INTRODUCTION

Menopause can be a challenging time for many women due to physical and psychological symptoms that may impact daily activities and quality of life. The number of women aged 50–64 years who are economically ac-tive in the United Kingdom has more than doubled over the last 30 years (Office for National Statistics, 2022), and menopausal symptoms can impact economic par-ticipation due to lower productivity, reduced job satis-faction and problems with time management (Bazeley et al., 2022; Brewis et al., 2017). Therefore, supporting women to manage their symptoms is important from a public health and economic perspective.Hormone replacement therapy (HRT) is often used to treat menopausal symptoms in accordance with national guidelines (NICE, 2015). However, it has been estimated that approximately half (51%) of UK women seek complementary and alternative medi-cines to manage their menopausal symptoms. Women may also be interested in lifestyle adjustments, such as dietary changes, to help manage symptoms and support longer-term health. It is therefore important that healthcare providers are up to date with current evidence to provide appropriate guidance and advice. Some existing position statements and guidelines have focussed on particular aspects of diet and menopausal health, such as Mediterranean-style diets (MedDiet; Cano et al., 2020), or non-hormonal approaches (life-style modifications, food supplements, non-hormonal medications, behavioural and alternative and com-plementary therapies) for managing specific symp-toms, such as vasomotor symptoms (VMS; Mintziori et al., 2015) or depression (Maki et al., 2019). This nar-rative review is based on a literature search for rele-vant articles in English to assess the current evidence for the influence of dietary factors in alleviating com-mon menopausal symptoms. These include VMS (hot flushes and night sweats), changes in bodyweight and composition, sleep disturbances, psychological symp-toms (anxiety, depression and cognitive changes), joint pain, skin changes and urogenital symptoms (NHS, 2022a; NICE, 2015). We focussed on prospec-tive cohort studies, randomised controlled trials (RCTs) and systematic reviews, including meta-analyses, where available. Reference lists were searched to identify additional relevant articles. Preference was given to studies defining menopausal status, or those including midlife women. Dietary factors impacting long-term health issues previously reviewed elsewhere, including bone health and cardiovascular disease , were not consid-ered, although dietary factors are important in the aeti-ology of these conditions.

THE MENOPAUSE

Menopause is defined as 12 consecutive months of amenorrhoea following the final menstrual period (FMP), which marks the end of a woman's reproduc-tive cycle and usually occurs between the ages of 45–55 years, with the average age in the United Kingdom being 51 years . However, women can start to experience symptoms months or years be-fore the FMP, and this can continue postmenopause. Perimenopause is the time from the start of symptoms until a woman has had 12 consecutive months with-out a period and is then deemed to have reached the menopause. After this 12-month period, a woman is considered to be postmenopausal. Natural menopause results from a decrease in ovarian function and changes in reproductive hormone levels as the ovaries become less responsive to follicle-stimulating hormone and lu-teinising hormone, leading to reduced circulating levels of oestrogen and progesterone. Hormonal changes may, in part, be responsible for the complex physiological mechanisms underlying menopausal symptoms.

SYMPTOMS OF THE MENOPAUSE

One-third of the UK female population is currently estimated to be perimenopausal or postmenopausal (NHS, 2022b). Many of these individuals will experience menopausal symptoms that can typically begin before the FMP and continue for several years . Menopausal symptoms can include VMS, mood changes, problems with memory and con-centration, sleep disturbances, headaches, changes in bodyweight and composition, skin changes, uri-nary problems, vaginal dryness, loss of interest in sex and joint and muscle pain or stiffness (NHS, 2022a; NICE, 2015). Symptoms can vary in terms of type, frequency and severity, and geographical location and ethnicity may influence the prevalence of certain symptoms (Monteleone et al., 2018). Symptoms may also be interconnected, although the direction of the effect is not always clear.

Diet and vasomotor symptoms

Vasomotor symptoms (VMS) include hot flushes, which are sudden sensations of heat in the upper chest and face that can become generalised throughout the body (Sarri et al., 2017), and night sweats, which are repeated episodes of severe sweating during sleep (NHS, 2021). They occur due to the constriction and dilatation of blood vessels in the skin leading to sud-den increases in blood flow, allowing heat dissipation (NICE, 2015). The physiological mechanisms are not fully understood but appear to involve changes in ther-moregulation, whereby smaller increases in core body temperature trigger sympathetic nervous system activ-ity via peripheral vasodilatation, and increased sweat gland activity (Monteleone et al., 2018). This may be associated with the brain's response to changing repro-ductive hormone levels, and fluctuations in the activity of neurotransmitters such as serotonin and noradrena-line (Monteleone et al., 2018).Vasomotor symptoms are among the most common menopausal symptoms across different geographical locations, but prevalence may vary widely depending on a variety of factors, such as diet and lifestyle (Freeman & Sherif, 2007). For example, a high proportion of body fat, smoking and alcohol consumption have been as-sociated with an increased likelihood of VMS (Hunter et al., 2012; Thurston et al., 2007, 2009). Surveys indi-cate up to 90% of peri- and postmenopausal women experience VMS, typically lasting 4–10 years, although symptoms may last longer (Avis et al., 2015; Freeman et al., 2 011; Hunter et al., 2012; Politi et al., 2008; Reed et al., 2013). While some studies have reported a lower prevalence and shorter duration of VMS among Asian women compared to White women in the same geographical areas (Avis et al., 2015; Reed et al., 2013), others have found no evidence of ethnic differences (Islam et al., 2017).

