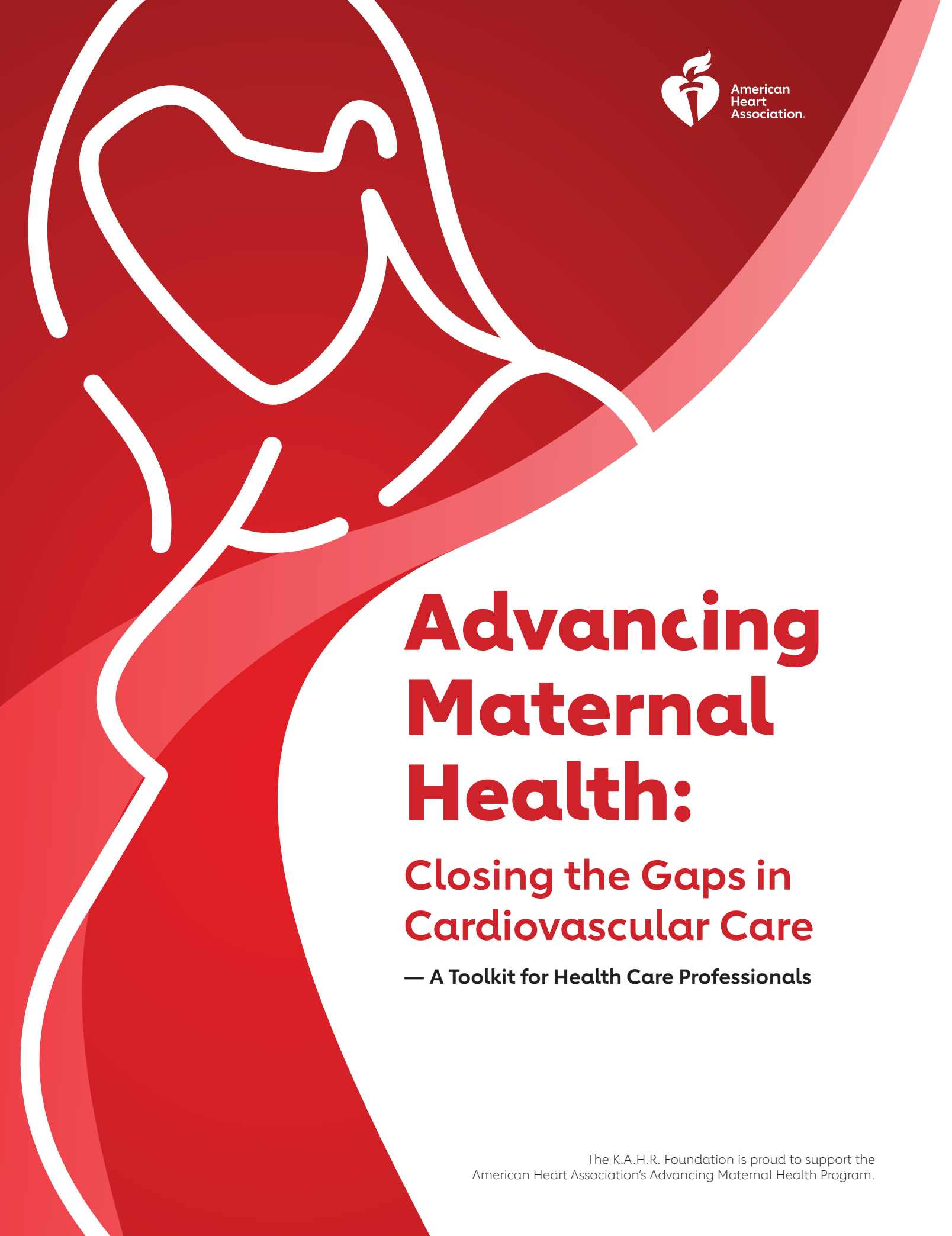


American Heart Association.

Advancing Maternal Health:

Closing the Gaps in Cardiovascular Care

— A Toolkit for Health Care Professionals

The K.A.H.R. Foundation is proud to support the American Heart Association's Advancing Maternal Health Program.

Publisher's Note
Reinventing Maternal Health Care is published by Ascend Media.
401 SW Ward Road, Suite 210, Lee's Summit, MO 64081

All references and data are as of October 2025.

Contents

Contributing Authors

Rachel M. Bond, MD, is a board-certified attending cardiologist who has devoted her career to the treatment of heart disease through early detection, education and prevention. She is the system director of Women's Heart Health at Dignity Health in Chandler, Arizona, as well as the co-chair of the Women in Cardiology Committee and chair of the Diversity and Inclusion Committee for the Arizona Chapter of the American College of Cardiology. She was recently appointed to serve on the Women in Cardiology Section Leadership Council for the National Chapter of the American College of Cardiology. She holds a faculty position as assistant professor of internal medicine at Creighton University School of Medicine.

Bond is the author of several review papers referencing sex and gender differences and cardiovascular conditions that predominantly affect women, along with opinion pieces aimed at addressing health equity, reducing health disparities and promoting the professional development of women and minorities in the health-science profession. She has a passion for advocacy of education and mentorship and has served as an expert source for multiple news and media outlets. Her clinical interests include heart disease prevention, pregnancy-related heart conditions and cardio-oncology and lipid disorders. Her research interests currently include the heart-mind connection, cardio-rheumatology and gender disparities in valvular heart disease.

Disclosures: Nothing to disclose

Bree Fallon, MSN, RNC-OB, C-EFM, has been in the field of obstetrics for over 20 years. Fallon has had the opportunity to participate in a variety of different roles including bedside nurse, clinical educator, high-risk obstetrics flight nurse, legal subject matter expert and most recently, perinatal risk management. She had the privilege of sitting on the Kansas Maternal Mortality Review Committee for a number of years and has presented on a variety of different topics on both the local and national level. Fallon remains in constant pursuit to learn and contribute to the highest level of care our interdisciplinary health care teams can collaboratively provide to obstetric patients and their families we serve.

Disclosures: Nothing to disclose

Joyce Njoroge, MD, is a board-certified physician and fellowship-trained cardiologist with Stanford Health Care's Advanced Heart Failure Program. She serves as a clinical assistant professor in the division of cardiovascular medicine. Her clinical focus includes advanced heart failure and transplant cardiology as well as preconception counseling and pregnancy care in this population. Her research explores genetic and biological markers to improve screening and care for high-risk pregnant populations, particularly addressing disparities affecting Black women. She is also involved in a multicenter clinical trial evaluating a drug for peripartum cardiomyopathy.

