Review

Informatics Interventions for Maternal Morbidity: Scoping Review

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Abstract

Background: Women have been entering pregnancy less healthy than previous generations, placing them at increased risk for pregnancy complications. One approach to ensuring effective monitoring and treatment of at-risk women is designing technology-based interventions that prevent maternal morbidities and treat perinatal conditions.

Objective: This scoping review evaluates what informatics interventions have been designed and tested to prevent and treat maternal morbidity.

Methods: MEDLINE, Embase, and Cochrane Library were searched to identify relevant studies. The inclusion criteria were studies that tested a medical or clinical informatics intervention; enrolled adult women; and addressed preeclampsia, gestational diabetes mellitus (GDM), preterm birth, Centers for Disease Control and Prevention–defined severe maternal morbidity, or perinatal mental health conditions. Demographic, population, and intervention data were extracted to characterize the technologies, conditions, and populations addressed.

Results: A total of 80 studies were identified that met the inclusion criteria. Many of the studies tested for multiple conditions. Of these, 73% (60/82) of the technologies were tested for either GDM or perinatal mental health conditions, and 15% (12/82) were tested for preeclampsia. For technologies, 32% (28/87) of the technologies tested were smartphone or tablet applications, 26% (23/87) were telehealth interventions, and 14% (12/87) were remote monitoring technologies. Of the many outcomes measured by the studies, almost half (69/140, 49%) were patient physical or mental health outcomes.

Conclusions: Per this scoping review, most informatics interventions address three conditions: GDM, preeclampsia, and mental health. There may be opportunities to treat other potentially lethal conditions like postpartum hemorrhage using proven technologies such as mobile apps. Ample gaps in the literature exist concerning the use of informatics technologies aimed at maternal morbidity. There may be opportunities to use informatics for lesser-targeted conditions and populations.

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KEYWORDS

scoping review; maternal morbidity; medical informatics; clinical informatics; informatics; mother; pregnant; perinatal; GDM; preeclampsia; maternity; gestational diabetes mellitus

Introduction

Women have been entering pregnancy less healthy than previous generations [1]. Maternal morbidities such as preeclampsia and gestational diabetes, and severe maternal morbidities such as postpartum hemorrhage all have implications for the long-term health of mothers well beyond the postpartum period. Preeclampsia is associated with cardiovascular disease for decades following pregnancy, including chronic hypertension, stroke, and age-adjusted overall mortality [2]. Gestational diabetes mellitus (GDM), a condition that in many cases resolves itself after delivery, can still affect mothers beyond the puerperium [3]. Severe maternal morbidity (SMM) encompasses myriad conditions, including acute myocardial infarction, eclampsia, and hemorrhage. Those who have experienced SMM are more likely to die at any point after delivery and into the decades beyond the postpartum period [4]. Preterm birth (PTB; delivering before 37 weeks gestation) is associated with long-term cardiovascular complications in the mother, including ischemic heart disease, stroke, and atherosclerosis [5].

Informatics interventions offer tools that can help to prevent perinatal health conditions that have long-term health consequences for mothers, monitor these conditions in the perinatal period so that mother and baby remain healthy, and follow mothers post partum to ensure that they continue to receive the health monitoring they need. Technology-based tools that can be used for these purposes include mobile apps, wearable technology, physician decision support, and telehealth, among others. As artificial intelligence (AI) technology becomes more common in health care, a range of interventions can be used to predict, diagnose, and treat maternal morbidities that lead to maternal complications, with the hope of reducing maternal morbidity and mortality [6]. While some patients are hesitant for their physicians to use AI to diagnose or treat medical problems, physicians have demonstrated growing acceptance and belief that AI will improve interactions with their patients [7]. As the landscape of health informatics shifts substantially with the advent of new technologies, it is important to assess what technologies have already been tested to prevent, diagnose, and treat common maternal morbidities so that gaps can be identified and addressed in future research [8].

In this scoping review, we seek to identify what informatics interventions have been designed and tested that address maternal morbidity. In addition, we aim to assess the extent, range, and nature of informatics interventions that have been tested to prevent, diagnose, and treat maternal morbidities known to have long-term health consequences for mothers. The review summarizes discrete populations addressed in the literature, types of informatics interventions tested in the literature, conditions addressed by these interventions, and outcomes measured.

Methods

Search Strategy

Our scoping review methodology was guided by Arksey and O'Malley's [9] framework, stages 1-5, and Joanna Briggs's *Manual for Scoping Reviews*. We asked what informatics interventions have been designed and tested for SMM. Using the PCC (Population, Concept, and Context) framework outlined in the *Manual for Scoping Reviews*, the population was adult women with SMM as defined by the Centers for Disease Control and Prevention (CDC), the concept was informatics interventions, and the context was prospective studies anywhere in the world. We developed a review protocol to guide the process. The literature searches were led by an expert information specialist (JCS) in consultation with the research team. Four electronic databases were searched from inception until June 6, 2022: MEDLINE and Embase (searched simultaneously on Ovid), Cochrane Library (Wiley), and Engineering Village (Elsevier). One database was searched from inception until June 7, 2022: IEEE Xplore (IEEE). The MEDLINE (Ovid) search was peer-reviewed by another expert librarian using the PRESS (Peer Review of Electronic Search Strategies) checklist and modified as required [10]. The search strategy was limited to the English language and encompassed all years of publication. Embase and MEDLINE citations were deduplicated in Ovid before exporting to Covidence online review software. The full search strategies for each database are publicly available in searchRxiv [11]. Lastly, review results are reported using PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) [12]. This checklist can be found in Multimedia Appendix 1. Our protocol was registered retrospectively in Open Science Framework Registries [13].

Study Selection

The inclusion and exclusion criteria are described in Textbox 1. Studies were included that prospectively tested a medical informatics intervention on either a group of women or physicians who treat women. Study methodologies could include both quantitative and qualitative approaches. Only studies analyzing primary data to describe a health-related outcome were included. Studies were included that tested medical or clinical informatics interventions on human subjects to prevent, monitor, or treat maternal conditions that have long-term health consequences for mothers within and beyond the perinatal period. Conditions included preeclampsia or hypertensive disorders of pregnancy, GDM, PTB, new mental health diagnoses, and SMM as defined by the US CDC [14].

Textbox 1. Criteria for inclusion and exclusion.

Inclusion criteria

- Test a medical informatics intervention prospectively
- Medical or clinical informatics interventions
- Adult women or physicians who treat women
- Preeclampsia, gestational diabetes mellitus, preterm birth, perinatal mental health diagnoses, severe maternal morbidity as defined by the Centers for Disease Control and Prevention (21 indicators)
- Physical health, patient-centered outcomes, mental health, health behavior, health knowledge or attitudes, health care use, quality of care outcomes

Exclusion criteria

- Systematic reviews, scoping reviews, literature reviews, opinion pieces, commentaries, proposals, reports, conference papers
- Pilot/feasibility studies
- Bioinformatics studies, including scans, ultrasounds, biomarkers, and predictive algorithms
- Adolescents
- Preexisting conditions: type 1 or 2 diabetes, chronic hypertension, preexisting mental health conditions
- Feasibility, acceptability, user experience

Systematic reviews, scoping reviews, and literature reviews were excluded together with opinion pieces, commentaries, proposals, reports, or gray literature. Studies were also excluded if they focused primarily on bioinformatics, effectively eliminating imaging (eg, ultrasounds), biomarkers, and predictive algorithm development.

Article references were entered into review software for screening and data extraction. The first and senior authors conducted an initial title, abstract, and keyword screening. If any author recommended inclusion, then the article underwent full-text screening. All authors except for the information specialist (JCS) then conducted a full-text screening, with two team members reviewing all articles. Studies with two votes to include were moved forward for extraction; those with two votes to exclude were excluded from the study. During the full-text screening, Cohen κ was used in the initial training to gauge agreement until reviewers reached a κ of 0.80. After training, disagreements were resolved by the first author.

Data Extraction

A subset of four authors extracted data using Covidence review software. Reviewers were given an initial set of 10 articles and met with the first author for consensus before reviewing the remaining articles. All studies were reviewed for extraction by the first author and one additional author. Most data extraction categories were developed a priori, and selection options were developed by the first and senior authors after reviewing all articles for trends. The following data categories were added after the protocol had been developed: aim of the study, years of data collection, population inclusion and exclusion criteria, and total number of participants. These categories were added to the data extraction form iteratively to provide more context to the reviewed studies.

Demographic data collected for each article by reviewers included title of article, year published, lead author surname, and country in which the study was conducted. The following characteristics of included studies were extracted: informatics technology tested, health problem, aim of study, study design, years of data collection, population description, study participation inclusion criteria, study participation exclusion criteria, total number of participants, and health outcome. Reviewers were given the option of selecting multiple answers for each study characteristic. An open-ended "other" option was available for the following study characteristics: informatics technology, health problem, study design, and outcome. Following extraction, the first and senior authors also extracted data on whether a significantly positive result was found in the studies, as well as racial diversity in participant samples for those studies conducted in the United States.

Data were synthesized by tallying the options from each category (study design, region, technology, health outcome, study population, study outcome, and results) and calculating the corresponding frequencies for each option.

