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Role of Anti-Inflammatory Diets in Managing Menopausal Transition

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ABSTRACT

The menopausal transition, marked by fluctuating and eventually declining estrogen levels, initiates a cascade of physiological changes that heighten systemic inflammation. This chronic low-grade inflammation plays a key role in the onset of vasomotor symptoms (VMS), osteoporosis, cardiovascular disease and metabolic dysfunction in middle-aged women. Anti-inflammatory dietary patterns offer a promising, non-pharmacological approach to managing menopause-related symptoms by targeting inflammatory pathways and supporting hormonal balance. This review explores the underlying pathophysiological mechanisms linking menopause to inflammation and evaluates the evidence surrounding specific dietary interventions—including the Mediterranean Diet, "30 Plants" Diet and Low-Fat Vegan + Soy Diet—in improving the quality of life for menopausal women. The paper also emphasizes the role of functional foods like soy isoflavones and discusses the broader metabolic and anti-inflammatory effects of key bioactive dietary components such as polyphenols, fiber, omega-3 fatty acids and phytoestrogens.

Keywords: Menopause, Cardiovascular disease, Anti-inflammatory, Mediterranean diet, Osteoporosis.

INTRODUCTION

Menopause is a pivotal stage in a woman's life, often accompanied by a host of uncomfortable symptoms and health risks due to the natural decline in estrogen. These hormonal changes lead to a pro-inflammatory state, evidenced by elevated levels of cytokines such as IL-6, TNF-α and C-reactive protein (CRP). Anti-inflammatory diets—characterized by high consumption of whole, plant-based foods, healthy fats and low intake of processed and inflammatory foods—can help reduce inflammation, alleviate symptoms, and protect against chronic diseases. Increasing evidence supports the role of nutritional strategies in improving physical and psychological well-being during menopause (Kirby, 2006; Vaidya and Udipi, 2015).

Inflammation and Menopause:

Menopause-induced estrogen deficiency is closely associated with an upsurge in pro-inflammatory cytokines, which are involved in numerous menopause-related complications (Table 1).

- ***Vasomotor symptoms (VMS)****:* Hot flashes and night sweats have been associated with systemic inflammation, although the exact causal pathways remain under investigation (Barrea *et al.*, 2021).
- ***Osteoporosis****:* IL-1, IL-6, and TNF-á promote bone resorption by stimulating osteoclast activity (Pfeilschifter *et al.,* 2002).
- ***Cardiometabolic risks****:* The inflammatory response contributes to endothelial dysfunction, atherosclerosis and insulin resistance, increasing the risk for cardiovascular disease (Vaidya and Udipi, 2015).

Dietary Inflammatory Index (DII):

The DII is a scoring system that quantifies the

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Table 1 : Common Inflammatory Biomarkers During Menopause		
Biomarker	Associated Condition	Reference
IL-6 (Interleukin-6)	Bone resorption, VMS	Kirby, 2006
TNF-α (Tumor Necrosis Factor-alpha)	Atherosclerosis, osteoporosis	Pfeilschifter *et al.* (2002)
CRP (C-Reactive Protein)	Cardiovascular disease risk	Barrea *et al.* (2021)

inflammatory potential of a diet. A higher DII score indicates a pro-inflammatory diet, while lower scores reflect anti-inflammatory dietary behaviour.

- **Clinical Relevance**: Studies have found that women with higher DII scores experience more severe menopausal symptoms, especially related to mood and sexual function (Haghshenas *et al*., 2023).
- **Food-Based DII (FDII)**: This modified index assesses whole-food patterns and has been found to predict menopause-specific quality of life more accurately than nutrient-based DII (Yang *et al*., 2020).

Pathophysiology of Inflammation in Menopause:

Hormonal Shifts and Inflammatory Cascade:

The drop in estrogen levels during menopause reduces its natural anti-inflammatory effect. Estrogen typically suppresses the activity of pro-inflammatory cytokines and modulates immune responses through estrogen receptor (ER) pathways.

