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SUPPLEMENT ARTICLE

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Hypertensive disorders of pregnancy and long-term cardiovascular health: FIGO Best Practice Advice

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Abstract

Hypertensive disorders of pregnancy (HDP) are the most common causes of maternal and perinatal morbidity and mortality. They are responsible for 16% of maternal deaths in high-income countries and approximately 25% in low- and middle-income countries. The impact of HDP can be lifelong as they are a recognized risk factor for future cardiovascular disease. During pregnancy, the cardiovascular system undergoes significant adaptive changes that ensure adequate uteroplacental blood flow and exchange of oxygen and nutrients to nurture and accommodate the developing fetus. Failure to achieve normal cardiovascular adaptation is associated with the development of HDP. Hemodynamic alterations in women with a history of HDP can persist for years and predispose to long-term cardiovascular morbidity and mortality. Therefore, pregnancy and the postpartum period are an opportunity to identify women with underlying, often unrecognized, cardiovascular risk factors. It is important to develop strategies with lifestyle and therapeutic interventions to reduce the risk of future cardiovascular disease in those who have a history of HDP.

KEYWORDS
blood pressure, cardiovascular function, cardiovascular risks, diet, hypertensive disorders, lifestyle modification, long-term health, pre-eclampsia, pregnancy

1 | INTRODUCTION

Hypertensive disorders of pregnancy (HDP) are the most common causes of maternal and perinatal morbidity and mortality.[1–3] They are responsible for 16% of maternal deaths in high-income countries and approximately 25% in low- and middle-income countries.[4,5] The impact of HDP can be lifelong as they are a recognized risk factor for future cardiovascular disease (CVD).

2 | MATERNAL CARDIOVASCULAR FUNCTION IN PREGNANCY

2.1 | Cardiovascular adaptions in normotensive pregnancy

Pregnancy is a unique condition that greatly changes a woman's physiology and is considered an early stress test for CVD.[6] During pregnancy, the cardiovascular system undergoes significant adaptive changes that ensure adequate uteroplacental blood flow and exchange of oxygen and nutrients to nurture and accommodate the developing fetus (Figure 1).[7] The adaptation to volume and pressure overload results in significant alterations in cardiac geometry and function starting from early pregnancy. Optimal maternal cardiovascular adaptation leads to increased blood volume and left ventricular mass, with concomitant increase in stroke volume, heart rate, and cardiac output; plasma volume expansion is more than compensated for by decreased systemic vascular resistance (SVR), resulting in slightly decreased blood pressure.[7–9] Following pregnancy, the physiological cardiac function normally returns to baseline without long-term risks to maternal health.[10,11]

2.2 | Cardiovascular changes in women with hypertensive disorders of pregnancy

Failure to achieve normal cardiovascular adaptation is associated with development of HDP.[12,13] The maternal hemodynamic alterations associated with HDP are likely to be the consequence of pre-existing maternal cardiovascular impairment and/or chronic changes in cardiovascular load during pregnancy.[14] These cardiovascular changes, which correlate with disease severity,[15–20] are initiated from the first trimester[21] and can be detected before the condition becomes clinically apparent.[22,23] More importantly, the hemodynamic alterations can persist for years and predispose the woman to long-term cardiovascular morbidity and mortality.[24,25]

Pregnancies complicated by HDP are generally characterized by a significantly increased left ventricular mass,[26–31] concentric hypertrophy,[27,28,32] and increased SVR[13,26,30,31,33] compared with normotensive pregnancy. Specifically, pregnant women with chronic hypertension are characterized by persistent high SVR and reduced intravascular volume expansion throughout pregnancy compared with normotensive pregnancy[34]; while evidence on cardiovascular changes in gestational hypertension is conflicting.[13,22,26,30,33,35,36] Stroke volume and myocardial performance index are expected to be reduced in pre-eclampsia compared with normotensive pregnancy.[37,38] Cardiac dysfunction can be found in up to 45% of women with pre-eclampsia.[38,39] It has been demonstrated that