Results

Overview

The PRISMA flow diagram for this scoping review can be found in Figure 1. A total of 3799 records were identified for title and abstract screening; 652 records underwent full-text screening for eligibility. Of these, 572 were excluded. Common reasons for exclusion were study design (eg, retrospective, systematic or other review, narrative), type of study outcome (user experience), or the wrong intervention (eg, machine learning algorithms or predictive models not tested with patients or providers). A total of 80 studies underwent full data extraction. A list of the studies and their characteristics can be found in Table 1.

Frequencies for synthesized data can be found in Table 2.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram.

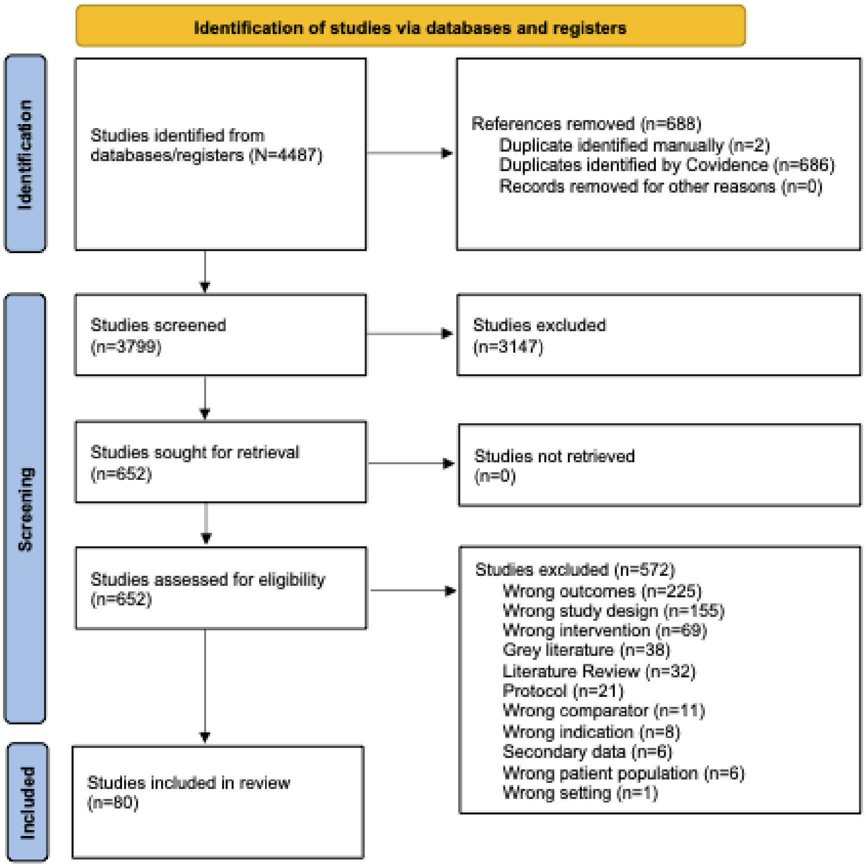

Table 1. Studies selected for extraction.

Author (year)	Country	Technology	Condition	Study design	Population	Sample size, n	Outcome
Abbaspoor et al [15] 2020	Iran	• SMS text message	GDM[a]	RCT[b]	Women	100	• Medical • Health behavior
Abejirinde et al [16] 2019	Ghana	• Smartphone/tablet application • DSSc	HDP[d], GDM	Nonrandomized experimental	Women	940	• Quality of care
Al-Ofi et al [17] 2019	Saudi Arabia	• Remote monitoring • Telehealth	GDM	RCT	Women	57	• Medical • Health behavior
Arias et al [18] 2022	United States	• Telehealth	HDP	Cohort	Women	1579	• Health behavior • Health care use • Quality of care
Bartholomew et al [19] 2015	United States	• Remote monitoring • Smartphone/tablet application • Web program	GDM	RCT	Women	74	• Number of readings
Baumel et al [20] 2018	United States	• Smartphone/tablet application • Web program	Mental health condition	Nonrandomized experimental	Women	19	• Mental health
Bellad et al [21] 2020	India	• Web application	HDP	RCT	Providers	14,783	• Medical
Borgen et al [22] 2019	Norway	• Smartphone/tablet application	GDM	RCT	Women	158	• Medical • Health behavior
Carlisle et al [23] 2022	United Kingdom	• DSS	Mental health condition, PTB[e]	RCT	Women	300	• Mental health
Carroll et al [24] 2013	United States	• DSS	Mental health condition	RCT	Providers	48	• Quality of care
Chan et al [25] 2019	China	• Smartphone/tablet application	Mental health condition	RCT	Women	660	• Mental health
Chappell et al [26] 2022	United Kingdom	• Remote monitoring	HDP	RCT	Women	454	• Medical
Cheung et al [27] 2019	Australia	• SMS text messaging • Wearable	GDM	RCT	Women	60	• Medical • Number of readings • Health behavior
Dennis et al [28] 2009	Canada	• Telehealth	Mental health condition	RCT	Women	846	• Medical • Mental health
Dennis et al [29] 2020	United States	• Telehealth	Mental health condition	RCT	Women	249	• Medical • Mental health • Health care use
Felder et al [30] 2017	United States	• Web program	Mental health condition	Nonrandomized experimental	Women	27	• Medical • Mental health

Author (year)	Country	Technology	Condition	Study design	Population	Sample size, n	Outcome
Ferrara et al [31] 2012	United States	• Telehealth	GDM	RCT	Women	1000	• Medical • Number of readings
Ferrara et al [32] 2016	United States	• Telehealth	GDM	RCT	Women	523	• Medical • Health behavior
Forsell et al [33] 2017	Sweden	• Telehealth • Web program	Mental health condition	RCT	Women	72	• Patient-centered outcomes • Mental health
Garnweidner-Holme et al [34] 2020	Norway	• Remote monitoring • Smartphone/tablet application	GDM	RCT	Women	238	• Health behavior
Ghaderi et al [35] 2019	Iran	• Smartphone/tablet application	GDM	RCT	Women	134	• Health knowledge/attitudes
Goetz et al [36] 2020	Taiwan	• Smartphone/tablet application	Mental health condition	Cohort	Women	30	• Mental health
Gong et al [37] 2021	China	• SMS text messaging	Mental health condition	RCT	Women	291	• Medical • Mental health
Guille et al [38] 2021	United States	• SMS text messaging • Telehealth	Mental health condition	Nonrandomized experimental	Women	2988	• Quality of care • Health behavior • Health care use
Guo et al [39] 2019	China	• Smartphone/tablet application	GDM	RCT	Women	172	• Medical • Number of readings • Health behavior • Health care use
Hantsoo et al [40] 2018	United States	• Smartphone/tablet application	Mental health condition	RCT	Women	61	• Health behavior • Health care use • Quality of care
Hedderson et al [41] 2018	United States	• DSS	GDM	RCT	Women	2014	• Medical
Heller et al [42] 2020	Netherlands	• Web program	Mental health condition	RCT	Women	159	• Mental health
Homko et al [43] 2007	United States	• Web program	GDM	RCT	Women	57	• Medical • Number of readings • Health knowledge/attitudes
Homko et al [44] 2012	United States	• Telehealth	GDM	RCT	Women	253	• Medical • Number of readings
Hoppe et al [45] 2020	United States	• Telehealth	HDP	Nonrandomized experimental	Women	428	• Medical • Number of readings • Health care use
	China		GDM	RCT	Women	309	• Medical

Author (year)	Country	Technology	Condition	Study design	Population	Sample size, n	Outcome
Huang et al [46] 2021		• Smartphone/tablet application					
Jannati et al [47] 2020	Iran	• Smartphone/tablet application	Mental health condition	RCT	Women	75	• Mental health
Klokkenga et al [48] 2019	Ghana	• Smartphone/tablet application	Hemorrhage	RCT	Women	146	• Medical
Krishnamurti et al [49] 2021	United States	• Smartphone/tablet application	HDP	Cohort	Women	2567	• Health behavior • Quality of care
Lanssens et al [50] 2017	Belgium	• Remote monitoring	HDP	Retrospective	Women	166	• Medical • Health care use • Quality of care
Lanssens et al [51] 2018	Belgium	• Remote monitoring	HDP	Retrospective	Women	320	• Medical • Health care use • Quality of care
Latendresse et al [52] 2021	United States	• Telehealth	Mental health condition	Nonrandomized experimental	Women	47	• Mental health
Lewey et al [53] 2022	United States	• SMS text messaging • Web program • Wearable	HDP	RCT	Women	127	• Medical • Health behavior
Li et al [54] 2021	China	• Telehealth	GDM	RCT	Women	287	• Medical • Health behavior
Lim et al [55] 2021	Singapore	• Smartphone/tablet application	GDM	RCT	Women	200	• Medical • Mental health
Mackillop et al [56] 2018	United Kingdom	• Telehealth • SMS text messaging	GDM	RCT	Women	203	• Medical • Number of readings • Patient-centered outcomes
Milgrom et al [57] 2016	Australia	• Web program	Mental health condition	RCT	Women	43	• Mental health
Milgrom et al [58] 2021	Australia	• Telehealth	Mental health condition	RCT	Women	116	• Mental health
Miremberg et al [59] 2018	Israel	• Smartphone/tablet application	GDM	RCT	Women	120	• Medical • Number of readings • Patient-centered outcomes • Health behavior
Missler et al [60] 2020	Netherlands	• Telehealth	Mental health condition	RCT	Women	130	• Mental health • Parenting measures
Ngai et al [61] 2015	China	• Telehealth	Mental health condition	RCT	Women	397	• Mental health

