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The effectiveness of mobile app-based interventions to improve parental mental health: a meta-analysis

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Abstract

Background Parental mental health is a critical determinant of family functioning and child development. Many parents experience heightened vulnerability to stress, depression, and anxiety during the transition to parenthood and across different stages of the parenting process. Structural barriers—including stigma, limited access to mental health services, and competing caregiving demands—often impede timely support. In this context, mobile health (mHealth) applications have emerged as scalable and accessible tools for delivering preventive and early-stage mental health interventions to parents.

Methods This meta-analysis synthesized data from 12 intervention studies, the majority of which were randomized controlled trials (RCTs), comprising a total of 2,789 parents. Following PRISMA guidelines, we evaluated the effectiveness of parent-targeted mobile application-based interventions on parental mental health, with a primary focus on depressive symptoms. Random-effects models were used to estimate pooled effect sizes. Subgroup analyses and publication bias assessments (funnel plot inspection and classic fail-safe N) were conducted to examine robustness and potential moderators.

Results The meta-analysis demonstrated small, statistically significant improvements in parental depressive symptoms (Hedges's $g = 0.378$, $p = .002$). Subgroup analyses indicated moderate and significant effects in mother-only samples, whereas effects in mixed-parent samples (mothers and fathers) were small and non-significant. Publication bias assessments did not indicate strong evidence of bias, although results should be interpreted cautiously given the limited number of studies.

Conclusions The findings suggest that theoretically grounded and appropriately designed mobile applications may serve as effective preventive tools for alleviating depressive symptoms and supporting parental mental health. Although not a substitute for clinical care, mobile app-based interventions represent a promising and scalable approach for expanding access to preventive mental health support for parents, particularly during periods of heightened caregiving demands.

Keywords Parental mental health, Parents, Caregivers, Mobile applications, Digital interventions, Meta-analysis, RCTs

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Introduction

Parental mental health is a critical determinant of family functioning and well-being, particularly during the transition to parenthood—a period characterized by heightened psychological vulnerability and increasing caregiving demands that may extend across different stages of the parenting process [1, 2]. While the birth of a child is often celebrated as a joyful milestone, parents are frequently exposed to substantial physical and emotional challenges that elevate the risk of depression and anxiety [3–7]. Accumulating evidence highlights that stressors such as financial strain, social isolation, limited personal time, and concerns related to child development can undermine psychological resilience and contribute to mental health difficulties during this period [8–10]. Beyond emotional strain, parenting involves sustained cognitive demands associated with daily decision-making and role management, which may further exacerbate psychological burden [11]. Collectively, these intersecting stressors place parents at increased risk for common mental health conditions, most notably depression and anxiety.

Depression and anxiety are the most commonly diagnosed mental health conditions among parents, with prevalence further exacerbated during periods of heightened societal stress, such as the COVID-19 pandemic [12, 13]. These disorders have been consistently linked to adverse outcomes, including impaired parent–child bonding and delays in children’s emotional, cognitive, and behavioral development [14–16]. Meta-analytic evidence further demonstrates that parental depression—particularly maternal depression—is associated with poorer child outcomes across multiple developmental domains [17]. Beyond child-level effects, parental psychopathology undermines caregiver well-being and increases the risk of intergenerational transmission of psychological distress [18]. Although research has historically focused on maternal mental health, accumulating evidence indicates that fathers also experience substantial levels of depression and anxiety across different stages of the parenting process, often exceeding population norms [19–21]. Together, these findings underscore the urgent need for effective and accessible interventions targeting parental mental health in order to support family systems and reduce intergenerational vulnerability.

Parental mental health problems are highly prevalent and associated with substantial risks, yet they frequently remain undiagnosed and untreated due to persistent structural barriers, including stigma, limited access to care, and logistical constraints [22, 23]. These barriers are particularly salient during periods of heightened caregiving demands, such as the perinatal period, when limited childcare support and reduced mobility further hinder engagement with conventional mental health services

[24]. Despite the availability of effective pharmacological and psychological treatments, detection and treatment gaps remain substantial across healthcare systems [19]. In response to these service gaps, mobile health (mHealth) technologies have emerged as scalable and accessible approaches for delivering mental health support [25]. Endorsed by the World Health Organization as important tools for mental health promotion—especially in underserved populations—mHealth solutions enable flexible access to psychoeducation, self-monitoring, and remote support within healthcare systems [26].

