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Review

Cardiovascular Disease Risk Factor Interventions in Women With Prior Gestational Hypertensive Disorders or Diabetes in North America: A Rapid Review

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ABSTRACT

Women with previous hypertensive disorders of pregnancy (HDP) or gestational diabetes mellitus (GDM) have a 2- to 3-fold increased risk of cardiovascular disease (CVD). The goal of this rapid review was to summarize evidence of the effectiveness of CVD risk factor interventions for postpartum women with a history of HDP or GDM. A comprehensive search strategy was used to search articles published in 5 databases—Ovid MEDLINE, PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, and Embase). Observational and intervention studies that identified CVD prevention, screening, and/or risk factor management interventions among postpartum women with prior HDP or GDM in Canada and the US were included. The quality of observational and interventional studies, and their risk of bias, were assessed using appropriate critical appraisal checklists. Eight studies, including 4 observational cohorts, 3 randomized controlled trials, and 1 quasi-experimental study, merited

RÉSUMÉ

Les femmes ayant déjà souffert de troubles hypertensifs de la grossesse (THG) ou d'un diabète gestationnel (DG) présentent un risque de maladie cardiovasculaire (MCV) accru de 2 à 3 fois. Cette brève revue de littérature visait à colliger les évidences concernant l'efficacité des interventions se concentrant sur les facteurs de risque de MCV chez les femmes en post-partum ayant des antécédents de THG ou de DG. Une stratégie de recherche exhaustive a été employée pour rechercher des articles publiés dans 5 bases de données (Ovid MEDLINE, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO et Embase). Les études d'observation et d'intervention qui ont identifié des interventions de prévention, de dépistage et/ou de gestion des facteurs de risque des MCV chez les femmes en postpartum ayant déjà souffert de THG ou de DG au Canada et aux États-Unis ont été incluses. La qualité des études observationnelles et interventionnelles, ainsi que leur risque de biais, ont été évalués à

Lay Summary

Women with high blood pressure or high blood glucose levels during pregnancy are at increased risk for heart and blood vessel diseases after childbirth, compared to those who do not experience these conditions. We did a comprehensive search of the literature to summarize evidence on the effectiveness of interventions to reduce this risk for these women after childbirth among women in North America. The most effective interventions include transition clinics after childbirth, risk factor education, and advice on lifestyle changes.

Cardiovascular disease (CVD) is the principal cause of death among women in Canada and the US. In Canada, cardiac disease is the most common diagnosis associated with maternal mortality during pregnancy and in the postpartum period, affecting 4.7 per 100,000 deliveries.[1] In the US, 44% of women live with heart disease of some type, and it is responsible for 1 in 5 female deaths.[2,3] Pregnancy is associated with physiological stress that may uncover adverse pregnancy outcomes, such as hypertensive disorders of pregnancy (HDP) and gestational diabetes mellitus (GDM), both of which are associated with elevated cardiometabolic risk factors during pregnancy and in the postpartum period.[4] The development of cardiometabolic risks, such as chronic hypertension, hypercholesterolemia, metabolic syndrome, and type 2 diabetes in the postpartum period is a major driver of premature CVD for women.[5-7] Notably, women with a history of HDP have a 2-3-fold increased risk of developing CVD at 5-10 years postpartum,[8] and those with prior GDM have a 2-fold increased risk of developing CVD, even in the absence of diabetes in the postpartum period.[9,10] To prevent CVD, several interventions to address risk factors have been proposed, and use of screening programs has been recommended, for hypertension, diabetes,

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inclusion for analysis. A total of 2449 participants were involved in the included studies. The most effective CVD risk factor intervention was comprised of postpartum transition and follow-up, CVD risk factor education, and advice on lifestyle changes. Most of the observational studies led to improvements in CVD risk factors, including improvements in CVD lifetime risk scores. However, none of the RCTs led to improvements in cardiometabolic risk factors. Few studies have investigated CVD risk factor interventions in the postpartum in women with previous HDP or GDM in North America. Further studies of higher quality are needed.

l'aide de listes de contrôle d'évaluation critique appropriées. Huit études, dont quatre cohortes observationnelles, trois essais contrôlés randomisés (ECR) et une étude quasi expérimentale, ont été incluses pour l'analyse, impliquant au total 2 449 participantes. L'intervention la plus efficace sur les facteurs de risque de MCV incluait une transition et un suivi post-partum, une sensibilisation aux facteurs de risque de MCV et des conseils sur les changements de mode de vie. La plupart des études observationnelles ont conduit à des améliorations concernant les facteurs de risque de MCV. Cependant, aucun des ECR n'a conduit à des améliorations des facteurs de risque cardiométabolique. Peu d'études ont examiné les interventions sur les facteurs de risque de MCV pendant le post-partum chez les femmes ayant déjà souffert de THG ou de DG en Amérique du Nord. D'autres études de meilleure qualité sont nécessaires.

and lipid abnormalities among women with prior GDM and HDP, beginning at age 30 years.[11]

Rates of CVD among postpartum women in North America remain high, especially among those with previous HDP or GDM. However, to our knowledge, no review has summarized the evidence on the effectiveness of CVD risk factor prevention, screening, and management interventions among this postpartum population in North America. The objective of this rapid review was to summarize the effectiveness of CVD risk factor interventions that have been implemented in Canada and the US for postpartum women with a history of HDP or GDM, and to assess the quality and risk of bias of included studies.