Dietary patterns and composition

Some evidence suggests that following a healthy di-etary pattern rich in fruits, vegetables, wholegrains, pulses and legumes, and having a higher proportion of healthier fats from foods such as oily fish, nuts and seeds, may help manage VMS. For example, in a large prospective cohort study (n = 6040) of middle-aged women who experienced natural menopause, a dietary pattern high in fat and sugar significantly increased the risk of VMS (adjusted odds ratio [OR] = 1.23; 95% CI: 1.05, 1.44), whilst a diet with more fruit (OR = 0.81; 95% CI: 0.71, 0.93) or a MedDiet (OR = 0.80; 95% CI: 0.69, 0.92) significantly decreased the risk (Herber-Gast & Mishra, 2013). However, such observational studies cannot demonstrate cause-and-effect relationships.The Women's Health Initiative Dietary Modification Trial found that 6104 postmenopausal women follow-ing a low-fat dietary pattern were more likely to report reduced VMS after 1 year compared to those in the control group, although there was no improvement for moderate-to-severe VMS (Kroenke et al., 2012). The study found significant weight loss in the intervention group was associated with the elimination of symp-toms (OR = 1.14; 95% CI: 1.01, 1.28), when adjusted for age, ethnicity, years since menopause and other life-style factors. Loss of symptoms was more likely among those who lost more than 10 lbs (OR = 1.23; 95% CI: 1.05, 1.46) or lost 10% or more of baseline bodyweight (OR = 1.56; 95% CI: 1.21, 2.02) compared to women who maintained weight over the year. Large weight loss (>22 lbs), but not dietary changes, was also related to the elimination of moderate and severe VMS. Hence, weight loss associated with healthy dietary modifications, may help eliminate VMS among postmenopausal women (Kroenke et al., 2012).Other trials have suggested that plant-based dietary patterns may be beneficial for relief of VMS (Barnard et al., 2022; Rotolo et al., 2019). A small-scale RCT re-ported that, among postmenopausal women, a lacto- ovo-vegetarian diet rich in omega-3 fats from flaxseed oil, walnuts and almonds (26 g/day) significantly re-duced the Kupperman Index sub-scale score for hot flushes after 16 weeks, but not night sweats, when compared to a lacto-ovo-vegetarian diet rich in extra virgin olive oil (Rotolo et al., 2019). More recently, an-other RCT (n = 84; postmenopausal women) reported the frequency of hot flushes, particularly those of moderate-to-severe intensity, to decrease significantly among women following a low-fat, vegan diet (including ½ cup [86 g] of cooked soybeans daily), compared to control (−88% vs. −34%). Bodyweight also decreased in the intervention group which may, in part, explain why the dietary intervention reduced hot flushes for some women, although the correlation between weight loss and symptom change was weak (Barnard et al., 2022).Following a review of observational and interven-tion studies, a position statement by the European Menopause and Andropause Society (EMAS) con-cluded that short-term high adherence to a MedDiet may improve VMS in peri- and postmenopausal women, although this was based on limited evidence (Cano et al., 2020). Evidence to date also suggests that other healthier plant-based diets may help to reduce the prevalence and severity of hot flushes, although the greatest benefit appears to be with accompanying weight loss.