- **Cytokine Elevation**: Postmenopausal women show increased levels of IL-1, IL-6, and TNF-á, which are implicated in osteoporosis, cardiovascular risk and metabolic dysfunction (Pfeilschifter *et al*., 2002).
- **Mechanisms**: Estrogen acts on ERá and ERâ to downregulate inflammation, regulate oxidative stress, and modulate gene transcription (Gold *et al*., 2022).

Adiposity and Systemic Inflammation:

- **Visceral fat accumulation** increases in postmenopausal women, secreting inflammatory mediators like ferritin and sTNFR(soluble Tumor Necrosis Factor Receptor) which worsen systemic inflammation (Barrios and Carías, 2012).
- **Hypothalamic inflammation** due to estrogen deficiency also contributes to disrupted appetite regulation and energy homeostasis (Yang *et al*., 2020).

Cardiovascular and Bone Risks:

- **Heart disease**: Menopausal women are at higher risk of coronary artery disease due to reduced estrogen-mediated protection of vascular function (Dessapt and Gourdy, 2012).
- **Bone loss**: Estrogen's decline is a critical factor in accelerated bone resorption. Pro-inflammatory cytokines stimulate osteoclast genesis (Pfeilschifter *et al.*, 2002).

Anti-Inflammatory Dietary Patterns:

Mediterranean Diet:

This diet emphasizes consumption of extra-virgin olive oil, nuts, legumes, vegetables, fruits, whole grains and moderate intake of fish. Rich in monounsaturated fats, antioxidants and polyphenols, it is associated with reduced levels of inflammatory markers such as C-Reactive ProteinandInterleukin-6 (Table 2).

- **Clinical Evidence**: Hart *et al.* (2021) found a significant reduction in C-Reactive Proteinlevels in individuals adhering to this diet.
- **EMAS Recommendation**: The European Menopause and Andropause Society endorses the Mediterranean Diet for improving menopausal symptoms, cardiovascular function,

Table 2 : Comparative Benefits of Anti-Inflammatory Diets			
Diet Type	Mechanisms	Symptom Relief	Reference
Mediterranean	Polyphenols, MUFAs, omega-3s	↓Vasomotor Symptoms, C-Reactive Protein↓, ↑ mood	Hart *et al.* (2021); Itsiopoulos (2022)
30 Plants	Microbiome modulation, antioxidants	↓ Psychological and physical symptoms	Setiawan and Ernawati (2023)
Vegan + Soy	Isoflavones, low AGEs	↓ Hot flashes (up to 92%)	Barnard *et al.* (2021)

mood and bone density (Itsiopoulos, 2022).

"30 Plants" Diet:

This approach encourages consumption of at least 30 different plant foods per week, promoting microbiota diversity, enhancing nutrient density and lowering inflammation.

- **Benefits**: Significantly reduces both physical and psychological symptoms associated with menopause (Setiawan and Ernawati, 2023).

Low-Fat Vegan + Soy Diet:

- **WAVS (Women's Study for the Alleviation of Vasomotor Symptoms) Trial**: A low-fat vegan diet with soy reduced hot flashes by 79% in 12 weeks, outperforming control groups (Barnard *et al.,* 2021).
- **Mechanism**: Reduced AGEs and increased isoflavone intake are key factors in alleviating symptoms.

Functional Foods: Soy Isoflavones

Soy-based foods contain phytoestrogens, particularly genistein and daidzein, which mimic estrogen by binding to estrogen receptors (Table 3).

- **Genistein** suppresses estrogen-positive cancers and enhances cardiovascular health (Kim, 2021).
- **S-equol**, a daidzein metabolite, offers stronger antioxidant effects and is more prevalent in Asian populations (Watanabe and Uehara, 2019).
- **Clinical Results**: Soy diets have shown up to 84% reduction in moderate-to-severe hot flashes over 12 weeks (Barnard *et al.*, 2021).

Mechanisms of Dietary Components:

- **Polyphenols** reduce Tumor Necrosis Factor-alpha, Interleukin-6, Interferon-gammaenhance gut microbiota, and lower oxidative stress (Shakoor *et al.,* 2021).
- **Fiber and SCFAs** promote estrogen metabolism, enhance intestinal immunity, and support cognitive and inflammatory regulation (Torre *et al.*, 2021).
- **Omega-3 Fatty Acids** improve cardiovascular health by lowering omega-6-derived eicosanoids and systemic inflammation (Man *et al.*, 2020).
- **Phytoestrogens** bind ERâ, mimicking estrogen, improving sleep, cognition, and hormonal balance (Man *et al*., 2020).

