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Digital Health Interventions for the Optimization of Postpartum Cardiovascular Health: A Systematic Scoping Review

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ABSTRACT

Background: Digital health technologies have been proposed as a potential solution to improving maternal cardiovascular (CV) health in the postpartum (PP) period. In this context we performed a systematic scoping review of digital health interventions designed to improve PP CV health.
Methods: We conducted a systematic review of PubMed/MEDLINE, EMBASE, CINAHL, Web of Science and the Cochrane Library. We included studies of PP women, with an intervention involving digital or mobile health (wearable devices, telemedicine, or remote monitoring). We included studies that measured an outcome related to CV health.
Results: 110 full studies were reviewed for eligibility and 38 were included. Studies were categorized into 4 broad CV outcomes: blood pressure (BP), physical activity (PA), diet/weight loss and cardiometabolic markers. Digital health interventions included mobile applications, text-based coaching, interactive websites, virtual reality, wearable devices. The majority of remote BP monitoring programs ($N = 5$ studies) were successful in optimizing BP. 14 studies examined interventions aimed at improving PA levels of which 6/14 studies showed modest benefit at increasing PA. The majority of interventions aimed at weight loss ($N = 27$ studies) showed no significant benefit in terms of lowered caloric intake and/or weight loss up to 1 year PP. 6 studies examined improvements in cardiometabolic markers such as lipids and glucose levels, of which the majority showed no benefit.
Conclusion: The majority of studies we reviewed found that digital health interventions such as mobile health, telemonitoring and wearable devices were feasible and had mixed effectiveness in improving postpartum CV health in the postpartum period.

1. Background

Maternal mortality and severe maternal morbidity are rising in the United States, with significant disparities among racial/ethnic minorities [1,2]. Cardiovascular disease (CVD) accounts for much of this increase, with most maternal mortality occuring in the postpartum period (PP) [2–4]. Despite this, postpartum follow-up rates remain poor[5], with even lower rates observed among minorities and women with lower socioeconomic status [6]. Interventions in the postpartum period are critical to reducing maternal mortality and improving cardiovascular health [7,8].

Digital health interventions (DHI) may be of particular importance among postpartum women [9–11]. These are interventions that involve digital or mobile health, specifically including wearable devices, remote monitoring, telemedicine, single messaging service (SMS), text messages, website access, or smartphone applications.

DHI may improve cardiovascular outcomes in postpartum women and have been shown in previous work to increase physical activity and exercise participation among postpartum women [12,13]. DHI can also reduce racial/ethnic and socioeconomic disparities[14], and have been shown to have a positive impact on risk factors for CVD in general [15].

In this context, we performed a systematic scoping review of the DHI

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among postpartum women for the improvement of cardiovascular health outcomes. Cardiovascular health outcomes for this review are defined based on the American Heart Association's "Life's Essential 8″ construct [16] which includes changes to cardiovascular health behavior (weight loss, physical activity, diet, smoking, sleep) or cardiovascular markers (blood pressure, glucose levels).

2. Methods

2.1. Search strategy

This systematic review followed the The PRISMA 2020 statement: an updated guideline for reporting systematic reviews [17]. In consultation with authors and a medical librarian trained in systematic review methods, a search strategy of subject headings and keywords was developed. PubMed/Medline (Ovid), Embase, the Cochrane Library, the Cumulative Index to Nursing and Allied Health (CINAHL), Global Health (Ovid), APA PsycInfo and Web of Science were searched on 4/10/23 and updated again on 10/2/23. Citation tracking was conducted from included references. There were no language limits. Our full list of search terms are detailed in Appendix 1. Citations were uploaded to EndNote for data management.

For the purposes of this review we defined *digital health* as technology which uses digital data and remote communication to collect, share or analyze health information for patient care. [18] This includes studies which investigated any of the following interventions: telehealth, telemedicine, mobile health, mobile applications, remote patient monitoring, and wearable devices. [19] We defined a cardiovascular health outcomes using the American Health Association's construct "Life's Essential 8″ which includes blood pressure, smoking, exercise, cholesterol, diet, body mass index (BMI), diabetes screening (HbA1c) and sleep [16].

2.2. Data screening, assessment and extraction

Data was exported from EndNote to Covidence, a web-based systematic review management program. All data was screened by a minimum of two authors AH and MP, and a third author, DB, resolved all conflicts. All screened records that met the first round of inclusion criteria were transferred to Covidence, and two authors were assigned to assess and extract full text using inclusion and exclusion variables. We included original research with the following criteria: 1) postpartum study population, 2) digital health intervention, 3) cardiovascular health (CVH) outcome. Exclusion included 1) pregnant population, 2) abstract, 3) methods paper, 4) review, 5) did not include digital health intervention, 6) did not include a CVH outcome (Appendix 2).

2.3. Quality assessment

The quality of the included studies was assessed using the best available tool for the methodology of each study [20]. Randomized controlled trials were assessed using the Revised Cochrane Risk of Bias Tool for Randomized Trials (ROB 2.0), which assessed for the risk of bias in an estimate of the effect of an experimental intervention compared with a comparator on a particular outcome [21]. This tool specifically graded studies based on random sequence generation, allocation concealment, blinding of participants, blinding of study personnel, blinding of outcome assessors, intention-to-treat analysis, and selective reporting. Non-randomized interventional trials were assessed using the Joanna Briggs Institute critical appraisal tool for quasi-experimental studies, which assessed baseline group compositions, causality, the presence of a control group, reliability of outcome measurements, completion of follow up, and appropriate statistical analysis. [22] Finally, observational cohort studies were critically appraised using the Newcastle-Ottawa Scale [23]. This tool judges a study based on the selection of the study groups, the comparability of the groups, and the measurement of the outcome of interest.

One author (M.P.) appraised all the articles, while another (A.H.) independently appraised 13 % of randomly selected studies. Inter-rater agreement of 81 % was achieved. Discrepancies were resolved by consensus (M.P., A.H.)."

3. Results

3.1. Identification of relevant studies

Our initial search identified 4134 studies. After removal of 1307 duplicates, 2827 potential citations were found. Abstracts were screened after which 110 full studies were assessed for detailed evaluation of eligibility. Of these, 38 met inclusion/exclusion criteria and were included in the systematic review (Fig. 1). Data extraction for all the 38 studies included study population, follow-up period, digital health intervention used, cardiovascular outcome assessed and results.

3.2. Characteristics of included studies

Study characteristics of the 38 included studies are summarized in Table 1. The median sample size was 43 in the intervention arm and 48.5 in the control arm, median time postpartum was 9 months. A total of 28/38 studies were randomized controlled trials, of which 12/28 were feasibility studies. The digital health interventions used were variable and included remote blood pressure programs with telemonitoring, Bluetooth enabled scales, text-based surveillance and coaching, smartphone applications, interactive websites, teleconferencing, virtual reality, and wearables (FitBit, pedometer, accelerometer) (Fig. 2). Duration of interventions varied between 6 weeks-12 months. Three studies examined blood pressure only, 7 studies examined physical activity alone, 14 studies examined weight or diet alone and 0 studies examined cardiometabolic markers alone, 13 studies examined multiple cardiovascular health outcomes. Individual study results are summarized in Table 2.

