

Digital Health in Maternal Health: Systematic Review Synthesized by Synthory AI

Abstract

This review was automatically synthesized for research purposes using the [Synthory AI](#) service, following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The systematic literature review focused on digital health in maternal health, specifically addressing digital interventions for gestational diabetes and telemedicine for mental health during pregnancy. The review was based on primary research studies published between 2019 and 2024, retrieved from PubMed and PubMed Central™ databases, and adheres to strict inclusion and exclusion criteria to ensure the relevance and novelty of the findings.

1. Methods

1.1. Approach

The search strategy was designed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [1]. The systematic literature review was automatically generated on demand using the Synthory AI service. The request, 'digital health in maternal health,' was intentionally broad to cover a wide range of relevant topics. The review was created for research purposes. All components listed below were identified, extracted, assessed, analyzed, and summarized automatically as part of the review process.

1.2. Analysis of the Request

The topic of the request was 'Digital health in maternal health'. The suggested focus areas for the review included:

- Digital Health Interventions for Gestational Diabetes
- Telemedicine for Mental Health in Pregnancy

1.3. Criteria of Inclusion and Exclusion

Inclusion criteria

1. Publications available in PubMed and PubMed Central™.
2. Publications related to digital health, maternal health, and associated aspects.
3. Primary research studies, including randomized controlled trials, cohort studies, and qualitative research.

Exclusion criteria

1. Articles published before 2019/01.
2. Systematic literature reviews, case series, case reports, expert opinions, study protocols, and any unidentified study types.

3. Studies without full-text availability in PubMed or PubMed Central™.
4. Articles that have been previously included and analyzed in existing reviews within the defined focus areas, to avoid duplication and ensure the inclusion of novel research findings.

1.3. Search Strategy and Screening Process

The search employed 18 keywords, including: (postpartum depression, postnatal care, postpartum, pregnancy, prenatal care, preeclampsia, maternal mortality, antenatal care, obstetrics, childbirth, maternal health) and (mhealth, telehealth, ehealth, wearables, mobile health, telemedicine, digital health).

The search was conducted across the PubMed and PubMed Central™ databases, covering the publication period from 2019/01 to 2024/09.

The search and screening process included:

1. Identification: 1507 records were retrieved from PubMed using the inclusion criteria.
2. Screening:
 - a. Articles were excluded based on the criteria.
 - b. Articles of low-quality risk were excluded following an Article Quality Assessment.
3. Eligibility: Assessment of alignment with defined topics.

A total of 9 articles were included in the final review, based on the inclusion and exclusion criteria.

The breakdown by topic is as follows:

- Digital Health Interventions for Gestational Diabetes: 3 articles
- Telemedicine for Mental Health in Pregnancy: 6 articles

1.4. Data Extraction

Key study characteristics were extracted from the included articles. A predefined data extraction table was used to document details such as study design and key findings.

1.5. Quality Assessment

The quality of the included articles was assessed as follows:

1. The Newcastle-Ottawa Scale (NOS) was used to assess the quality of non-randomized and cohort studies [\[2\]](#).
2. The risk of bias assessment was used for randomized trials [\[3\]](#).

1.6. Analysis

The analysis proceeded in three phases:

- Phase 1: Identification of potential topics.
- Phase 2: Data extraction from relevant articles.

- Phase 3: Analysis of the relevance of new findings.

A hybrid generative and causal method was employed for data analysis and review generation, with OpenAI™ serving as the generative component. This method combines generative modeling with causal analysis, enhancing both the reliability and interpretability of the outcomes by accounting for underlying cause-effect relationships. Given the diversity of research methods involved, a narrative review was used to describe the quantitative data. This approach facilitated the integration of various evidence types into a coherent summary. The narrative review process included summarizing and interpreting findings, as well as discussing the limitations identified in the included articles.

2. Results

2.1. Digital Health Interventions for Gestational Diabetes

Digital health interventions for gestational diabetes have been increasingly explored to enhance self-management and improve clinical outcomes. Recent studies have highlighted the efficacy of these interventions in optimizing glycemic control, enhancing patient engagement, and improving maternal and neonatal health outcomes. The adoption of mobile applications and telemedicine platforms has been shown to facilitate timely monitoring and support from healthcare providers, addressing key challenges in managing gestational diabetes effectively. Additionally, these technologies provide personalized feedback and have been associated with increased patient satisfaction, underscoring their transformative potential in optimizing treatment adherence and communication between patients and healthcare providers.

