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DIGITAL MENOPAUSE CARE AS AN EMERGING FemTech FIELD: A REVIEW OF MOBILE APPLICATIONS, WEARABLE SENSORS, AND AI-BASED SYMPTOM MONITORING IN PERI- AND POSTMENOPAUSAL HEALTH

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ABSTRACT

Digital menopause care is becoming one of the most important areas of FemTech development, responding to the growing needs of women in the peri- and postmenopausal period, for whom vasomotor symptoms, sleep disturbances, mood swings, urogenital problems, and a decline in quality of life often remain underdiagnosed and undertreated. The aim of this review article is to discuss the current capabilities and limitations of mobile health apps, wearable devices, and AI-based tools in symptom monitoring, self-management support, health education, and the personalization of menopause care. An analysis of available studies indicates that mobile apps and digital health programs can help reduce the severity of menopausal symptoms and improve physical activity, sleep quality, mental well-being, communication with healthcare providers, and patients' sense of agency. At the same time, the evidence remains heterogeneous, and many solutions require better clinical validation, greater involvement of medical experts, transparent quality standards, and more effective data protection. Issues of accessibility, digital literacy, user representativeness, and the risk of exacerbating health inequalities are also of particular importance. Digital menopause care has the potential to complement traditional treatment models, but its safe implementation requires interdisciplinary collaboration among clinicians, technology designers, researchers, and regulators.

KEYWORDS

Menopause; FemTech; Mobile Health Applications; Wearable Sensors; Artificial Intelligence; Women's Digital Health

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1. Introduction

Menopause is a natural but complex stage of life that marks the permanent cessation of menstruation and results from the decline in ovarian function and the gradual loss of gonadal steroids. The perimenopausal period preceding the last menstrual period is characterized by irregular cycles, hormonal fluctuations, and a variable response of the hypothalamic-pituitary-ovarian axis. Although menopause is a physiological process, its clinical course varies widely: in some women, symptoms are mild or nearly imperceptible, while in others they persist for many years and significantly disrupt daily functioning, mental health, sexuality, sleep, occupational activity, and overall quality of life [8, 10, 12, 27].

The significance of menopause as a public health issue is growing alongside the aging of the population and the increasing life expectancy of women. Women may spend a significant portion of their lives in the peri- or postmenopausal period, and symptoms such as hot flashes, night sweats, sleep disturbances, irritability, mood swings, anxiety, reduced concentration, urogenital symptoms, pain, skin changes, decreased libido, or metabolic issues may require long-term support. Vasomotor symptoms are among the most common manifestations of this period, but menopause also involves psychological, cognitive, skeletal, cardiovascular, and social consequences. It is particularly important to note that symptoms may begin as early as perimenopause, intensify during the late phase of the menopausal transition, and persist after menopause, requiring a continuous approach rather than merely short-term medical intervention [8, 10, 12, 18, 21, 29].

Despite the prevalence of menopause, many women still report insufficient preparation for this stage of life, limited access to reliable education, and difficulties in obtaining adequate medical care. Studies emphasize that women often feel underinformed, and symptoms are sometimes downplayed by both their social circle and the healthcare system. A lack of knowledge can influence how symptoms are interpreted, delay seeking help, and increase feelings of isolation. Additionally, menopause is often a taboo subject, particularly in the context of work, sexuality, mental health, and aging, which hinders open communication with doctors, family, employers, and coworkers [1, 8, 10, 14, 19, 20, 27].

Traditional menopausal care is based on clinical consultations, hormone therapy, selected non-hormonal therapies, psychological interventions, and lifestyle recommendations. Menopausal hormone therapy remains the most effective treatment for bothersome vasomotor symptoms and some urogenital symptoms in appropriately selected patients; however, not every woman can or wants to use it. There are also non-hormonal therapies, behavioral interventions, physical activity, cognitive-behavioral therapy, and educational support that can improve specific areas of functioning. At the same time, access to specialized care is often limited by time constraints in primary care, uneven availability of specialists, costs, geographic barriers, stigmatization, and low competence among some staff regarding menopause [10, 11, 12, 24].

In this context, digital menopause care is gaining increasing importance, encompassing mobile apps, educational platforms, telemedicine, symptom-monitoring tools, digital behavioral interventions, wearable devices, and systems utilizing artificial intelligence. These solutions can support women in self-tracking symptoms, identifying triggers, monitoring sleep, physical activity, and mood, preparing for medical consultations, and making treatment decisions. Apps and digital programs can also offer educational content, relaxation exercises, elements of cognitive-behavioral therapy, pelvic floor muscle exercises, support from specialists, and personalized recommendations, making them a potential complement to traditional care [1, 2, 4, 6, 7, 8, 11, 13, 17, 19, 24, 27].

The development of digital menopause tools is part of the broader field of FemTech, i.e., technologies designed with women's health needs in mind. FemTech can help bridge the data gap regarding women's health, promote health self-awareness, and empower patients. This is particularly significant in the context of menopause, as this stage of life has long been underrepresented in both research and the design of health technologies. From a societal perspective, FemTech can shift menopause from the private, stigmatized, and marginalized realm to that of an overt, measurable, and supportable health need [23, 25, 26, 27].

At the same time, enthusiasm for FemTech requires critical evaluation. Analyses to date indicate that some health apps for women do not contain sufficiently reliable medical information, lack clear input from clinical experts, fail to meet high privacy standards, or are based on simplified notions of gender, the body, reproduction, and aging. In the case of menopause, this issue is particularly important, as apps may process data on psychological, sexual, and urogenital symptoms, hormone therapy, physical activity, and lifestyle. A lack of transparency regarding how data is stored and used can undermine users' trust and limit the ability to safely implement digital care [5, 23, 25, 26, 27].

Mobile apps are a key component of digital menopause care. Reviews of menopause apps show that available solutions vary in quality, functionality, readability, content scope, and the level of expert involvement. Some apps focus primarily on education, while others allow users to track symptoms, their cycle, mood, activity, or triggers. Research findings suggest that regular use of these apps may be associated with reduced symptom severity, improved knowledge, better preparation for doctor visits, and a greater sense of control. At the same time, the quality of evidence varies, and many available apps have not been evaluated in rigorous clinical trials [1, 5, 6, 7, 11, 13, 14, 17, 19, 27].

