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DIGITAL HEALTH INTERVENTIONS FOR MENOPAUSE SYMPTOM MANAGEMENT: A META-ANALYSIS

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ABSTRACT
Menopause is associated with vasomotor, psychological, sleep, and quality-of-life disturbances that significantly affect women's physical, emotional, and social well-being. Digital health interventions have emerged as accessible, personalized, and patient-centered approaches for menopause management; however, their overall effectiveness remains uncertain. This meta-analysis assessed how well digital health treatments helped peri-, menopausal, and postmenopausal women with their menopausal symptoms, psychological and sleep results, quality of life, and functional outcomes. In order to find relevant research published between 2015 and 2026, electronic databases were thoroughly examined. Eight studies met the inclusion criteria, and those providing independent quantitative data were included in the meta-analysis. Pooled effects were estimated using random-effects models, and heterogeneity was evaluated using Cochran's Q, τ^2, and I^2 statistics. Visual examination of a funnel plot was used to investigate publication bias. Overall menopausal symptom severity was significantly reduced, according to the pooled analysis (SMD = −0.93, 95% CI: −1.41 to −0.45; $p < 0.001$). Additionally, notable enhancements in the quality of sleep (MD = −1.90, 95% CI: −3.57 to −0.24; $p = 0.025$) and quality-of-life and functional outcomes (Hedges' g = 0.82, 95% CI: 0.14–1.50; $p = 0.019$). Although moderate-to-high heterogeneity was observed, all pooled estimates consistently favored digital health interventions. These findings indicate that digital health interventions are effective adjuncts to conventional menopause care, improving symptom control, sleep quality, and life quality. To bolster the evidence and encourage wider clinical use, more extensive, carefully planned randomised controlled trials with standardised outcome measures are required.

KEYWORDS: Digital health; Menopause; Meta-analysis; Mobile health; Quality of life.

INTRODUCTION

Menopause is a natural process that occurs when the ovaries stop functioning and menstruation ceases, at around 45 to 55 years of age. Since women have a longer life expectancy, menopause has become a major public health problem because women spend about a third of their life in this phase. Menopause is not a medical disorder, but often women experience a variety of hormonal changes that lead to a host of physical, psychological, and urogenital symptoms. Other signs can be vasomotor disturbances such as hot flushes and sweating at night, and they may also occur along with insomnia, emotional changes, fatigue, mental issues, and decreased sexuality. The symptoms are not equal in severity and duration, and present significant health and functional problems to women. Treatment options encompass hormone therapy, non-hormone medications, and lifestyle changes, but treatment decisions should be based on the individual patient's medical history, symptom severity and patient preference (Kaunitz & Manson, 2015). Additionally, women who have a history of hormone-sensitive cancers may have fewer treatment options and women may be more likely to be dependent on supportive care for managing menopause (Hickey et al., 2024).

Menopausal symptoms can have emotional, as well as physical, consequences and often involve emotional/psychological, work, and interpersonal challenges and quality of life issues. Ongoing vasomotor symptoms may affect sleep quality, resulting in fatigue during the day, decreased ability to concentrate, irritability and decreased productivity. Women with psychological symptoms (anxiety, depressive mood, emotional distress) may also have worse social functioning and engagement at work. The multidimensional effects emphasize the importance of holistic management strategies to treat both physical and psychosocial health. Menopausal women have benefitted from lifestyle-based interventions such as dietary changes, regular exercise, and behavioral support, which have shown a positive impact on reducing vasomotor symptoms and enhancing overall quality of life (Barnard et al., 2023). Likewise, web-based multimodal lifestyle programs have been shown to reduce symptom severity, healthy behaviors and quality of life, with potential long-term benefits (Anderson et al., 2015). As a result, an effective management of the symptoms has turned into a priority to improve healthy ageing and functional independence in midlife.

In recent years, the advent of digital health technology has completely changed how menopausal care is provided by facilitating access to personalized education, symptom monitoring, behavioral support, and self-management resources. Digital interventions, such as mobile health applications, online learning resources, telehealth and digital therapeutic

programs, allow women to track symptoms, access evidence-based advice, and connect with health care providers from across the globe. In general, systematic evidence indicates that digital interventions often employ behavior change techniques, self-monitoring, goal setting, education and feedback as tools to support ongoing symptom control and health behaviors (Sediva et al., 2022). Other emerging evidence suggests that co-designed digital resources which involve patients with their development are more usable, acceptable and engaging for patients, leading to greater satisfaction and better self-management for women going through menopause (Yeganeh et al., 2022). Recent literature reviews have also emphasized the growing importance of eHealth tools for managing the menopause journey by tracking symptoms, providing decision support, and monitoring remotely, alongside traditional healthcare (Vollrath et al., 2024). Furthermore, digital healthcare models are becoming a crucial part of menopause care in the future, as they enhance the accessibility, continuity of care, and patient-centred management of menopause (Guille et al., 2025).

While there are growing examples of digital health interventions for managing menopause, there is a wide range of types of interventions, outcome measures, study populations, and methodological quality of available studies. There is potential for benefit for symptom management, psychological well-being, workplace functioning, and self-care, but with significant heterogeneity, there is limited ability to draw definitive conclusions about the overall effectiveness (Cronin et al., 2021; Vollrath et al., 2024). In addition, advancements in the field of precision medicine and digital health technologies, combined with psychosocial interventions, highlight the potential for personalized menopause care, as evidenced by the efficacy of some studies, though the evidence is still limited and needs to be strengthened (Okpete & Byeon, 2025). In other clinical groups, digital symptom management has been associated with successful outcomes, such as breast cancer survivors undergoing endocrine therapy (Graetz et al., 2018), extending the potential reach of technology-assisted symptom monitoring and patient support. While these developments have occurred, a detailed quantitative synthesis to specifically focus on digital health interventions for managing menopausal symptoms at multiple clinical outcomes is limited in scope, with the need for an updated meta-analysis.