Njoroge has published in top journals, such as *Circulation Research* and *Journal of Cardiac Failure*, and co-authored a chapter on cardiovascular disease and pregnancy in *Current Diagnosis and Treatment: Cardiology*. She is a member of the Association of Black Cardiologists, ACC, AHA, ISHLT and HFSA.

Disclosures: Nothing to disclose

Nisha Parikh, MD, MPH, is the system director of the Women's Heart Program, director of cardiovascular medicine at the Katz Institute for Women's Health and co-director of the Center for Women's Heart Health at the Northwell Cardiovascular Institute. She is associate professor in the department of cardiology, Donald and Barbara Zucker School of Medicine, at Hofstra/Northwell. She received her undergraduate and master's degree in public health from the University of California, Berkeley, and her medical degree from New York Medical College. She also completed a research fellowship in cardiovascular epidemiology at the Framingham Heart Study. Prior to joining Northwell Health one year ago, she was an academic researcher and clinician at UCSF in San Francisco, California, where she led NIH- and AHA-sponsored studies. Parikh served as cardiology deputy editor for UpToDate/Wolters Kluwer covering topics related to women's health and prevention. She has published over 90 peer-reviewed papers. As a volunteer for the AHA, she chaired the first comprehensive statement sponsored by the AHA on adverse pregnancy outcomes and CVD in women.

Disclosures: Nothing to disclose

Relationship disclosures within the past 24 months:

The American Heart Association (AHA) is committed to ensuring balance, independence, objectivity and scientific rigor in its certified educational activities. All faculty, planners and contributors in a position to control the content for an AHA-sponsored activity are required to disclose to the activity audience any financial relationships regardless of the amount during the **prior 24 months** with (1) the manufacturer(s) of any ineligible company product(s) and/or interest(s) of ineligible companies regardless of relation to the content of the activity and (2) any ineligible company supporters of the activity. When an unlabeled use of a commercial product or an investigational use not yet approved for any purpose is discussed during an educational activity, the faculty must disclose that the product is not labeled for the use under discussion or that the product is still investigational.

Stacy Perrin, PhD, RN, APRN, ACNS-BC, CCRN, SCRN, FAHA, LSSBB, is a clinical nurse specialist with extensive experience in acute care, emergency services, neuroscience and quality improvement. She has led education, competency and quality initiatives across hospital systems and has served as faculty in patient care fundamentals, preparing future nursing assistants for certification and practice. Perrin's research and scholarly work focus on health literacy, stroke and cardiovascular health, with multiple contributions to American Heart Association scientific statements and educational programming. She is passionate about advancing interdisciplinary education, maternal health equity and evidence-based care to improve patient outcomes across diverse populations.

Disclosures: Nothing to disclose

Mark Santillan, MD, PhD, is a professor in the department of OB/Gyn and molecular medicine at the University of Iowa. He is a maternal fetal medicine subspecialist and physician-scientist. His clinical and research interests are in hypertensive disorders in pregnancy, particularly in the early pregnancy mechanisms of short- and long-term health effects of hypertension to the mother and child. His lab is investigating the predictive, preventative, therapeutic and curative potential of the vasopressin and RGS2 pathway in preeclampsia. He serves as the clinical translational core co-director for the NIH-funded Iowa Hawkeye Intellectual and Developmental Disabilities Research Center (NIH P50) as well as the associate director for special populations in the Iowa Institute for Clinical and Translational Science (NIH UL1).

Disclosures:
Consultant/Advisory Board: Comanche Biopharma
Intellectual Property: Patent - US20170315130A1: Early Prediction of Preeclampsia; Patent - MX2013009863A: Anti-Mullerian Hormone Changes in Pregnancy and Predication of Adverse Pregnancy Outco; Patent - WO2014124396A1: Therapeutic Strategies For the Treatment of Preeclampsia; Patent - WO2018191406A1: Detection of Predictors of Preeclampsia

Sarah Thordsen, MD, is a clinical associate professor and cardiologist at the University of Wisconsin. She has a special interest in heart disease complicating pregnancy, especially peripartum cardiomyopathy. She is involved in clinical program development, including surrounding cardio-obstetrics and cardiovascular imaging.

Disclosures: Nothing to disclose

Karol Watson, MD, PhD, is an attending cardiologist and a professor of medicine/cardiology at the David Geffen School of Medicine at UCLA. She is director of the UCLA Women's Cardiovascular Health Center, director of the UCLA-Barbra Streisand Women's Heart Health Program, co-director of the UCLA Program in Preventive Cardiology and director of the UCLA Fellowship Program in Cardiovascular Diseases. Watson is a principal investigator for several large National Institutes of Health research studies, including the Diabetes Prevention Program Outcomes Study and the Multiethnic Study of Atherosclerosis. She is a Fellow of the American College of Cardiology and a member of the American Heart Association. She is also a board member of the American Heart Association, Western States Affiliate, and chair of the Scientific Advisory Board for WomenHeart, the largest national organization for women survivors of heart disease.

Disclosures: Consultant/Advisory Board: Amgen, Boehringer Ingelheim, Eli Lilly and Company, Merck, Novartis, Novo Nordisk Inc

Robin Elise Weiss, PhD, MPH, MSHPE, AdvCD/BDT(DONA), FACCE, is a veteran doula, childbirth educator and public health professor with more than 30 years of experience supporting families and training doulas. An award-winning author of multiple books and widely published articles on pregnancy, parenting and lactation, Weiss has trained and mentored more than 10,000 doulas worldwide. She also teaches at the university level, where her focus includes health systems, health care management and public health practice. Weiss is known for combining evidence-informed practice with real-world application, helping doulas, clinicians and educators build sustainable careers while fostering inclusive, client-centered care. Her professional contributions have been recognized nationally and internationally, making her a trusted voice in parent, doula and clinician training.