Evidence-Based Studies and Practical Applications:

Mediterranean Diet and Menopause:

- Provides a synergistic mix of healthy fats, fiber, antioxidants, and polyphenols (Table 4).
- Clinical trials confirm reductions in inflammation (Interleukin-6, C-Reactive Protein), improved weight management, and cardiometabolic protection (Barrea *et al*., 2021; Mukherjee *et al*., 2022).

Soy Intake and Inflammation:

- Soy isoflavones are estrogen-like compounds shown to reduce C-Reactive Proteinlevels.
- Natural soy intake correlates with a 9% reduction in C-Reactive Proteinand milder vasomotor symptoms (Meta-analysis, 2022).

Nutrient Therapy and Lifestyle Modifications:

Nutritional supplements (Menopace®, vitamin D, calcium, B-complex) effectively reduce hot flashes and improve cognitive function (Kirby, 2006; Erdélyi *et al*., 2023).

Practical Dietary and Lifestyle Recommendations:

Key Components of the Mediterranean Diet:

- **Olive Oil and Nuts**: Supply healthy fats and antioxidants, supporting vascular health and inflammation reduction (Dreher, 2018; Trajkovska and Trajkovska, 2021).
- **Whole Grains and Legumes**: Enhance hormonal regulation and metabolic balance (Kaufman-Shriqui *et al.,* 2022).
- **Fatty Fish and Leafy Greens**: Provide omega-3s and micronutrients that protect against

Table 3 : Bioactive Soy Compounds and Menopausal Benefits

Compound	Effect	Outcome	Reference
Genistein	Anti-proliferative	↓ Breast cancer risk	Kim (2021)
Daidzein	Estrogenic	↓ Hot flashes, ↑ vaginal health	Rohr *et al.* (2008)
S-equol	Antioxidant, neuroprotective	↓ Hot flashes, ↓ inflammation	Barnard *et al.* (2021)

Table 4 : Anti-Inflammatory Dietary Strategies and Outcomes		
Strategy	Target Symptom/Outcome	Study Evidence
Mediterranean Diet	↓ CRP, ↓ VMS, ↓ Metabolic Risk	Barrea *et al* (2021); Mukherjee *et al*. (2022)
Soy Isoflavones	↓ CRP, ↓ VMS	Steenson (2023)
DII/FDII	↓ Symptom Severity, ↑ QoL	Haghshenas *et al* (2023)
Nutrient Therapy	↓ Hot Flashes, ↑ Cognitive Function	Kirby (2006); Erdélyi *et al.* (2023)

oxidative stress and systemic inflammation (Mantzioris, 2024).

- **Diverse Plant Foods**: A wide variety supports microbiota health and nutrient diversity (Garcia, 2023).

Lifestyle Adjuncts:

- **Physical Activity**: Maintains musculoskeletal and cardiovascular health, alleviates stress (Mastorakou*et al*., 2020).
- **Stress Management**: Yoga, mindfulness, and relaxation techniques help regulate cortisol and improve symptom burden (Garcia, 2023).
- **Sleep Hygiene and Hydration**: Critical for hormonal regulation and inflammation control. Probiotics further enhance gut-brain axis health (Mastorakou *et al.*, 2019).

Broader Perspective:

- Adopting anti-inflammatory diets like the Mediterranean Diet can be challenging in non-Mediterranean cultures.
- Gradual adaptation by emphasizing local, plant-based, and minimally processed foods is feasible and beneficial (Lorgeril *et al.,* 2020).

Limitations and Future Directions:

Current Limitations:

- **Inconsistent Findings**: Studies differ in methodology and outcome measures (Noll *et al*., 2021).
- **Limited Longitudinal Evidence**: Most are cross-sectional and lack causal strength (Tabung *et al*., 2016).
- **Inconsistent Dietary Indices**: Variability in DII/FDII application and interpretation (Haghshenas *et al*., 2023).
- **Demographic Bias**: Limited diversity across age, ethnicity and geography (Vaidya and Udipi, 2015).