The purpose of this meta-analysis was to provide an overview of the efficacy of digital health treatments for controlling menopausal symptoms in peri-, menopausal, and postmenopausal women. In order to provide a digital health evidence-based understanding of the role of DHTs in menopause management, the study aimed to synthesise the available evidence on DHTs, quantitatively analyse the impact on major menopausal symptoms, psychological and sleep outcomes, quality-of-life and functional outcomes, and evaluate the methodological quality and potential risk of bias of all the included studies.

2. METHODOLOGY

2.1 Study Design

The current study evaluated the efficacy of employing digital health treatments to reduce menopausal symptoms and other related illnesses using a meta-analysis methodology. A structured approach for this research has been adopted that consisted of systematic literature search, study selection, qualitative synthesis, and meta-analysis. Qualitative synthesis included randomized controlled trials, prospective cohort studies, single arm intervention studies, and follow-up studies; however, meta-analysis only included those studies which provided numerical information.

2.2 Eligibility Criteria

Study selection criteria comprised research that involved perimenopausal, menopausal, and post-menopausal women using a digital intervention, such as mobile applications, internet interventions, telemedicine, or other digital therapeutics. Studies selected had menopausal symptoms, vasomotor symptoms, sleep quality, psychological well-being, quality of life, or functional outcomes in their results and were published in English in the period from 2015 through 2026. Excluded were review articles, conference abstracts, qualitative studies, protocols that lacked any information about outcomes, duplicated papers, and studies which did not have enough information for effect sizes calculations.

2.3 Information Sources

The literature review was conducted in a methodical manner by searching multiple databases, including PubMed, Scopus, Web of Science, and Google Scholar, for all papers published between 2015 and 2026. The bibliographies of selected studies were searched to identify additional studies that fit into the pre-defined inclusion/exclusion criteria.

2.4 Search Strategy

A search strategy was designed through the use of combinations of Medical Subject Headings (MeSH) and key words associated with menopause, digital health technologies, and clinical outcomes. The primary search string was: "digital health" AND "mobile app") AND ("digital intervention") AND (menopause OR perimenopause OR postmenopause) AND ("menopausal symptoms" OR "vasomotor symptoms" OR "hot flashes" OR "quality of life") AND (randomized OR trial OR intervention OR "clinical trial". To maximise the retrieval of pertinent research, the search technique was modified in accordance with each database's indexing needs.

2.5 Study Selection

All identified records were entered into the reference manager program, and duplicates were excluded. After screening the titles and abstracts according to the predetermined inclusion and exclusion criteria, the possibly eligible studies underwent further full-text screening. Studies that satisfied the criteria for inclusion were considered in the qualitative synthesis, but those with compatible quantitative data only were selected for the meta-analysis.

2.6 Data Extraction
A preset data extraction programme was used to extract the data. Variables such as study features, participants' characteristics, nature of the intervention, comparison group, duration of follow up, outcome measures, and statistical data needed for conducting a meta-analysis were among those extracted. For studies that provided more than one effect estimate on a particular outcome measure for the same participant pool, one independent effect estimate per analysis was included.

2.7 Risk of Bias Assessment
Using a general framework of domains to assess bias risk, the methodological quality of the papers chosen for analysis was evaluated. There were five such domains analyzed, which included the following: selection bias, performance bias, attrition bias, detection bias, and reporting bias. All domains were assigned either a low risk of bias or an unclear risk of bias status depending on the study's methodology.

2.8 Data Synthesis and Statistical Analysis
The quantitative synthesis analysis adopted a random-effects meta-analysis considering the clinical and methodological heterogeneity that is likely to be present across the studies. In situations where the outcome variable was assessed using different scales or instruments, standardized mean differences (SMD) or Hedges' g was computed. However, where the outcome measures were assessed using the same measuring instrument, the mean differences was computed. Cochran's Q test, variance ($\tau 2$), and the I2 statistic were used to assess statistical heterogeneity.

2.9 Publication Bias
The possible presence of publication bias was assessed by visual examination of a funnel plot based on the independent quantitative effect estimates obtained from the included studies. Since less than ten independent studies were available for quantitative analysis, the funnel plot was used merely for exploratory purposes without conducting any tests of publication bias because of the poor reliability of such tests with a low number of studies.

3. RESULTS
3.1 Study Selection
The literature evaluation yielded a total of 531 articles, of which 503 were discovered through database searches and 28 were discovered through manual searches of the references and other sources. Out of the total number of 531 articles, 126 duplicate articles were removed and left behind 405 articles for further analysis of titles and abstracts. From the total number of 405 articles, 314 articles were excluded based on their eligibility. Amongst these, 83 articles were eliminated due to several reasons such as being a protocol or ongoing study (n = 12), review, editorial, conference paper, or book chapter (n = 10), using non-digital intervention (n = 16), recruiting an ineligible sample (n = 14), having irrelevant outcomes (n = 12), absence of full text (n = 9), lack of adequate quantitative data for effect size calculation (n = 7), and being duplicated or overlapped study samples (n = 3). Ultimately, eight papers were chosen for qualitative synthesis and meta-analysis after meeting all inclusion requirements. Figure 1 illustrates this selection procedure.