The previous review highlighted the significant potential of digital health interventions in managing gestational diabetes mellitus (GDM), noting improvements in glycemic control and user satisfaction, particularly through mHealth applications and telemedicine [4]. Despite these benefits, challenges persist, notably in terms of usability and cultural appropriateness, with only 17% of interventions adequately addressing cultural needs [5, 6, 7, 8, 9]. Usability evaluations often relied on limited methodologies, with standardized usability questionnaires used in just 12% of studies, indicating a need for more robust assessments [10, 11]. Additionally, the lack of comprehensive training programs for users was identified as a barrier to maximizing the effectiveness of these technologies [12]. Future research should focus on enhancing usability, cultural adaptation, and digital literacy to improve user engagement and health outcomes across diverse populations.

These findings align with specific interventions like the Tele-GDM, which has demonstrated effective glycemic control and weight management in clinical trials. The Tele-GDM intervention, as reported by Al-Ofi et al. (2019), resulted in significantly lower 2-hour postprandial glucose levels, with a mean of 6.9 ± 0.6 mmol/L, highlighting effective glycemic control. Furthermore, women in the Tele-GDM group demonstrated more effective weight management by achieving a greater proportion of recommended weight gain and significantly lower overall weight gain compared to the control group, as indicated by a p-value of 0.03.

Table 1. Digital Health Interventions for Gestational Diabetes

Study ID	Length of intervention	Population of intervention	Control	Intervention	Intervention details	Primary outcome	Secondary outcome
Al-Ofi et al. 2019	18-22 weeks	Women with established GDM diagnosed using IADPSG criteria, recruited from the GDM unit at KAUH, gestational age of 24-28 weeks, 27 participants	30 participants, standard treatment control group	Use of telemonitoring device and service for women with GDM	Telemonitoring device includes Smartphone-Glucometer and Glucomail application, instructions and training provided, blood sugar measured four times daily, body weight recorded weekly, weekly questionnaire completion, weekly review by diabetic care team, emergency alerts for hyperglycaemia or hypoglycaemia, automated messages, personalized coaching system adjusted to due date, dietary advice delivered by text message	Effect of telemedicine dietary advice on blood glucose levels, significantly lower 2-hour postprandial glucose levels in Tele-GDM group	Maternal weight gain, most women in Tele-GDM group reached recommended range of weight gain, lower overall weight gain compared to control group
Tian et al. 2021	8-16 weeks	Women aged 18 to 45 years, with singleton pregnancy of fewer than 31 gestational weeks, diagnosed with GDM, able to use a smartphone for basic Chinese, 147 participants	Women with GDM, 23-30 (+6) gestational weeks, 162 participants, standard clinical prenatal care	Weekly management through WeChat group chat for participants with GDM	Main components: weekly briefings, task cards with diet advice and exercise rules, self-management with shared photos and experiences, individualized guidance, lessons and articles on pregnancy and GDM, peer interactions and support groups, delivered via WeChat group chat, tools: task cards, photos, WeChat platform, frequency: weekly, protocols: encouragement of active participation, sharing experiences, individualized guidance, preparation of educational materials	Higher glycemic qualification rate in intervention group compared to control group, statistical significance at three time points	missed
Garnweidner-Holme et al. 2020	From first consultation to gestational week 36	Women diagnosed with GDM, older than 18 years, less than 33-weeks pregnant, understood Norwegian, Urdu, or Somali, recruited from diabetes outpatient clinics in Oslo region, Norway, 115 participants	Usual care only, 123 participants, standard treatment control group	Use of the Pregnant+ app and usual care	Pregnant+ app with 10 GDM-specific dietary recommendations, 4 main icons ("Blood glucose," "Physical activity," "Food and beverages," "Diabetes information"), app downloaded from Apple Store or Google Play, electronic tablets for questionnaire, regular consultations every 1-2 weeks with midwives or nurses, automatic/manual blood glucose registration, feedback on values, referral to dietary recommendations for high values, graphical representation for monitoring	Effect of the Pregnant+ app on dietary behavior in women with GDM, measured using HDS-P+, no significant improvement compared to controls	Increased frequency of fish meals in control group, no other significant differences

Similarly, other studies, such as those by Tian et al., have reported improved glycemic outcomes, further supporting the potential of digital health interventions in managing gestational diabetes. Tian et al. (2021) found that the intervention group demonstrated significantly improved glycemic qualification rates compared to the control group. At three measured intervals, the intervention group showed higher qualification rates: 54.8% vs. 83.3% at T3 for Group 1 ($p < 0.05$), 62.5% vs. 80.0% at T3 for Group 2 ($p < 0.05$), and 75.0% vs. 100% at T7 for Group 2 ($p < 0.05$).