Future Research Directions:

- **Whole-Diet Focus**: Greater emphasis on dietary patterns rather than individual nutrients (Vaidya and Udipi, 2015).
- **Causal Research**: Longitudinal and interventional designs to validate diet-symptom associations (Tabung *et al.*, 2016).
- **Global Representation**: Broader inclusion of diverse populations (Vaidya and Udipi, 2015).
- **Mechanistic Insights**: In-depth exploration of biological pathways and bioactive compounds (Skoczek-Rubiñska *et al.*, 2021).
- **Integrated Interventions**: Combine nutrition, physical activity and stress reduction for holistic care (Steenson, 2023).

Conclusion:

The menopausal transition presents a critical window where systemic inflammation, driven by declining estrogen levels, contributes to a range of physiological disturbances including vasomotor symptoms, bone loss, cardiovascular risk and metabolic dysfunction. As this review demonstrates, anti-inflammatory dietary interventions—particularly the Mediterranean Diet, the 30 Plants Diet, and low-fat vegan diets enriched with soy—isoflavones—offer safe, evidence-based strategies for alleviating menopausal symptoms and enhancing overall health. These diets exert their beneficial effects through multiple pathways: reducing pro-inflammatory cytokines, modulating gut microbiota, balancing oxidative stressand mimicking estrogenic activity via phytoestrogens. Tools such as the Dietary Inflammatory Index (DII) and its food-based variants further support the utility of diet in assessing and mitigating inflammation-related health burdens during menopause.

Incorporating functional foods like soy, polyphenol-rich fruits and vegetables, omega-3 fatty acids and high-fiber grains can meaningfully enhance quality of life while reducing long-term disease risk. Coupling these dietary patterns with supportive lifestyle practices—such as physical activity, stress management and sleep hygiene—

creates a comprehensive, integrative model of care for menopausal women. Future research must emphasize longitudinal, mechanistic and culturally adaptive studies to further refine and validate these interventions. Ultimately, adopting anti-inflammatory diets is not just a symptomatic remedy but a preventive and empowering approach to women's midlife health.

REFERENCES

Barnard, N. D., Kahleova, H., Holtz, D., del Aguila, F., Neola, M., Crosby, L. M. and Holubkov, R. (2021). The Women's Study for the Alleviation of Vasomotor Symptoms (WAVS): a randomized, controlled trial of a plant-based diet and whole soybeans for postmenopausal women. *Menopause*, **28**(10) : 1150–1156. https://doi.org/10.1097/GME.0000000000001812.

Barrea, L., Pugliese, G., Laudisio, D., Colao, A., Savastano, S. and Muscogiuri, G. (2021). Mediterranean diet as medical prescription in menopausal women with obesity: a practical guide for nutritionists. *Critical Reviews in Food Science & Nutrition*, **61**(7) : 1201–1211. https://doi.org/10.1080/10408398.2020.1755220

Barrea, L., Pugliese, G., Laudisio, D., Savastano, S., Colao, A. and Muscogiuri, G. (2021). Does mediterranean diet could have a role on age at menopause and in the management of vasomotor menopausal symptoms? The viewpoint of the endocrinological nutritionist. *Current Opinion in Food Science*, **39** : 171–181. https://doi.org/10.1016/J.COFS.2021.02.018

Barrios, Y. and Carías, D. (2012). *Adiposidad, estado pro-inflamatorio y resistencia a la insulinadurante la menopausia* [Adiposity, pro-inflammatory state, and insulin resistance during menopause]. Retrieved from https://www.researchgate.net/profile/Yubire_Barrios/publication/233734005_ADIPOSIDAD_ESTADOPROINFLAMATORIO_Y_RESISTENCIA_A_LA_INSULINA_DURANTE_LA_MENOPAUSIA/links/09e4150ae4c1fe67ed000000.pdf

Dessapt, A.L. and Gourdy, P. (2012). Ménopause et risque cardiovasculaire Menopause and cardiovascular risk. *Journal De GynecologieObstetrique Et Biologie De La Reproduction*, **41**(7). https://doi.org/10.1016/J.JGYN.2012.09.003

