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The Impact of Digital Health Interventions in the Treatment and Management of Perinatal Depression: A Systematic Review

Minor dissertation in partial fulfilment of the requirements for the degree:

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Declaration

I, Nongcebo Nokukhanya Mahlalela, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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Abstract

Background

Perinatal depression, a significant complication of pregnancy and the postpartum period is common amongst women within the reproductive age. Despite its significant contribution to the disease burden and being one of the leading factors of disability, mental healthcare for treating and managing perinatal depression remains a low priority globally (Almond, 2009; Dadi et al., 2020; Rahman et al., 2013). Digital health interventions (DHIs) are implemented to address the accessibility and cost barriers related to mental healthcare. This systematic review aims to examine the impact of the integration of DHIs and psychological approaches in decreasing the symptoms of perinatal depression amongst women aged between 16 and 55. An assessment of the effectiveness, acceptability, usability and cost-effectiveness of the mentioned DHIs will be conducted.

Methodology

The systematic search was conducted in six academic health databases: PubMed, Cochrane, CINHAL, PsycInfo, PsycArticles and Medline. The year of publication of the studies was between the first of January 2007 and the thirty-first of December 2020. Randomised control trials (RCT), quasi-experimental, and cohort studies assessing the effectiveness of DHIs in treating perinatal depression were included. The study participants were limited to pregnant and postpartum women aged 16 to 55. The psychological interventions include cognitive behavioural therapy (CBT), interpersonal psychotherapy (IPT), psychoeducation, peer support and counselling.

Furthermore, the DHIs included mobile health applications and telephone-based and web-based solutions. The studies that met the inclusion criteria after screening were included for data extraction. Lastly, a narrative analysis was conducted to synthesise the results from the included studies.

Results

Out of 271 articles, 24 met the inclusion criteria, where randomised control trials (RCT) were the most predominant studies for eligibility (n = 21). The participants consisted of perinatal (n = 1), postpartum (n =18) and pregnant women (n =5). Surprisingly, only one study was conducted in a low-and-middle-income country (LMIC). Fifteen studies utilised web-based interventions: five used telephone-based solutions, while only four used mobile health applications. For the review outcomes, twenty studies assessed the effectiveness, while 13 assessed the acceptability. Notably, the outcomes of cost-effectiveness (n =2) and usability (n = 3) were assessed in only a few studies.

Discussion

The findings of the present review indicate the success of DHIs in treating perinatal depression, especially when integrated with the predominant psychological approaches such as CBT. However, the shortage of literature that evaluates its efficacy in LMICs highlights a significant research gap. Furthermore, due to its limited availability in literature, the outcomes of cost-effectiveness and usability need to be further assessed in future research.

The systematic review protocol has been successfully registered with the International Prospective Register of Systematic Reviews (PROSPERO), registration number: CRD42021264253.

Conclusion

The integration of CBT, peer support and psychoeducation with digital health reports positive outcomes among the perinatal population. Despite the positive outcomes reported in the application of CBT, psychoeducation and peer support, disproportionate access to digital devices among the LMICs remains, calling for an increase in the implementation of telehealth instead of web-based interventions.

Keywords

Digital health, mHealth, eHealth, telemedicine, perinatal depression, low-and-middle-income countries, mental health, maternal health

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Abbreviations and Definitions

Abbreviations

Table 1: List of Abbreviations and Acronyms

Abbreviation	Definition
CBT	Cognitive behavioural therapy
CMDs	Common mental health disorders
DH	Digital Health
DHI	Digital health interventions
eHealth	Electronic Health
HICs	High-income countries
IPT	Interpersonal Psychotherapy
IT	Information Technology

Abbreviation	Definition
LMICs	Low-and-middle-income countries
MeSH	Medical subject headings
mHealth	Mobile Health
PICO	Patient Intervention Comparator Outcome
SADAG	South African Depression and Anxiety Group
TAU	Treatment As Usual
USA	The United States of America
USSD	Unstructured Supplementary Service Data
WHO	World Health Organization

Definitions

Table 2: List of Definitions

Definition	Description
Antenatal Period	The period between conception and before childbirth (Cresswell et al., 2013)
Conversational Agents	Dialogue systems that conduct natural language processing with the help of artificial intelligence to make verbal interactions with end-users (Sciuto et al., 2018).
Digital Health (DH)	The use of information and communication technologies (ICT) in the practice of healthcare to manage illnesses and promote well-being (WHO, 2011). DH exists in a broad scope that includes categories such as telemedicine, telehealth, electronic health (eHealth), mobile health (mHealth), health information technology (IT), wearable devices, and personalised medicine (FDA, 2020).
Electronic Health (eHealth)	The use of a network of technology applications includes web-based and mobile health applications (WHO, 2011).
Mobile Health (mHealth)	The practice of medical and public health supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices (WHO, 2011).

Definition	Description
Maternal Morbidity	The diverse complications (diseases and medical conditions) that women and young girls experience during and after pregnancy (WHO, 2018)
Maternal Mortality	The annual number of female deaths from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy (WHO, 2019).
Perinatal Depression	Depression that occurs during and after pregnancy (Stuart- Parrigon & Stuart, 2014).
Perinatal Period	The timeframe that extends from the gestational age (pregnancy) at which the fetus attains the weight of I 000 g (equivalent to 28 *completed* weeks of gestation) to the end of the seventh completed day (168 *completed* hours) of life (FIGO, 1995).
Postpartum Period	The six-to-8-week time period following the childbirth and the removal of the placenta (Fahey & Shenassa, 2013).

Telemedicine	The process where information is shared across distances for the diagnosis and decisions related to patients' clinical management (Smith, Patterson & Scott, 2007).

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Chapter 1: Introduction

1.1 The Global Disease Burden of Perinatal Depression

Perinatal depression is a declared global public health concern, accounting as one of the leading causes of the global disease burden (Almond, 2009; Dadi et al., 2020; Rahman et al., 2013). Perinatal depression is characterised by a major depressive episode or disorder which occurs during pregnancy (antenatal period) or within a year after childbirth (postpartum period) (Dagher et al., 2021). The World Health Organisation (WHO) reports that 1 in 5 women suffer from perinatal mental disorders, with 20% experiencing suicide ideation and self-harm (WHO, 2022). Evidence from 2018 reported a global prevalence of 17.7% (Hahn-Holbrook, Cornwell-Hinrichs & Anaya, 2018). The percentage of the perinatal population suffering from depression has increased to approximately 34% since the COVID-19 pandemic (Chen et al., 2022).

1.2 The Disease Burden of Perinatal Depression in Low-and-middle-income Countries

Low-and-middle-income countries (LMICs) are disproportionally affected by the disease burden of perinatal depression. A prevalence of 20% in LMICs and 10% in high-income countries (HICs) has been reported, where an estimated 50% of the affected population remains untreated (Davenport et al., 2020; O'Hara & Wisner, 2014). In addition, compared to HICs, a higher prevalence of adverse outcomes is accounted for by women diagnosed with perinatal depression in LMICs (WHO, 2008a). The disparity in access to healthcare between the two income levels is another challenge, where HICs have more access to healthcare resources than LMICs.

1.3 The Treatment of Perinatal Depression in Low-and-middle-income Countries

Despite its high global prevalence, the treatment of perinatal depression remains inadequate since there are barriers to seeking the appropriate medical treatment. For instance, access to mental healthcare services, especially in LMICs, is limited as the funds for mental health in public healthcare facilities are often limited (Grote et al., 2010; Honikman, Heyningen & Field, 2010; Kakuma et al., 2011; Stuart & Koleva, 2014). In addition, some of the interventions implemented in HICs are not always applicable nor compatible with the needs and resources available in LMICs (Gajaria & Ravindran, 2018). These challenges delay the progress towards reducing the disease burden of perinatal depression, especially in LMICs.

1.4 Digital Health

Fortunately, digital tools are readily available and constantly evolving as they are applied

to various health fields. Moreover, the COVID-19 pandemic has led to a surge in the utilization of these tools in healthcare facilities (Hincapié et al., 2020). Digital health interventions (DHIs), such as telemedicine, electronic health (eHealth) and mobile health (mHealth), are all tools delivered via mobile and web-based platforms (Lattie et al., 2019). Positive health outcomes of the implementation of DHIs have been reported in the following fields: non-communicable diseases, oral health, sexual and reproductive health, substance use, maternal and infant health and mental health (El Benny et al., 2021).

1.5 Digital Health in Low-and-middle-income Countries

The limited access to conventional healthcare services in LMICs has contributed to the growing adoption of DHIs. As DHIs seek to break geographical barriers, access to healthcare is enabled, influencing the improvement of diagnostics and the appropriate distribution of financial resources (Bień et al., 2019). The rapid growth in access to information communication technology (ICT) in LMICs has led to an increase in the implementation of DHIs (Sandberg et al., 2019).

1.6 Digital Health Amongst the Perinatal Population in Low-and-middle-income Countries

The use of DHIs among the perinatal population has been investigated over the years to address maternal and neonatal morbidity and mortality. Telemedicine programs have been developed to help monitor chronic conditions like diabetes, hypertension, and mental disorders among perinatal patients to improve maternal and neonatal outcomes (Leighton et al., 2019; Odibo, Wendel & Magann, 2013). Given the detrimental effects of depression, women of reproductive age are the appropriate benefactors of DHIs (Danaher et al., 2013) (Danaher et al., 2013; Milgrom, J. et al., 2016; O'Mahen et al., 2013b; Van Den Heuvel et al., 2018).

1.7 Rationale

The application of digital health as an enabling tool to support mental well-being during the perinatal period could address essential health outcomes in maternal health. However, there is a lack of literature regarding what is understood about the effectiveness, acceptability, usability and cost-effectiveness of digital systems and their integration into mental healthcare (Lakshminarayanan, Kathuria & Mehra, 2020). Online psychotherapy and counselling methods exist; however, most LMICs are yet to benefit from these interventions due to the digital divide. Research is needed to identify the most profound DHIs implemented mainly for perinatal populations to treat and manage depression. Furthermore, the contribution of the digital divide in some of the disadvantages concerning these interventions needs to be evaluated.

1.8 Research Question

The research question of this study is: Compared to conventional in-person interventions, what is the impact of integrating digital health interventions with psychological approaches in treating and managing perinatal depression?

The Patient Intervention Comparator Outcome (PICO) analysis is shown in Table 1.

Table 3: PICO Analysis

Definition	**Description**
Participants	Pregnant and post-partum women diagnosed with major depressive disorder
Interventions	Digital health interventions treating and managing the symptoms of perinatal depression
Comparator	Conventional mental health interventions treating perinatal depression
Outcome	Improved perinatal mental health

1.9 Aims and Objectives

This study aims to determine the impact of DHIs integrated with psychological approaches for screening, treating, and managing perinatal depression.

The objectives of the systematic review include:

To assess the effectiveness of DHIs in decreasing the symptoms of perinatal depression

To assess the acceptability, usability, and cost-effectiveness of DHIs

1.10 Thesis Outline

The present systematic review comprises five chapters: the introduction, literature review, methodology, results, discussion, and conclusions.

Chapter 1 provides a background overview of perinatal depression, its global prevalence, and the implications of untreated depression on mother and child. Lastly, the research question, PICO analysis and the aims and objections of the review are included.

Chapter 2 is the literature review providing an overview of perinatal depression symptomatology, its implications and epidemiology. The integration of mental healthcare services in maternal care is elaborated, along with some of the most effective psychological approaches used to treat perinatal. Additionally, an outline of the existing challenges in the utilisation of DHIs is provided.

Chapter 3 is the method section describing the eligibility criteria, the data selection and collection process, and the synthesis methods utilized.

Chapter 4 provides the results section with an in-depth overview of the search results and the analysis of the studies retrieved.

The final chapter provides the implication of the results concerning the research question and objectives of the review. The limitations and future recommendations of the study are also provided.

Chapter 2: Literature Review

This chapter reviews the literature on perinatal depression, conventional psychological treatment, and DHIs. It provides an overview of perinatal depression symptomatology, its implications and epidemiology. The integration of mental healthcare services in maternal care is elaborated, along with some of the most effective psychological approaches used to treat perinatal depression. Furthermore, this section reviews the use of DHIs, focussing on the various definitions, functions, and their acceptability amongst the perinatal population. Lastly, an outline of the existing challenges in the utilisation of DHIs is provided.

2.1 Perinatal Depression

Perinatal depression refers to the existence of a depressive episode during pregnancy and during the post-partum period (Sparling et al., 2017; Stuart-Parrigon & Stuart, 2014). Reminiscent of the general population, perinatal women experience the following symptoms: a depressed mood, diminished interest in most activities (anhedonia), neurovegetative symptoms, fatigue, psychomotor agitation, distorted thought patterns, feelings of worthlessness and guilt, and sometimes, suicide ideation; for two weeks (APA, 2013). The duration of five or more of the nine symptoms of depression is a determiner for diagnosing a depressive episode. The infant's relationship with their primary caregiver is essential for healthy infant development (Weaver, Cervoni & Champagne). Therefore, the dynamics of this relationship are determined by whether the primary caregiver can meet the infant's basic needs.

2.1.1 Epidemiology

The prevalence of perinatal depression in high-income countries (HICs) such as the United States of America (USA) is around 10% among pregnant women and 15% among post-partum women (Fisher, Rowe & Hammarberg, 2011; Guintivano, Manuck & Meltzer-Brody, 2018). Past research conducted in Australia reports that 17% of pregnant women and 12% of post-partum women have reported depressive symptomatology (Brown et al., 2017; Leigh & Milgrom, 2008)

In contrast, two studies report a higher prevalence in LMICs, where about 15.6% of women experience depression during pregnancy, while 19.8% experience depression during the post-partum period (Baumel et al., 2018). Contrary to the prevalence rate of 8.3% in Nigeria, a systematic review focusing on Ethiopia reports a higher average of 25.8% in eight studies (Adewuya et al., 2007; Mersha, 2018). Then, in the South American continent, two studies have reported distinct findings in the prevalence in Brazil. A prevalence of 20% was reported in one study, contrary to the findings in another study, reporting a prevalence rate of 15.9% (Faisal-Cury et al., 2004; Pereira et al., 2009). In Asia, 19.7% of Chinese women within the antenatal period and 14. 8% within

the postnatal period have been reported in one meta-analysis to suffer from depression (Nisar et al., 2020). Meanwhile, a recent meta-analysis in Japan reports a prevalence of 14.3% in post-partum depression (Tokumitsu et al., 2020).

2.1.2 The Negative Implications of Perinatal Depression

Perinatal depression contributes to the negative implications of the infant-caregiver attachment style (Hoffman, Robertson & Tierney, 2017; McFarland et al., 2011; Pisoni et al., 2014). In a pithy observation made by McFarland et al. (2011), the feelings of guilt and worthlessness may reduce expectant mothers' sense of efficacy in parenting and increase maternal resistance, which contributes to the insecure mother-infant attachment style. Another study confirms that anhedonia contributes to inadequate postnatal care and reduced attendance and sensitivity to the infant's needs (King et al., 2019). In addition, adverse fetal and child outcomes caused by perinatal depression have been reported in previous studies. For instance, preterm delivery, pre-eclampsia and low birth weight have been attributed to perinatal depression (Gajaria & Ravindran, 2018; Kim, Deborah R et al., 2013; Sockol, 2015). Consequently, these adverse outcomes instigate a higher risk of infant- and maternal morbidity and mortality.

2.1.3 Diagnosis

Screening for perinatal depression is essential since the symptoms are often attributed to Baby Blues (Maurer, Raymond & Davis, 2018), which refers to the mild mood changes that new mothers often exhibit related to meeting the new demands of motherhood (Moslemi et al., 2012). Women must be screened for depression at least once during their perinatal period. For instance, the American College of Obstetrics and Gynecology (ACOG) recommends mandatory screening at least once during pregnancy and four weeks post-partum (ACOG, 2018).

A few standardised and validated screening instruments have been recommended over the decades to diagnose perinatal depression, namely the Edinburg Postnatal Depression Scale (EPDS), the Patient Health Questionnaire 9 (PHQ-9), the Becks Depression Inventory, the Center for Epidemiologic Studies Depression Scale and the Post-partum Depression Screening Scale (ACOG, 2018; Maurer, Raymond & Davis, 2018; Stuart-Parrigon & Stuart, 2014). The EPDS has been recognised as the most used screening tool due to its advantages, including multilingualism and time efficiency (Maurer, Raymond & Davis, 2018). Furthermore, the scale has proved to score relatively high in the following psychometric properties, namely, sensitivity (86%), specificity (76%) and positive predictive value (73%) (Cox, Holden & Sagovsky, 1987). Above all, earlier screening for post-partum depression has improved mental health outcomes. For example, in one systematic review, the remission of symptoms among post-partum women who had a follow-up screening was higher than those not screened after childbirth (O'Connor et al., 2016). As a result, the early diagnosis of a depressive episode makes it possible for the early implementation of mental healthcare interventions.

2.1.4 Conventional Treatment and Management of Perinatal Depression

The conventional methods designed to treat depressive episodes amongst the general population can also treat perinatal depression. To date, mental healthcare has been integrated into maternal health programs such as community-based interventions in combination with different psychological approaches such as cognitive behavioural therapy (CBT), interpersonal psychotherapy (IPT), psychoeducation and counselling (WHO, 2008b).

