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Systematic Review/Meta-analysis

Women's Knowledge of Future Cardiovascular Risk Associated With Complications of Pregnancy: A Systematic Review

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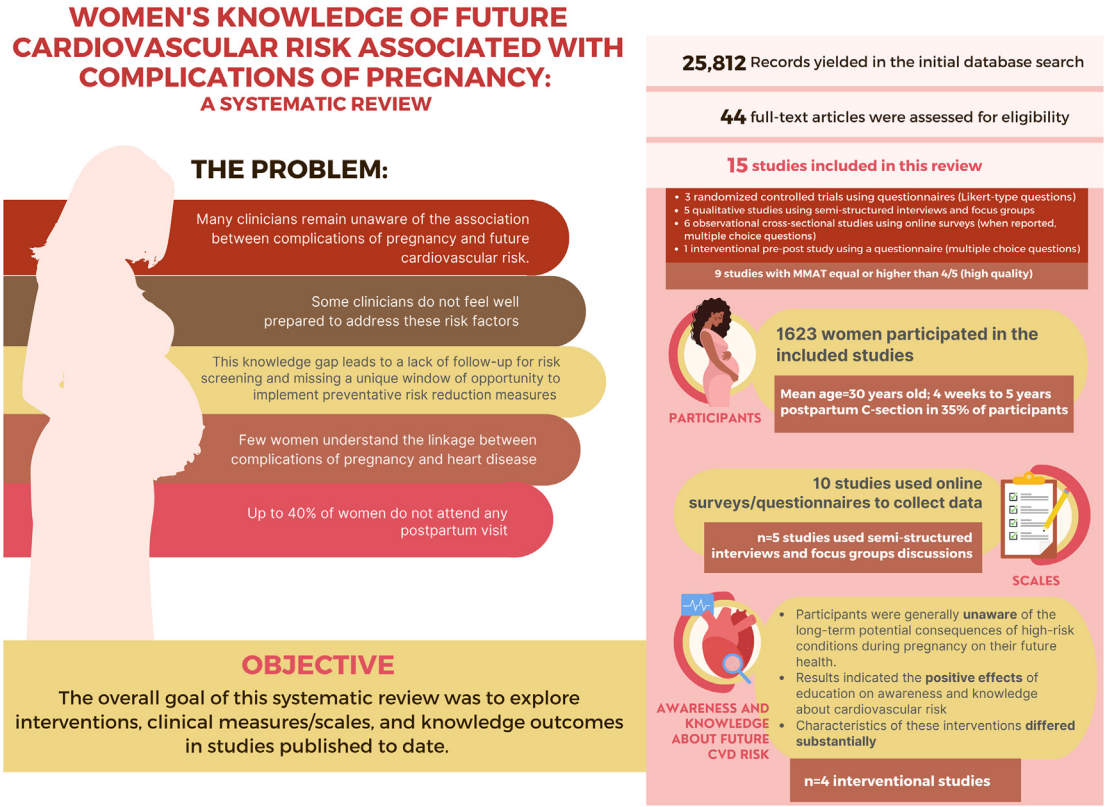

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ABSTRACT

Background: Several common pregnancy conditions significantly increase a woman's risk of future cardiovascular diseases (CVD). Patient education and interventions aimed at awareness and self-management of cardiovascular risk factors may help modify future cardiovascular risk. The aim of this systematic review was to examine education interventions for cardiovascular risk after pregnancy, clinical measures/scales, and knowledge outcomes in published qualitative and quantitative studies.

Methods: Five databases were searched (from inception to June 2023). Studies including interventions and validated and nonvalidated measures of awareness/knowledge of future cardiovascular risk among women after complications of pregnancy were considered. Quality was rated using the Mixed Methods Appraisal Tool. Results were analyzed using the Synthesis Without Meta-analysis reporting guideline. Characteristics of interventions were reported using the Template for Intervention Description and Replication. Fifteen studies were included; 3 were randomized controlled trials.

Results: In total, 1623 women had a recent or past diagnosis of hypertensive disorders of pregnancy, gestational diabetes mellitus, and/or premature birth. Of the 7 studies that used online surveys or questionnaires, 2 reported assessing psychometric properties of tools. Four studies used diverse educational interventions (pamphlets, information sheets, in-person group sessions, and an online platform with health coaching). Overall, women had a low level of knowledge about their future CVD risk. Interventions were effective in increasing this knowledge.

Conclusions: In conclusion, women have a low level of knowledge of risk of CVD after pregnancy complications. To increase this level of knowledge and self-management, this population has a strong need for psychometrically validated tailored education interventions.

RÉSUMÉ

Contexte : Plusieurs problèmes médicaux liés à la grossesse augmentent significativement le risque d'une maladie cardiovasculaire (MCV) ultérieure chez les femmes. L'éducation des patients et les interventions axées sur la sensibilisation aux facteurs de risques cardiovasculaire et sur l'autoprise en charge pourraient aider à limiter le risque de MCV. La présente analyse des études qualitatives et quantitatives publiées visait à examiner les interventions éducatives au sujet des risques cardiovasculaires après la grossesse, les mesures et échelles cliniques qui y sont associées, et les résultats de ces interventions sur le plan des connaissances.