Disclosures: Nothing to disclose

Introduction

Cardio-obstetrics — closing the gaps in care between pregnancy, delivery and the remaining decades of life — is the next frontier in CVD prevention and treatment for women.[1-E, D]

Cardiovascular disease (CVD) is the leading cause of death in women globally[1-F] and the leading cause of pregnancy-related maternal mortality in the United States.[1-A] Although maternal mortality has fallen globally in recent decades, the proportion of CVD-related maternal mortality is rising, especially in higher income areas. As many as two-thirds of CVD-related pregnancy deaths could be prevented by bridging gaps in care with appropriate surveillance, prevention and treatment strategies from preconception to a reimagined fourth trimester of postpartum care.[1-F, A; 2-A, B]

CVD presents and is treated differently in men and women due to underlying biologic differences between the sexes and underutilization of evidence-based approaches.[3-A] Women are at particular risk for CVD during and after pregnancy. Even uncomplicated pregnancies and deliveries are a physical and psychological stress test for every organ system.[1-B] The maternal mortality rate in the United States is among the highest of all high-income countries, with the largest toll affecting American Indian, Alaska Native and Black women. CVD disproportionally affects these same populations, largely due to the higher prevalence of CVD risk factors.[4-A]

The normal physiology of pregnancy increases CVD risk. Cardiac output increases by 30% to 50% with increased stroke volume and heart rate.[1-B] Pregnancy increases the risk of acute myocardial infarction three to fourfold as well as acute cardiac syndrome and cardiomyopathy.[3-A, B, C] A pregnant person's blood vessels can remodel, and certain measurements can increase, including plasma volume, hypercoagulability, LDL cholesterol, triglycerides, insulin resistance and vascular dysfunction.[3-C]

The increased CVD risk often presents as one or more **hypertensive disorders of pregnancy (HDP)**, including chronic hypertension, gestational hypertension, preeclampsia/eclampsia, preeclampsia superimposed on chronic hypertension and HELLP (hemolysis, elevated liver enzymes and low platelet count) syndrome. HDP occurs in about 10% of pregnancies[9-A] and is the second leading cause of maternal mortality after maternal hemorrhage. It is also an important cause of short- and long-term maternal and fetal/offspring morbidity and mortality.[4-B]

Many women undergo the stress of pregnancy and delivery without significant residual effects, but population-wide increases in underlying risk factors, such as chronic hypertension, obesity, older age at pregnancy, diabetes and tobacco use, can heighten individual risk for **adverse pregnancy outcomes (APOs)**, including preterm birth, gestational diabetes, preeclampsia, gestational hypertension, small-for-gestational-age infant and placental abruption. APOs are associated with adverse maternal events, including arrhythmia, heart failure, peripartum cardiomyopathy, valvular disorders, cerebrovascular accidents, coronary artery disease,[1-B, C] stroke and chronic kidney disease.[5-A]

In addition to adverse maternal outcomes, fetal exposure to HDP and/or APOs is associated with increased risk of CVD and CVD mortality,[6-A, B] hypertension, diabetes and dyslipidemia for offspring later in life.[6-C; 5-B] Elevated maternal systolic **blood pressure (BP)** during pregnancy, even at levels below accepted thresholds for hypertension, are associated with increased risk for preterm delivery and infants who are small-for-gestational age and low birth weight.[4-C]

Maternal hypertension develops more frequently following HDP than after normotensive pregnancies. Women with HDP develop hypertension faster and are diagnosed up to 10 years earlier compared to women with normotensive pregnancies. Cardiometabolic risk factors and CVD events develop earlier following HDP, and women with HDP have higher rates of accumulated chronic conditions and comorbidities. HDP may also accelerate maternal aging.[4-D]

In many cases, HDP can be mitigated or prevented by bridging gaps in care,[2-B, C] implementing lifestyle changes in line with Life's Essential 8,[7-A] taking appropriate medications to manage hypertension and other APOs[8-A] and improving peripartum and postpartum care. Continuing follow-up into the fourth trimester[2-D] — the first three months following delivery — presents an opportunity to engage women in early identification of CVD and CVD risk factors that may have developed as a result of pregnancy. Early involvement in cardioprotective strategies can delay or prevent CVD later in life.

Hypertensive Disorders of Pregnancy and Cardiovascular Disease

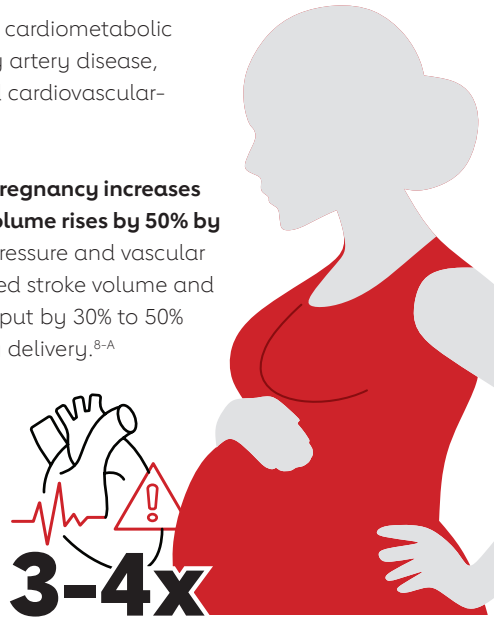
Current guidelines addressing CVD and females may include historical and unsubstantiated perspectives affecting women's health throughout their reproductive lives that should be avoided in future publications.[4-B] **Social determinants of health (SDOH)** can also affect the quality, quantity and timing of CVD care.[3-A; 4-A]

SDOH and ethnic/racial disparities in maternal health play major roles in maternal and offspring outcomes. Maternal mortality in the United States was 18/100,000 live births in 2012, among the highest of all high-income countries. The overall maternal mortality rate masks dramatic variations. The estimated maternal mortality rate in 2016 for white women was 13/100,000 live births compared to 30 for American Indian/Alaska Native women and 41 for Black women.[4-A]

HDP disproportionately affects Black, American Indian and Alaska Native women, largely due to the higher prevalence of CVD risk factors. Severe morbidity and mortality related to preeclampsia are higher for Black women, while Hispanic women tend to have better pregnancy outcomes than either Black or white women with similar risk factors.[4-A]

CVD outcomes in current or previously pregnant women are driven largely by the **hypertensive disorders of pregnancy (HDP)**. Women with a history of HDP have an elevated risk of multiple cardiovascular and cardiometabolic diseases, including coronary artery disease, cerebrovascular disease and cardiovascular-related mortality.[9-A]

The normal physiology of pregnancy increases CVD risk. Maternal blood volume rises by 50% by 32 weeks. Although blood pressure and vascular resistance decrease, increased stroke volume and heart rate boost cardiac output by 30% to 50% with further increases during delivery.[8-A]



Pregnancy increases the risk of acute myocardial infarction three to fourfold as well as acute cardiac syndrome (ACS) and cardiomyopathy.

3–4x increased risk

Preeclampsia and eclampsia may contribute to ACS in pregnancy in addition to illegal drugs like cocaine and commonly used peripartum drugs, such as tocolytics and oxytocics.