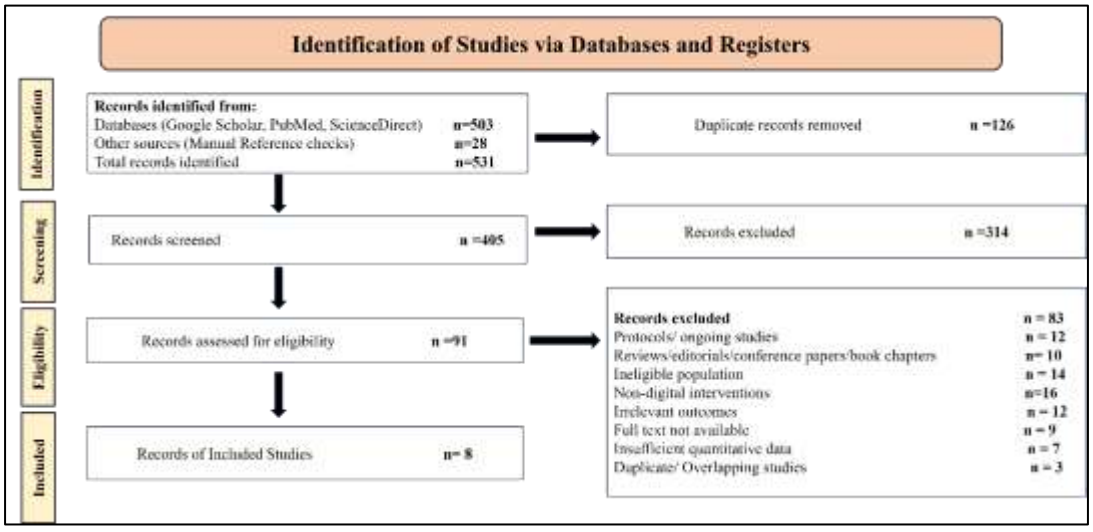

Figure 1. PRISMA Flow Diagram

3.2 Characteristics of Included Studies
3.2.1 Summary of Included Studies
The reviewed studies were diverse in terms of the type of digital health interventions that were assessed for their efficacy in menopause management and involved smartphone applications, digital health solutions, telehealth cognitive behavioural therapy, and mobile self-management interventions. Generally, the investigated interventions proved to be effective in improving the severity of menopausal symptoms, sleep quality, vasomotor symptoms, psychological well-being, self-management activities, and attitudes towards menopause. Table 1 displays the key characteristics and quantitatively analysed outcomes of the included research.

Table 1. Quantitative Characteristics and Main Findings of the Included Studies

Study	Country	Design	Sample (I/C)	Intervention	Duration	Outcome Measure	Main Statistical Findings
McCurry et al. (2016)	USA	RCT	53/53	Telephone CBT-I	8 weeks	ISI, PSQI	ISI ↓9.9 vs ↓4.7 ($p<0.001$); PSQI ↓4.0 vs ↓1.4 ($p<0.001$); 84% vs 43% insomnia remission
Rafati et al. (2023)	Iran	RCT	30/30	Self-care App	8 weeks	MRS, PRQC	MRS significantly reduced; marital relationship improved (both $p=0.001$)
Duffecy et al. (2025)	USA	RCT	75/74	Caria App	6 weeks	VMS, PHQ-8, GAD-7, PROMIS	Significant improvements across all primary outcomes (all $p<0.05$)
Andrews et al. (2023)	UK	Cohort	1900	Health & Her App	2 months	Symptom score	Mixed-effects model showed significant symptom reduction with higher engagement
Jahnke et al. (2025)	Germany	Pre-post	180	Digital menopause platform	3 months	MRS	Significant reductions in total and domain-specific MRS scores ($p<0.001$)
Ohsuga et al. (2026)	Japan	Pre-post	91	JoyHer Pro	6 months	sQACS, SMI	Significant improvement in self-care and symptom scores ($p<0.05$)
Rafati et al. (2026)	Iran	RCT	30/30	Self-care App	8 weeks	ATM	ANCOVA: $R^2=0.863$, $p=0.01$
Atema et al. (2016)	Netherlands	Protocol	Planned 248	Mobile App	Planned	MENQOL	Protocol only; no quantitative results

As seen from Table 1 below, there was a wide heterogeneity regarding sample sizes, intervention duration, outcome variables used, and different statistical methods. Despite all these methodological variations, most of the studies found that digital health interventions were effective.

3.2.2 Geographic Distribution

In terms of the included studies, there was notable international participation, which can be attributed to the increasingly widespread usage of numerical health technologies to manage menopause. The three studies that came from Asia included two from Iran and one from Japan, showing an increase in the number of studies being done using culturally tailored smartphone applications for the self-management of menopause. On the other hand, two studies were done in North America (US), involving digital therapeutic technology and telehealth cognitive behavioral therapy. From Europe, there were studies from the UK, Germany, and the Netherlands. Such diversity is important in increasing the external validity of the review due to the inclusion of different populations. However, there is no presence of data from Africa, South America, and low-income countries.

3.2.3 Study Designs and Sample Characteristics

Table 1 presents the methodological aspects of the selected articles. Out of eight articles included in the review, four (50.0%) are randomized controlled trials, two (25.0%) are prospective studies with only one group, one (12.5%) is a longitudinal observational cohort study, and one (12.5%) article is a protocol of a randomized controlled trial (Atema et al., 2016; Andrews et al., 2023; Duffecy et al., 2025; Jahnke et al., 2025; McCurry et al., 2016; Ohsuga et al., 2026; Rafati et al., 2023, 2026). The sample size in all articles varies between 60 to 1,900 participants, while the total number of participants is 2,824 women. Peri- and postmenopausal women aged approximately 40-65 years old were mainly recruited into the interventions that lasted from 6 weeks up to 6 months. In accordance with Table 1, the selected studies have varied methodologically in regard to the research design, number of participants, characteristics of the studied individuals, as well as the follow-up period. Notwithstanding this heterogeneity, randomized controlled trials have shown the significance of changes in the studied variables associated with menopause in comparison to routine care or control groups, while the single arm studies and observations revealed significant improvements after the usage of digital intervention from the initial point in time (Andrews et al., 2023; Duffecy et al., 2025; Jahnke et al., 2025; McCurry et al., 2016; Ohsuga et al., 2026; Rafati et al., 2023, 2026).

