al., 2022).

In a study, which employed a cross-sectional design, a group of 78 postmenopausal women from Granada, aged between 44 and 76 years were examined by Vázquez-Lorente *et al.* (2020). The findings indicated a notable incidence of vitamin D which generally correlated with body mass index, over-all fatness as well as other anthropometric parameters like hip and arm circumference (Vázquez-Lorente *et al.,* 2020).

Vitamin D levels, measured as circulating plasma 25(OH)D, display an inverse relationship with markers of adiposity. It has been postulated that vitamin D, being a fat-soluble vitamin, could be sequestered within adipose tissue depots, resulting in reduced bioavailability in individuals with obesity. This hypothesis has been supported by studies involving both humans and animal models that received high doses of oral vitamin D (Migliaccio *et al*., 2019).

Other factors influencing weight gain in midlife

Obesity is influenced by a complex interplay of hereditary, demographic, social, and behavioral factors. On a global scale, there is an inverse relationship between obesity in women and indicators of lower education and rural living. In the context of midlife women, several other factors have been identified as significant predictors of obesity, including low physical activity levels, parity (number of children), a family history of obesity, and marrying at a younger age. Additionally, a range of dietary habits and behaviors, such as skipping breakfast, frequent snacking, irregular meal patterns, dining out, the eating of high-energy ultra-processed foods, adherence to a low-fiber Western diet, excessive intake of sugar-sweetened beverages, frequent consumption of take-away foods, huge portion sizes, eating until full, emotional eating, as well as the presence of depression and anxiety, have also been connected with a higher chance developing obesity (Khandelwal, 2020).

Consequences of menopausal weight gain

The detrimental consequences of obesity in midlife extend beyond concerns related to body image and have significant implications for the overall health of women in this age group (Chopra *et al*., 2021). The process of aging in women is characterized by a gradual decrease in the concentrations of several hormones like dehydroepiandrosterone (DHEA) or prasterone, estrogen, and growth hormone-insulin-like growth factor I (GH-IGF-I). These hormonal fluctuations can contribute to changes in body composition and weight gain. Postmenopausal adiposity is often accompanied with a range of metabolic disruptions, ultimately leading to an increased risk of mortality (Naser *et al*., 2021).

Menopause is linked to a reconfiguration of body weight as well as increase in weight in a significant proportion of women, which largely contributes to the heightened prevalence of metabolic syndrome. Several cross-sectional studies have consistently demonstrated an elevated risk of metabolic syndrome in postmenopausal women, ranging from 32.6% to 41.5% (Chedraui *et al*., 2007). The unfavorable metabolic alterations associated with obesity during midlife substantially amplify the risk of cardiovascular disease (CVD) and stroke by a factor of three, elevate the likelihood of death from CVD by a factor of four, and surge the chance of type II diabetes mellitus by a factor of five. Remarkably, a modest reduction in weight, typically within the range of 5% to 10%, proves sufficient to ameliorate many of these metabolic irregularities (Khandelwal, 2020).

The chances of developing metabolic syndrome are exacerbated by the distribution of fat around the abdomen. Fat surrounding the visceral organs functions as an active metabolical tissue, generating inflammatory markers such as tumor necrosis factor-alpha (TNF-α), leptin, interleukin (IL)-1 and IL-6 which play a regulatory role in metabolic processes. Moreover, research indicates a positive correlation between elevated abdominal fat and conditions like insulin resistance, high blood pressure and an atherogenic blood lipid profile—well-known hazards for cardiovascular diseases (Chopra *et al*., 2019; Fenton, 2021).

A nine-year-long longitudinal observational investigation involving a cohort of 438 indigenous Australian women, aged 45 to 55 at the study's commencement, revealed robust connections between cardiovascular disease (CVD) risk due to obesity and elevated FSH levels, as well as reduced estradiol (E2) levels during the menopausal transition (Jung *et al*., 2015).

In an investigation involving 200 women residing in Amritsar, India, the presence of metabolic syndrome was identified in 16% premenopausal women compared to 42% postmenopausal women exhibiting this condition. Notably, waist circumference exceeded normal thresholds in 64% of postmenopausal women, a substantially higher proportion compared to the younger cohort where only 20% exceeded the threshold. Additionally, both systolic and diastolic blood pressure levels and the serum triglyceride levels were

considerably higher and serum high-density lipoprotein (HDL) levels were notably lower in the postmenopausal group. The strongest association with metabolic syndrome was observed for low high-density lipoprotein levels, followed closely by elevated waist circumference (Mehndiratta *et al*., 2020).