3.3. Cardiovascular health outcomes

3.3.1. Blood pressure

Of the included studies, there were 5 that examined blood pressure interventions (4/5 were randomized controlled trials, 3/4 of which were pilot feasibility studies). Digital health interventions for these studies included remote blood pressure monitoring, text-based surveillance and coaching, smartphone applications, and telehealth services. [24–27]4/5 involved interventions aimed at women <6 months postpartum [24,25,27,28]. All studies showed that remote blood pressure monitoring with associated telehealth platforms resulted in improved self-management of blood pressure and modest reductions in blood pressure as compared to controls. In the only large RCT powered to detect differences in blood pressure between groups, Kitt et al. studied 220 postpartum patients immediately following HDP randomized to home BP self-monitoring with physician-optimized antihypertensive titration compared to usual care. [27] They found the 24-hour mean (SD) systolic and diastolic blood pressures were significantly lower in the intervention group vs control (between group difference in systolic BP −6.51 mmHg [95 % CI, −8.80 to −4.22; $P < .001$] and diastolic BP −5.8 mmHg [95 % CI, −7.40 to −4.20; $P < .001$]. Differences persisted up to 9 months postpartum.

3.3.2. Physical activity levels

Of the included studies, there were 14 that examined digital health interventions for optimization of postpartum physical activity levels. Of these, 11/14 were RCTs (6/11 were feasibility pilot studies). DHI included videoconferencing exercise groups, mobile apps, text-based coaching, telehealth counseling, and interactive websites. Wearable devices studied included accelerometers, pedometers, heart rate

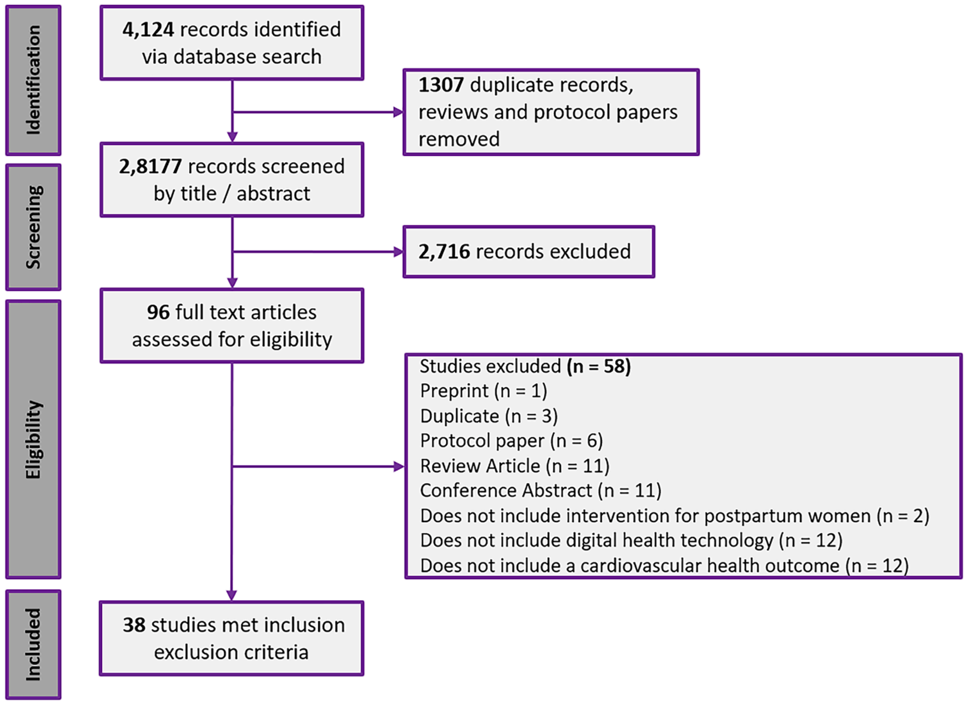

Fig. 1. PRISMA Study Flow Diagram.

monitors and FitBits. Duration of interventions ranged from 6 weeks-12 months, mean 4.41 +/- 2.98 months. 12 studies measured moderate to vigorous physical activity (MVPA) as an outcome, of which 6 used accelerometers and step count to measure MVPA and the remaining 6 studies used self report. 6/14 studies showed some improvement in physical activity levels including improvements in MVPA among baseline inactive mothers [29], increase in daily steps and days with step goal achieved [30], improved self reported (but not accelerometer-derived) MVPA when compared to contro[31–33]. Fjeldsoe et al. 2015 performed a 12-week RCT comparing an intervention consisting of an in-person PA goal setting consultation, followed by tailored SMS text messages, telephone-coaching, web-based resources and use of an accelerometer, which was compared to minimal contact controls (no SMS) [31]. There was a significant improvement in duration of MVPA (intervention effect of 48.5 [13.2, 82.9] mins/week) and frequency of MVPA (intervention effect of 1.6 [0.6,2.6] days/week) based on self-report but no difference in MVPA duration or frequency based on accelerometer data [31]. Two other studies which assessed MVPA both subjectively via questionnaires and objectively using accelerometers also found improvements in only subjective MVPA but not MVPA measured by accelerometer [32,33]. In the largest physical activity intervention trial, Bijholt et al. performed an RCT of a 6-month combined lifestyle intervention involving a smartphone application and in-person coaching paired with wearable activity monitors among 724 women at 6 weeks postpartum with excessive gestational weight gain (compared to 726 controls) [34]. They found no difference in physical activity and sedentary time among intervention vs control groups.

3.3.3. Diet/Weight loss

There were 27 studies that examined interventions aimed at improving diet quality, eating behaviors and/or weight loss. Of these 18 were RCTs, of which 7/18 were pilot feasibility studies. DHI for these studies included websites, mobile apps, text- and email- based coaching, telehealth counseling, and a virtual reality program. Monitoring devices included pedometers and home scales. Only 9/27 studies demonstrated any improvements in weight or dietary behavior among intervention participants. Successful interventions included a combination of education, with text-, phone- or in person- based coaching. In a weight loss focused intervention, Phelan et al. performed a cluster randomized trial comparing a web-based weight loss intervention combined with the "Special Supplemental Nutrition Program for Women, Infants, and Children (WIC program)" ($N = 174$) versus standard WIC controls ($N = 197$), for low-income women who were 6 weeks-12 months postpartum with elevated BMI or weight >4.5 kg above pre-pregnancy weight. [35] The intervention included standard WIC plus a web-based program with calorie and physical activity goals, education, weight and activity tracking and text-based coaching. They found a greater weight loss and greater proportion of participants who returned to preconception weight or below in the intervention group compared to controls over 12 months. There were no differences in physical activity or calorie intake between groups [35]. Chang et al. performed a community-based RCT that also targeted mothers enrolled in the WIC program who were >6 weeks postpartum with BMI 25–39.9 kg/m2, comparing a 16-week intervention of educational DVDs focused on stress management, healthy eating and physical activity combined with peer support group teleconferences ($N = 410$) to passive education controls ($N = 202$) [36]. They found no differences in weight loss after 3 months between intervention and control groups. Kim et al. performed a quasi-experimental study investigating the effects of a 12-week mobile virtual reality (VR) program for women immediately postpartum with gestational diabetes ($N = 57$) compared to passive education age- and birth-matched controls ($N = 64$). [37] The VR program included exercise training with virtual trainer, diet/nutrition program with feedback, neonatal first aid and laughter therapy. They found significant reductions in body weight, body fat, fasting glucose and HbA1c and improvements in dietary habits in the experimental group compared to controls. [37]