3.2.4 Characteristics of Digital Interventions

These interventions included a variety of technology-based interventions such as smartphone apps, digital therapeutic platforms, mobile self-care programs, symptom tracking apps, and telephone delivered cognitive behavioral therapy (CBT) (Atema et al., 2016; Andrews et al., 2023; Duffecy et al., 2025; Jahnke et al., 2025; McCurry et al., 2016; Ohsuga et al., 2026; Rafati et al., 2023, 2026). The interventions most commonly studied involved smartphone-based technologies, with the majority of the included studies involving these interventions (Andrews et al., 2023; Jahnke et al., 2025; Ohsuga et al., 2026; Rafati et al., 2023, 2026). Such strategies typically included information on menopause, symptom management, behavioural advice, lifestyle changes, sleep advice, and self-care support (Andrews et al., 2023; Duffecy et al., 2025; Ohsuga et al., 2026; Rafati et al., 2023). The length of interventions ranged from 6 weeks to 6 months, with the majority of programs making an explicit request for participants to engage with the intervention on a regular basis and provide self-monitoring data, or through the use of reminders, or structured educational components (McCurry et al., 2016; Andrews et al., 2023; Duffecy et al., 2025; Jahnke et al., 2025; Ohsuga et al., 2026). All of the completed studies reported one or more improvements in menopause-related outcomes as presented in Table 1, indicating that digital health interventions can be useful in managing menopause symptomology in a variety of clinical contexts.

3.2.5 Result Measures Used

There was a noteworthy diversity in the assessment tools, as menopause is a multidimensional process, and a variety of the goals desired from digital health interventions. The Menopause Rating Scale (MRS) and the Simplified Menopausal Index (SMI) were the most widely used tools for evaluating the overall intensity of menopausal symptoms. The validated sleep-related outcomes were assessed using the Pittsburgh Sleep Quality Index (PSQI) and the Insomnia Severity Index (ISI). A few studies also assessed the distress from the vasomotor symptoms, psychological functioning, depression, anxiety, quality of life, self-care behaviours, marital relationships, and attitudes towards menopause using standardized questionnaires. Table 2 summarises the outcome measures reported in the included studies.

Table 2. Measures of Outcomes Employed in All Included Studies

Study	Primary Outcome Measure(s)	Outcome Domain
McCurry et al. (2016)	ISI, PSQI, HFRDIS	Sleep quality, insomnia, hot-flash interference
Rafati et al. (2023)	MRS, PRQC	Menopausal symptoms, marital relationship
Andrews et al. (2023)	Health & Her Symptom Score	Menopausal symptom severity
Duffecy et al. (2025)	HFRDIS, PHQ-8, GAD-7, PROMIS-SD	Vasomotor, psychological, sleep outcomes
Jahnke et al. (2025)	MRS	Menopausal symptom severity
Ohsuga et al. (2026)	SMI, sQACS	Menopausal symptoms, self-care
Rafati et al. (2026)	ATM Scale	Attitudes toward menopause
Atema et al. (2016)	MENQOL	Menopause-related quality of life

All the outcome measures were validated measures, and each measured clinically relevant domains of menopausal health and intervention effectiveness, as listed in Table 2.

3.3 Risk of Bias Assessment

Based on five domains—Selection bias (D1), Performance bias (D2), Attrition bias (D3), Detection bias (D4), and Reporting bias (D5) a general domain-based risk of bias assessment was carried out on the included research. The methodological information reported by the individual studies was used to categorize each domain as low risk or unclear risk. The aggregate evaluation across all areas was used to determine the overall risk of bias. Figure 2 summarises the domain-specific risk of bias for each of the eight included research.

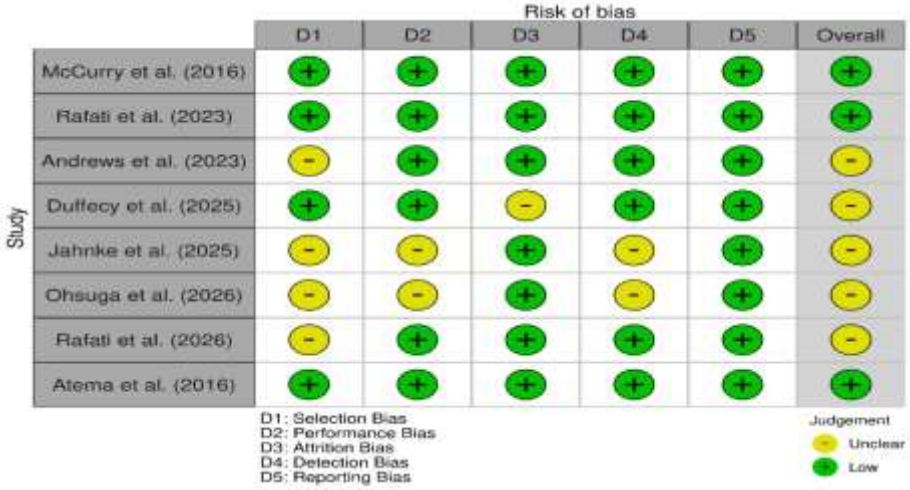

Figure 2. Risk of bias assessment

The majority of the research in the majority of the domains had a low risk of bias, according to the key outcomes of the investigations, as shown in Figure 2. McCurry et al. (2016), Rafati et al. (2023) and Atema et al. (2016) were considered to be at low risk across all areas assessed. Andrews et al. (2023), Duffecy et al. (2025), Jahnke et al. (2025), Ohsuga et al. (2026), and Rafati et al. (2026) demonstrated mixed results due to issues with participant selection, performance, dropouts, or outcome measurement. There was no indication of a persistently high risk of bias in any of the assessed domains, and the methodological quality of the included research was usually adequate.