A second important area involves wearable devices and physiological monitoring technologies. Wearables can measure physical activity, sleep, heart rate, temperature, skin conductance, metabolic parameters, or signals associated with vasomotor symptoms. In the context of menopause, the ability to continuously, passively, and more objectively monitor symptoms is particularly important, as these symptoms have often been assessed solely on the basis of self-reports. This applies especially to hot flashes, sleep disturbances, physical activity, and cardiovascular parameters. At the same time, wearables require further validation in perimenopausal and postmenopausal women, as measurement accuracy, data interpretation, and the clinical significance of results may vary depending on age, body weight, comorbidities, medications, and the context of use [2, 10, 12, 15, 16, 18, 28, 29, 30].

Artificial intelligence can expand the capabilities of digital menopause care by analyzing large datasets, detecting symptom patterns, predicting risk, personalizing recommendations, and integrating data from apps, wearable devices, medical records, and patient-reported experiences. In an ideal model, AI could support the transition from reactive care, in which a woman seeks help only when symptoms become severe, to proactive care, based on early detection of changes, monitoring of treatment response, and tailoring interventions to an individual's health profile. Such an approach may encompass not only vasomotor symptoms but also sleep, mood, and metabolic, cardiovascular, bone, and urogenital risks [4, 10, 12, 15, 16, 22, 28, 29].

At the same time, digital menopause care raises questions about equitable access. Mobile technologies can increase access to education and support for women who do not have easy access to a specialist, fear stigmatization, or need a flexible tool that can be used in daily life. They can also facilitate communication with a doctor through organized data on the patient's symptoms and questions. On the other hand, digital solutions may exacerbate inequalities if they are designed primarily for people with high digital literacy, strong language proficiency, stable internet access, higher socioeconomic status, and experience using health apps. Therefore, the evaluation of digital menopause care must encompass not only clinical efficacy but also accessibility, usability, data representativeness, and safety [14, 17, 19, 20, 21, 23, 25, 26, 27].

The aim of this review article is to discuss digital menopause care as an emerging area of FemTech, with a particular focus on mobile apps, wearable devices, and AI-based tools for monitoring symptoms and supporting the health of women during the perimenopausal and postmenopausal periods. The review focuses on the potential of these technologies in terms of education, self-monitoring, personalized care, improved communication with healthcare providers, and reducing the burden associated with menopausal symptoms. At the same time, it analyzes the limitations of the evidence, issues regarding app quality, data privacy, the risk of digital inequities, and the need to design solutions based on sound clinical knowledge and the actual needs of users [1, 2, 3, 5, 6, 8, 10, 11, 12, 14, 17, 19, 23, 25, 26, 27].

2. Methodology

This article is a narrative literature review focused on analyzing digital menopause care as an emerging area of FemTech. The review is based on a corpus of 30 publications, including primary studies, cohort and intervention studies, study protocols, systematic and narrative reviews, analyses of mobile applications, and publications on wearable devices, artificial intelligence, telemedicine, data privacy, and the clinical background of menopause [1–30].

The main research question was: How can mobile apps, wearable devices, and AI-based tools support symptom monitoring, health education, self-management, personalized care, and improved quality of life for perimenopausal and postmenopausal women? Additional areas of analysis included the quality and functionality of apps, the effectiveness of digital health interventions, the role of physical activity and behavioral interventions, the importance of telemedicine and AI, as well as limitations related to data privacy, information reliability, digital inequalities, and user representation [1, 2, 3, 5, 6, 7, 8, 11, 12, 14, 15, 17, 19, 22, 25, 26, 27].

The review included studies directly related to menopause, perimenopause, or the health of middle-aged women, provided they discussed the use of digital technologies, mobile apps, online programs, wearable devices, telemedicine, artificial intelligence, decision-support tools, or digital sources of health information. General publications on the physiology and symptoms of menopause, as well as broader applications of AI, telemedicine, and wearables, were also included if they provided clinical, technological, or ethical context relevant to digital menopause care [10, 12, 15, 16, 18, 21, 22, 28, 29, 30].

For each publication, information was extracted regarding the objective, study type, population or user group, type of technology analyzed, main results, limitations, and clinical and social implications. The data were grouped thematically into the following areas: mobile apps and digital programs, physical activity and health behavior change, wearable devices and objective monitoring of physiological parameters, artificial intelligence and risk prediction, health education, communication with healthcare professionals, mental health, workplace, pelvic floor health, data privacy, ethics, and equity of access [1, 2, 3, 6, 7, 8, 12, 14, 15, 17, 18, 19, 20, 21, 22, 25, 26, 27].

Due to the diversity of study types, populations, measurement tools, observation periods, interventions, and endpoints, a meta-analysis was not conducted. A descriptive narrative synthesis was used, focused on identifying recurring findings, research gaps, and practical implications for the design and implementation of digital menopause care. The quality of evidence was assessed narratively, taking into account, among other factors, the lack of randomization in some studies, the self-reported nature of the results, short follow-up periods, limited representativeness of the samples, varying quality of the applications, insufficient clinical validation, and potential conflicts of interest related to the evaluation of commercial solutions [1, 2, 3, 5, 6, 7, 8, 11, 13, 14, 17, 19, 22, 25, 26, 27].

This methodology allowed us to combine clinical, technological, behavioral, and social perspectives, in line with the interdisciplinary nature of the topic. The results are presented thematically rather than chronologically to highlight both the potential of mobile applications, wearable devices, and artificial intelligence, as well as the conditions for their safe, effective, and equitable implementation in the care of perimenopausal and postmenopausal women [1–30].

3. Results

3.1 Clinical Significance of Digital Menopause Care

The analyzed studies indicate that menopause and the perimenopausal period constitute a multidimensional health experience, encompassing not only vasomotor symptoms but also sleep disturbances, mood changes, urogenital symptoms, sexual complaints, metabolic changes, bone, skin, and cognitive issues, as well as social and occupational consequences. These symptoms may appear as early as perimenopause, intensify during the later stages of the menopausal transition, and persist for many years after the last menstrual period. For this reason, digital menopause care should be understood not as a single tool for tracking hot flashes, but as a potential long-term support system encompassing education, symptom monitoring, support for therapeutic decisions, promotion of healthy behaviors, and improved communication with healthcare providers [1, 6, 8, 10, 12, 18, 21, 24, 29, 30].