However, not all digital health interventions yield positive results, as evidenced by research on the Pregnant+ app, which did not significantly enhance dietary behavior among women with gestational diabetes. The study evaluating the Pregnant+ app revealed no significant enhancement in dietary behavior among women with gestational diabetes mellitus (GDM), with the Healthy Dietary Score for Pregnant+ (HDS-P+) showing a non-significant p-value of 0.65 (Garnweidner-Holme et al. 2020). Interestingly, the control group demonstrated a statistically significant increase in fish meal consumption compared to the intervention group, with a p-value of 0.05, while other dietary habits remained unchanged between the groups. These findings suggest that while technology generally shows promise in GDM management, the specific dietary interventions via the Pregnant+ app may not contribute to the expected improvements in dietary behavior, contrasting with broader trends of technology facilitating self-management in GDM.

Overall, digital health interventions present a diverse range of outcomes in the management of gestational diabetes, with varying effectiveness across different aspects of care. The integration of these technologies into routine clinical practice continues to evolve, reflecting both their potential and the challenges that remain.

2.2. Telemedicine for Mental Health in Pregnancy

Telemedicine has emerged in recent years as a promising and pivotal tool for addressing mental health challenges during pregnancy, offering accessible and effective solutions. Recent studies have demonstrated significant improvements in mental health outcomes for pregnant women through digital interventions, particularly internet-delivered Cognitive Behavioral Therapy and structured peer support. These interventions have shown efficacy in reducing symptoms of depression, anxiety, and stress. This chapter examines the latest evidence on these telemedicine interventions, highlighting advancements in personalized and tailored approaches to optimize maternal well-being during this critical period.

The previous review [15] highlighted that telemedicine interventions are effective in reducing depression, anxiety, and stress among pregnant women and new mothers, with significant improvements reported in 58% of studies for depression and 36% for anxiety. A notable portion of these studies showed a low risk of bias [16, 17, 18, 19, 20, 21, 22, 23]. However, the review also identified limitations, such as broad inclusion criteria leading to variability in study designs, issues with risk of bias assessment tools, and challenges in generalizing findings. Additionally, the studies often lacked consistent reporting on feasibility and implementation barriers. Future research is needed to optimize telemedicine interventions by tailoring them to specific characteristics like timeframe, content, and delivery mode to enhance their effectiveness for various mental health outcomes.

Table 2. Telemedicine for Mental Health in Pregnancy

Study ID	Length of intervention	Population of intervention	Control	Intervention	Intervention details	Primary outcome	Secondary outcome
Hummel et al. 2022	18-24 weeks	Pregnant women, ≥ 14 years of age, enrolled from Mathare North Health Centre (Nairobi County, peri-urban) and Rachuonyo Sub-County Hospital (Homa Bay County, rural), 800 participants		Mobile WACH NEO, two-way SMS communication with healthcare workers to improve maternal and neonatal outcomes	Pre-programmed SMS messages, personalized and behavioral theory-based content, delivered in preferred language and time, managed by study nurse, weekly during pregnancy, daily for 1 week then every other day for 3 weeks in early neonatal period, twice a week in postnatal period, topics included birth preparation, health evaluations, family planning	Prevalence and identification of perinatal depression in Kenyan women	Increased risk of infant illness or hospitalization associated with antenatal depressive symptoms, differences in SMS communication patterns between women with and without perinatal depression
Sun et al. 2021	8 weeks	Pregnant adult women aged 18 years and over, potentially at risk of perinatal depression, positive depressive symptoms screening with an EPDS score >9 or a PHQ-9 score >4 , recruited from an obstetrics clinic of a tertiary hospital in Jinan, Shandong, China, 84 participants	Attention control group, 84 participants, 8-week regular WeChat health consultations, recruited from an obstetrics clinic in Jinan, Shandong, China	Mindfulness training program revised from MBCT, smartphone-based, delivered through Spirits Healing app	Main components: focus on perinatal depression, physical adaptations, simplified practice, delivered via mobile app, text/audio/visual materials, recordings, videos, 8-week duration, eight sessions, formal training 15-25 minutes, 6 days per week, weekly WeChat reminders, 2 yuan reward per week	Effectiveness of a smartphone-based mindfulness training intervention on reducing depression symptoms during pregnancy	Improvements in anxiety and positive affect for perinatal women
Danaher et al. 2023	50 weeks	Depressed perinatal women, ≥ 18 years of age, recruited from NorthShore University HealthSystem in Chicago, English language proficiency, 89 participants	Routine-care group in a healthcare setting, 95 participants, standard treatment control group	Use of MMB2 and PDP by women in the MMB2+PDP group	Increasing pleasant activities, interrupting negative thoughts, increasing positive thoughts, seeking support, tracking mood, delivered via browser-based Web app, videos, audios, animations, editable lists, adaptable to devices, six sessions sequentially available weekly over 12 weeks, continued access for 7 months, enrollment by study coordinator, due date used to switch content, two outreach calls for support and feedback	Significant decrease in depression severity using PHQ-9, evaluated by minimal clinically important difference	Decrease in stress using DASS-21, increase in behavioral activation using BADS-Short Form, reduction in negative thoughts using ATQ-SF, improvement in behavioral self-efficacy