Author (year)	Country	Technology	Condition	Study design	Population	Sample size, n	Outcome
Nieminen et al [62] 2016	Sweden	• Web program	Mental health condition	RCT	Women	43	• Patient-centered outcomes • Mental health • Health behavior
Niksalehi et al [63] 2018	Iran	• SMS text messaging	Mental health condition	Nonrandomized experimental	Women	54	• Mental health
Nishimwe et al [64] 2021	Rwanda	• Smartphone/tablet application	Hemorrhage	Nonrandomized experimental	Providers	54	• Health knowledge/attitudes • Quality of care
Parsa et al [65] 2019	Iran	• Smartphone/tablet application	HDP	Nonrandomized experimental	Women	110	• Health knowledge/attitudes
Perry et al [66] 2018	United Kingdom	• Remote monitoring • Smartphone/tablet application	HDP	Case control	Women	108	• Medical • Number of readings • Health care use
Posmontier et al [67] 2016	United States	• Telehealth	Mental health condition	Cohort	Women	61	• Patient-centered outcomes • Mental health • Quality of care
Potzel et al [68] 2022	Germany	• Smartphone/tablet application	GDM	RCT	Women	203	• Medical • Number of readings • Health behavior
Rahman et al [69] 2017	Bangladesh	• Web program	Hemorrhage	RCT	Women	310	• Quality of care
Rasekaba et al [70] 2018	Australia	• Telehealth	GDM	RCT	Women	95	• Medical • Health care use
Sawyer et al [71] 2019	Australia	• Smartphone/tablet application	Mental health condition	RCT	Women	133	• Mental health
Shamshiri Milani et al [72] 2015	Iran	• Telehealth	Mental health condition	RCT	Women	126	• Mental health
Silva-Jose et al [73] 2021	Spain	• Telehealth • Web program	HDP	RCT	Women	206	• Medical • Health behavior
Simhi et al [74] 2021	Israel	• Telehealth	Mental health condition	RCT	Women	77	• Mental health • Health behavior
Skar et al [75] 2018	Norway	• Smartphone/tablet application	GDM	Qualitative	Women	17	• Mental health • Health knowledge/attitudes
St Pierre et al [76] 2017	Germany	• Anesthesia machine cognitive aid	Myocardial infarction	RCT	Women	83	• Quality of care
Sun et al [77] 2021	China	• Smartphone/tablet application	Mental health condition	RCT	Women	186	• Mental health
	Korea		GDM	RCT	Women	21	• Medical

Author (year)	Country	Technology	Condition	Study design	Population	Sample size, n	Outcome
Sung et al [78] 2019		• Remote monitoring • Smartphone/tablet application					
Sung et al [79] 2021	Korea	• Telehealth	GDM	Cohort	Women	176	• Medical • Health care use
Tian et al [80] 2020	China	• Smartphone/tablet application	GDM	RCT	Women	169	• Health behavior
Tian et al [81] 2021	China	• Telehealth	GDM	RCT	Women	309	• Medical
Triebwasser et al [82] 2020	United States	• SMS text messaging • Web-based program	HDP	RCT	Women	333	• Number of readings
Tucker et al [83] 2022	United Kingdom	• Remote monitoring • Smartphone/tablet application	HDP	RCT	Women	2346	• Medical • Mental health • Quality of care
Ugarriza and Schmidt [84] 2006	United States	• Telehealth	Mental health condition	RCT	Women	30	• Mental health
Vandenberk et al [85] 2019	Belgium	• Remote monitoring	HDP	RCT	Women	108	• Number of readings • Mental health
van den Heuvel et al [86] 2020	Netherlands	• Remote monitoring • Smartphone/tablet application	HDP	Case control	Women	133	• Medical • Health care use
van Montfort et al [87] 2020	Netherlands	• Web program	HDP	Cohort	Women	850	• Quality of care
Van Ryswyk et al [88] 2015	New Zealand	• SMS text messaging	GDM	RCT	Women	268	• Medical • Health behavior
Vigod et al [89] 2021	Canada	• Web program	Mental health condition	RCT	Women	98	• Mental health
Wozney et al [90] 2017	Canada	• Telehealth	Mental health condition	RCT	Women	62	• Mental health
Yang et al [91] 2018	China	• Smartphone/tablet application	GDM	RCT	Women	107	• Medical
Yew et al [92] 2021	Singapore	• Smartphone/tablet application	GDM	RCT	Women	340	• Medical
Zera et al [93] 2015	United States	• DSS	GDM	RCT	Women	847	• Quality of care
Zhuo et al [94] 2022	China	• Smartphone/tablet application	GDM	RCT	Women	124	• Medical • Health behavior

[a]GDM: gestational diabetes mellitus.

[b]RCT: randomized controlled trial.

[c]DSS: decision support system.

[d]HDP: hypertensive disorders of pregnancy.

[e]PTB: preterm birth.

Table 2. Outcomes measured.

	Frequency, n (%)
Study design (n=80)	
Randomized controlled trial	60 (75)
Nonrandomized experimental	9 (11)
Cohort	6 (8)
Case control	2 (3)
Retrospective	2 (3)
Qualitative	1 (1)
Region (n=80)	
North America	24 (30)
East Asia and Pacific	22 (28)
Europe and Central Asia	20 (25)
Middle East and North Africa	9 (11)
Sub-Saharan Africa	3 (4)
South Asia	2 (3)
Latin America and Caribbean	0 (0)
Technology (n=87)	
Application	28 (32)
Telehealth/telemedicine	23 (26)
Remote monitoring	12 (13)
Web-based program	10 (11)
SMS text messaging	8 (9)
EHR[a] DSS[b]	3 (3)
Wearable	2 (2)
Other	1 (1)
Perinatal health outcome (n=82)	
New mental health diagnosis	30 (37)
GDM[c]	30 (37)
Preeclampsia/HDP[d]	12 (15)
Hypertension	5 (6)
Hemorrhage	3 (4)
Preterm birth	1 (1)
Myocardial infarction	1 (1)
Study population (n=80)	
Women	77 (96)
Providers	3 (4)
Outcomes (n=140)	
Medical outcomes	39 (27.9)
Mental health outcomes	30 (21.4)
Health behavior	21 (15.0)
Quality of care	19 (13.6)
Number of readings	13 (9.3)

	Frequency, n (%)
Health care use	12 (8.6)
Health knowledge/attitudes	5 (3.6)
Other	1 (0.7)
Results (n=80)	
Significant for at least one measure	63 (79)
No significance	17 (21)

[a]EHR: electronic health record.

[b]DSS: decision support system.

[c]GDM: gestational diabetes mellitus.

[d]HDP: hypertensive disorders of pregnancy.

Included studies were mostly RCTs (n=60). Other study designs included nonrandomized experimental (n=9), cohort (n=6), case control (n=2), retrospective (n=2), and qualitative (n=1). Included studies represented a range of countries and regions. Most of the studies were conducted in North America (n=24), East Asia and the Pacific (n=22), and Western Europe (n=20). Fewer studies were authored from the Middle East and North Africa (n=9), sub-Saharan Africa (n=3), and South Asia (n=2). No studies focused on Latin America or the Caribbean.

Informatics Technologies

The specific informatics technologies tested by the study were described. Descriptive categories included telehealth or telemedicine (remote consultation via telephone or video chat that may replace medical consultation), remote monitoring (patient-performed measurements of vital signs and blood glucose), electronic health record decision support system (tools within the electronic health record that assist providers with clinical decisions), smartphone or tablet applications, SMS text messages (between providers and patients or between patients), web-based programs (patient portals and other programs administered through a web browser, not through a smartphone or tablet application), and other (with the technology charted manually). Studies tested a range of informatics technologies. The most frequently tested technologies included smartphone/tablet applications (n=28) and telehealth/telemedicine (n=23). Technologies tested less frequently included remote monitoring (n=15), web-based programs (n=10), and SMS text messaging (n=8). Technologies assessed in very few studies included electronic health record decision support (n=3), wearable technologies (n=2), and other (cognitive aid on an anesthesia machine; n=1).

Health Problems

Articles were categorized by the health problems treated by the informatics technology; some tested more than one. These included preeclampsia or hypertensive disorders of pregnancy, hypertension, GDM, PTB, hemorrhage, and new (perinatal) mental health diagnoses. Although our protocol searched for “severe maternal morbidity as defined by the CDC” and included a list of 21 conditions [13], after reviewing the articles, it was clear that the only condition from the CDC list that was frequently tested by informatics technology was postpartum hemorrhage. Thus, any additional conditions were added manually in the “other” option. Studies primarily used informatics technologies to address new mental health conditions (n=30) and GDM (n=30). Other health problems addressed by the studies include preeclampsia or hypertensive disorders of pregnancy (n=12), hypertension (n=5), and hemorrhage (n=3). One study each addressed preterm birth and myocardial infarction.

Population Type

Population type was categorized as either: women or medical providers who treat women. Included studies overwhelmingly tested informatics technologies on women, with only 3 studies testing informatics technologies on providers. US studies were also coded for sample demographics.