A key finding of the review is the recurring description across many sources of a gap between the scale of women's health needs and the actual availability of menopausal care. Women often report insufficient knowledge about menopause, difficulty interpreting symptoms, a sense of isolation, a lack of preparation for discussions with their doctor, and the experience of having their symptoms downplayed. At the same time, some primary care physicians and other specialists may lack sufficient training to comprehensively manage patients during the menopausal period. In this context, digital solutions can serve as a bridge between the daily experience of symptoms and formal medical care [1, 8, 12, 14, 19, 20, 24, 27].

3.2 Mobile Apps as Tools for Education, Self-Monitoring, and Symptom Management

Mobile apps are among the most frequently studied forms of digital menopause care. However, studies evaluating menopause apps reveal significant variation in the quality, functionality, readability, and reliability of available solutions. Some apps offer basic education, while others allow users to track symptoms, menstrual cycles, triggers, mood, sleep, physical activity, or self-management strategies. Review studies have noted that many apps have limited involvement of medical experts, insufficiently developed therapeutic features, and overly complex language, which may limit their usefulness for some users [1, 5, 14, 19, 27].

Reviews of apps available on the market indicate that the number of apps meeting rigorous inclusion criteria is often small, and their quality, as assessed using standardized tools such as the Mobile Application Rating Scale, frequently leaves room for improvement. One analysis of the German market identified a very limited number of menopause apps meeting linguistic and thematic criteria, and expert ratings were low, particularly regarding engagement, subjective quality, and potential therapeutic benefit. Similar conclusions emerge from a review of apps with a specific focus on osteoporosis, which highlighted that only a fraction of the apps contained content related to this important postmenopausal health issue, and that overall functionality and quality required improvement [1, 5].

At the same time, studies on the use of specific apps and digital programs suggest that regular use of mobile tools may be associated with an improvement in menopausal symptoms. In a study of the Health & Her app, greater engagement with the app over two months was associated with a greater reduction in symptoms, and specific aspects of usage, such as daily activities within the app, symptom logging, and menstrual tracking, were also associated with improvement. Similarly, a study of a digital menopause program reported a reduction in the total Menopause Rating Scale score and in the somatic, psychological, and urogenital subscales after three months of program use [6, 7].

The significance of mobile apps is not limited to the direct reduction of symptoms. Users also describe apps as tools that increase knowledge, help organize the experience of menopause, and facilitate communication with doctors. Tracking symptoms can provide patients with concrete data that strengthens their sense of control and aids in conversations with medical staff. In qualitative studies, apps were presented as a tool to counter epistemic injustice, that is, a situation in which women's experiences are undervalued, disbelieved, or not taken seriously enough within the healthcare system [14, 19, 20, 27].

3.3 Digital Interventions for Physical Activity and Health Behavior Change

An important group of the interventions analyzed consists of digital programs supporting physical activity and health behavior change in middle-aged women. A systematic review of mobile physical activity interventions for menopausal women indicated that activity-tracking apps and devices may lead to a small or moderate increase in physical activity, at least in the short term. Studies also reported beneficial changes in body weight, anxiety, sleep quality, and menopause-related quality of life, although the heterogeneity of the interventions limited the ability to draw definitive conclusions [2].

Digital behavioral interventions often utilize behavior change techniques such as self-monitoring, feedback, goal setting, behavioral instructions, repetition, substitution, and knowledge reinforcement. However, a review of behavior change techniques in digital interventions for middle-aged women showed that, despite the use of many techniques, the application of psychological theories was often weak or insufficiently described. The lack of a clear link between theory, intervention technique, and the expected mechanism of change makes it difficult to assess which components of digital programs are actually effective [3].

A study using WhatsApp-based education, grounded in the Health Belief Model, demonstrated that simple and widely accessible digital tools can improve knowledge, health constructs, physical activity levels, and quality of life among perimenopausal women. This suggests that digital menopause care does not always have to involve advanced AI-based applications; it can also include low-cost, easily accessible channels for education and support, provided they are well-designed, theory-based, and tailored to users' needs [9].

3.4 Digital Therapeutic Programs and Support for Vasomotor Symptoms, Sleep, and Mental Health

Among the most promising findings are data on digital therapeutic programs targeting vasomotor symptoms and mental health. A randomized trial of the Caria app demonstrated improvements in the severity of hot flashes, depressive symptoms, and sleep quality in the group using the app compared to an online educational control. Participants had problematic vasomotor symptoms and at least one severe behavioral symptom, such as depression, anxiety, or sleep disturbances, making the study particularly relevant for women with a more complex clinical presentation of menopause [11].

Mental health is one of the key areas of digital menopause care. A study on the intention to use mental health apps during menopause showed that a large proportion of participants reported a negative impact of menopausal symptoms on their mental health, and many of them sought help online. The most desired app features were psychoeducation, symptom tracking, and self-help tips. The Health Belief Model suggested that the intention to use the app is particularly influenced by cues to action, perceived barriers, susceptibility, and benefits, which underscores the importance of credible recommendations, ease of access, and the reduction of barriers to use [17].

Digital tools can also support cognitive-behavioral therapy, relaxation exercises, meditation, and self-regulation strategies. Although not all of the studies reviewed directly addressed digital CBT, many emphasized the importance of behavioral, educational, and self-help components in managing menopausal symptoms. From a clinical perspective, it is particularly important that digital support can be accessed outside the doctor's office, in real time, and in everyday life, when symptoms such as hot flashes, insomnia, or anxiety are most bothersome [3, 6, 10, 11, 17].

3.5 Wearable Devices and Objective Symptom Monitoring

Wearable devices are an important component of future digital menopause care, as they enable continuous or frequent monitoring of physiological parameters such as heart rate, skin temperature, activity, sleep, skin conductance, blood pressure, and other biological signals. In general medicine, wearables are described as tools supporting a predictive, preventive, personalized, and participatory model of care. Their significance in menopause stems from the ability to transition from a subjective and retrospective description of symptoms to more continuous, contextual, and partially objective monitoring [15, 16, 18, 28, 29, 30].

Hot flashes are a particularly relevant example. Classic studies of the mechanisms underlying hot flashes indicate that they are associated with a rapid heat dissipation response, involving sweating, peripheral vasodilation, and a sensation of intense heat. Objective measurements, such as skin conductance, can detect episodes of hot flashes, including those occurring at night, which are not always accurately recalled and reported. This provides a theoretical and practical rationale for the development of sensors capable of more precise monitoring of vasomotor symptoms in the home environment [10, 30].