3.4 Quantitative Synthesis

There was no indication of a persistently high risk of bias in any of the assessed domains, and the methodological quality of the included research was usually adequate. Different meta-analyses were done for different menopausal outcomes since there were different variables that should be considered in each outcome analysis.

3.4.1 Overall Effect of Digital Health Interventions on Menopausal Symptoms

Overall menopausal symptoms were assessed via a random effects meta-analysis of the effect of digital health interventions. With an overall standardised mean difference (SMD) of −0.93 (95% CI: −1.41 to −0.45; $p < 0.001$), the pooled analysis demonstrated a substantial decrease in menopausal symptom severity, suggesting a medium to large treatment effect with a positive sign. Moderate to high heterogeneity was found among the studies included ($I^2 = 80.1\%$). The included studies showed moderate to high heterogeneity ($I^2 = 80.1\%$), due to different modes of intervention, instruments used for outcome measurement, and/or differences in participants' characteristics and length of intervention across the studies.

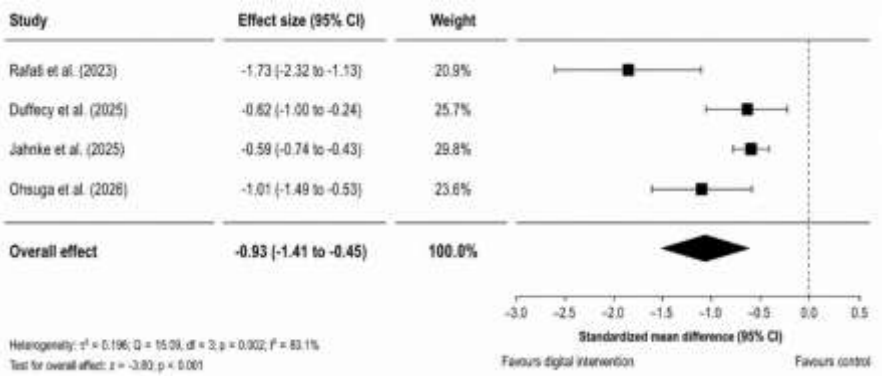

Figure 3. Forest plot of the effect of digital health interventions on overall menopausal symptoms

All four studies included in this review included preferred digital health interventions as shown in Figure 3. Rafati et al. (2023) were able to show the greatest treatment effect, and Duffecy et al. (2025), Jahnke et al. (2025), and Ohsuga et al. (2026) had similarly positive effects. Even with the noted heterogeneity, the pooled effect continued to be statistically significant and digital health interventions were effective in the reductions of overall menopausal symptoms.

3.4.2 Effect on Psychological and Sleep Outcomes

Due to the use of various validated instruments across studies, psychological and sleep outcomes were synthesized separately. Depression and anxiety outcomes were not pooled, since they were from the same cohort and measured constructs. (see Figure 4) The outcomes of sleep quality were meta-analyzed in two independent studies, in contrast.

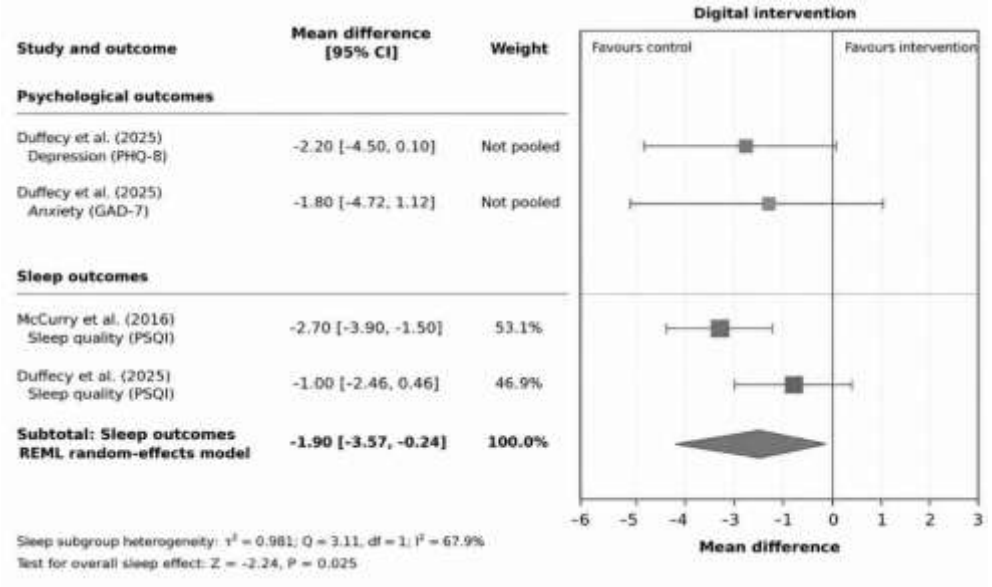

Figure 4. Forest plot of the effect of digital health interventions on psychological and sleep outcomes

As seen in Figure 4, the pooled analysis revealed a substantial increase in sleep quality (MD = −1.90, 95% CI: −3.57 to −0.24; p = 0.025). Some degree of heterogeneity was seen (I^2 = 67.9%), possibly resulting from the study populations, the characteristics of the interventions, treatment length and the manner in which digital health interventions are implemented in the two included studies. Psychological outcomes were assessed on an individual basis and were not pooled statistically since they were different constructs that were measured in the same group of participants.

3.4.3 Effect on Quality-of-Life and Functional Outcomes

A random-effects meta-analysis was used to examine the effects of digital health treatments on QOL and functional outcomes in three separate trials. The overall effect was significant (Hedges' g = 0.82; 95% CI: 0.14–1.50; p = 0.019) as seen in the pooled analysis (see Figure 5). The included studies exhibited a significant degree of variability (I^2 = 82.7%), but this may have been explained by differences in the outcome measures, the components of the intervention, the populations of participants, and the length of the follow-up period across the studies. However, the overall pooled effect was consistently in favor of the intervention.