About 10% of pregnancies are affected by hypertensive disorders of pregnancy.[9-A]

Preexisting conditions that contribute to uteroplacental blood flow and vascular insufficiency increase risk for HDP, including:

- Chronic hypertension
- Renal disease
- Diabetes
- Obstructive sleep apnea
- Thrombophilia
- Autoimmune disease

Additional factors that put women at elevated risk for HDP are:

- Prior history of preeclampsia
- HELLP syndrome
- Twin or other multiple pregnancies
- Body mass index greater than 30
- Aged 35 years or more
- First-degree relative who had gestational hypertension.[11-A]

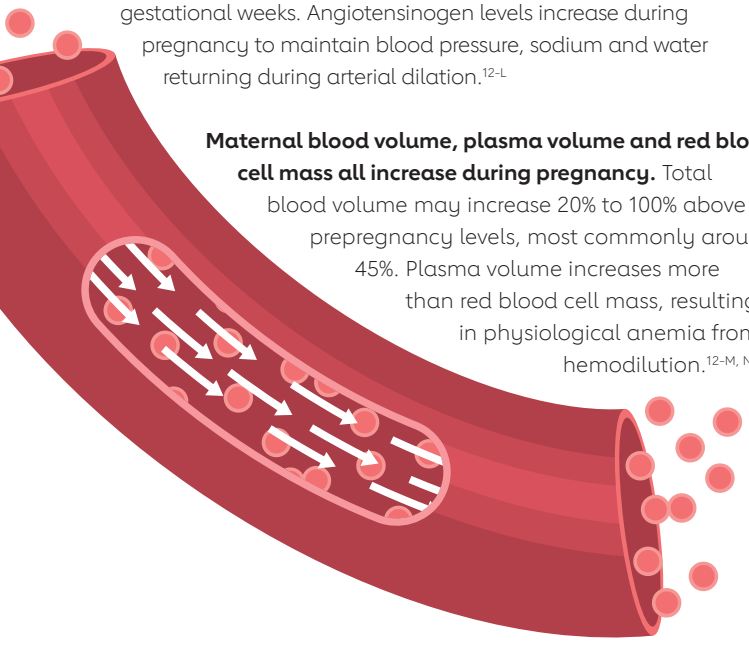
Physiologic Changes in Pregnancy

Pregnancy and labor are hemodynamically taxing periods with multiple psychologic and physiologic stressors.[3-A, B, C] Adapting to these changes can contribute to an adverse cardiometabolic risk profile during and after pregnancy.

Pregnancy brings significant changes in hormonal levels, including increased estrogen and progesterone, which help to maintain early pregnancy and contribute to peripheral and systemic vasodilation.[12-K] Systemic vasodilation begins as early as five weeks, and peripheral vascular resistance can fall 35% to 40% from baseline by the middle of the second trimester.[12-A]

Vasodilation in the kidneys increases renal plasma flow and glomerular filtration rate up to 50% by the end of the first trimester, reducing serum creatinine, urea and uric acid. Levels that appear normal before pregnancy may indicate borderline kidney function during pregnancy.[13-A;14-M]

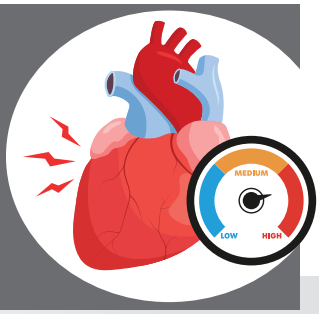
Pregnancy activates the **renin-angiotensin-aldosterone system (RAAS)**, with plasma volume increasing as early as five to eight gestational weeks. Angiotensinogen levels increase during pregnancy to maintain blood pressure, sodium and water returning during arterial dilation.[12-L]



Maternal blood volume, plasma volume and red blood cell mass all increase during pregnancy. Total blood volume may increase 20% to 100% above prepregnancy levels, most commonly around 45%. Plasma volume increases more than red blood cell mass, resulting in physiological anemia from hemodilution.[12-M, N]

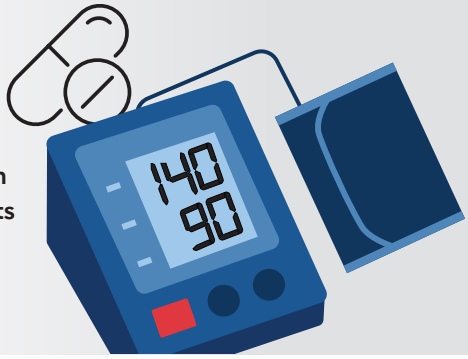
Pregnancy can increase a person's heart rate, stroke volume and cardiac output. Heart rate can be expected to progressively increase 20% to 25% over baseline.[12-I] Stroke volume increases gradually through the end of the second trimester and may decrease late in pregnancy.[12-D] The sharpest rise in cardiac output is usually seen by the beginning of the first trimester and continues to increase into the second trimester.

By 24 weeks, cardiac output can be up to 45% higher than prepregnancy levels in a normal, singleton pregnancy.[12-C]



Both **systolic blood pressure (SBP)** and **diastolic blood pressure (DBP)** fall during pregnancy, with a greater reduction in DBP. Mean arterial pressure can fall 5–10 mmHg below baseline. Arterial pressure begins to increase during the third trimester and should return to near preconception levels postpartum.

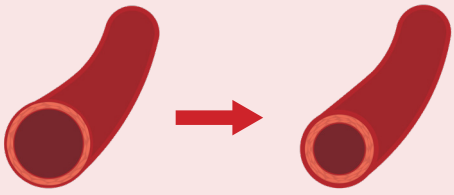
Women on antihypertensive medications for any reason require regular BP monitoring to inform medication adjustments during and after pregnancy.[12-E; 15-Table 4]



Expect maximum cardiac output during labor and immediately postpartum with 60% to 80% increase over levels before the onset of labor.

The sharply increased output is the result of increased heart rate and preload with the pain of uterine contractions, increased catecholamines and autotransfusion of 300–500 mL of blood from the uterus to systemic circulation with each contraction.[12-Q]

Spinal anesthesia is associated with decreased vascular resistance with a corresponding increase in heart rate and stroke volume. Prophylactic vasopressors, such as phenylephrine, can prevent hypotension associated with spinal anesthesia.[12-R]



decreased vascular resistance associated with spinal anesthesia

blood vessel after prophylactic vasopressor

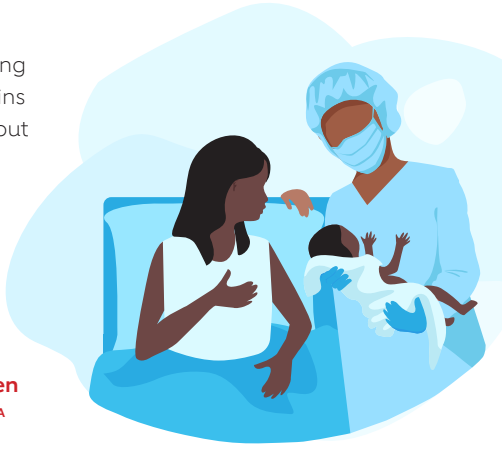
Supine posture during later pregnancy may lead to compression of the **inferior vena cava (IVC)** by the uterus. Compression of the IVC decreases venous return and stroke volume, which leads to a drop in arterial blood pressure. The heart rate increases to restore cardiac output, which impairs diastolic filling time and may result in inadequate fetal perfusion.