3.3.4. Cardiometabolic markers

There were 6 studies that examined intervention effects on cardiometabolic markers including cholesterol and glucose. Of these, 4/6 were RCTs (1 pilot feasibility study). DHI for these studies included interactive and educational websites, e-mail lifestyle education, text-based coaching, VR, and wearables such as pedometer and heart rate

Table 1
Baseline Study Characteristics:

Author (year), country	Study Design	Population	Exclusion	Control Condition	Digital Health Intervention (DHI)	Cardiovascular Health Outcome (CVO)	Study Sample Groups: n	Duration of intervention	Follow-up Time after Intervention
Albright et al. (2014), United States	Randomized controlled trial	Women with < 30 min/week of MVPA, BMI between 18.5–40, and an infant aged 2 months – 12 months		Website with standard physical activity resources	Website with tailored physical activity resources, telephone coaching, pedometer	MVPA	I: 154 ; C: 157	12 months	N/A
Bijlholt et al. (2021), Belgium	Randomized controlled trial	Women aged >=18 years, 6 weeks postpartum from singleton pregnancy with gestational weight gain	Pre-pregnancy underweight	Treatment as usual	Smartphone application, in-person coaching	Eating behaviors, physical activity (MET-mins/week)	I: 724 ; C: 726	6 months	12 months
Cairns et al. (2018), England	Pilot randomized controlled trial, feasibility study	Women <6 months postpartum with HDP	>3 anti-HTN medications, cHTN	Community midwife BP monitoring and general practitioner medication titration	Home BP monitor and smartphone app with remote medication titration	Blood pressure	I: 45, C: 46	Daily monitoring until 5 consecutive days off anti-HTN treatment, then weekly until 6 months	6 months
Chang et al. (2017), United States	Randomized controlled trial	Women with BMI 25–39.9, enrolled in WIC, and 6 weeks – 4.5 years postpartum	DM	Printed materials and 10-minute DVD containing information about food and home safety	Lifestyle DVD intervention videos and peer support group teleconferences	Weight	I: 410 ; C: 202	16 weeks	3 months
Davenport et al. (2011), Canada	Randomized controlled trial	Overweight women with BMI >= 25 or >5 kg from pre-pregnancy weight who were 7–9 weeks postpartum		Twenty age, BMI, and parity matched sedentary controls within 6 months postpartum were given pedometers and literature about healthy eating	Weekly in-person exercise, exercise prescription with pedometer and HR monitor	Weight, glucose, LDL-C, adiponectin	I_mod (70 % HRR): 20 ; I_low (30 % HRR): 20 ; C: 20	16 weeks	N/A
Fjeldsoe et al. (2010), Australia	Randomized controlled trial, pilot feasibility study	Women < 5 days/ week of 30 min MVPA and < 12 months postpartum		Initial face-to-face consultation followed by reminder phone calls to confirm 6-week and 13-week assessments	Text-based coaching (3–5 texts per week)	MVPA	I: 45 ; C: 43	12 weeks	N/A
Fjeldsoe et al. (2015), Australia	Randomized controlled trial, feasibility study	Women with at least 1 child between 6 w and 5y old		Minimal contact (no personalized text messages or contact with counselor)	Text-based and telephone coaching, pedometer	MVPA	I: 133 ; C: 130	13 weeks	6 months
Gilmore et al. (2017), United States	Randomized controlled trial, pilot feasibility study	Women >=18 years with BMI 25–40 and 6 – 8 weeks postpartum from singleton pregnancy who were certified for WIC		WIC standard care	WIC standard care and smartphone app	Weight	I: 20 ; C: 20	16 weeks	N/A
Hauspurg et al. (2023), United States	Pilot randomized controlled trial, feasibility study	Women > 6 weeks and <6 months postpartum with HDP and pre-pregnancy BMI >= 25	cHTN ; DM	Heart Health 4 New Moms (HH4NM) control website with generic lifestyle recommendations to prevent CVD	1) HBPM: HH4NM control website and remote BP monitor with daily remote BP monitoring for one week per month with text reminders ; 2) Combined: Above plus electronic scale and HH4NM lifestyle program website with modules on healthy diet and	Blood pressure, weight change, BMI	I (HBPM alone): 49 ; I (HBPM + HH4NM): 51 ; C: 48	6 months	N/A

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Table 1 (*continued*)

Author (year), country	Study Design	Population	Exclusion	Control Condition	Digital Health Intervention (DHI)	Cardiovascular Health Outcome (CVO)	Study Sample Groups: n	Duration of intervention	Follow-up Time after Intervention
					physical activity and online coaching				
Herring et al. (2014), United States	Randomized controlled trial, pilot feasibility trial	Women aged >=18 years postpartum from singleton delivery in last 2 weeks to 12 months with early pregnancy BMI >= 25, with at least 5 kg increase of weight during pregnancy	Tobacco use	Standard of care offered to postpartum mothers from their primary care providers (e.g. one visit 6–8 weeks postpartum)	Telephone- and text-based coaching, Facebook self-monitoring, scale, and pedometer	Weight	I: 9 ; C: 9	14 weeks	N/A
Herring et al. (2017), United States	Randomized controlled trial, pilot efficacy study	African American women >=18 years with BMI 25–45 on Medicaid who were 10 weeks postpartum		Usual care	Text- and telephone- based coaching, educational Facebook posts	Weight	I: 33 ; C: 33	6 months	12 months
Holmes et al. (2018), United Kingdom	Randomized controlled trial	Overweight women with BMI >= 25 who were 4–6 weeks postpartum from a pregnancy with GDM	DM outside of pregnancy ; Heart, liver, kidney disease	Treatment as usual with an educational DVD	In-person educational session, membership to community weight management organization, text- and phone-based coaching	Weight, glucose	I: 29 ; C: 31	6 months	N/A
Horn et al. (2023), Norway	Nonrandomized pilot study, pilot feasibility study	Women >=18 years with PEC or GDM and were 3 months – 12 months postpartum	cHTN ; DM ; Hypercholesterolemia	N/A	Phone counseling with dietician, educational website	Physical activity, Weight, HbA1c, total cholesterol, LDL, HDL, triglycerides	PEC: 20 ; GDM: 25	6 months	N/A
Horwitz et al. (2023), United States	Randomized controlled trial	Women aged 18–39 years with recent GDM diagnosis or BMI >=25 who were >32 weeks pregnant		Standard educational materials through usual care providers and WIC offices	Telephone-based coaching	MVPA, Weight	I: 90 ; C: 91	Started immediately postpartum, lasted 5 months	
Hutchesson et al. (2020), Australia	Pilot randomized controlled trial, feasibility study	Women aged 18–45 years with PEC in last 4 years	DM	Email with links to the National Heart Foundation of Australia website	Cardiovascular health promoting lifestyle behavior intervention delivered via website and email	Blood Pressure, weight, waist circumference, BMI, cholesterol panel, glucose, insulin	I: 16 ; C: 15	3 months	N/A
Kernot et al. (2019), Australia	Randomized controlled trial	Women up to 12 months postpartum		1) Pedometer and printed logbook only ; 2) Written advice (via email) on increasing physical activity	Facebook application, automated emails, pedometer	MVPA, BMI	I: 41 ; C1: 39 ; C2: 40	6 weeks	6 months
Kim et al. (2012), United States	Randomized controlled trial, pilot feasibility study	Women >=18 years with GDM in pregnancy within past 3 years, at least 6 weeks postpartum, and < 150 min/week of PA	DM	Mailings with information regarding GDM and diabetes risk and recommendations regarding lifestyle modification.	Interactive website, pedometer	Weight	I: 21 ; C: 28	13 weeks	N/A
Kim et al. (2021), South Korea	Non-randomized interventional trial	Women >20 years who delivered after GDM	Auditory, visual, active disabilities inhibiting use of VR	Age, birth experience, birth type, family history of DM, and breastfeeding matched controls.	Mobile VR program consisting of exercise, diet/nutrition, laughter therapy, and neonatal first aid	Weight, A1c, fasting glucose	I: 64 ; C: 64	12 weeks	N/A