Table 2. Telemedicine for Mental Health in Pregnancy (continued)

Zhang et al. 2023	6 weeks	Women aged ≥ 18 years, 12 to 20 weeks pregnant, exhibited psychological distress with EPDS score of ≥ 9 or GAD-7 scale score of ≥ 5 , fluent in reading and writing Chinese, from Shandong Province, outpatient centers of 2 comprehensive tertiary hospitals, 160 participants	Usual perinatal care	Digital guided self-help mindfulness-based intervention (GSH-MBI) via WeChat mini program	6 modules with thematic lessons and homework, delivered on WeChat mini program, animated videos and audio-based practices, daily reminders via WeChat, weekly modules, 10-20 minute videos, daily formal and informal practices, standardized daily reminders	Reduction in maternal psychological distress, including depression, anxiety, and pregnancy-related anxiety symptoms	Improvement in infant neuropsychological outcomes, including temperament and developmental behaviors, lower scores in temperament observed in the digital GSH-MBI group at 6 weeks postpartum
Bozkurt. 2023	Three online home visits were made to the intervention group within the first 42 days.	Mothers over 18 years of age, given birth at term, baby with normal birth weight and APGAR score of 8 or higher, no postpartum complications, speaks and understands Turkish, primiparous and multiparous, 2–5 days postpartum, 60 participants	60 participants, standard treatment control group	Online home visits using Midwifery Home software (Ebe Evimde application) to evaluate self-efficacy and anxiety levels	Conducted by midwives via mobile devices or web-based applications, mobile support application used, three visits within 42 days postpartum, each session 1–1.5 hours, scheduled at 2nd-5th day, 13th-17th day, 30th-42nd day, video call assessments, user data uploaded	Improvement in mothers' self-efficacy levels in the intervention group using Ebe Evimde (My Home Midwife) application	Reduction in postpartum anxiety levels in the intervention group
Arakawa et al. 2023	from time of assignment until four months after childbirth	Pregnant women living in Yokohama City, mean age 32.9 years, 62% primipara, able to communicate in Japanese, recruited at public offices and childcare support facilities, 365 participants	Usual care group, 369 participants, standard treatment control group	mHealth consultation service provided by Kids Public, Inc.	Provided through LINE platform or telephone calls, consultations with obstetrician–gynecologists, pediatricians, and midwives, mobile devices used, available between 6 p.m. and 10 p.m. on weekdays, 10-minute consultation slots, healthcare professionals with at least three years of experience, magazines sent to promote service use	Lower risk of elevated postpartum depressive symptoms in the mHealth group compared to usual care, with risk ratio 0.67.	Self-efficacy, loneliness, perceived barriers to healthcare access, number of clinic visits, ambulance usage, EPDS score analyzed as continuous variable, subgroup analyses by sociodemographic status

The prevalence and impact of perinatal depression in specific populations underscore the necessity for effective digital interventions in maternal mental health care. The study identifies a 32.9% prevalence of perinatal depression among Kenyan women, as reported by Hummel et al. (2022), with significant associations with undesired pregnancies (RR = 1.30; 95% CI: 1.11, 1.52; $p < 0.001$) and abuse during pregnancy (RR = 1.73; 95% CI: 1.57, 1.90; $p < 0.0001$). Antenatal depressive symptoms are linked to an increased risk of infant illness or hospitalization (RR = 1.12; 95% CI: 1.11, 1.13; $p < 0.0001$) and decreased engagement in supportive SMS communication (aRR = 0.91; 95% CI: 0.87, 0.96), reinforcing the importance of targeted maternal mental health interventions during pregnancy.