For decades, CBT has proven its efficacy in treating and managing major depression (Cuijpers et al., 2008; Cuijpers et al., 2013; Sockol, 2015). CBT is a psychological approach designed to help alter dysfunctional thought patterns and maladaptive behaviour (Beck & Haigh, 2014). The patient-centred nature of this form of psychotherapy fosters a collaborative therapeutic relationship between the patient and the psychotherapist (Borza et al., 2017; Li et al., 2020). Previous research reports the efficacy of CBT in treating perinatal depression (Dennis, Cindy-Lee & Hodnett, 2007; Muñoz et al., 2007).

Also regarded as one of the most effective psychotherapeutic treatments for depression, IPT focuses on the patient's social context, intervening in the social dysfunction associated with the illness (De Mello et al., 2005). Moreover, this psychological approach

has been used in the maternal population. A 16-week clinical trial investigated the effectiveness of IPT compared to a parenting educational programme amongst women diagnosed with antenatal depression (Spinelli & Endicott, 2003). The findings suggest an improvement in mood and associated symptoms amongst the IPT treatment group compared to the control group. Another study has proven the efficacy of IPT in reducing the symptoms of antenatal depression (Grote et al., 2010).

A systematic review focussing on the treatment approaches of perinatal depression and anxiety by general practitioners suggests that most general practitioners prefer antidepressant medication, counselling, and referral to psychiatrists, psychologists, social workers, and support networks as forms of treatment and management (Ford et al., 2017). The use of pharmaceuticals was the most chosen option for treating perinatal depression. The reasons for choosing pharmaceutical interventions such as antidepressants are related to low teratogenicity risk, the practitioner's experience with medication and its good efficacy. In contrast, the reasons for not choosing pharmaceuticals were related to the possible negative implications that most medications might have on the unborn baby and the lack of experience using pharmaceutical interventions by both the practitioner and patient. Unfortunately, most conventional mental healthcare interventions are limited as past research findings report an equal sparsity in human resources, with a shortage of mental healthcare professionals such as psychiatrists, psychologists, mental healthcare nurses, and social workers (Kakuma et al., 2011). Therefore, the need for alternative treatment approaches is essential.

2.2 Digital Health Interventions

2.2.1 Digital Health and Technological Devices ownership

Digital health refers to the use of information and communication technologies in healthcare to manage illnesses and promote well-being (Ronquillo, Meyers & Korvek, 2017; WHO, 2011). Digital tools are readily available and are applied to different health specialities. As recognised in the 2030 Agenda for Sustainable Development, the spread of information and communication technologies can improve human progress, address the digital divide, and develop global knowledge societies globally (WHO, 2021).

There has been a rapid growth in smartphone ownership over the last five years, and to date, approximately 6,3 billion people worldwide have access to smartphones (Torous et al., 2019). However, there is an extreme disparity in smartphone ownership and internet connectivity between the LMICs and HICs. Findings in 2019 reported that just over 40% of the LMIC population was connected to the internet (Bahia & Suardi, 2019). In comparison, mobile phone ownership is greater than 90% in HICs, and almost 76% of the population in HICs have smartphones (Silver, 2019). Nevertheless, young women in their reproductive age (15 to 49 years) frequently use the internet, smartphone applications, and social media platforms (Wallwiener et al., 2016). As a result, the rapid growth in information and communication technology use is beneficial since the different DH modalities require various devices.

2.2.2 Digital Health Modalities and Functions

The Food and Drug Administration (FDA) (2020) recognises the broad scope in which digital health exists, namely telemedicine, electronic health (eHealth), mobile health (mHealth), health information technology, wearable devices, and personalised medicine. Telemedicine, eHealth and mHealth are public health's most predominant DH solutions.

Telemedicine is a process where information is shared across distances for the diagnosis and decisions related to patients' clinical management (Smith, 2007). The emergence of telemedicine as a term in the 1960s has led to the evolution of many digital health initiatives committed to connecting rural areas to health facilities (Aziz & Abochar, 2015). For instance, a systematic review focusing on telemedicine in managing obesity amongst older adults in rural areas reports improved patient satisfaction and cost-effectiveness (Batsis, John A et al., 2017). Another systematic review recognises the potential of telemedicine to address the challenges related to primary healthcare in rural Australia, offering a variety of telehealth services in healthcare specialities such as mental healthcare, neonatology, and community care (Bradford, Caffery & Smith, 2016).

Electronic health (eHealth) is recognised as the hypernym for DH; however, there has been a further elaboration of the definition, emphasising the use of a network of technology applications that includes web-based and mobile health applications (Oh et al., 2005; WHO, 2011). As a component of eHealth, mobile health (mHealth) refers to the practice of medical and public health that is reinforced and sustained by mobile devices such as mobile phones, smartphones, personal digital assistants (PDAs), and patient monitoring devices (WHO, 2011). Past research affirms that DHIs improve participation, medical decision-making, commitment to treatment, and the health outcomes of patients (Lin et al., 2018; Van Den Heuvel et al., 2018). In addition, mHealth interventions have proven their efficacy in decreasing healthcare professionals' workload while encouraging efficient self-care strategies for patients (Rathbone & Prescott, 2017).

2.2.3 Digital Health and Perinatal Care

Digital healthcare solutions have proven to impact health outcomes in perinatal care significantly. For example, mHealth solutions in perinatal care have been implemented and well-received in the following domains: lifestyle, diabetes care, health information, mental health, telemonitoring and teleconsultation (Van Den Heuvel et al., 2018). MomConnect, a mHealth initiative developed in South Africa, has successfully addressed the accessibility and personal cost barriers related to national maternal registration and perinatal healthcare information (Barron et al., 2016). Another mHealth application, NeoTree, proved its efficacy in conducting digital auditing for neonatal admissions in Malawi, ensuring that the data collected aids in providing relevant preventative strategies related to neonatal morbidity and mortality (Crehan et al., 2020).

2.2.4 Digital Health and Depression

Various psychological treatments used among perinatal women suffering from mental disorders have proven efficient delivery on digital platforms. CBT, IPT, behavioural

activation (BA) and mindfulness are the predominant evidence-based psychological treatments successfully integrated with DH solutions (Hussain-Shamsy et al., 2020). For instance, a recent study proved the efficacy of CBT integrated with DH in improving the sleep quality of perinatal women (Kalmbach et al., 2020). Another study effectively delivered psychoeducation through Short Message Service (SMS) to prevent post-partum depression (Dondé et al., 2019). Psychoeducation and peer-support mHealth interventions are appropriate for managing mild-to-moderate symptoms of perinatal depression and anxiety. At the same time, psychotherapeutic approaches such as CBT are beneficial for more severe cases, although existing research states that these interventions are less predominant when integrated with mHealth (Hussain-Shamsy et al., 2020).

2.2.5 Challenges to implementing DH

Although the uptake of DH is considered beneficial for the health system, several barriers affect its implementation in various public healthcare settings. The following have been considered in past research as significant barriers: cost and reimbursement, privacy and confidentiality concerns, the lack of implementation models, lack of appropriate equipment and issues related to licencing (Cherney, 2012; Kaplan, 2020; Mohammadzadeh, Safdari & Rahimi, 2013; Molfenter et al., 2015; Petersen & DeMuro, 2015).

Reimbursement is declared a primary determiner of adopting digital health services (Lin et al., 2018). With some web-based interventions being free of charge, a disadvantage from a health practitioner's perspective is posed, as some governments have not yet established a reimbursement scheme for telemedicine services (Smith, 2007). As a result, more health practitioners are less likely to offer their services while using digital health platforms. Furthermore, with the conflict around the definitions concerning the varying DHIs, deciding which DHI qualifies for reimbursement has become challenging once the services are rendered (Crane et al., 2018).

The lack of funding is another factor that hinders the production of telemedicine services. Without funding, there is a limit on the maintenance of equipment and infrastructure, low formal evaluation, and research findings, which results in insufficient evidence of telemedicine in literature reviews (Hailey, Roine & Ohinmaa, 2002; Hailey, Ohinmaa & Roine, 2004; Hailey, Roine & Ohinmaa, 2008; Smith, 2007; Wootton, 2008).

The inaccessibility to mobile and electronic technology is one of the biggest challenges in utilising digital health services. The digital divide refers to the gap between those with access to IT communication and those without access (DiMaggio et al., 2004). Individuals of racial/ ethnic minorities, older age, those residing in rural residences as well as those with a low level of education and low source of income; are the ones who could benefit the most from the use of digital health services, yet they remain among the most who are negatively implicated by the digital divide and the health disparities that exist (Viswanath & Kreuter, 2007; Zillien & Hargittai, 2009b).

The present literature review provides evidence that perinatal depression has dire implications that lead to the morbidity and mortality of mother and infant. The highest

prevalence of perinatal depression is in LMICs, where mental healthcare services are limited. CBT, IPT and psychoeducation have proven well integrated with DH in treating and managing depression. However, the review highlights a few significant knowledge gaps in research related to the implementation of DH in public healthcare settings. Conflict exists in understanding the terms of the different DH modalities. For instance, telemedicine, eHealth, and mHealth all share the same definitions and serve the same function, healthcare providence from a distance. Furthermore, evidence suggests that the implementation of DH solutions in HICs is not necessarily compatible with the needs of LMIC populations. Lastly, the digital divide is also seen as another contributing factor to the utilisation of DH, especially in LMICs.

Chapter 3: Methods

This chapter provides a comprehensive overview of the steps and methods applied to conduct the review systematically. The chapter highlights the eligibility criteria for selected studies and describes the search strategy utilized. The Cochrane Handbook of Systematic Reviews for Interventions guidelines were followed for the conduct and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA-P 2020) guidelines for reporting this systematic review (Higgins, Julian PT et al., 2019; Page et al., 2021).

3.1 Protocol and Registration

The protocol has been registered with the International Prospective Register of Systematic Reviews (PROSPERO), registration number: CRD42021264253.

3.2 Eligibility Criteria

3.2.1 Types of Studies

The primary studies included in the present review were experimental research designs (randomised and non-randomised control trials) evaluated for the use of digital health interventions to manage and treat perinatal depression. In addition, these studies included controlled before-and-after studies (CBA), interrupted time series, quasi-experimental, mixed methods, and observational study designs. Studies excluded were systematic reviews, meta-analyses, literature overviews, case studies, and solely qualitative studies; however, these studies aided in finding primary literature for the paper. We also limited the publication date and language of the literature.

The outcomes assessed in this review are as follows: effectiveness, acceptability, usability, and cost-effectiveness. *Effectiveness* is how an intervention serves more good than harm in healthcare practice (Kim, S. Y., 2013). On the other hand, *acceptability* examines the extent to which the intervention is well received by the target population by meeting their needs (Ayala & Elder, 2011). *Usability* is defined by the International Standards Organization (ISO) as "the extent to which specified users can use a system, product or service to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Bevan, Carter & Harker, 2015). Lastly, *cost-effectiveness* refers to the intervention's ability to serve its function without creating excessive financial strain, especially for the users (Shi & Nambudiri, 2017).

3.2.2 Types of participants

The participants included in the study were women aged between 15 and 55 who had been diagnosed with depression irrespective of race and socio-economic status and had been exposed to one or two digital health interventions (DHIs) for depression. Studies that included perinatal women who were not symptomatic of perinatal depression were

excluded from the study.

3.2.3 Types of interventions

We reviewed DHIs (telemedicine, mHealth and eHealth interventions) integrated into the clinical practice of managing perinatal depression. The interventions ranged from digital psychological treatment such as internet-based cognitive behavioural therapy, video-delivered cognitive processing therapy, virtual reality treatment, and psychoeducation. These interventions allowed different types of mobile technologies, where some operated in online chatrooms, mobile applications, social media platforms, and websites, while some only allowed access to Unstructured Supplementary Service Data Protocol (USSD) SMSs. DHIs not designed for mental health outcomes- specifically perinatal depression, were excluded from this study. Furthermore, interventions that did not support mobile devices, such as wearable devices, were excluded from the study.

3.2.4 Outcomes

The review metrics were evaluated based on the impact of DHIs on health outcomes related to perinatal depression. The health outcomes included decreased symptoms of perinatal depression (see table 3), adaptive coping strategies during the perinatal period, decreased maternal and infant morbidity, and improved quality of life among mother and child. Furthermore, the interventions were assessed as accessible, user-friendly, and cost-effective. In the context of accessibility, we evaluated whether the interventions in the literature indicate improved access to mental healthcare services. In the context of usability, we assessed whether the interventions are user- friendly when utilised by the users and the relevant practitioners and admin staff. In the context of cost, we reviewed whether the DHIs are cost-effective compared to conventional clinical practices. In addition, we estimated literature that proved whether interventions such as online counselling and -therapy indicate conformity to the general principles applied in conventional psychological interventions.

These outcomes were measured using the following self-report scales: the Edinburg Postnatal Depression Scale (EPDS), the Becks Depression Inventory Scale, the Patient Health Questionnaire (PHQ-9) and the Hamilton Depression Rating Scale (HAM-D) to measure depression. In contrast, the Patient Satisfaction scale was mainly used to measure the acceptability of the intervention.

Finally, we excluded studies focussing on health outcomes unrelated to treating and managing perinatal depression. For instance, insomnia is a primary symptom of depression; however, its independent existence as a maternal illness does not categorise it as a mental disorder. Therefore, all studies that aimed to treat insomnia solely were excluded from the review.

Table 4 consists of the inclusion and exclusion criteria compiled by the author, with the guidance of previous searches.

3.3 Information Sources

The databases included in the search were PubMed, Medline, Cochrane, CINAHL, PsycARTICLES and PsychINFO. The selected studies used search terms containing medical subject headings (MeSH terms) and free text. The search terms described the perinatal population, the different types of DHIs, and the relevant mental health services for treating perinatal depression. Following the iPhone's debut, the smartphone's timeline began in January 2007 (Arthur, 2012). As a result, 2007 is the start date chosen to identify publications for this study.

3.4 Search Strategy

The studies were identified by utilising a search strategy developed by the author, the research supervisors (TD & JF) and the UCT Health Sciences Library personnel. The search terms were relevant to the criteria concerning the PICO analysis of the study. In addition, the terms varied in categories, namely medical subject headings (MeSH terms), free text and Boolean search operators. The launch of iPhone devices in 2007 gave rise to the use of smartphone devices; therefore, the year of publication of the study was from 2007 to 2020 (Arthur, 2012).

Table 4: Eligibility Criteria

Parameters	Inclusion Criteria	Exclusion Criteria
Study Characteristics	English literature Published between 1 January 2007 to 31 December 2020	Non-English literature Published before 1 January 2007 to 31 December 2020
Study Design	Experimental studies (randomised and non-randomised trials) reviewed and evaluated for the use of digital health interventions in treating and managing maternal mental illnesses (depression) will be included in this review. These studies include controlled before-and-after studies (CBA), quasi-experimental, mixed methods and observational study designs.	Systematic reviews Literature overviews Case studies Research editorials Qualitative studies Non-English literature Literature published before 2007

Study Participants	Women experiencing symptoms related to depression within the perinatal period	Women who are not pregnant nor within the postpartum Women who are not currently treated for perinatal depression
Types of Interventions	The interventions will include digital health interventions, namely telemedicine, eHealth and mobile health, used for perinatal depression. Mobile technologies Unstructured Supplementary Service Data (USSD), SMSs, online chatrooms, social media platforms and websites	Interventions that are not designed for mental health. Mental health interventions that are not designed to treat depression Pharmaceutical treatment or hospitalisation Mental health interventions that do not support the use of mobile technology

Types of Outcomes	Positive effect digital health interventions in maternal mental healthcare Successful implementation and delivery of digital health interventions Health outcomes related to maternal mental care Decreased symptoms of common mental disorders Decrease in low mood affect (emotional distress, agitation, restlessness) Adaptive functioning in parenting A secure attachment between mother and child Adequate prenatal care Adaptive coping strategies during and after pregnancy Decrease in maternal and infant morbidity and mortality	Health outcomes that are not related to maternal mental care Decrease in gestational diabetes Decrease in insomnia/sleep deprivation without symptoms related to perinatal depression Mental health outcomes related to perinatal anxiety and substance abuse

Table 5: PubMed Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	pregnancy[MeSH Terms]	897,401
#2	MeSH terms:	Perinatal Care[MeSH Terms]	10,249
#3	MeSH terms:	Postpartum Period[MeSH Terms]	65,347
#4	Free text:		1,144,473

#5	#1 OR #2 OR #3 OR #4	(((((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post- partum)) OR (Postpartum Period[MeSH Terms])) OR (Perinatal Care[MeSH Terms])) OR (pregnancy[MeSH Terms])	1,145,458
Intervention: Digital Health			
#6	MeSH terms:	Telemedicine[MeSH Terms]	29,768
#7	MeSH terms:	Cell Phone[MeSH Terms]	10,853
#8	MeSH terms:	Smartphone[MeSH Terms]	4,631
#9	MeSH	Mobile Applications[MeSH Terms]	6,246

	terms:		
#10	MeSH terms:	medical Informatics Applications[MeSH Terms]	456,788
#11	MeSH terms:	Reminder Systems[MeSH Terms]	3,492
#12	Free text:		292,618
#13	#6 OR #7 OR #8 OR #9 OR #10 OR#11 OR #12	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR	728,402

		portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (CellPhone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH	
		Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	

Intervention: Psychological interventions			
#14	MeSH terms:	Mental Health[MeSH Terms]	39,073
#15	MeSH terms:	Psychotherapy[MeSH Terms]	196,581
#16	#Free text		339,099
#17	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior	537,778

		therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	
Outcomes: Maternal Mental Well-being			
#18	MeSH terms:	Maternal Mental Illness[MeSH Terms]	30,537
#19	Free text:		57,546
#20	#18 OR #19	(Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR	77,763

		(maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post-partum psychoses) OR (maternal substance abuse)))	
#21	Filter	Publication Type: Journal Articles Date: 2007/01/01 to 2020/12/31 Language: English	74

#22	#5 AND #13 AND #17 AND #20		74

3.5 Selection Process

The search results were exported from the various databases to Endnote reference manager. The articles were exported again from Endnote to Covidence systematic review manager to remove the duplicates and screen the articles. The author screened the titles and abstracts of the articles independently. The second author guided the process by ensuring that the articles selected adhered to the eligibility criteria. Articles that did not focus on the integration of DHIs and psychotherapeutic approaches for the treatment of perinatal depression were excluded. In addition, study protocols, editorials, and studies with missing data (such as the results and discussion) were excluded from full-text screening.