Méthodologie : Des recherches ont été réalisées dans cinq bases de données (de leur date de création jusqu'à juin 2023). Les études considérées incluaient des interventions et des mesures validées ou non de la sensibilisation des femmes au sujet des risques de MCV après des complications liées à la grossesse ou de leurs connaissances à ce sujet. La qualité des études a été évaluée avec l'*Outil d'évaluation de la qualité méthodologique des études incluses dans une revue mixte*, et les résultats ont été évalués à l'aide de la méthodologie *Synthesis Without Meta-analysis*. Les caractéristiques des interventions ont été relevées selon le modèle *Template for Intervention Description and Replication*. Quinze études ont été retenues, dont 3 essais contrôlés randomisés.

Résultats : Au total, 1623 femmes avaient reçu récemment ou auparavant un diagnostic de trouble hypertensif lié à la grossesse, de diabète gestationnel et/ou de travail prématuré. Parmi les 7 études ayant eu recours à des questionnaires ou des sondages en ligne, 2 mentionnaient l'évaluation des propriétés psychométriques des outils. Dans 4 études, plusieurs interventions éducatives ont été utilisées (dépliants, feuillets informatifs, séances de groupe en personne et plateforme en ligne offrant un accompagnement en matière de santé). De manière générale, le niveau de connaissance des femmes au sujet de leur risque de MCV était faible, mais les interventions se sont révélées efficaces pour améliorer ces connaissances.

Conclusions : En conclusion, les femmes ne connaissent pas bien les risques de MCV associés aux complications survenues au cours de la grossesse. Pour améliorer le niveau des connaissances et l'autoprise en charge, des interventions conçues pour cette population et validées sur le plan psychométrique sont indispensables.

Lay Summary

This review identified major gaps in knowledge about pregnancy complications and the future risk of cardiovascular disease. Although education can improve women's knowledge, the use of nonstandardized education tools and content, and a lack of understanding of patient preferences, barriers, and facilitators, limited its effectiveness. To improve women's cardiovascular health and quality of life after pregnancy complications, appropriate educational interventions need to be designed, and their usefulness evaluated.

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See page 192 for disclosure information.

Hypertensive disorders of pregnancy (HDP; gestational hypertension, chronic hypertension, and preeclampsia), gestational diabetes, and preterm birth complicate up to 20% of all pregnancies.[1] These conditions are associated with up to 33% of all maternal deaths in developed countries.[2] Growing evidence supports the significant link between conditions of pregnancy and an increased risk of cardiovascular disease (CVD) later in life.[3]

Clinical practice recommendations emphasize that healthcare providers ask women about their reproductive history when assessing risk factors and overall cardiovascular health.[3,4] For women with a history of certain pregnancy complications, a 3- to 6-month postpartum follow-up appointment with a healthcare provider is generally recommended for individualized risk assessment and counselling.[5,6] Also suggested is that education be provided to inform women of their long-term cardiovascular risk and counselling regarding the importance of a healthy lifestyle and regular follow-up to monitor cardiovascular risk factors, including blood pressure, fasting lipids, and blood glucose.[4,5]

Despite these strong epidemiologic data and management recommendations, several studies have identified that many clinicians remain unaware of the association between common complications during pregnancy and long-term cardiovascular risk.[7-11] Furthermore, many clinicians report being unprepared to address these female-specific risk factors.[12] This knowledge gap often leads to a lack of follow-up for cardiovascular risk screening and a unique opportunity being missed to implement preventative risk-reduction measures for these high-risk women who may be at risk of future cardiovascular events.[13] An important finding is that few women understand the linkage between complications of pregnancy and cardiovascular disease.[12,14,15] Thus, during patient pregnancy could be an opportune time for clinicians to initiate targeted education, intervention, and lifestyle recommendations regarding cardiometabolic health. A better understanding of educational needs and essential follow-up care are needed, as these could potentially reduce women's future cardiovascular risk.

The overall goal of this systematic review was to examine education-focused interventions, clinical measures/scales, and knowledge outcomes in qualitative and quantitative studies published to date. The specific objectives of this review are as follows: (i) to identify scales used to measure awareness and knowledge of future cardiovascular risk among women after pregnancy-related complications; (ii) to describe the characteristics of the educational interventions that have been examined to date; and, (iii) to examine the intervention outcomes of awareness and knowledge of future cardiovascular risk among this population.

Material and Methods

The reporting of this study followed the **P**referred **R**eporting **I**tems for **S**ystematic Reviews and **M**eta-**A**nalyses (PRISMA) statement (Supplemental Appendix S1),[16] and addressed the items outlined in the **A** **M**ea**s**urement **T**ool to **A**ssess Systematic **R**eviews (AMSTAR) checklist.[17] This systematic review was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD42022332102).