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Table 1 (*continued*)

Author (year), country	Study Design	Population	Exclusion	Control Condition	Digital Health Intervention (DHI)	Cardiovascular Health Outcome (CVO)	Study Sample Groups: n	Duration of intervention	Follow-up Time after Intervention
				Provided with written educational materials on GDM					
Kitt et al. (2021), United Kingdom	Observational study	Women £ 6 months postpartum with HDP recontacted from original SNAP-HT trial (Cairns 2018)	>3 anti-HTN medications , cHTN requiring medications	Community midwife BP monitoring and general practitioner medication titration	Home BP monitor and smartphone app with remote medication titration	Blood Pressure	I: 30 ; C: 31	Daily monitoring until 5 consecutive days off anti-HTN treatment, then weekly until 6 months	3.6 ± 0.4 years
Kitt et al. (2023), United Kingdom	Randomized controlled trial	Women 18 years < 6 days postpartum following HDP requiring anti-HTN when discharged	cHTN ; Severe postpartum depression or anxiety	Usual postnatal care involving BP review 7–10 days postpartum with midwife and 6–8 weeks postpartum with GP	BP self-monitoring with validated wireless, Bluetooth cuff, and physician-optimized antihypertensive titration	Blood Pressure	I: 112 ;C: 108	9 months	N/A
Lewey et al. (2022), United States	Randomized controlled trial	Women 4 – 16 weeks postpartum diagnosed with an HDP at time of delivery		Wearable device and daily automated text messages	FitBit, text-based team gamification intervention	Step Count	I: 63 ; C: 64	12 weeks	N/A
Lim et al. (2021), Singapore	Randomized controlled trial	Postpartum women aged >= 21 years diagnosed with GDM antenatally	Pre-existing type 1 diabetes mellitus or T2DM ; Delivered before 36 weeks	Treatment as usual with follow-up appointment at 6 weeks	App platform with web-interactions with providers, goal logs, food diary, step counting, videos	Weight, caloric intake	I: 101 ; C: 99	4 months	N/A
Lohr et al. (2023), United States	Secondary analysis of prospective non-randomized controlled trial (Hoppe et al. 2020)	Women immediately following a pregnancy complicated by an HDP		Usual care involving clinic visits at 10 days and 6 weeks postpartum	Remote BP monitoring and Bluetooth-enabled digital scale	Weight	I: 214 ; C: 214	6 weeks	N/A
Mascarenhas et al. (2018), United States	Randomized controlled trial	Women aged 18–60 years with a child < 12 years old		Those on the waitlist for the intervention	Mobile app-based exercises, video exercise group	MVPA	I: 29 ; C: 32	8 weeks	N/A
McGirr et al. (2020), Northern Ireland	Randomized controlled trial	Women >=18 years with BMI >=25 who were 6 weeks – 2 years postpartum		Automated SMS messages about child health and development.	Text-based coaching	Weight	I: 51 ; C: 49	12 months	N/A
Napolitano et al. (2021), United States	Randomized controlled trial, feasibility study	African American women aged 18–40 years with BMI 25–40, who were within 3 days of delivery	Current/planned use of weight loss medications or other structured weight loss strategies	Treatment as usual with information regarding healthy practices postpartum	Mobile app with education and tracking, private Facebook group	MVPA, Weight, dietary behavior	I: 65 ; C: 71	12 weeks	N/A
Nicklas et al. (2014/ 2019), United States	Randomized controlled trial	Women aged 18–45 years with BMI 24–50 who had GDM in most recent pregnancy and were at least 6 weeks postpartum	T2DM, bariatric surgery, weight loss medications	National Diabetes Education Program handout for women with prior GDM called "It's Never Too Early to Prevent Diabetes."	Interactive website with videos, communication with lifestyle coach, and goal tracking	Weight, A1c, glucose, adiponectin, LDL, HDL, triglycerides, hsCRP, and IL-6	I: 36 ; C: 39	12 months	N/A
Phelan et al. (2017), United States	Randomized controlled trial	Women aged 18–40 years with BMI 25–40 or 22–24.9 but exceeding pre-pregnancy weight but at least 4.5 kg who		Standard WIC program and newsletters every 2 months	Standard WIC program plus web-based weight loss program and weekly text messages.	Weight, diet	I: 174 ; C: 197	12 months	N/A

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Table 1 (*continued*)