3.5.1 Data Collection Process

The author collected data independently using the Covidence data extraction application and Microsoft Office Excel. The Covidence data extraction application was utilised for the following purposes: removing duplicates, title and abstract screening, full-text screening, and data extraction. Then, the data was exported onto the Microsoft Excel extraction sheet using a standardised template to extract the relevant data.

The fields used for the data extraction were as follows:

1 Author (s)

2 Year of publication

3 Country of study setting

4 Study design, sample size

5 Participants, intervention

6 Psychological treatment

7 Technological device

8 Outcome

9 Outcome measuring instrument

10 Results

3.5.2 Dealing with Missing Data

Studies with missing data, such as an incomplete result section, were automatically excluded from the study.

3.5.3 Synthesis Methods

The guidelines formulated by the *Cochrane Handbook for Systematic Reviews* were adhered to analyse and synthesise the data collected (Higgins, Julian P T et al., 2011). The author analysed the data independently using Microsoft Excel for the quantitative analysis and NVivo analysis software for the qualitative data analysis of the review.

Chapter 4: Results

In this chapter, a comprehensive report of the findings is provided. An overview of the search results is given, which includes which databases were searched and which study selection and characteristics of the records were selected. The PRISMA flow diagram is included as a graphical representation of the study selection and screening process. A definitive list and brief discussion of the excluded studies and their reasons for exclusion are also presented. Finally, an overview of the results of individual studies and a narrative synthesis of the results from the individual studies is provided.

4.1 Study Selection

Two hundred seventy-one (271) articles were retrieved from the following databases: PubMed, Cochrane, CINHAL, PsycInfo, PsycArticles and Medline. Twenty-three duplicates were removed, and the remaining 248 articles were evaluated for the title and abstract screening. After screening, 198 articles were excluded as they did not meet the inclusion criteria. A total of 50 articles were deemed eligible for full-text screening.

Figure 1 shows the PRISMA flow diagram created to illustrate how the articles were generated for the systematic review. It shows the number of records identified, the duplicates removed, and the number of records screened and considered for eligibility.

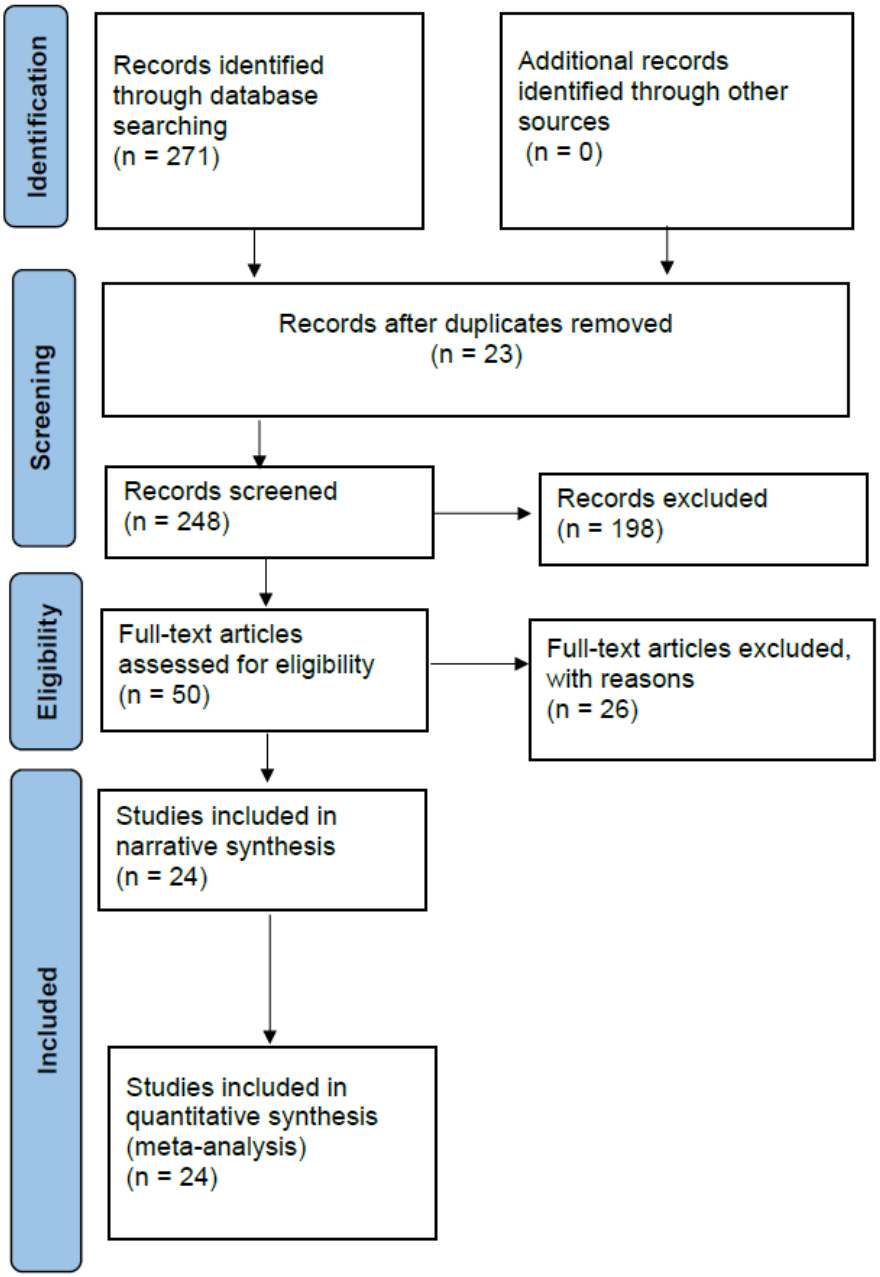


Figure 1: PRISMA Diagram of Studies Included

4.2 Included Study Characteristics

This sub-section provides an overview of the included studies according to the PICO analysis. Table 9 provides a complete summary of each included study and its characteristics.

4.2.1 Types of studies

Randomised control trials (RCT) were the most predominant studies selected for eligibility (n = 21). The other included studies were cohort studies (n = 2) and mixed-method non-RCT (n = 1).

Figure 2 is a map chart illustrating the number of studies conducted in different countries, namely the United States of America (USA) (n = 6), United Kingdom (UK) (n = 4), Canada (n = 4), China (n = 4), Australia (n = 2), Sweden (n = 1), Portugal (n = 1), Iran (n = 1) and Norway (n = 1).

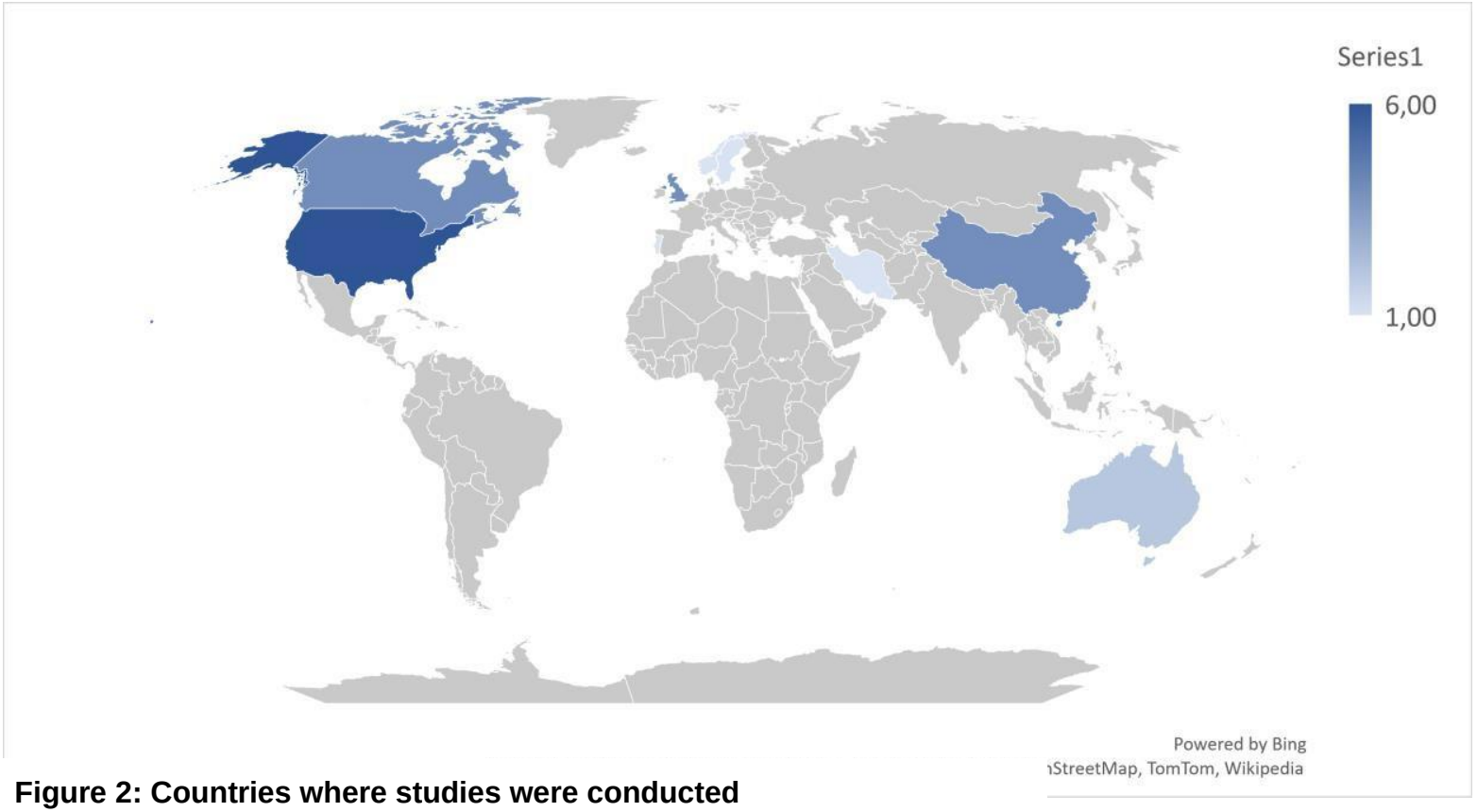


Figure 2: Countries where studies were conducted

Figure 3 is a pie chart depicting the number of studies conducted in HICs and LMICs. Nineteen (79%) of the records considered for extraction represent HICs, while only five (21%) of the remaining records were studies conducted in LMICs.

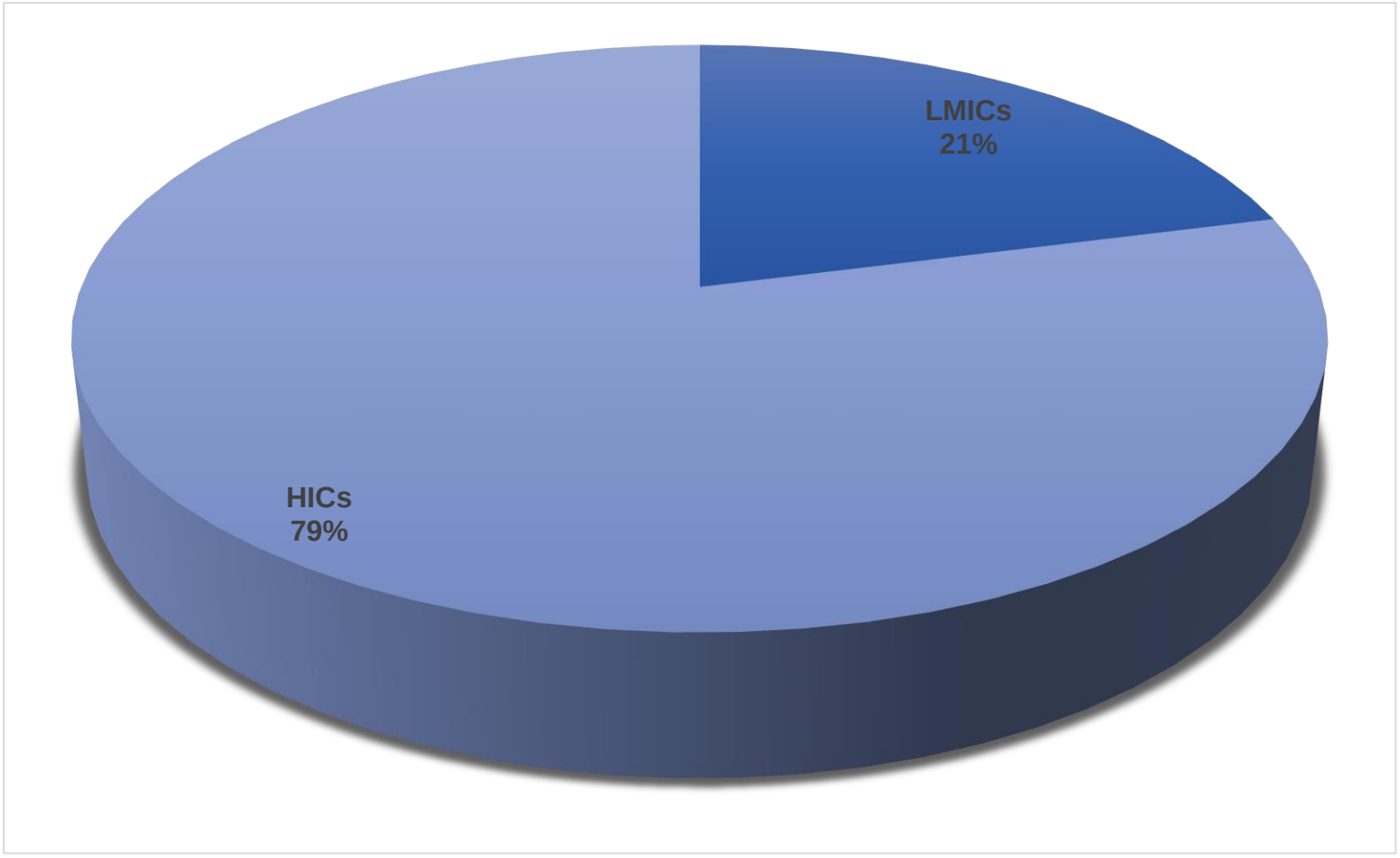


Figure 3: The disparity in the studies conducted between HICs and LMICs

4.2.2 Types of Participants

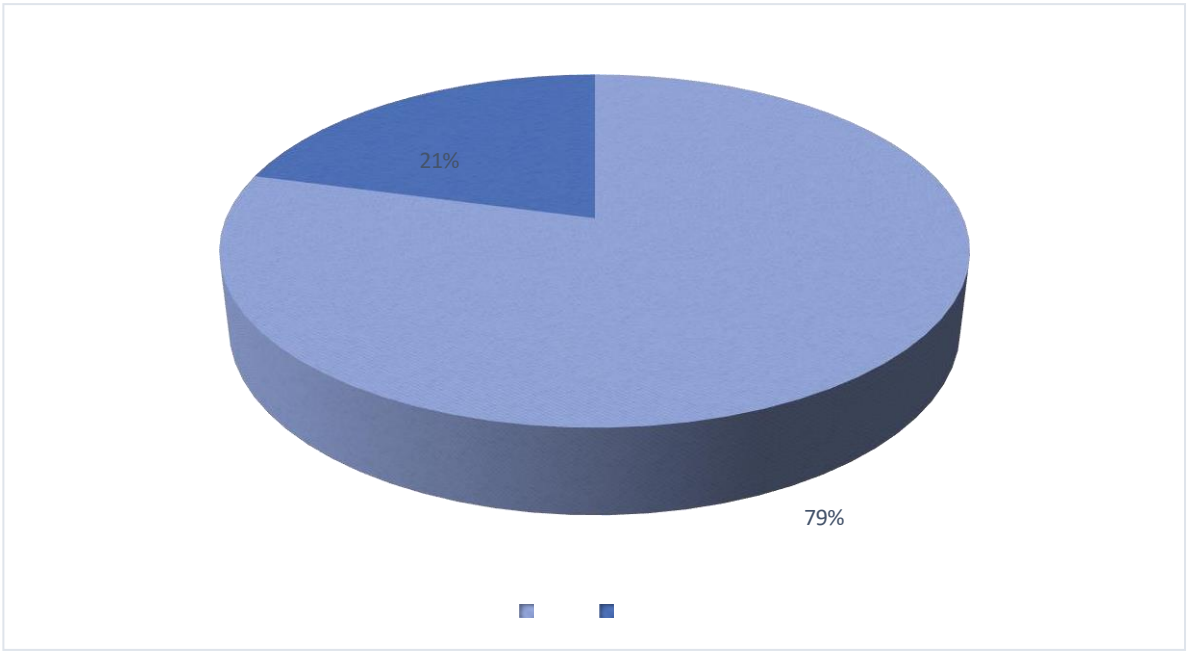
A total of 7601 participants were represented across the 24 studies selected. Eighteen (n = 18) of the studies included focus on the postpartum population, while only five (n = 5) focused solely on the pregnant women population; only one (n = 1) study focused on the perinatal group - pregnant and postpartum women. Table 6 summarises the participant categories.