Dreher, M.L. (2018). *Whole Plant Foods in Aging and Disease* (pp. 59–116). Humana Press, Cham. https://doi.org/10.1007/978-3-319-59180-3_3

Erdélyi, A., Pálfi, E., Tûû, L., Nas, K., Szûcs, Z., Török, M., Jakab, A. and Várbíró, S. (2023). The Importance of Nutrition in Menopause and Perimenopause—A Review. *Nutrients*. https://doi.org/10.3390/nu16010027

Garcia Hernandez (2023). Emphasized the health-promoting effects of the Mediterranean diet and lifestyle, particularly in relation to oxidative stress and chronic disease prevention.

Gold, E. B., Xing, G., Avis, N. E., Harlow, S. D., Joffe, H., Matthews, K. A., Pavlovic, J. M., Thurston, R. C. and Waetjen, L. E. (2022). The longitudinal relation of inflammation to incidence of vasomotor symptoms. *Menopause*, **29** (8) : 894–904. https://doi.org/10.1097/GME.0000000000002005

Haghshenas, N., Hosseini Baharanchi, F., Melekoglu, E., Sohouli, M. H. and Shidfar, F. (2023). Comparison of predictive effect of the dietary inflammatory index and empirically derived food-based dietary inflammatory index on the menopause-specific quality of life and its complications. *BMC Women's Health,* **23**, Article 275. https://doi.org/10.1186/s12905-023-02485-y

Hart, M.J., Torres, S. J., McNaughton, S. A. and Milte, C. M. (2021). Dietary patterns and associations with biomarkers of inflammation in adults: a systematic review of observational studies. *Nutrition Journal*, **20**(1) : 1–14. https://doi.org/10.1186/S12937-021-00674-9

Itsiopoulos, C. (2022). The anti-inflammatory effects of a Mediterranean diet: a review. *Current Opinion in Clinical Nutrition and Metabolic Care*, **25**(6) : 415–422. https://doi.org/10.1097/mco.0000000000000872

Kaufman-Shriqui, V., Navarro, D. A., Salem, H. and Boaz, M. (2022). Mediterranean diet and health – a narrative review. *Functional Foods in Health & Disease*, **12**(9) : 479. https://doi.org/10.31989/ffhd.v12i9.989

Kim, I.-S. (2021). Current Perspectives on the Beneficial Effects of Soybean Isoflavones and Their Metabolites for Humans. *Antioxidants*, **10**(7), 1064. https://doi.org/10.3390/ANTIOX10071064

Kirby, R.S. (2006). Menopacenutrient therapy: an alternative approach to pharmaceutical treatments for menopause. *International Journal of Fertility and Women's Medicine*, **51**(3) : 125–129. https://www.ncbi.nlm.nih.gov/pubmed/17039856

La Torre, D., Verbeke, K. and Dalile, B. (2021). *Dietary fibre and the gut–brain axis: microbiota-dependent and independent mechanisms of action*. *2*. https://doi.org/10.1017/GMB.2021.3

Lorgeril, M., Salen, P. and Zalvan, C. H. (2020). *The Mediterranean Diet: A Healthy Diet for the Modern Times* (pp. 409–434). Springer, Cham. https://doi.org/

10.1007/978-3-030-48890-1_40

Man, A. W. C., Zhou, Y., Xia, N. and Li, H. (2020). Involvement of Gut Microbiota, Microbial Metabolites and Interaction with Polyphenol in Host Immunometabolism. *Nutrients*, **12**(10) : 3054. https://doi.org/10.3390/NU12103054

Mantzioris, E. (2024). Can the Mediterranean diet be a key to unlocking women's reproductive health? *Proceedings of the Nutrition Society*. https://doi.org/10.1017/s0029665124000351

Mastorakou, D., Rabaeus, M., Salen, P., Pounis, G. and de Lorgeril, M. (2019). *Mediterranean Diet: A Health-Protective Dietary Pattern for Modern Times* (pp. 233–258). Academic Press. https://doi.org/10.1016/B978-0-12-814556-2.00009-9

