

A Systematic Literature Review of the Impact of Climate Change on Menopause: Altering the Age, Severity of Symptoms and Long-Term Effects

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Abstract

Objective: This systematic review investigates the impact of climate change on menopause, focusing on the correlation between geographical location—considering altitude, temperature, humidity, and annual temperature range—and women’s menopausal experiences. This study aims to interpret how these environmental factors influence the age of onset, severity of symptoms such as hot flushes and night sweats, and other long-term effects of menopause. Understanding these relationships addresses a significant gap in current knowledge and could guide future public health strategies. **Methods:** Through a comprehensive analysis of three cross-continental studies involving 1500 postmenopausal women from Spain, South American countries (Ecuador, Panama, Chile), various climates in Türkiye (Black Sea, Mediterranean, Continental), and the United Arab Emirates (UAE), this review evaluates diverse environmental impacts. Studies were selected based on their methodological rigor, geographical diversity, and focus on the unique and personal experiences of menopause. Data was collected via questionnaires and routine medical checkups, analyzing demographic, lifestyle, mood, symptom severity, and onset age variables. **Results:** Preliminary analysis indicates that 52.5% of participants from Spanish-speaking countries and the UAE reported vasomotor symptoms, with those in higher temperatures and lower altitudes experiencing exacerbated symptoms. Notably, Mediterranean climates were associated with an earlier menopause onset. Seasonal changes had minimal impact across all regions, suggesting lifestyle and other environmental factors play a more significant role. **Conclusions:** The findings highlight a clear link between climate-related geographical factors and the

menopausal experience. Women in warmer, lower-altitude regions suffer more severe symptoms, while those in Mediterranean climates face earlier onset. The absence of significant seasonal variations across the studies underscores the predominance of lifestyle and environmental factors over purely climatic conditions. These insights pave the way for targeted interventions and support the need for further public health research into the complex interactions between climate change and menopause.

Keywords

Menopause, Climate Change, Women's Health, Perimenopause

1. Introduction

Menopause, marked by the cessation of menstruation and the end of reproductive capacity, typically occurs between the ages of 45 and 55, with the median age around 51 [1]. The timing of menopause is influenced by a variety of factors, including educational level, occupation, marital status, age at menarche, parity, and smoking habits [2]. Notably, the age at which menopause occurs carries its own health implications: early menopause is linked to an increased risk of cardiovascular disease, osteoporosis, and metabolic syndrome, while late menopause heightens the risk of estrogen-sensitive cancers [3].

The experience of menopause and its accompanying symptoms vary significantly among individuals. Common symptoms include hot flashes, night sweats, mood changes, weight gain, and sleep disturbances [4]. Research suggests that ethnicity may influence the severity of vasomotor symptoms such as hot flashes and night sweats [5]. However, the term “ethnicity” encompasses a broad range of factors, including body mass index (BMI), educational attainment, parity, diet, socioeconomic status, physical activity, attitudes and beliefs toward menopause, climate, and genetic predispositions [6].

Studies have reported relatively high frequencies of hot flashes in women from diverse regions, including North America, Europe, Latin America, Africa, the Middle East, and Western countries, compared to lower frequencies observed among Asian women [7] [8]. Nonetheless, significant evidence points to the role of environmental factors and geographical location in shaping menopause experiences [9]. For instance, women who migrate from eastern to western regions tend to report more severe vasomotor symptoms, suggesting that environmental influences may outweigh ethnic determinants [10]. While some evidence hints at climate's potential impact on menopause, conclusive findings are lacking, likely due to variations in study designs, sampling methods, and populations [11]-[13].

This systematic literature review aims to delve into the existing body of research, focusing on the three studies that have specifically investigated the im-

pact of climate change on menopause [14]-[16]. It seeks to interpret how climate change may be altering the age of onset, severity of symptoms, and long-term effects of menopause, filling a crucial gap in our understanding of this complex phenomenon. While prior research has broadly examined this association, this review dissects the nuances of the aforementioned factors and how this might exacerbate or mitigate menopausal symptoms.

2. Methods

2.1. Study Design and Participants

This systematic literature review synthesizes findings from three distinct studies exploring the impact of climate change on menopause, with each study employing rigorous methodology to investigate certain associations within different populations and diverse geographical settings [14]-[16]. Additionally, the uniqueness in population studies and climate variables make these strong studies for analysis. Criteria for inclusion also emphasized the comprehensive assessment of menopausal symptoms, diversity in climatic exposure, and representation of varying altitudes and temperatures. Our systematic search spanned databases such as PubMed, Web of Science, and Scopus, using keywords related to “menopause,” “climate change,” “geographical factors,” and “menopausal symptoms.” The search, covering literature up to April 2023, followed PRISMA guidelines for systematic reviews. Studies were screened for relevance based on titles, abstracts, and full texts, applying inclusion and exclusion criteria to ensure focus and quality. We assessed the quality of included studies using the Newcastle-Ottawa Scale, considering their design, comparability, and outcome measurement.