Methods

Search strategy

A comprehensive search strategy was developed to find published studies on CVD risk factor prevention, screening, and/or management among postpartum women with prior HDP or GDM, covering the period from database inception to May 2023. The initial Ovid MEDLINE search strategy (Supplemental Appendix S1) was adapted and performed across the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, PsychINFO, and Embase. All studies identified during the search were uploaded into Covidence (2023; www.covidence.org), duplicates were removed, and each study was assessed for relevance based on the information provided in the title and abstract. For all papers that appeared to meet the inclusion criteria, a full text of the article was retrieved and assessed for eligibility against the inclusion criteria, to determine its relevance to the review objective.

Inclusion criteria

Studies that were included could be of any design (qualitative or quantitative), published in English-language peer-reviewed journals, took place in North America, and were conducted among postpartum women with prior HDP or GDM. Interventions could include risk factor screening, primary prevention of CVD (including risk factor treatment), and/or increasing awareness (knowledge) of risk factors, and educational programs. Studies that investigated outcomes in the early (immediate) postpartum period and the late postpartum period (up to 10 years or more) were included, as evidence has shown that the period up to 10 years postpartum is a critical time for the development of CVD after childbirth.

Exclusion criteria

We excluded articles that investigated women who had preexisting CVD, as our review focused on primary prevention and CVD risk factor interventions; studies of women with existing CVD would have included CVD treatment or secondary prevention interventions. We also excluded studies that were not published in English, as well as those conducted outside of North America.

Data extraction and quality appraisal

We extracted data from all eligible papers using data-extraction forms developed by our research team (Supplemental Appendix S2). The data-extraction form was validated for scope and relevance using the Joanna Briggs Institute (Adelaide, Australia) data-extraction form for review and research synthesis. Briefly, data on country of origin, aim of the study, population characteristics (participants, setting), study design, description of the main intervention or program, mode of delivery of intervention, main findings and/or intervention effectiveness, and limitations were extracted. One standardized form was used for both observational and intervention studies that merited inclusion. Data were extracted independently by authors L.H., K.S., and R.L. and were verified by author D.Y.Q. Any disparities were resolved by consensus-based discussions among the authors. The quality of each study was assessed using relevant Joanna Briggs Institute critical appraisal checklists for cohort studies,[12] randomized controlled trials (RCTs),[13] and quasi-experimental studies. The critical appraisal forms assessed the study aims, sampling procedures, data collection methods, analysis approach, limitations, reliability, validity, and generalizability of the included papers.

Data synthesis

Findings from observational studies and RCTs were integrated into themes using the multi-source synthesis method,[14] an analytical technique that enhances transparency in the synthesis of quantitative and/or contextual data, thus providing a platform for comparison among studies. This

method also serves as a guide in synthesizing data from primary studies, to give a meaningful and broad understanding of the subject.

Results

Characteristics of included studies

Our literature search identified 3252 potential papers. Of these, 1764 were from PubMed and MEDLINE, 1177 were from Embase, 305 were from CINAHL and PsycINFO, and 8 were from other sources (citation searching and grey literature). Of these 3246 papers, 14 were removed as duplicates. Thus, 3240 papers were screened for title and abstract, 17 were screened at full text, and 8 met the inclusion criteria and are included in this review.[15-22] Figure 1 shows the flowchart of the included studies. Of the 8 studies, 4 were observational cohort studies,[18-21]), 3 were RCTs,[15-17] and 1 was a quasi-experimental study.[22] Studies were published between 2014 and 2023. Of the 4 observational studies, 3 implemented a postpartum maternal health program,[19-21] and 1 used an electronic registry to identify women who had previous HDP, for postpartum follow-up.[18] Among the RCTs, only 1 was a multicentre study.[16] Details on the methodology, sample size, sampling, and analysis of the included observational and intervention studies are summarized in Tables 1 and 2, respectively.