Isoflavones

are a type of phytoestrogen (non-steroidal plant-based compound) found in foods including soybeans, soy foods, beans, chickpeas and lentils. Soybeans and soy foods (such as tofu and miso) are abundant sources of isoflavones, including daid-zein, genistein and glycitein . Isoflavones have a similar chemical structure to oestrogen (17-βoestradiol) and may induce weak oestrogenic-like ef-fects by interacting with oestrogen receptors (ERs) .Interest in the role of isoflavones in managing VMS was stimu-lated by observational studies reporting menopausal symptoms to be inversely correlated with soy intake in Japanese women (Nagata et al., 1999, 2001). However, results from clinical studies on the effects of soy prod-ucts or isolated isoflavones on VMS have been mixed.In 2012, the European Food Safety Authority (EFSA) provided a scientific opinion on health claims for the relationship between soy isoflavones and VMS as-sociated with menopause (EFSA Panel on Dietetic Products Nutrition and Allergies, 2012a). This report concluded there was insufficient evidence from 15 RCTs to establish a cause-and-effect relationship be-tween soy isoflavones (27–120 mg/day of isoflavones for 6 weeks to 24 months) and reduced VMS among peri- and postmenopausal women. The RCTs provided inconsistent evidence regarding the effect of soy isofla-vones on the frequency and/or severity of hot flushes, and those investigating night sweats showed no effect. A high risk of bias was found, due to methodological weaknesses in statistical analyses and/or data not being adequately reported. Inconsistent results could also not be explained by dose, sample size, study du-ration or baseline frequency or severity of VMS. These findings were supported by a Cochrane review around the same time, reporting inconclusive evidence from 25 RCTs that 33–200 mg/day of soy isoflavones from dietary soy or soy extracts (administered for 12 weeks to 2 years) reduced the frequency or severity of VMS in peri- or postmenopausal women (Lethaby et al., 2013). A recent meta-analysis of 6 out of 11 RCTs (with sig-nificant heterogeneity) included by Kang et al. (2022), found no significant effect of 49.3–135 mg/day of isofla-vones or soy isoflavones administered for 12 weeks to 6 months.In contrast, a systematic review and meta-analysis (17 RCTs) by Taku et al. (2012) assessing the effect of extracted or synthesised soy isoflavones, exclud-ing dietary soy, on the frequency and/or severity of hot flushes in peri- and postmenopausal women showed that consuming soy isoflavones (median 54 mg agly-cones) for 6 weeks to 12 months significantly decreased the frequency (−20.6%, random effects model, 13 RCTs) and severity (−26.2%, 9 RCTs) of hot flushes compared to placebo. Although there was substantial heterogeneity (p = 0.0003, I^2 = 67%), the authors re-ported that the findings were robust following sensitivity analysis. Also, results should be interpreted with cau-tion as some RCTs included women with breast can-cer. A meta-analysis of 21 RCTs by Franco et al. (2016) also found dietary and supplemental soy isoflavones (10–100 mg/day; mean difference [MD] -0.79; 95% CI: −1.35 to −0.23) or supplemental and extracts of soy isoflavones (10–100 mg/day; MD -1.09; 95% CI: −1.96 to −0.22) improved the frequency of daily hot flushes using random effects models, whilst dietary soy isofla-vones alone (42–90 mg/day; MD -0.98; 95% CI: −1.23 to −0.73) only improved hot flush frequency in a fixed effects model. Due to limited study availability, a meta- analysis of the effect of isoflavones on night sweats was not performed (Franco et al., 2016).A key issue when reviewing the evidence for an as-sociation between isoflavones and VMS is the high het-erogeneity among RCTs, which limits the reliability of meta-analyses. Studies differed in terms of population, duration, dose and type of isoflavone, which may have led to variations in observed effects. Sub-group anal-ysis by Taku et al. (2012) revealed that interventions of >12 weeks significantly reduced hot flush frequency approximately three times more than shorter durations (−34.29% vs. −12.66%), and higher genistein concen-tration (>18.8 mg/day) was significantly more effective at reducing hot flush frequency than lower genistein concentrations (≤18 mg/day; −29.13% vs. −12.47%). In the Cochrane review discussed earlier, Lethaby et al. (2013) supported this finding with a narrative review of four RCTs administering genistein extracts (30–60 mg/day) for 12 weeks to 2 years, reporting sig-nificant reductions in hot flush frequency (24%–56%) compared to placebo among symptomatic postmeno-pausal women.Despite more recent RCTs exploring the effect of higher dietary intakes of isoflavones (100–600 ml/day of a soy drink or 10–60 mg/day of isoflavones) on VMS (Furlong et al., 2020; Simpson et al., 2019; Tranche et al., 2016), it is not clear whether the effects of dietary and supplemental soy isoflavones are comparable. More studies are also needed during perimenopause. Currently, National Institute for Health and Care Excellence (NICE) guidelines acknowledge that there is some evidence that isoflavones may relieve VMS, but highlight that multiple preparations are available, and their safety and interaction with other medications are uncertain

Lignans

Lignans are another type of phytoestrogen found in wholegrains, flaxseeds, fruits and vegetables. The available evidence from RCTs is limited to flax-seed interventions. The Cochrane review by Lethaby et al. (2013) highlighted limited evidence from three RCTs for the effect of flaxseed dietary supplements or extracts (50–200 mg/day of lignans) on VMS. An RCT by Simbalista et al. (2010) found that consuming two slices of bread containing 25 g of flaxseed (46 mg of lig-nans) daily for 12 weeks was no more effective than a placebo (bread containing 25 g of wheat bran, <1 mg of lignans) at reducing hot flushes. Hence, there is no evidence to indicate that the consumption of flaxseed is effective at alleviating VMS.