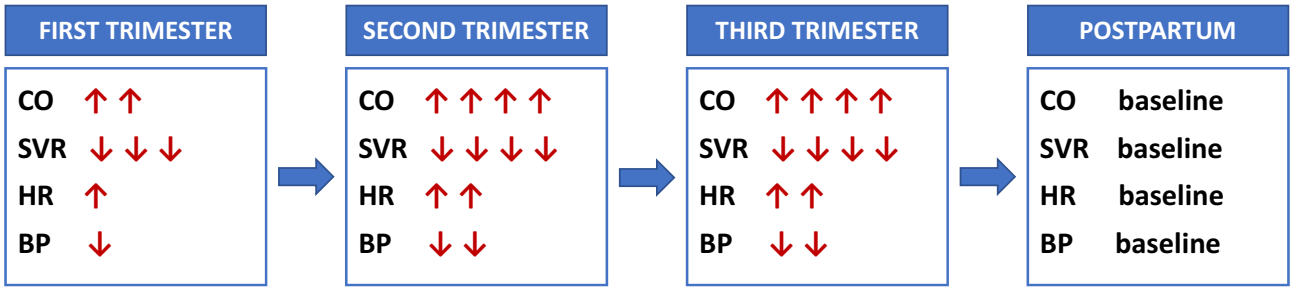

FIGURE 1 Hemodynamic changes associated during pregnancy and postpartum. CO, cardiac output; BP, blood pressure; HR, heart rate; SVR, systemic vascular resistance. ↑: 10% increase from baseline per arrow; ↓: 10% decrease from baseline per arrow. Adapted with permission granted by Elsevier, from Khedagi et al[152]

pre-eclampsia has a greater effect on the cardiovascular systems than gestational hypertension, and changes are most pronounced in early-onset pre-eclampsia or pre-eclampsia with severe features.[16] Pregnancy and the postpartum period are an opportunity to identify women with underlying, often unrecognized, cardiovascular risk factors. It is important to develop strategies with lifestyle and therapeutic interventions to reduce the risk of future CVD in those with a history of HDP.

3 | FUTURE HEALTH COMPLICATIONS IN WOMEN WITH HYPERTENSIVE DISORDERS OF PREGNANCY (BOX 1)

BOX 1 Future health complications in women with hypertensive disorders of pregnancy (HDP)

Recurrence of HDP in subsequent pregnancies:
- Gestational hypertension
- Pre-eclampsia
- Eclampsia
- HELLP syndrome

Cardiovascular risks and disease:
- Chronic hypertension
- Coronary artery disease
- Peripheral vascular disease
- Heart failure
- Stroke
- Cardiovascular disease-related mortality

Neurological disorders:
- Epilepsy
- Dementia

Kidney diseases:
- Chronic kidney disease
- End-stage kidney disease

Type 2 diabetes mellitus

Metabolic disorders:
- Obesity
- Insulin resistance
- Elevated fasting blood sugar
- Dyslipidemia
- Microalbuminuria

Venous thromboembolism

3.1 | Subsequent pregnancy

3.1.1 | Strategies for minimizing recurrence risks

Best practice advice
- Women with previous HDP are offered first-trimester combined screening for individualized assessment of the risk of recurrence[3]
- Women at high risk of developing recurrent HDP should be recommended to take aspirin prophylaxis
- Following a pregnancy complicated by HDP, postnatal women should be informed of the risks of recurrence in future pregnancies and advised that dietary and lifestyle modifications can reduce such risks
- Written information regarding the risks of recurrence in future pregnancies and the measures for reducing such risks should be provided to postnatal women before being discharged from the maternity unit or hospital

Pragmatic practice advice
- Where resources are limited, first-trimester screening for individualized assessment of the risk of recurrence is based on maternal factors and mean arterial pressure

HDP have a recurrence rate of 20%–50% in a subsequent pregnancy.[40–45] Recurrence risks are further modified by the presence of any additional risk factors[40,46–53] as well as the gestational age at the time of onset of HDP in the index pregnancy.[41,46–48,51,53–55]

FIGO encourages all countries and its member associations to adopt and promote resource appropriate strategies for pre-eclampsia screening and prevention. FIGO has recommended that the baseline screening test should be a combination of maternal factors and mean arterial pressure.[3,56] There is substantial evidence that prophylaxis with low-dose aspirin reduces the rate of pre-eclampsia by 12%–33%. In line with previous FIGO documents on screening and prevention of pre-eclampsia, low-dose aspirin is more effective in reducing the rate of preterm pre-eclampsia in high-risk women when taken as a daily dose of ≥100 mg and initiated at ≤16 weeks of gestation.[3,56–58]

It is important to counsel women with a history of HDP on the benefits of dietary and lifestyle modification to reduce the risk of HDP in future pregnancies.[59–61] It has been demonstrated that adequate consumption of vegetables (OR 0.38; 95% CI, 0.18–0.80)

and fruits (OR 0.42; 95% CI, 0.24–0.71) and adoption of the DASH (Dietary Approaches to Stop Hypertension) diet, which consists of fresh vegetables, fruits, low-fat dairy products etc., could reduce the incidence of pre-eclampsia and HDP in the general pregnant population,[62,63] as well as in women diagnosed with either gestational hypertension or chronic hypertension compared with the control diet (43.2% vs 65.9%, $P = 0.036$).[64] Extensive evidence has demonstrated that physical activity before and during pregnancy is associated with a significantly lower risk of developing HDP.[65–68] A meta-analysis has demonstrated that regular physical activity could reduce the risk of HDP (OR 0.66; 95% CI, 0.48–0.90) and other maternal adverse outcomes in the general pregnant population.[65] Aerobic exercise for 30–60 min 2–7 times per week is associated with a significantly lower incidence of HDP (RR 0.70; 95% CI, 0.53–0.83).[66] Based on this evidence, it is reasonable to deduce that dietary and lifestyle modifications before future pregnancy would be beneficial for those with a history of HDP to reduce the risk of recurrence.

