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Update: Systemic Diseases and the Cardiovascular System (X)

# The Heart During Pregnancy

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ABSTRACT

During pregnancy, there are a number of important changes to cardiovascular function which are necessary for progression of a successful pregnancy. Additionally, preexisting cardiovascular conditions can be exacerbated by the adaptations that occur during gestation. These can present serious therapeutic challenges in the management of the cardiology patient during pregnancy. Significantly, the number of pregnant women at risk of cardiovascular complications is on the rise, so identification of risk factors that predict cardiac outcomes is essential to proper screening of the obstetrical patient. In diagnosed preexisting conditions, such as pulmonary hypertension, counseling is important prior to pregnancy. In the case of underlying disorders unmasked by pregnancy, or new-onset complications like preeclampsia, appropriate monitoring and treatment of the cardiovascular complications is warranted. Ultimately, collaborative care by both obstetricians and cardiologists is essential for the successful resolution of cardiovascular dysfunction in the obstetrical patient.



## El corazón durante el embarazo

*Palabras clave:*
Gasto cardiaco
Embarazo
Insuficiencia cardiaca
Arritmia

RESUMEN

Durante el embarazo se produce una serie de cambios en la función cardiovascular que son necesarios para la buena evolución de la gestación. Además, las adaptaciones que ocurren durante la gestación pueden agravar las enfermedades cardiovasculares preexistentes. Por lo tanto, estas modificaciones pueden suponer importantes desafíos terapéuticos en el manejo de la paciente cardiológica durante el embarazo. El número de mujeres embarazadas en riesgo de sufrir complicaciones cardiovasculares está aumentando significativamente, por lo que identificar los factores de riesgo que predicen enfermedades cardiacas es de vital importancia para una correcta detección sistemática en la gestante. En el caso de enfermedades preexistentes, como la hipertensión pulmonar, es importante que la paciente reciba asesoramiento antes del embarazo, y en el caso de alteraciones subyacentes enmascaradas por el embarazo o nuevas complicaciones como la preeclampsia, es estrictamente necesario realizar un seguimiento adecuado y tratar las complicaciones cardiovasculares. Por último, es esencial que los obstetras y los cardiólogos trabajen en conjunto para resolver adecuadamente la disfunción cardiovascular en la paciente obstétrica.



## CARDIOVASCULAR ADAPTATIONS DURING NORMAL PREGNANCY

A variety of changes in the cardiovascular system occur during normal pregnancy, including increases in cardiac output, arterial compliance, and extracellular fluid volume and decreases in blood pressure (BP) and total peripheral resistance.[1] Mean BP gradually falls during pregnancy, with the largest decrease in BP typically occurring at 16 to 20 weeks.[2] BP then begins to rise during the mid-third trimester to levels approaching prepregnancy BP values (Fig. 1). The decrease in BP during pregnancy is characterized by decreases in both systolic BP (SBP) and diastolic BP (DBP) with the decrements in DBP exceeding those in SBP.

Blood flow to various organs increases during pregnancy to meet the increased metabolic needs of tissues. Thus, venous return and cardiac output increases dramatically during pregnancy. Cardiac output gradually increases during the first 2 trimesters with the largest increase occurring by 16 weeks of gestation.[3] The increase in cardiac output is well established by 5 weeks of gestation and increases to 50% above prepregnancy levels by 16 to 20 weeks of gestation. The rise in cardiac output typically plateaus after 20 weeks of gestation and remains elevated until term. The increases in cardiac output are associated with significant

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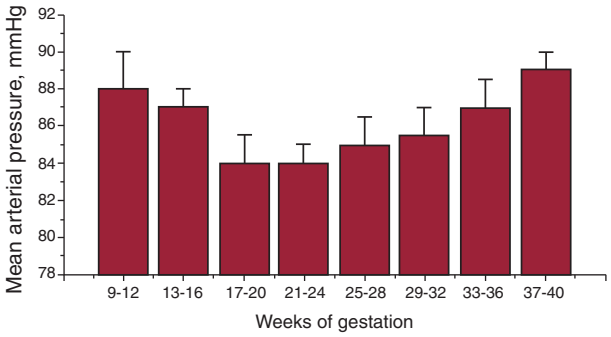


**Figure 1.** Mean arterial pressure in women during normal pregnancy (Redrawn from Moutquin et al.[2]).

increases in stroke volume and heart rate (HR) (Fig. 2). Mean circulatory filling pressure, an important determinant of venous return, is also elevated during pregnancy. Moreover, resistance to venous return is dramatically reduced during pregnancy.

The increased cardiac output and slight decrease in BP during pregnancy is associated with a marked reduction in systemic vascular resistance.[4] Total peripheral resistance decreases very early during pregnancy and continues to decrease throughout the second and third trimester, although to a lesser extent near term (Fig. 3). Arterial compliance also changes dramatically during pregnancy. Arterial compliance increases during the first trimester and remains elevated throughout the remainder of pregnancy. Thus, both steady and pulsatile afterload decreases occur during normal pregnancy in humans.