Red clover

Red clover (Trifolium pratense L., Fabaceae) is a leg-ume containing isoflavones such as formononetin, biochanin A, genistein and daidzein.
studies found a significant reduction in the daily occurrence of hot flushes in women receiving active treatment compared to

Black cohosh

Black cohosh (Cimicifuga racemosa or Actaea racemosa) is a herb that contains bioactive compounds such as triterpene glycosides actein and cimicifugo-side, fatty acids, resins, caffeic acids, isoferulic acids and isoflavones (Leach & Moore, 2012). A Cochrane review reported no significant difference between monopreparations of black cohosh and placebo for the frequency or intensity of hot flushes among peri- and postmenopausal women (Leach & Moore, 2012). The risk of bias for most RCTs was also unclear given the limited extent of the information provided, and the Cochrane authors recommended improved reporting of methodology. This was supported by a subsequent meta-analysis of four RCTs by Franco et al. (2016), which found no impact of monopreparations of black cohosh (6.5–160 mg/day for 8–48 weeks) on hot flush frequency. However, a network meta-analysis of 32 RCTs (n = 4165 women) of 12 treatment classes re-ported positive effects of black cohosh on the fre-quency of VMS compared to placebo (mean ratio 0.40; 95% CI: 0.16, 0.90), although the authors of the meta-analysis recommend that these results should be interpreted with caution, due to the variety of herbal preparations used in the different studies (Sarri et al., 2017). NICE guidelines (NICE, 2015) therefore highlight that there is currently limited evidence re-garding the most appropriate formulation, dose, dura-tion and safety of preparations of black cohosh, and cautions that interactions with medications have been reported.

Equol

An individual's response to isoflavones may depend on their ability to produce equol, a potent daidzein metabo-lite with oestrogenic activities. It is estimated that 20%– 30% of people in Western countries and 40%–60% in Asian countries are equol producers (Iino et al., 2019). Daidzein is metabolised by intestinal bacteria to pro-duce equol and inter-individual variability in equol-producing bacteria may contribute to differences in response to soy isoflavones. In an observational study of peri- and postmenopausal women, those who ate at least three servings of soy foods per day and were confirmed to be equol producers, were found to have 76% fewer VMS than equol non-producers (Newton et al., 2015).

However, Barnard et al. (2022) found that differences in equol production did not lead to differences in the impact of dietary soybean supplementa-tion on hot flushes.A meta-analysis of five RCTs included trials that gave S-equol or placebo to equol non-producing subjects and trials which provided isoflavones instead of equol to equol producers and non-producers (Daily et al., 2019).

The RCTs, mostly including postmenopausal women, assessed the efficacy of soy isoflavones or equol for alleviating VMS over durations of 8 weeks to 6 months. Hot flush scores were significantly lower in those re-ceiving 10 mg of equol (4 studies; MD −0.30; 95% CI: −0.50 to −0.10) or in those receiving the best dose of equol reported in the same four studies (MD −0.35; 95% CI: −0.55 to −0.15), compared to placebo, using fixed effect models. However, removing one study from the meta-analyses rendered the results non-significant for both 10 mg of equol and the best dose reported. Daily et al. (2019) suggested that supplemental equol may support women who are equol non-producers but pro-vides little benefit to women who are equol producers. However, a limited number of studies were considered, and methodology varied between studies, therefore re-sults cannot be extrapolated.

Omega-3 fatty acids and vitamin E

have been explored for VMS alleviation, although trials have provided mixed results. One meta-analysis of three RCTs (n = 483) found no effect of omega-3 supplements on the frequency or severity of hot **flushes** (Mohammady et al., 2018). A systematic review of 10 studies (n = 1100) found that vitamin E and omega-3 in combination significantly reduced the intensity of hot flushes compared to pla-cebo, although no individual effects on the frequency or intensity of VMS were found (Maghalian et al., 2022). The authors concluded there was insufficient evidence that omega-3 supplements improve VMS (Maghalian et al., 2022).

Other botanical supplements

Polyphenols and botanical supplements, such as St John's Wort (Liu et al., 2014), evening primrose oil (Farzaneh et al., 2013; Kazemi et al., 2021), sage (Bommer et al., 2 011), milk thistle (Saberi et al., 2020), ginseng (Lee et al., 2016, 2022) and combined bo-tanical supplements (Rattanatantikul et al., 2022) have been explored. Despite some studies reporting positive results, concerns about methodology, study heteroge-neity and insufficient large-scale interventions mean it is not possible to conclude whether a causal relation-ship exists for reducing VMS. Botanicals are also not recommended in clinical guidelines or position state-ments, due to limited and conflicting evidence regarding efficacy and safety (Mintziori et al., 2015; NICE, 2015).

Diet, bodyweight and composition

Women may experience changes such as weight gain, body fat redistribution, increased fat mass and reduced lean mass due to reproductive ageing, although chron-ological ageing is considered to be an important con-tributing factor. The relative contributions and interacting effects of chronological and reproductive ageing are difficult to determine as they progress concurrently.
The physiological mecha-nisms by which reproductive hormones may elicit their effects on body composition are also not fully under-stood. However, a higher oestrogen to androgen ratio due to declining oestrogen levels may promote a shift in body fat distribution towards the abdominal region, characterised by higher visceral adiposity (Janssen et al., 2010, 2015; Lovejoy et al., 2008).
Changes such as higher follicle-stimulating hormone levels and oestrogen deficiency may also adversely affect the maintenance of lean muscle mass (Monteleone et al., 2018). Levels of physical activity and ethnicity may also be associated with changes in bodyweight and composition .
Other menopausal symptoms, including VMS and urogenital symp-toms have been associated with changes in bodyweight and composition.
Joint pain , weight gain and higher ab-dominal visceral adiposity, also increase the risk of health conditions, such as cardiovascular disease (CVD) and cancer, in later life (Chen, Arthur, et al., 2019; Chen, Ko, et al. 2019; Sun et al., 2019). Managing body-weight and composition before, during and after the menopausal transition is therefore important.