Maternal activities should avoid supine positioning whenever possible, particularly after 20 weeks gestation.[16-A] Fetal heart monitoring may guide maternal positioning during necessary medical procedures.[17-A]

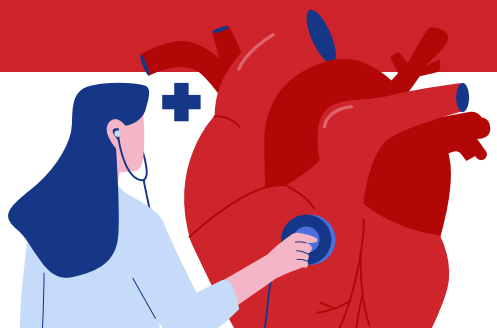
Pregnancy creates a **prothrombotic state** with changes in coagulation to support hemostatic control during pregnancy and delivery, when blood loss is expected. The rate and level of thrombin generation increases progressively during pregnancy and plasma fibrinogen increases by about 50%.[14-A] Fibrin-degradation products also increase with the net changes favoring fibrin formation.

Antithrombin levels, including coagulation inhibitor proteins C and S, decrease throughout pregnancy, then return to baseline within 72 hours postpartum.[14-A, B, C, D]

The risk of a thrombotic event remains elevated at least 12 weeks after delivery, with the greatest increase in absolute risk seen during the first six weeks.[18-A]



Postpartum Changes Can Affect CVD Risk

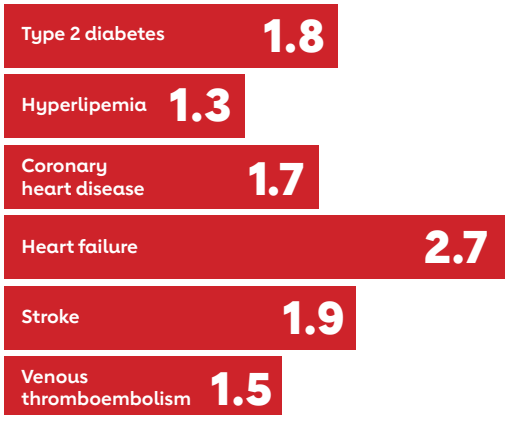


Normal physiologic changes in pregnancy can enhance the pathogenesis of CVD in women with underlying risk factors. These underlying risk factors have become more common in recent years with more women having children later in life, and there are population-wide increases in traditional cardiometabolic risk factors, such as chronic hypertension, obesity or overweight, diabetes and tobacco use.[1-B, C]

All these risk factors can increase maternal risk for HDP and adverse pregnancy outcomes (APOs), including preterm birth, gestational diabetes, preeclampsia, gestational hypertension, small-for-gestational age neonates and placental abruption.

Both HDP and APOs increase lifetime risk for poor cardiometabolic outcomes for both mother and child.

Below are hazard ratio increases as a result of HDP:[4-Table 2]



The maternal hazard ratio for **people with hypertension** equal to or greater than 140/90 mmHg **increases to 2.3** compared to pregnancy without HDP.

Women who develop gestational hypertension have:

- **40% higher risk for CVD**
- **3x risk for vascular dementia**
- **Nearly 4x risk for end-stage kidney disease**

The offspring of women with HDP are at increased risk for CVD, stroke, obesity and hypertension.

Although any HDP increases the likelihood of maternal hypertension in the following years, women with recurrent HDP after an index HDP pregnancy are at higher risk of hypertension and other CVD compared to women with a single episode of HDP. Women may develop hypertension within months to years after HDP.

An episode of HDP can increase the risk of hypertension within two years postpartum more than sixfold. The risk of developing hypertension is highest in the first six months postpartum (18.33-fold), falling to 4.36-fold between six months and one year, then rebounding to 7.24-fold between one and two years postpartum. Women with preeclampsia are at even higher risk of hypertension, 57.08-fold, 4.83-fold and 7.44-fold at the same time periods.[9-B, C]

HDP is the second leading cause of maternal mortality after maternal hemorrhage.[4-B] The incidence of HDP is rising as a result of the increasing prevalence of obesity, advancing age at pregnancy and other cardiometabolic risk factors.[4-E]

- **CVD** accounts for up to half of all maternal deaths.
- **HDP-associated strokes** have more than doubled compared to non-HDP-associated strokes.
- **Preeclampsia** alone complicates up to 8% of pregnancies globally and an increased 25% of pregnancies in the United States between 1987 and 2004.[19-A]

In addition to documented adverse maternal effects, HDP also affects offspring. Blood pressure falls during the first trimester of a normal pregnancy, reaching a maximum decline of 10–15 mmHg by mid-pregnancy, then returning to prepregnancy levels by term.[20-A] Elevated systolic BP during pregnancy is associated with elevated risk of preterm delivery and infants who are small for gestational age and have low birth weight, even if BP is below diagnostic thresholds for hypertension.[4-C]

Fetal exposure to preeclampsia nearly doubles the risk of hypertension and dyslipidemia and increases the risk of diabetes by more than 50% into early adulthood.[6-C; 5-B]

HDP may be a useful clinical marker for increased risk of future hypertension for both mother and her children,[5-C] and early detection and treatment can reduce the toll of maternal, fetal and neonatal mortality and morbidity.[7-B]

Preventing and Managing HDP

Health care professionals have an expanding toolbox to help prevent HDP by mitigating risk factors before pregnancy and manage HDP after conception using combinations of lifestyle changes and appropriate pharmacotherapy.

Lifestyle changes made before and during pregnancy that reduce blood pressure can modify both maternal and fetal risks.

Dietary changes can reduce gestational weight gain and improve pregnancy outcomes, while exercise may reduce gestational hypertension and preeclampsia by 30% and 40%, respectively.