Outcomes

Finally, outcomes were categorized to gain an understanding of the measures upon which the studies focused; many tested more than one measure. These included medical outcomes (eg, weight loss, blood pressure, blood glucose), number of remote measures (eg, patient-collected and -reported blood pressure or blood glucose measurements), mental health outcomes (eg, Edinburgh Postnatal Depression Scale score, subjective well-being measures), health behaviors (eg, dietary habits, exercise frequency), health knowledge or attitudes (eg, patient’s understanding of health condition, patient-reported attitude toward care), health care use (eg, number of emergency room visits, number of prenatal care visits), quality of care (eg, Hospital Consumer Assessment of Healthcare Providers and Systems [HCAHPS] scores, safety of care, effectiveness of care, efficiency of care), or other. Studies measured myriad outcomes, and many studies measured more than one outcome. Many assessed medical outcomes (n=39), mental health outcomes (n=30), and patient health behaviors (n=21). Fewer measured quality of care (n=19), number of remote readings (n=13), and health care use (n=12). Very few measured health knowledge and attitudes (n=5) or other outcomes (n=1).

Effect

Studies were coded as to whether a significant positive effect was exhibited for at least one health outcome measure (yes/no). Most (n=63) studies found that the informatics technology yielded at least one positive effect for a health-related (ie, not user experience) outcome. Some (n=17) studies showed no significant positive effect of the informatics technology tested.

Discussion

Principal Findings

This scoping review was performed to characterize what informatics interventions have been tested to address the maternal morbidities that result in long-term negative health outcomes for mothers. Our results show that most of the tested informatics technologies were tested in North America, East Asia, and Western Europe. They overwhelmingly focused on patient populations diagnosed with GDM, mental health conditions, and preeclampsia. Most were patient focused and most aimed to prevent, diagnose, or treat physical or mental health outcomes.

Women have been entering pregnancy less healthy than previous generations. As the world population grows increasingly obese, high BMI presents critical risks for birthing people, with obesity linked to such perinatal complications as gestational diabetes [95], preeclampsia [96], and postpartum hemorrhage [97]. Women also currently enter pregnancy in poorer cardiovascular health than previous generations, with prepregnancy hypertension especially pronounced in rural populations of childbearing age [98]. This scoping review surveys the landscape of informatics interventions tested to treat these increasingly common conditions.

Most of the technologies were tested in North America, East Asia or the Pacific, and Western Europe. Despite some evidence of resistance to new technologies [99], studies generally show perceptions of mobile health to be positive in sub-Saharan Africa, especially toward maternal health applications [100]. There may be opportunities to test technologies developed in North America, Asia, and Europe in underserved parts of the world. In addition to improving maternal health in these underserved areas, testing in diverse types of populations may yield compelling findings that could be translated into US, Asian, and European contexts through a process of reciprocal innovation [101].

Our results show that most of the tested informatics technologies focused on patient populations diagnosed with GDM; mental health conditions; and, to a lesser extent, preeclampsia. Far fewer focused on preventing or treating postpartum hemorrhage. Although prevalences of GDM and mental health conditions are high, preeclampsia and hemorrhage are leading causes of maternal mortality and pregnancy-associated deaths in both the United States and abroad [101]. Postpartum hemorrhage, in particular, is the leading cause of maternal death worldwide, causing 94% of maternal deaths [102,103].

There are at least two possible reasons for this imbalance in testing of interventions. First, diabetes mellitus and mental health conditions are also common in the general population, unlike preeclampsia and hemorrhage. Thus, preexisting interventions may be more easily transferrable to pregnant populations. Second, GDM and postpartum depression can be diagnosed through routine screening, with GDM diagnosed via prenatal glucose testing and postpartum depression diagnosed using the Edinburgh Postnatal Depression Scale. Indeed, 9.3% of interventions measured the extent/accuracy with which patients review their own biodata, including blood glucose levels. Screening for GDM could be seen as a parsimonious method to improve women's health. On the other hand, postpartum hemorrhage is less predictable, typically being diagnosed through an urgent/emergent presentation. Thus, the ease of routine screening practices may lend certain diagnoses to being more amenable to the implementation of informatics interventions.

Most of the interventions in this review aimed to prevent, diagnose, or treat physical or mental health outcomes, and almost all were patient focused. Very few interventions (n=3, 4%) were tested on providers who treat women. Of those studies, two of the interventions focused on midwives and one used a decision support system to assist physicians in screening for maternal depression. Most interventions in this review were tested on women and involved active participation from patients (eg, taking blood glucose readings, logging symptoms in an app, participating in an online support group). In other words, most of the interventions entrusted patients with aspects of their own health.

This focus on outcomes is logical given the maternal mortality crisis both within and outside of the United States. Mental health conditions are the leading cause of pregnancy-related deaths in the United States according to state Maternal Mortality Review Committees [104] and of non-Hispanic White and Hispanic women when stratified by ethnicity. Cardiac conditions are the leading cause of pregnancy-related death for Black/African American women in the United States, but the focus on interventions aimed at patients themselves minimizes the role provider knowledge and practice within a health system plays in the crisis. Research shows that lack of standardized emergency obstetric care, maternity care coordination [105], and systemic racism [106] can play a role in the safe and effective delivery of care. The results of this scoping review show a large gap in the literature related to using informatics to improve the quality of care for maternal morbidities. Interventions such as telehealth have been shown to improve obstetric quality, including perinatal smoking cessation and breastfeeding [107]. It is possible that expanding such technologies and examining the way they are used by physicians can help improve the quality of care and ultimately save the lives of women.

The need for informatics interventions does not end with birth. Prior research suggests that many physicians, including obstetricians, are unaware of how maternal morbidity can influence maternal health in the decades following pregnancy [108]. Because of this lack of awareness, patients often do not know to monitor their own health in the long term, and they may not receive referrals for proper follow-up services. The paucity of provider-focused technologies identified in this review may also present opportunities for the development of informatics-based interventions targeting physicians and affiliated providers—especially in the treatment and prevention of postpartum preeclampsia and hemorrhage—that could use technologies like decision support to improve maternal health.

Limitations

Our study has several limitations. Because this is a scoping review, we did not systematically assess the quality of individual studies. The studies reviewed may vary in quality or contain potential biases or methodological limitations. Therefore, this study is not intended to assess the quality of the evidence supporting informatics-based interventions on the given perinatal health conditions. Additionally, the nature of a scoping review is not to analytically aggregate studies so as to make claims about effect sizes. When additional, more comparable studies have accumulated, further research is needed to examine which informatics interventions are most effective and the size of the impact on maternal and perinatal health.

In addition, we only considered published studies that tested an informatics intervention and presented health-related outcomes. We excluded many studies because they tested feasibility or acceptability. It is possible that such excluded feasibility studies will eventually test health-related outcomes. Overall, this scoping review summarizes trends in the populations, geographic areas, technologies, and conditions targeted by informatics interventions tested and disseminated in the available literature.

Conclusions

This scoping review paints a picture of the landscape of informatics interventions aimed at preventing and treating maternal morbidity. Most interventions identified in this study were tested in North America, East Asia and the Pacific, or Western Europe. Most tested either smartphone/tablet applications or telehealth/telemedicine, and most technologies tested for new mental health conditions and GDM. Almost all the studies tested technologies on populations of women and reported medical, mental health, and patient behavior outcomes. Results suggest that there may be opportunities to use informatics technologies to target providers who treat women as well as conditions such as postpartum hemorrhage that are more likely to lead to mortality. As the landscape of informatics applications in health care continues to expand, maternal health is poised to be an important target of these interventions.

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Data Availability

The search strategies used in this study are openly available at searchRxiv [11,109-111].

Authors' Contributions

Conceptualization: JI (lead), DAH (equal), JCS (supporting)
Formal analysis: JI (lead), RCS (supporting), SS (supporting), DAH (supporting)
Supervision: DAH (lead), JI (equal)
Writing – original draft: JI (lead), JCS (supporting)
Writing – review and editing: JI (lead), JCS (supporting), DAH (supporting)
Methodology: JCS (lead), DAH (supporting)
Investigation: RCS (lead), SS (equal), SAEA (supporting), OO (supporting), BB (supporting)
Generative artificial intelligence was not used in the writing of this manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) checklist.
[DOCX File , 26 KB-Multimedia Appendix 1]

References

1. Chivers BR, Boyle JA, Lang AY, Teede HJ, Moran LJ, Harrison CL. Preconception health and lifestyle behaviours of women planning a pregnancy: a cross-sectional study. J Clin Med. Jun 02, 2020;9(6):1701. [FREE Full text] [doi: 10.3390/jcm9061701] [Medline: 32498329]
2. Bellamy L, Casas J, Hingorani AD, Williams DJ. Pre-eclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis. BMJ. Nov 10, 2007;335(7627):974. [FREE Full text] [doi: 10.1136/bmj.39335.385301.BE] [Medline: 17975258]
3. Neiger R. Long-term effects of pregnancy complications on maternal health: a review. J Clin Med. Jul 27, 2017;6(8):76. [doi: 10.3390/jcm6080076] [Medline: 28749442]