Wearables can also support the monitoring of sleep and physical activity, which are closely linked to the well-being of women during menopause. Reviews on wearable devices in sleep disorders and cardiometabolic health monitoring show that these technologies increasingly utilize artificial intelligence algorithms for pattern recognition, risk classification, and diagnostic support. In menopause, this could be important for identifying sleep disorders, vasomotor symptom burden, changes in activity, cardiovascular risk, and overall health profile over time [15, 16, 18, 28, 29].

At the same time, the review highlights significant limitations of this group of technologies. Data generated by consumer devices may be inaccurate, depending on the device type, algorithm, method of wear, signal quality, and user characteristics. Many solutions require clinical validation in populations of perimenopausal and postmenopausal women. It is also essential to assess whether additional data actually improve clinical decisions and quality of life, or merely increase the information burden on patients and physicians [15, 16, 18, 22, 28, 29].

3.6 Artificial Intelligence and Personalization of Postmenopausal Care

Artificial intelligence is presented in the analyzed sources as a technology capable of supporting risk prediction, early detection of health problems, personalized interventions, and analysis of data from multiple sources. In the context of postmenopausal health, AI can support the assessment of risk for osteoporosis, cardiovascular disease, metabolic disorders, breast cancer, sleep disorders, vasomotor symptoms, and mental health. Its potential lies in integrating clinical, imaging, biometric, behavioral, and patient-reported data to create more personalized care models [12, 15, 16, 22, 28, 29].

With regard to menopause, the ability to transition from reactive to proactive care is particularly important. Instead of reacting only to severe symptoms or complications, AI systems could identify patterns of worsening sleep, increased hot flashes, low mood, decreased physical activity, or increased cardiovascular risk. They could also support recommendations regarding lifestyle, treatment decisions, medical consultations, or intensified monitoring. However, such a model requires high-quality data, algorithmic transparency, and clinical validation [12, 15, 16, 22, 28, 29].

AI can also support digital telemedicine through triage automation, symptom analysis, detection of warning signs, decision support, and personalized health education. A review on AI in telemedicine indicates that this technology can improve diagnostics, patient monitoring, and remote care delivery, but at the same time raises issues related to privacy, algorithmic bias, interoperability, accountability, and limited validation in real-world clinical settings. The same limitations will apply to digital menopause care, particularly if algorithms are intended to support therapeutic decisions [22].

3.7 Digital Menopause Care in the Workplace

Another important area concerns the impact of digital menopause care on occupational functioning. Menopausal symptoms, such as hot flashes, sleep disturbances, fatigue, irritability, concentration problems, and low mood, can affect productivity, absenteeism, job satisfaction, and decisions regarding continued employment. A study of a specialized digital app offered by an employer showed a reduction in the severity of menopausal symptoms and a decrease in impairment of work performance, and symptom improvement was associated with the degree of engagement with the app [8].

These results suggest that digital menopause programs can be part of broader strategies to support women in the workplace. Apps can offer education, personalized support, access to specialists, symptom tracking, and coping strategies, while maintaining greater privacy than traditional forms of disclosing health issues in the workplace. This is particularly important because menopause remains a taboo subject, and women may not feel comfortable discussing symptoms with supervisors or coworkers [8, 14, 19, 20].

3.8 Digital Urogenital Care and Pelvic Floor Health

Although the main focus of this article is on apps, wearables, and AI in menopause care, the findings also highlight the importance of digital programs for pelvic floor dysfunction. A prospective study of a digital program for postmenopausal women with pelvic floor dysfunction demonstrated high completion rates, high engagement, a low rate of adverse events, and improvements in symptoms, the impact of symptoms on daily life, mental health, and productivity. The program combined education, pelvic floor muscle training, a mobile app, real-time biofeedback, and asynchronous supervision by a physical therapist specializing in pelvic health [18].

This area demonstrates that digital menopause care can extend beyond monitoring hot flashes to address issues that are often embarrassing, under-treated, or difficult to report in traditional care settings. Pelvic floor dysfunction, urinary incontinence, genitopelvic pain, and symptoms related to pelvic organ prolapse are common in the postmenopausal period, and barriers to accessing treatment include time, geography, stigma, and a lack of specialists. Remote programs can increase access to care, provided they are safe, personalized, and supervised by appropriately trained specialists [10, 18, 23].

3.9 Information Reliability, Information Overload, and the Role of Healthcare Professionals

The qualitative studies and narrative reviews analyzed show that women use digital information sources to better understand symptoms, compare their experiences with those of others, and prepare for health decisions. The use of digital technologies can increase a sense of empowerment, satisfaction with decisions, and facilitate conversations about menopause. However, users also encounter difficulties: information overload, conflicting messages, unclear author credibility, the commercial nature of some content, and a lack of representation of diverse menopause experiences [14, 19, 20].

The results indicate that digital information sources do not replace medical staff. Women still prefer the opportunity to speak with a competent doctor or other specialist who can help interpret symptoms, assess risks, and select treatment. Digital technologies should therefore support, not replace, the clinical relationship. The most promising model is one in which an app or platform organizes data, provides reliable education, and prepares the patient for a consultation, while therapeutic decisions are made in collaboration with medical staff [13, 14, 19, 20, 24].

3.10 Data Privacy, Security, and FemTech Ethics

One of the most important findings of the review is the identification of data privacy as a key prerequisite for the safe development of digital menopause care. FemTech apps may collect highly sensitive information regarding vasomotor symptoms, mental health, sexuality, menstrual cycle, hormone therapy, comorbidities, physical activity, and lifestyle. An analysis of menopause apps available in the European Union indicated that some of them do not provide a sufficient level of transparency, security, and compliance with data protection expectations [25].

A broader ethical reflection on FemTech shows that the risks are not limited to technical data security. They also concern the medical reliability of the apps, gender stereotypes, a narrow understanding of women's health, the commercialization of data, algorithmic discrimination, and the risk of shifting responsibility for health solely onto users. The proposed capability-sensitive design approach emphasizes the need to design technologies that genuinely enhance users' capabilities, rather than merely generating data or reinforcing the pressure for self-monitoring [23, 25, 26, 27].