Study 1: Multinational Cross-Sectional Survey

The first study targeted Spanish-speaking members of CAMS (South and Central America and Spain), aiming for a diverse sample in terms of temperature, humidity, and altitude across urban environments [14]. Participants were perimenopausal or postmenopausal women aged 45 - 55 years, primarily from non-clinical settings. Exclusions included severe medical conditions, psychiatric disorders, and non-natural menopause causes. Data collection involved detailed questionnaires on health, lifestyle, and menopausal symptoms, utilizing measures like the Hot Flush Rating Scale (HFRS) and the Women’s Health Questionnaire (WHQ) for symptom assessment.

Study 2: Menopause Clinic Patients

The second study focused on 232 postmenopausal women attending a menopause clinic in a teaching hospital, divided according to the climate of their reproductive years (Continental, Black Sea, Mediterranean) [17]. The study investigated natural menopause’s onset age and metabolic factors, adjusting for known contributors like educational status and lifestyle habits. Physical measurements and biochemical analyses were conducted, with statistical analyses determining associations between climatic exposure and menopausal outcomes.

Study 3: Cross-Sectional Survey in the UAE

The third study recruited 200 women per season in the United Arab Emirates, aiming to understand the hyper-arid climate's effect on vasomotor symptoms among perimenopausal and postmenopausal women [16]. Inclusion criteria mirrored those of Study 1, adapted for the native Emirati population. This study also employed the HFRS and WHQ, alongside the Menopause Representations Questionnaire (MRQ) to capture perceptions and beliefs about menopause. Data collection varied seasonally to examine potential differences in symptom reporting.

2.2. Data Collection and Analysis

In all studies, questionnaires were translated into the local language using forward and backward translation techniques to ensure linguistic and cultural appropriateness. The studies utilized a mix of recruitment strategies, from health centers to public places and media outreach, striving for broad representation. Ethical approvals were obtained in accordance with local regulations. Data from completed questionnaires were analyzed at a coordinating center in the UK, employing the SPSS software for statistical analysis. The analysis focused on quantifiable data such as symptom frequency and severity, lifestyle factors, and demographic details. Advanced statistical methods, including ANOVA, chi-square tests, and regression analyses, were used to explore predictors of menopausal symptoms and the influence of climatic factors.

2.3. Synthesis Approach

This review systematically evaluated the methodologies and findings of the three studies to identify common themes and divergent results. By integrating diverse research approaches and outcomes, the review aims to offer a comprehensive understanding of how climate change might influence menopause's clinical and personal experiences.

3. Results

3.1. Sociodemographic and Health Variables across Studies

Study 1 involved 896 women, mainly married or with a partner, aged 50, with children, and working full-time or part-time [14]. The average BMI was in the overweight range. Most consumed meat, fish, and vegetables, with low alcohol intake and exercise levels. Hot flush prevalence varied by location, with an average of 58.5% experiencing vasomotor symptoms. The study found associations between hot flush prevalence and several factors, including temperature, age, general health, and diet, but not BMI or altitude. Hot flush frequency and problem rating were inversely related to altitude and directly related to temperature and humidity.

Study 2's participants had a mean age of 59.7 years and lived in various climates [17]. Differences were noted in the age at menopause, menarche, gravidity,

ty, BMI, and HDL levels across climates, with the lowest mean age at menopause in the Mediterranean climate. Climate and cigarette smoking were associated with the age at menopause. The study emphasized the impact of climate, smoking, and other factors on menopausal age and health markers.

Study 3 surveyed 372 women in the UAE, focusing on perimenopausal and postmenopausal women [16]. The study highlighted the role of sociodemographics, lifestyle, and health variables on menopause symptoms. Employment, diet, BMI, and psychological factors were significant predictors of hot flashes and night sweats (HFNS) prevalence. The findings underscored the complex interplay of various factors, including diet and lifestyle, on menopause symptoms for each individual.

3.2. Key Findings and Implications

The three studies collectively highlight the multifaceted nature of menopause experiences, influenced by sociodemographic factors, health and lifestyle variables, climate, and geographic altitude [14]-[20]. While the specific impacts vary across studies, several trends emerge:

- **Impact of Climate and Geography:** Altitude, temperature, and humidity have varied effects on menopause symptoms [14]-[16]. Higher altitudes are associated with lower symptom prevalence, while higher temperatures and humidity correlate with increased vasomotor symptom severity. Mediterranean climates are linked to an earlier onset of menopause, suggesting climate influences the timing and experience of menopause [17].
- **Sociodemographic and Lifestyle Influences:** Lifestyle choices and health variables, including BMI, smoking, diet, and exercise, significantly impact menopause symptoms [14]-[20]. Employment status, educational level, and psychological factors further contribute to the individual variability in menopause experiences.
- **Cultural and Regional Variations:** The studies, conducted in diverse geographic and cultural settings, indicate that menopause experiences and symptom prevalence can vary significantly by region [14]-[16]. This diversity underscores the need for culturally sensitive approaches to menopause management and support.
- **Health Implications:** The association between menopause symptoms, particularly vasomotor symptoms, and broader health markers such as HDL levels suggests that menopause can have significant long-term health implications [17]. This connection highlights the importance of addressing menopause symptoms not only for immediate quality of life but also for long-term health outcomes.