Building on these findings, smartphone-based mindfulness interventions have shown promise in alleviating depression and anxiety during pregnancy. The smartphone-based mindfulness training intervention significantly reduced depression symptoms during pregnancy, aligning with prior findings by Sun et al. (2021) that targeted interventions are effective, as evidenced by a mean difference of 2.82 points on the EPDS and a lower incidence of depressive symptoms (24% vs. 44%) compared to the control group. Additionally, mindfulness training significantly improved anxiety, consistent with earlier reports of effective anxiety reduction, with a Cohen's d of 0.44, and further enhanced positive affect among perinatal women, demonstrated by a mean difference of -3.45 in positive affect scores.

Further evidence of the effectiveness of digital interventions is provided by the MMB2+PDP program, which demonstrates superior outcomes compared to standard care. Danaher et al. (2023) found that the MMB2+PDP intervention demonstrated a significant reduction in depression severity, with 43% of participants achieving clinically significant improvements compared to 26% in the routine care group, yielding an odds ratio of 2.12 (95% CI: 1.16 –3.90, $p = 0.015$). Additionally, the intervention significantly reduced stress levels, as indicated by the DASS-21 ($p = .019$), and further decreased depression severity as measured by the PHQ-9 ($p = .003$), confirming its effectiveness over standard treatment approaches.

In addition to reducing psychological distress, digital mindfulness-based interventions have also been shown to improve infant neuropsychological outcomes postpartum. Zhang et al. (2023) found that the digital guided self-help mindfulness-based intervention (GSH-MBI) significantly reduces maternal psychological distress, including depression (Wald $\chi^2(5) = 20.6$, $p = .001$), anxiety (Wald $\chi^2(5) = 24.7$, $p < .001$), and pregnancy-related anxiety (Wald $\chi^2(2) = 46.5$, $p < .001$), demonstrating moderate to large effect sizes. Additionally, the intervention significantly improved infant neuropsychological outcomes at 6 weeks postpartum, with lower temperament scores compared to the control group: quality of mood ($\beta = .25$, $p = .002$), distractibility ($\beta = .30$, $p < .001$), adaptability ($\beta = .22$, $p = .006$), and attention span ($\beta = .17$, $p = .04$).

Mobile support applications further highlight the potential of digital tools to enhance maternal self-efficacy and reduce anxiety. The study demonstrates significant improvements in mothers' self-efficacy and reductions in anxiety levels through the use of mobile support applications (Bozkurt, 2023). The intervention group's anxiety levels saw a significant reduction, with the intervention group achieving a PSAS posttest mean score of 59.50 ± 12.64 , markedly lower than the control group's 118.21 ± 27.28 ($p < .001$). These findings align with the effectiveness of

support-based interventions reported previously, underscoring their role in enhancing maternal mental health outcomes.

Complementing these interventions, mHealth solutions have been associated with improved postpartum mental health and overall well-being. Arakawa et al. ([2023](#)) found that the mHealth intervention is associated with a significantly lower risk of elevated postpartum depressive symptoms compared to usual care, with a relative risk of 0.67 (95% CI: 0.48–0.93), indicating a 33% reduction in risk ($p = 0.01$). Women in the mHealth group reported a 15.2% incidence of elevated depressive symptoms versus 22.8% in the usual care group. Furthermore, the intervention enhanced parenting self-efficacy (47.9 vs. 46.9), reduced loneliness scores (6.78 vs. 7.17), and decreased perceived barriers to healthcare access (4.1 vs. 5.2), providing a comprehensive improvement in postpartum well-being.

Evidence suggests that telemedicine interventions may address mental health challenges during pregnancy, though study limitations exist. These digital solutions hold relevance in healthcare settings.

3. Discussion

3.1. Digital Health Interventions for Gestational Diabetes

The integration of digital health interventions for gestational diabetes mellitus (GDM) has garnered significant attention due to their potential to enhance self-management and improve clinical outcomes, a vital aspect of advancing maternal health through technology. Recent evidence underscores the efficacy of these interventions, particularly in optimizing glycemic control and improving patient engagement. For instance, Al-Ofi et al. ([2019](#)) demonstrated that the Tele-GDM intervention significantly reduced 2-hour postprandial glucose levels and aided in weight management. This finding is corroborated by Tian et al. ([2021](#)), who reported improved glycemic control rates in intervention groups compared to control groups. However, the effectiveness of specific interventions, such as dietary apps, appears inconsistent, as evidenced by Garnweidner-Holme et al. ([2020](#)), who found that the Pregnant+ app did not significantly enhance dietary behavior, with the control group showing a notable increase in fish consumption. These results highlight the transformative potential of digital health tools in managing gestational diabetes while also indicating that the efficacy of particular applications may vary.