While the mechanisms responsible for mediating the changes in systemic hemodynamics have yet to be completely elucidated, a number of important factors are thought to contribute to physiological changes in the vascular system that occur during pregnancy. Substantial evidence indicates that nitric oxide (NO) production is elevated in normal pregnancy and that these increases appear to play an important role in the vasodilation of pregnancy.[5] Inhibition of NO synthesis in animal models of pregnancy attenuates the decreases in total peripheral resistance and increases in cardiac output associated with pregnancy.

Hormonal factors such as estrogen and relaxin are thought to be important in stimulating the production of NO during pregnancy. Relaxin, which is primarily produced by the corpus luteum, has been shown to chronically reduce total peripheral resistance and increase cardiac output and systemic arterial compliance.[6] In addition, neutralization of endogenous circulating relaxin by antibodies during early gestation markedly attenuate the changes in cardiac output, systemic vascular resistance, and arterial compliance during pregnancy. These effects of relaxin are thought to be mediated by interactions between endothelin type B receptors and NO. Thus, relaxin appears to play an important role in many of the cardiovascular adaptations of pregnancy via NO-dependent mechanisms.

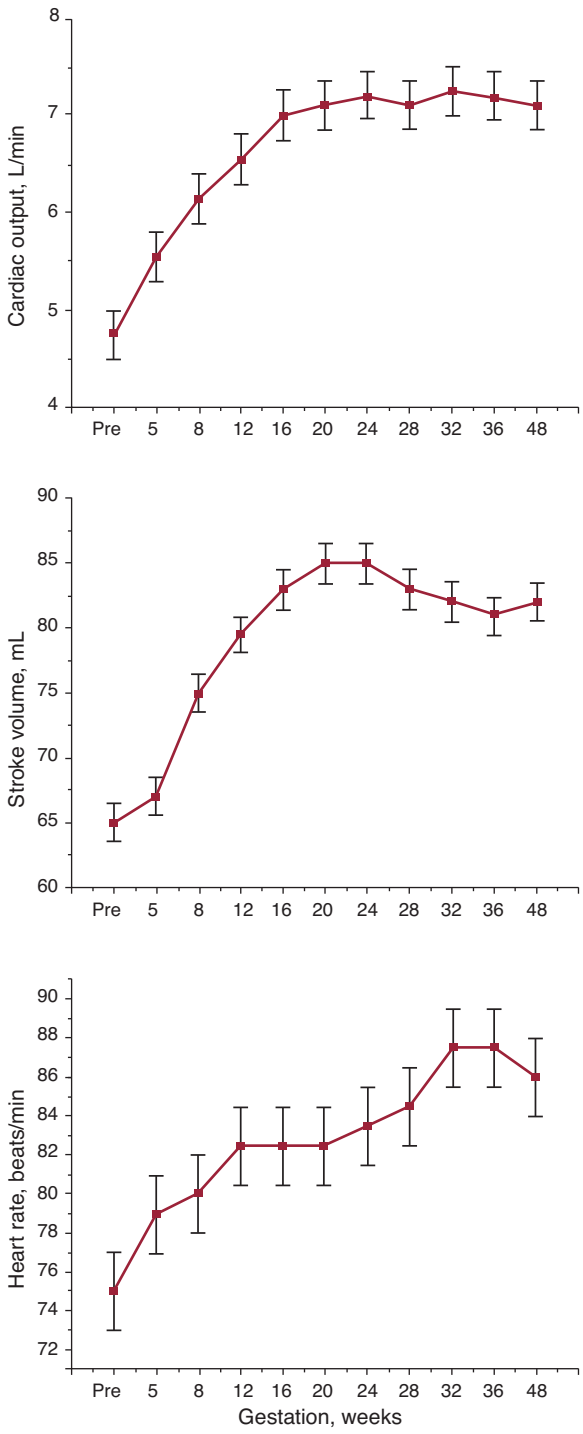


**Figure 2.** Changes in cardiac output, stroke volume, and heart rate during pregnancy (Redrawn from Hunter et al.[3]).

## PREGNANCY AND HEART DISEASE

Although maternal cardiac disease complicates a small percentage of pregnancies overall, it is a significant cause of nonobstetrical maternal and fetal morbidity and mortality.[7] Pregnancy is associated with significant hemodynamic changes, namely volume expansion and increased cardiac output, which in the setting of underlying maternal cardiac disease may lead to decompensation and fetal demise. In addition to the hemodynamic changes imposed by the gravid state, factors such as peripheral vasodilation from anesthesia or blood loss that may occur with delivery may aggravate cardiac dysfunction in women with significant underlying cardiac disease (Table 1).

Congenital heart disease is becoming more prevalent in women of childbearing age as a result of improved diagnostic modalities and reparative techniques.[8] Furthermore, acquired heart disease has become more prevalent now that many women are postponing pregnancy until later ages when the risk of cardiovascular disease is increased due to hypertension (HTN), diabetes, and obesity. Risk assessment in women with underlying cardiac disease is crucial. In a prospective study of 562 consecutive pregnant women with