4. Ukah UV, Dayan N, Potter BJ, Ayoub A, Auger N. Severe maternal morbidity and risk of mortality beyond the postpartum period. Obstet Gynecol. Feb 01, 2021;137(2):277-284. [doi: 10.1097/AOG.0000000000004223] [Medline: 33416296]
5. Robbins CL, Hutchings Y, Dietz PM, Kuklina EV, Callaghan WM. History of preterm birth and subsequent cardiovascular disease: a systematic review. Am J Obstet Gynecol. Apr 2014;210(4):285-297. [FREE Full text] [doi: 10.1016/j.ajog.2013.09.020] [Medline: 24055578]
6. Iftikhar P, Kuijpers MV, Khayyat A, Iftikhar A, DeGouvia De Sa M. Artificial intelligence: a new paradigm in obstetrics and gynecology research and clinical practice. Cureus. Feb 28, 2020;12(2):e7124. [FREE Full text] [doi: 10.7759/cureus.7124] [Medline: 32257670]
7. Reed T. Health gaps emerge in how doctors and patients see AI. Axios. Apr 15, 2024. URL: https://www.axios.com/2024/04/15/doctors-patients-ai [accessed 2024-04-18]
8. Jean-Francois B, Bailey Lash T, Dagher RK, Green Parker MC, Han SB, Lewis Johnson T. The potential for health information technology tools to reduce racial disparities in maternal morbidity and mortality. J Womens Health (Larchmt). Feb 2021;30(2):274-279. [FREE Full text] [doi: 10.1089/jwh.2020.8889] [Medline: 33211604]
9. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodology. Feb 2005;8(1):19-32. [doi: 10.1080/1364557032000119616]
10. Sampson M, McGowan J, Cogo E, Grimshaw J, Moher D, Lefebvre C. An evidence-based practice guideline for the peer review of electronic search strategies. J Clin Epidemiol. Sep 2009;62(9):944-952. [doi: 10.1016/j.jclinepi.2008.10.012] [Medline: 19230612]
11. Stumpff JC, Inderstrodt J, Haggstrom D. Systematic search: severe maternal morbidity and informatics (Engineering Village). searchRxiv. Preprint posted online on May 11, 2023. [doi: 10.1079/searchrxiv.2023.00212]
12. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Implement. Mar 2021;19(1):3-10. [doi: 10.1097/XEB.0000000000000277] [Medline: 33570328]
13. Inderstrodt J. Maternal morbidity and informatics scoping review. Open Science Framework. Dec 20, 2024. URL: https://osf.io/nfvce [accessed 2025-02-13]
14. Identifying severe maternal morbidity (SMM). Centers for Disease Control and Prevention. May 15, 2024. URL: https://www.cdc.gov/maternal-infant-health/php/severe-maternal-morbidity/icd.html [accessed 2024-06-10]
15. Abbaspoor Z, Amani A, Afshari P, Jafarirad S. The effect of education through mobile phone short message service on promoting self-care in pre-diabetic pregnant women: a randomized controlled trial. J Telemed Telecare. May 2020;26(4):200-206. [doi: 10.1177/1357633X18791419] [Medline: 30193565]
16. Abejirinde IO, De Brouwere V, van Roosmalen J, van der Heiden M, Apentibadek N, Bardají A, et al. Viability of diagnostic decision support for antenatal care in rural settings: findings from the Bliss4Midwives Intervention in Northern Ghana. J Glob Health. Jun 2019;9(1):010420. [FREE Full text] [doi: 10.7189/jogh.09.010420] [Medline: 30937164]
17. Al-Ofi EA, Mosli HH, Ghamri KA, Ghazali SM. Management of postprandial hyperglycaemia and weight gain in women with gestational diabetes mellitus using a novel telemonitoring system. J Int Med Res. Feb 2019;47(2):754-764. [FREE Full text] [doi: 10.1177/0300060518809872] [Medline: 30442052]
18. Arias MP, Wang E, Leitner K, Sannah T, Keegan M, Delferro J, et al. The impact on postpartum care by telehealth: a retrospective cohort study. Am J Obstet Gynecol MFM. May 2022;4(3):100611. [FREE Full text] [doi: 10.1016/j.ajogmf.2022.100611] [Medline: 35331971]
19. Bartholomew ML, Soules K, Church K, Shaha S, Burlingame J, Graham G, et al. Managing diabetes in pregnancy using cell phone/internet technology. Clin Diabetes. Oct 2015;33(4):169-174. [FREE Full text] [doi: 10.2337/diaclin.33.4.169] [Medline: 26487790]
20. Baumel A, Tinkelman A, Mathur N, Kane JM. Digital peer-support platform (7Cups) as an adjunct treatment for women with postpartum depression: feasibility, acceptability, and preliminary efficacy study. JMIR Mhealth Uhealth. Feb 13, 2018;6(2):e38. [FREE Full text] [doi: 10.2196/mhealth.9482] [Medline: 29439944]
21. Bellad MB, Goudar SS, Mallapur AA, Sharma S, Bone J, Charantimath US, et al. CLIP India Working Group (Table S1). Community level interventions for pre-eclampsia (CLIP) in India: a cluster randomised controlled trial. Pregnancy Hypertens. Jul 2020;21:166-175. [FREE Full text] [doi: 10.1016/j.preghy.2020.05.008] [Medline: 32554291]
22. Borgen I, Småstuen MC, Jacobsen AF, Garnweidner-Holme LM, Fayyad S, Noll J, et al. Effect of the Pregnant+ smartphone application in women with gestational diabetes mellitus: a randomised controlled trial in Norway. BMJ Open. Nov 11, 2019;9(11):e030884. [FREE Full text] [doi: 10.1136/bmjopen-2019-030884] [Medline: 31719080]
23. Carlisle N, Watson HA, Seed PT, Carter J, Kuhrt K, Tribe RM, et al. Impact of a medical mobile phone app (QUiPP) for predicting preterm birth on the anxiety and decisional conflicts faced by women in threatened preterm labour. Midwifery. Jan 2021;92:102864. [doi: 10.1016/j.midw.2020.102864] [Medline: 33137547]
24. Carroll AE, Biondich P, Anand V, Dugan TM, Downs SM. A randomized controlled trial of screening for maternal depression with a clinical decision support system. J Am Med Inform Assoc. 2013;20(2):311-316. [FREE Full text] [doi: 10.1136/amiajnl-2011-000682] [Medline: 22744960]