Table 6: Study Participants

Participant Category	Number of Studies
Postpartum	18
Pregnant	5
Perinatal	1
Grand Total (n)	24

4.2.3 Types of Interventions and Technological Devices

As shown in figure 4, the DHIs identified are mobile health (n = 4), telephone-based (n = 5) and web-based interventions (n = 15) – which are included in most studies conducted in HICs.


21%
79%

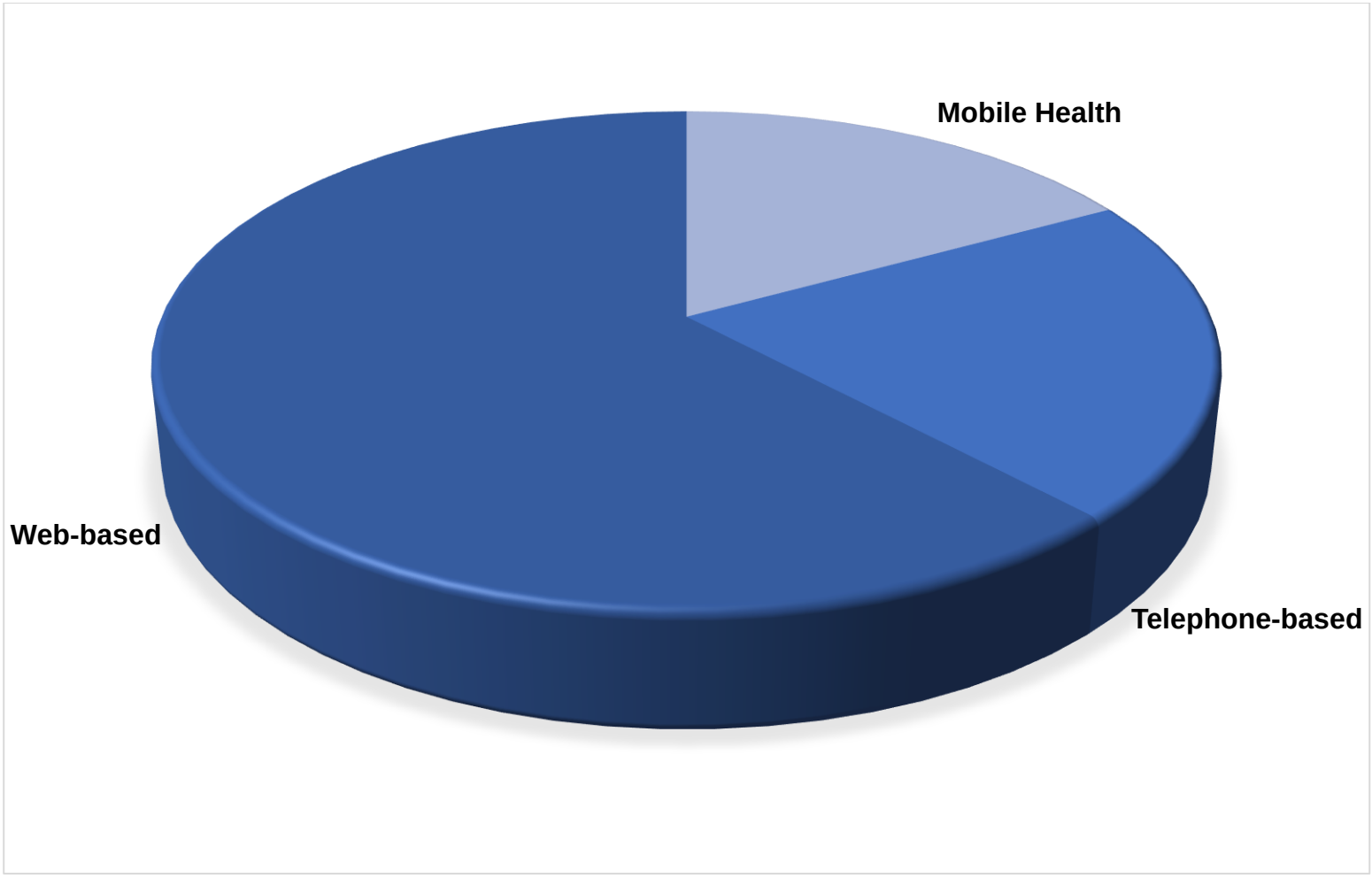


Figure 4: The digital health modalities included in the studies

Table 7 represents the psychological approaches and assessments integrated with different types of DHIs.

Table 7: Psychological Approaches and Assessments Integrated with DHIs

Types of Psychological Approaches and Assessments	Types of DHIs (n)			Total (n)
	Web-based	mHealth	Telephone-based	
CBT	3	2	2	7
BA	3	0	0	3
IPT	0	0	1	1
Mindfulness	2	0	0	2
Types of Psychological				

Approaches and Assessments	**Web-based**	**mHealth**	**Telephone-based**	**Total (n)**
BA and CBT	2	0	0	2
Counselling	0	0	2	2
Peer-support	1	0	0	1
Mood Screening	1	0	0	1
Mood screening, Psychoeducation and CBT	1	0	0	1
Types of Psychological Approaches and				

Assessments	Web-based	mHealth	Telephone-based	Total (n)
Theory of planned behaviour (TPB)	1	0	0	1
Peer-support and CBT	0	1	0	1
CBT and IPT	1	0	0	1
CBT and Psychoeducation	0	1	0	1
Grand Total (n)	15	4	5	24

As represented in Figure 5: Technological devices used for DHIs, smartphone devices were the most prevalent technological devices utilised (n = 13), representing 52% of the studies conducted. Only 18% of the studies (n = 5) included interventions requiring telephone devices. Interestingly, 22% of the studies required telephone and smartphone devices (n = 6). Lastly, only one study required the use of an iPhone device.

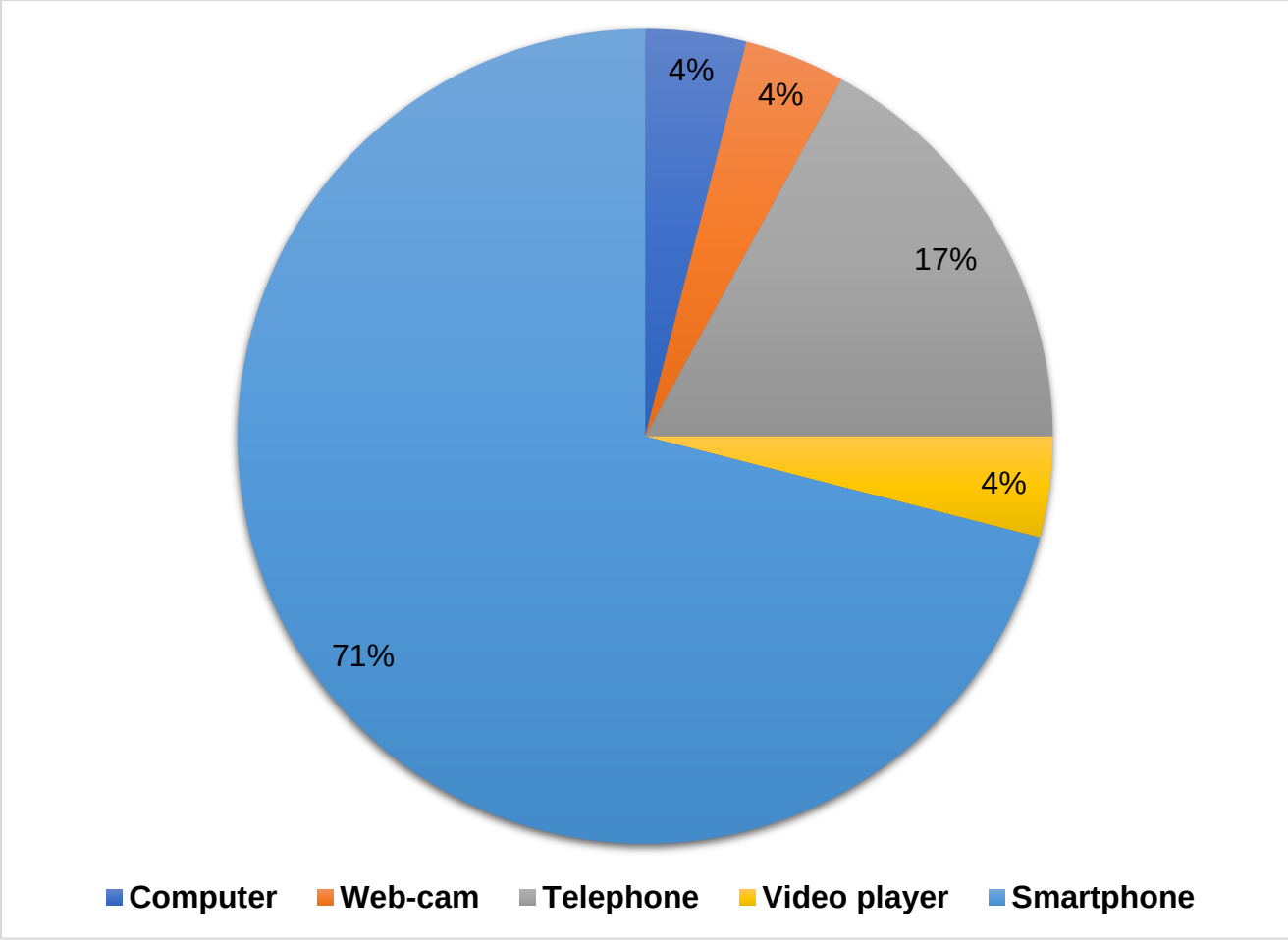


Figure 5: Technological devices used for the utilization of DHIs

4.2.4 Reported Outcomes

Table 8 provides a summary of the outcomes. The table and the associated references describe significant findings and limitations of the outcomes.

The effectiveness of interventions was the most predominant outcome resulting in twenty studies (n = 20), whereas thirteen studies (n = 13) examined the acceptability of the interventions. The least amount of studies accounted for the interventions' usability (n = 3) and cost-effectiveness (n = 2).

Table 8: Summary of the Reported Outcomes

Outcomes	Comments	Reference
Effectiveness (n = 20)	Key Findings: The outcome was tested on all three types of DH modalities. Web-based: (n = 13) mHealth: (n = 4) Telephone-based: (n = 3) Limitations: Some studies reported high attrition and the existence of external factors that could have affected the statistical significance of the results.	Dáu et al. (2017), Dennis et al. (2020), Forsell et al .(2017), Guo et al. (2020), Haga et al. (2019), Jannati et al. (2020), Kingston et al. (2017), Lewis et al. (2018), Logsdon et al. (2010), Logsdon et al. (2018), Milgrom & Gemmill, (2014), Milgrom et al. (2016), Monteiro et al. (2020), Ngai et al. (2017), O'Mahen et al. (2013), O'Mahen et al. (2013), O'Mahen et al. (2017), Ramachandran et al. (2020), Stein et al. (2018), Wisner et al. (2017), Wozney et al. (2017), Yang et al. (2019).

Outcomes	Comments	Reference
Acceptability (n = 13)	Key Findings: The outcome was tested on all three DH modalities, and statistically significant results in all studies were reported. Web-based: (n = 9) mHealth: (n = 1) Telephone-based: (n = 3) Limitations: Only three studies (n = 3) solely tested the outcome and acceptability.	Forsell et al. (2017), Guo et al., (2020), Kingston et al. (2017), Logsdon et al. (2010), Milgrom & Gemmill, (2014), Monteiro et al. (2020), Ngai et al. (2019; O'Mahen et al. (2017), Posmontier et al. (2016), Wisner et al. (2017), Wozney et al. (2017), Yang et al. (2019), Yang et al. (2019).
Usability (n = 3)	Key Findings: All three studies reported positive results. Web-based: n = 1 mHealth: n = 1 Telephone-based: n = 1	Kingston et al., (2017), Logsdon et al., (2010), Wisner et al., (2017).

Outcomes	**Comments**	**References**
	Limitations: Usability was assessed in the pilot studies	
Cost-effectiveness (n =2)	Key Findings: The interventions were web-based mindfulness programmes. The interventions were reported to be cost-effective. Web-based: (n = 2) Limitations: The limited number of studies testing the cost-effectiveness outcome makes it challenging to generalize the findings.	Wozney et al. (2017), Yang et al., (2019)

4.2.4.1 DH modalities and the Reported Outcomes

Web-based and CBT Interventions

Seven studies focussed on the integration of web-based interventions with solely CBT. Only five studies reported statistically significant results in the effectiveness of decreasing the symptoms of depression (Forsell et al.., 2017; Milgrom & Gemmill, 2014; Milgrom et al.., 2016; Stein et al.., 2018; Yang et al.., 2019). Furthermore, four studies reported high acceptability scores (Forsell et al.., 2017; Milgrom & Gemmill, 2014; Monteiro et al., 2020; Yang et al.., 2019). Lastly, only one of the studies reported the cost-effectiveness of the web-based CBT intervention, although the intervention effect in decreasing depressive symptomatology was not found significant.

Web-based and BA Interventions

All five studies' BA interventions are web-based, of which four reported statistically significant results in effectiveness and acceptability (Milgrom & Gemmill, 2014; O'Mahen et al.., 2013; O'Mahen et al.., 2017; Stein et al.., 2018). One study reported uncertainty about whether the decrease in depressive symptoms was due to the BA treatment (O'Mahen et al.., 2013).

Mobile Health and CBT Interventions

Two of the four studies examining the integration of mHealth and CBT interventions reported statistically significant differences (Jannati et al.., 2020; Ramachandran et al.., 2020). The remaining two studies did not report statistically significant results (Dáu et al.., 2017; Wisner et al.., 2017).

Telephone-based Interventions

Of the five studies focussing on telephone-based modalities, two examined their effectiveness when integrated with IPT and CBT (Dennis et al.., 2020; Ngai et al.., 2017). In addition, acceptability studies were conducted in two studies, integrated with CBT and counselling (Ngai et al.., 2019; Posmontier et al.., 2016). Logsdon et al.. (2010) examined three of the outcomes, namely effectiveness, acceptability and usability, of which the findings yielded statistically significant results for all outcomes for the integration of counselling treatment.

Table 9: Characteristics of the Included Studies

Author, Year	Study Design, Country and ICT Device	Participant Category	DHIs	Treatment Approach	Outcomes	Measuring Tools	Results
Dáu et al., 2017	Cohort USA Smart-phone	Post-partum Intervention group N=20	MoMBA: Smart-phone Mobile Application	CBT	Effectiveness	NICHD's Observational Record of the Caregiving Environment (ORCE) Patient Health Question-naire-9 (PHQ-9)	Average PHQ-9 score varied from 0.21 to 11.29 (mean = 4.65; SD = 3.13) based on 12 months of data Maternal sensitivity scores ranged from 2 to 4.5 (mean = 3.40; SD = 0.80), intrusiveness scores varied from 1 to 4.5 (mean = 2.51; SD = 0.99), and positive regard for the child ranged from 2.25 to 5 (mean = 4.04; SD = 0.68) (Dáu et al., 2017).
Dennis, Cindy-Lee et al., 2020	RCT Canada: Toronto	Postpartum Intervention group N = 120	Telephone-based IPT	IPT	Effectiveness	SCID-I major depression module EPDS	Significant differences were reported in findings to the advantage of the intervention group (IPT) for comorbid anxiety and partner relationship quality

	Telephone/ Mobile phone	Control group N = 121				State-Trait Anxiety Inventory (STAI) Dyadic Adjustment Scale (DAS) Experiences in Close Relationships scale (ECR)	21% of the intervention group and 51% in the control group had an EPDS score >12 (OR = 0.26, 95% CI 0.14–0.48) Decreased scores in avoidant attachment were reported to be at an increase among the intervention group compared to the control group (p = 0.02) No differences were found in health service or antidepressant treatment Telephone-based IPT was proven effective in decreasing anxiety and depressive symptoms amongst the post-partum population (Dennis, Cindy-Lee et al., 2020).
Forsell et al., 2017	RCT Sweden Smartphone	Pregnant Intervention group N = 21 Control group N = 18	Internet-based CBT program	CBT	Effectiveness and Acceptability	Montgomery Åsberg Depression Rating Scale Self-report version (MADRS-S) Edinburgh Postnatal	Decreasing symptoms of depression: ICBT group had significantly lower depression scores post-treatment compared to TAU (p<0.001), and the between-groups effect was large (Hedges' g = 1.21) An increase in remission was found amongst the intervention group (33%) compared to the control group (11%).