Mukherjee, M. S., Han, C. Y., Sukumaran, S., Delaney, C. L. and Miller, M. (2022). Effect of anti-inflammatory diets on inflammation markers in adult human populations: a systematic review of randomized controlled trials. *Nutrition Reviews*. https://doi.org/10.1093/nutrit/nuac045

Noll, P. R. e S., Campos, C. A. S., Leone, C., Zangirolami-Raimundo, J., Noll, M., Baracat, E. C., Junior, J. S., &Sorpreso, I. C. E. (2021). Dietary intake and menopausal symptoms in postmenopausal women: a systematic review. *Climacteric*, **24**(2) : 128–138. https://doi.org/10.1080/13697137.2020.1828854

Pfeilschifter, J., Köditz, R., Pfohl, M. and Schatz, H. (2002). Changes in proinflammatory cytokine activity after menopause. *Endocrine Reviews*, **23**(1) : 90–119. https://doi.org/10.1210/EDRV.23.1.0456

Rohr, U., Metka, M., Nadjafi, C. and Clementi, W. (2008). Wirkungen von Isoflavonenbeim Menschen – Überblick und Diskussion. *Menopauz*, **2**(3): 23–31. Available from: http://menopau.com/wp-content/uploads/2013/02/wien_isoflavone.pdf

Setiawan, B. and Ernawati, E. (2023). *Dietary Strategies for Alleviating Inflammation and Metabolic Disorders: A Narrative Review*, **1**(2) : 51–61. https://doi.org/10.30742/cmj.v1i2.23

Shakoor, H., Feehan, J., Feehan, J., Apostolopoulos, V., Platat, C., Al Dhaheri, A. S., Ali, H. I., Cheikh Ismail, L., Cheikh Ismail, L., Bosevski, M., Stojanovska, L. and Stojanovska, L. (2021). Immunomodulatory Effects of Dietary Polyphenols. *Nutrients*, **13**(3) : 728. https://doi.org/10.3390/NU13030728

Skoczek-Rubińska, A., Muzsik-Kazimierska, A., Chmurzynska, A., Jamka, M., Walkowiak, J. and Bajerska, J. (2021). Inflammatory Potential of Diet Is Associated with Biomarkers Levels of Inflammation and Cognitive Function among Postmenopausal Women. *Nutrients*, **13**(7) : 2323. https://doi.org/10.3390/NU13072323

Steenson, S. (2023). The role of diet in managing menopausal symptoms: A narrative review. *Nutrition Bulletin*, **48**(1) : 43–65. https://doi.org/10.1111/nbu.12607

Tabung, F. K., Tabung, F. K., Steck, S. E., Zhang, J., Ma, Y., Liese, A. D., Tylavsky, F. A., Vitolins, M. Z., Ockene, J. K. and Hébert, J. R. (2016). Longitudinal Changes in the Dietary Inflammatory Index: An Assessment of the Inflammatory Potential of Diet over Time in Postmenopausal Women. *European J. Clinical Nutrition*, **70**(12) : 1374–1380. https://doi.org/10.1038/EJCN.2016.116

Trajkovska-Broach A. and Trajkovska Petkoska A. (2021). Mediterranean diet ingredients: Their antioxidant and anti-inflammatory potential. *Austin J Biotechnol Bioeng,* **8**(2): 1114.

Vaidya, R. and Udipi, S. (2015). Metabolic syndrome in menopausal women: Modulation of contributory inflammatory markers by dietary substrates. *Journal of Obesity & Metabolic Research*, **2**(3), 155. https://doi.org/10.4103/2347-9906.162342

Watanabe, S. and Uehara, M. (2019). *Health Effects and Safety of Soy and Isoflavones* (pp. 379–394). Academic Press. https://doi.org/10.1016/B978-0-12-813148-0.00022-0

Yang, H. R., Tu, T. H., Jeong, D. Y., Yang, S. and Kim, J. G. (2020). Obesity induced by estrogen deficiency is associated with hypothalamic inflammation. *Biochemistry and Biophysics Reports*, **23**, 100794. https://doi.org/10.1016/J.BBREP.2020.100794

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