25. Chan KL, Leung WC, Tiwari A, Or KL, Ip P. Using smartphone-based psychoeducation to reduce postnatal depression among first-time mothers: randomized controlled trial. JMIR Mhealth Uhealth. May 14, 2019;7(5):e12794. [FREE Full text] [doi: 10.2196/12794] [Medline: 31094354]
26. Chappell L, Tucker K, Galal U, Yu L-M, Campbell H, Rivero-Arias O, et al. Effect of self-monitoring of blood pressure on blood pressure control in pregnant individuals with chronic or gestational hypertension: the BUMP 2 randomized clinical trial. JAMA. May 03, 2022;327(17):1666-1678. [FREE Full text] [doi: 10.1001/jama.2022.4726] [Medline: 35503345]
27. Cheung NW, Blumenthal C, Smith BJ, Hogan R, Thiagalingam A, Redfern J, et al. A pilot randomised controlled trial of a text messaging intervention with customisation using linked data from wireless wearable activity monitors to improve risk factors following gestational diabetes. Nutrients. Mar 11, 2019;11(3):590. [FREE Full text] [doi: 10.3390/nu11030590] [Medline: 30862052]
28. Dennis C, Hodnett E, Kenton L, Weston J, Zupancic J, Stewart DE, et al. Effect of peer support on prevention of postnatal depression among high risk women: multisite randomised controlled trial. BMJ. Jan 15, 2009;338:a3064. [FREE Full text] [doi: 10.1136/bmj.a3064] [Medline: 19147637]
29. Dennis C, Grigoriadis S, Zupancic J, Kiss A, Ravitz P. Telephone-based nurse-delivered interpersonal psychotherapy for postpartum depression: nationwide randomised controlled trial. Br J Psychiatry. Apr 2020;216(4):189-196. [doi: 10.1192/bjp.2019.275] [Medline: 32029010]
30. Felder JN, Segal Z, Beck A, Sherwood NE, Goodman SH, Boggs J, et al. An open trial of web-based mindfulness-based cognitive therapy for perinatal women at risk for depressive relapse. Cognitive Behav Pract. Feb 2017;24(1):26-37. [doi: 10.1016/j.cbpra.2016.02.002]
31. Ferrara A, Hedderson MM, Ching J, Kim C, Peng T, Crites YM. Referral to telephonic nurse management improves outcomes in women with gestational diabetes. Am J Obstet Gynecol. Jun 2012;206(6):491.e1-491.e5. [FREE Full text] [doi: 10.1016/j.ajog.2012.04.019] [Medline: 22631866]
32. Ferrara A, Hedderson MM, Brown SD, Albright CL, Ehrlich SF, Tsai A, et al. The comparative effectiveness of diabetes prevention strategies to reduce postpartum weight retention in women with gestational diabetes mellitus: the Gestational Diabetes' Effects on Moms (GEM) cluster randomized controlled trial. Diabetes Care. Jan 2016;39(1):65-74. [FREE Full text] [doi: 10.2337/dc15-1254] [Medline: 26657945]
33. Forsell E, Bendix M, Holländare F, Szymanska von Schultz B, Nasiell J, Blomdahl-Wetterholm M, et al. Internet delivered cognitive behavior therapy for antenatal depression: a randomised controlled trial. J Affect Disord. Oct 15, 2017;221:56-64. [FREE Full text] [doi: 10.1016/j.jad.2017.06.013] [Medline: 28628768]
34. Garnweidner-Holme L, Henriksen L, Torheim LE, Lukasse M. Effect of the Pregnant+ smartphone app on the dietary behavior of women with gestational diabetes mellitus: secondary analysis of a randomized controlled trial. JMIR Mhealth Uhealth. Nov 04, 2020;8(11):e18614. [FREE Full text] [doi: 10.2196/18614] [Medline: 33146620]
35. Ghaderi M, Farahani MA, Hajiha N, Ghaffari F, Haghani H. The role of smartphone-based education on the risk perception of type 2 diabetes in women with gestational diabetes. Health Technol. Aug 7, 2019;9(5):829-837. [doi: 10.1007/s12553-019-00342-3]
36. Goetz M, Schiele C, Müller M, Matthies LM, Deutsch TM, Spano C, et al. Effects of a brief electronic mindfulness-based intervention on relieving prenatal depression and anxiety in hospitalized high-risk pregnant women: exploratory pilot study. J Med Internet Res. Aug 11, 2020;22(8):e17593. [FREE Full text] [doi: 10.2196/17593] [Medline: 32780023]
37. Gong M, Zhang S, Xi C, Luo M, Wang T, Wang Y, et al. Comprehensive intervention during pregnancy based on short message service to prevent or alleviate depression in pregnant women: a quasi-experimental study. Early Interv Psychiatry. Apr 2021;15(2):352-359. [doi: 10.1111/eip.12953] [Medline: 32232971]
38. Guille C, Maldonado L, Simpson AN, Newman R, King C, Cortese B, et al. A non-randomized trial of in-person versus text/telephone screening, brief intervention and referral to treatment for pregnant and postpartum women. Psychiatr Res Clin Pract. 2021;3(4):172-183. [FREE Full text] [doi: 10.1176/appi.prcp.20210027] [Medline: 36101654]
39. Guo H, Zhang Y, Li P, Zhou P, Chen L, Li S. Evaluating the effects of mobile health intervention on weight management, glycemic control and pregnancy outcomes in patients with gestational diabetes mellitus. J Endocrinol Invest. Jun 2019;42(6):709-714. [doi: 10.1007/s40618-018-0975-0] [Medline: 30406378]
40. Hantsoo L, Criniti S, Khan A, Moseley M, Kincler N, Faherty LJ, et al. A mobile application for monitoring and management of depressed mood in a vulnerable pregnant population. Psychiatr Serv. Jan 01, 2018;69(1):104-107. [FREE Full text] [doi: 10.1176/appi.ps.201600582] [Medline: 29032705]
41. Hedderson MM, Brown SD, Ehrlich SF, Tsai A, Zhu Y, Quesenberry CP, et al. A tailored letter based on electronic health record data improves gestational weight gain among women with gestational diabetes mellitus: the Gestational Diabetes' Effects on Moms (GEM) cluster-randomized controlled trial. Diabetes Care. Jul 2018;41(7):1370-1377. [FREE Full text] [doi: 10.2337/dc17-1133] [Medline: 29669736]
42. Heller HM, Hoogendoorn AW, Honig A, Broekman BFP, van Straten A. The effectiveness of a guided internet-based tool for the treatment of depression and anxiety in pregnancy (MamaKits Online): randomized controlled trial. J Med Internet Res. Mar 23, 2020;22(3):e15172. [FREE Full text] [doi: 10.2196/15172] [Medline: 32202505]

43. Homko CJ, Santamore WP, Whiteman V, Bower M, Berger P, Geifman-Holtzman O, et al. Use of an internet-based telemedicine system to manage underserved women with gestational diabetes mellitus. Diabetes Technol Ther. Jun 2007;9(3):297-306. [doi: 10.1089/dia.2006.0034] [Medline: 17561800]
44. Homko CJ, Deeb LC, Rohrbacher K, Mulla W, Mastrogiannis D, Gaughan J, et al. Impact of a telemedicine system with automated reminders on outcomes in women with gestational diabetes mellitus. Diabetes Technol Ther. Jul 2012;14(7):624-629. [FREE Full text] [doi: 10.1089/dia.2012.0010] [Medline: 22512287]
45. Hoppe KK, Thomas N, Zernick M, Zella JB, Havighurst T, Kim K, et al. Telehealth with remote blood pressure monitoring compared with standard care for postpartum hypertension. Am J Obstet Gynecol. Oct 2020;223(4):585-588. [doi: 10.1016/j.ajog.2020.05.027] [Medline: 32439388]
46. Huang F, Zhang S, Tian Y, Li L, Li Y, Chen X, et al. Effect of mobile health based peripartum management of gestational diabetes mellitus on postpartum diabetes: a randomized controlled trial. Diabetes Res Clin Pract. May 2021;175:108775. [FREE Full text] [doi: 10.1016/j.diabres.2021.108775] [Medline: 33771645]
47. Jannati N, Mazhari S, Ahmadian L, Mirzaee M. Effectiveness of an app-based cognitive behavioral therapy program for postpartum depression in primary care: a randomized controlled trial. Int J Med Inform. Sep 2020;141:104145. [doi: 10.1016/j.ijmedinf.2020.104145] [Medline: 32480319]
48. Klokkenga C, Enemark U, Adanu R, Lund S, Sørensen B, Attermann J. The effect of smartphone training of Ghanaian midwives by the Safe Delivery application on the incidence of postpartum hemorrhage: a cluster randomised controlled trial. Cogent Med. Jul 17, 2019;6(1):1632016. [doi: 10.1080/2331205x.2019.1632016]
49. Krishnamurti T, Davis AL, Rodriguez S, Hayani L, Bernard M, Simhan HN. Use of a smartphone app to explore potential underuse of prophylactic aspirin for preeclampsia. JAMA Netw Open. Oct 01, 2021;4(10):e2130804. [FREE Full text] [doi: 10.1001/jamanetworkopen.2021.30804] [Medline: 34714341]
50. Lanssens D, Vandenberk T, Smeets CJ, De Cannière H, Molenberghs G, Van Moerbeke A, et al. Remote monitoring of hypertension diseases in pregnancy: a pilot study. JMIR Mhealth Uhealth. Mar 09, 2017;5(3):e25. [FREE Full text] [doi: 10.2196/mhealth.6552] [Medline: 28279948]
51. Lanssens D, Vonck S, Storms V, Thijs IM, Grieten L, Gyselaers W. The impact of a remote monitoring program on the prenatal follow-up of women with gestational hypertensive disorders. Eur J Obstet Gynecol Reprod Biol. Apr 2018;223:72-78. [FREE Full text] [doi: 10.1016/j.ejogrb.2018.02.015] [Medline: 29500948]
52. Latendresse G, Bailey E, Iacob E, Murphy H, Pentecost R, Thompson N, et al. A group videoconference intervention for reducing perinatal depressive symptoms: a telehealth pilot study. J Midwifery Womens Health. Jan 2021;66(1):70-77. [FREE Full text] [doi: 10.1111/jmwh.13209] [Medline: 33576146]
53. Lewey J, Murphy S, Zhang D, Putt ME, Elovitz MA, Riis V, et al. Effectiveness of a text-based gamification intervention to improve physical activity among postpartum individuals with hypertensive disorders of pregnancy: a randomized clinical trial. JAMA Cardiol. Jun 01, 2022;7(6):591-599. [FREE Full text] [doi: 10.1001/jamacardio.2022.0553] [Medline: 35442393]
54. Li M, Lin Q, Shi J, Xi Y, Xiang C, Yong C, et al. The impact of lifestyle intervention on dietary quality among rural women with previous gestational diabetes mellitus-a randomized controlled study. Nutrients. Jul 30, 2021;13(8):2642. [FREE Full text] [doi: 10.3390/nu13082642] [Medline: 34444802]
55. Lim K, Chan S, Lim SL, Tai BC, Tsai C, Wong SR, et al. A Smartphone App to Restore Optimal Weight (SPAROW) in women with recent gestational diabetes mellitus: randomized controlled trial. JMIR Mhealth Uhealth. Mar 16, 2021;9(3):e22147. [FREE Full text] [doi: 10.2196/22147] [Medline: 33724204]
56. Mackillop L, Hirst JE, Bartlett KJ, Birks JS, Clifton L, Farmer AJ, et al. Comparing the efficacy of a mobile phone-based blood glucose management system with standard clinic care in women with gestational diabetes: randomized controlled trial. JMIR Mhealth Uhealth. Mar 20, 2018;6(3):e71. [FREE Full text] [doi: 10.2196/mhealth.9512] [Medline: 29559428]
57. Milgrom J, Danaher BG, Gemmill AW, Holt C, Holt CJ, Seeley JR, et al. Internet cognitive behavioral therapy for women with postnatal depression: a randomized controlled trial of MumMoodBooster. J Med Internet Res. Mar 07, 2016;18(3):e54. [FREE Full text] [doi: 10.2196/jmir.4993] [Medline: 26952645]
58. Milgrom J, Danaher BG, Seeley JR, Holt CJ, Holt C, Ericksen J, et al. Internet and face-to-face cognitive behavioral therapy for postnatal depression compared with treatment as usual: randomized controlled trial of MumMoodBooster. J Med Internet Res. Dec 08, 2021;23(12):e17185. [FREE Full text] [doi: 10.2196/17185] [Medline: 34889742]
59. Miremberg H, Ben-Ari T, Betzer T, Raphaeli H, Gasnier R, Barda G, et al. The impact of a daily smartphone-based feedback system among women with gestational diabetes on compliance, glycemic control, satisfaction, and pregnancy outcome: a randomized controlled trial. Am J Obstet Gynecol. Apr 2018;218(4):453.e1-453.e7. [doi: 10.1016/j.ajog.2018.01.044] [Medline: 29425836]
60. Missler M, van Straten A, Denissen J, Donker T, Beijers R. Effectiveness of a psycho-educational intervention for expecting parents to prevent postpartum parenting stress, depression and anxiety: a randomized controlled trial. BMC Pregnancy Childbirth. Oct 31, 2020;20(1):658. [FREE Full text] [doi: 10.1186/s12884-020-03341-9] [Medline: 33129314]
61. Ngai F, Wong PW, Leung K, Chau P, Chung K. The effect of telephone-based cognitive-behavioral therapy on postnatal depression: a randomized controlled trial. Psychother Psychosom. 2015;84(5):294-303. [doi: 10.1159/000430449] [Medline: 26278623]