3.11 Equitable Access and the Risk of Digital Exclusion

The results indicate that digital menopause care has the potential to reduce access barriers, but it may also create new inequalities. Apps, telemedicine, and wearable devices can be particularly helpful for women living far from specialists, with limited time, fearing stigmatization, or needing anonymous support. They may also help increase self-efficacy, health literacy, and physical activity, as shown by studies on internet use and the health of older adults [14, 17, 19, 20, 21, 22].

At the same time, digital solutions may be less accessible to people with lower digital literacy, lower levels of education, limited internet access, lower incomes, language barriers, or less trust in technology. If apps are designed primarily for well-educated, affluent, and digitally literate users, they may fail to address the needs of women most at risk of being left without care. Therefore, an evaluation of digital menopause care should always include an assessment of who can benefit from it, who remains excluded, and whether the technology exacerbates existing health inequalities [17, 21, 23, 25, 26].

3.12 Summary of Findings

In summary, the analyzed studies indicate that digital menopause care is an area with great potential but still requires clinical, technological, and regulatory maturity. The most promising results pertain to digital applications and programs supporting symptom reduction, education, self-monitoring, physical activity, mental health, pelvic floor health, and occupational functioning. Wearables and AI may enhance the personalization of care in the future through continuous monitoring and analysis of symptom patterns; however, their use requires validation, data protection, and careful design [1, 2, 3, 6, 7, 8, 10, 11, 12, 15, 16, 17, 18, 22, 27, 28, 29, 30].

The most significant limitations of current solutions include the heterogeneity of evidence, short follow-up periods in many studies, the self-reported nature of some results, limited sample representativeness, varying app quality, insufficient involvement of clinical experts, data privacy concerns, and the risk of digital exclusion. Digital menopause care should therefore not be treated as a substitute for traditional care, but as a potential complement to it, requiring integration with clinical practice, transparent quality standards, and design focused on the real needs of women in the perimenopausal and postmenopausal periods [1, 5, 6, 8, 11, 14, 19, 20, 22, 23, 25, 26, 27].

4. Discussion

4.1 Digital Menopause Care as a Complement, Not a Substitute, for Clinical Care

The results of the review indicate that digital menopause care can become an important element of the modern model of support for women in the perimenopausal and postmenopausal periods, but it should not be treated as a standalone substitute for medical consultation. Mobile apps, digital programs, telemedicine tools, and wearable devices can facilitate education, symptom monitoring, preparation for medical visits, and long-term self-monitoring; however, decisions regarding hormonal treatment, non-hormonal therapies, the diagnosis of alarm symptoms, or the assessment of cardiovascular and oncological risks still require professional clinical interpretation [1, 6, 7, 10, 11, 12, 13, 14, 19, 24].

The most valuable approach appears to be a hybrid model, in which technology enhances the patient–healthcare provider relationship rather than replacing it. An app can help a woman organize her symptoms, identify their severity, duration, and possible triggers, and then present this information to her doctor in a more concrete way than a general description during a brief visit. This approach can improve the quality of communication, support shared decision-making, and reduce the risk of symptoms being downplayed, especially when the patient has previously experienced difficulties in obtaining care [13, 14, 19, 20, 24, 27].

At the same time, technology does not automatically solve systemic problems, such as the inadequate preparation of some clinicians for menopausal care, limited appointment time, the lack of clear diagnostic and therapeutic pathways, or the social stigmatization of menopause. If apps are designed without integration into medical practice, they may merely shift the responsibility for recognizing and managing symptoms onto women, without actually improving the quality of care. Therefore, digital tools should be implemented as part of a broader system of education, communication, and access to specialized support [10, 12, 14, 19, 20, 22, 23, 26].

4.2 The Importance of Mobile Apps in Education and Symptom Self-Management

Mobile apps are currently the most visible component of digital menopause care. Their potential stems from their accessibility, flexibility, and ability to be used in the everyday context where symptoms actually occur. Compared to traditional educational materials, apps can offer dynamic symptom tracking, reminders, personalized content, behavioral activities, exercises, psychoeducational materials, and summaries ready to discuss with a doctor. This may support a sense of agency, particularly among women who previously lacked clear language to describe their menopausal experiences [1, 5, 6, 7, 13, 14, 17, 19, 27].

Available findings suggest that greater engagement with apps and digital programs may be associated with a reduction in menopausal symptoms, improved knowledge, better well-being, and greater willingness to discuss treatment. Particularly promising are data from studies in which regular use of an app or digital program was associated with a reduction in the severity of somatic, psychological, and urogenital symptoms. However, it should be emphasized that some of these studies were single-arm, observational, or based on self-reports, which limits the ability to draw conclusions about causality [6, 7, 8, 11, 18].

The uneven quality of apps available on the market remains a problem. Reviews of menopause apps point to limited functionality, insufficient expert involvement, poor content readability, and a lack of full clinical validation for many solutions. In practice, this means that the mere presence of an app in an online store should not be treated as proof of its quality, safety, or effectiveness. Women and physicians need reliable app evaluation systems that take into account medical accuracy, usability, language accessibility, data security, and real-world impact on health outcomes [1, 5, 13, 14, 19, 25].

4.3 Personalized Care: The Greatest Promise and the Greatest Challenge

One of the most compelling arguments for digital menopause care is the ability to personalize support. Menopause does not follow a single pattern: the age of symptom onset, predominant symptoms, their severity, duration, and impact on sleep, work, sexuality, mental health, and quality of life all vary. For this reason, digital solutions should enable not only general symptom tracking but also account for individual goals, treatment preferences, comorbidities, risk factors, lifestyle, and social context [1, 6, 7, 10, 12, 14, 19, 20].

Artificial intelligence and analysis of data from wearable devices may enhance this personalization in the future by identifying patterns not visible in a single consultation. For example, a system could combine data on sleep, activity, heart rate, hot flashes, mood, and interventions used to better identify which symptoms worsen under specific conditions and which strategies lead to improvement. Such an approach could support more precise recommendations regarding physical activity, sleep hygiene, behavioral techniques, medical consultations, or health risk monitoring [12, 15, 16, 18, 22, 28, 29, 30].