3.2 | Cardiovascular risks

3.2.1 | Cardiovascular risk assessment in women with a history of HDP

Best practice advice

- Following a pregnancy complicated by HDP, women should undergo cardiovascular and metabolic risk screening in the first year postpartum (typically around 6 months)

Pragmatic practice advice

- Where resources are limited, following a pregnancy complicated by HDP, women should have their blood pressure assessed and treated (if necessary) annually starting within the first year postpartum

Pregnancy is considered a cardiovascular stress test.[69,70] Failure of appropriate cardiovascular adaptation during pregnancy (i.e., development of HDP)[71] leads to the unmasking of physiological susceptibility to and risk of future CVD.[72,73] It is also possible that HDP contribute to the future CVD. Therefore, pregnancy and the postpartum period provide a unique early window of opportunity to estimate a woman's lifetime cardiovascular risk and consider intervention.[69,71,72,74]

A number of international guidelines now identify pregnancy and HDP as important opportunities for the identification and modification of an individual's cardiovascular risk.[75–78] Several risk assessment calculators have been proposed for the estimation of cardiovascular risk.[79–86] However, each of these multivariate risk models has its advantages and disadvantages; no single cardiovascular risk assessment tool is appropriate for all populations. It is recommended that healthcare professionals should take several factors into consideration beyond the single risk score system when making decisions about the intensity of preventive therapy.[78] Regarding women with HDP, these risk scores might be less applicable as these women are still young and will have a low baseline risk of CVD within the coming 10 years. Thus, even if a woman's individual risk for hypertension and CVD is increased by 2–6-fold after a pregnancy complicated by pre-eclampsia, her individual risk might still be too low to be picked up by the risk scoring system that is primarily constructed for middle- or older-aged people. By the time that this woman reaches middle age, other risk factors might already have overshadowed the risk conferred by pre-eclampsia and she might already have developed hypertension or other cardiovascular risks.

Women with HDP are more likely to develop cardiovascular risks and CVD within five years after delivery compared with those who have experienced a normotensive pregnancy. Extensive evidence has concluded that HDP are associated with an increase in the risk of developing hypertension within five years after birth.[87–89] A study of 1 452 926 singleton pregnancies showed that women with HDP had double the risk of developing acute myocardial infarction, stroke, or heart failure within three years of delivery compared with women without a history of HDP, although the absolute risk is still very low.[90] HDP are also associated with an increased risk of coronary artery disease (HR 2.80; 95% CI, 2.02–3.88) and maternal mortality (HR 1.67; 95% CI, 1.16–2.41) compared with those without HDP within one year after delivery.[91] This trend attenuates but remains significant over the next four years.[91]

A recent meta-analysis involving more than 13 million women has confirmed that those with a history of HDP have approximately double the risk of long-term CVD-related morbidity and mortality.[73] In particular, compared with normotensive pregnancies, HDP are associated with greater risks of coronary artery disease (RR 1.66; 95% CI, 1.49–1.84), heart failure (RR 2.87; 95% CI, 2.14–3.85), peripheral vascular disease (RR 1.60; 95% CI, 1.29–2.00), stroke (RR 1.72; 95% CI, 1.50–1.97), hypertension (RR 3.16; 95% CI, 2.74–3.64), and CVD-related mortality (RR 1.78; 95% CI, 1.58–2.00). The cardiovascular risk also depends on specific pregnancy characteristics. Early-onset pre-eclampsia is associated with a higher burden of CVD-related morbidity and mortality compared with late-onset pre-eclampsia[92] Moreover, severe pre-eclampsia or HDP in more than one pregnancy is associated with a greater risk of premature CVD.[93–95] In contrast, having one or more subsequent normotensive pregnancies after the first pregnancy with pre-eclampsia would significantly reduce the risk of maternal cardiovascular death.[96]

Recently, the American Heart Association (AHA) and American Stroke Association recognized the pregnancy-related disorders of pre-eclampsia, gestational hypertension, and gestational diabetes as female-specific risk factors for CVD, including stroke.[97]

3.3 | Other associated risks

Women with pregnancy disorders such as pre-eclampsia are at greater risk not only of later CVD but also of neurological, renal, and metabolic disorders, and venous thromboembolism (VTE).