						Depression Scale (EPDS) Insomnia Severity Index (ISI) Work and Social Adjustment Scale (WSAS) Client Satisfaction Questionnaire-8 item version (CSQ-8)	However, the group difference was not statistically significant The difference in responder status for the MADRS-S was statistically significant, with 71% of participants representing the intervention group and 22% representing the control group ((n = 39, Fischer's exact p = 0.004) The study's findings report that the internet-based intervention was effective and acceptable in treating and managing antenatal depression (Forsell et al., 2017).
Guo et al., 2020	RCT China/Tiagin Hospital Smartphone	Pregnant Intervention group N = 144 Control group N = 140	Internet-based Mindfulness and self-compassion program	Mindfulness	Effectiveness and Acceptability	EPDS State-Trait Anxiety Inventory I and II Beck Depression Inventory-II (BDI) Mindfulness Attention Awareness	The intervention was found feasible and acceptable by the majority of students A significant decrease in the EPDS scores was found amongst the intervention group compared to the control group Assessing mindfulness, there was a significant increase found in the MAAS and SCS scores (p < 0.05 A significant improvement in maternal wellness is reported amongst the

						Scale (MAAS) (Chinese version) Self-Compassion Scale (Chinese version) Well-Being Index World Health Organization Five (WHO-5)	intervention group between three months and one year post-partum ($p < 0.05$) The mindfulness programme has been reported to have the potential to decrease the symptoms of postnatal depression (Guo et al., 2020).
Haga et al., 2019	RCT Norway Smartphone	Pregnant Intervention group N = 678 Control group N = 644	Mama Mia: Automated internet-based intervention	Peer-support	Effectiveness	Edinburg Postnatal Depression Scale (EPDS)	No significant difference was found in the change in depressive symptoms between the intervention group and the control group Participants in the Mamma Mia group displayed fewer depressive symptoms than participants in the control group during follow-up [$F(1) = 7.03$, $p = 0.008$] The prevalence of women with EPDS-score $\geqslant 10$ was lower in the Mamma Mia group at all follow-up measurements differences between groups in women's disclosure of

							emotional wellbeing (Haga et al., 2019).
Jannati et al., 2020	RCT Iran: Kerman Smartphone	Perinatal Intervention group N=38 Control group N = 37	Happy Mom Application: mHealth intervention integrated with CBT	CBT	Effectiveness	Edinburg Postnatal Depression Scale (EPDS)	Before treatment: no statistically significant difference between the EPDS score between the two groups ($p < 0.001$). After treatment: the average EPDS score amongst the intervention group was 9.24, and in the control group was 2.34, which was statistically significant ($p < 0.001$) (Jannati et al., 2020).
Kingston et al., 2017	RCT Canada: Alberta Smartphone	Pregnant Intervention Group N = 305 Control roup N = 331	Web-based e-screening tool for emotional distress and distress	Mood Screening	Effectiveness, Acceptability and Usability	Edinburg Postnatal Depression Scale (EPDS)	Intervention passed the usability test as no changes to the tool were made after initial testing More women in the e-screening group strongly or somewhat agreed that they would like to use a tablet for answering questions on emotional health (57.9%, 175/302 vs 37.2%, 121/325) and would prefer using a tablet to paper (46.0%, 139/302 vs 29.2%, 95/325), compared with women in the paper-based screening

							group. There were no differences between groups in women's disclosure of emotional health concerns (94.1%, 284/302 vs 90.2%, 293/325). Therefore the use of web-based intervention while using a tablet was considered acceptable Women in the e-screening group consistently reported the features of e-screening more favourably than controls (more private or confidential, less impersonal, less time-consuming). In the multivariable models, being in the e-screening group was significantly associated with preferring e-screening (AOR 2.29, 95% CI 1.66-3.17), while no factors were significantly associated with disclosure (Kingston et al., 2017).
Logsdon et al., 2010	Non-RCT: Mixed Method USA: Southern and urban area	Post-partum N = 97	New Mother Program: Telephone-based depression care management	Counselling	Effectiveness, Acceptability and Usability	Attitude Towards Seeking Psychological Help Scale (ATSPPH-SF)	The scores for acceptability are as follows for each item: *The website is easy to use* (n = 124; 80.8%)

	Telephone					Stigma Scale for Receiving Psychological Help Health Self Determination Index; 1 item Mental Health Intention Scale; The Patient Health Questionnaire (PHQ-2)	*An internet website is a good place for me to learn about depression* (n = 108, 70.2%) *I can relate to one or more of the stories presented on the homepage* (n = 76, 49.2%) *I would recommend this website to another teen mom* (n = 110, 71.5%) Usability was established in the pilot study: 77% of the users found it easier to use the website Effectiveness: Attitude change and Perceived control A significant improvement in both scores (attitude and perceived control) is reported among the intervention group ($p = 0.018$, $p = 0.040$, and $p < 0.001$, respectively), while the control group reported consistent scores attitude, $p = 0.841$; subjective norms, $p = 0.784$; and perceived control, $p = 0.913$) Mothers found the intervention acceptable

							Rates for depressive symptoms were lower in both groups compared to past literature The authors also acknowledge that the use of a different instrument either than the EPDS, the PHQ Results from thematic analysis: Themes: - Conflict with the father of the baby - Conflicted family relationships - The adolescent's transitioning from being a child to being a mother - Role adjustment as adolescent's mother - Adolescent's dependence on mother (Logsdon et al., 2010)
Logsdon et al., 2018	RCT USA: Kentucky Smartphone	Post-partum Intervention group N =151	An internet-based intervention based on the theory of planned behaviour	Theory of planned behaviour (TPB)	Effectiveness	Attitude Towards Seeking Psychological Help Scale (ATSPPH-SF)	Adolescent mothers in the intervention group answered questions and completed the intervention from a computer of their choice

		Control group N = 138	that seeks to encourage adolescent mothers displaying symptoms of PPD to seek treatment and evaluation			The Patient Health Questionnaire (PHQ-2)	The intervention led to significant changes in attitude, perceived control, intention to seek mental health treatment and depression treatment Untreated postpartum depression dramatically impacts a mother's relationship with her child, functioning at work and school, healthcare-seeking behaviours, mothering skills, and development An internet-based depression intervention is an inexpensive method to increase rates of depression treatment (Logsdon et al., 2018).
Milgrom & Gemmill, 2014)	RCT Australia: Melbourne Smartphone	Postpartum Intervention group N = 181 TAU N = 162	NetMums: Internet-based behaviour activation program using CBT principles	BA and CBT	Effectiveness and Acceptability	Edinburg Postnatal Depression Scale (EPDS)	High attrition has been reported: only 38% of participants remained in the trial after 15 weeks Session attendance decreased sharply after the second session Results after treatment: A significant reduction in numbers scoring above the EPDS threshold compared to the control group (n=66/181 vs n=91/162, OR=2.16).

							Acceptability of the programme has been reported as good according to the participants that completed the study (Milgrom, Jeannette & Gemmill, 2014).
Milgrom et al., 2016).	RCT Australia: Melbourne Smartphone	Post-partum Intervention group N = 21 TAU N = 22	MumMoodBooster program. Mood screening, CBT with trained psychologists and psychoeducation provided by health coaches. Also, consist of a partner website (NetMums) for behaviour activation	Mood Screening, Psychoeducation and CBT	Effectiveness	Structured Clinical Interview for DSM-IV (SCID-IV) Becks Depression Inventory ((BDI-II) Patient Health Questionnaire (PHQ-9)	The mean EPDS for screening was 16.2 (SD 2.9) A significant linear decrease was reported in PHQ-9 values for all study participants (estimate=–0.23, SE 0.08, *P*=.01, partial *r* =–.22) and a differential trajectory between conditions, with the intervention groups' scores decreasing (improving) at a greater rate (estimate=–0.34, SE 0.12, *P* = .01, partial *r* = –.23) Participant engagement has been reported to be high Overall, an increase in remission rates and a significant reduction in the severity of depressive symptomatology were reported in the intervention group (Milgrom, J. et al., 2016).

Monteiro et al. (2020)	RCT Portugal/Coimbra Smartphone	Post-partum Intervention group N = 98 Control group N = 96	BeAMom: Web-based intervention integrated with CBT	CBT	Effective-ness and Acceptability	Postpartum Depression Predictors Inventory-Revised (PDPI-R) Portuguese version Mental Health Continuum Short Form (MHC-SF) Portuguese Version [PV] Edinburgh Postnatal Depression Scale (EPDS) Portuguese version [PV] Empowerment Scale (ES) Perceived Maternal Parenting Self-	The overall retention rate at the post-intervention assessment was 67.8%. The intervention arm had significantly higher loss to follow-up than the control arm (intervention group: n = 87, 45.5% vs control group: n = 31, 17.6%, 2 = 32.77, p < 0.001) Potential differences between completers and dropouts on baseline sociodemographic and clinical characteristics were explored but did not reveal any significant differences The only exception was infant age, with infants of the participants who dropped out of the study being older than the infants of those who completed the postintervention assessment (M = 2.11 months, SD = 0.97 vs M = 1.77 months, SD = 1.20, t = 2.68, p = 0.008) The proportion of women who had psychological/psychiatric treatment after the baseline assessment was also similar in both groups (intervention group: n = 8, 7.7% vs

						Efficacy (PMPS-E) Be a Mom's acceptability	control group: n = 7, 4.9%, 2 = 0.85, p = 0.356) (Monteiro et al., 2020).
Ngai et al., 2017)	RCT China: Hong Kong Telephone	Postpartum Intervention group N= 197 TAU N = 200	Telephone-based CBT	CBT	Effectiveness	Medical Outcomes Study Short-Form 12-Item Health Survey (SF-12) Physical Component Score (PCS) Mental Component Score (MCS	A significant effect was reported for the PCS (F[2,1147] = 3.58, p = 0.028) and (F[2,1147] = 7.58, p = 0.006) on the MCS The intervention group (T-CBT), compared to the control group (TAU), scored higher in the mental component of health-related quality of life. However, the difference was a non-significant mean difference of 1.19 [95% CI, 0.09–2.28]; p = 0.034; d = 0.18) (Ngai et al., 2017).
Ngai et al., 2019	RCT China: Hong Kong Telephone	Postpartum Intervention group N=197 TAU N = 200	Telephone-based CBT	CBT	Acceptability	Renker and Tonkin's assessment	57.9% of women (175/302 vs 37.2%, 121/325) found the use of an e-screening tool acceptable in answering questions related to emotional health

							Women in the e-Screening group found screening less time-consuming (that is, utilization is feasible) Both groups of women preferred self-reporting screening compared to a face-to-face screening Only 10% of women in both groups admitted feeling comfortable enough to have nurses ask them emotional health-related questions (Ngai et al., 2019).
O'Mahen et al., 2013	RCT UK Smartphone	Post-partum Intervention group N = 41 TAU N = 42	NetMums: Phase 1 RCT of Online Behavioural Activation program	BA	Effectiveness	Edinburgh Postnatal Depression Scale (EPDS)	Post-treatment EPDS was completed by 37/41 (90%) women in the intervention group and by 34/42 (81%) women in the TAU group ($\chi 2 = 1.45$, $p=0.23$) 6-month follow-up EPDS was completed by 31/41 (76%) women in the intervention group and 28/41 (68%) women in the TAU group ($\chi 2 = 0.37$, $p=0.47$) Results suggest that NetMums is feasible and effective in treating postnatal depression (O'Mahen et al., 2013a)

O'Mahen et al., 2014	RCT UK Smartphone	Post-partum Intervention group N = 41 TAU N = 42	NetMums: Phase 2 RCT Web-based peer support and behavioural activation program	BA	Effectiveness	Edinburgh Postnatal Depression Scale (EPDS) Behavioural Activation for Depression Scale	Primary result: There is a linear and quadratic pattern that predicts change in the online BA intervention A significant linear in EPDS scores were found in depressive symptomatology from a baseline mean of 18.11 (SE ¼ 0.42) over time (b ¼ _1.20, SE ¼ 0.12, p < 0.001). Correlation: (b ¼ 0.86, SE ¼ 0.34, p ¼ 0.01) The initial rapid decrease of symptoms was followed by a reduction in speed in the change of symptoms. The findings show that women who reported sudden gains were the ones who completed the BA program compared to the control group. A report in sudden gains is an indication of less depressive symptomatology since participants were addressing their dysfunctional behavioural patterns through the BA program BA in the study may or may not be the direct factor in the increase in

							sudden gains among 51% of the participants Authors suggest that the factors such as adverse life stressors during therapy should be considered as a possible impact in the presence or absence of sudden gains (O'Mahen, H. A. et al., 2014).
O'Mahen et al., 2017	RCT UK Smartphone	Post-partum Intervention group N = 41 TAU N = 42	NetMums: Online Behavioural Activation program	BA	Effectiveness and Acceptability	Hamilton Rating Scale for Depression (HDRS) Edinburg Postnatal Depression Scale (EPDS) Client Satisfaction Questionnaire (CSQ- 8) Qualitative interview	The HDRS at 8 and 12 weeks was significantly lower among women in the treatment group than the control group (Week 8, P = .047; Week 12, P = .029). Client satisfaction was high in the intervention and control groups (O'Mahen et al., 2017).

(Posmontier et al., 2016)	Cohort USA Telephone	Postpartum Intervention group N = 41 Control group N = 20	Telephone-administrated Psychotherapy with the help of certified nurse-midwives	Counselling	Acceptability	Client Satisfaction Questionnaire (CSQ- 8) Work Alliance Inventory - Short Revised (WAI-SR)	64% of participants reported high satisfaction (CSQ-8 ≥ 24) 28% of participants reported high WAI-SR scores (WAI-SR ≥ 48). Only 27% of the application users were relatively satisfied, while 43% reported medium WAI-SR scores (Posmontier et al., 2016).
Ramachandran et al., 2020	RCT United States: Califonia Smartphone	Post-partum Intervention group N=96 TAU N = 96	Chatbots (conversational agents) integrated with cognitive behavioural therapy	Peer-support and CBT	Effectiveness	Edinburgh Postnatal Depression Scale (EPDS) Infant Behaviour Questionnaire (IBQ)	Levels of post-partum depression decreased significantly by 85% over two years since the intervention in both groups (video-feedback therapy (VFT) and progressive muscle relaxation (PMR)) Consequently, fewer children were exposed to maternal depression There were no group differences reported in child outcome (cognitive development, adjusted difference –1·01 [95% CI –5·11 to 3·09], p=0·63; language development, 1·33 [–4·16 to 6·82], p=0·63; behaviour problems, –1·77 [–4·39 to 0·85], p=0·19; attachment security, 0·02 [–0·06 to 0·10], p=0·58), with both groups

							achieving scores similar to non-clinical norms on all outcomes. Six adverse events were reported: five in the video-feedback therapy (VFT) group (two participants) and one in the progressive muscle relaxation (PMR) group. However, they were not treatment-related Maintaining the remission of maternal depression has proved to mitigate the long-term effects of postpartum depression on infants (Ramachandran et al., 2020)
Stein et al., 2018	RCT UK: Oxford Smartphone	Post-partum Intervention group N = 72 Control group N = 72	Video feedback therapy integrated with CBT and BA	BA/CBT	Effectiveness	Edinburg Postnatal Depression Scale (EPDS) Structured Clinical Interview for DSM-IV (SCID-I)	The was an improvement in the mean depressive scores reported in both the treatment and control groups (scoring was greater than 50%) Women with a history of childhood sexual abuse reported significant scores when using telephone-based intervention ($p<0.02$) (Stein et al., 2018).
Wisner et al., 2017	RCT	Post-partum	Depression Care Management:	CBT/Psychoeducation	Effectiveness, Acceptabili	Structured Clinical Interview for	Usability was pilot tested on 11 mothers

	USA: Pennsylvania and Pittsburg Smartphone	DCM Intervention group N = 312 EUC TAU N = 316	Offers psychoeducation and psycho-therapy telephonically		ty and Usability	DSM-IV (SCID-1) Becks Depression Inventory (BDI-II) Edinburg Postnatal Depression Scale (EPDS) MOM Satisfaction Questionnaire	After intervention: participants reported high satisfaction with the usability Findings suggest the intervention effectively reduced the proportion of depression diagnosis outcomes at each time point, though statistically superior outcomes to the control conditions were only observed at the long-term follow-up. At the 12-month follow-up, the intervention group showed a significantly greater likelihood of diagnostic remission than the control group and a significant dosage effect As such, this trial is original and contributes to research on postpartum depression (Wisner et al., 2017).
Wozney et al., 2017	RCT Canada: Nova Scotia Smartphone Video player	Postpartum Intervention group N = 32 Control group	Managing Our Mood(MOM): A 12-session CBT program	CBT	Effectiveness, Acceptability and Cost-effectiveness	Edinburg Postnatal Depression Scale (EPDS) Parental Stress Scale	There were no significant intervention effects on depressive symptoms Higher gestational weight gain was associated with worsened mood and lower physical quality of life during pregnancy