Eligibility criteria for study selection

The inclusion criteria involved studies that evaluated an educational intervention and/or used scales (validated and nonvalidated) to measure the outcome of level of awareness and knowledge about future cardiovascular risk among women with a history of complications during pregnancy. Pregnancy-related complications were defined as follows:

- HDP, including gestational hypertension (high blood pressure that develops after 20 weeks of pregnancy), preeclampsia (high blood pressure that develops after 20 weeks of pregnancy and is associated with signs of involvement of other organ systems or the fetus; in women with preexisting hypertension, new or worsening proteinuria is also present).
- Gestational diabetes: diabetes diagnosed for the first time during pregnancy.
- Premature birth or preterm birth: live births delivered before 37 weeks of pregnancy.

Primary studies of any methodological design were considered for inclusion in this study (ie, quantitative, qualitative, and mixed methods). Narrative, systematic, and scoping reviews were reviewed to identify additional primary studies. Non-peer-reviewed literature was excluded. Studies published in any language were considered.

Information sources

Five databases were searched for the date range from their inception to June 2023: Medline All (Ovid, includes PubMed non-Medline), Embase (Ovid), Emcare Nursing (Ovid), CINAHL Complete (Cumulative Index to Nursing and Allied Health Literature; EBSCO), and Web of Science Core Collection. The search strategies were developed in collaboration with an Information Specialist, utilizing the PICO (ie, population, intervention, comparator, outcome) framework, subject headings as appropriate for each database, and free-text terms relevant to the topical concepts. Potential studies identified through a hand-search from the reference lists were also considered for inclusion. The full search strategy from all databases is available in Supplemental Appendix S2.

Selection, data extraction process, and data management

Duplicate citations from across the databases were removed using Mendeley software, with the unique citations imported into Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia; www.covidence.org). Two researchers (G.L.M.G. and L.B.) independently screened all citations identified by the search strategy for eligibility using titles and abstracts. The full texts of potential citations were then examined to ascertain whether they met eligibility criteria (by G.L.M.G. and L.M.C.). For citations with unclear eligibility, the corresponding authors were contacted to obtain information required to make the inclusion decision. For non-English studies, abstracts were translated to English when necessary. The study selection process and data extraction forms were piloted (n = 5 studies) prior to full data extraction.

One researcher independently extracted data on the following: study design, setting, intervention description (if applicable), participant characteristics, psychometric properties of the scales used to assess awareness or knowledge, comparison description (if applicable), outcome measures (level of participant knowledge and awareness of future CVD), key findings, and limitations using a standardized data collection form. Authors were contacted to provide missing or unclear information. Extracted data were then reviewed independently and verified by a second researcher (L.M.C.). Any discrepancies were resolved by consensus, and when agreement could not be reached, by the senior author (T.J.F.C.). A researcher (G.L.M.G.) from the team is fluent in Spanish and extracted data for the one non-English included study. The quality of included studies was assessed by 2 researchers (G.L.M.G. and L.B.) using the **M**ixed-**M**ethods **A**ppraisal **T**ool (MMAT),[18] which is applicable to multiple designs. Each study design has 5

items, which are rated as being present (yes), not present, or indeterminate. The total overall score (ranging from 0 to 5) and a detailed presentation of ratings are included in Table 1.

Full texts, figures, tables and supplementary materials of the results sections of the included studies were considered for data extraction, and all study results were synthesized in a tabular format. In accordance with the **S**ynthesis **Wi**thout **M**eta-analysis (SWiM) reporting guideline,[19] a formal narrative synthesis was used to analyze outcomes that could not be meta-analyzed. This decision was made after examining the outcomes from included studies. For those scales that were psychometrically validated, the quality of the psychometric properties was assessed using the quality criteria developed by Terwee et al.[20] Information about the educational interventions was described using the **T**emplate for **I**ntervention **D**escription and **R**eplication (TIDieR) framework for intervention description.[21] Due to the high level of heterogeneity in the data and intervention design, a meta-analysis was not performed.[20]

Results

Characteristics of included studies and participants

As outlined in the study selection PRISMA flow diagram (Fig. 1), the initial database search yielded 25,812 records. After duplicate studies and studies that did not meet eligibility criteria based upon titles and abstracts were excluded, 44 full-text articles were assessed for eligibility. Two potentially eligible studies were excluded following 2 unsuccessful attempts to contact all listed authors to obtain missing information. Overall, 15 studies were included in the review,[22-36] 14 in English and 1 in Spanish.[33]

Table 1 summarizes the characteristics of included studies. Studies were conducted in all World Health Organization's World Regions,[37] except for the Eastern Mediterranean Region, and were published from 2011 to 2023. Three studies were randomized controlled trials that used questionnaires to assess knowledge (Likert-type questions);[31,32,36] 5 were qualitative in design using semistructured interviews and focus groups discussions;[23,26,28-30] 6 were observational cross-sectional studies using online surveys (when reported, using multiple-choice questions);[22,24,25,27,34,35] and 1 was an educational intervention with a pre-post design using a questionnaire (multiple-choice questions) to assess knowledge.[33] The quality of each study is also shown in Table 1. Based on the MMAT, 9 of 15 included studies presented scores higher than 4 (out of 5), which indicates "good quality." [8] The median number of "yes" responses (indicating good quality) per study was indicating a score of 4 out of 5. No studies were excluded based on quality.