Study participants

A total of 2449 participants were involved in the 8 studies. Of these, 1721 women were included in the observational studies, and 728 were included in the intervention studies. Among the observational studies, the number of participants ranged from 21 women[21] to 1131 women.[18] For the intervention studies, the number of participants ranged from 64 women in the smallest study[22] to 333 women in the largest study.[15] Overall, the age of participants ranged from 18 to 55 years. Participants were recruited from both urban and rural settings and had a diversity of demographic characteristics and ethnic origins. The observational studies recruited women who had had recent HDP or GDM. The intervention studies recruited women with a history of HDP and/or GDM. Participants were recruited in the immediate postpartum period in 3 studies,[15,19,21] at 6 months postpartum in 1 study,[20] and in the first year postpartum in 1 study.[17] The timing of recruitment was unclear in 3 studies.[16,18,22]

CVD risk factor interventions deployed

Observational studies. Figure 2 summarizes the numbers and types of interventions applied in the included studies. Three of the observational studies implemented a CVD risk factor education intervention for postpartum women with a history of HDP or GDM.[18,19,21] In all 3 studies, letters were sent to the participants' primary care provider (PCP) or obstetrical care provider (for women without a PCP), to explain the participants' risks for premature CVD and to reinforce delivery of postpartum follow-up. In 1 study, participants also received numerous messages regarding CVD risk, through a personal electronic health record platform.[18] The postpartum follow-up program in another study included hypertension management guidelines, and patient and provider education.[19] In addition to advice on lifestyle changes, 1 study further assessed women's modifiable CVD risk factors, including poor diet, physical inactivity, high levels of glucose, blood pressure, and cholesterol, and smoking.[21] This study tailored education based on individualized CVD risk goals, as well as medication and smoking counselling.[21] Two studies included dietary education as part of their intervention program.[23,24] One study provided participants with a nutrition handout on healthful postpartum eating, with considerations relating to hypertension and breastfeeding,[19]

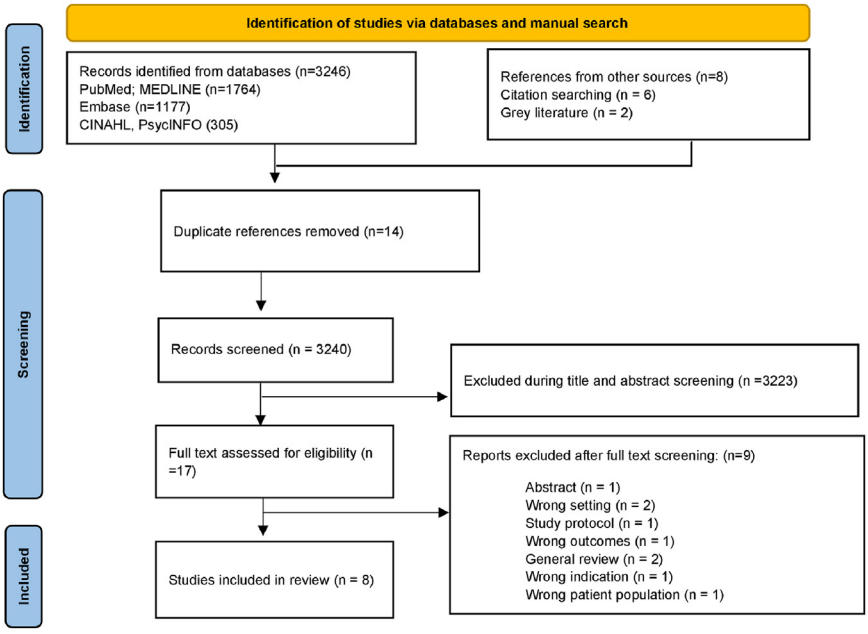

Figure 1. Flowchart of study inclusion in this review. CINAHL, Cumulative Index to Nursing and Allied Health Literature.