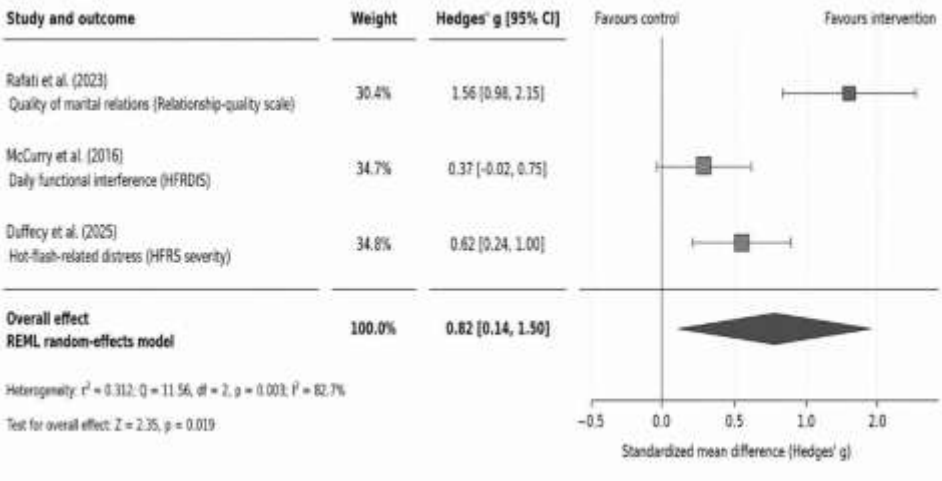

Figure 5. Forest plot of the effect of digital health interventions on quality-of-life and functional outcomes

Rafati et al. (2023) reported that the intervention had the greatest effect on quality-of-life and functional outcomes, and McCurry et al. (2016) and Duffecy et al. (2025) also showed positive effects of the intervention. Although there was some variation in the size of the treatment effect, the weight of all included studies was in favor of the digital health interventions, yielding a statistically significant pooled effect that indicates that digital health interventions are beneficial in improving quality-of-life and functional outcomes.

3.4.4 Sensitivity Analysis

The general direction of the treatment effects appeared to be consistent across trials, according to the sensitivity analysis results. Moderate to high heterogeneity was seen in the pooled analyses, but there did not seem to be any individual study to exert undue influence on the overall estimate. The results thus indicate that increased effects of digital health interventions for menopausal symptoms, sleep quality and QoL outcomes are found across different characteristics of digital health interventions and outcome measures.

4. DISCUSSION

This meta-analysis combined the evidence to date surrounding the effects of digital health interventions for managing menopause symptomology and found these interventions were associated with meaningful improvements in a number of clinically relevant outcomes. The intensity of all menopausal symptoms significantly decreased in quantitative synthesis, and sleep quality, quality of life, and functional outcomes all improved. The usefulness of digital health treatments as a complement to traditional menopausal care was consistently supported by small studies, despite high variability across several analyses. This heterogeneity in observations is likely due to variations in intervention modalities, duration, and participant characteristics and measures of outcome, not to variable intervention effects. Overall, these findings reinforce the potential of digital health tools to enhance symptom management, encourage self-care, and enable accessible and patient-centric menopause health care, increasingly deemed as a priority in global healthcare (Delanerolle et al., 2024).

The current meta-analysis's findings are consistent with earlier systematic reviews that have focused on digital health interventions in women's health and have shown their growing effectiveness. Seo and Seo (2025) conducted a systematic review that showed digital healthcare interventions successfully enhanced symptom management, patient self-management, and patient engagement for women with menstrual disorders. In both reviews, the clinical populations were different, but the studies overall suggested that digital platforms are effective for helping to manage symptoms for female reproductive health concerns. Likewise, digital behavior change interventions offer benefits shown by education, self-monitoring, personalized feedback, and goal-setting, which are likely mechanisms that accounted for the positive effects seen in the present review (Roberts et al., 2017).

There is also evidence from other chronic disease populations that the positive results seen in this meta-analysis are confirmed. In the context of osteoporosis treatment, a systematic review of digital interventions showed that technology-supported health care delivery led to the improvement of long-term self-management, adherence to treatment, and empowerment of patients (Alhussein & Hadjileontiadis, 2021). Similarly, randomized trials in adult cancer patients have demonstrated that digital interventions improve symptom management, teaching and communication with health care providers, and their versatility across a variety of health care settings (Lee et al., 2023). Similar results have been reported in breast cancer survivors, who experienced better symptom management, treatment adherence and health-related quality of life (HRQoL) after implementing electronic health interventions (Singleton et al., 2022). In addition, a content analysis of mobile health apps has shown that mobile health platforms are rapidly proliferating and are increasingly used to assist with symptom monitoring and patient self-management (Charbonneau et al., 2020).

The improvements in menopausal symptoms are also significant in light of high prevalence of vasomotor symptoms in large electronic health record analyses of midlife women (Sussman et al., 2015). While traditional medical interventions are still effective for many women, there are concerns about contraindications, long-term safety, and patient preferences, leading to a growing interest in complementary approaches for healthcare management (Johnson et al., 2019). A few systematic reviews have also shown the positive impacts of some herbal and plant-based medications on alleviating menopausal symptoms (Kargozar et al., 2017; Franco et al., 2016). These are not meant to replace these methods, but digital health interventions can be used alongside existing treatments to enhance patient education, symptom monitoring, way of living and engagement with health care providers. Furthermore, new conceptions highlight the need for comprehensive, personalized care for women after menopause, which can be implemented through a combination of medical interventions, behavioral strategies, and ongoing monitoring, all of which are well-suited for digital healthcare technologies (Mishra et al., 2024).