However, personalization requires high-quality data and careful interpretation. If algorithms are trained on data primarily from women in specific social, linguistic, ethnic, or economic groups, their recommendations may be less accurate for users outside these groups. Furthermore, menopausal symptoms are strongly influenced by psychological, cultural, and social contexts that cannot be fully captured by biometric measurements. Personalization cannot, therefore, rely solely on automated data analysis but should combine algorithms with clinical knowledge and the patient's own experience [12, 14, 19, 20, 22, 23, 26, 27].

4.4 Wearables and the Objective Assessment of Menopausal Symptoms

Wearable devices can change the way menopausal symptoms are assessed, particularly those that are variable, episodic, or difficult to recall accurately. Hot flashes, night sweats, and sleep disturbances often occur outside the doctor's office, and their assessment based solely on retrospective self-report may be subject to memory bias, the placebo effect, or underestimation of nocturnal episodes. The ability to record parameters such as skin conductance, temperature, activity, heart rate, and sleep provides a basis for more objective monitoring of selected symptoms [10, 15, 16, 18, 28, 29, 30].

The greatest value of wearables may lie not so much in a single measurement as in observing changes over time. Long-term data can help determine whether symptoms are worsening or improving, and whether they are associated with sleep, stress, physical activity, ambient temperature, or ongoing therapies. In clinical practice, such data could support the assessment of the effectiveness of interventions, such as hormone therapy, non-hormonal medications, physical activity, breathing techniques, or digital behavioral programs [2, 6, 7, 10, 11, 15, 18, 29, 30].

However, excessive reliance on consumer devices should be avoided. The accuracy of measurements depends on sensor quality, the algorithm, how the device is worn, skin type, movement, ambient temperature, comorbidities, and many other factors. Furthermore, not every parameter measured by a smartwatch or fitness tracker has direct clinical significance. Before incorporating such data into medical decisions, validation in populations of perimenopausal and postmenopausal women is necessary, as well as a clear determination of which indicators are helpful and which may only generate anxiety or information overload [15, 16, 18, 22, 28, 29].

4.5 The Importance of Mental Health and Sleep in Digital Menopause Care

Mental health and sleep should be central to the design of digital menopause care. The reviewed studies indicate that depression, anxiety, irritability, fatigue, cognitive problems, and sleep disorders can be just as burdensome as vasomotor symptoms. Additionally, these symptoms often exacerbate one another: night sweats worsen sleep, insomnia increases susceptibility to mood swings, and anxiety may amplify the subjective experience of somatic symptoms [10, 11, 17, 29].

Digital tools can support mental health through psychoeducation, mood tracking, self-help strategies, elements of cognitive-behavioral therapy, breathing exercises, meditation, sleep monitoring, and referrals to professional support when symptoms are severe. Research suggests that women are interested in such features, especially if they are reliable, easy to use, and recommended by trusted sources. Of particular importance are action prompts, understood as features that encourage users to seek help, as well as the reduction of barriers related to cost, time, stigma, and digital literacy [11, 17, 19, 20].

At the same time, mental health apps for menopause must have clearly defined limits. They should not replace the diagnosis of depression, anxiety disorders, chronic insomnia, or suicide risk. Instead, they should help users recognize when symptoms require consultation with a specialist and offer safe pathways for escalating care. Otherwise, there is a risk that women with severe symptoms will receive only general self-help advice instead of appropriate clinical intervention [10, 11, 17, 22].

4.6 Physical Activity and Behavior Change: The Need for Theory and Sustainability

Digital physical activity interventions have great potential in menopause care, as exercise can support metabolic, cardiovascular, bone, and mental health, as well as overall quality of life. Apps, trackers, and messaging platforms can help women set goals, monitor progress, receive feedback, and stay motivated. Review results suggest the possibility of short-term improvements in physical activity, as well as beneficial changes in selected menopausal symptoms and quality of life [2, 3, 9, 10, 21].

However, the key challenge remains the sustainability of behavioral change. Many digital interventions work best in the first weeks or months, when the novelty of the app boosts motivation. The long-term effect depends on whether the tool addresses the real barriers faced by middle-aged women: lack of time, family and work responsibilities, fatigue, pain, low self-confidence, shame, lack of a safe space to exercise, or previous negative experiences with physical activity. The step-counting feature alone may be insufficient if it is not accompanied by psychological, educational, and social support [2, 3, 9, 17, 21].

In designing such interventions, there is a need for greater use of behavior change theory. Reviews show that while apps and programs often employ techniques such as self-monitoring, goals, and instructions, they do not always clearly describe the mechanism of action or the link to a theoretical model. To increase effectiveness, future tools should precisely specify whether the intervention is intended to increase knowledge, self-efficacy, motivation, capacity for action, social support, or behavioral regulation, and then measure these mechanisms in studies [2, 3, 9, 17, 21].

4.7 Digital Tools and Patient Agency

One of the most valuable aspects of digital menopause care is its potential to empower patients. Apps and platforms can provide a language for describing symptoms, allow for the observation of changes over time, facilitate the recognition of recurring patterns, and prepare women for a more collaborative conversation with their doctor. In qualitative studies, users of menopause apps described a sense of greater knowledge, confidence, and the ability to advocate for their own experiences when interacting with the healthcare system [14, 19, 20, 27].

This significance is particularly relevant in light of the concept of epistemic injustice. Women going through menopause may encounter situations where their symptoms are dismissed as “normal,” “psychological,” “age-related,” or not worth treating. Data from the app does not automatically guarantee a change in the doctor’s attitude, but it can empower the patient by helping her present her symptoms in an organized manner. In this sense, technology can serve as a communication and educational tool, not merely a monitoring one [14, 19, 20, 27].

However, it is important to distinguish between empowerment and shifting responsibility. Truly supportive technology should not suggest that a woman alone bears the responsibility for resolving all menopausal issues through tracking, optimization, and self-discipline. Empowerment means greater access to knowledge, choice, and support, but it still requires accountability from the healthcare system, employers, technology designers, and regulators [23, 25, 26, 27].

4.8 Data Privacy as a Prerequisite for Trust

Data privacy is one of the most important conditions for the responsible development of digital menopause care. Data collected by menopause apps may include information on mental health, sexuality, the menstrual cycle, urogenital symptoms, hormone therapy use, relationships, work, sleep, and lifestyle. This is particularly sensitive information, the misuse of which could lead to privacy violations, discrimination, stigmatization, or a loss of trust in health technologies [23, 25, 26].