Table 1. Summary of observational studies included in the review

Authors (Year) Country	Study design Sample Objective	Selection criteria	Summary of intervention components and/or program	Major findings
Burgess and Stover[18] (2023) USA	Retrospective chart review n = 1131 women To improve awareness of cardiovascular risk and follow-up with a PCP after HDP	**Inclusion:** Women with history of HDP and delivered at any of the 5 birthing hospitals of WellSpan Health **Exclusion:** Women with no history of HDP	**Program components:** • Managing a registry • Updating the patients with history of HDP • Sending electronic outreach to patients and PCPs • Assessing the impact of the program	90% of patients who received outreach communication viewed the letter. ↗ Appointment with PCPs following the implementation of the program increased from 16% to 26% and participants' discussion of cardiopreventative strategies up from 16% at baseline.
Celi et al.[19] (2019) USA	Observational cohort n = 412 women To develop a postpartum transition clinic to support women after hypertensive pregnancy to manage CVD risk factors	**Inclusion:** Women in the immediate postpartum after a hypertensive pregnancy; average age of 31 years **Exclusion:** Not reported	**Program components:** • Obstetric transition to primary care • Education of patient and PCP on CVD risk factors • Letter supporting the transitioning care of these patients' PCPs • Postpartum nutrition handout based on DASH diet	47.3% of women had 2−3 visits ↗Acquisition of home blood pressure monitors increased from 56.8% to 93.8%; 48% had antihypertensive medication adjustments. ↗Nutrition consultation attendance increased (86.8%). ↗Adherence to scheduled follow-up PCP appointments was increased (those with PCPs; 79.5%).
Cusimano et al.[20] (2014) Canada	Observational study n = 157 women To inspire lifestyle changes, encourage long-term follow-up and initiate primary prevention	**Inclusion:** Women with a history of HDP or GDM **Exclusion:** Women without HDP or GDM; women outside of the catchment area of the program	**Program components:** • Patients seen at 6 months postpartum, undergo CVD risk examinations • Meet obstetrician to discuss CVD risk • Advice on lifestyle modifications • Letter and clinical data sent to both patient and her PCP for follow-up • Further consults to endocrinology, cardiology, and nephrology as needed based on individual profile	↗ Lifetime and 30-year CVD risk estimates were higher compared with healthy controls (different cohort). ↗ Rates of metabolic syndrome were increased (17.4% vs 6.78%).
Janmohamed et al.[21] (2015) Canada	Retrospective chart review n = 21 women Effect of attendance of interdisciplinary lifestyle educational clinic on cardiovascular risk factors in women with recent preeclampsia	**Inclusion:** Women with a recent history of preeclampsia and who attended a postpartum preeclampsia clinic **Exclusion:** Women without recent preeclampsia and who did not attend the postpartum clinic	**Program components:** • Educate women about the future CVD implications of preeclampsia • Assess modifiable CVD risk factors • Improve CVD risk factors thorough lifestyle advice with supplemental pharmacologic therapies • Session with dietician on dietary changes • Medication and smoking counselling with the clinic pharmacist • Individualized goals for CVD risk factors	= Weight (mean weight loss of 0.4 ± 4.5 kg) and BMI were similar (mean decrease in BMI 0.1 ± 1.7 kg/m^2) at a mean of 4.4 mo postpartum. ↗ Physical activity increased from 14% to 76% at a mean of 4.4 mo postpartum.

↗, significant augmentation; =, no significant difference.

BMI, body mass index; CVD, cardiovascular disease; DASH, dietary approaches to stop hypertension; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; PCP, primary care provider.

Table 2. Summary of interventional studies included in the review

Authors (Year) Country	Study design Sample Objective	Selection criteria	Summary of intervention components and/or program	Major findings
Nicklas et al.[17] (2019) USA	RCT n = 75 women To determine if Web-based lifestyle education leads to changes in cardiovascular, metabolic, and inflammatory markers	**Inclusion:** Women aged 18−45 y, history of GDM during the first year of postpartum, BMI ≥ 24 (≥ 22 for Asian participants) and < 50 kg/m^2 **Exclusion:** Women with a history of T2DM or bariatric surgery or on glucose metabolism or weight medications; women who delivered before 32 wk gestation or if they had net weight loss during pregnancy	**Components of the intervention:** Web-based lifestyle • Weekly lifestyle modification conversation with a coach • Access to Web site with online presentations on healthy eating and physical activity education • Logging diet and physical activity on Web site **Duration of intervention:** • 1-y duration with measures at 6 wk, 6 mo, and 12 mo	= Cardiometabolic risk markers were not significantly improved in women in intervention group compared to control group Large overlap of weight and waist circumference changes Correlation between changes in diabetes and CVD risk factors with changes in weight and waist circumference (The strongest associations were observed for fasting insulin, HOMA-IR, and fasting glucose)
Triebwasser et al.[15] (2020) USA	RCT n = 333 women To determine the effect of a text-based blood pressure monitoring intervention on clinical outcomes	**Inclusion:** Women aged > 18 years, speaks English, has access to cell phone with text-message capabilities, has a history of gestational hypertension, preeclampsia, chronic hypertension **Exclusion:** Not reported	**Program components** Text-based BP monitoring: • Education on BP monitor use • Check BP twice a day and report values • Daily reminders to check BP • Referred to a doctor if BP high • Medications when needed;If values are normal after the 10 d, patients are informed to exit the study **Duration of intervention:** 10 d, unless values are above normal ranges at the end of the 10 d	= No differences in BP between intervention and control group at the end of the intervention = BP ascertainment was similar among different ethnic groups = The proportion of women meeting ACOG recommendations were similar between groups
Aderibigbe et al.[16] (2023) USA	RCT n = 256 women To determine whether starting antihypertensive therapy at 140/90 mm Hg would result in less maternal morbidity than a threshold of 150/95 mm Hg	**Inclusion:** Women aged 15−55 y with a history of chronic hypertension, gestational hypertension, or preeclampsia **Exclusion:** Aged < 18 y, does not speak English, enrolled in another hypertension study, on antihypertensive therapy before or during pregnancy, known major cardiac or cerebrovascular disease	**Program components:** Postpartum antihypertensive therapy • Participants randomized to initiation of antihypertensive therapy at 1 of 2 BP thresholds: 140/90 mm Hg ("tight control" group) or 150/95 mm Hg ("liberal control" group) • Participants in "tight control" group started medication following randomization • Medication for participants in "liberal control" group if systolic BP was ≥ 150 mm Hg or diastolic BP was ≥ 95 mm Hg on 2 occasions 4 h apart	= Initiation of antihypertensive therapy at a lower BP threshold of 140/90 mm Hg did not decrease maternal morbidity or improve outcomes compared with a threshold of 150/95 mm Hg = Rates of all secondary outcomes and the individual components of the primary and secondary outcome = Hospital readmission for hypertension, persistence of hypertension beyond 14 d, medication side effects, and time to BP control were similar between groups