		N = 30				Patient-Reported Costs Questionnaire (PRCQ) Telemedicine Satisfaction Questionnaire (TSQ)	High satisfaction was reported in VC utilization The average TSQ item score was 4.7 out of 5, with average scores of 4.7 (SD 0.43), 4.7 (SD 0.31), and 4.6 (SD 0.67) in the domains of *quality of care provided, similarity to in-person face-to-face interaction, and perception of the interaction* Participants also reported the cost-effectiveness of the DHI Average savings of Can $26 and 2.5 hours for travelling and childcare expenses (SD 1.6, range: 1-7 hours) (Wozney et al., 2017)
Yang et al.**, 2019**	RCT Canada: Ontorio and Toronto Computer Webcam	Post-partum VC-TAU N = 19 TAU N = 19	Integration of office-based treatment for depression with video conferencing. - Office-based treatment includes CBT and IPT	CBT and IPT	Acceptability	Patient Health Questionnaire (PHQ-9) Five Facets of Mindfulness Questionnaire Generalized Anxiety	The mindfulness intervention was reported as acceptable and feasible The intervention group also showed a significant decline in depressive symptoms compared to the control group (Yang, R., Vigod & Hensel, 2019)

			adapted for post-partum depression. The Ontorio Telemedicine Network hosts the Web-based VC program.			Disorder Scale (GAD)	
Yang, M. et al., 2019	RCT China: Zhejiang Smartphone	Pregnant Intervention group N = 62 Control group N = 61	Eight- week Online Mindfulness-based intervention	Mindfulness	Effectiveness, Acceptability and Cost-effectiveness	Edinburg Postnatal Depression Scale (EPDS) Parental Stress Scale Patient-Reported Costs Questionnaire (PRCQ) Telemedicine Satisfaction Questionnaire (TSQ)	There were no significant intervention effects on depressive symptoms Higher gestational weight gain was associated with worsened mood and lower physical quality of life during pregnancy High satisfaction was reported in VC utilization The average TSQ item score was 4.7 out of 5, with average scores of 4.7 (SD 0.43), 4.7 (SD 0.31), and 4.6 (SD 0.67) in the domains of *quality of care provided, similarity to in-person face-to-face interaction, and perception of the interaction* Participants also reported the cost-effectiveness of the DHI

							Average savings of Can $26 and 2.5 hours for travelling and childcare expenses (SD 1.6, range: 1-7 hours) (Yang, M. et al., 2019)

4.3 Excluded Studies

The main reason for excluding studies in the title and abstract screening was that most records were study protocols. In addition, one study was disregarded for focussing on DH interventions integrated with pharmaceutical interventions (Bilszta et al., 2012). One study was removed later in the full-screening process because the DH intervention was integrated with a physical activity program (Lewis et al., 2018). The rest of the studies excluded focussed on the wrong participants and outcomes (Altazan et al., 2019; Hantsoo et al., 2017; Kelman et al., 2018; Ngai et al., 2016; Suharwardy et al., 2020). Table 1 0 provides a summary of the excluded studies with reasons for exclusion.

Table 10: List of Excluded Studies

Article ID	Reasons for Exclusion
(Altazan et al., 2019)	**Outcomes are not directly related to the treatment of PPD**
(Bilszta et al., 2012)	**Digital health intervention was integrated with pharmaceutical intervention**
(Bischoff et al., 2019)	**Protocol**
(Bright et al., 2019)	**Protocol**
(Caramlau et al., 2011)	**Protocol**
(Dennis, C. L. et al., 2012)	**Protocol**
(Duffecy et al., 2019)	**Pilot Study**
(Dyurich & Oliver, 2020)	**The study was solely qualitative**
(Fonseca et al., 2020)	**Pilot Study**

Article ID	Reason for Exclusion
(Hantsoo & Epperson, 2017)	**The study includes non-pregnant and male participants**
(Heller et al., 2014)	**Protocol**
(Kingston et al., 2014)	**Protocol**
(Kelman et al., 2018)	**The study included participants who were not a part of the perinatal population**
(Lewis, Seko & Joshi, 2018)	**Wrong intervention: DHI is integrated with a physical activity program**
(Loughnan et al., 2018)	**Wrong Outcomes**
(Milgrom, J. et al., 2019)	**Abstract**
(Muller et al., 2020)	**Protocol**
(Ngai et al., 2016)	**The study does not focus on outcomes related to PPD**
(Nishi et al., 2020)	**Protocol**

Article ID	Reason for Exclusion
(O'Mahen, H.A. et al., 2014)	**Duplicate**
(Schwank et al., 2020)	**Protocol**
(Sjömark et al., 2018)	**Protocol** **Outcomes are not related to the treatment of perinatal depression**
(Suharwardy et al., 2020)	**Evidence is insufficient**
(Sun et al., 2019)	**Protocol**
(Willey et al., 2020)	**The study was solely qualitative**
(Zuccolo et al., 2021)	**Protocol**
Total (n)	**26**

4.4 Results of Individual Studies

4.4.1 The impact of the integration of DHI and psychological treatment approaches

Peer-support interventions were included in two studies. One study by Haga et al. (2019) examined the effectiveness of a web-based peer-support programme amongst 1322 pregnant women (N = 678, Intervention group, N = 644 control group). The findings report fewer depressive symptoms at follow-up amongst the intervention group than the control group [F(1) = 7.03, p = 0.008]. Contrary to the findings reported by Ramachandran et al. (2020), no significant difference was found in the change in depressive symptoms.

Recent cognitive behavioural therapy studies include a randomised control trial conducted by Ramachandran et al. (2020). The investigators randomised 192 postpartum women to deliver usual care or automated conversational agents (chatbots) integrated with CBT content. The participants in the intervention group had access to smartphones that allowed real-time text-messaging interfaces. Apart from reducing the symptoms of perinatal anxiety and mood disorders, the study's primary outcomes included client satisfaction and the acceptability of the DHI intervention, in which 64% of the participants were highly satisfied (CSQ-8 ≥ 24), and 28% reported high WAI-SR scores (WAI-SR ≥ 48). Only 27% of the application users were relatively satisfied, while 43% reported medium WAI-SR scores. The results proved the efficacy of chatbot applications in treating mood disorders amongst the postpartum population.

Jannati et al. (2020) conducted a randomised control trial investigating the effectiveness of another mobile health intervention, Happy Mom. The application includes an EPDS screening tool and CBT sessions integrated with psychoeducation. Thirty-eight perinatal women were a part of the intervention group, while 37 participants were allocated to the control group, face-to-face CBT. After trial completion, an average EPDS score of 8.18 was reported within the intervention group and an average of 15.05 within the control group.

Milgrom and Gemmill (2014) reported results from a study examining the use of an internet-based BA and CBT programme, NetMums. Their primary goal was to evaluate the program's feasibility in delivering adaptive coping strategies amongst the postpartum population in Melbourne, Australia. The authors found a significant decrease in participants scoring above the threshold within the EPDS (n=66/181 vs n=91/162, OR=2.16). The reduction is due to the high attrition that led to only 38% of the participants remaining to complete the study.

In a study where 38 postpartum women received a telephone-based IPT intervention, only 10.6% of the 19 women within the treatment group who completed the program showed depressed symptomatology after twelve weeks after randomisation (Yang et al., 2019).

Dennis et al. (2020) conducted a randomised control trial where 141 postpartum women were randomised to a telephone-based nurse-delivered IPT programme. The participants received the programme well since it was reported that approximately 10.6% remained depressed after 12 weeks of being within the programme.

Yang et al. (2020) evaluated the usability and cost-effectiveness of CBT and IPT treatment delivered through office-based videoconferencing. Nineteen postpartum women were a part of the intervention group, while another group of 19 women was part of the control group – office-based treatment without videoconferencing. Although there were no significant differences between the two groups in reducing perinatal depression symptomology (EPDS ($F_{1,9}=0.058$, $P=.81$)), the program proved its efficacy in its feasibility and cost-effectiveness.

One study proved its efficacy in encouraging at-risk adolescent mothers to seek psychological help using an internet-based intervention integrated with the (TPB) perspective. There was a positive change in the following measures: change in attitude, perceived control, and intention to seek mental health treatment (Logsdon et al., 2018).

Web-based psychoeducational and peer-support groups have also been found effective in three studies. Milgrom et al. (2016) randomised 43 women to one of two conditions: internet-based CBT, psychoeducation and mood screening program or treatment as usual (TAU), which excluded internet use. Subjects received six interactive sessions. The psychoeducational feature of the program included articles related to relaxation, parental support and basic problem-solving strategies, whereas the peer-support feature included a web-based forum where participants could post, read and comment on each other's messages. A significant increase in the reduction of depressive symptomatology was reported in the intervention group

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4.5 Results of synthesis

The narrative synthesis consists of two comparisons, focussing solely on CBT interventions integrated with web-based, mHealth and telemedicine- based interventions. The exclusive selection of CBT interventions is based on its predominance in the number of studies conducted. No synthesis was conducted on research trials where other psychological approaches were included and CBT.

4.5.1 Comparison 1: The effect of web-based CBT treatment on intervention effectiveness compared to mHealth-based CBT treatment

Three of the seven CBT studies are web-based interventions focussing on decreasing the symptoms of depression and increasing remission. Forsell et al. (2017) found that the intervention group (N = 21) had a statistically significant increase in lower depressive scores compared to the control group (N = 18) ($p<0.001$). Furthermore, an increase in remission was found amongst the intervention group (33%) compared to the control group (11%), although these findings were not statistically significant. Monteiro et al. (2020) also report significant positive mental health improvement amongst the intervention group compared to the control group (n = 21, 20.2% vs n = 14, 9.7%, $X^2 = 10.59$, $p = 0.014$) when examining the efficacy of the BeAMom intervention in enhancing mental health among postpartum women. Wozney et al. (2017) reported results that were not statistically significant in reducing depressive symptoms.

The findings in one of the mHealth-based CBT interventions were not statistically significant. For instance, in Dáu et al. (2017)'s study, the maternal sensitivity scores ranged from 2 to 4.5 (see Table 9). However, Jannati et al. (2020) report statistically significant findings in the mean EPFDS score of 9.24 and 2.34 in the control group ($p< 0.001$).

4.5.2 Comparison 2: Effect of web-based CBT treatment on intervention acceptability compared to mHealth CBT treatment

Two studies assessed the acceptability of web-based CBT trials, while only one focused on the acceptability of a telemedicine intervention. In the BeAMom trial (Monteiro et al., 2020), 74.1% of those who completed the trial within the intervention group (postpartum web-based CBT group) reported high satisfaction with the assistance provided by the intervention compared to those who did not complete the trial (n = 43, 74.1% vs n = 31, 56.4%, $X^2 = 3.95$, p = 0.047), while 93.1 (n = 54, 93.1% vs n = 42, 76.4%, $X^2 = 6.19$, p = 0.013) agreed that they would recommend the programme to a friend. Notably, 92% (n = 104) of the intervention group rated the overall quality as satisfactory. In addition, the study conducted by Forsell et al. (2017) reported a mean score of 23.8 (SD = 3.1) in the client satisfaction questionnaire (CSQ), which indicates reasonable satisfaction and acceptability. Lastly, in the telephone-based CBT trial by Ngai et al. (2019), 57.9% of women within the intervention group (175/302 vs 37.2%, 121/325) reported high satisfaction with using the e-screening tool to answer questions related to emotional health.

Chapter 5: Discussion

This systematic review provides evidence that the integration of DHIs and psychotherapeutic approaches yields effective results in treating and managing perinatal depression. The findings report that the perinatal population finds the utilisation of DHIs effective, acceptable, usable, and cost-effective. This section discusses results in the context of the research question, the aims and objectives and the literature review conducted. Lastly, a summary of the limitations and recommendations is provided.

5.1 Types of Studies

Although the initial search yielded 271 research studies, only twenty-four were included for data extraction and analysis, with twenty-one of the studies being RCTs, two being cohort studies, and one being a non-randomised mixed-method study. The high prevalence of RCTs in the included studies was found satisfactory as RCTs ensure scientific rigour (Bhide, Shah & Acharya, 2018). However, the limited number of studies included in this review indicates that despite the rapid growth in research focussing on the utilisation of psychological approaches and DHIs in the clinical practice of mental health, there is still a limited number of studies focussing on the integration of these interventions in treating the perinatal population. One factor that could be attributed to this could be that the treatment interventions for depression are often generalised to be effective for the general population. While past literature might have supporting evidence that proves that some psychological treatment approaches that are implemented for the general population are effective in improving the mental wellbeing of the perinatal population (Fitelson et al., 2010; WHO, 2008a), it is essential to design and implement a treatment approach relevant for the target population. In addition, the disproportionate number of studies conducted outside of LMICs highlights a significant research gap that implies that the experiences of women diagnosed with perinatal depression in LMICs remain uncaptured. The limited number of studies conducted in LMICs could be attributed to the limited infrastructure required for DHIs, especially in rural and remote areas. Lastly, the studies that focussed on one or two elements of depressive symptomatology (such as insomnia, anhedonia and the distress related to depression) were excluded (Ngai et al., 2016; Sjömark et al., 2018). This, too, poses a limitation as the evidence might have had implications for the treatment of the entire depressive symptomatology.

5.2 Types of Participants

Postpartum women accounted for most of the studies compared to pregnant women, while the perinatal group was the least represented. Despite supporting evidence highlighting the high prevalence of postpartum depression, the limited number of studies focussing on the antenatal population is concerning. For instance, the generalisation of the findings to the perinatal population in this review remains questionable as it becomes challenging to determine whether the success of these interventions among postpartum women could also cater for the needs of the perinatal population. Therefore, this calls for future research to equally focus on antenatal and postpartum populations. Addressing

perinatal depression with DHIs designed for the perinatal population could help combat the symptoms during the earlier stages (that is, pregnancy), which will consequently help decrease the risk of developing further health implications.

5.3 Types of Interventions and Technological Devices

Assessing the different types of DH modalities and technological devices used, the findings report the superiority in the number of studies focussing on web-based and smartphone devices to studies focussing on mHealth and telephone- based interventions. In addition, the studies focussing on web-based interventions are primarily prevalent in HICs. The increased number of studies utilising web-based interventions and smartphones in HICs could be attributed to the higher percentage of smartphone ownership (Silver, 2019). Compared to LMICs, HICs have the infrastructure and the financial resources required to utilise web-based and mHealth interventions. When inferring these findings from the digital divide perspective, the required infrastructure for the utilisation of web-based and mHealth interventions poses a further disproportion in those who have access to DH and, consequently, a vast majority in treatment approaches for their varying illnesses (Viswanath & Kreuter, 2007; WHO, 2021; Zillien & Hargittai, 2009a). Furthermore, HICs have more access to healthcare resources, such as mental healthcare workers - essential in utilising DHIs and the relevant psychological approaches.

While DHIs seek to address the limited access to healthcare, it cannot be overlooked that the most effective and functional DHIs, such as web-based and mobile health interventions, still require smartphone ownership. Therefore, the lower prevalence of smartphones amongst women in LMICs is a significant barrier to its feasibility. In addition, the barriers related to licencing and implementation models for DH's inaccessibility to ICT remain among the biggest challenges in utilising DHIs in LMICs.

Assessing the psychological approaches, most studies examined the integration of CBT with DHIs, resulting in fourteen studies where significant results were reported for effectiveness, acceptability and cost-effectiveness. The high utilisation of CBT as a treatment approach in the included studies is attributed mainly to its proven effectiveness in treating clinical depression (Cuijpers et al., 2008; Cuijpers et al., 2013; Sockol, 2015). CBT supports the notion that depression is based on dysfunctional thought patterns manifested in maladaptive behaviour. CBT-based DHIs also reported high patient satisfaction and engagement (Jannati et al., 2020; Milgrom et al., Ramachandran et al., 2020; Wozney et al., 2017). Borza (2017) and Li et al. (2020) echoed these findings by stating that CBT fosters a collaborative therapeutic relationship. A peer-support programme and another mood screening tool reported statistically significant results when integrated with psychoeducation and CBT (Milgrom et al., 2016; Ramachandran et al., 2020). This raises the question of whether integrating multidisciplinary approaches is more effective than implementing only one treatment approach.

DHIs are the most affordable when the technological device and utilisation processes are not considered complex. Compared to mobile applications, telephone-based interventions require minimal effort as the process only requires text messaging and

telephone calls as a form of consultation. Thus, IPT was reported as cost-effective and accessible when integrated with telephone-based interventions (Dennis et al., 2020; Yang et al., 2019). DHIs, such as web-based interventions among the perinatal population, have proven beneficial in treating and managing perinatal depression, especially when integrated with CBT and IPT. While the digital gap is gradually narrowing, smartphone ownership in LMICs is still low in prevalence; hence, web-based interventions may not always be feasible.

5.4 Types of Outcomes

The outcomes of this review were to assess the effectiveness, acceptability, usability and cost-effectiveness of DHIs integrated with psychological approaches compared to conventional treatment in the treatment and management of perinatal depression.

Twenty studies evaluated the effectiveness in decreasing depressive symptoms, of which seventeen reported statistically significant results amongst the intervention groups. The remaining four studies did not report significant intervention effects in decreasing or managing depressive symptoms due to several factors, such as sample size and measuring outcomes. The sample size was mainly attributed to attrition as it was reported that most participants – especially postpartum women, withdrew their participation right before or during the trial. The attrition of participants does not come as a surprise since the progression of the perinatal period is accompanied by an increase in demands associated with the infant's upbringing.