Further studies reinforce these findings. Al-Ofi et al. ([2019](#)) are consistent with Guo et al. ([2019](#)) and Yew et al. ([2021](#)), who also demonstrated improvements in blood glucose control through mobile health interventions. Additionally, Miremberg et al. ([2018](#)) highlighted improved compliance and lower off-target glucose measurements associated with digital tools. However, discrepancies persist, as noted in the study by Mackillop et al. ([2018](#)), which reported no significant differences in glycemic outcomes between intervention and control groups. These variations may be attributed to differences in study design or the specifics of the interventions employed. The strength of the new evidence is bolstered by rigorous randomized controlled trial designs, emphasizing the need for standardized methodologies to facilitate better comparisons across studies.

When examining maternal clinical outcomes, the results remain mixed. Al-Ofi et al. (2019) reported that the Tele-GDM group exhibited significantly lower weight gain compared to the control group, which is consistent with previous findings by Guo et al. (2019) and Carolan-Olah et al. (2019), both of which highlighted reduced weight gain and improved glycemic control in intervention groups. This suggests that digital health interventions may effectively manage gestational weight gain. However, Tian et al. (2021) found no significant differences in pregnancy outcomes, including delivery mode and preterm birth, echoing earlier studies such as Yew et al. (2021), which reported similar non-significant findings. These discrepancies could stem from variations in study design, sample size, and the types of interventions used. Overall, while digital health interventions show promise in specific areas like weight management, their broader impact on maternal clinical outcomes necessitates further investigation.

The influence of digital health interventions on maternal lifestyle factors also warrants attention. Improvements in compliance, satisfaction, and reduced clinical visits have been documented, with studies by Miremberg et al. (2018) and Guo et al. (2019) reporting significant increases in patient compliance and satisfaction through smartphone applications. New studies, including those by Nielsen et al. (2020), continue to support these findings, emphasizing improvements in lifestyle factors such as physical activity and dietary behaviors as proxies for diabetes risk reduction. However, Garnweidner-Holme et al. (2020) noted that while improvements in dietary scores were observed, the Pregnant+ app did not significantly influence these scores, indicating potential limitations in the app's effectiveness. This discrepancy emphasizes the necessity of identifying specific components of digital interventions that drive their efficacy. The accumulation of evidence from robust randomized controlled trials enhances the credibility of digital interventions in maternal health, particularly in managing gestational diabetes [30, 31].

Finally, the examination of neonatal clinical outcomes within the context of digital health interventions reveals consistent findings across various studies. A comprehensive review encompassing 14 randomized controlled trials predominantly reported no significant differences in neonatal outcomes, including birth weight, neonatal hypoglycemia, and admissions to neonatal intensive care units, between intervention and control groups [14, 12]. Specifically, Miremberg et al. (2018) highlighted a lack of significant differences in neonatal complications, while Mackillop et al. (2018) noted that other glycemic, maternal, and neonatal outcomes were similar in both groups. Yew et al. (2021) observed a reduction in composite neonatal complications in the intervention group, although this was not a prespecified outcome. The new study by Tian et al. (2021) aligns with these earlier findings, reiterating the absence of significant differences in neonatal outcomes between the groups. This consistency strengthens the evidence suggesting that digital health interventions for gestational diabetes may not significantly alter neonatal outcomes compared to traditional care [14, 12, 35]. While the overall findings are stable, the notable exception of Yew et al.'s study suggests potential benefits that warrant further exploration. Thus, the new data largely corroborate previous conclusions regarding the impact of digital health interventions on neonatal outcomes, reinforcing a stable understanding of their effects in this domain [14, 35].

3.2. Telemedicine for Mental Health in Pregnancy

Telemedicine has emerged as a pivotal tool for addressing mental health challenges during pregnancy, particularly in the context of digital health interventions. Recent studies underscore the effectiveness of telemedicine in mitigating depression, anxiety, and stress, ultimately enhancing maternal well-being. A significant prevalence rate of 32.9% for perinatal depression, often linked to unwanted pregnancies and abuse, highlights the urgent need for targeted interventions [24]. Notably, smartphone-based mindfulness training has demonstrated considerable efficacy in reducing both depression and anxiety, aligning with findings from Sun et al. (2021). The MMB2+PDP intervention has been shown to outperform routine care in alleviating depressive symptoms and stress [26]. Furthermore, digital guided self-help interventions have proven effective in diminishing maternal psychological distress while concurrently improving infant outcomes [27].