Canadian guidelines recommend physical activity for all women during pregnancy unless there are preexisting contraindications.[4-F]

Cardiovascular health is not simply the absence of CVD but a broader concept of specific health factors that are associated with longer CVD-free survival, total longevity and higher quality of life.[7-B] **The American Heart Association s Life s Essential 8™ focuses on:**[7-Figure 1]

- **Diet**
- **Physical activity**
- **Nicotine exposure**
- **Sleep health**
- **Body mass index**
- **Blood lipids**
- **Blood glucose**
- **Blood pressure**

Each element represents one or more CVD risk factors that can be modified to improve cardiovascular health preconception, during pregnancy and postpartum. Health care professionals can use motivational interviewing approaches to help patients identify areas that can be improved and practical approaches they can envision themselves taking.[7-C]

The American College of Obstetricians and Gynecologists (ACOG) classifies HDP into four categories:[29-A; 8-D]

1. **Chronic hypertension,** either primary or secondary, predates the pregnancy or is diagnosed before 20 weeks. Chronic hypertension is associated with increased risk of preterm delivery, fetal growth restriction and perinatal death.

2. **Gestational hypertension** develops at or after 20 weeks without features of preeclampsia or eclampsia. Gestational hypertension increases the risk of preeclampsia.

3. **Preeclampsia** are multisystem disorders that can feature renal, hematologic, hepatic, neurologic and pulmonary complications. Adverse maternal outcomes can include eclampsia, stroke, multiorgan failure, hemorrhage and death. Fetal complications include growth restriction, preterm delivery, placental abruption and perinatal death.

4. **Preeclampsia superimposed on chronic hypertension** combines the increased risks and adverse outcomes of hypertension and preeclampsia/eclampsia.[8-E]

Other publications add eclampsia and HELLP (hemolysis, elevated liver enzymes and low platelet count) syndrome to the list of HDPs.[9-A]

Starting low-dose aspirin between 12 and 16 weeks reduces the risk for preeclampsia and HDP-associated adverse outcomes, including preterm birth, fetal growth restriction and stillbirth. When given early in pregnancy, aspirin alters the thromboxane-prostacyclin equilibrium to favor prostacyclin and associated vasodilatory effects while inhibiting platelet aggregation, thought to improve implantation, placentation and vascular remodeling.

The U.S. Preventive Services Task Force and ACOG recommend low-dose aspirin (81 mg daily) for women with one or more major risk factors, including:

- A history of preeclampsia
- Multiple gestation
- Chronic hypertension
- Diabetes
- Kidney disease
- Renal disease
- Autoimmune disorders.[8-C; 21-A, Table 1]

Risk reduction was estimated at 24% for preeclampsia, 20% for growth restriction and 14% for preterm birth. The benefits of aspirin appear to be dose-related, with suggestions of risk reduction up to 82% for early preeclampsia from 150 mg daily.[8-C]

Likewise, ACOG recommends daily low-dose aspirin for women with two or more moderate risk factors, including 25 years of age or more, Black race or low socioeconomic status, family history of preeclampsia (mother or sister), history of low birth weight pregnancies, any APO, more than 10 years between pregnancies, BMI greater than 30 kg per m2 or nulliparity.[21-A, Table 1]

The following agents are generally accepted as safe during pregnancy:[20-Table2]

Antihypertensive drug	Class/ action	Dose	Adverse effects
labetalol	Beta blocker	100 mg twice a day to 400 mg three times a day	Bradycardia, bronchospasm, headache
nifedipine controlled release	Calcium channel blocker	30 mg daily to 60 mg twice a day	Headache (first dose effect), flushing, tachycardia, peripheral edema
methyldopa	Central acting	250 mg twice a day to 750 mg three times a day	Depression, dry mouth, sedation, rarely hemolysis and hepatitis
hydralazine	Vasodilator	25–50 mg three times a day	Flushing, headache, lupus-like syndrome
prazosin	Alpha blocker	0.5 mg twice a day to 5 mg three times a day	Orthostatic hypotension

Labetalol or methyldopa are widely accepted as first-line hypertension agents during pregnancy.[4-K] OTIS, the Organization of Teratology Information Specialists provides up-to-date information on the safety of medications during pregnancy and breastfeeding.[4-L]

Studies of nutritional supplements such as antioxidant vitamins C and E show no statistically significant reduction in the risk of preeclampsia. Calcium supplementation appears to reduce the risk of preeclampsia in women who are calcium deficient but not in the general U.S. population.[8-D]

Experimental evidence and clinical studies suggest metformin may reduce the risk of gestational hypertension in women with gestational diabetes and may also prevent preeclampsia.[4-F]

The U.S. Preventive Services Task Force recommends that all adults be screened for hypertension and concludes that screening has substantial net benefits.[22-A, B] AHA and the American College of Cardiology (ACC) use a hypertension threshold of 130/80 mmHg for the general population. For people with chronic hypertension before or during pregnancy, the treatment threshold is 140/90 mmHg, as defined by AHA,[24] ACOG[25-A] and most international societies.[4-I] The updated recommendation by AHA, as of 2025, reflects increasing evidence that pregnant individuals may reduce their risk of serious complications by adhering to stricter blood pressure control.[25]

ACOG lowered its previous treatment threshold following the Chronic Hypertension and Pregnancy (CHAP) trial,[24-A] which confirmed better pregnancy outcomes when targeting a BP of less than 140/90 mmHg compared to reserving hypertension treatment for more severe hypertension with systolic BP equal to or greater than 160 and/or diastolic BP equal to or greater than 105.[25-A] Women in the active treatment arm of the trial took labetalol or nifedipine and had a lower risk of preeclampsia with severe features, medically indicated preterm birth before 35 weeks, placental abruption or fetal/neonatal death without apparent maternal or fetal/neonatal harm.[23-Table 2] The trial hypothesis did not address treatment thresholds below 140/90 mmHg.[23-B]

Women with known hypertension may already be on pharmacotherapy before or at the time of conception.

- Multiple classes of antihypertensives should be avoided during pregnancy due to potential adverse effects of mother, fetus or both.
- ACE inhibitors and angiotensin receptor blockers are contraindicated for teratogenic effects and should be stopped before conception or at the time of pregnancy diagnosis.[20-B, C]
- Many diuretics, beta blockers (other than labetalol) and calcium channel blockers (other than nifedipine and diltiazem) may need to be avoided for potential maternal and fetal side effects. Alternative antihypertensive agents are frequently recommended.[8-A, B]

Managing Maternal Health Postpartum

Attention to maternal health cannot lapse after delivery.
The definitive treatment for gestational hypertension, preeclampsia and eclampsia is delivery, and maternal sequelae are expected to resolve rapidly postpartum,[11-B] but not all ill effects resolve as expected. More than half of maternal deaths occur postpartum.[26-A]

First **6 months**

Hypertension risk highest

- ↑ **13.39-fold** with any HDP
- ↑ **43.95-fold** with preeclampsia[9-D]

First **2 years**

Hypertension risk elevated by HDP

- ↑ **6.28-fold** with any HDP[9-B]
- ↑ **7.49-fold** with preeclampsia[9-C]

First **3 years**

Any HDP doubles the risk for:

- **Cardiovascular readmission**
- **Acute myocardial infarction**
- **Stroke**
- **Heart failure**[9-E]

Health care professionals and patients can take positive steps to reduce the risk of pregnancy-related postpartum adverse events. For example, breastfeeding is strongly associated with reduced maternal cardiovascular risk in addition to other recognized benefits for infants and mothers. Children who have been breastfed have reduced risk of death from infectious disease and reduced risk of respiratory infections.[27-A]

Lactation may help to reset maternal metabolic homeostasis after pregnancy.