These results of this meta-analysis have important implications for clinical practice. Digital health interventions offer patient-friendly, scalable, and accessible options to support traditional management of menopause, especially among women who may not have access to menopause-specific services. Mobile apps, online platforms, and telehealth initiatives enable ongoing symptom tracking, self-management and personalized learning opportunities, and minimize geographical and healthcare access barriers. Remotely delivered healthcare has been shown to have similar benefits in chronic cardiovascular disease (CVD) management, with evidence showing positive impacts in a range of clinical conditions (Kuan et al., 2022). Moreover, digital technologies can play a role in closing the gender gap in the delivery of women health services by enabling more timely assessment and personalized treatment of menopausal symptoms (Ancochea et al., 2021).

An overview of the most recent research on the efficacy of digital health treatments for menopausal management is provided in this article. Inappropriate pooling of clinically different endpoints was avoided by conducting separate quantitative analyses of menopausal symptoms, sleep outcomes, and quality-of-life outcomes. Furthermore, the use of a random-effects model allowed taking methodological and clinical heterogeneity into account and further strengthened the analysis. Furthermore, evidence from various digital intervention modalities were included, thus giving a comprehensive evaluation of current digital healthcare approaches.

It is important to be aware of a few limitations. A very modest number of investigations served as the foundation for the quantitative synthesis, which reduced the precision of the pooled estimates and limited the assessment of publication bias. There was a lot of variability in the characteristics of the interventions, the length of follow-up, populations of participants and outcome measures. In addition, some of the studies included were conducted in a non-randomized or single arm design that may have increased the risk of methodological bias.

In order to produce large, multicenter, randomised controlled trials with standardised outcome measures, future studies should be more similar to enhance comparability across studies. They should also have extended follow-up periods and standardised outcome measures. Long-term adherence, cost-effectiveness, patient engagement, and personalized digital interventions using AI and wearables and remote monitoring should also be assessed. This research will bolster evidence and contribute to the creation of more effective, person-centered digital healthcare approaches for management of menopause.

5. CONCLUSION

This is a meta-analysis that shows that digital health interventions are effective for peri-, menopausal, and postmenopausal women for managing menopausal symptoms. The quantitative synthesis showed notable improvements in sleep quality and quality of life, as well as notable reductions in the intensity of overall menopausal symptoms and functional outcomes, suggesting that technology-assisted interventions could be an important addition to menopause treatment. However, there was moderate to high heterogeneity across the pooled analyses, with the direction of treatment effect being consistently more beneficial for digital health interventions, suggesting potential applicability across a variety of populations and intervention formats. The results underscore the increasing importance of mobile apps, Web platforms, telehealth services, and other digital health tools that facilitate symptom monitoring, self-management, patient education, and behavioral support. These interventions are patient-centered, scalable and accessible, and could help to address the barriers to care for menopause, especially in places where specialized healthcare services are limited. The evidence available in the current study, however, is limited by the mixed study design, study intervention properties, outcome measures and the relatively small number of studies included in quantitative synthesis. Future large-scale, carefully planned, controlled studies with standardised outcome measures and extended follow-up periods are required to bolster the evidence even more. In summary, digital health treatments have the potential to improve menopause management and promote women's health and well-being during and beyond the menopausal transition.