Continued

Table 2. Continued.

Authors (Year) Country	Study design Sample Objective	Selection criteria	Summary of intervention components and/or program	Major findings
			• All other aspects of postpartum care were provided according to standard institutional guidelines **Duration of intervention:** • Not reported	
Spratling et al.[22] (2014) USA	Quasi-experimental study (exploratory single group, pretest/posttest design) n = 64 women Effect of educational intervention on CVD risk perception among women with recent preeclampsia	**Inclusion:** Women aged ≥ 19 y; up to 12 mo postpartum, history of preeclampsia, including eclampsia, able to read and speak English, absence of fetal demise in the recent pregnancy **Exclusion:** Women with known histories of non-pregnancy-related HDP and women with GDM	**Program components** **Pre- and post-test education intervention:** • CVD education on healthy meal planning, physical activity, medication compliance • Education on regular BP and cholesterol screenings • Dietary education based on the dietary guidelines • Education script reviewed by cardiovascular and maternal health practitioners **Duration of intervention:** • Virtual intervention: telephone call lasting for 30 to 40 min	↗ Participants' levels of CVD risk perception were increased following the education intervention, compared to baseline

↗, significant augmentation; =, no significant difference.

ACOG, American College of Obstetricians and Gynecologists; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; DBP, diastolic BP; DASH, dietary approaches to stop hypertension; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; HOMA-IR, The homeostatic model assessment of insulin resistance; PCP, primary care provider; RCT, randomized controlled trial; T2DM, type 2 diabetes mellitus.

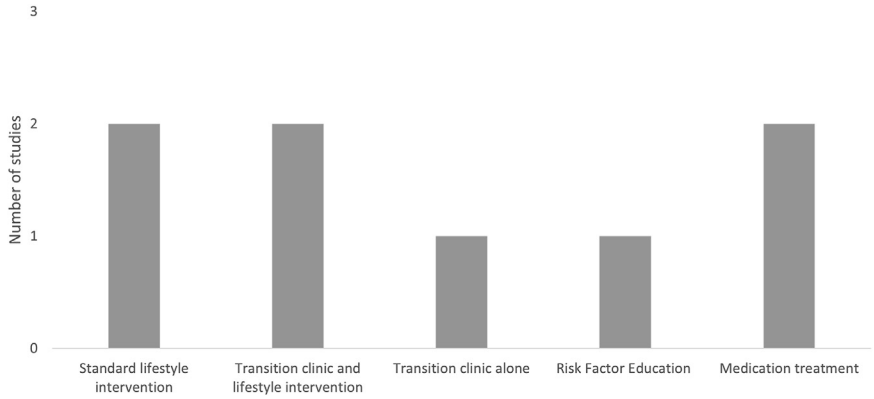

Figure 2. Summary of types of cardiovascular disease risk factor interventions in the included studies.

and the other offered education and counselling from a dietitian.[21] Overall, the duration of these risk factor education interventions was between 4 and 6 months, but 1 study followed women for up to 5 years postpartum.

One observational study implemented a risk factor screening program,[20] in which participants were seen at 6 months postpartum, to undergo a history taking, bloodwork, and physical examination; follow-up letters were sent to participants' PCPs for follow-up after risk factor screening.

Intervention studies. Two RCTs provided an education intervention to women with previous preeclampsia.[15,22] One intervention consisted of education on the use of a blood pressure monitor to report blood pressure values during the study duration, and participants were sent daily text reminders, to improve their adherence.[15] In the other RCT, participants received education on healthy meal planning, physical activity, medication compliance, and the importance of regular blood pressure screening.[22] Participants were sent daily text reminders to improve their adherence, were informed of abnormal blood pressure values, and were referred to a maternal-fetal medicine physician for management, as needed.