Accumulating evidence suggests that mHealth interventions may offer potential benefits for parental mental health, although findings remain heterogeneous. Some reviews and meta-analyses have reported improvements in maternal mental health outcomes following mHealth-based interventions, with several studies conducted in perinatal samples [27]. More broadly, mobile applications have demonstrated effectiveness in supporting mental health outcomes such as depression and anxiety across diverse adult populations, including individuals managing a range of physical and mental health conditions (e.g., depressive and anxiety disorders, diabetes, and cardiovascular disease), largely due to their adaptability, accessibility, and real-time responsiveness [28–30]. These interventions are often characterized as low-cost, low-intensity approaches that can be delivered across clinical and non-clinical settings [31, 32]. Systematic reviews focusing on parent populations indicate that mobile interventions may provide educational, emotional, and psychological support during periods of heightened caregiving demands, including the perinatal period [33]. However, despite their increasing availability, important gaps remain in both intervention design and empirical validation. Evidence from scoping and systematic reviews suggests that relatively few parent-focused mobile applications explicitly target parental mental health, and that findings regarding their impact on depressive symptoms are mixed and, in some cases, inconclusive [34–36]. Taken together, these observations underscore the need for more targeted, theory-driven, and rigorously evaluated mobile app-based interventions specifically designed to address parental mental health outcomes.

Despite growing interest in mobile app-based interventions for parental mental health, evidence from randomized controlled trials (RCTs) remains mixed, with several studies reporting limited or no effects on depressive symptoms. Across trials, app-based interventions have more consistently demonstrated improvements in parenting-related outcomes, anxiety, or self-efficacy, without corresponding reductions in depressive symptoms [37–43]. These patterns have been observed across interventions grounded in psychoeducational, cognitive-behavioral, behavioral, and chatbot-supported

approaches, suggesting that effectiveness may vary by outcome domain as well as by intervention design and theoretical grounding. Such inconsistencies raise important questions regarding theoretical fidelity, user engagement, and the contextual suitability of app-based interventions for diverse parental populations. In line with these concerns, recent systematic reviews and meta-analyses report that mHealth interventions targeting perinatal depression and anxiety often yield non-significant effects, noting that many commercially available applications are of moderate quality, infrequently evaluated in rigorous RCTs, and commonly lack clearly articulated evidence-based components [44]. Taken together, the existing evidence suggests that mobile app-based interventions may play a supportive—rather than stand-alone—role in promoting parental mental health across the parenting process. However, the available evidence is developmentally concentrated, with the majority of trials conducted during the perinatal period and early stages of parenthood (e.g., pregnancy, postpartum, infancy, and early childhood). A smaller number of studies have extended beyond this window to include parents of preschool- and school-aged children, indicating emerging but still limited evidence for later parenting stages. Accordingly, the conclusions of this meta-analysis should be interpreted primarily within perinatal and early parenting contexts, while underscoring the need for well-designed, theory-driven, and rigorously evaluated interventions targeting parents across later developmental stages to achieve consistent improvements in depressive symptoms and related mental health outcomes.

While these inconsistencies raise important concerns regarding the reliability and contextual suitability of existing mobile interventions, a subset of trials has reported more favorable outcomes under specific conditions, suggesting that mobile app-based approaches may yield clinically meaningful reductions in parental depressive symptoms when appropriately designed and implemented. Evidence from selected trials indicates that interventions grounded in multicomponent, cognitive-behavioral, mindfulness-based, or peer-supported frameworks have been associated with reductions in depressive symptoms, predominantly within the perinatal period, including pregnancy and the early postpartum phase [45–49]. Notably, such interventions often incorporate structured therapeutic content, personalization, or elements of human support, which may enhance user engagement and intervention effectiveness. More recently, emerging evidence suggests that hybrid models extending beyond the perinatal period—such as digital interventions combined with personalized coaching—may also yield benefits for parents in later caregiving contexts [50].

Building on these findings, recent evidence further suggests that hybrid models combining digital tools with personalized coaching or facilitation may offer additional benefits, particularly among underserved populations [50]. Overall, these findings indicate that mobile app-based interventions hold promise for improving parental mental health outcomes; however, their effectiveness appears to be contingent upon clear theoretical grounding, the inclusion of active and engaging intervention components, and alignment with the contextual needs of diverse parenting populations.

Despite these promising developments, the existing evidence base remains fragmented and inconclusive with respect to the effectiveness of mobile technologies for supporting parents' psychological well-being and parental mental health outcomes. Previous reviews have largely focused on technology-based parenting interventions aimed at improving child behavioral or emotional outcomes, often giving limited attention to parental mental health or failing to isolate mobile app-based delivery formats [51, 52]. Other syntheses have reported modest improvements in parental mental health but have aggregated heterogeneous digital modalities—including websites, videos, and mobile applications—thereby limiting conclusions regarding app-specific effects [53, 54]. More targeted reviews focusing on mobile app-based interventions have identified promising yet inconsistent findings for outcomes such as depression, anxiety, and self-efficacy, while emphasizing the need for further rigorously designed trials [33, 55]. However, existing meta-analyses and systematic reviews have largely aggregated heterogeneous digital delivery modalities or focused predominantly on perinatal maternal samples, limiting conclusions regarding the effectiveness of mobile application-based interventions specifically targeting parental mental health outcomes. To address this gap, the present meta-analysis focuses exclusively on parent-targeted mobile application-based interventions and synthesizes evidence drawn primarily from randomized controlled trials. By doing so, this study provides an up-to-date and methodologically focused synthesis of app-based interventions targeting both mothers and fathers across diverse caregiving contexts, thereby extending prior reviews that were constrained by mixed digital formats or narrower population scopes. Accordingly, while much of the existing evidence on mobile app-based interventions for parental mental health are derived predominantly from perinatal and early parenting contexts and remains methodologically limited, the present meta-analysis does not seek to overgeneralize beyond this evidence base. Rather, it aims to clarify the scope, strengths, and limitations of app-based interventions within the parenting stages represented in the included studies,

while highlighting the need for future research extending beyond early parenthood.