Author (year), country	Study Design	Population	Exclusion	Control Condition	Digital Health Intervention (DHI)	Cardiovascular Health Outcome (CVO)	Study Sample Groups: n	Duration of intervention	Follow-up Time after Intervention
		were 6 weeks to 12 months postpartum recruited at WIC clinics							
Rich-Edwards et al. (2019), United States	Randomized controlled trial	Women aged 18–45 years with PEC in last 5 years and BMI 18.5–40	cHTN ; DM	Internet links to publicly available CVD risk reduction information on the Heart Health 4 Moms (HH4M) control website.	Website and telephone- and email-based lifestyle coaching from dietitian	Weight, diet	I: 76 ; C: 75	9 months	N/A
Seely et al. (2020), United States	Pilot feasibility pre-post study	Hispanic women aged 18–45 years with GDM in the past 5 years and getting care at FQHC in Boston		N/A	Mobile app, text-based coaching, weight tracking, virtual rewards	Weight	I: 21	8 weeks	N/A
Silfee et al. (2018), United States	Iterative single-group pilot feasibility studies	Women 18 years with BMI >=27 who were 6 weeks – 6 months postpartum and WIC recipients		N/A	Facebook group with informational posts and communication with leaders, mobile app to track diet, physical activity, and weight.	Weight	Pilot 1: 27 ; Pilot 2: 24 ; Pilot 3: 16	16 weeks	N/A
Teychenne et al. (2021),	Randomized controlled trial, pilot feasibility trial	Women aged 18 years who had < 150 min/ week of MVPA and were 3–9 months postpartum	On anti-depressant medication	Usual Care	Home exercise equipment, web-app access	MVPA	I: 32 ; C: 30	12 weeks	N/A
Tinius et al. (2022), United States	Randomized controlled trial, pilot feasibility trial	Women aged 18–44 years who were pregnant with singleton fetus or up to 12 weeks postpartum from delivering a singleton pregnancy	Multiple gestation pregnancy	Educational brochure	Mobile app with physical activity, calorie, weight, and symptom tracking and exercise videos	MVPA	I: 17 ; C: 18	Starts 23–25 weeks pregnant and ends 12 weeks postpartum	N/A
van der Pligt et al. (2018), Australia	Non-randomized controlled trial, pilot intervention	First time mothers aged >= 18 years and < 12 months postpartum	Non-singleton pregnancy	C1: Treatment as usual in Australia ; C2: Group sessions, delivered quarterly by a Dietitian	Access to an online behavior therapy website, mobile application, dietitian telephone calls, pedometer	MVPA, postpartum weight retention (PPWR), and waist circumference	I: 28 ; C1: 48 ; C2: 43	9 months	N/A
Vincze et al. (2018), Australia	Single-arm feasibility trial	Women 3 –12 months postpartum with BMI > 25 or > 2 kg above pre-pregnancy weight		N/A	Video conferencing with a dietician and exercise physiologist	MVPA, VO2max, weight, waist circumference,% dietary energy from noncore foods	I: 30	8 weeks	N/A
Waring et al. (2018), United States	Pilot feasibility study	Women 18 years 6 weeks – 12 months postpartum with BMI 25		N/A	Facebook lifestyle education and community building intervention	Weight	I: 19	12 weeks	N/A
Waring et al. (2023), United States	Randomized controlled trial, pilot feasibility study	Women >=18 years 8 weeks – 12 months postpartum with BMI ^{3}25	DM	In person Diabetes Prevention Program lifestyle intervention. Counselors conducted groups in person.	Facebook lifestyle education and community building intervention.	Weight	I: 30 ; C: 32	6 months	12 months

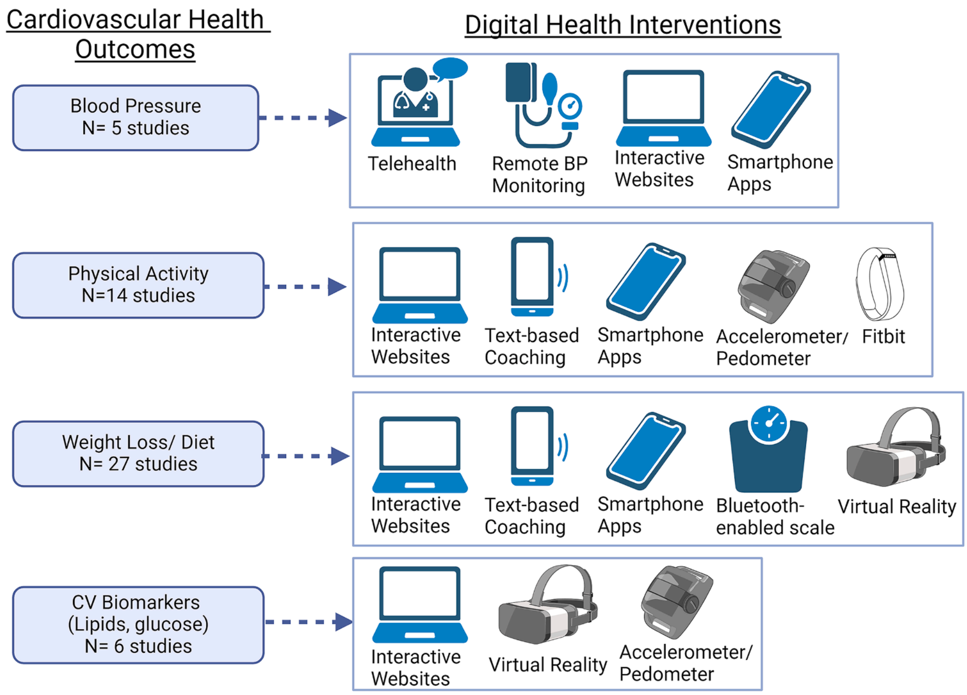

Fig. 2. Digital health interventions used in studies categorized by cardiovascular health outcomes.

monitor. Of these, two studies showed modest improvement in cardiometabolic markers. Davenport et al. performed a nutrition plus low and moderate intensity exercise intervention combined with pedometer and HR monitor compared to controls over 16 weeks starting at 7–9 weeks postpartum [38]. They demonstrated mild reductions in low-density lipoprotein and glucose concentrations in the exercise groups compared to controls. Nicklas et al. performed a 12-month web-based lifestyle intervention consisting of videos, communication with lifestyle coach, and goal tracking as compared to controls without access to the program among women with prior gestational diabetes. They found no difference in HbA1c, fasting glucose, fasting insulin, adiponectin, LDL, HDL, triglycerides, hsCRP, or IL-6 between intervention and control participants. [39,40]

3.3.5. Discussion

To our knowledge, this is the first systematic scoping review focused on digital health interventions aimed at improving cardiovascular health among postpartum women. In particular, we are the first to use the novel construct of the AHA "Life's Essential 8″ to categorize cardiovascular health outcomes. This review demonstrates the wide scope of digital health technologies that have been used to study cardiovascular health outcomes among postpartum women. A total of 38 relevant studies were included. Nearly half of these studies (17/38) were small, pilot feasibility studies limiting conclusions regarding efficacy. These studies included various digital health-enabled interventions including telemedicine, remote blood pressure monitoring, text-based coaching, mobile applications, web-based platforms, wearable devices. Cardiovascular health outcomes assessed by these studies included blood pressure, physical activity, weight/diet and cardiometabolic markers. Overall, DHI including remote blood pressure monitoring with remote medication titration resulted in improvements in blood pressure. DHI interventions targeting physical activity, weight and diet demonstrated overall low to modest efficacy. DHI resulting in more frequent contact and more personalization (such as text-based coaching) may result in great efficacy of intervention. The majority of interventions with extended follow up showed no durability in effect. No studies demonstrated a meaningful improvement in cardiometabolic markers such as glucose or lipids after DHI intervention.

This review illustrates the diversity of modalities and potential benefits of the use of DHI for the improvement of postpartum cardiovascular health. Importantly, the majority of studies suggest that it is feasible to engage individuals who are early (within weeks) postpartum in behavioral and lifestyle interventions. This is likely a critical period for intervention and cardiovascular prevention, particularly after pregnancies complicated by adverse outcomes such as hypertensive disorders of pregnancy. This review highlights that the accessibility and scalability of DHI is promising, particularly in this population with multiple barriers to access to in-person care and adoption of healthy lifestyle habits. The majority of interventions incorporated behavior change techniques such as goal setting, self-monitoring and feedback. However, there are multiple challenges to the implementation of DHI in this population that should be considered such as financial costs, disparities in relation to access to wireless and internet connectivity and technological savviness.