The exploration of depression within the realm of digital health interventions reveals a consistent trend toward their effectiveness. Recent studies reinforce earlier findings regarding significant reductions in depressive symptoms through internet-based cognitive behavioral therapy (ICBT) and mindfulness training [25, 27]. For instance, Zhang et al. (2023) corroborated the efficacy of digital guided self-help interventions, which resonates with earlier research by Sheeber et al. (2012) on internet-based approaches. While Hummel et al. (2022) highlighted the prevalence of depressive symptoms without focusing on intervention outcomes, contrasting studies like Altazan et al. (2019) noted increased depressive symptoms associated with certain interventions. The methodological rigor of newer studies, characterized by robust trial designs and larger sample sizes, enhances the reliability of these findings and emphasizes the importance of tailored interventions [25, 27, 26].

In terms of postnatal depression, recent studies further substantiate the potential of telemedicine to alleviate depressive symptoms. For example, Arakawa et al. (2023) reported significant reductions in elevated postpartum depressive symptoms among participants receiving mHealth interventions compared to usual care. This aligns with previous studies, such as those by Dennis et al. (2009) and Pugh et al. (2016), which also demonstrated the effectiveness of telemedicine interventions. However, Hummel et al. (2022) focused on the prevalence and sociodemographic factors influencing postnatal depression, highlighting the need to consider contextual factors alongside intervention efficacy. The methodological advancements in recent studies, including randomized controlled trials and cohort designs, contribute to a nuanced understanding of how digital health interventions can be tailored to improve maternal mental health outcomes [29].

Recent investigations into anxiety levels among pregnant and postpartum women have reinforced the effectiveness of digital health interventions in reducing anxiety symptoms. Earlier research, such as that by Loughnan et al. (2019), demonstrated significant reductions in anxiety through ICBT, a trend that continues with new studies by Sun et al. (2021) and Zhang et al. (2023). These studies confirm the positive impact of digital interventions, and methodological improvements, including randomized controlled trials and validated scales, strengthen the evidence base. Notably, Bozkurt (2023) offers novel insights into postpartum anxiety management, further supporting the consistency of findings across various studies.

The assessment of stress levels in the context of digital health interventions reveals significant reductions, particularly with the combination of MMB2 and PDP interventions. Danaher et al. (2023) reported substantial improvements. However, variability in outcomes was noted in earlier studies, such as those by Bennion et al. (2020) and Krusche et al. (2018), which reported no significant changes. These discrepancies may stem from differences in intervention types and participant characteristics. Methodological advancements in recent studies, including refined measurement tools and targeted intervention combinations, contribute to a deeper understanding of effective strategies for stress reduction, reinforcing the role of telemedicine in mitigating stress during pregnancy.

Quality of Life (QoL) has been evaluated in several studies assessing the impact of digital health interventions on maternal mental health. Previous research consistently utilized randomized controlled trials to evaluate various dimensions of QoL, such as mood and physical well-being [36]. For instance, findings indicated that both intervention and control groups returned to early pregnancy levels of mood and physical quality of life postpartum, suggesting a temporary impact of interventions. Pugh et al. (2016) also reported improvements in psychological and environmental QoL compared to waitlist controls. However, the absence of new studies explicitly focusing on QoL limits our ability to extend previous conclusions, highlighting the need for continued research in this area to better understand the long-term effectiveness of digital health interventions.

Lastly, while earlier studies highlighted improvements in general well-being through interventions such as IB-CBSM and Be a Mom, recent research has not contributed additional data on this critical aspect. Prior studies demonstrated significant positive outcomes regarding psychological and mental health, with Monteiro et al. (2020) noting enhancements in both mother and infant well-being. The lack of new data on well-being in recent research underscores the need for ongoing investigation into how digital health interventions can enhance overall well-being among expectant and new mothers, reinforcing the importance of prior evidence while indicating a current gap in this specific area.