Dietary interventions

Dietary interventions tend to focus on calorie restriction and modifying macronutrient composition

.A meta-analysis of 11 RCTs and prospective stud-ies assessed different dietary interventions, such as calorie-restriction only, calorie-restriction and low- fat diet, or low-fat and low-sugar substitutions, alone or combined with aerobic or resistance exercise, for 3–12 months in peri- and postmenopausal women (Cheng et al., 2018). Dietary interventions alone signifi-cantly reduced bodyweight, fat mass and lean mass compared to control, while combined dietary and exer-cise interventions significantly reduced bodyweight, fat mass and lean mass compared to dietary interventions alone.

However, heterogeneity was often high between studies. Other randomised trials assessing calorie re-striction (400–800 kcal/day energy deficit), alone or combined with exercise, for 5–6 months reported sig-nificant decreases in bodyweight, fat mass, fat-free mass (FFM) or lean mass, and other measures of body composition, with no difference between calorie re-striction with or without exercise, among early and late postmenopausal women (Messier et al., 2010; Nicklas et al., 2009).

Seimon et al. (2019) also found that higher energy restriction (65%–75%) induced greater loss of weight, fat mass, lean mass and other body compo-sition measures after 12 months compared to lower energy restriction (25%–35%) among postmenopausal women with obesity.Different dietary patterns have been shown to be ef-fective if they promote a reduction in energy intake. For example, a 16-week RCT of postmenopausal women with obesity (n = 144) found no difference in weight loss or metabolic health from consuming either a calorie-restricted MedDiet or Central European diet (CED; low in fat, moderate in carbohydrates and high in di-etary fibre derived from European food items; Bajerska et al., 2018). suggesting that both calorie-restricted dietary patterns were equally effective, regardless of differences in mac-ronutrient composition (Bajerska et al., 2018).

However, reduced visceral fat was associated with increased carbohydrate and dietary fibre intake, and decreased total fat and saturated fatty acid intake in the CED group.

Lower fat diets or foods, alone or combined with exercise, have been reported to reduce bodyweight and fat mass after 12 weeks to 6 years follow-up among postmenopausal women, although results for lean mass were mixed . Findings from these studies suggest low-ering fat intake, either with or without pre-planned calorie restriction, may promote a decrease in body-weight and fat mass, but also lean mass. However, results should be interpreted with caution as older postmenopausal women were included in some trials (age range 44–79 years).

Body composition outcomes may also depend on other dietary components such as fibre intake, participant race/ethnicity, body mass index (BMI), diabetes, HRT use or level of dietary .Trials including women with overweight and obesity ≥45 years of age have reported inconsistent changes in lean mass between higher (1.2–1.5 g/kg/day) and lower (0.8 g/kg/day) protein intakes when following a calorie- restricted diet for 3–6 months (Bales et al., 2017; Englert et al., 2021; Mojtahedi et al., 2 011).

Observational evidence suggests that reduced carbohydrate diets may decrease the risk of post-menopausal weight gain (Ford et al., 2017), whereas results from RCTs have reported inconsistent results for non- calorie- restricted reduced- carbohydrate diets in relation to bodyweight and fat mass among women during midlife (Liu et al., 2013; Shai et al., 2008). As menopausal status was not defined in these RCTs and ages ranged from 30–65 years, results cannot be gen-eralised for the menopause.

Calorie-restricted diets may also be associated with eating behaviours and psychosocial factors in postmenopausal women with overweight and obesity (Mason et al., 2019; Messier et al., 2010). Post- hoc analysis from a 12-month RCT suggested a calorie-restricted low-fat diet (1200–2000 kcal/day, <30% en-ergy from fat), alone or combined with aerobic exercise, may modify eating behaviour (Mason et al., 2019). Significant decreases in uncontrolled eating and emotional eating scores and an increase in restrained eating were observed for the calorie-restricted low-fat diet, alone or combined with aerobic exercise, and lower binge eating for the calorie-restricted low-fat diet only, compared to control. Exploratory analysis further highlighted that weight loss was sometimes associated with these changes in eating behaviour. Exercise alone showed no significant relationship with eating behaviour compared to control.