Prior reviews of digital health interventions in the postpartum period have found benefits in other outcomes including breastfeeding success [41] and postpartum depression and anxiety[42]. Qualitative studies examining perceptions of postpartum digital health interventions for lifestyle modification suggest that women find DHI to be an acceptable way of delivering lifestyle interventions, and that behavior change strategies could be effectively delivered via DHI platforms [43]. Few studies focus on effectiveness of DHI for postpartum cardiovascular health among racial and ethnic minority women who are most vulnerable to poor follow up and adverse outcomes after birth. For example, Hirshberg et al. found that remote BP monitoring reduced disparities in postpartum BP monitoring. [44] Phelan et al. reported on effects of a weight loss intervention among low-income women who are postpartum.[67] Future studies should focus on these vulnerable populations who may benefit from the potential for DHI to help improve cardiovascular health.

4. Strengths and limitations

This systematic review was conducted using a comprehensive and robust search strategy. Due to the variable quality, small sample sizes and diverse nature of the included studies, it is challenging to draw

Table 2
Overall Study Results:.

Author (year)	Control Condition	Digital Health Intervention (DHI)	Study Sample Groups: n	Cardiovascular Health Outcome	Results
Blood Pressure (BP)					
Cairns (2018)	Usual care	Home BP monitor and smartphone app with remote medication titration	I: 45 C: 46	Blood pressure at 6 months after enrollment	BP significantly lower in interventiongroup than controlgroup at 6 weeks with diastolic reduction persistent to 6 months.
Hauspurg (2023)	Heart Health 4 New Moms (HH4NM) control website with generic lifestyle recommendations to prevent CVD	1) HBPM: HH4NM control website and remote BP monitor with daily remote BP monitoring for one week per month with text reminders 2) Combined: Above plus electronic scale and HH4NM lifestyle program website with modules on healthy diet and physical activity and online coaching	I (HBPM alone): 49 I (HBPM + HH4NM): 51 C: 48	Blood pressure at 6 months after enrollment	Combined intervention group had non-significant decrease in BP at 6 months compared to the HBPM-only and control groups.
Hutchesson (2020)	Email with links to the National Heart Foundation of Australia website	Cardiovascular health promoting lifestyle behavior intervention delivered via website and email	I: 16 C: 15	Blood pressure at 3 months after enrollment	No significant difference in blood pressure from enrollment to follow up between groups.
Kitt (2021)	Community midwife BP monitoring and general practitioner medication titration	Home BP monitor and smartphone app with remote medication titration	I: 30 C: 31	Blood pressure at 3.6 ± 0.4 years postpartum measured by 24-hour ambulatory and at clinic visit	Women who had received a short period of postpartum BP self-management had persistently lower diastolic BP at follow-up.
Kitt (2023)	Usual postnatal care involving BP review 7–10 days postpartum with midwife and 6–8 weeks postpartum with GP	BP self-monitoring and physician-optimized antihypertensive titration	I: 112 C: 108	24-hour mean diastolic BP at 9 months postpartum, adjusted or baseline postnatal BP	Intervention group had significantly lower systolic and diastolic blood pressure than the control group.
Physical Activity					
Van der Pligt (2018)	C1: Treatment as usual in Australia C2: Group sessions, delivered quarterly by a Dietitian	Access to an online behavior therapy website, mobile application, dietitian telephone calls, pedometer	I: 28 C1: 48 C2: 43	Self-reported MVPA mins/week at 9 months after enrollment.	No significant difference in MVPA between groups
Horn (2023)	N/A	Phone counseling with dietician, educational website	PEC: 20 GDM: 25	Self-reported MVPA (min/day) and accelerometer-derived physical behaviors (min/day) at 6 months after enrollment	No significant changes in self-reported physical activity throughout the study. Significant reduction, among all study completers regardless of PEC or GDM, in accelerometer-derived moderate intensity activity and total steps per day, but not in low or vigorous intensity activity.
Mascarenhas (2018)	Those on the waitlist for the intervention	Mobile app-based exercises, video exercise group	I: 29 C: 32	Self-reported MVPA minutes per week at 8 weeks after enrollment	No significant difference in change in MVPA between intervention and control groups. Among inactive mothers, MVPA increased significantly more in intervention than control group.
Fjeldsoe (2010)	Initial face-to-face consultation followed by reminder phone calls to confirm 6-week and 13-week assessments	Text-based coaching (3–5 texts per week)	I: 45 C: 43	Self-reported days/week of at least 30 min MVPA and min/week of walking for exercise at 12 weeks after enrollment	Walking for exercise and MVPA frequency (days/week) increased more over time in the intervention than in the control group, but not total duration (mins/week)
Fjeldsoe (2015)	Minimal contact (no personalized text messages or contact with counselor)	Text-based and telephone coaching, pedometer	I: 133 C: 130	Self-reported and accelerometer-derived MVPA and brisk walking duration (min/week) and frequency (days/week) at 13 weeks and 6 months after enrollment	Self-reported MVPA duration and frequency significantly increased at 13 weeks, and non-significantly increased at 6 months. Accelerometer-derived MVPA duration not different at either timepoint
Albright (2014)	Website with standard physical activity resources	Website with tailored physical activity resources, telephone coaching, pedometer	I: 154 C: 157	Self-reported and accelerometer-derived duration of MVPA (min/week) at 12 months after enrollment	Self-reported, but not accelerometer-derived, MVPA duration increased significantly more in the intervention group than the control group, and both self-reported and accelerometer-derived MVPA increased in both groups from baseline to follow-up
Lewey (2022)	Wearable device and daily automated text messages	FitBit, text-based team gamification intervention	I: 63 C: 64	Mean daily steps and proportion of days meeting	Intervention group had greater increase in mean daily steps and

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Table 2 (*continued*)