The impact of climate change on menopause is a complex issue influenced by a range of factors including geographic location, lifestyle, health status, and sociodemographic variables [14]-[20]. The reviewed studies provide evidence of the diverse ways in which climate and environmental factors can influence menopause symptoms and experiences. Further research is needed to understand

the mechanisms behind these associations and to develop targeted interventions to support women through the menopausal transition in a changing climate.

3.3. Bias and Limitations

Potential biases include variations in sampling methods, participant self-reporting, and the representativeness of the samples [14]-[20]. The studies may have selection biases, especially in recruitment from clinical settings or specific populations, which could limit generalizability. Publication bias might be present, as studies with significant findings are more likely to be published. Future research should employ longitudinal designs to better capture the long-term effects of climate change on menopause and consider the cultural and societal influences that shape menopause experiences.

4. Discussion

4.1. Synthesis of Findings across Studies

This review synthesizes findings from three studies, providing a comprehensive understanding of how climate change and geographical factors impact menopause [14]-[16]. The results underscore the complexity of menopause, shaped by an interplay of environmental, physiological, psychological, and sociodemographic factors.

Environmental Influences: Consistently, the studies reveal that higher temperatures and specific climate conditions (e.g., Mediterranean climate) are correlated with increased prevalence and severity of menopausal symptoms, particularly HFNS [14]-[17]. This association suggests that climatic factors directly influence women's experiences of menopause, potentially through effects on the body's thermoregulatory systems.

Altitude and Seasonality: Interestingly, the first study highlighted an inverse relationship between altitude and HFNS frequency and severity, suggesting that women living at higher altitudes experience fewer and less severe symptoms [14]. This finding adds a complex layer to understanding menopause, indicating that not only temperature but also altitude and perhaps oxygen levels may play roles in symptom manifestation.

Health and Lifestyle Factors: Across the studies, factors such as BMI, exercise, diet, and psychological health (anxiety and depression) emerged as significant predictors of menopausal symptoms [14]-[20]. These results affirm the multifaceted nature of menopause, where biological, psychological, and lifestyle factors intersect to shape women's experiences.

Sociodemographic Variables: The influence of sociodemographic variables such as marital status, employment, and educational level on menopause symptoms was explored, with mixed findings [14]-[16]. Cultural and societal factors significantly shape menopause experiences. The studies underscore the need to consider cultural attitudes, beliefs, and practices when addressing symptoms. These factors may indirectly impact menopausal experiences through their ef-

fects on women's health, lifestyle choices, and access to care.

4.2. Implications for Future Research and Practice

Future studies should employ longitudinal designs to capture the long-term effects of climate change on menopause through:

- Exploring Interactions between Environmental and Individual Factors: Investigate how individual health and lifestyle choices interact with environmental factors like climate and altitude to influence menopause symptoms.
- Developing Tailored Interventions: Given the variability in symptom experiences based on geographic location and personal health factors, interventions should be customized to address the specific needs and contexts of different populations.
- Addressing Psychological Components: With the significant role of anxiety and depression in exacerbating menopausal symptoms, there is a clear need for integrated care approaches that address both physical and psychological aspects of menopause.
- Considering Cultural and Societal Influences: Further research should explore how cultural perceptions of menopause and societal norms influence women's experiences and coping strategies during the menopausal transition.

5. Conclusions

This systematic literature review highlights the complex interplay between climate change, geographical factors, and the menopause experience [14]-[20]. The reviewed studies collectively point to significant environmental impacts on menopausal symptoms, with temperature and altitude playing crucial roles [14]-[17]. They also reaffirm the importance of considering individual health, psychological factors, and lifestyle choices in understanding and managing menopause.

This review acknowledges the potential confounding effects of lifestyle and socioeconomic status on the relationship between climate and menopause symptoms [14]-[20]. For instance, access to healthcare and diet might mediate the severity of symptoms experienced in different climates, suggesting that future research should incorporate these variables into their analysis. This review is subject to limitations, including potential publication bias and the heterogeneity of study designs. The variability in geographical settings and climatic conditions of the included studies may affect the generalizability of our findings. Future research should aim for more standardized study designs to enhance comparability.

The findings emphasize the necessity for a multifaceted approach in research and healthcare practice, one that considers the holistic environmental, physiological, psychological, and sociodemographic dimensions of menopause [14]-[20]. Actional public health strategies such as the development of targeted public health campaigns that educate women on the potential impact of climate on

menopause as well as healthcare providers considering environmental factors when advising women on managing menopausal symptoms bring awareness and education to the public and policymakers. As climate change continues to alter environmental conditions globally, understanding its impact on health, particularly menopausal health, becomes increasingly vital for developing effective support and interventions for women worldwide.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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