Women with previous pre-eclampsia, particularly eclampsia, experience poorer cognitive function months to years after pregnancy[98–100] and a 3–4-fold increased risk of dementia later in life, in

particular vascular dementia.[99,101] In addition, women with previous pre-eclampsia and eclampsia have a 2- and 6-fold increased risk of epilepsy, respectively.[102]

Women with a history of HDP are at increased risk of chronic kidney disease and end-stage kidney disease: 1.5- and 2-fold increased risk for women with gestational hypertension, and a 2- and 5-fold increased risk for women with pre-eclampsia, respectively, compared with normotensive women.[103,104] However, the incidence of end-stage kidney disease is still very low.[105]

Furthermore, women who have had any HDP also have a 2–3-fold increased risk of type 2 diabetes later in life.[106] This increased risk is slightly attenuated to 1.9-fold but still significant when controlling for important confounding factors, namely body mass index (BMI), chronic hypertension, and gestational diabetes.[106] Women with pre-eclampsia also run an increased risk of metabolic syndrome. There are different definitions of metabolic syndrome, but all include several of the following: obesity, hypertension, insulin resistance, elevated fasting blood sugar, dyslipidemia, and microalbuminuria.[107] In a recent meta-analysis, five observational studies including 55 000 women showed a moderately increased adjusted OR of 1.67 for development of metabolic syndrome later in life. However, the included studies seldom adjusted for confounding factors and the association might be driven mainly by other factors such as increased BMI during pregnancy.[108]

Pre-eclampsia is also a risk factor for later VTE. A meta-analysis of three studies demonstrated RR of 1.79 (95% CI, 1.37–2.33). One of the studies adjusted for smoking and socioeconomic status.[25] These results were later confirmed in another population-based study, when also excluding events in the first 3 months postpartum and adjusting for age, country of birth, and number of previous pregnancies. Women with pre-eclampsia then had an incidence rate of 4.3 (3.7–5.0) per 10 000 person-years, yielding HR of 2.1 (1.8–2.4), compared with women with normotensive pregnancies.[109]

4 | MANAGEMENT

4.1 | Interventions for minimizing medium- to long-term health risks

Best practice advice

- Initiate targeted interventions to improve cardiovascular risk following pregnancies complicated by HDP during the postpartum period
- Postpartum recommendations for women with pregnancy-related cardiovascular risk indicators include breastfeeding and lifestyle modifications such as a heart-healthy diet and appropriate physical activity
- Longer breastfeeding duration is recommended to improve cardiometabolic risks and reduce the risk of future CVD
- At least 150 min of moderate-intensity exercise or more than 75 min of high-intensity exercise per week is recommended to reduce the risk of future CVD
- The importance of and options for contraception must be explained and provided

The postpartum period represents a critical window to initiate targeted interventions to improve cardiovascular risk following pregnancies complicated by HDP. Postpartum recommendations for women with pregnancy-related cardiovascular risk indicators include breastfeeding and lifestyle modifications, such as a heart-healthy diet and appropriate physical activity.[86,110]

Breastfeeding provides optimal nutrition for newborns and has many important non-nutritional benefits for the child and the mother. The benefits of breastfeeding for women who are at risk of future CVD have been well documented.[111–115] A recent meta-analysis involving 1 192 700 women showed that breastfeeding is associated with a significantly reduced maternal risk of CVD (HR 0.89; 95% CI, 0.83–0.95), coronary artery disease (HR 0.86; 95% CI, 0.78–0.95), stroke (HR 0.88; 95% CI, 0.79–0.99), and maternal CVD-related death (HR 0.83; 95% CI, 0.76–0.92).[116] Furthermore, longer breastfeeding duration can be beneficial to reduce multiple cardiovascular risk factors that can lead to future CVD.[117,118] However, one of the biggest challenges is that women with HDP are more likely to stop breastfeeding when compared with normotensive women.[119,120] Therefore, healthcare professionals should promote and support breastfeeding for this high-risk population via appropriate education on lactation-associated maternal cardiovascular benefits.

The DASH diet has been demonstrated to reduce the 10-year Framingham risk score (FRS) for CVD by 13%.[121] Physical activity has been shown to reduce the risk of CVD and increase life expectancy.[122,123] At least 150 min of moderate-intensity exercise (fast walking, biking, active yoga, light swimming, etc.) or more than 75 min of high-intensity exercise (jogging, running, cycling, tennis, intensive swimming, etc.) per week is recommended to reduce the risk of future CVD.[86] More importantly, physical activity programs involving women with HDP during the postpartum period have been shown to improve cardiovascular risk indicators.[124] An observational cohort study, the Nurses' Health Study,[125] demonstrated that increased risk of chronic hypertension after gestational hypertension disorders was attenuated by a healthy lifestyle, whilst maintaining a healthy BMI was particularly important in women with a history of gestational hypertension compared with those without.