Overall, 1623 women participated in the included studies. All studies included women with a recent or past diagnosis of HDP, including 7 studies focused on preeclampsia.[24,26-28,30,32,36] Six studies also included women with a current diagnosis or a history of gestational diabetes,[22-25,29,33] and 3 women with a history of premature birth.[22,23,25] The mean age of participants was 30 years (age range reported as < 18 to > 45 years). Eight studies reported the ethnicity of participants,[22,25-27,31,32,34,35] with the majority being White, except in one study where the majority of participants were Hindu.[35] The duration postpartum ranged from 4 weeks to 5 years. Type of birth was only reported in one study, in which 35% of participants had a caesarean delivery.[27] Severity of HDP was reported in only 2 studies: one study reported maternal intensive care treatment in 24% of participants,[27] and another study reported that 2% of participants had Hemolysis, Elevated Liver enzymes and Low Platelets (HELLP) syndrome.[31]

Scales to measure awareness and knowledge of future cardiovascular risk

As shown in Table 1, a total of 10 studies used online surveys or questionnaires to measure knowledge outcomes, ranging from 1 to 51 question items.[22,24,25,27,31-36] No studies report classification criteria of questionnaire scores. Only 2 studies reported assessment of psychometric properties of the educational tools: 1 reported the assessment of content validity,[27] and 1 reported face validity[34]; however, numerical measurements of validity were not reported following Terwee et al.'s criteria.[20]

Characteristics of educational interventions

Table 2 presents the characteristics of educational interventions in the 4 interventional studies included in this review.[31-33,36] The timing of the education intervention ranged from 4 weeks to 12 months postpartum, with none being delivered prior to childbirth. As described, 2 studies provided a paper form of the educational materials (pamphlet or information sheet).[31,36] Two studies provided education as part of a structured program— one used an online intervention combining a website and a health behavioural coach,[32] and the other used in-person group sessions to deliver the education.[33] These interventions were described as being well attended, with most participants ($> 76\%$) attending one of the in-person or online sessions. Information regarding tailoring of educational tools to women with pregnancy complications was not provided in any of the studies.

Participant awareness and knowledge of future cardiovascular risk

In regard to the 7 studies that assessed knowledge of future CVD risk following preeclampsia,[24,26-28,30,32,36] participants qualitatively reported having "some knowledge" of their increased risk,[26,28] although in one study, knowledge was lacking.[30] An important finding from one study is that few participants learned of this risk association from their healthcare providers, but rather through social media.[27] In the 2 studies that provided education as part of a structured program, knowledge significantly increased among those receiving education ($P < 0.05$).[32,36]

In the remaining 7 studies that assessed women with a history of HDP,[22,23,25,29,31,34,35] results varied, but overall, participants had "some knowledge" about the increased risk of CVD; however, participants demonstrated a limited understanding of their individual risk and were unsure about the long-term impacts on future pregnancies and their future health. Similarly, at 1 month after an educational pamphlet intervention, the randomized controlled trial found no significant improvement in patients' general health knowledge, compared to that in the control group ($P = 0.11$).[31] However,

Table 1. Characteristics of the included studies (n = 15), psychometric properties of scales used to measure outcomes, and study results

Study Author (Year) Country	Methods Study design Setting Quality appraisal*	Participants Sample size Mean age/age range, y Ethnicity Number of wk postpartum Type of birth Severity of HDP	Outcome Method of data measurement Psychometric properties of tools	Results
Aldridge et al.[22] (2023) Australia	Observational cross-sectional Postpartum prevention clinic 3/5	Women with a history of HDP, gestational diabetes, or premature birth n = 188 Mean age: 32.8 (SD = 5.4) White = 63% 7 wk postpartum Type of birth = NR Severity = NR	Women's awareness of the link between pregnancy complications and future CVD Self-administered survey: 7 questions, 1 related to cardiovascular risk "After diagnosis of your complication, were you made aware of the link between pregnancy complications and the higher risk of heart disease down the track?" Psychometric properties were not assessed.	31% (n = 58) were aware of the association between pregnancy complications and CVD.
Andraweera et al.[23] (2022) Australia	Qualitative Tertiary care hospital 5/5	Women with a history of HDP, gestational diabetes, or premature birth n = 13 Age = NR Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's knowledge of long-term sequelae (including CVD) after experiencing a major pregnancy complication Focus group discussions: duration NR NA	Overall, women were aware that pregnancy complications had adverse impacts on health but did not have any knowledge about specific adverse impacts, including the CV impact.
Atkinson et al.[24] (2023) Australia	Observational cross-sectional Tertiary care hospital 4/5	Women with a history of preeclampsia or gestational diabetes n = 438 Age = NR Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's knowledge of CVD risk following a pregnancy affected by preeclampsia or gestational hypertension. Survey (51 items) Psychometric properties were not assessed.	62.6% (n = 273) were unaware of their increased risk of CVD following an HDP
Beussink-Nelson et al.,[25] (2022) USA	Observational cross-sectional Hospital 4/5	Women with a history of HDP, gestational diabetes, or premature birth n = 182 Mean age: 35.0 (SD = 4.0) White = 64.1% Wk postpartum = NR Type of birth = NR Severity = NR	Women's knowledge of CVD risk following a pregnancy complication Online survey: 5 items with a series of CVD risk factors and preventive behaviours, as well as factors that have no known impact on CVD risk and asked how each item affects the risk of heart disease for women. Psychometric properties were not assessed.	Among participants who experienced HDP, 79.5% identified hypertension during pregnancy as a risk factor for CVD. Among those who experience gestational diabetes, 71.1% identified gestational diabetes as a risk factor for CVD. In contrast, among participants who experienced premature birth, 15.4% identified premature birth as a risk factor for CVD.