While depressive symptoms constitute the primary outcome of interest, this meta-analysis also incorporates studies assessing broader indicators of parental well-being, allowing for a more comprehensive evaluation of parental mental health. In line with prevailing patterns in the literature, parental mental health is operationalized primarily through depression outcomes, with anxiety and well-being examined where data permit. Accordingly, the present study addresses the following research question: *Do parent-targeted mobile application-based interventions improve parental mental health outcomes, across randomized controlled trials?*

Method

Identification and selection of studies

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [56]. The primary aim was to systematically evaluate the effectiveness of *parent-targeted mobile application-based interventions* on parental mental health. The final search was completed on 10 June 2025.

A comprehensive literature search was performed across four electronic databases—PubMed, Scopus, Web of Science, and Google Scholar. Google Scholar was additionally used to identify potentially relevant records not indexed in traditional bibliographic databases. The search strategy combined controlled vocabulary and free-text terms using Boolean operators (AND/OR). Key search terms included variations of “mobile health,” “mHealth,” “mobile applications,” “smartphone apps,” “digital interventions,” “parents,” “parental caregivers,” “mothers,” “fathers,” “mental health,” and “randomized controlled trials (RCTs).” The inclusion of broader caregiver- and digital-related terminology was intended to enhance search sensitivity and capture variation in terminology across the literature. However, consistent with the predefined eligibility criteria, only interventions delivered via mobile applications and explicitly targeting parents (i.e., mothers and/or fathers) were retained for inclusion in the meta-analysis. In addition, eligibility was restricted to peer-reviewed articles published in English.

Although the search strategy did not explicitly restrict studies to perinatal-specific terminology (e.g., “perinatal,” “postpartum”), the primary aim of the present meta-analysis was to comprehensively identify mobile-based mental health interventions targeting parents, irrespective of the developmental stage of their children. Accordingly, the search strategy was designed to capture studies involving parents across a broad range of child developmental periods. In addition to the database search, manual screening of reference lists from included

articles and relevant reviews was conducted to identify potentially eligible studies that may have been missed by electronic searches. Studies were eligible for inclusion if they: (a) evaluated the effectiveness of a mobile application designed specifically for parents (i.e., mothers and fathers); (b) reported at least one outcome measure related to parental mental health; (c) provided sufficient statistical information (e.g., means, standard deviations, p-values, or confidence intervals) to allow for the calculation of effect sizes. The primary focus of the present synthesis was on randomized controlled trials (RCTs). However, one non-randomized feasibility study meeting all other eligibility criteria was also included to provide a more comprehensive overview of the emerging evidence base. Studies were excluded if they: (a) focused exclusively on parents of children with diagnosed clinical conditions (e.g., autism spectrum disorder, epilepsy, trauma-related disorders, or severe behavioral problems), in order to minimize confounding effects of child-related clinical stressors on parental mental health outcomes; (b) evaluated interventions delivered solely via SMS, tele-coaching, or web-based platforms without an integrated mobile application component; or (c) lacked sufficient methodological transparency or statistical reporting to support quantitative synthesis.

A comprehensive literature search of PubMed, Scopus, Web of Science, and Google Scholar yielded 1,017 records (search conducted through June 2025). An additional 12 records were identified through manual screening of reference lists. After the removal of 102 duplicate records, 927 unique records remained for title and abstract screening. Following this screening stage, 69 full-text articles were assessed for eligibility. Of these, 57 articles were excluded for the following reasons: non-randomized study design ($n=15$), interventions not involving a parent-targeted mobile application ($n=14$), studies focusing exclusively on parents of children with diagnosed clinical conditions ($n=12$), insufficient statistical reporting for effect size calculation ($n=9$), and other reasons ($n=7$). In total, 12 intervention studies met the eligibility criteria and were included in both the systematic review and the quantitative meta-analysis, the majority of which were randomized controlled trials (RCTs). The studies that met the predefined eligibility criteria and were ultimately included in the meta-analysis predominantly focused on parents of newborns and infants. Specifically, seven studies targeted parents of newborns, one study focused on parents of infants aged 6–17 months, and one study included parents of children aged 0–24 months. In addition, a smaller number of studies addressed parents of older children, including one study each focusing on parents of children aged 1.5–5 years, 4–10 years, and 5–12 years. This distribution indicates that the current evidence base for mobile app-based

mental health interventions for parents is heavily concentrated in the earliest stages of parenthood, with comparatively limited evidence available for later developmental periods. Importantly, studies targeting later stages of parenting were not excluded a priori; rather, no eligible mobile-based trials focusing on later parenting phases met the inclusion criteria during the screening process. The PRISMA flow diagram illustrating the study selection process is presented in Supplementary Material 1.