A woman's awareness of her own cardiovascular risk can be associated with initiation of preventive actions,[126] highlighting the need for targeted cardiovascular risk and CVD educational interventions. One study investigated the effect of an online education program to increase awareness of cardiovascular risk factors in women who had pre-eclampsia in the 5 years preceding enrolment.[127] Compared with those who did not participate in the online program, women who had online education reported an increase in knowledge of cardiovascular risk factors, self-efficacy for healthy eating, and physical activities. **Thus, combined educational, nutritional, and physical activity programs targeting an individual's specific needs are likely to be the most effective approach in reducing cardiovascular risk.**

In terms of pharmacological interventions, antiplatelet agents (primarily low-dose aspirin) have been shown to reduce the risk of pre-eclampsia and delivery of small-for-gestational-age neonates.[57,128] A

prospective cohort study demonstrated that women with a history of HDP who were not taking aspirin experienced a higher risk of having a stroke before the age of 60 (adjusted HR 1.5; 95% CI, 1.0–2.1) than women without a history of HDP. Taking aspirin regularly is associated with a nonsignificant reduction in the risk of stroke before age 60 among women with a history of HDP (adjusted HR 0.8, 95% CI, 0.4–1.7). In contrast, statins have not been shown to have any benefits in reducing this risk.[129] However, high-quality evidence to confirm these findings is lacking, and the effects of aspirin on other cardiovascular events in women with a history of HDP remain uncertain. It is important to note that the use of aspirin for an extended period is related to a 46% increased relative risk of major bleeding events.[130] Therefore, these therapeutic agents are not currently recommended for the primary prevention of CVD in women with a history of HDP.

4.2 | Optimal short-, medium-, and long-term follow-up plans

4.2.1 | When

Best practice advice

- Following a pregnancy complicated by HDP, women should be followed up within a relatively short time postpartum, ideally within the first week and at 6–12 weeks. It is essential to link up with clinical management for other pregnancy complications or the newborn vaccination program (soon after birth, 6 weeks, 6 months, and 12 months after birth)
- Following a pregnancy complicated by HDP, women should be followed up for blood pressure assessment every 6–12 months and cardiovascular screening at least every 4–6 years

4.2.2 | Short to medium term

Evidence indicates that cardiovascular risk screening for women experiencing HDP should be carried out within the first year postpartum.[131] Early intervention for women with underlying cardiovascular risk can potentially inhibit progression of the disease process. Furthermore, other cardiovascular risk factors, including weight gain or retention postpartum,[132] increase the risk of future pregnancy complications. Therefore, earlier identification allows for more realistic timeline goals to improve future pregnancy outcomes. It is also essential to link up with clinical management for other pregnancy complications or the newborn vaccination program. Specifically, guidelines for women who have had a pregnancy complicated by gestational diabetes recommend a hemoglobin A1c (HbA1c) test between 6 weeks and 6 months postpartum.[133,134] The World Health Organization recently updated the recommendations for routine immunization for newborns and children, which highlight four main timepoints during the first year postpartum, including soon after birth, 6 weeks, 6 months, and 12 months after birth.[135] Combining the newborn vaccination schedule and short-term maternal cardiovascular follow-up would be optimal to enhance maternal adherence to the postpartum follow-up plan. A recent AHA statement has proposed that cardiovascular screening, including measurement of blood pressure and BMI and lifestyle counselling should be carried out at 6 weeks, 12 weeks, 6 months, and 12 months postpartum for women who have experienced HDP (Figure 2).[136]

4.2.3 | Longer term

Women who have an identified cardiovascular risk factor prior to pregnancy, such as hypertension or diabetes mellitus, should already be involved in a cardiovascular risk reduction program with planned long-term follow-up. The development of HDP is a way of identifying women with underlying, though often unrecognized, cardiovascular risk who are not involved in such a program but who would benefit from intervention and close clinical follow-up.[69,78,137] The new guideline from the American College of Cardiology (ACC)/AHA recommends that all women aged 20 years and older should be assessed for cardiovascular risk factors at least every 4–6 years.[86] This periodic assessment of risk factors aims to benefit women with a history of HDP, who are classified as an 'at-risk' group for future CVD,[78] through aggressive cardiovascular risk modification and secondary preventive efforts to reduce cardiovascular events. However, it is important to note the limitation of this risk assessment as most women with HDP remain to have low absolute risk for CVD within the first 5–10 years after a pregnancy affected by HDP.

4.2.4 | Where and who

Best practice advice

- Postpartum follow-up should ideally be done via a multidisciplinary team approach. The team should comprise healthcare and allied healthcare providers who are able to provide medium- and longer-term medical follow-up

Despite potential barriers, a recent evidence-based review of postpartum cardiovascular risk management has called for the development of structured postpartum cardiovascular risk screening programs after complicated pregnancies.[138,139] Postpartum clinics would ideally be comprised of the following multidisciplinary team members:

- Obstetric care providers and maternal–fetal medicine specialists play a critical role in identifying women in need of postpartum follow-up and advise on strategies to minimize adverse pregnancy outcomes in future pregnancies.
- Healthcare providers who are able to provide longer-term medical follow-up (i.e., gynecologists, general practitioners, family physicians, general internists, cardiologists, nurse practitioners).
- Allied healthcare professionals, such as dieticians, social workers, physiotherapists, and personal trainers who may assist with behavioral and lifestyle modification interventions.