Brown et al.[26] (2013) United Kingdom	Qualitative Postnatal clinic 5/5	Women with a history of preeclampsia n = 12 Age range: ≤ 25 = 1; 26−34 = 7; ≥ 35 = 4 White = 92% Median = 47 wk postpartum (range 24−62 wk) Type of birth = NR Severity = NR	Women's personal understanding and awareness of future cardiovascular risk. Semistructured interviews: 25−95 min duration. NA	Family history of CVD was associated with a greater awareness of future cardiovascular risk. Women without traditional CVD risk factors found it challenging to envisage themselves as being at risk and may not see the relevance of CVD education information. Recommendation of presenting information several months after delivery in order for a woman to be able to fully consider her own health as well as the baby's; reminders of risk and health information are needed.
Burgess et al.[27] (2019) USA	Observational cross-sectional Facebook preeclampsia support groups 3/5	Women with a current diagnosis or history of preeclampsia n = 241 Age range: ≤ 18 = 1; 19−25 = 33; 26−30 = 62; 31−34 = 79; 35−39 = 42; ≥ 40 = 24 White = 82% 2−5 y postpartum = 70% C-section = 35% Maternal ICU admission = 27%	Women's self-reported knowledge of the association between preeclampsia and CVD. Online survey (closed responses; other details were NR). Content validity: the survey was reviewed by content experts to improve validity. Results for this psychometric property were NR.	63% (n = 152) reported being aware of the association between preeclampsia and CVD. More than half (51%, n = 77) of the participants reported learning of the association from social media. Only 39% (n = 60) reported learning of this association from their healthcare providers.
Dijkhuis et al.[28] (2020) Netherlands	Qualitative HELLP Foundation online platform 5/5	Women with a current diagnosis of preeclampsia or gestational hypertension n = 15 Age range: between 25 and 45 Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's knowledge about CVD risk associated with preeclampsia or gestational hypertension, current and future follow-up. Semistructured interviews: 20−40 min duration; questions divided into 3 categories (current knowledge of CVD following preeclampsia, current interventions and follow-up, and future follow-up). NA	Women had "some knowledge" about their increased CVD risk following preeclampsia. Many participants demonstrated a limited understanding of their personal risk and reported a lack of information provided on future risk.
Nagraj et al.[29] (2019) India	Qualitative Community centres 5/5	Women with a history of HDP or gestational diabetes n = 24 Age = NR Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's perceptions of long-term complications associated with HDP and diabetes in pregnancy. Semistructured interviews and focus group discussions: 30−60 min duration. NA	Pregnant women were unsure about the long-term consequences of high-risk conditions in pregnancy in relation to future pregnancies and their own future health.
Nielsen et al.[30] (2022) Denmark	Qualitative Tertiary care hospital 5/5	Women with a history of preeclampsia n = 10 Age range: between 38 and 53 Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's awareness of preeclampsia and the increased risk of CVD later in life. Semistructured interviews: duration NR NA	Awareness of the increased risk of later CVD associated to preeclampsia was lacking among participants.

Continued

Table 1. Continued.