REFERENCES

1. Alhussein, G., & Hadjileontiadis, L. (2021). Digital health technologies for long term self-management of osteoporosis: a systematic review and meta-analysis. Available at SSRN 3897963.
2. Ancochea, J., Izquierdo, J. L., Savana COVID-19 Research Group, & Soriano, J. B. (2021). Evidence of gender differences in the diagnosis and management of coronavirus disease 2019 patients: an analysis of electronic health records using natural language processing and machine learning. Journal of Women's Health, 30(3), 393-404.
3. Anderson, D., Seib, C., McGuire, A., & Porter-Steele, J. (2015). Decreasing menopausal symptoms in women undertaking a web-based multi-modal lifestyle intervention: The Women's Wellness Program. Maturitas, 81(1), 69-75.
4. Andrews, R., Lancastle, D., Bache, K., & Lacey, A. S. (2023). Does Health & Her app use improve menopausal symptoms? A longitudinal cohort study. BMJ open, 13(12), e077185.
5. Atema, V., van Leeuwen, M., Oldenburg, H. S., Retèl, V., van Beurden, M., Hunter, M. S., & Aaronson, N. K. (2016). Design of a randomized controlled trial of Internet-based cognitive behavioral therapy for treatment-induced menopausal symptoms in breast cancer survivors. BMC cancer, 16(1), 920
6. Barnard, N. D., Kahleova, H., Holtz, D. N., Znayenko-Miller, T., Sutton, M., Holubkov, R., ... & Setchell, K. D. (2023). A dietary intervention for vasomotor symptoms of menopause: a randomized, controlled trial. Menopause, 30(1), 80-87.
7. Charbonneau, D. H., Hightower, S., Katz, A., Zhang, K., Abrams, J., Senft, N., ... & Thompson, H. S. (2020). Smartphone apps for cancer: A content analysis of the digital health marketplace. Digital health, 6, 2055207620905413.
8. Cronin, C., Hungerford, C., & Wilson, R. L. (2021). Using digital health technologies to manage the psychosocial symptoms of menopause in the workplace: a narrative literature review. Issues in mental health nursing, 42(6), 541-548.
9. Delanerolle, G., Phiri, P., Elneil, S., Talauker, V., Eleje, G. U., Kareem, R., ... & Briggs, P. (2024). Menopause: A Global Health and Wellbeing Issue Needing Urgent Attention. The Lancet Global Health.
10. Duffecy, J., Rehman, A., Gorman, S., Huang, Y. L., & Klumpp, H. (2025). Evaluating a mobile digital therapeutic for vasomotor and behavioral health symptoms among women in midlife: randomized controlled trial. JMIR mHealth and uHealth, 13, e58204.
11. Franco, O. H., Chowdhury, R., Troup, J., Voortman, T., Kunutsor, S., Kavousi, M., ... & Muka, T. (2016). Use of plant-based therapies and menopausal symptoms: a systematic review and meta-analysis. Jama, 315(23), 2554-2563.
12. Graetz, I., McKillop, C. N., Stepanski, E., Vidal, G. A., Anderson, J. N., & Schwartzberg, L. S. (2018). Use of a web-based app to improve breast cancer symptom management and adherence for aromatase inhibitors: a randomized controlled feasibility trial. Journal of Cancer Survivorship, 12(4), 431-440.
13. Guille, C., Jahnke, H., Shah, N., & Henrich, N. (2025). Evolving the health care service model for menopause with digital health. Women's Health Issues, 35(4), 230-232.
14. Hickey, M., Basu, P., Sassarini, J., Stegmann, M. E., Weiderpass, E., Chilowa, K. N., ... & Brennan, D. J. (2024). Managing menopause after cancer. The Lancet, 403(10430), 984-996.
15. Jahnke, H. R., Brinson, A., Silverman Fine, S., & Henrich, N. (2025). Reduction in menopause symptoms after engagement in a digital health program. Digital Health, 11, 20552076251395567.
16. Johnson, A., Roberts, L., & Elkins, G. (2019). Complementary and alternative medicine for menopause. Journal of evidence-based integrative medicine, 24, 2515690X19829380.
17. Kargozar, R., Azizi, H., & Salari, R. (2017). A review of effective herbal medicines in controlling menopausal symptoms. Electronic physician, 9(11), 5826.
18. Kaunitz, A. M., & Manson, J. E. (2015). Management of menopausal symptoms. Obstetrics & Gynecology, 126(4), 859-876.
19. Kuan, P. X., Chan, W. K., Ying, D. K. F., Rahman, M. A. A., Peariasamy, K. M., Lai, N. M., ... & Anand, A. (2022). Efficacy of telemedicine for the management of cardiovascular disease: a systematic review and meta-analysis. The Lancet Digital Health, 4(9), e676-e691.
20. Lee, K., Kim, S., Kim, S. H., Yoo, S. H., Sung, J. H., Oh, E. G., ... & Lee, J. (2023). Digital health interventions for adult patients with cancer evaluated in randomized controlled trials: scoping review. Journal of medical Internet research, 25, e38333.
21. McCurry, S. M., Guthrie, K. A., Morin, C. M., Woods, N. F., Landis, C. A., Ensrud, K. E., ... & LaCroix, A. Z. (2016). Telephone delivered cognitive-behavior therapy for insomnia in midlife women with vasomotor symptoms: an MsFLASH randomized trial. JAMA internal medicine, 176(7), 913.
22. Mishra, G. D., Davies, M. C., Hillman, S., Chung, H. F., Roy, S., Maclaran, K., & Hickey, M. (2024). Optimising health after early menopause. The Lancet, 403(10430), 958-968.
23. Ohsuga, T., Egawa, M., Tsuyuki, K., Ohtsuki, M., Wanjie, Y., Juan, S., ... & Mandai, M. (2026). A self-care smartphone application for midlife women with menopausal symptoms: A proof-of-concept study. Digital Health, 12, 20552076261459996-20552076261459996.
24. Okpete, U. E., & Byeon, H. (2025). Optimizing perimenopausal mental health by integrating precision biomarkers, digital health interventions, and psychosocial care. World Journal of Psychiatry, 15(7), 101906.
25. Rafati, F., Dastyar, N., Nejad, F. K., & Yusefi, A. R. (2026). The effect of mobile app-based self-care training on the postmenopausal women's attitudes toward menopause: a clinical trial study in southern Iran. Scientific Reports.
26. Rafati, F., Pourshahrokhi, N., Bahador, R. S., Dastyar, N., & Mehralizadeh, A. (2023). The effect of mobile app-based self-care training on the quality of marital relations and the severity of menopausal symptoms in postmenopausal women: a clinical trial study in Iran. BMC Women's Health, 23(1), 306.

27. Roberts, A. L., Fisher, A., Smith, L., Heinrich, M., & Potts, H. W. (2017). Digital health behaviour change interventions targeting physical activity and diet in cancer survivors: a systematic review and meta-analysis. Journal of Cancer Survivorship, 11(6), 704-719.
28. Sediva, H., Cartwright, T., Robertson, C., & Deb, S. K. (2022). Behavior change techniques in digital health interventions for midlife women: systematic review. JMIR mHealth and uHealth, 10(11), e37234.
29. Seo, M. S., & Seo, B. N. (2025). Effectiveness of digital healthcare in managing menstrual symptoms: a systematic review. Women's Health Nursing, 31(2), 108-118.
30. Singleton, A. C., Raeside, R., Hyun, K. K., Partridge, S. R., Di Tanna, G. L., Hafiz, N., ... & Redfern, J. (2022). Electronic health interventions for patients with breast cancer: systematic review and meta-analyses. Journal of Clinical Oncology, 40(20), 2257-2270.
31. Sussman, M., Trocio, J., Best, C., Mirkin, S., Bushmakin, A. G., Yood, R., ... & Louie, M. (2015). Prevalence of menopausal symptoms among mid-life women: findings from electronic medical records. BMC women's health, 15(1), 58.
32. Vollrath, S., Theis, S., Kolokythas, A., Janka, H., Schleich, S., Moreth, J., ... & Stute, P. (2024). Self-management eHealth solutions for menopause–a systematic scoping review. Climacteric, 27(3), 255-268.
33. Yeganeh, L., Boyle, J. A., Johnston-Ataata, K., Flore, J., Hickey, M., Kokanović, R., ... & Vincent, A. J. (2022). Positive impact of a co-designed digital resource for women with early menopause. Menopause, 29(6), 671-679.