62. Nieminen K, Berg I, Frankenstein K, Viita L, Larsson K, Persson U, et al. Internet-provided cognitive behaviour therapy of posttraumatic stress symptoms following childbirth-a randomized controlled trial. Cogn Behav Ther. Jun 2016;45(4):287-306. [doi: 10.1080/16506073.2016.1169626] [Medline: 27152849]
63. Niksalehi S, Taghadosi M, Mazhariazad F, Tashk M. The effectiveness of mobile phone text massaging support for mothers with postpartum depression: a clinical before and after study. J Family Med Prim Care. 2018;7(5):1058-1062. [FREE Full text] [doi: 10.4103/jfmpc.jfmpc_120_17] [Medline: 30598957]
64. Nishimwe A, Ibisomi L, Nyssen M, Conco DN. The effect of an mLearning application on nurses' and midwives' knowledge and skills for the management of postpartum hemorrhage and neonatal resuscitation: pre-post intervention study. Hum Resour Health. Jan 26, 2021;19(1):14. [FREE Full text] [doi: 10.1186/s12960-021-00559-2] [Medline: 33499870]
65. Parsa S, Khajouei R, Baneshi MR, Aali BS. Improving the knowledge of pregnant women using a pre-eclampsia app: a controlled before and after study. Int J Med Inform. May 2019;125:86-90. [doi: 10.1016/j.ijmedinf.2019.03.001] [Medline: 30914185]
66. Perry H, Sheehan E, Thilaganathan B, Khalil A. Home blood-pressure monitoring in a hypertensive pregnant population. Ultrasound Obstet Gynecol. Apr 2018;51(4):524-530. [FREE Full text] [doi: 10.1002/uog.19023] [Medline: 29468771]
67. Posmontier B, Neugebauer R, Stuart S, Chittams J, Shaughnessy R. Telephone-administered interpersonal psychotherapy by nurse-midwives for postpartum depression. J Midwifery Womens Health. Jul 2016;61(4):456-466. [doi: 10.1111/jmwh.12411] [Medline: 26970401]
68. Potzel AL, Gar C, Banning F, Sacco V, Fritsche A, Fritsche L, et al. A novel smartphone app to change risk behaviors of women after gestational diabetes: a randomized controlled trial. PLoS One. 2022;17(4):e0267258. [FREE Full text] [doi: 10.1371/journal.pone.0267258] [Medline: 35476681]
69. Rahman A, Akhter S, Nisha MK, Islam SS, Ashraf F, Rahman M, et al. Can mHealth improve access to safe blood for transfusion during obstetric emergency? Int J Womens Health. 2017;9:235-243. [FREE Full text] [doi: 10.2147/IJWH.S120157] [Medline: 28461767]
70. Rasekaba TM, Furler J, Young D, Liew D, Gray K, Blackberry I, et al. Using technology to support care in gestational diabetes mellitus: quantitative outcomes of an exploratory randomised control trial of adjunct telemedicine for gestational diabetes mellitus (TeleGDM). Diabetes Res Clin Pract. Aug 2018;142:276-285. [doi: 10.1016/j.diabres.2018.05.049] [Medline: 29885390]
71. Sawyer A, Kaim A, Le H, McDonald D, Mittinty M, Lynch J, et al. The effectiveness of an app-based nurse-moderated program for new mothers with depression and parenting problems (eMums Plus): pragmatic randomized controlled trial. J Med Internet Res. Jun 04, 2019;21(6):e13689. [FREE Full text] [doi: 10.2196/13689] [Medline: 31165715]
72. Shamshiri Milani H, Azargashb E, Beyraghi N, Defaie S, Asbaghi T. Effect of telephone-based support on postpartum depression: a randomized controlled trial. Int J Fertil Steril. 2015;9(2):247-253. [FREE Full text] [doi: 10.22074/ijfs.2015.4246] [Medline: 26246884]
73. Silva-Jose C, Sánchez-Polán M, Diaz-Blanco Á, Coterón J, Barakat R, Refoyo I. Effectiveness of a virtual exercise program during COVID-19 confinement on blood pressure control in healthy pregnant women. Front Physiol. 2021;12:645136. [FREE Full text] [doi: 10.3389/fphys.2021.645136] [Medline: 33776798]
74. Simhi M, Sarid O, Rowe H, Fisher J, Cwikel J. A cognitive-behavioral intervention for postpartum anxiety and depression: individual phone vs. group format. J Clin Med. Dec 18, 2021;10(24):5952. [FREE Full text] [doi: 10.3390/jcm10245952] [Medline: 34945248]
75. Skar JB, Garnweidner-Holme LM, Lukasse M, Terragni L. Women's experiences with using a smartphone app (the Pregnant+ app) to manage gestational diabetes mellitus in a randomised controlled trial. Midwifery. Mar 2018;58:102-108. [doi: 10.1016/j.midw.2017.12.021] [Medline: 29329023]
76. St Pierre M, Luetcke B, Strembski D, Schmitt C, Breuer G. The effect of an electronic cognitive aid on the management of ST-elevation myocardial infarction during caesarean section: a prospective randomised simulation study. BMC Anesthesiol. Mar 20, 2017;17(1):46. [FREE Full text] [doi: 10.1186/s12871-017-0340-4] [Medline: 28320312]
77. Sun Y, Li Y, Wang J, Chen Q, Bazzano AN, Cao F. Effectiveness of smartphone-based mindfulness training on maternal perinatal depression: randomized controlled trial. J Med Internet Res. Jan 27, 2021;23(1):e23410. [FREE Full text] [doi: 10.2196/23410] [Medline: 33502326]
78. Sung J, Lee DY, Min KP, Park C. Peripartum management of gestational diabetes using a digital health care service: a pilot, randomized controlled study. Clin Ther. Nov 2019;41(11):2426-2434. [doi: 10.1016/j.clinthera.2019.09.005] [Medline: 31587813]
79. Sung Y, Zhang D, Eswaran H, Lowery CL. Evaluation of a telemedicine program managing high-risk pregnant women with pre-existing diabetes in Arkansas's Medicaid program. Semin Perinatol. Aug 2021;45(5):151421. [doi: 10.1016/j.semperi.2021.151421] [Medline: 34274150]
80. Tian Y, Zhang S, Huang F, Shi F, Li Y, Chen X, et al. Glycemic qualification rate and frequency of self-monitoring blood glucose glycemic qualification rate and frequency of self-monitoring blood glucose (SMBG) in women with gestational diabetes mellitus (GDM). Diabetes Res Clin Pract. Dec 2020;170:108482. [doi: 10.1016/j.diabres.2020.108482] [Medline: 32998018]