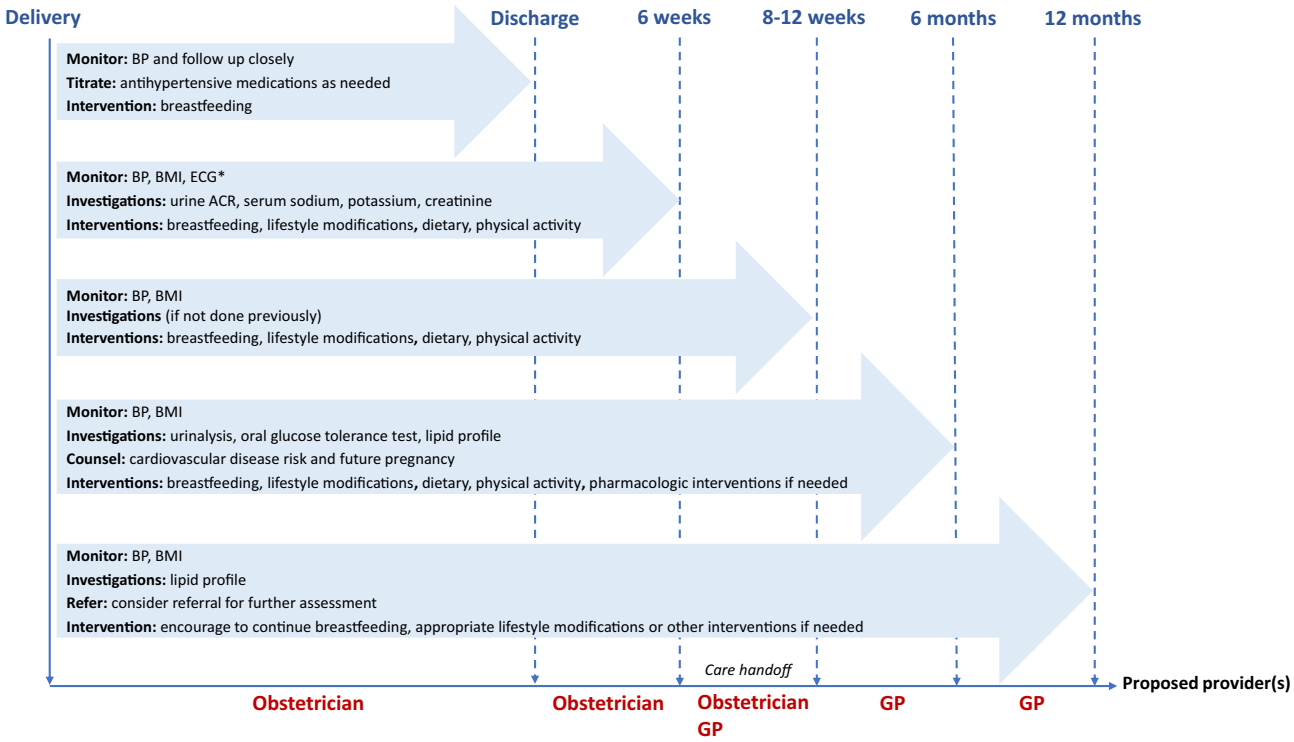

FIGURE 2 Timing of CVD risk factor follow-up within the first year postpartum. ACR, albumin-to-creatinine ratio; BMI, body mass index; BP, blood pressure; ECG, electrocardiogram. * if available. Modified from Parikh et al.[136] and Graves et al[110]

The American College of Obstetricians and Gynecologists (ACOG) has recently called the postpartum period the fourth trimester to expand the focus beyond the traditional single postpartum visit.[140] This longer coverage for pregnancy care allows the obstetrician or other healthcare providers to screen for the development of cardiovascular risk factors and provide adequate counselling for cardiovascular risk prevention with the aim to reduce long-term health risk for women with HDP.[140] The AHA has proposed a transition of postpartum care for women with HDP from the obstetricians to the primary care providers starting from 3 months after delivery to assess cardiovascular risk factors.[136] It has also been emphasized that consistent documentation of pregnancy complications in medical records and coordination between obstetric and primary care providers are key for optimal care.