Privacy analyses of FemTech apps show that some solutions fail to meet expectations regarding transparency, security, and compliance with data protection principles. Potential issues include unclear descriptions of data processing purposes, a lack of understandable consent, sharing data with third parties, the commercialization of health information, or insufficient technical safeguards. In the case of menopause, the risk is particularly acute, as women may use these apps during a period of heightened vulnerability to mental, professional, and social challenges [25, 26, 27].

Trust in digital menopause care will depend on whether users receive clear information about what data is collected, why, by whom, how long it will be stored, to whom it may be disclosed, and how it can be deleted. Privacy policies should be written in plain language, and data protection settings should be easy to find and change. Without such transparency, even clinically valuable apps may raise legitimate concerns and limit users’ trust [23, 25, 26].

4.9 Risks of Algorithmic Bias and Digital Inequalities

Artificial intelligence can support personalized care, but at the same time, it can perpetuate or exacerbate inequalities. Algorithms learn from data that often reflects existing underrepresentation. If datasets are derived mainly from women in high-income countries, with higher education, better internet access, and more experience using health apps, the models may perform worse for women from underrepresented groups. This may relate to differences in ethnicity, language, culture, economics, education, age, disability, or place of residence [12, 17, 21, 22, 23, 26].

Digital inequalities also pertain to access to technology itself. Apps and wearable devices may be inaccessible to women who lack a modern smartphone, stable internet, the financial means to purchase devices, adequate digital literacy, or trust in online tools. Additional barriers may include language, content readability, lack of accessibility for people with disabilities, or interface designs tailored to users already well-versed in technology [1, 5, 14, 17, 19, 20, 21, 25].

For this reason, the effectiveness of digital menopause care should be assessed not only by the average improvement in symptoms within the study group, but also by whether the benefits are equitably accessible. Future studies should analyze outcomes by age, socioeconomic status, education level, digital literacy, place of residence, and other factors influencing access to care. Without such an analysis, there is a risk that digital solutions will improve care primarily for women who already had relatively good access to information and health services [17, 21, 22, 23, 25, 26].

4.10 Menopause in the Workplace: The Potential and Limitations of Digital Solutions

Digital menopause programs may be particularly important in the workplace, where symptoms such as hot flashes, sleep disturbances, fatigue, irritability, and concentration problems can affect productivity, absenteeism, and career decisions. Employer-provided apps can increase access to education and specialized support while allowing for a more private way to seek help than openly disclosing symptoms in the workplace [8, 14, 19, 20].

Research findings on workplace-based apps suggest that engagement with digital support may be associated with symptom improvement and reduced impairment in work functioning. This may be particularly important given the growing number of perimenopausal women remaining in the workforce. Employers may view digital programs as part of a broader health policy encompassing education, work flexibility, reducing stigma, and access to professional care [8].

However, care must be taken to ensure that programs offered by employers do not violate privacy or create pressure to disclose health data. Women should have full control over whether they use the program and what information is visible to the employer. Digital support in the workplace should be voluntary, confidential, and linked to tangible organizational changes, rather than treated as a simple way to shift the responsibility for occupational well-being solely onto female employees [8, 23, 25, 26].

4.11 The Role of Digital Urogenital Care and Pelvic Floor Health

Digital menopause care should also address often-overlooked areas such as urogenital symptoms, urinary incontinence, genitopelvic pain, and pelvic floor dysfunction. These are common problems that affect quality of life, sexuality, social activity, and mental health, yet are burdened by stigma and low reporting rates. Remote educational programs, pelvic floor muscle training, biofeedback, and physical therapy supervision can increase access to care for women who do not use traditional forms of treatment [10, 18, 23].

Research on digital pelvic floor programs shows that remote care can be safe, engaging, and effective in reducing symptoms and improving function. This area is particularly important because it demonstrates that digital menopausal healthcare should not focus exclusively on the most high-profile symptoms, such as hot flashes, but should encompass the full spectrum of postmenopausal health [10, 18].

At the same time, programs of this type require high-quality clinical supervision. Pelvic floor muscle training, biofeedback, and interventions for pain or urinary incontinence should be tailored to the individual patient's condition. Improperly selected exercises, lack of differential diagnosis, or ignoring warning signs could limit effectiveness and, in some cases, delay appropriate treatment. Therefore, digital urogenital programs should be designed as a remote form of professional care, rather than solely as a self-directed training app [10, 18, 24].

4.12 Quality of Evidence and the Need for More Rigorous Studies

Although the results of many studies are promising, the quality of the evidence remains mixed. Some studies are observational, single-arm, short-term, or rely on self-reported symptom measures. Such data are valuable in the early stages of technology development but are insufficient for a comprehensive assessment of the efficacy, safety, and cost-effectiveness of digital menopause care. There is a particular need for randomized controlled trials, longer-term follow-ups, comparisons with active interventions, and analysis of which elements of the app are responsible for the observed effect [2, 3, 6, 7, 8, 11, 13, 18].

Studies should also better define endpoints. Symptom reduction is important, but it is not sufficient as the sole indicator. Quality of life, sleep, mental health, sexual functioning, physical activity, communication with the physician, satisfaction with treatment decisions, safety, engagement, user retention, and the impact on healthcare utilization should be measured. For AI and wearables, it is also necessary to assess accuracy, clinical utility, and the impact of data on treatment decisions [2, 3, 11, 12, 15, 16, 18, 22, 28, 29].

It is also important to report negative results and limitations. Publications on digital technologies often focus on potential and innovation, but for clinical practice, information about low engagement, app dropout, misunderstanding of content, lack of effect, anxiety caused by monitoring, or technical difficulties is equally important. Only full reporting of benefits and limitations will allow us to distinguish between tools that are genuinely helpful and solutions that are marketable but of limited clinical utility [1, 5, 11, 14, 19, 20, 25, 26].

4.13 Implications for the Design of Future FemTech Tools

Future menopause apps and platforms should be designed with the involvement of women in various stages of menopause, clinicians, psychologists, physical therapists, data experts, ethicists, and accessibility design specialists. User-centered design should encompass not only the interface's appearance but also its language, content scope, data visualization methods, personalization options, support escalation pathways, and privacy protection. It is particularly important to take into account women with varying levels of digital and health literacy [1, 3, 5, 14, 17, 19, 20, 23, 26, 27].