Breastfeeding reduces the risk of:

- **Breast cancer**
- **Ovarian cancer**
- **Type 2 diabetes** [27-A]
- **Hypertension**
- **Subclinical atherosclerosis** [27-B]

Breastfeeding relatively reduces the risk of:

- **CVD (11%)**
- **Coronary heart disease (14%)**
- **Stroke (12%)**
- **Fatal CVD (17%)** [27-C, D]

Any HDP should trigger serial BP monitoring in the first months to years following delivery. Patients who have been diagnosed with pregnancy-associated high blood pressure should have their BP checked at least annually[25]. Lifestyle changes, medical therapy and standard follow-up care are also appropriate.[9-F]

Following delivery, women who have chronic hypertension can transition back to their usual antihypertensive treatment subject to compatibility with breastfeeding. Antihypertensive agents that are safe during pregnancy are also safe during breastfeeding. ACE inhibitors have low concentrations in breast milk and are often used during the breastfeeding period. Angiotensin receptor blockers are not recommended due to lack of safety information.[20-E]

Gestational hypertension and preeclampsia contribute to increased risk for subsequent cardiovascular and cardiometabolic disease, including new onset hypertension, stroke, diabetes, venous thromboembolism and chronic kidney disease. Routine follow-up with annual reviews of BP, fasting lipids and blood glucose are recommended.[20-D] The AHA's Life's Essential 8 may be a useful tool to help optimize cardiovascular health, including a healthy lifestyle and diet, normal BMI, tobacco cessation and regular exercise.[7- Figure 1]

The Fourth Trimester

All these actions aimed at improving maternal health postpartum — breastfeeding recommendations, monitoring BP and other metabolic parameters, starting or adjusting hypertensive medications as needed and making appropriate lifestyle adjustments — assume clinical follow-up after delivery. Too many women never attend a comprehensive postpartum visit.

The postpartum visit can include multiple types of care, from acute issues arising after pregnancy, delivery or the immediate postpartum period to chronic conditions, infant care and feeding and engaging new mothers in preventative care for themselves and their infants. The reality is that postpartum attendance rates vary widely by geography, population, insurance coverage and data source, ranging from 24.9% to 95% with a mean of 74.2%.[28-A, B]

A substantial proportion of women who have given birth do not attend at least one postpartum visit, which may contribute to maternal morbidity and mortality.[28-C; 26-A]

Not only do more than half of all maternal deaths occur postpartum,

40% **occur within the first six weeks**

19% **within one to six days**

21% **within seven to 42 days**

12% **within 43 to 365 days.[26-A]**

Postpartum care has traditionally focused on a single clinical visit six to eight weeks after delivery.[26-C] To optimize the health of women and infants, ACOG has called for a redesign of postpartum care as an ongoing process throughout a fourth trimester of care, with services and support tailored to each woman's individual needs.[2-A, D]

ACOG recommends all women should have contact with a maternal care provider within the first three weeks postpartum. This initial exam should be followed by appropriate care as needed to support each woman's individual needs, concluding with a comprehensive postpartum visit no later than 12 weeks after birth.[2-B, D]

The comprehensive visit should include a full assessment of physical and psychological well-being. Women with pregnancies complicated by HDP, preterm birth or gestational diabetes should be advised that these events are associated with a higher lifetime risk of maternal cardiometabolic disease.[2-E; 26-B, C]

Women with chronic conditions, such as hypertensive disorders, obesity, diabetes, thyroid disorders, kidney disease, mood disorders or substance use disorders, should receive counseling regarding appropriate medical follow-up with their OB/GYN or primary care provider for continuing coordination of care.[2-F; 9-G]

Improving coordination between OB/GYNs and primary care providers during the fourth trimester is only one element in the reinvention of maternal health care. **CVD is the leading cause of pregnancy-related mortality and is rising. As many as two-thirds of pregnancy-related CVD deaths may be preventable, identifying an important gap in care and CVD prevention.** Pregnancy and the fourth trimester can be an opportunity for CVD risk evaluation, stratification and implementation of primary and secondary prevention strategies that are not widely recognized or used at this time.[1-A, F]

Chronic hypertension, diabetes, dyslipidemia, obesity, tobacco use and sleep apnea are recognized risk factors for CVD. All can be amplified during pregnancy, and all can be modified before, during and after pregnancy with the appropriate prevention strategies.[1-F] ACOG and the AHA have long advocated the use of multidisciplinary care by cardiologists and obstetricians.[1-G]

Establishing postpartum follow-up opens the door for continuing interventions to better manage CVD risk factors, including pharmacotherapy, lifestyle management and education.[1-D, F]

Postpartum visits need not always be in person. Telemedicine can help women maintain breastfeeding, manage postpartum depression and continue BP monitoring, among other benefits. The use of telemedicine may improve access to care, especially for women with time and/or resource constraints.[1-H] Regardless of the type of visit, continued follow-up during the fourth trimester can improve early identification and intervention for CVD and CVD risk.[1-D]

References

1. Thakkar A, Hailu T, Blumenthal RS, et al. Cardio-Obstetrics: The Next Frontier in Cardiovascular Disease Prevention. *Curr Atheroscler Rep.* 2022 Jul;24(7):493-507. doi:10.1007/s11883-022-01026-6. Epub 2022 May 7. PMID: 35524915; PMCID: PMC9076812

2. American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 736: Optimizing Postpartum Care. *Obstet Gynecol.* 2018;131(5):e140-e150. doi:https://doi.org/10.1097/AOG.0000000000002633

3. Davis E, Gorog DA, Rihaj C, Prasad A, Srinivasan M. "Mind the Gap" Acute Coronary Syndrome in Women: A Contemporary Review of Current Clinical Evidence. *Intl J Cardiol.* 2017; 227: 840-849. doi:10.1016/j.ijcard.2016.10.020