Attrition and low adherence have been reported in previous research as one of the primary challenges in the use of DHIs across a range of diseases (Fleming et al., 2018; Pfammatter et al., 2017). Health literacy, age and education are possible factors attributed to the high attrition rates in mHealth interventions for chronic diseases (Meyerowitz-Katz et al., 2020). In a study examining the sustainability of a mHealth intervention for dietary self-monitoring, only 2% of the sample reported sustained use of the app – questioning the need for app usage (Helander et al., 2014). More studies reveal that high attrition threatens the validity of these interventions and their uptake in public health (Linardon & Fuller-Tyszkiewicz, 2020; Meyerowitz-Katz et al., 2020). As a result, it is risky to infer whether statistically insignificant results in these studies indicate the ineffectiveness of DHIs instead of the decreased sample size towards the end of the trial. However, not all studies that reported high attrition reported statistically insignificant results. For instance, in one of the studies, only 38% of the participants remained for the trial duration, which resulted in statistically significant results for the effectiveness and acceptability of a web-based intervention (Milgrom & Gemmill, 2014).

Thirteen studies examined the acceptability of the interventions, of which all reported significant scores in the patient- or client-satisfaction scales. These findings are satisfactory as they indicate that the perinatal population is increasingly becoming more receptive to the implementation of DHIs in the clinical practice of mental healthcare.

Only three studies examined usability in pilot studies, of which positive results were reported (Kingston et al., 2017; Logsdon et al., 2010; Wozney et al., 2017). This limited

number of studies measuring this outcome may pose negative implications in future research for measuring other outcomes, such as effectiveness, feasibility and acceptability. For example, in the studies that reported statistically insignificant results in either the effectiveness or acceptability of the interventions, it became a challenge to determine whether usability could have been a factor in the reported findings of the outcomes. The limited knowledge of how digital health systems operate in research settings highlights a significant research gap (Ettinger et al., 2016). Similarly, the limited number of studies measuring the usability of these interventions in treating perinatal depression could hinder the innovation and implementation of context-sensitive interventions for the perinatal population. Therefore, it is essential not to limit usability measurement to solely pilot studies.

This study was conducted in Canada and reported positive findings on the intervention's efficacy in addressing the cost barriers related to access to mental healthcare. The cost-effectiveness was also measured the least, accounting for only one of the studies. Furthermore, these results are consistent with the findings reported in past literature, where DH proves its potential for cost-effectiveness, including in LMICs (Barron et al., 2016; Batsis, J. A., Pletcher & Stahl, 2017). However, future research is still needed to determine the cost-effectiveness of these interventions within the perinatal population by considering infrastructure availability and maintenance.

5.5 Limitations

This review is not without limitations. Firstly, the risk of bias assessment was not performed. As a result, the findings cannot be reported without bias. In addition, the exclusion of grey literature increases the publication bias in the study and raises the question of whether this exclusion could be attributed to the number of included studies. The limited amount of studies conducted in LMICs highlights a significant research gap, considering that the literature reports a higher prevalence of perinatal depression in LMICs. Furthermore, the disproportionate number of studies focussing on pregnant women makes it challenging to generalise the study findings to the perinatal population. Lastly, with the limited number of studies examining the interventions' usability and cost-effectiveness, this review could not determine the efficacy of DHIs in addressing these outcomes.

5.6 Recommendations

This review has provided evidence that the integration of DHIs and psychological approaches has the potential to provide positive health outcomes for the perinatal population when treating and managing depression. There is sufficient evidence that proves the effectiveness and acceptability of these interventions. For future research purposes, the following is recommended.

- Incorporation of all four outcomes, namely effectiveness, acceptability, usability, and cost-effectiveness

- Increased focus on the perinatal population
- The larger sample size for the intervention groups

- Increase in research exploring the use of DHIs in LMICs in order to determine the accessibility barriers that may exist
  Implementation of holistic and multidisciplinary psychological approaches instead of a single treatment approach

5.7 Conclusion

This systematic review focused on the impact of integrating digital health interventions with psychological approaches in treating and managing perinatal depression. The DHIs and psychological approaches reviewed in this study have proven their effectiveness and acceptability with reasonable certainty. Therefore, this review provides sufficient evidence highlighting that DHIs positively affect the treatment outcomes of perinatal depression. Compared to antenatal women, the findings have identified postpartum women as the main population of interest, where higher scores in all four outcomes were reported mainly on the utilisation of web-based and mHealth interventions. The findings also suggest that CBT can improve the perinatal population's patient outcomes, especially when integrated with other treatment approaches, such as peer support and psychoeducation, since these approaches were compatible with all three DH modalities. The limited number of studies conducted in LMICs highlights a significant research gap to be addressed in the near future. While the digital gap is gradually narrowing, smartphone ownership in LMICs is still low in prevalence; hence, web-based interventions may not always be feasible. Since telephone-based interventions are deemed more affordable in specific contexts, future research could assess all four outcomes of implementing telephone-based interventions in LMICs.

In conclusion, the results suggest that integrating DHIs with psychological approaches is deemed effective and acceptable when treating perinatal depression.

For pregnant women, mainly from LMICs, more research trials that focus on the usability and cost-effectiveness of the interventions are warranted.

Chapter 6: Summary

Perinatal depression contributes significantly to the global disease burden, implicating the mother and the infant. This systematic review investigated the integration of DHIs and conventional psychological approaches in treating and managing perinatal depression among low-and-middle-income populations. This review assessed these interventions' effectiveness, acceptability, usability and cost-effectiveness.

The symptoms of perinatal depression and the limited access to conventional treatment emphasise the significance of DH as an alternative approach. Past literature highlights increased access to technological devices in the LMICs, especially amongst the perinatal population. Along with the issues related to legislation, reimbursement and infrastructure, the digital divide might hinder the uptake of DHIs in LMICs.

A narrative synthesis focused on English peer-reviewed literature published between January 2007 and December 2020. The eligibility criteria included perinatal women within the reproductive age, diagnosed with depression and the implementation of DHIs with psychological treatments including CBT, BA, IPT, psychoeducation and counselling.

This review highlights a limited number of studies conducted in LMICs, focusing on treating perinatal depression using DHIs. The findings of this review revealed a high prevalence in studies focussing on the post-partum population (n=18) compared to pregnant women (n =5). In addition, web-based interventions were the most utilised (n=15), followed by telephone-based (n=5) and mHealth interventions (n =4). High effectiveness and acceptability were reported in integrating DHIs with CBT, psychoeducation and peer-support programmes, inspiring the question of whether integrating multidisciplinary approaches with DHIs could be more effective. In addition, the risk of bias was not conducted in this study.

Appendix i: Search Strategies

Table 11: PubMed Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	pregnancy[MeSH Terms]	897,401
#2	MeSH terms:	Perinatal Care[MeSH Terms]	10,249
#3	MeSH terms:	Postpartum Period[MeSH Terms]	65,347
#4	Free text:	(((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum)	1,144,473

#5	#1 OR #2 OR #3 OR #4	(((((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum)) OR (Postpartum Period[MeSH Terms])) OR (Perinatal Care[MeSH Terms])) OR (pregnancy[MeSH Terms])	1,145,458
Intervention: Digital Health			
#6	MeSH terms:	Telemedicine[MeSH Terms]	29,768
#7	MeSH terms:	Cell Phone[MeSH Terms]	10,853
#8	MeSH terms:	Smartphone[MeSH Terms]	4,631
#9	MeSH terms:	Mobile Applications[MeSH Terms]	6,246
#10	MeSH terms:	medical Informatics Applications[MeSH Terms]	456,788
#11	MeSH	Reminder Systems[MeSH Terms]	3,492

	terms:		
#12	Free text:	Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR	292,618

		Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube	
#13	#6 OR #7 OR #8 OR #9 OR #10 OR#11 OR #12	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR	728,402

		(Reminder Systems[MeSH Terms])	
Intervention: Psychological interventions			
#14	MeSH terms:	Mental Health[MeSH Terms]	39,073
#15	MeSH terms:	Psychotherapy[MeSH Terms]	196,581

#16	#Free text	psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies)	339,099
#17	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	537,778
Outcomes: Maternal Mental Well-being			
#18	MeSH terms:	Maternal Mental Illness[MeSH Terms]	30,537

#19	Free text:	(postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post- partum psychoses) OR (maternal substance abuse))	57,546
#20	#18 OR #19	(Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post-partum psychoses) OR (maternal substance abuse)))	77,763
#21	Filter	Publication Type: Journal Articles Date: 2007/01/01 to 2020/12/31	74

		Language: English	
#22		((((((((((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum)) OR (Postpartum Period[MeSH Terms])) OR (Perinatal Care[MeSH Terms])) OR (pregnancy[MeSH Terms])) AND (((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR	74

		Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms]))) AND (((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies)))) AND	

		((Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood	

		disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (maternal substance abuse))))) AND (("2007/01/01"[Date - Publication] : "2020/12/31"[Date - Publication])) AND (English[Language])	

Table 12: Cochrane Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	pregnancy[MeSH Terms]	22290
#2	MeSH terms:	Perinatal Care[MeSH Terms]	581
#3	MeSH terms:	Postpartum Period[MeSH Terms]	1674
#4	Free text:	(((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum) OR (pregnancies)	74641
#5	#1 OR #2 OR #3 OR #4	(((((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum)) OR (Postpartum Period[MeSH Terms])) OR (Perinatal Care[MeSH Terms])) OR (pregnancy[MeSH Terms])	75023

Intervention: Digital Health			
#6	MeSH terms:	Telemedicine[MeSH Terms]	2708
#7	MeSH terms:	Cell Phone[MeSH Terms]	1756
#8	MeSH terms:	Smartphone[MeSH Terms]	358
#9	MeSH terms:	Mobile Applications[MeSH Terms]	722
#10	MeSH terms:	medical Informatics Applications[MeSH Terms]	8894
#11	MeSH terms:	Reminder Systems[MeSH Terms]	963

#12	Free text:	Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR	49532
		mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube	

#13	#6 OR #7 OR #8 OR #9 OR #10 OR#11 OR #12	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	57 385

Intervention: Psychological interventions			
#14	MeSH terms:	Mental Healthcare[MeSH Terms]	1565
#15	MeSH terms:	Psychotherapy[MeSH Terms]	24419
#16	#Free text	psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies)	35310

#17	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	46739
Outcomes: Maternal Mental Well-being			
#18	MeSH terms:	Maternal Mental Illness[MeSH Terms]	0

#19	Free text:	(postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR	3237
		(post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post- partum psychoses) OR (maternal substance abuse))	

#20	#18 OR #19	(Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality)OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post-partum psychoses) OR (maternal substance abuse)))	3237
#21	Filter	Publication Year from 2007 to 2020, with Cochrane Library publication date from Jan 2007 to Dec 2020, in Trials	
#22	#5 AND #13 AND #17		173

Table 13: PsycArticle Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	DE "Pregnancy" OR DE "Adolescent Pregnancy" OR DE "Pregnancy Outcomes" OR DE "Primipara" OR DE "Pregnancy Outcomes" OR DE "Birth" OR DE "Induced Abortion" OR DE "Obstetrical Complications" OR DE "Spontaneous Abortion" OR DE "Prenatal Care" OR DE "Childbirth Training"	1,466
#2	MeSH terms:	DE "Perinatal Period" OR DE "Perinatal Women"	76
#3	MeSH terms:	DE "Postnatal Period"	168

#4	Free text:	(pregnancy or pregnant or prenatal or antenatal or perinatal or maternal) OR (antepartum or perinatal) OR (intrapartum or labour or labor or childbirth or birth or delivery) OR gestation OR (postpartum or postnatal or after pregnancy or after birth or after childbirth) OR post- partum OR perinatal OR pregnancies	(9,618
#5	#1 OR #2 OR #3 OR #4	(((((((pregnancy) OR (pregnant)) OR (gestation)) OR (perinatal)) OR (postpartum)) OR (post-partum)) OR (Postpartum Period[MA MeSH Subject Heading])) OR (Perinatal Care[MA MeSH Subject Heading])) OR (pregnancy[MA MeSH Subject Heading])	9,644
Intervention: Digital Health			
#6	MeSH terms:	DE "Telemedicine" OR DE "Online Therapy" OR DE "Teleconferencing" OR DE "Teleconsultation" OR DE "Telepsychiatry" OR DE "Telepsychology" OR DE "Telerehabilitation" OR DE "Electronic Health Services" OR DE "Digital	15,267

		Interventions" OR DE "Mobile Health"	

		OR DE "Precision Medicine" OR DE "Telemedicine" OR DE "Wearable Devices"	
#7	MeSH terms:	DE "Mobile Phones" OR DE "Smartphones" OR DE "Text Messaging" OR DE "Smartphones" OR DE "Mobile Applications"	197
#8	MeSH terms:	DE "Mobile Phones" OR DE "Text Messaging" OR DE "Mobile Technology"	139
#9	MeSH terms:	DE "Medical Informatics" OR DE "Health Information Technology"	7
#10	MeSH terms:	Reminder Systems or clinical reminders [MeSH Terms]	12

#11	Free text:	Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube	2,362

#12	#7 OR #8 OR #9 OR #10OR #11	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile	2,499

		phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	
Intervention: Psychological interventions			

#13	MeSH terms:	DE "Preventive Mental Health Services" OR DE "Mental Health Literacy" OR DE "Serious Mental Illness" OR DE "Mental Health Programs" OR DE "Mental Health Program Evaluation" OR DE "Chronic Mental Illness" OR DE "Mental Health Services" OR DE "Mental Health and Illness Assessment" OR DE "Community Mental Health Centers" OR DE "Public Mental Health" OR DE "Digital Mental Health Resources" OR DE "Health Psychology Assessment" OR DE "Mini Mental State Examination" OR DE "Community Mental Health Services" OR DE "Community Counseling" OR DE "Transcultural Psychiatry" OR DE "Psychiatric Hospitals" OR DE "Commitment (Psychiatric)" OR DE "Outpatient Commitment" OR DE "Biopsychosocial Approach" OR DE "Behavioral Health Services" OR DE "Therapists" OR DE "Telepsychology" OR DE "Social Psychiatry" OR DE "Serotonin Norepinephrine Reuptake Inhibitors" OR DE "Psychosocial Assessment" OR DE "Psychopathology" OR DE	10,190

		"Psychoeducation" OR DE "Psychodiagnostic Typologies" OR DE "Diagnostic and Statistical Manual" OR DE "International Classification of Diseases" OR DE "Research Diagnostic Criteria" OR DE "Psychodiagnostic Measures" OR DE "Psychodiagnosis" OR DE "Free Association"	
#14	MeSH terms:	DE "Psychotherapy" OR DE "Adlerian Psychotherapy" OR DE "Adolescent Psychotherapy" OR DE "Affirmative Therapy" OR DE "Analytical Psychotherapy" OR DE "Autogenic Training" OR DE "Brief Psychotherapy" OR DE "Brief Relational Therapy" OR DE "Child Psychotherapy" OR DE "Client Centered Therapy" OR DE	14,567
		"Conversion Therapy" OR DE	

		"Couples Therapy" OR DE "Eclectic Psychotherapy" OR DE "Emotion Focused Therapy" OR DE "Existential Therapy" OR DE "Experiential Psychotherapy" OR DE "Expressive Psychotherapy" OR DE "Eye Movement Desensitization Therapy" OR DE "Feminist Therapy" OR DE "Geriatric Psychotherapy" OR DE "Gestalt Therapy" OR DE "Group Psychotherapy" OR DE "Guided Imagery" OR DE "Humanistic Psychotherapy" OR DE "Hypnotherapy" OR DE "Individual Psychotherapy" OR DE "Insight
		Therapy" OR DE "Integrative	

		Psychotherapy" OR DE "Interpersonal Psychotherapy" OR DE "Logotherapy" OR DE "Narrative Therapy" OR DE "Network Therapy" OR DE "Persuasion Therapy" OR DE "Primal Therapy" OR DE "Psychoanalysis" OR DE "Psychodrama" OR DE "Psychodynamic Psychotherapy" OR DE "Psychotherapeutic Counseling" OR DE "Psychotherapeutic Techniques" OR DE "Rational Emotive Behavior Therapy" OR DE	

		"Reality Therapy" OR DE "Relationship Therapy" OR DE "Solution Focused Therapy" OR DE "Strategic Therapy" OR DE "Supportive Psychotherapy" OR DE "Transactional Analysis" OR DE "Individual Psychotherapy" OR DE "Brief Psychotherapy" OR DE "Psychodynamic Psychotherapy" OR DE "Analytical Psychotherapy" OR DE "Supportive Psychotherapy" OR DE "Adlerian Psychotherapy" OR DE "Integrative Psychotherapy" OR DE "Humanistic Psychotherapy" OR DE "Client Centered Therapy" OR DE "Interpersonal Psychotherapy" OR DE "Group Psychotherapy" OR DE "Expressive Psychotherapy" OR DE "Experiential Psychotherapy" OR DE "Psychotherapeutic Techniques" OR DE "Client Centered Therapy" OR DE "Transactional Analysis" OR DE "Solution Focused Therapy" OR DE "Psychotherapeutic Processes" OR DE "Narrative Therapy" OR DE "Gestalt Therapy" OR DE "Existential Therapy" OR DE "Cognitive Behavior Therapy"	

#15	#Free text	psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies)	20,977
#16	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies	31,672

		OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	
Outcomes: Maternal Mental Well-being			
#17	MeSH terms:	DE "Postpartum Depression"	106

#18	Free text:	postpartum depression or postnatal depression or ppd or pnd or post-partum depression or post-natal depression) OR (postpartum mood and anxiety disorders) OR postpartum bipolar OR (postpartum and depression or ppd) OR (postpartum anxiety or postnatal anxiety or ppa) OR (maternal mental health or postnatal mental health or perinatal mental health) OR (maternal mental health or maternal anxiety or maternal stress) OR maternal mental illness	458
#19	Free Text	perinatal anxiety or postnatal anxiety or postpartum anxiety) OR perinatal substance abuse OR perinatal stress	48
#20	#17 OR #18 OR #19		465

#21	Filter	Publication Year from 2007 to 2020, with Cochrane Library publication date from Jan 2007 to Dec 2020, in Trials	1
#22	#5 AND #12 AND #16 AND #20		1

Table 14: CINHAL Search strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	(MH "Pregnancy+") OR (MH "Pregnancy Outcomes") OR (MH "Pregnancy Complications, Psychiatric/ED/EC/PF")	206,023
#2	MeSH terms:	(MH "Perinatal")	106
#3	MeSH terms:	(MH "Postpartum women")	1,198
#4	Free text:	(MH "Expectant Mothers") OR (MH "Pregnancy Outcomes") OR (MH "Pregnancy Complications, Psychiatric")	33,231
#5	#1 OR #2 OR #3 OR	S1 OR S2 OR S3 OR S4	221,722

	#4		
Intervention: Digital Health			
#6	MeSH terms:	Telemedicine[MeSH Terms]	13,096
#7	MeSH terms:	Cell Phone[MeSH Terms]	1,314
#8	MeSH terms:	Smartphone[MeSH Terms]	3,054
#9	MeSH terms:	Mobile Applications[MeSH Terms]	8,686
#10	MeSH terms:	medical Informatics Applications[MeSH Terms]	5,080
#11	MeSH terms:	Reminder Systems[MeSH Terms]	2,962

#12	Free text:	(MH "Cellular Phone+") OR (MH "Mobile Applications") OR (MH "Telehealth+") OR (MH "Mobile Health Units") OR (MH "Social Mobility") OR (MH "Internet-Based Intervention") OR "Android OR blog OR Cell phones OR Cellular phones OR Digital health	42,924

		interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR ...	