4.2.5 | What

Best practice advice

- At each follow-up visit, the following should be carried out: history taking and physical examination, measurement of blood pressure, BMI, and waist circumference, and investigations including oral glucose tolerance test, lipid profile, and urine protein

The ACOG Task Force recommends that women with a history of preterm pre-eclampsia or recurrent pre-eclampsia should have an annual assessment of their blood pressure, BMI, glucose testing, and lipid profile.[141]

- Blood pressure: criteria for blood pressure monitoring and management should be based on local guidelines for hypertension.
- BMI and waist circumference: postpartum follow-up is an opportunity to promote a healthy lifestyle for all women, and should include a discussion about good nutrition, reduction of sodium intake, physical activity, and appropriate body weight.[142]
- Investigations: oral glucose tolerance test,[143] lipid profile, and urinalysis to determine the albumin-to-creatinine ratio. For abnormal results, the recommendation is for 6 months of lifestyle modification (i.e. physical activity and dietary changes) followed by repeat testing. If the low-density lipoproteins remain elevated, the woman is a candidate for a moderate-intensity statin which would be stopped at the beginning of her next pregnancy. If no future pregnancy is planned, consider repeat lipid testing after 6–12 months of treatment to assess attainment of target lipid level and subsequent dosage adjustment.

Following completion of history taking and physical examination and obtaining biochemical measures, women should be counselled about their identified risk factors. In a multidisciplinary clinic, a discussion with a dietician about dietary changes to align with the national guidelines should occur. Strategies to increase physical activity levels to align with national guidelines should also be discussed. However, lifestyle programs that are affordable and translatable to wherever a woman lives need to be developed.[144]

5 | IMPLEMENTATION

Best practice advice

- Review health systems in local contexts, identify strengths and gaps with respect to needs of women with CVD
- Criteria for blood pressure monitoring and management should be based on local guidelines for hypertension
- Implement corrective actions for optimum care of women with CVD especially to enable screening and long-term monitoring with the purpose of minimizing long-term effects on health

ACOG has recommended that women with HDP are counselled on the importance of timely follow-up with their obstetricians or primary care providers for ongoing coordination of care.[145] HDP warrant closer long-term follow-up and lifestyle modifications to better manage risk factors for CVD.[146] However, identifying the appropriate timing and venue for this counselling as well as implementing recommended interventions for risk reduction is challenging.[147] Moreover, evidence shows that only half of high-risk women return for postpartum follow-up appointments.[145,148,149] This could be explained by the fragmented healthcare system with no cohesive

(a)

Pregnancy-Related Cardiovascular Risk Indicators

- Preeclampsia ☐
- Gestational Hypertension ☐
- Gestational Diabetes ☐
- Placental Abruption ☐
- Unexplained Preterm Birth (<37 Weeks) ☐
- Intrauterine Growth Restriction ☐

If you are unsure whether you experienced any of the above complications during this or a previous pregnancy ask your healthcare provider at your next follow up appointment.

Baby's Information

- Gestational Age at Delivery (weeks): _____
- Birthweight (grams): _____
- Sex: ☐M ☐F
- Percentile Weight for Sex & Gestational Age: _____
- Length (cm): _____
- Head Circumference (cm): _____

How can you lower your risk?

Stay active by exercising at least 150 minutes per week.

Aim to be a healthy body weight. Get back to your pre-pregnancy weight after delivery.

Live smoke free.

Breastfeed as long as possible.

Eat a healthy diet by lowering your salt, fat, and sugar intake.

See your primary care provider for routine appointments.

When planning your next pregnancy speak to your provider to optimize your health.

For assistance filling out any Section, for more information, and for definitions of terms used please visit:

www.themothersprogram.ca/postpartum-health/postpartum-health-record

MOTHERS Postpartum Health Record©

The MotHERS Program — Mother's Health Education, Research and Screening

Name:

Mother's Date of Birth:

Date of Delivery:

Pregnancy can be nature's stress test on the heart. Pregnancy and the postpartum period is the best time to be screened for heart disease risk factors.

Are you at risk?

Version August 2019

(b)

Your baby's check-ups and immunizations are a great time to fill out this record with your healthcare provider! Keep this form with your baby's immunization record for an easy reminder.

Recommended Health Check-Up Schedule

Time Since Delivery	Date	Blood Pressure (mmHg)	Weight (kg)	Body Mass Index (kg/m²)	Waist Circumference (cm)
6 Weeks					
2 Months					
4 Months					
6 Months					
12 Months					

Weight History & Goal Setting

Height (cm):	Weight (kg)	Body Mass Index (kg/m²)	Waist (cm)
Pre-pregnancy			
Delivery			
Goal at 12 Months			
Recommended Goals	*≤ Pre-pregnancy*	*< 25.0*	*< 88.0*

Recommended 6 Month Blood Work

Cholesterol (mmol/L)	
HDL (mmol/L)	
LDL (mmol/L)	
Triglycerides (mmol/L)	
Fasting Glucose (mmol/L)	
High Sensitivity CRP (mg/L)	
Urine Microalbumin Creatinine Ratio (mg/mmol)	
75g Oral Glucose Tolerance Test (mmol/L) *For women who experienced gestational diabetes*	Fasting ____ 2 Hr ____