Another RCT found that greater weight loss over 6 months was significantly associated with higher body esteem, health perceptions, dietary restraint, self-efficacy and lower disinhibition, stress and hunger when follow-ing a reduced energy intake (500–800 kcal energy deficit) with or without resistance training (Messier et al., 2010). Improvements in eating behaviour and psychosocial factors whilst following a reduced en-ergy intake, either alone or combined with exercise, may therefore influence weight loss. However, the potential for an association between these factors is not fully understood, and the potential for maintaining long-term weight loss and eating behaviour changes is unknown

Food supplements

Supplements containing polyunsaturated fatty acids (PUFAs), such as docosahexaenoic acid or conju-gated linoleic acid, have been linked to improvements in bodyweight and composition, including fat mass, in small groups of postmenopausal women, but results were not always different from placebo (Félix-Soriano et al., 2021; Raff et al., 2009). Additionally, supplement-ing the diet with protein (5 g leucine for 10 weeks or 25 g soy protein for 16 weeks), was reported to have no ad-ditional effect on improving FFM or muscle mass in un-trained peri- and postmenopausal women following a resistance training programme (Funderburk et al., 2020; Orsatti et al., 2018). RCTs investigating calcium (1000– 1500 mg/day) and/or vitamin D (400–2000 IU/day) sup-plements use in postmenopausal women have reported mixed results in relation to bodyweight, BMI, fat mass, lean mass, waist circumference and hip circumference (Caan et al., 2007; Ilich et al., 2019; Mason et al., 2014). It could be hypothesised that other factors may have in-fluenced the results aside from calcium and vitamin D, such as macronutrient composition, calorie restriction or HRT, therefore, the results are inconclusive.A meta-analysis of nine RCTs suggested soy isofla-vone supplementation (40–160 mg) may reduce body-weight in non-Asian postmenopausal women (Zhang et al., 2013). Significant reductions in bodyweight were reported for durations <6 months (vs. ≥6 months), doses <100 mg (vs. ≥100 mg) and women with a BMI <30 kg/m^2 (vs. ≥30 kg/m^2). Other measures of body composition were not considered. Subgroup analysis revealed the type of phytoestrogen and pre- existing medical conditions may affect the outcome. Evidence for using phytoestrogens to reduce bodyweight and counter-act adverse changes in body composition is therefore inconsistent.

Diet and skin changes

Women may experience skin changes, such as dryness and itchiness, reduced skin elasticity, increased rough-ness, uneven skin tone and increased wrinkles, during and after the menopausal transition. It is dif-ficult to determine whether skin changes are related to menopause or skin ageing, environmental factors and/or psychological influences.Skin ageing may be exacerbated by menopause, particularly due to the reduction in oestrogen, which may contribute to collagen loss, skin atrophy, reduced skin hydration, decreased skin elasticity and increased wrinkle formation . Preventative and therapeutic strategies to address these skin changes have included dietary modifications .Skin needs a balance of essential nutrients which all contribute to the maintenance of normal skin, irrespec-tive of menopause . However, whilst deficiencies can impact skin health, higher intakes may not be benefi-cial once an adequate status is achieved. Studies have investigated supplements containing nutrients and other bioactive ingredients, such as soy isoflavones, collagen, black cohosh, chaste-tree berry and evening primrose oil

A 14-week RCT reported that early and late post-menopausal women consuming a test drink containing either high or low doses of vitamin C, vitamin E, lycopene and soy isoflavones plus two omega-3 fish oil capsules (660 mg/day) had significantly lower crow's foot in the eye area wrinkle depth, and sever-ity of skin roughness, compared to a placebo drink plus two sunflower oil capsules (Jenkins et al., 2014). No significant differences in skin elasticity, transepidermal water loss (TEWL), hydration or barrier qual-ity were observed compared to the placebo. Biopsy analyses also revealed significantly more women in the lower dose intervention had increased collagen, but not elastin, quantity and quality compared to pla-cebo (Jenkins et al., 2014).Vitamin C contributes to normal collagen forma-tion However, vitamin C status was not measured at baseline, and it is, therefore, unclear whether a deficiency was being addressed for some participants. Jenkins et al. (2014) also hypothesised that soy isoflavones may have promoted the increase in collagen, but there is currently limited evidence to recommend soy isoflavones to improve skin health postmenopause. An RCT reported that S-equol improved crow's foot wrinkle area (for 10 and 30 mg/day) and depth (for 30 mg/day) compared to placebo but not skin hydration, TEWL or skin elasticity in equol non- producing Japanese early postmenopausal women (Oyama et al., 2012) whilst EFSA Panel on Dietetic Products Nutrition and Allergies (2 011a) previously re-jected a health claim linking soy isoflavones with the maintenance of skin tonicity in postmenopausal women because no evidence was provided for how skin tonic-ity could be related to skin function.An RCT assessing a combined botanical supple-ment containing Glycine max (soy, 100 mg isoflavones), Cimicifuga racemose (black cohosh, 520 mg, 2 mg trit-erpene glycosides), Vitex agnus- castus (chaste- tree berry, 400 mg) and Oenothera biennis (evening primrose oil, 500 mg, 50 mg gamma-linolenic acid, 325 mg linoleic acid) extracts reported significant improvements in skin roughness after 6 weeks, and skin elasticity, rough-ness, smoothness, scaliness and wrinkle density after 12 weeks, compared to placebo (soybean oil). No differences in hydration or TEWL were found between the intervention and placebo, even though linoleic acid, which contributes to maintaining the water permeability skin barrier (EFSA Panel on Dietetic Products Nutrition and Allergies, 2010d), is found in evening primrose oil.