#13	#6 OR #7 OR #8 OR #9 OR #10 OR#11 OR #12	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	50,113

Intervention: Psychological interventions			
#14	MeSH terms:	(MH "Mental Healthcare")	2,351
#15	MeSH terms:	(MH "Psychotherapy")	21,656)
#16	#Free text	(MH "Behavior Therapy+") OR (MH "Cognitive Therapy") OR (MH "Cognitive Therapy (Iowa NIC)+") OR (MH "Dialectical Behavior Therapy")	35,631

		OR (MH "Behavior Therapy (Iowa NIC)") OR "psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive b ...	

#17	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	55,254
Outcomes: Maternal Mental Well-being			
#18	MeSH terms:	Maternal Mental Illness[MeSH Terms]	3,079

#19	Free text:	(MH "Affective Disorders+") OR (MH "Seasonal Affective Disorder") OR (MH "Stress Disorders, Post- Traumatic+") OR (MH "Substance Use Disorders+") OR (MH "Postnatal Period+") OR (MH "Depression, Postpartum") OR "(postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety	311,789

		disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal ...	

#20	#18 OR #19	(Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post-partum psychoses) OR (maternal substance abuse)))	311,798
#21	Filter	Publication Type: Journal Articles Date: 2007/01/01 to 2020/12/31	

		Language: English	
#22	#5 AND #13 AND #17 AND #20	Limiters - Published Date: 20070101-20201231 Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	10

Table 15: Medline Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	(MH "Pregnancy+") OR "Pregnancy" OR (MH "Pregnancy Complications+/MO/PX") OR (MH "Pregnancy Outcome+")	1,007,860
#2	MeSH terms:	(MH "Perinatal Mortality") OR (MH "Perinatal Death") OR (MH "Perinatal Care+") OR (MH "Pregnant Women") OR (MH "Peripartum Period/PX")	22,927
#3	MeSH terms:	(MH "Postpartum Period/PX") OR (MH "Peripartum Period/PX")	2,424

#4	Free text:	MH "Postpartum Period+") OR (MH "Pregnant Women") OR (MH "Depression, Postpartum") OR (MH "Peripartum Period") OR (MH "Postnatal Care") OR "pregnancy OR pregnancies OR gestation OR postpartum OR post-partum OR (postpartum women or postpartum period or postnatal mother or postnatal women) OR perinatal OR perinatal period OR perinatal women OR pregnant OR (pregnant women or pregnancy or expectant mothers)."	86,961
#5	#1 OR #2 OR #3 OR #4		1,034,626
Intervention: Digital Health			
#6	MeSH terms:	(MH "Telemedicine") OR "Telemedicine"	36,567
#7	MeSH terms:	(MH "Cell Phone+") OR (MH "Cell Phone Use")	17,175

#8	MeSH terms:	(MH "Smartphone") OR "smartphone"	13,545
#9	MeSH terms:	(MH "Mobile Applications") OR (MH "Mobile Health Units") OR (MH "Medical Informatics Applications+")	459,349
#10	MeSH terms:	(MH "Medical Informatics+") OR (MH "Medical Informatics Applications+")	459,525
		OR (MH "Medical Informatics Computing+") OR (MH "Informatics")	
#11	MeSH terms:	MH "Reminder Systems") OR (MH "Systems Analysis+") OR (MH "Computer Systems+") OR (MH "Information Systems+") OR (MH "Online Systems+")	481,434

#12	Free text:	(MH "Mobile Applications") OR (MH "Cell Phone+") OR (MH "Mobile Health Units") OR (MH "Cell Phone Use") OR (MH "Internet-Based Intervention") OR (MH "Telemedicine+") OR "Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mob ...	101,167

#13	#6 OR #7 OR #8 OR #9 OR #10 OR#11 OR #12	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR	759,323

		(Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	
Intervention: Psychological interventions			
#14	MeSH terms:	(MH "Mental Health Services+") OR (MH "Mental Healing") OR (MH "Mental Health")	138,711
#15	MeSH terms:	(MH "Psychotherapy+") OR (MH "Psychotherapy, Psychodynamic") OR (MH "Psychotherapy, Group+") OR (MH "Psychotherapy, Multiple") OR (MH "Interpersonal Psychotherapy") OR (MH "Psychotherapy, Rational-Emotive") OR (MH "Person-Centered Psychotherapy") OR (MH "Psychotherapy, Brief") OR (MH "Imagery, Psychotherapy") OR (MH "Cognitive Behavioral Therapy+")	201,177

#16	#Free text	"Cognitive Behavioral Therapy+") OR Dialectical Behavior Therapy OR "psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive ...	544,969
#17	#14 OR #15 OR #16	((Mental Health[MeSH Terms]) OR (Psychotherapy[MeSH Terms])) OR (psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR	761,748

		(cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies))	
Outcomes: Maternal Mental Well-being			
#18	MeSH terms:	(MH "maternal mental illness")	23,726
#19	Free text:	(MH "Depression, Postpartum") OR (MH "Maternal Mortality") OR (MH "Maternal Behavior+/PX") OR "(postpartum depression or postnatal depression or ppd or pnd or post-partum depression or post-natal depression) OR postpartum mood disorders OR perinatal depression OR (perinatal anxiety or postnatal anxiety or postpartum anxiety) OR maternal substance abuse OR maternal suicide OR maternal mortality OR maternal morbidity"	19,058

#20	#18 OR #19		19,427
#21	Filter	**Limiters** - Date of Publication: 20070101-20201231 **Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase	60
#22	#5 AND #13 AND #17 AND #20		60

Table 16: PsycInfo Search Strategy

Search		Query	Items Found
Population: Pregnant and postpartum women			
#1	MeSH terms:	“DE "Pregnancy" OR DE "Pregnancy Outcomes" OR DE "Birth" OR DE "Induced Abortion" OR DE "Obstetrical Complications" OR DE "Spontaneous Abortion" OR DE "Prenatal Care" OR DE "Childbirth Training"	54,801
#2	MeSH terms:	“DE "Perinatal Period" OR DE "Perinatal Women"	3,115
#3	MeSH terms:	“DE "Postpartum Depression" OR DE "Intrapartum Period" OR DE "Antepartum Period" OR DE "Postnatal Period"	9,776

#4	Free text:	(pregnancy or pregnant or prenatal or antenatal or perinatal or maternal) OR (antepartum or perinatal) OR (intrapartum or labour or labor or childbirth or birth or delivery) OR gestation OR (postpartum or postnatal or after pregnancy or after birth or after childbirth) OR post- partum OR perinatal OR pregnancies	295,693
#5	#1 OR #2 OR #3 OR #4		296,664
Intervention: Digital Health			
#6	MeSH terms:	DE "Telemedicine" OR DE "Electronic Health Services"	7,382

#7	MeSH terms:	DE "Mobile Applications" OR DE "Smartphones" OR DE "Mobile Technology" OR DE "Mobile Phones" OR DE "Mobile Health" OR DE "Computer Applications" OR DE "Mobile Devices" OR DE "Text Messaging" OR DE "Electronic Health Services" OR DE "Wireless Technologies" OR DE "Health Information Technology"	22,946

#8	MeSH terms:	“DE "Mobile Phones" OR DE "Text Messaging" OR DE "Telepsychology" OR DE "Smartphones" OR DE "Mobile Applications"	8,223

#9	MeSH terms:	DE "Artificial Intelligence" OR DE "Affective Computing" OR DE "Artificial Neural Networks" OR DE "Cognitive Computing" OR DE "Knowledge Engineering" OR DE "Knowledge Representation" OR DE "Machine Learning" OR DE "Natural Language Processing" OR DE "Human Computer Interaction Measures" OR DE "Health Information Technology" OR DE "Medical Records" OR DE "Precision Medicine" OR DE "Telemetry" OR DE "Electronic Health Services" OR DE "Digital Interventions" OR DE "Mobile Health" OR DE "Precision M ...	31,421
#10	MeSH terms:	DE "Medical Informatics" OR DE "Health Information Technology"	792

#11	Free text:	Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube	91,583
#12	#6 OR #7 OR #8 OR	((((((Android OR blog OR Cell phones OR Cellular phones OR Digital health interventions OR e-counselling OR	129,877

	#9 OR #10 OR#11	Facebook OR eHealth OR ehealth OR iphone OR Internet-based OR Messaging OR mHealth OR mhealth OR Mobile apps OR Mobile applications OR Mobile based OR mobile devices OR mobile health OR Mobile phone based OR Mobile phones OR Mobile technology OR MMS OR online chat OR online social network OR podcasts OR portable electronic applications OR SMS OR Smartphones OR smartphone OR social media OR telecommunication in medicine OR telecare OR telehealth OR telephone-based OR telehealth OR Telemedicine OR Text messaging OR Text messages OR Tweet OR Twitter OR Web-based OR web site OR Youtube) OR (Telemedicine[MeSH Terms])) OR (Cell Phone[MeSH Terms])) OR (Smartphone[MeSH Terms])) OR (Mobile Applications[MeSH Terms])) OR (medical Informatics Applications[MeSH Terms])) OR (Reminder Systems[MeSH Terms])	
Intervention: Psychological interventions			

#13	MeSH terms:	DE "Preventive Mental Health Services" OR DE "Mental Health Program Evaluation" OR DE "Mental Health Literacy" OR DE "Mental Health and Illness Assessment" OR DE "Public Mental Health" OR DE "Digital Mental Health Resources" OR DE "Digital Health Resources" OR DE "Digital Mental Health Resources" OR DE "Digital Information" OR DE "Digital Health Resources" OR DE "Digital Libraries" OR DE "Digital Literacy" OR DE "Electronic Books" OR DE "Digital Technology" OR DE "Mental Health" OR DE "Mental H ...	38,459
#14	MeSH terms:	DE "Psychotherapy" OR DE "Adlerian Psychotherapy" OR DE "Adolescent Psychotherapy" OR DE "Affirmative Therapy" OR DE "Analytical Psychotherapy" OR DE "Autogenic Training" OR DE "Brief	225,375

		Psychotherapy" OR DE "Brief Relational Therapy" OR DE "Child Psychotherapy" OR DE "Client Centered Therapy" OR DE "Conversion Therapy" OR DE "Couples Therapy" OR DE "Eclectic Psychotherapy" OR DE "Emotion Focused Therapy" OR DE "Existential Therapy" OR DE "Experiential Psychotherapy" OR DE "Expressive Psychotherapy" OR DE "Eye Movement Desensitization Therapy" OR DE "Feminist Therapy" OR DE "Geriatric Psychotherapy" OR DE "Gestalt Therapy" OR DE "Group Psychotherapy" OR DE "Guided Imagery" OR DE "Humanistic Psychotherapy" OR DE "Hypnotherapy" OR DE "Individual Psychotherapy" OR DE "Insight Therapy" OR DE "Integrative Psychotherapy" OR DE "Interpersonal Psychotherapy" OR DE "Logotherapy" OR DE "Narrative Therapy" OR DE "Network Therapy" OR DE "Persuasion Therapy" OR DE "Primal Therapy" OR DE "Psychoanalysis" OR DE "Psychodrama" OR DE "Psychodynamic Psychotherapy" OR DE "Psychotherapeutic Counseling"	

		OR DE "Psychotherapeutic Techniques" OR DE "Rational Emotive Behavior Therapy" OR DE "Reality Therapy" OR DE "Relationship Therapy" OR DE "Solution Focused Therapy" OR DE "Strategic Therapy" OR DE "Supportive Psychotherapy" OR DE "Transactional Analysis" OR DE "Individual Psychotherapy" OR DE "Brief Psychotherapy" OR DE "Psychodynamic Psychotherapy" OR DE "Analytical Psychotherapy" OR DE "Supportive Psychotherapy" OR DE "Psychotherapy Training" OR DE "Adlerian Psychotherapy" OR DE "Integrative Psychotherapy" OR DE "Schema Therapy" OR DE "Humanistic Psychotherapy" OR DE	

		"Client Centered Therapy" OR DE "Ericksonian Psychotherapy" OR DE "Interpersonal Psychotherapy" OR DE "Group Psychotherapy" OR DE "Expressive Psychotherapy" OR DE "Experiential Psychotherapy" OR DE "Psychotherapeutic Techniques" OR DE "Client Centered Therapy" OR DE "Transactional Analysis" OR DE "Solution Focused Therapy" OR DE "Self Psychology" OR DE "Psychotherapeutic Processes" OR DE "Narrative Therapy" OR DE "Gestalt Therapy" OR DE "Feminist Therapy" OR DE "Existential Therapy" OR DE "Cognitive Behavior Therapy"	

#15	#Free text	psychotherapy OR psychotherapies OR (interpersonal psychotherapy) OR (interpersonal psychotherapies) OR (cognitive behavioural therapy) OR (cognitive behavioural therapies) OR (cognitive behavioral therapy) OR (cognitive behavioral therapies) OR (cognitive behaviour therapy) OR (cognitive behaviour therapies) OR (cognitive behavior therapy) OR (cognitive behavior therapies) AND (cognitive processing therapy) OR (cognitive processing therapies) OR (rational emotive behavioural therapy) OR (rational emotive behavioural therapies) OR (rational emotive behavioral therapy) OR (rational emotive behavioral therapies)	266,850
#16	#14 OR #15 OR #16		366,767
Outcomes: Maternal Mental Well-being			
#17	MeSH	DE "maternal mental illness"	25,135

	terms:		
#18	Free text:	(postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR	1,793
		(post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (maternal substance abuse))	

#19	#18 OR #19	(Maternal Mental Illness[MeSH Terms]) OR ((postpartum mood disorder) OR (postpartum mood disorder) OR (post-partum mood disorder) OR (post-partum mood disorders) OR (postpartum anxiety disorder) OR (postpartum anxiety disorders) OR (post-partum anxiety disorder) OR (post-partum anxiety disorders) OR (maternal suicide) OR (maternal mortality) OR (postpartum psychosis) OR (postpartum psychoses) OR (post-partum psychosis) OR (post-partum psychoses) OR (maternal substance abuse)))	(1,797)
#20	Filter	**Publication Year from 2007 to 2020, with Cochrane Library publication date from Jan 2007 to Dec 2020, in Trials**	2

#21	#5 AND #13 AND #17 AND #20		2

Appendix ii: Data Extraction Template

Table 17: Data Extraction Template

Form completed by:		
Author:		
Full Reference:		
Problem:		
Is study eligible for inclusion (yes/no):		
If not eligible, provide reasons:		
Authors' Conclusions:		
Year of Study:		
Country of study setting:		
Type of study participants:	**Pregnant/Antenatal**	

	Post-partum	
	Perinatal (Pregnant and Post-partum	
Type of digital health intervention:		
Type of psychotherapeutic approach:		
Types of outcomes:		
Type of technology device and equipment:		
Sample size:		
Findings/Results:		
Comments:		

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