Author (year)	Control Condition	Digital Health Intervention (DHI)	Study Sample Groups: n	Cardiovascular Health Outcome	Results
				step goal from baseline to 12 weeks, measured by a FitBit	days with step goals achieved at 12 weeks than the control group
Bijlholt (2021)	Treatment as usual	Smartphone application, in-person coaching	I: 724 C: 726	Self-reported physical activity (MET-minutes), sedentary behavior at 6 months (end of intervention) and 12 months postpartum	No significant difference in physical activity or sedentary behavior at end of intervention or subsequent follow-up.
Vincze (2018)	N/A	Video conferencing with a dietician and exercise physiologist	I: 30	MVPA (min/week) determined by in-person assessment, HR monitor, and surveys, also VO2max, all at 8 weeks after enrollment	No significant increase in MVPA, but significant increase in VO2max
Tinius (2022)	Educational brochure	Mobile app with physical activity, calorie, weight, and symptom tracking and exercise videos	I: 17 C: 18	MVPA measured by actigraph accelerometer (% of time in MVPA) at 12 weeks postpartum	No significant difference in percent of time MVPA between the intervention and control groups
Teychenne (2021)	Usual Care	Home exercise equipment, web-app access	I: 32 C: 30	Self-reported physical activity (min/week) and accelerometry-based MVPA (min/week) at 12 weeks after enrollment	Significantly more self-reported physical activity at 4 weeks among intervention group compared to control, not sustained at 12 weeks. More time in MVPA per actigraph at 12 weeks in control group vs intervention
Horwitz (2023)	Standard educational materials through usual care providers and WIC offices	Telephone-based coaching	I: 90 C: 91	Self-reported MVPA (min/week) via survey and chart review at 9–12 months postpartum	No significant difference in MVPA between control and intervention groups.
Napolitano (2021)	Treatment as usual with information regarding healthy practices postpartum	Culturally specific, branded BeFAB app with education and tracking, integrated with a private Facebook group	I: 65 C: 71	Self-reported MVPA (min/week) and vigorous PA (min/week) at 12 weeks after enrollment	Increase in min/week of MVPA and vigorous PA among the intervention and control participants but no difference between groups
Kernot (2019)	1) Pedometer and printed logbook only 2) Written advice (via email) on increasing physical activity	Facebook application, automated emails, pedometer	I: 41 C1: 39 C2: 40	Accelerometer derived MVPA and self-reported physical activity at 6 weeks and 6 months after enrollment	All 3 conditions had significant increases in MVPA from baseline (at 6 weeks and 6 months). No between group differences.
Weight/ diet					
Phelan (2017)	Standard WIC program and newsletters every 2 months	Standard WIC program plus web-based weight loss program and weekly text messages.	I: 174 C: 197	Weight change and caloric intake over 12 months, proportion of patients returning to preconception weight	Greater weight loss in intervention group than control group. Higher return to preconception weight in intervention group than controls. No significant between group difference in calorie intake at 6 or 12 months.
Kernot (2019)	1) Pedometer and printed logbook only 2) Written advice (via email) on increasing physical activity	Facebook application, automated emails, pedometer	I: 41 C1: 39 C2: 40	BMI at 6 weeks and 6 months after enrollment	No significant difference in BMI between the three groups.
Napolitano (2021)	Treatment as usual with information regarding healthy practices postpartum	Mobile app with education and tracking, private Facebook group	I: 65 C: 71	Weight, dietary behavior (fruits and vegetable servings per day and fast-food consumption per week)	No difference in weight loss or diet quality between intervention and control groups.
Horwitz (2023)	Standard educational materials through usual care providers and WIC offices	Telephone-based coaching	I: 90 C: 91	Postpartum weight change at 9–12 months postpartum	There was no difference in weight loss from baseline to follow up between the intervention and control groups.
Vincze (2018)	N/A	Video conferencing with a dietician and exercise physiologist	I: 30	Waist circumference, weight loss% energy from noncore foods at 8 weeks after enrollment	No significant mean weight change. Mean waist circumference significantly decreased. Reduction in dietary% energy form noncore foods.
Van der Pligt (2018)	C1: Treatment as usual in Australia C2: Group sessions, delivered quarterly by a Dietitian	Access to an online behavior therapy website, mobile application, dietitian telephone calls, pedometer	I: 28 C1: 48 C2: 43	PPWR and waist circumference at 9 months after enrollment	No significant difference in PPWR. Intervention group had significant reduction in waist circumference at follow-up compared to controls.
Hutchesson (2020)	Email with links to the National Heart Foundation of Australia website	Cardiovascular health promoting lifestyle behavior intervention delivered via website and email	I: 16 C: 15	Weight, BMI, waist circumference at 3 months after enrollment	Mean weight change, BMI, and waist circumference were not significantly different between intervention and control.
Hauspurg (2023)	Heart Health 4 New Moms (HH4NM) control website with generic lifestyle recommendations to prevent CVD	1) HBPM: HH4NM control website and remote BP monitor with daily remote BP monitoring for one week per month with text reminders	I (HBPM alone): 49 I (HBPM + HH4NM):	Change in weight, BMI at 6 months after enrollment	No statistical differences in weight change orBMI, at 6 month follow-up visit between study arms.

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Table 2 (*continued*)

Author (year)	Control Condition	Digital Health Intervention (DHI)	Study Sample Groups: n	Cardiovascular Health Outcome	Results
		2) Combined: Above plus electronic scale and HH4NM lifestyle program website with modules on healthy diet and physical activity and online coaching	51 C: 48		
Lim (2021)	Treatment as usual with follow-up appointment at 6 weeks	App platform with web-interactions with providers, goal logs, food diary, step counting, videos	I: 101 C: 99	Proportion reaching 1st trimester weight (BMI <23) or 5 % weight loss (BMI >23), absolute weight loss, and caloric intake at 4 months postpartum	No significant difference in achieving optimal weight or in weight reduction between the two groups. Intervention group had significantly reduced caloric intake and higher health-directed behavior scores.
Holmes (2018)	Treatment as usual with an educational DVD	In-person educational session, membership to community weight management organization, text- and phone- based coaching	I: 29 C: 31	Weight loss and waist circumference at 6 months after enrollment	Significantly more weight loss and decrease in waist circumference in intervention group vs control group.
Davenport (2011)	Twenty age, BMI, and parity matched sedentary controls within 6 months postpartum were given pedometers and literature about healthy eating	Weekly in-person exercise, exercise prescription with pedometer and HR monitor	I_mod (70 % HRR): 20 I_low (30 % HRR): 20 C: 20	Weight and waist circumference at 16 weeks after enrollment	The exercise groups both significantly and similarly reduced body mass, waist circumference.
Chang (2017)	Printed materials and 10-minute DVD containing information about food and home safety	Lifestyle DVD intervention videos and peer support group teleconferences	I: 410 C: 202	Body weight at end of 16-week intervention and at subsequent 3 month follow up	There were no significant weight differences between the intervention and comparison groups, at 16-weeks or at 3 months follow up.
Herring (2014)	Standard of care offered to postpartum mothers from their primary care providers (e.g. one visit 6–8 weeks postpartum)	Telephone- and text-based coaching, Facebook self-monitoring, scale, and pedometer	I: 9 C: 9	Change in body weight at 14 weeks from baseline	Greater weight loss in intervention group compared to controls, which was primarily mediated by diet and not activity.
Kim (2021)	Age, birth experience, birth type, family history of DM, and breastfeeding matched controls. Provided with written educational materials on GDM.	Mobile VR program consisting of exercise, diet/nutrition, laughter therapy, and neonatal first aid.	I: 64 C: 64	Body weight, body fat, and self-reported dietary habits at 12 weeks after enrollment	Significantly greater weight loss, body fat reduction, and dietary improvement in the intervention group than the control group.
Lohr (2023)	Usual care involving clinic visits at 10 days and 6 weeks postpartum	Remote BP monitoring and Bluetooth-enabled digital scale	I: 214 C: 214	Change in weight at 6 weeks from baseline	No difference in weight loss between the intervention and control groups.
Nicklas et al. (2014/2019)	National Diabetes Education Program handout for women with prior GDM called "It's Never Too Early to Prevent Diabetes."	Interactive website with videos, communication with lifestyle coach, and goal tracking	I: 36 C: 39	Change in weight, BMI, waist circumference at 6 months and 12 months postpartum	Higher return to pre-pregnancy weight and weight loss in intervention group compared to controls
Silfee (2018)	N/A	DPP Fresh Start intervention was adapted for Facebook. A Facebook group with informational posts and communication with leaders was created. Participants utilized an app to track diet, physical activity, and weight.	Pilot 1: 27 Pilot 2: 24 Pilot 3: 16	Change in weight at 16 weeks after enrollment	Weight loss across all groups.
McGirr (2020)	Automated SMS messages about child health and development.	Text-based coaching	I: 51 C: 49	Change in weight and waist circumference at 12 months after enrollment	No difference in weight loss and waist circumference change between intervention and control groups.
Herring (2017)	Usual care	Text- and telephone- based coaching, educational Facebook posts	I: 33 C: 33	Return to early pregnancy weights at 6 months and 12 months after enrollment	Intervention group significantly more likely to be at or below early pregnancy weights compared to usual care at 6 months, but no differences between groups at 12 months.
Gilmore (2017)	WIC standard care	WIC standard care and smartphone app	I: 20 C: 20	Weight change at 16 weeks after enrollment	No significant difference in body weight change between the groups.
Horn (2023)	N/A	Phone counseling with dietician, educational website	PEC: 20 GDM: 25	Weight change and diet quality at 6 months after enrollment	BMI, waist circumference, hip circumference, and visceral fat area decreased significantly among all study completers (including both groups). No significant change in diet quality.
Kim (2012)	Mailings with information regarding GDM and diabetes risk and recommendations	Interactive website, pedometer	I: 21 C: 28	Weight change at 13 weeks after enrollment	No changes in weight between intervention and control groups.