However, it is unclear whether a single ingredient or combination of ingredients is responsible for observed effects.

Collagen supplements have been investigated regarding the potential to support skin health when collagen levels decrease with ageing and menopause. RCTs as-sessing the effects of 2.5–10 g/day of collagen hydroly-sate or collagen peptides for 4–12 weeks have reported improvements in various skin parameters including skin elasticity, eye wrinkle volume, skin hydration and der-mal collagen density among women aged 40–65 years. Persistence of effect for improvements in skin elasticity and eye wrinkle volume was also observed. However, Proksch et al. (2014) did not define menopausal status, and Asserin et al. (2015) and Sangsuwan and Asawanonda (2021) only included postmenopausal women. Therefore, findings cannot be generalised across menopausal stages.

Diet and joint pain

Arthralgia (joint pain) is a type of musculoskeletal pain experienced by at least 50% of women during and after the menopausal transition, which may be asso-ciated with hormonal changes but can have a variety of other causes. The effect of oestrogen loss on joint pain is not fully understood, although it may affect joint tissues, such as cartilage, due to the presence of oestrogen receptors (ERs). However, it is difficult to differentiate between menopause-related joint pain and joint pain associated with inflammatory conditions, such as osteoarthritis . Other factors such as higher BMI, difficulty concentrating, hot flushes, night-time awakening and depressed mood have also been associated with joint pain , although the direc-tion of association is unclear.Intervention studies exploring the role of diet for alle-viating joint and muscle pain or discomfort are scarce. Available studies mainly include postmenopausal women and report mixed results that are largely incon-clusive. Some of the dietary components investigated have included calcium and vitamin D (Chlebowski et al., 2013), omega-3 fatty acids (Purzand et al., 2020), soy isoflavones and/or equol, pomegranate seed oil (Auerbach et al., 2012), sage (Bommer et al., 2 011) and combined botanical supplements (Rattanatantikul et al., 2022). Vitamin C contributes to normal collagen formation for the normal function of cartilage, although the role of vitamin C in menopause-related joint pain is unclear. Collagen, glucosamine, chondroitin and cur-cumin are used in products marketed to reduce joint pain but no health claims are authorised by EFSA for these ingredients regarding joint health Overall, there is limited evidence linking diet and joint pain during the stages of meno-pause, although weight loss is generally recommended if overweight to relieve joint pain

Diet and genitourinary syndrome of the menopause

Genitourinary syndrome of the menopause (GSM) re-fers to a chronic, progressive vulvovaginal, sexual and lower urinary tract condition which is characterised by several genital, sexual and urinary symptoms that may coexist but are not associated with other medi-cal conditions. Symptoms may include vaginal dry-ness, loss of lubrication, vaginal bleeding and discharge, vulval burning, dryness and urinary symptoms which may include recurrent urinary tract infections, urge or stress incontinence. Symptoms are due to a reduction in circulating oestrogen levels, which may impact pre- and postmenopausal women.Genitourinary syndrome of the menopause has been estimated to affect 15% of premenopausal women (Gandhi et al., 2016) and 27% to 84% of middle-aged and older women experience GSM symptoms, with women usually experiencing more than one symptom. Prevalence has been reported to increase after menopause, with up to 65% of women experiencing GSM 1 year after the menopause and 84% experi-encing GSM 6 years after the menopause. This can vary due to factors such as age, sexual activity and socio-cultural background. A lack of awareness about the cause of the symptoms as well as reluctance to discuss symptoms with a healthcare professional means that prevalence is difficult to ascertain (NAMS Position Statement, 2020).It is unclear whether all GSM symptoms are due to the menopause itself, ageing or other lifestyle factors, such as the concomitant weight gain that often occurs during the menopausal transition (Waetjen et al., 2013).

Dietary patterns and composition

A systematic review of 19 articles found that a diet high in mayonnaise, liquid oils, sweets and desserts was as-sociated with genitourinary symptoms, as well as other symptoms, whereas a diet high in vegetables, fruits and wholegrains was associated with a lower intensity of urogenital symptoms (Noll et al., 2021). However, these findings were mostly based on cross-sectional stud-ies (n = 14), and studies included small sample sizes, making it difficult to extrapolate results.

Caffeine or cof-fee consumption has also been associated with an in-creased prevalence of urinary incontinence, although only in a single cross-sectional study with a small sam-ple size (n = 91) of postmenopausal Libyan women (Taher et al., 2013).

A systematic review by Chen, Ko, et al. (2019) con-cluded that there is no clear evidence to indicate that phy-toestrogens influence urogenital symptoms. Previously, the SWAN phytoestrogen study followed 2721 women (42–52 years) with no incontinence at baseline for 10 years and found that dietary phytoestrogens did not affect the risk of developing urinary incontinence, or any subtype, during any stage of the menopause (Waetjen et al., 2013). Similarly, there was no clinically signif-icant effect on urogenital symptoms in an RCT where postmenopausal women (n = 60) were given a soy iso-flavone supplement (150 mg isoflavone) for 16 weeks, ei-ther with or without a probiotic (Ribeiro et al., 2018).