Screening, data extraction, and coding

The study selection process was conducted in two sequential stages. First, titles and abstracts were independently screened by two reviewers to assess initial eligibility. Full texts of potentially relevant articles were subsequently retrieved and evaluated in detail against the predefined inclusion criteria. Risk of bias was independently assessed for each study by two reviewers. Any disagreements between the reviewers were resolved through discussion and consensus. If consensus could not be reached, discrepancies were resolved in consultation with a third reviewer. In total, 12 intervention studies met the eligibility criteria and were included in the systematic review and quantitative meta-analysis. For each included study, data were systematically extracted and coded using a standardized extraction form. Extracted variables included: (a) authors and year of publication; (b) country of study; (c) sample size and participant characteristics (e.g., mothers only versus both mothers and fathers); (d) intervention name, core components, and duration; (e) description of the control condition or comparator; (f) type of mental health measure used (e.g., EPDS, PHQ-9, CES-D); and (g) relevant statistical information (e.g., means, standard deviations, p-values, t-values, or confidence intervals) required for effect size calculation.

Intervention characteristics varied substantially across the included studies. As summarized in Supplementary Table S1, interventions differed in terms of content, intensity, duration, and delivery format. Most interventions incorporated psychoeducational components, often combined with cognitive-behavioral strategies, mindfulness-based practices, behavioral training, or peer support features. Intervention duration ranged from brief programs lasting approximately 3–4 weeks to more extended interventions delivered over 2 to 3 months or, in some cases, spanning the prenatal to early postpartum period. With respect to delivery format, the majority of interventions were delivered through self-guided mobile applications; however, several studies employed facilitated or hybrid approaches that included telehealth coaching sessions, professional guidance, moderated forums, or chatbot-based support. These intervention characteristics were systematically extracted to aid interpretation of

between-study heterogeneity and to contextualize variability in observed effect sizes. When studies reported multiple mental health outcomes, only one outcome was selected from each study for inclusion in the meta-analysis. Outcome selection followed a prespecified hierarchy: (a) the study's primary mental health outcome; if not specified, (b) depressive symptom severity; and when multiple time points were reported, (c) immediate post-intervention outcomes were prioritized for the primary analysis. Specifically, one study included measures of depression, anxiety, and stress; ten studies assessed depression outcomes; and one study examined mental well-being.

Data analysis

All statistical analyses in this study were conducted using version 4.0 of the CMA software. Heterogeneity was initially assessed using Cochran's Q and the I^2 statistic. A random-effects model was used to account for the heterogeneity observed among the studies. Hedges's g was used in the meta-analysis to assess the impact of app-based interventions on mental health outcomes among parents. Hedges's g is considered a suitable and robust effect size metric in meta-analyses that include studies with differing sample sizes [57]. Effect sizes were calculated as standardized mean differences between intervention and control groups at post-intervention; when means and standard deviations were not available, effect sizes were derived from equivalent statistics (e.g., t-values, p-values, or confidence intervals) using standard conversions. Based on Sawilowsky's [58] framework, effect sizes are categorized as very small ($d = 0.01$), small ($d = 0.20$), medium ($d = 0.50$), large ($d = 0.80$), very large ($d = 1.20$), and huge ($d = 2.00$). In this study, this classification was used as the basis for interpreting Hedges's g . Because the outcome of interest was overall mental health, depression-focused measures were coded so that positive effect sizes consistently indicated better mental health (i.e., fewer symptoms) in the intervention group compared with the control group; accordingly, symptom-based scales were reverse-coded when necessary to ensure that higher values uniformly reflected improvement. Subsequently, a test of the null hypothesis was performed to determine whether the overall effect size significantly deviated from zero. Publication bias was subsequently assessed using multiple methods, including funnel plot analysis and the Classic Fail-safe N technique. Finally, to further explore potential sources of heterogeneity, a meta-analytic analysis of variance (meta-ANOVA) was conducted to examine whether the composition of the intervention group—mothers only versus a both mothers and fathers' group—functioned as a moderating variable.

Ethics and registration

This review was not prospectively registered on PROSPERO or any other systematic review registry. The study was approved by the institutional ethics committee (Report No: 20250505348). The analysis was based on previously published data and did not involve the collection of new data from human participants, no additional informed consent was required.

Results

Effect size and heterogeneity test

The primary outcome assessed in this meta-analysis was parental depressive symptoms, as measured by validated self-report instruments. Additionally, one study that evaluated parental mental well-being was included. Both depressive symptoms and well-being outcomes were synthesized under the broader construct of parental mental health, with depression representing the most frequently assessed outcome across trials. Effect sizes were calculated using Hedges's g , which adjusts for potential bias due to small sample sizes [59]. Given the anticipated heterogeneity in sample characteristics and intervention components across studies, a random-effects model was employed to obtain pooled estimates. Between-study heterogeneity was evaluated using Cochran's Q statistic and the I^2 index, with I^2 values of 25%, 50%, and 75% interpreted as indicators of low, moderate, and high heterogeneity, respectively [60].