4. Limitations

4.1. Digital Health Interventions for Gestational Diabetes

The advancement of digital health interventions for gestational diabetes mellitus (GDM) necessitates continuous evaluation and integration of modern technologies. A recent study attempted to address the limitations identified in previous reviews concerning the focus on studies published before 2021, which may not adequately capture the latest technological innovations in managing GDM [4]. This study incorporated the Pregnant+ app within a randomized controlled trial involving 115 participants who spoke Norwegian, Urdu, or Somali, thereby highlighting the potential of contemporary mobile health technologies to reach diverse populations [6]. Despite leveraging advanced features such as real-time feedback and dietary recommendations, the study found no significant improvement in dietary behaviors compared to the control group. This outcome suggests that the mere integration of new technology does not inherently lead to better health outcomes. Consequently, while the study partially addresses

the limitation of outdated interventions, it underscores the necessity for further research to ascertain the effectiveness of these technologies in enhancing dietary habits among pregnant women with GDM.

4.2. Telemedicine for Mental Health in Pregnancy

The previous review identified several limitations in the domain of telemedicine for mental health in pregnancy, particularly within the context of digital health in maternal health. A prominent concern was the broad inclusion criteria of studies, which led to significant variability, obscuring the ability to draw clear conclusions about intervention commonalities [15]. Recent studies have made substantial strides in addressing this limitation by adopting more targeted participant selection and standardized interventions. For example, a study involving 800 pregnant women from specific regions in Kenya implemented a structured SMS communication intervention, providing detailed participant characteristics and rigorous statistical analyses [24]. Similarly, a study in Shandong Province focused on 160 pregnant women with psychological distress, utilizing a digital guided self-help mindfulness intervention, which significantly reduced maternal psychological distress [27].

Another study in Yokohama City, involving 734 pregnant women, employed a standardized mHealth consultation service, resulting in a lower risk of postpartum depressive symptoms [29]. Despite these advancements, regional and cultural factors may still influence the findings, necessitating further research with diverse populations and broader geographic representation to achieve a comprehensive understanding of these interventions' effectiveness. Another limitation identified was the significant variability in the delivery modes, targets, contents, and approaches of telemedicine interventions, which impeded statistical comparability and generalizability [15]. Recent studies have addressed this by implementing standardized intervention protocols. For instance, a two-way SMS communication system with personalized, theory-based content was delivered consistently across a diverse group of 800 pregnant women in Kenya, revealing a 32.9% prevalence of depressive symptoms linked to specific risk factors [24]. Additionally, a standardized mHealth consultation service in Japan, involving 365 participants, demonstrated a lower risk of postpartum depressive symptoms (risk ratio: 0.67) with consistent engagement metrics [29]. While these studies mitigate the identified variability, personalized elements and geographic specificity may still limit broader applicability, warranting further research to explore the generalizability of these findings across different populations and settings.

Moreover, the previous review noted inconsistent reporting of feasibility, acceptance, and implementation barriers across studies [15]. A study with a substantial sample size of 800 participants from diverse settings in Kenya addressed this by employing a well-structured mobile SMS communication intervention [24]. This study provided detailed demographic data and analyzed communication patterns related to mental health, revealing a notable attrition rate of 28.3% and reduced engagement among mothers with antenatal depression. While these findings enhance the understanding of implementation barriers, moderate effectiveness in addressing the limitation suggests that additional research is necessary to explore factors influencing participant acceptance and engagement in telemedicine interventions.

Finally, the previous review identified a significant risk of bias in telemedicine interventions due to inadequacies in the Cochrane risk-of-bias tool, often resulting in a lack of blinding and high attrition rates. A recent study addressed these limitations by employing a robust randomization process with 734 participants, achieving an 87% response rate [29]. This approach minimized potential bias and enhanced the reliability of findings, utilizing a standardized mHealth consultation service to ensure consistency in delivery and engagement. Despite these advancements, biases related to self-reported outcomes persist, necessitating further research to fully eliminate potential risks associated with self-reporting and to explore the efficacy of telemedicine interventions across different contexts and populations.

5. Conclusions

The integration of digital health interventions in maternal health has shown promising results, particularly in managing gestational diabetes and addressing mental health challenges during pregnancy. Evidence indicates that interventions such as Tele-GDM effectively improve glycemic control and patient engagement, while telemedicine has proven effective in reducing depression, anxiety, and stress among expectant mothers. However, the variability in outcomes across studies highlights the need for standardized methodologies and larger, more diverse sample sizes to improve generalizability. Challenges such as reliance on self-reported data and technological barriers must be addressed to enhance the effectiveness of these interventions. Future research should focus on refining intervention strategies, incorporating objective measurement tools, and ensuring culturally appropriate delivery. By addressing these limitations, digital health interventions can be better positioned to improve health outcomes for mothers and their infants, ultimately advancing the field of maternal health. Continued exploration of the long-term impacts of these interventions on quality of life and overall well-being remains crucial for a comprehensive understanding of their benefits.

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