An RCT involving menopausal Italian women (n = 50) given a mixture of isoflavones (40 mg), calcium (500 mg), vita-min D (300 IU) and inulin (3 g) found that the participants in the treatment group reported a significant reduction in Menopause-specific Quality of life vasomotor, physical and sexual domain score, and a significant increase in all Female Sexual Function Index scores after 12 months.However, this was a multi-component supplement, making it difficult to ascribe benefits to a specific component (Vitale et al., 2018).

An RCT of 92 postmenopausal women investigat-ing oral supplementation with ergocalciferol (40 000 IU/week for 12 weeks) showed that vitamin D2 supple-mentation improved vaginal health outcomes in those with vulvovaginal symptoms, although there was no significant difference observed compared to the control group (Kamronrithisorn et al., 2020). However, partici-pants were not vitamin D deficient and further research is needed to consider the dose, duration and form of vitamin D (D2 vs. D3) given, which might impact the po-tential for vitamin D supplementation to improve symp-toms of GSM.

Botanical supplements

Two small-scale RCTs reported a significant reduction in vaginal dryness among perimenopausal and postmenopausal women administered a standardised ex-tract of fenugreek husk (FenuSMART™; 1000 mg/day), possibly due to phytoestrogenic properties (Sreeja et al., 2010).
A meta-analysis of 36 studies reported that com-posite and specific phytoestrogen supplementation is associated with a modest reduction in the frequency of hot flushes and vaginal dryness but not night sweats. However, sample sizes were small and there was high heterogeneity between studies (Franco et al., 2016). A systematic review of 15 RCTs reviewed the impact of different types of ginseng on menopausal women's health, and a meta-analysis of three RCTs found that ginseng did not have a positive effect on either sexual function or endometrial thickness (Lee et al., 2022).In a one-year RCT of 351 peri- and postmenopausal women, black cohosh had no effect on vaginal dryness, vaginal epithelium, endometrium or reproductive hor-mones when given alone, or as part of a multi-botanical product, either with or without soy (Reed et al., 2008). A North American Menopause Society (NAMS) position statement on the management of the GSM concluded that herbal products appear ineffective for managing GSM (NAMS Position Statement, 2020).

Diet and sleep disturbances

Poor quality sleep is commonly reported during the menopausal transition (Baker et al., 2018), with a higher reported prevalence among peri- (39% to 47%) and postmenopausal (35% to 60%) compared to premenopausal women (16% to 42%; Kravitz & Joffe, 2 011), although the pathophysiology appears to be complex (Cheng et al., 2021). Disturbed sleep may be a primary disorder or related to secondary factors, including declining oestradiol production (Marlatt et al., 2022), psychological and psychosocial factors or other physical or medical conditions (Cheng et al., 2021). VMS can contribute to sleep disruption during the menopausal transition, and sleep difficulties appear to largely explain the relationship be-tween often/severe VMS and subsequent depressed mood (Chung et al., 2018).Clinical guidelines and expert statements for meno-pausal sleep disturbances in North America and the United Kingdom recommend offering advice on sleep hygiene (NICE, 2022; Shea et al., 2021), a set of behaviours and environmental factors to promote better quality sleep and cognitive behavioural therapy (Shea et al., 2021). Hormone therapies, including 17β- oestradiol and combined oestrogen and progesterone, are also reported to have a beneficial effect (Cheng et al., 2021; Pan et al., 2022).

Dietary patterns

A healthy dietary pattern may benefit sleep (Scoditti et al., 2022), partly due to changes in bodyweight (Cao et al., 2020). Studies focussing on peri- and post-menopausal women report that lower sleep efficiency and quality are associated with elevated levels of in-flammatory markers (Huang et al., 2017; Nowakowski et al., 2018), whilst closer adherence to a MedDiet is reported to reduce markers of inflammation (Koelman et al., 2022), and is associated with better sleep quality, duration and fewer insomnia symptoms .

Food and botanical supplements

No significant benefit of n-3 PUFA supplementation for insomnia severity or sleep was reported from three RCTs of women experiencing VMS (n = 483; Mohammady et al., 2018),

while a single RCT of 218 postmenopausal women with overweight reported that vitamin D supplementation led to an overall worse qual-ity of sleep (Mason et al., 2016).Limited evidence is available for other nutrient and/or botanical supplements in relation to sleep disturbances . Other botanical supple-ments studied in relation to sleep during the peri- or postmenopause include (number of trials; effect on sleep): red clover (n = 1; sleep dysfunction increased); fenugreek (n = 1 trial; im-provement); soy (n = 6 trials; inconsistent effects); bitter orange and lavender (n = 1 trial; improvement); valerian (n = 1 trial; improvement); Schisandra chinensis (n = 1; no improvement) and pine bark extract (Pycnogenol®; n = 1; improvement)