The heterogeneity analysis, summarized in Table 1, demonstrated considerable variation across the 12 independent samples, as evidenced by a significant Q value ($Q = 96.117$, $p = .000$) and a high I^2 index (88.556). Given that the p -value for the Q statistic falls below the significance level of 0.10, this indicates the presence of significant heterogeneity among the effect sizes across studies. The I^2 value represents the percentage of overall variation in observed effect sizes that can be attributed to true heterogeneity among studies, rather than to random sampling error. The analysis indicates that 88.556% of the observed variance across study results reflects actual heterogeneity among the studies [61]. An I^2 statistic greater than 75% is interpreted as indicating substantial heterogeneity according to the classification by Higgins et al. [60], supporting the notion that variability across studies is meaningfully high in this meta-analysis.

The overall mean effect size derived from 12 app-based intervention studies yielded a Hedges's g of 0.378, reflecting a statistically significant, positive, and small [58] treatment effect in favor of the intervention condition.

Because mental health was the dependent variable, studies focusing on depression were coded so that positive effect sizes indicated more favorable mental health outcomes for the intervention group compared to the control group. Evidence from the analysis suggests the effectiveness of app-based interventions in promoting better mental health outcomes among parents. A Z -score of 3.125 ($p = .002$) obtained from the null hypothesis test indicates that the overall effect size is statistically distinct from zero. As noted by Borenstein et al. [62], the statistically significant effect observed for app-based interventions on parental mental health is more likely to represent a true underlying effect rather than a consequence of random sampling fluctuations. Figure 1 presents a forest plot illustrating the overall effect size of app-based interventions on parental mental health across the studies included in the analysis.

Publication bias and sensitivity analysis

To evaluate the potential presence of publication bias, both statistical and visual approaches were employed. The classic fail-safe N analysis indicated that 133 unpublished studies with null findings would be required to reduce the observed effect of app-based interventions on parental mental health to non-significance [63]. This finding suggests that the overall effect size is relatively robust and unlikely to be an artifact of selective reporting. Complementing this analysis, a funnel plot was generated (see Supplementary Fig. 2). In the absence of publication bias, effect sizes are expected to distribute symmetrically around the pooled mean; by contrast, asymmetry would indicate potential bias [64]. As illustrated in Supplementary Fig. 2, the distribution of the 12 included effect sizes appeared broadly symmetrical, though minor asymmetry was evident due to a small number of outlying studies. This pattern does not provide strong evidence of publication bias, although the possibility of small-study effects cannot be completely excluded.

Moderator analysis

A random-effects model was employed to examine whether the composition of the intervention group—mothers only versus both mothers and fathers—moderated the effect of app-based interventions on parental mental health. Among the 12 included intervention studies, five focused exclusively on mothers, whereas the remaining seven involved mixed parent groups comprising both mothers and fathers. Of these seven studies, three specifically included couples, whereas the other

Table 1 Results of the random effects meta-analyses

k	N	Hedges's g	95%CI	Test of Null		Heterogeneity			
				Z-value	p	Q	df (Q)	p	I^2
12	2789	0.378	[0.141, 0.615]	3.125	0.002	96.117	11	0.000	88.556