Study Author (Year) Country	Methods Study design Setting Quality appraisal*	Participants Sample size Mean age/age range, y Ethnicity Number of wk postpartum Type of birth Severity of HDP	Outcome Method of data measurement Psychometric properties of tools	Results
Parfenova et al. [31] (2021) Canada	Randomized controlled trial HDP postpartum clinics 5/5	Women with a recent history of HDP n = 113 Mean age: 30.7 (SD = NR) White = 89% 4 wk to 12 mo postpartum Type of birth = NR HELLP syndrome = 2%	Women's knowledge about risks of HDP in the next pregnancy, long-term health risks associated with CVD, and risk perception. Questionnaire:15 Likert-type questions (range 1−6) related to pregnancy risk and risk perception. Psychometric properties were not assessed.	Knowledge subscore of risk for future pregnancy and subscore for risk for future health were both significantly improved between groups at 1 month and in the intervention group between baseline and 1 month. There was no difference in the perception of global cardiovascular risk between groups at 1 mo (control 4.0 ± 0.97 vs intervention 4.3 ± 0.94; $P = 0.11$). The same was found within each group from baseline to 1 mo (control 3.9 ± 1.14 vs 4.0 ± 0.97; $P = 0.43$; intervention: 4.0 ± 0.78 vs 4.3 ± 0.94; $P = 0.09$).
Rich-Edwards et al.[32] (2019) USA	Randomized controlled trial Internet-based 4/5	Women with a recent history of preeclampsia (< 5 y) n = 151 Mean age: 31.1 (SD = 4.7) White = 82% 58% < 1 y postpartum Type of birth = NR Severity = NR	Women's knowledge about CVD risk after preeclampsia. Questionnaire: results based on the question "How informed are you about hypertension and heart disease in women who have had preeclampsia?" (Likert scale: not at all; moderately; well; very well informed). Psychometric properties were not assessed.	The degree to which participants reported being informed about the risk of hypertension and CVD in women with a history of preeclampsia increased in both groups over follow-up. The increase in knowledge was significantly higher among intervention arm participants ($P = 0.01$).
Rivas-Blasco et al. [33] (2021) Venezuela	Interventional pre-post study Public hospital 2/5	Women with gestational diabetes n = 62 Mean age: 31.0 (SD = 6.4) Ethnicity = NR 2 to 12 mo postpartum Type of birth = NR Severity = NR	Women's knowledge about cardiometabolic risk after gestational diabetes. Questionnaire: The Cardiometabolic Risk has 20 multiple choice items and was developed by coauthors. Psychometric properties were not assessed.	Total knowledge score was 10.45/20 (SD = 3.16) pre-intervention and 14.82/20 (SD = 2.76) post-intervention ($P < 0.001$).
Roth et al.[34] (2020) Australia	Observational cross-sectional Social media 2/5	Women with a history of HDP n = 174 Age range: 18−25 = 12; 26−35 = 117; 36−45 = 126; ≥ 45 = 10; NR = 1 White = 89% Less than 3 y postpartum Type of birth = NR Severity = NR	Women's knowledge regarding long-term cardiovascular health after HDP. Online survey (details NR) Face validity: the survey was reviewed by 24 volunteers (patients) to assess face validity.	Total knowledge score was 5.6/10 with 33% having high level of knowledge. Women had "high" level of knowledge with regard to recurrence of HDP in a subsequent pregnancy and risk of future chronic hypertension, but "low" level of knowledge about risk of future diabetes.

Sangeetha & Baby[35] (2018) India	Observational cross-sectional Tertiary care hospital 1/5	Women with a history of HDP n = 100 Age range: 26–30 = 79; NR = 21 Hindu = 57% Wk postpartum = NR Type of birth = NR Severity = NR	Women's knowledge, attitudes, and practice regarding preeclampsia. Online survey: 20 items Psychometric properties were not assessed.	71 women (71%) had moderately adequate knowledge, 28 (28%) had inadequate knowledge, and only 1% had adequate knowledge.
Van der Merwe et al.[36] 2011 South Africa	Randomized controlled trial Tertiary and secondary referral centres 1/5	Women with early-onset preeclampsia n = 74 Mean age: 26.9 (SD = NR) Ethnicity = NR Wk postpartum = NR Type of birth = NR Severity = NR	Women's understanding and knowledge about preeclampsia, including CVD risk. Questionnaire: 22 questions, 5 questions (Likert-type) investigated the patients' understanding of the immediate and long-term risks to patient and baby. Psychometric properties were not assessed.	Participants in the intervention group significantly improved their understanding of CVD risk ($P < 0.01$).

CVD, cardiovascular disease; HDP, hypertensive disorders of pregnancy; HELLP, hemolysis, elevated liver enzymes and low platelets; ICU, intensive care unit; NA, not applicable; NR, not reported; SD, standard deviation.

*Assessed using the Mixed Methods Appraisal Tool (MMAT).