In menopausal women, an elevated BMI serves as an autonomous risk factor for the development of cancers of endometrium, uterus and breast. Obese postmenopausal women experience prolonged exposure to estrogen, primarily stemming from the ongoing production of this hormone by fat tissues. An unmitigated exposure to estrogen is a significant contributor to the heightened cancer risk observed in this population. Additionally, increased adiposity independently elevates the risk of systemic complications, including respiratory issues, obstructive sleep apnea, chronic liver conditions, chronic kidney disease and sexual dysfunction, in comparison to their counterparts with healthier body weights.

In midlife women, the connection between sleep and immune-metabolic changes appears to be more pronounced compared to men. Existing evidence indicates the presence of a noteworthy bidirectional relationship, whereby sleep-wake cycles exert impact over gonadotropins and steroids released from ovaries, while these hormones, in turn, impact sleep-wake patterns. The substantial variations in ovarian hormones and gonadotropins that occur during the transition to menopause are likely to play a role in the mechanisms contributing to sleep disruptions and disorders associated with menopause, thereby increasing associated risks. Estrogens are known to enhance energy expenditure and reduce food consumption, and the depletion of ovarian estrogen during menopause constricts the range of metabolic adaptability. Notably, hormone replacement therapy appears to have a positive impact on sleep health and promotes metabolic health (Kravitz et al., 2018).

Following menopause, women undergo alterations in their serum lipid profiles, marked by an increase in triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), along with a reduction in high-density lipoprotein cholesterol (HDL-C). Specifically, it is noteworthy that the prevalence of elevated LDL-C levels is more than sixfold higher among women in their 50s compared to those in their 30s. These dyslipidemic changes significantly elevate the risk of atherosclerosis and cardiovascular diseases. In fact, women with HDL-C levels below 50 mg/dL face a 30% heightened risk of cardiovascular disease-related mortality, while those with TC levels ranging from 200 to 399 mg/dL experience a 65% increased risk of such outcomes (Jeong and Kim, 2022).

Similarly, in another cross-sectional examination, significantly lesser HDL-C levels and elevated triglyceride levels were observed in postmenopausal females with PCOS in comparison to those without PCOS. Additionally, higher chances for developing dyslipidemia are present in women with premature ovarian insufficiency (POI) and early menopause (Torosyan *et al*., 2022).

In a study aimed at exploring the relationship between serum lipid profiles and follicle-stimulating hormone (FSH) levels in postmenopausal women, the investigation revealed an inverse association between FSH levels and low-density lipoprotein cholesterol (LDL-C). This association persisted even after accounting for potential confounding factors such as age, estradiol, luteinizing hormone, body mass index, systolic and diastolic blood pressure. This is a significant factor that contributes to an increased risk of heart and circulatory problems (Xu *et al*., 2022).

Conclusion

It can be concluded that the reduced concentration of estrogen, alterations in distribution of body fat, and the natural process of chronological aging collectively render women in middle age more susceptible to weight increment and ensuing obesity potentially elevating the risk of unfavorable health consequences. Effectively addressing these issues is a crucial aspect of providing care for women in midlife. A multi-faceted approach involving pharmacological intervention, dietary changes, physical activity and psychological support can be generally suggested to help this population segment. To compensate the falling levels of estrogen, postmenopausal women may be prescribed hormone replacement therapy (HRT), typically involving the usage of exogenous estrogen, often in conjunction with progestin therapy. It is important to note that no single dietary approach like low fat, low in carbohydrates, or a high protein, demonstrates clear superiority over others. Adherence to the Mediterranean diet – rich in plant-based foods, has shown promise in lowering the possibility of menopausal weight accumulation while simultaneously improving cardiometabolic indicators and treating symptoms associated with menopause. A combination of balance exercises, aerobic activities and resistance training is the most effective technique for controlling weight, minimising the severity of

vasomotor symptoms, and relieving psychological distress in menopausal women. Overweight and obesity management should be treated holistically, beginning with a complete understanding of the individual's situation, their specific requirements and ambitions, as well as the potential barriers they may face in achieving these goals.

Conflict of Interest

The Authors declare no conflict of interest.

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