One study implemented a lifestyle modification intervention for women with recent GDM,[17] in which women received weekly support from a lifestyle coach and access to online modules that contained healthy eating and physical activity educational tips and trackers. Another [16] randomized women with a history of chronic hypertension, gestational hypertension, and preeclampsia to antihypertensive medication therapy or a control group.

In the quasi-experimental study,[22] participants received education on healthy meal planning, physical activity, medication compliance, and the importance of regular blood pressure screening.

Outcomes of the CVD risk factor interventions

Observational studies. Half (50%) of the observational studies led to improvements in CVD risk factors among postpartum women with a history of HDP or GDM.[18,19] Two studies reported improvements in follow-up visits between patients and their PCPs following the intervention.[18,20] In 1 study, 26% of participants met their PCP for follow-up and discussed cardio-preventative strategies, compared to 16% at baseline.[18] In another study, 80% of women kept their scheduled follow-up visits with their PCPs, and 87% (79 of 91) attended a nutrition consultation.[19] One study reported a nonsignificant improvement in weight and body mass index at 4 months postpartum; however, physical activity improved significantly, from 14% at baseline to 76% during the same period.[21] In the studies that recruited women with a history of preeclampsia, 1 reported a 37% increase in acquisition of home blood pressure monitors, and half of patients had antihypertensive medication adjustments.[19] Although effects on blood pressure were not investigated, women were reported to need at least 3 visits in the first 6 weeks postpartum, to achieve blood pressure control. One study reported increased lifetime and 30-year CVD risk estimates in women with at least 1 relevant pregnancy complication, compared to those for a normotensive cohort.[20]

Intervention studies. None of the RCTs led to improvements in CVD risk factors.[15-17] One RCT reported a large overlap of weight change and change in waist circumference between the intervention and control groups[17]; however, in a post hoc analysis, changes in weight and waist circumference were correlated significantly with changes in diabetes and cardiovascular risk factors, and the strongest associations were observed for fasting glucose level and insulin resistance.[17] In the 2 studies that recruited women with previous HDP, there were no differences in blood pressure values between groups at the end of the intervention.[15,16] Outcomes, including hospital readmission for hypertension, persistence of hypertension, medication side effects, and time to blood pressure control, were all similar between groups. In the quasi-experimental study, participants' levels of CVD risk perception were significantly higher during the post-test assessment, compared to those at the baseline.[22]

Quality assessment of included studies

Table 3 shows the quality assessment of the observational studies included in this review. We rated 50% of the observational studies to be of fair quality,[18,21] and 50% to be of high quality,[19,20] based on the assessment criteria.[12] The studies deemed to be of high quality were those that included the following: detailed description of the design and

Table 3. Quality assessment of observational studies included in the review

Author (year)	Were groups similar and recruited from same population	Exposure measures similar in both groups	Valid measure of exposure	Confounding factors identified and dealt with	Are outcomes assessed using objective criterion	Were participants free of outcome at the start of study	Were outcomes reliably measured and valid	Was follow-up reported and sufficient and if yes, complete	Was appropriate statistical analysis used	Quality
Burgess and Stover[18] (2023)	NA	N	Y	N	Y	Y	U	Y	NA	Fair
Celi et al.[19] (2019)	Y	Y	Y	NA	Y	Y	Y	Y	Y	High
Cusimano et al.[20] (2014)	N	Y	Y	N	Y	Y	Y	Y	Y	High
Janmohamed et al.[21] (2015)	NA	NA	Y	N	Y	Y	Y	Y	Y	Fair

NA, not available; N, no; U, unclear; Y, yes.

methodology used, the process of recruiting participants, and the study setting; clear presentation of findings; and study limitations that were unlikely to affect the reliability and validity of study findings. Studies rated to be of fair quality were those that did not include explicit information on data analysis, did not describe the subject recruitment processes, had unclear outcome measures, or had other methodological issues that could lead to a high risk of bias. Overall, the observational studies did not report on changes in lifestyle factors, such as diet modification, physical activity changes, or changes in weight after the sessions with their PCPs.[18-21] In addition, few studies reported adherence to the PCP appointments.[18,19] Sample size was relatively small in most studies; postpartum follow-up duration was relatively short; and a control group was lacking in the observational studies.

Tables 4 and 5 summarize our risk-of-bias assessments of the included RCTs and the quasi-experimental study, respectively. We rated all the intervention studies to be of fair quality based on the assessment criteria,[13] for both the RCTs[15-17] and the quasi-experimental study.[22] The RCTs were assessed to have high-risk of bias, owing to the following reasons: allocation groups were not concealed or were not described; participants were not blinded to treatment assignment, or use of blinding was unclear; and outcome assessors were not blinded to allocation and treatment, or use of blinding was not described sufficiently. Overall, only 1 study had a follow-up period of at least 12 months. Some studies were underpowered to detect differences in primary outcomes, compared to those in the control group.[16] Two studies had relatively low sample sizes.[17,22] Although the intervention duration was reported in most studies, the intervention dose was unclear in all studies.