4. Garovic VD, Dechend R, Easterling T, et al. Hypertension in Pregnancy: Diagnosis, Blood Pressure Goals and Pharmacotherapy: A Scientific Statement From the American Heart Association. *Hypertension.* 2022;79:e21–e41. doi:https://doi.org/10.1161/HYP.0000000000000208

5. Dines VA, Kattah AG, Weaver AL, et al. Risk of Adult Hypertension in Offspring From Pregnancies Complicated by Hypertension: Population-Based Estimates. *Hypertension.* 2023;80(9):1940-1948. doi:10.1161/hypertensionaha.123.20282

6. Paramsothy A, Hegvik TA, Engeland A, Bjørge T, Egeland GM, Klungsøyr K. Fetal Exposure to Preeclampsia and Later Risk of Cardiometabolic Disorders: A Population-Based Cohort Study. *Hypertension.* 2023;80(11):e158-e166. doi:https://doi.org/10.1161/hypertensionaha.122.20682

7. Lloyd-Jones DM, Allen NB, Anderson CAM, et al. Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association. *Circulation.* 2022;146(5). doi:10.1161/cir.0000000000001078

8. Leavitt K, Običan S, Yankowitz J. Treatment and Prevention of Hypertensive Disorders During Pregnancy. *Clin Perinatol.* 2019;46(2):173-185. doi:10.1016/j.clp.2019.02.002

9. Giorgione V, Ridder A, Kalafat E, Khalil A, Thilaganathan B. Incidence of Postpartum Hypertension Within Two Years of a Pregnancy Complicated by Preeclampsia: A Systematic Review and Meta-Analysis. *BJOG: An International Journal of Obstetrics & Gynecology.* 2021;128(3):495-503. doi:https://doi.org/10.1111/1471-0528.16545

10. Armstrong C. High Blood Pressure: ACC/AHA Releases Updated Guideline. *Am Fam Physician.* 2018;97(6):413-415.

11. Luger RK, Kight BP. Hypertension in Pregnancy. *PubMed.* Published 2022. https://www.ncbi.nlm.nih.gov/books/NBK430839/

12. Sanghavi MS, Rutherford JD. Cardiovascular Physiology of Pregnancy. *Circulation.* 2014;130:1003-1008. doi:10.1161/circulationaha.114.009029

13. Cunningham FG, Leveno K, Dashe JS, Hoffman BL, Spong CY, Casey BM. Appendix I: Serum and Blood Constituents. *Williams Obstetrics.* 26th ed. McGraw Hill Medical; 2022. ISBN:9781260462746

14. Cunningham FG, Leveno K, Dashe JS, Hoffman BL, Spong CY, Casey BM. Chapter 4: Maternal Physiology. *Williams Obstetrics.* 26th ed. McGraw Hill Medical; 2022. ISBN:9781260462746

15. Cunningham FG, Leveno K, Dashe JS, Hoffman BL, Spong CY, Casey BM. Chapter 55: Thromboembolic Disorders. *Williams Obstetrics.* 26th ed. McGraw Hill Medical; 2022. ISBN:9781260462746

16. American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 804. Physical Activity and Exercise During Pregnancy and the Postpartum Period. *Obstetrics & Gynecology.* 2020;135:e178-e188. doi: 10.1097/AOG.0000000000003772

17. American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 775. Nonobstetric Surgery During Pregnancy. *Obstetrics & Gynecology.* 2019;133(4):e285-e286. doi:https://doi.org/10.1097/aog.0000000000003174

18. Kamel H, Navi BB, Sriram N, Hovsepian DA, Devereux RB, Elkind MSV. Risk of a Thromotic Event After the 6-Week Postpartum Period. *N Engl J Med.* 2014;370(14):1307-1315. doi:10.1056/nejmoa1311485

19. American College of Obstetricians and Gynecologists. Gestational Hypertension and Preeclampsia. *Obstetrics & Gynecology.* 2020;135(6):e237-260. doi:https://doi.org/10.1097/aog.0000000000003891

20. Beech A, Mangos G. Management of Hypertension in Pregnancy. *Aust Prescr.* 2021;44(5):148-152. doi:10.18773/austprescr.2021.039

21. Croke L. Gestational Hypertension and Preeclampsia: A Practice Bulletin From ACOG. *Am Fam Physician.* 2019;100(10):649-650. https://www.aafp.org/pubs/afp/issues/2019/1115/p649.html

22. Krist AH, Davidson KW, Mangione CM, et al. Screening for Hypertension in Adults: U.S. Preventive Services Task Force Reaffirmation Recommendation Statement. *JAMA.* 2021;325(16):1650–1656. doi:10.1001/jama.2021.4987

23. Tita AT, Szychowski JM, Boggess K, et al. Treatment for Mild Chronic Hypertension During Pregnancy. *N Engl J Med.* 2022;386(19):1781-1792. doi:10.1056/NEJMoa2201295

24. Jones DW, Ferdinand KC, Taler SJ, et al. 2025 AHA/ACC/AANP/AAPA/ABC/ACCP/ACPM/AGS/AMA/ASPC/NMA/PCNA/SGIM Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *PubMed.* Published online August 14, 2025. doi:https://doi.org/10.1161/cir.0000000000001356

25. Clinical Guidance for the Integration of the Findings of the Chronic Hypertension and Pregnancy (CHAP) Study. Published April 2022. https://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2022/04/clinical-guidance-for-the-integration-of-the-findings-of-the-chronic-hypertension-and-pregnancy-chap-study

26. Postpartum Care for Women up to One Year After Birth (A Systematic Review). Published August 27, 2021. https://www.pcori.org/research-results/2021/postpartum-care-women-one-year-after-birth-systematic-review

27. Tschiderer L, Seekircher L, Kunutsor SK, Peters SAE, O'Keeffe LM, Willeit P. Breastfeeding Is Associated With a Reduced Maternal Cardiovascular Risk: Systematic Review and Meta-Analysis Involving Data From 8 Studies and 1 192 700 Parous Women. *J Am Heart Assoc.* 2022;11(2):e022746. doi:https://doi.org/10.1161/jaha.121.022746

28. Attanasio LB, Ranchoff BL, Cooper MI, Geissler KH. Postpartum Visit Attendance in the United States: A Systematic Review. *Women's Health Issues.* 2022;32(4):369-375. doi:10.1016/j.whi.2022.02.002

29. American College of Obstetricians and Gynecologists. Hypertension in Pregnancy. *Obstetrics and Gynecology.* 2013;122(5):1122-1131. doi:10.1097/01.aog.0000437382.03963.88