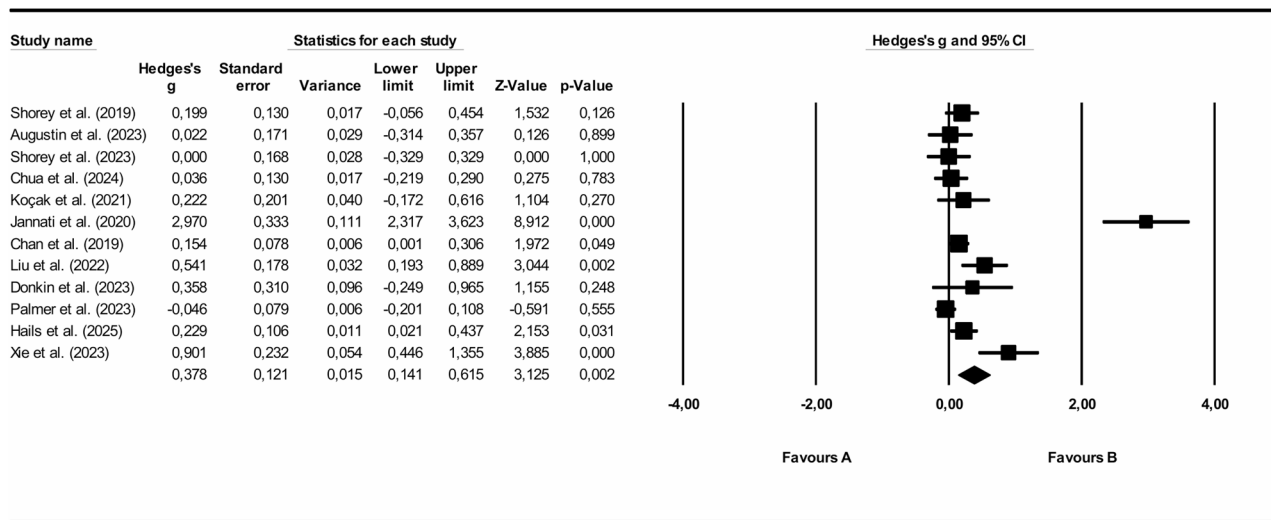


Fig. 1 Forest Plot

Table 2 Meta-ANOVA results for the moderating role of group composition

Group Composition	n	Q _b	g [LL, UL]	p
		5.698 (1)		0.017
Mixed groups	7		0.074 [-0.025, 0.174]	0.057
Mother-only groups	5		0.902 [0.230, 1.575]	0.009

Note. Bold values indicate effect sizes whose 95% confidence intervals do not include zero

four involved mothers and fathers participating individually rather than as couples. A meta-analytic ANOVA was conducted to assess the moderating effect of group composition on the overall effect size.

As presented in Table 2, the results indicate that group composition significantly moderated the effect of app-based interventions on parental mental health ($Q = 5.698$, $df = 1$, $p = .017$). In subgroup analyses, app-based interventions did not yield a statistically significant effect on parental mental health in mixed parent groups ($g = 0.074$, $p = .057$), whereas a moderate and statistically significant effect was observed in mother-only groups ($g = 0.902$, $p = .009$).

Discussion

This meta-analysis synthesized evidence from 12 intervention studies, including 11 randomized controlled trials and one single-arm intervention study without a control group, to evaluate the effectiveness of mobile app-based interventions on parental mental health. The pooled results indicated a statistically significant effect, suggesting that app-based interventions may contribute to improvements in parental mental health. However, substantial between-study heterogeneity suggests that effects likely vary by sample characteristics and intervention features. Examination of the developmental timing of the included interventions revealed a clear

concentration in early stages of parenthood. Specifically, six studies were conducted during the perinatal period, encompassing pregnancy and the early postpartum phase (≤ 6 months), while an additional four studies targeted parents during the transition from postpartum to early parenting, including infancy and early childhood (approximately 0–5 years). Only two studies extended beyond these early stages to focus on parents of school-aged children. Across studies, most participants were mothers. Five studies included only mothers, while seven studies included both mothers and fathers. However, only three studies recruited parents as couples; in the remaining studies, mothers and fathers participated individually. Geographically, the included studies were conducted across a limited set of countries—namely Singapore, Canada, Germany, New Zealand, the United Kingdom, the United States, Türkiye, Iran, Hong Kong, China, and Taiwan—providing important contextual boundaries for interpreting the scope and generalizability of the findings. Taken together, these characteristics indicate that the current evidence base for mobile app-based interventions for parental mental health is developmentally concentrated in the perinatal and early parenting periods, with comparatively limited evidence available for later stages of parenthood. Moreover, the evidence base is drawn largely from high- and upper-middle-income settings, which may further limit generalizability to under-resourced contexts.

Within the scope of parental mental health, depressive symptoms were the most consistently assessed outcome (10 studies), while general mental well-being was assessed in one study, and one study evaluated depression, anxiety, and stress jointly as indicators of parental mental health. By focusing exclusively on mobile app-based delivery formats and drawing primarily on

randomized controlled trial evidence, this meta-analysis offers a more precise and methodologically focused estimate of effectiveness compared with prior reviews that aggregated heterogeneous digital modalities and study designs [55, 65]. Although fathers were underrepresented across the included studies, the inclusion of interventions involving both mothers and fathers allows for initial insights into paternal mental health outcomes, highlighting a critical yet still underexamined dimension of parental mental health research.

Our findings are consistent with a growing body of evidence suggesting that mHealth interventions may support parental mental health, particularly among mothers during the perinatal and early parenting period. For instance, Dol et al. [55] reported significant reductions in Edinburgh Postnatal Depression Scale scores among mothers receiving mHealth-based interventions, and Zhou et al. [65] identified a pooled mean difference of favoring mHealth approaches. However, these earlier syntheses frequently combined randomized and non-randomized designs and aggregated heterogeneous delivery modalities—including mobile applications, web-based platforms, and telephone-based programs—which may limit interpretability and inflate pooled effects [55, 65]. By contrast, the present meta-analysis mobile application-delivered interventions and relies predominantly on randomized evidence, thereby providing a more focused and transparent estimate of effect. Complementing these findings, Chua and Shorey [33] synthesized evidence from 12 studies—most of which were RCTs—and reported improvements in parental depression and anxiety, although no quantitative synthesis was conducted due to outcome heterogeneity. Building on this work, the present study extends the literature by providing pooled effect sizes, subgroup analyses, and publication bias assessments. Importantly, although most included studies focused on mothers, the inclusion of interventions involving both mothers and fathers allows for preliminary insights into paternal mental health outcomes, underscoring the importance of considering diverse caregiving roles in the design and evaluation of mobile mental health interventions for parents.