81. Tian Y, Zhang S, Huang F, Ma L. Comparing the efficacies of telemedicine and standard prenatal care on blood glucose control in women with gestational diabetes mellitus: randomized controlled trial. JMIR Mhealth Uhealth. May 25, 2021;9(5):e22881. [FREE Full text] [doi: 10.2196/22881] [Medline: 33783365]
82. Triebwasser JE, Janssen MK, Hirshberg A, Srinivas SK. Successful implementation of text-based blood pressure monitoring for postpartum hypertension. Pregnancy Hypertens. Oct 2020;22:156-159. [doi: 10.1016/j.preghy.2020.09.001] [Medline: 32980623]
83. Tucker KL, Mort S, Yu L, Campbell H, Rivero-Arias O, Wilson HM, et al. Effect of self-monitoring of blood pressure on diagnosis of hypertension during higher-risk pregnancy: the BUMP 1 randomized clinical trial. JAMA. May 03, 2022;327(17):1656-1665. [FREE Full text] [doi: 10.1001/jama.2022.4712] [Medline: 35503346]
84. Ugarriza DN, Schmidt L. Telecare for women with postpartum depression. J Psychosoc Nurs Ment Health Serv. Jan 2006;44(1):37-45. [doi: 10.3928/02793695-20060101-08] [Medline: 16475443]
85. Vandenberk T, Lanssens D, Storms V, Thijs IM, Bamelis L, Grieten L, et al. Relationship between adherence to remote monitoring and patient characteristics: observational study in women with pregnancy-induced hypertension. JMIR Mhealth Uhealth. Aug 28, 2019;7(8):e12574. [FREE Full text] [doi: 10.2196/12574] [Medline: 31464190]
86. van den Heuvel JFM, Lely AT, Huisman JJ, Trappenburg JCA, Franx A, Bekker MN. SAFE@HOME: digital health platform facilitating a new care path for women at increased risk of preeclampsia - a case-control study. Pregnancy Hypertens. Oct 2020;22:30-36. [FREE Full text] [doi: 10.1016/j.preghy.2020.07.006] [Medline: 32717653]
87. van Montfort P, Smits LJM, van Dooren IMA, Lemmens SMP, Zelis M, Zwaan IM, et al. Implementing a preeclampsia prediction model in obstetrics: cutoff determination and health care professionals' adherence. Med Decis Making. Jan 2020;40(1):81-89. [FREE Full text] [doi: 10.1177/0272989X19889890] [Medline: 31789093]
88. Van Ryswyk EM, Middleton PF, Hague WM, Crowther CA. Postpartum SMS reminders to women who have experienced gestational diabetes to test for type 2 diabetes: the DIAMIND randomized trial. Diabet Med. Oct 2015;32(10):1368-1376. [doi: 10.1111/dme.12769] [Medline: 25816702]
89. Vigod SN, Slyfield Cook G, Macdonald K, Hussain-Shamsy N, Brown HK, de Oliveira C, et al. Mother matters: pilot randomized wait-list controlled trial of an online therapist-facilitated discussion board and support group for postpartum depression symptoms. Depress Anxiety. Aug 2021;38(8):816-825. [FREE Full text] [doi: 10.1002/da.23163] [Medline: 33949762]
90. Wozney L, Olthuis J, Lingley-Pottie P, McGrath PJ, Chaplin W, Elgar F, et al. Strongest Families™ Managing Our Mood (MOM): a randomized controlled trial of a distance intervention for women with postpartum depression. Arch Womens Ment Health. Aug 2017;20(4):525-537. [doi: 10.1007/s00737-017-0732-y] [Medline: 28593360]
91. Yang P, Lo W, He Z, Xiao X. Medical nutrition treatment of women with gestational diabetes mellitus by a telemedicine system based on smartphones. J Obstet Gynaecol Res. Jul 2018;44(7):1228-1234. [doi: 10.1111/jog.13669] [Medline: 29797375]
92. Yew TW, Chi C, Chan S, van Dam RM, Whitton C, Lim CS, et al. A randomized controlled trial to evaluate the effects of a smartphone application-based lifestyle coaching program on gestational weight gain, glycemic control, and maternal and neonatal outcomes in women with gestational diabetes mellitus: the SMART-GDM study. Diabetes Care. Feb 2021;44(2):456-463. [FREE Full text] [doi: 10.2337/dc20-1216] [Medline: 33184151]
93. Zera CA, Bates DW, Stuebe AM, Ecker JL, Seely EW. Diabetes screening reminder for women with prior gestational diabetes: a randomized controlled trial. Obstet Gynecol. Jul 2015;126(1):109-114. [FREE Full text] [doi: 10.1097/AOG.0000000000000883] [Medline: 26241263]
94. Zhuo Y, Pan Y, Lin K, Yin G, Wu Y, Xu J, et al. Effectiveness of clinical pharmacist-led smartphone application on medication adherence, insulin injection technique and glycemic control for women with gestational diabetes receiving multiple daily insulin injection: a randomized clinical trial. Prim Care Diabetes. Apr 2022;16(2):264-270. [doi: 10.1016/j.pcd.2022.02.003] [Medline: 35168915]
95. Najafi F, Hasani J, Izadi N, Hashemi-Nazari S, Namvar Z, Mohammadi S, et al. The effect of prepregnancy body mass index on the risk of gestational diabetes mellitus: a systematic review and dose-response meta-analysis. Obes Rev. Mar 2019;20(3):472-486. [doi: 10.1111/obr.12803] [Medline: 30536891]
96. Poorolajal J, Jenabi E. The association between body mass index and preeclampsia: a meta-analysis. J Matern Fetal Neonatal Med. Nov 2016;29(22):3670-3676. [doi: 10.3109/14767058.2016.1140738] [Medline: 26762770]
97. Blomberg M. Maternal obesity and risk of postpartum hemorrhage. Obstet Gynecol. Sep 2011;118(3):561-568. [doi: 10.1097/AOG.0b013e31822a6c59] [Medline: 21860284]
98. Cameron NA, Molsberry R, Pierce JB, Perak AM, Grobman WA, Allen NB, et al. Pre-pregnancy hypertension among women in rural and urban areas of the United States. J Am Coll Cardiol. Dec 01, 2020;76(22):2611-2619. [FREE Full text] [doi: 10.1016/j.jacc.2020.09.601] [Medline: 33183896]
99. Osei E, Mashamba-Thompson TP. Mobile health applications for disease screening and treatment support in low-and middle-income countries: a narrative review. Heliyon. Mar 2021;7(3):e06639. [FREE Full text] [doi: 10.1016/j.heliyon.2021.e06639] [Medline: 33869857]

100. Peprah P, Abalo EM, Agyemang-Duah W, Budu HI, Appiah-Brempong E, Morgan AK, et al. Lessening barriers to healthcare in rural Ghana: providers and users' perspectives on the role of mHealth technology. A qualitative exploration. BMC Med Inform Decis Mak. Feb 10, 2020;20(1):27. [FREE Full text] [doi: 10.1186/s12911-020-1040-4] [Medline: 32041608]
101. Ruhl LJ, Kiplagat J, O'Brien R, Wools-Kaloustian K, Scanlon M, Plater D, et al. A Global Health Reciprocal Innovation grant programme: 5-year review with lessons learnt. BMJ Glob Health. Nov 2023;8(Suppl 7):e013585. [FREE Full text] [doi: 10.1136/bmjgh-2023-013585] [Medline: 37977589]
102. Trost S, Beauregard J, Chandra G, Njie F, Berry J, Harvey A, et al. Pregnancy-related deaths: data from Maternal Mortality Review Committees in 36 US states, 2017-2019. CHAMPS. URL: https://champsonline.org/assets/files/Resources/ClinicalDocs/DiseaseCondition/MaternalMortalityReviewCommitteePregnancyRelatedDeathsData2017-2019.pdf [accessed 2024-01-15]
103. James AH, Federspiel JJ, Ahmadzia HK. Disparities in obstetric hemorrhage outcomes. Res Pract Thromb Haemost. Jan 2022;6(1):e12656. [FREE Full text] [doi: 10.1002/rth2.12656] [Medline: 35146237]
104. Four in 5 pregnancy-related deaths in the U.S. are preventable. Centers for Disease Control and Prevention. Sep 19, 2022. URL: https://www.cdc.gov/media/releases/2022/p0919-pregnancy-related-deaths.html [accessed 2024-06-10]
105. Ahn R, Gonzalez GP, Anderson B, Vladutiu CJ, Fowler ER, Manning L. Initiatives to reduce maternal mortality and severe maternal morbidity in the United States : a narrative review. Ann Intern Med. Dec 01, 2020;173(11 Suppl):S3-S10. [FREE Full text] [doi: 10.7326/M19-3258] [Medline: 33253021]
106. Hailu EM, Maddali SR, Snowden JM, Carmichael SL, Mujahid MS. Structural racism and adverse maternal health outcomes: a systematic review. Health Place. Nov 2022;78:102923. [FREE Full text] [doi: 10.1016/j.healthplace.2022.102923] [Medline: 36401939]
107. DeNicola N, Grossman D, Marko K, Sonalkar S, Butler Tobah YS, Ganju N, et al. Telehealth interventions to improve obstetric and gynecologic health outcomes: a systematic review. Obstet Gynecol. Feb 2020;135(2):371-382. [FREE Full text] [doi: 10.1097/AOG.0000000000003646] [Medline: 31977782]
108. Roth H, LeMarquand G, Henry A, Homer C. Assessing knowledge gaps of women and healthcare providers concerning cardiovascular risk after hypertensive disorders of pregnancy-a scoping review. Front Cardiovasc Med. 2019;6:178. [FREE Full text] [doi: 10.3389/fcvm.2019.00178] [Medline: 31850374]
109. Stumpff JC. Systematic search: severe maternal morbidity and informatics (Cochrane CENTRAL). searchRxiv. Preprint posted online on September 27, 2022. [doi: 10.1079/searchRxiv.2022.00024]
110. Stumpff JC. searchRxiv. Preprint posted online on September 6, 2022. [doi: 10.1079/searchRxiv.2022.00017]
111. Stumpff JC, Inderstrodt JM, Haggstrom D. Systematic search: severe maternal morbidity and informatics (IEEE Xplore). searchRxiv. Preprint posted online on May 11, 2023. [doi: 10.1079/searchRxiv.2023.00211]

Abbreviations

AI: artificial intelligence
CDC: Centers for Disease Control and Prevention
GDM: gestational diabetes mellitus
HCAHPS: Hospital Consumer Assessment of Healthcare Providers and Systems
PCC: Population, Concept, and Context
PRESS: Peer Review of Electronic Search Strategies
PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews
PTB: preterm birth
SMM: severe maternal morbidity

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