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Table 2 (*continued*)

Author (year)	Control Condition	Digital Health Intervention (DHI)	Study Sample Groups: n	Cardiovascular Health Outcome	Results
	regarding lifestyle modification.				
Rich-Edwards (2019)	Internet links to publicly available CVD risk reduction information on the Heart Health 4 Moms (HH4M) control website.	Website and telephone- and email-based lifestyle coaching from dietitian	I: 76 C: 75	Weight change and DASH diet score at 9 months after enrollment	No changes in weight or diet between intervention and control groups
Waring (2023)	In person Diabetes Prevention Program lifestyle intervention. Counselors conducted groups in person.	Facebook lifestyle education and community building intervention	I: 30 C: 32	Percent weight change at 6 months after enrollment and at 12 months follow-up	No changes in weight between intervention and control groups
Seely (2020)	N/A	Mobile app, text-based coaching, weight tracking, virtual rewards	I: 21	Weight change at 8 weeks after enrollment	Non-significant decrease in weight
Waring (2018)	N/A	Facebook lifestyle education and community building intervention	I: 19	Weight loss at 12 weeks after enrollment	Most women lost weight, there was no commentary on significance of the weight loss.
Bijlholt (2021)	Treatment as usual	Smartphone application, in-person coaching	I: 724 C: 726	Calorie intake, eating behaviors and total energy intake at 6 months (end of intervention) and 12 months postpartum	Intervention group had significantly more reduction in overall energy intake. Impact was lost at follow-up.
Cardiometabolic Risk Factors					
Holmes (2018)	Treatment as usual with an educational DVD	In-person educational session, membership to community weight management organization, text- and phone- based coaching	I: 29 C: 31	Fasting glucose levels at 6 months after enrollment	No difference in change in fasting glucose between the groups
Davenport (2011)	Twenty age, BMI, and parity matched sedentary controls within 6 months postpartum were given pedometers and literature about healthy eating	Weekly in-person exercise, exercise prescription with pedometer and HR monitor	I_mod (70 % HRR): 20 I_low (30 % HRR): 20 C: 20	Cholesterol, fasting glucose, adiponectin	The exercise groups both significantly reduced, glucose, LDL-C, and increased adiponectin concentrations, no difference between groups.
Hutchesson (2020)	Email with links to the National Heart Foundation of Australia website	Cardiovascular health promoting lifestyle behavior intervention delivered via website and email	I: 16 C: 15	Cholesterol panel, glucose, insulin at 3 months after enrollment	Cholesterol panel, glucose, and insulin were not significantly different between intervention and control.
Kim (2021)	Age, birth experience, birth type, family history of DM, and breastfeeding matched controls. Provided with written educational materials on GDM.	Mobile VR program consisting of exercise, diet/nutrition, laughter therapy, and neonatal first aid	I: 64 C: 64	A1c, fasting glucose at 12 weeks after enrollment	A1c and fasting glucose in the experimental group were significantly improved compared with the control group.
Nicklas et al. (2014/2019)	National Diabetes Education Program handout for women with prior GDM called "It's Never Too Early to Prevent Diabetes."	Interactive website with videos, communication with lifestyle coach, and goal tracking	I: 36 C: 39	A1c, fasting glucose, fasting insulin, 75 g 2-hr OGTT, adiponectin, LDL, HDL, triglycerides, hsCRP, and IL-6 at 6 months and 12 months postpartum	Cardiometabolic risk factors did not improve in the intervention group vs control group.
Horn (2023)	N/A	Phone counseling with dietician, educational website	PEC: 20 GDM: 25	HbA1c, total cholesterol, LDL, HDL, triglycerides	No significant difference in A1c or cholesterol.

definitive conclusions on the effectiveness of these DHI interventions for postpartum cardiovascular health. We were unable to conduct meta-analyses for the outcomes of interest due to the heterogeneous nature of study reporting and outcomes assessed. We were thus unable to draw conclusions about the effectiveness of DHI interventions overall.

5. Conclusion

This review of research studies involving digital health interventions in the postpartum period for the optimization of cardiovascular health demonstrates a diverse spectrum of modalities that have been developed and tested. While digital health tools represent a promising approach to delivery of lifestyle interventions, larger trials powered to detect differences in effectiveness are needed. Future research directions should focus on identifying which components of DHI are most effective and durable, and which cardiovascular health outcomes are most modifiable in this population.

CRediT authorship contribution statement

Anaïs Hausvater: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mitchell Pleasure:** Writing – review & editing, Writing – original draft, Validation, Formal analysis, Data curation, Conceptualization. **Dorice Vieira:** Writing – original draft, Methodology, Data curation, Conceptualization. **Darcy Banco:** Writing – original draft, Methodology, Data curation. **John A. Dodson:** Supervision, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Anais Hausvater and John Dodson report financial support was provided by National Institutes of Health. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Search Strategy

(Post-partum OR postpartum OR peripartum OR puerperium OR post partum period OR "after childbirth") AND (heart disease risk factors OR cardiovascular risk OR cardiometabolic risk factors OR obesity paradox OR body mass index OR bmi OR blood lipids OR blood glucose OR blood sugar OR blood pressure OR diastolic pressure OR systolic pressure OR sleep health OR nicotine exposure OR physical activity OR exercise OR diet OR cardiovascular pregnancy complications) AND (digital health interventions OR digital health OR mobile health OR e-health OR ehealth OR telemedicine OR telehealth OR virtual medicine OR remote monitoring OR mobile medical devices OR wearable technology OR fitbit OR digital medicine OR mhealth OR m-health OR accelerometer OR actigraph OR fitness tracker OR health wearables OR mobile device OR patient monitoring device* OR personal digital assistant* OR physical activity sensing device OR physical activity tracker OR smart watch OR smartwatch OR sport tracker* OR sports tracker* OR wearable activity tracker OR wireless devices OR patient portal* OR telemonitor* OR remote sensing technolog* OR telerehabilitation OR facebook OR social media OR internet-based interventions OR text messag* OR teleconferenc* OR mobile applications OR biomedical technology)

Appendix B. American Heart Association Construct of Cardiovascular Health (“Life’s Essential 8″)

Cardiovascular health outcomes:

- Body mass index
- Blood pressure
- Physical activity
- Diet
- Blood glucose
- Cholesterol
- Nicotine exposure
- Sleep

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