Physical Activity

Time Since Delivery	Minutes of Activity Per Week	Average Steps Per Day
2 Months		
4 Months		
6 Months		
12 Months		
Recommended Goals	*≥ 150*	*≥ 10,000*

Personal and Family History

With which ethnicity do you identify? Caucasian ☐ African ☐ Asian ☐ Indigenous ☐ Other ☐ _____	
Do you smoke cigarettes?	Yes / No
Have you had a heart attack or stroke?	Yes / No
Did you have high blood pressure before pregnancy?	Yes / No
Did you have diabetes before pregnancy?	Yes / No
Has your mother or sister(s) had preeclampsia or high blood pressure in pregnancy ?	Yes / No / Unknown
Has your father, mother or sibling(s) had a heart attack or stroke?	Yes / No / Unknown
Does your father, mother or sibling(s) have high blood pressure?	Yes / No / Unknown
Does your father, mother or sibling(s) have diabetes?	Yes / No / Unknown

Risk Scores at 6 Months Postpartum

Lifetime Risk Score:		To calculate your risk visit:
Metabolic Syndrome:		
Cardiometabolic Age:		

FIGURE 3 Postpartum heath record. https://www.themothersprogram.ca/postpartum-health/postpartum-health-record. Reproduced with permission granted by The MotHERS Program

transition from the obstetrician to internist or cardiologist, underlying socioeconomic issues such as unpaid parental leave or insurance, and maternal stress after a traumatic delivery experience.[147] Therefore, feasible interventions are needed to improve adherence to postpartum care with the purpose of minimizing long-term health effects. For instance, a randomized controlled trial suggested that text message-based home postpartum hypertension monitoring programs are more effective in obtaining blood pressure and meeting current clinical guidelines in the immediate postdischarge period in women with HDP than traditional office-based follow-up.[149] Furthermore, attendance rates are even lower among women in limited-resource regions,[147] of African American ethnicity, and those who had fewer prenatal visits.[148] Hence, postpartum follow-up programs for women with HDP need to be adapted to the local healthcare system to optimize preventive strategies for reducing future CVD.

5.1 | A case study

In Canada, the Maternal Health Clinic (MHC) at Kingston Health Sciences Centre has been developed and operated to introduce a structured postpartum initiative to identify and promote modification of cardiovascular risk since 2011.[71] Pregnant women with specific pregnancy complications are routinely referred to MHC for physical assessment and biochemical screening at 6 months after delivery. During the visit, healthcare professionals discuss with these women their physical findings and provide counselling regarding lifestyle modification. Written information is then sent to both the woman and her primary healthcare provider identifying risks and recommendations (Figure 3). Women with either a high 30-year cardiovascular risk (>10%) or a high lifetime risk (>39%) or those who meet the criteria for metabolic syndrome are referred for further assessment by internal medicine and/or cardiology. This facility may serve as an effective primary screening and intervention strategy for long-term CVD. MHC has successfully identified women with increased long-term CVD risk scores[69] and also improved specific interpregnancy outcomes such as weight reduction and type 2 diabetes.[150] However, only 50% of women with high CVD risk scores attend the follow-up referral appointment.[151] Therefore, further modification of current practice would be beneficial to improve attendance adherence.

6 | RESEARCH

There is a substantial body of evidence demonstrating that lifestyle modifications, diet control, and regular physical activities are beneficial to reduce the risk of developing HDP and future cardiovascular events in the general population. However, whether these interventions can specifically prevent recurrent events and reduce future cardiovascular risk in women with a history of HDP remains unclear. This research question warrants investigations in well-designed clinical trials. Large randomized controlled trials designed to compare specific interventions, commencing at different timepoints including before, during, and after pregnancy, of both supervised and unsupervised interventions, in different resources settings, are needed. Future research should also focus on strategies to improve adherence to the aforementioned interventions. Similarly, it is well established that breastfeeding is robustly associated with decreased maternal risk of short- and long-term cardiovascular adverse outcomes. However, the role of lactation in reducing recurrence risk and future cardiovascular risk specifically in hypertensive pregnant women remains uncertain and should be addressed with well-design trials. Furthermore, additional studies are needed to clarify the potential benefits of extended breastfeeding on cardiovascular events in this specific high-risk group.

The AHA guidelines suggest the need for aggressive treatment of cardiovascular risk factors. However, specific targets and therapeutic strategies for women with a pregnancy-related cardiovascular risk indicator need to be studied through well-designed clinical trials. Randomized controlled trials are also warranted to establish the efficacy of aspirin or other therapeutic agents for the primary prevention of long-term cardiovascular events in women with a history of HDP.

AUTHOR CONTRIBUTIONS

LP, LNH, GS, LB, PO, and FM conceptualized the article. LP, LNH, GS, LB, and PO wrote the manuscript. All authors reviewed and approved the final article.

CONFLICT OF INTEREST

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