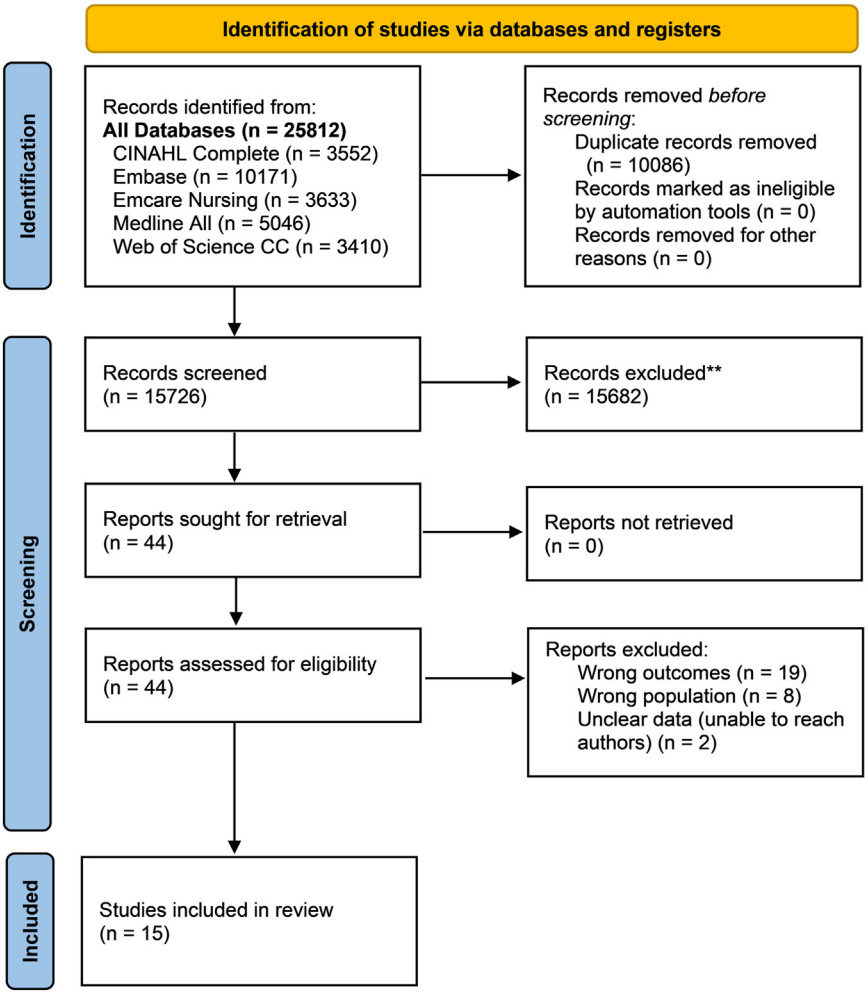

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) study flow diagram.[16] CINAHL, Cumulative Index to Nursing and Allied Health Literature (EBSCO); Web of Science CC, Web of Science Core Collection. For more information, visit: http://www.prisma-statement.org/.

women who received the educational pamphlet had a significantly higher level of perception of risk specifically for heart disease ($P = 0.04$).[31]

In 6 studies focused on women with a history of gestational diabetes, women were unsure about the long-term impacts of pregnancy complications on future pregnancies and their future health.[22-25,29,33] However, in the one study that used in-person group sessions to deliver the education for this population, a significant improvement in participant knowledge was noted.[33] Finally, among the 3 studies of women with a history of premature birth, women were somehow aware of the CVD risk associated with their pregnancy complication, although no specific data regarding their awareness were included.[22,23,25] When awareness was reported,[22,24,27,34,35] a median of 38% of women participants were aware of the link between pregnancy complications and an increased CVD risk.

Discussion

Overall, a paucity of published research has focused on the awareness of the long-term health impacts of several pregnancy complications (HDP and gestational diabetes) among women who experienced these conditions. The limited data to date are important in that they identify major knowledge gaps regarding future health risks among women who have experienced HDP (including preeclampsia) and gestational diabetes. Although the 4 educational intervention studies suggest that education has a small positive impact on patient awareness and knowledge about future cardiovascular risk, many of these improvements were not statistically significant, and the interventions differed substantially; thus, no information clearly identifies the most effective clinical tools to educate this high-risk population. Further, evaluation data are limited regarding the impacts of knowledge uptake on patient-focused outcomes of health behaviour change and/or self-management of future risk. Further, this systematic review did not identify any psychometrically validated scales to measure patient awareness and knowledge of future cardiovascular risk. Together, these findings underscore the need for targeted research to examine patient preferences and impacts of health education interventions on a range of measurable outcomes, including knowledge, self-efficacy, quality of life, health behaviours (physical activity, nutrition, etc.), cardiovascular risk factors (eg, blood pressure, weight, cholesterol,

Table 2. Characteristics of educational interventions (n = 4)

Study	Items included in the TIDieR checklist*									
Author (year) Country	*Brief name*	*Why*	*What*	*Who provided*	*How*	*Where*	*When How much*	*Tailoring*	*Modifications*	*How well*
Parfenova et al.[31] (2021) Canada	Educational pamphlet	To inform women with a recent history of HDP and compare knowledge about future health risks after reading an educational pamphlet	A 2-page pamphlet with information in French about HDP, causes and risk factors, risks for recurrence in future pregnancies, long-term health risks including cardiovascular diseases, and strategies to mitigate those risks.	Research assistant	Pamphlet given to patient in-person	After clinic physician consultation	4 wk to 12 mo postpartum NA	NR	R	NR
Rich-Edwards et al. [32] (2019) USA	Heart Health 4 Moms (HH4M)	Improve outcomes in women that had preeclampsia in the past 5 years	Website: audiovisual modules on topics, including healthy eating, using the balanced plate and modeled on the DASH diet, increasing physical activity, and identifying promoters and barriers to adopting a healthy lifestyle. Personalized lifestyle coaching Online community forum: where patients could communicate with each other and the lifestyle coach, as well as access a toolbox of additional resources (eg, meal plans, recipes, and exercise videos)	Registered dietitian trained in patient-centred counselling	Internet and phone calls	Home	58% < 1 y postpartum Coaching was provided through 6 scheduled calls and 3 scheduled e-mails for 3 mo, with interim ad hoc communication as initiated by participants.	NR	NR	99% accessed the intervention website; 84% accessed at least one educational module on the website; 89% completed at least 3 of the 6 scheduled calls with the lifestyle coach.
Rivas-Blasco et al [33] (2021) Venezuela	Programa Educativo (PE) †	Increase knowledge in women with previous gestational diabetes on cardiometabolic risk and recommendations to reduce it.	Session schedule: introductions by the facilitator, round of introduction by participants; content presented via Powerpoint, question and answer period, and physical activity demonstration. Educational content: maternal metabolic risk, nutritional guidance, food portions, physical exercise, pulse count, how to relax and manage stress.	Multidisciplinary team: a medical specialist in internal medicine and diabetes, a medical specialist in internal medicine with training in sports health, a diabetes nurse educator, and a dietitian.	Face-to-face groups of a maximum of 9 women with partners or relatives	Public hospital	2 to 12 mo postpartum 4 interactive theoretical-practical sessions lasting 2 h for 4 wk, for a total of 8 h	NR	NR	70 (76%) participated in the educational sessions, with 62 (68%) attending all sessions.
Van der Merwe et al.[36] (2011) South Africa	Information sheet	To provide information about preeclampsia.	A double-sided, patient information sheet	NR	Pamphlet given to patient in-person	Tertiary and secondary referral centres	Timing of intervention NR NA	NR	NR	NR