A good digital tool should combine several functions: reliable education, intuitive symptom tracking, data interpretation in an understandable format, support for communication with a doctor, elements of behavior change, and clear safety guidelines. Not every app needs to include artificial intelligence or advanced sensors; in many cases, a simple, reliable, accessible, and clinically grounded tool may be of greater value than a technologically complex system without validation [1, 5, 9, 13, 14, 19, 24].

At the same time, apps should avoid reducing menopause to a matter of individual productivity, beauty, or body control. Menopause is a biological, psychological, and social experience; therefore, FemTech tools should support health, autonomy, and quality of life, rather than reinforcing the pressure to constantly monitor, optimize, and hide symptoms. Responsible design should take into account the diverse experiences of menopause, including women with chronic conditions, varying economic status, different identities, differing work experiences, and varying access to care [14, 19, 20, 23, 26, 27].

4.14 Implications for Clinical Practice and the Healthcare System

For clinical practice, the most important conclusion is the need to consciously incorporate digital tools into conversations about menopause. Physicians and other specialists should be aware that patients often use apps, websites, podcasts, forums, and social media before they come into the office. Instead of ignoring these sources, it is worth asking which tools the patient uses, what information she has found, and whether she needs help interpreting it [14, 19, 20, 24, 27].

The healthcare system could develop lists of recommended, vetted apps and platforms, similar to how treatment guidelines are created. However, such lists should be regularly updated, as apps evolve rapidly, and their features, business models, and privacy policies may change. The evaluation should cover not only medical content but also data security, accessibility, readability, and evidence of effectiveness [1, 5, 13, 14, 19, 25].

Integrating digital menopause care into the system also requires training for healthcare personnel. Clinicians should understand the basic capabilities and limitations of apps, wearables, and AI so as not to dismiss patients' data, but also not to overestimate its significance. Competencies are needed in interpreting patient-reported data, recognizing reliable sources of information, and engaging in shared decision-making using digital tools [10, 12, 13, 14, 19, 22, 24].

4.15 Limitations of This Review

This review is narrative in nature and is based on a corpus of 30 studies; therefore, it does not constitute a comprehensive systematic review of the entire literature on digital menopause care. The included publications varied in study design, population, type of technology, duration of observation, and endpoints, which precluded conducting a meta-analysis or directly comparing effect sizes across interventions [1–30].

An additional limitation is the dynamic nature of the FemTech field: apps, algorithms, wearable devices, and telemedicine platforms evolve faster than the traditional cycle of scientific publications; therefore, conclusions regarding specific applications should be considered time- and context-dependent. Some of the analyzed studies also addressed general digital technologies, AI, wearables, or telemedicine, rather than exclusively in the context of menopause; therefore, their conclusions should be considered contextual and requiring further validation in the perimenopausal and postmenopausal female population. Their inclusion was justified because they provide insight into the technological and ethical background of digital care [12, 15, 16, 22, 25, 26, 28, 29].

4.16 Directions for Future Research

Future research should focus on rigorously evaluating the long-term effectiveness of digital menopause tools. In particular, randomized controlled trials are needed to compare apps, digital programs, telehealth, or wearables with standard care, traditional education, or active behavioral interventions. Studies should cover not only vasomotor symptoms but also sleep, mental health, urogenital symptoms, physical activity, quality of life, communication with the physician, and occupational functioning [2, 3, 6, 7, 8, 11, 13, 18, 24].

Research is also needed to determine which components of digital interventions are most important. It is not yet known whether the greatest effect stems from symptom tracking, education, reminders, contact with a specialist, social support, CBT elements, biofeedback, algorithmic personalization, or increased awareness alone. A better understanding of the mechanisms of action will allow for the design of tools that are more effective, less burdensome, and better tailored to users' needs [2, 3, 6, 7, 11, 17, 18].

Finally, future research should place greater emphasis on ethics, privacy, and equitable access. Any evaluation of digital menopause care should ask not only “does it work?” but also “for whom does it work?”, “who lacks access?”, “what data is being collected?”, “does the user understand what happens to her data?”, and “does the technology empower autonomy, or does it merely increase the pressure for self-monitoring?”. Without answers to these questions, digital menopause healthcare may develop faster than its ethical and clinical frameworks [14, 17, 19, 20, 21, 22, 23, 25, 26, 27].

5. Conclusions

Digital menopause care is a rapidly developing area of FemTech that addresses an important gap in education, symptom monitoring, self-management, and access to support for perimenopausal and postmenopausal women. The reviewed evidence suggests that mobile apps, digital programs, wearable devices, telemedicine, and AI-based tools may help women better understand symptoms, monitor their variability, prepare for medical consultations, and make more informed health decisions. These technologies may also support physical activity, sleep, mental health, pelvic floor health, occupational functioning, and communication with healthcare providers [1, 2, 3, 6, 7, 8, 10, 11, 12, 14, 17, 18, 19, 20, 24, 27].

Despite this potential, digital menopause care should not be viewed as a replacement for traditional clinical care. Current evidence remains heterogeneous, and many studies are observational, short-term, single-arm, or based on self-reported outcomes. Available apps also differ in quality, clinical involvement, usability, content clarity, privacy standards, and validation. Therefore, digital tools should be treated as complementary elements of a hybrid care model, in which symptom tracking, education, and data visualization support, but do not replace, professional diagnosis, risk assessment, shared decision-making, and therapeutic planning [1, 5, 6, 8, 11, 13, 14, 19, 22, 24, 25].

The safe implementation of digital menopause care requires stronger clinical validation, transparent quality standards, algorithmic accountability, and effective data protection. Privacy and ethics are particularly important because FemTech tools may collect sensitive information on mental health, sexuality, urogenital symptoms, hormone therapy, sleep, work, and lifestyle. At the same time, digital solutions must be designed to avoid reinforcing

inequalities among women with lower digital literacy, reduced access to care, lower socioeconomic status, language barriers, or limited representation in training datasets [14, 17, 19, 21, 22, 23, 25, 26, 27].

Future research should prioritize randomized controlled trials, longer follow-up periods, validation of wearable data, evaluation of AI algorithms, cost-effectiveness analyses, and studies conducted in diverse populations of women. Responsibly designed and clinically validated digital tools can become an important complement to menopausal care, but their development should remain interdisciplinary, ethically grounded, and focused on improving women's quality of life rather than simply expanding technological possibilities [1–30].

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