Discussion

This rapid review summarized the effectiveness of CVD risk factor interventions among postpartum women with a history of HDP or GDM in Canada and the US, and assessed the quality of the studies included. We observed that very few studies have investigated CVD risk factor interventions for postpartum women with prior HDP or GDM, and all included studies occurred in the past 9 years. The CVD risk factor interventions deployed in the included studies were lifestyle interventions, transition clinics, risk factor education, screening, and pharmacologic interventions. The most promising CVD risk factor interventions included in this review are programs of transitional care to postpartum follow-up, CVD risk factor education, and advice on lifestyle changes. However, none of the RCTs led to improvements in cardiometabolic risk factors. One study that employed a quasi-experimental design led to an increased perception of CVD risk. Half of the observational studies were assessed to be of high quality, whereas all of the intervention studies were assessed to be of fair quality.

Half of the observational studies in this review led to improvements in CVD risk factor follow-up and in physical activity among postpartum women. In all studies, the use of transitional clinics to initiate postpartum follow-up with participants' PCPs was common. This approach required the identification of women's risk, and the sending of letters to PCPs, highlighting women's CVD risk after a complicated

Table 4. Risk of bias of included randomized controlled trials

Author (year)	Randomization used to assign participants to treatment groups	Allocation to groups concealed	Were treatment groups similar at baseline	Participants blind to treatment assignment	Outcome accessors blinded to treatment allocation	Groups similar at baseline	Outcome assessors blind to treatment	Similar outcome measure for both groups	Outcomes measured in the same way	Outcome Reliably measured	Follow-up complete	Participant analyzed in their groups	Appropriate statistics used	Total
Nicklas et al.[17] (2019)	Y	NR	Y	NR	NR	Y	NR	Y	Y	Y	Y	Y	Y	Fair
Triebwasser et al.[15] (2020)	Y	NR	Y	NR	NR	Y	NR	Y	Y	Y	N	Y	Y	Fair
Aderibigbe et al.[16] (2023)	Y	N	Y	N	N	Y	N	Y	Y	Y	N	Y	Y	Fair

N, no; NR, not reported; Y, yes.

Table 5. Risk of bias of included quasi-experimental studies

Author (year)	Clear cause and effect described	Were participants similar	Participant received similar treatment other than exposure of interest	Was there a control group	Multiple outcome measures assessed both pre and post intervention	Was there a follow-up and if not differences in groups described	Outcomes measured in the same way	Outcome reliably measured	Appropriate statistics used	Total
Spratling et al.[22] (2014)	Y	Y	Y	N	Y	N	Y	U	Y	Fair

N, no; NR, not reported; U, unclear; Y, yes.

pregnancy and the importance of postpartum CVD follow-up. In addition to these, most of the studies provided education to women regarding lifestyle modifications. The included observational studies used multiple approaches that were multifactorial and interdisciplinary, and they placed a strong focus on lifestyle modifications and increased adherence to the intervention. This finding is consistent with those of recent studies suggesting that although lifestyle interventions may be effective, the extent of risk reduction[25] might depend on multifactorial intervention domains.[26] Notably, the included studies did not conduct long-term follow-up, and this may limit the interpretation of these results. Our findings are consistent with those of a recent review that suggested the integration of transitional clinics, lifelong postpartum follow-up, and clinician and patient education, as promising strategies to improve women's cardiometabolic health in the postpartum period after any adverse pregnancy outcome (APO).[27] Although this recent study investigated components of interventions to mitigate CVD risk after any APO, our study was focused specifically on women with previous HDP and GDM, as they are the 2 most commonly seen pregnancy-related cardiometabolic conditions, they may coexist in the same or different pregnancies of the same mother, and they are significant independent risk factors for early and severe cardiovascular outcomes.[23,28] Our study also differed in that we evaluated the effectiveness of CVD risk factor interventions for HDP and GDM, specifically, and we completed critical appraisals of the included studies. Despite these differences, the 2 reviews have some overlap.

Although all demonstrated feasibility, none of the RCTs included in this review led to improvements in CVD risk factors, for several possible reasons.[15-17] First, the risks of bias in the RCTs were higher, as demonstrated by our quality assessment. The RCTs were graded to be of fair quality, due to lack of concealment and blinding. These factors could influence behavioural changes in participants (especially in studies that implemented lifestyle interventions), potentially creating a ceiling effect. In addition, studies did not define minimum protocol requirements of their interventions and did not perform per-protocol analysis of at least their primary outcomes. Performing per-protocol analyses might have produced different results based on intervention adherence. The timing of these interventions and the lack of long-term follow-up in all the included studies could also account for the lack of success of the interventions.