Comparisons with recent syntheses further clarify the contributions of the present meta-analysis. Tsai et al. [44], for example, examined mobile applications for perinatal depression and anxiety and reported no statistically significant effects on depressive or anxiety symptoms, attributing these null findings to substantial heterogeneity, small sample sizes, short follow-up periods, and the inclusion of interventions with limited evidence bases. In contrast, the present synthesis focused specifically on parent-targeted mobile applications and drew primarily on randomized controlled trial evidence, while including a small number of feasibility studies with sufficient

outcome data to support quantitative synthesis. Within this more methodologically focused evidence base, we observed a statistically significant small overall effect on parental mental health, with stronger effects evident in mother-only samples, suggesting that intervention effectiveness may vary by sample composition and caregiving role. Similarly, Miura et al. [66], in their review of preventive interventions for postpartum depression, reported modest symptom reductions without significant effects on depression incidence, highlighting heterogeneity and the exclusion of fathers as key limitations. By incorporating both preventive and treatment-focused interventions, as well as studies involving both mothers and fathers, the present meta-analysis offers a more integrated perspective on app-based interventions for parental mental health. Collectively, these findings underscore the potential of mobile applications as scalable and accessible tools within parental mental health care, while emphasizing the importance of caregiving roles and sample composition when interpreting intervention effects.

Subgroup analyses revealed meaningful differences in intervention effectiveness according to sample composition and caregiving roles. Interventions exclusively targeting mothers were associated with statistically significant and comparatively larger effects, whereas interventions that included both mothers and fathers generally demonstrated small or non-significant effects. Importantly, closer examination of the latter group reveals substantial heterogeneity in paternal representation and study design. Only a limited number of trials employed truly dyadic (couple-based) designs with balanced maternal and paternal participation, and these studies were predominantly conducted during the perinatal period [5, 42, 45]. While some perinatal dyadic interventions yielded modest benefits on selected outcomes, overall effect sizes remained small, and several outcomes did not reach statistical significance. In contrast, many studies nominally including fathers were characterized by a markedly low proportion of paternal participants, with samples overwhelmingly composed of mothers, thereby limiting the extent to which findings reflect paternal or dyadic processes [35, 50, 67]. Accordingly, subgroup differences should be interpreted primarily as reflecting variation in sample composition and measurement focus, rather than definitive evidence of differential effectiveness by parent gender.

Notably, most mother-focused interventions were implemented during the perinatal or early parenting period—a developmental stage that has been widely characterized in the broader literature as involving heightened vulnerability to depressive symptoms [1, 8, 19]. This contextual and developmental alignment may help explain the stronger effects observed in mother-only samples. Conversely, the inclusion of fathers within

broadly defined or non–role-specific intervention frameworks may attenuate overall intervention effects, particularly when parental roles, psychological needs, and caregiving responsibilities differ substantially. Furthermore, the small pooled effects observed in the meta-analysis may partly reflect the inclusion of studies reporting minimal or null intervention effects, especially among mixed-parent samples. Taken together, these findings underscore the need for future mobile app–based interventions to adopt gender-sensitive and role-aligned designs, with differentiated or adaptive content pathways that more precisely address the distinct needs of mothers and fathers, particularly during the perinatal period.

When each study included in the meta-analysis is examined separately, intervention effects indicate substantial variability, with some studies reporting statistically significant effects on parental mental health outcomes, while others report minimal or null effects. Several randomized controlled trials reported improvements in parental depressive symptoms following app-based interventions, particularly those incorporating multicomponent or theory-driven elements such as cognitive-behavioral strategies, mindfulness-based approaches, or peer support [45–49]. In addition, hybrid models that combined app-based tools with elements of human support (e.g., coaching or facilitation) showed favorable outcomes in specific populations [50]. By contrast, a number of studies reported no significant reductions in depressive symptoms despite adequate user engagement or usability, instead demonstrating improvements in related outcomes such as perceived parenting support or self-efficacy [37, 38, 41–43]. Taken together, these findings suggest that variability in intervention content, intensity, and theoretical grounding may meaningfully influence observed outcomes. By focusing specifically on parent-targeted mobile applications and drawing primarily on randomized controlled trial evidence, the present meta-analysis provides a conservative yet methodologically robust synthesis of the available literature, highlighting both the potential and the boundaries of app-based interventions for supporting parental mental health.

Implications, limitations, and future directions

This meta-analysis shows that mobile app–based interventions have small to moderate effects on parental mental health, but these effects are close to the moderate range [58]. Therefore, such interventions have meaningful potential as accessible and scalable tools that complement traditional mental health services. At the same time, the pattern of findings underscores the importance of intervention design and target population. Stronger effects observed in mother-focused interventions highlight the potential value of tailoring

content to gender- and caregiving-specific needs, while also emphasizing the need for future interventions that more explicitly engage fathers and co-parenting dyads. From a research perspective, these findings point to the importance of rigorous study designs, including adequate follow-up periods and careful attention to intervention fidelity and user engagement. Collectively, these implications suggest that thoughtfully designed mobile applications have the capacity to extend preventive mental health support for parents, while also identifying critical directions for methodological refinement and innovation in future trials.