DASH, dietary approaches to stopping hypertension; HDP, hypertensive disorders of pregnancy; NA, not applicable; NR, not reported; TIDieR, Template for Intervention Description and Replication.

* Information to include when describing an intervention.

† Name of intervention in Spanish.

etc.), and cardiovascular events (myocardial infarction and stroke) among women with a history of pregnancy complications.

The number of available health questionnaires to assess health knowledge and status has increased dramatically over the past several years; consequently, the choice of which specific questionnaire to use for outcome evaluation is becoming difficult. Surprisingly, none of the questionnaires and surveys included in the studies was psychometrically validated specifically for women who have had pregnancy complications. Only 2 studies reported evaluation of any psychometric properties (specifically, content and face validity); however, the actual psychometric properties were not reported following the quality criteria recommended by Terwee et al.[21] This finding highlights the need to develop and psychometrically validate an evaluation tool that can be easily used to assess awareness and knowledge about cardiovascular risk and that is specifically tailored for women with a history of pregnancy complications. An important point to note is that, although the basis of validity testing has been the statistical properties of a scale and the assessment of its properties, the literature recommends the need to not only assess properties but *investigate*, through a range of methods, the extent to which a proposed interpretation and use of scale scores is justified.[38]

Knowledge and awareness of CVD risk is a challenging construct to assess given the multiple components of risk (ie, traditional CVD risk factors, sex-specific risk factors), varying patient health literacy levels, etc. This challenge is evidenced in the large variations in aspects of awareness and knowledge about CVD risk assessed in the included studies. For example, some studies included only one high-level question to measure "how informed women were about hypertension and heart disease" in women who had preeclampsia,[32] whereas other studies used further questions[22,24,25,27,31,33-36] and hours of interviews and focus groups[23,26,28-30] to understand various factors related to CVD knowledge. The latter may provide more insights into development of educational tools. Assessment of women's knowledge was also limited by the lack of standardization of terminology used in assessment tools. For example, some studies used the words "understanding" and "perceptions," thus distinguishing between direct knowledge and how women at risk may understand or perceive their risk. This distinction is important, as risk perception is often considered a foundational component of health behaviour change interventions and theories.[39] Sheeran et al.'s meta-analysis suggests that interventions that successfully change participants' risk perceptions lead to improvements in health behaviours.[40] Therefore, assessment of risk perception, as well as of knowledge, should be included in future research on effects of health educational interventions for women after they have had pregnancy complications.

Effective health education tools may increase patient involvement in and confidence in shared decision-making. Women with pregnancy complications often face additional challenges in the early postpartum period while they are managing the acute illness and complex health needs of their infants, although no study specifically examined barriers and facilitators to knowledge acquisition. These challenges, may, in part, underlie the findings of other studies demonstrating that these women often are dissatisfied with the amount, type, and timing of health information and communication provided by healthcare providers.[41,42] Thus, research should focus on not only the educational content, but also the timing and communication of individualized education on future health risks.

This systematic review has limitations that warrant caution when interpreting the study findings. First, the synthesis of the included studies was conducted through narrative analysis, as a meta-analysis was not possible due to the heterogeneity of the included study designs, interventions, and outcome measures. Second, only 3 studies applied randomization; therefore, the majority of study results were based on lower-quality methodological designs. Third, in the 8 studies that reported ethnicity, the majority of participants were White, except in one study where the majority were Hindu; therefore, the burden of pregnancy complications and CVD risk in marginalized populations was not represented. This information also highlights the underrepresentation of marginalized populations in this research area. Fourth, only 3 studies included preterm birth—a complication of pregnancy known to be associated with increased cardiovascular risk. Hence, the evidence may not be necessarily generalizable to this condition. Fifth, although this review included studies published in any language, the grey literature was not searched. Finally, confounding factors associated with knowledge/awareness of CVD risk in this population should be explored in future research.

Conclusion

This systematic review identifies major research gaps in the education of women with pregnancy complications (HDP and gestational diabetes mellitus) regarding future cardiovascular risk. These include nonstandardized education tools and content, a lack of understanding of patient preferences, and of barriers and facilitators to patient knowledge acquisition, and a lack of validated tools to measure patient knowledge and risk perceptions. The need is urgent to co-design and evaluate evidence-based educational interventions tailored specifically for women who have had pregnancy complications, to ultimately improve their cardiovascular health and quality of life.

Ethics Statement

This research reported has adhered to the relevant systematic review ethical guidelines.

Patient Consent

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

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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.2023.07.010.