Adopting early and regular screening of traditional CVD risk factors, providing support for health behaviours including breastfeeding, using reproductive plans, and setting health goals can be an effective strategy to improve CVD outcomes.[24] Lifestyle interventions, including the adoption of a heart-healthy diet and regular physical activity that start in the early postpartum period and continue across the lifespan, are important and can improve CVD risk factors in these women.[4] In addition to these strategies, an understanding of relevant postpartum practices and norms, and the integration of postpartum-specific sociocultural factors, can improve postpartum CVD intervention uptake and adherence.[29,30] Studies have shown that integrating and adapting specific practices and norms in CVD risk factor interventions can lead to successful outcomes in both Indigenous women in Canada[31-33] and South Asian women in North America.[34-36] None of the studies in this review was designed to include specific postpartum practices or norms; we believe that this could have influenced the effectiveness of the interventions, especially for the RCTs. Future studies should consider specific postpartum norms and practices in CVD risk factor interventions for postpartum women, as a means to address the specific needs of women during the critical postpartum period, and potentially improve uptake and sustained effects of the interventions.

This review highlights the need for well-designed and targeted interventions to help prevent premature CVD in relatively young but high-risk women. For women with prior HDP or GDM, we propose a CVD prevention strategy, to be considered during pregnancy and in the postpartum period, to detect, prevent, or reduce the risk of CVD (Fig. 3). During pregnancy, CVD prevention interventions should include screening for cardiometabolic risk factors, and women at high risk for CVD (eg, HDP and/or GDM) should undergo personalized behavioural and appropriately tailored clinical interventions. Postpartum interventions should include transitional care follow-up, cardiometabolic risk assessment, and education on CVD risk following a high-risk pregnancy. Women at high risk for CVD should undergo personalized behavioural and clinical interventions to reduce their CVD risk factors.

This review is the first to summarize evidence on CVD risk factor interventions and their effects in postpartum women with recent HDP or GDM in Canada and the US. We chose to focus on studies from Canada and the US for the following

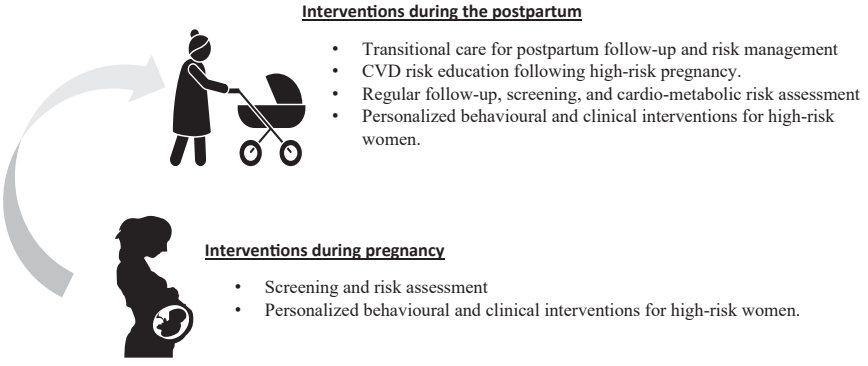

Figure 3. A model for cardiovascular disease (CVD) prevention during pregnancy and in the postpartum period in women with prior hypertensive disorders of pregnancy and gestational diabetes mellitus.

reasons: (i) given the numerous calls to action and guideline recommendations to screen for and manage cardiovascular risk following APOs from cardiovascular and obstetrics and gynecology associations in both countries for over 10 years[37-41]; (ii) Canada has known leadership in postpartum CVD preventive care[42]; and (iii) to reflect our aim of developing a CVD prevention network for women in Canada. Despite the emergence of recommendations in both countries, we found relatively few intervention studies, and none published earlier than 2014. Despite our broad inclusion criteria, the low number of studies included in this review, and our focus on studies in North America, may limit the generalization of our results. Our focus on women with previous HDP and GDM may limit the applicability of our results to women with a history of other APOs. The results identified are compelling; however, the known cardiometabolic outcomes following adverse pregnancy conditions highlight the critical need for well-designed studies aiming to improve behavioural and clinical outcomes among high-risk postpartum women.

Conclusions

Only a few studies have investigated the effectiveness of CVD risk factor interventions in women with previous HDP or GDM in North America. Future studies of higher quality are needed, and they should focus on strategies to increase maternal postpartum screening and follow-up, improve accessibility to interventions, expand awareness of sex-specific CVD risk factors, and define evidence-based prevention strategies for postpartum women.

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Ethics Statement

This rapid review included studies that either explicitly stated having or were understood to have complied with all appropriate ethical standards. Our analysis was rigorously conducted based on the available data.

Patient Consent

This is a review of the literature; therefore, patient consent is not applicable.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Open* at https://www.cjcopen.ca/ and at https://doi.org/10.1016/j.cjco.2023.12.015.