Substantial heterogeneity was observed across studies, reflecting marked variation in intervention duration, structure, delivery format, and therapeutic components. This degree of heterogeneity limits the ability to isolate which specific intervention features or active ingredients most strongly contribute to observed effects. Moreover, differences in participant engagement and the extent of contextual adaptation across studies further complicate the interpretation of pooled estimates. In addition, most outcomes were assessed via self-report measures, which may be influenced by reporting biases and limits conclusions about change. Several otherwise eligible studies could not be included in the quantitative synthesis due to incomplete statistical reporting, most commonly the absence of means or standard deviations required for effect size calculation. Together, these limitations underscore the need for more transparent, standardized, and comprehensive reporting practices in primary trials. Addressing these methodological challenges in future research—through designs that facilitate component-level analyses and the inclusion of longer-term follow-up assessments—will be essential for strengthening the robustness and cumulative value of the evidence base in this field.

Beyond methodological heterogeneity, an additional limitation concerns the contextual scope of the available evidence. Although this meta-analysis synthesized predominantly randomized controlled trials conducted across multiple countries, the generalizability of the findings to broader cultural and socioeconomic contexts remains uncertain. While geographic diversity was present, key contextual determinants—such as digital access, internet connectivity, device availability, and levels of digital literacy—were rarely assessed or systematically reported in the primary trials. Consequently, the potential moderating influence of these factors on engagement with, and the effectiveness of, mobile app–based interventions could not be formally examined. Accordingly, the present meta-analysis does not assume cross-contextual equivalence of intervention effects but instead situates its conclusions within the specific populations, settings, and structural conditions represented in the

included studies. Moreover, the existing evidence base is developmentally concentrated, as most included studies have focused on the perinatal and early parenting periods. Consequently, the conclusions of this meta-analysis should be interpreted with particular consideration of these developmental stages, while recognizing that a smaller number of studies also extend beyond the immediate perinatal context. This pattern highlights the need for future research examining the effectiveness of mobile interventions across later stages of parenthood.

In addition, the potential risk of publication bias cannot be fully excluded. Visual inspection of the funnel plot revealed only modest asymmetry (see Supplementary Fig. 2), and the classic fail-safe N analysis indicated that 133 additional studies with null findings would be required to reduce the observed effect to non-significance—an implausibly large number given the current size of the evidence base. Although these findings provide some reassurance regarding the robustness of the pooled effect, they do not eliminate the possibility of bias entirely. Given the limited number of included studies, publication-bias tests and visual diagnostics should be interpreted cautiously. Future research should address this limitation by prospectively registering trials, encouraging the publication of null findings, expanding search strategies to include grey literature and regional databases, and conducting larger-scale randomized controlled trials with rigorous methodological standards. Collectively, such efforts will be essential for strengthening the transparency, reliability, and cumulative value of evidence on mobile app-based interventions for parental mental health.

Conclusion

This study constitutes an investigation that demonstrates how mobile-based applications may contribute to mental health in the context of parenting. Overall, the present meta-analysis suggests that mobile app-based interventions may yield statistically significant improvements in parental mental health, primarily in depressive symptoms. The findings indicate that such interventions may be considered potentially protective tools for enhancing parental mental health, including indicators such as depressive symptoms, anxiety, and stress. However, research on mobile-based applications targeting parental mental health is still at an early stage of development. In this context, it is understood that the emergence of intervention effects depends on the clear articulation of theoretical foundations, the systematic structuring of intervention content, the evaluation of effectiveness through RCTs, and the adequate representation of parents with children at different developmental stages. Overall, the present findings help contextualize the potential role of mobile-based applications in parental

mental health within an emerging and still-developing evidence base.

Abbreviations

mHealth	Mobile Health
RCT	Randomized Controlled Trial
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
CMA	Comprehensive Meta-Analysis
EPDS	Edinburgh Postnatal Depression Scale
PHQ-9	Patient Health Questionnaire-9
CES-D	Center for Epidemiologic Studies Depression Scale
SMD	Standardized Mean Difference
MD	Mean Difference

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Studies included in the meta-analysis are indicated with an asterisk (*) in the reference list.

Authors' contributions

SM: Writing—original draft, investigation, data curation, and conceptualization. EGU: Formal analysis, visualization, validation, and resources. SME: Writing—review and editing, supervision, methodology. All authors read and approved the final manuscript.

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Data availability

Data will be made available upon reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Yildiz Technical University Scientific Research and Ethical Review Board (Report No: 20250505348). The analysis was based on previously published data and did not involve the collection of new data from human participants; therefore, no additional informed consent was required.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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