Original Article

A Comparative Study of Morphometric and Morphological Changes in the Placenta of Hypertensive and Normotensive Pregnancies

Raj Kumar Raman[1]

[1]Assistant Professor, Department of Anatomy, Geetanjali Medical College, Udaipur, India

Abstract

Background: Maternal and perinatal morbidity and mortality are significant contributors to PPDs, which is associated with a negative effect on placental morphology and functioning. As the placenta is a critical organ in the growth and development of the fetus, morphometric and morphological evaluation of the placenta is quite informative on the effect of maternal hypertension on fetal outcome. The aim is to create the morphometric and morphological assessment of human placenta in hypertensive women and to compare the results with the results of normal pregnancies. **Material and Methods:** It was an observational study in forms of comparative observations on 180 placentas comprising of two groups: control (n = 90) and hypertensive (n = 90). The hypertensive group consisted of the cases of gestational hypertension, preeclampsia and eclampsia. The placentas were collected and washed after delivery and then weighed, measured, surface area, volume, count of cotyledons, fetoplacental ratio, shape and fibrin deposition examined. **Results:** There was significant difference between the mean placental weight of the hypertensive group and the control group ($p < 0.001$) and also the fetal weight ($p < 0.001$). Hypertensive pregnancies experienced considerable loss of placental thickness, surface area, volume and cotyledons. **Conclusion:** The pregnancies experiencing hypertensive disorders result in pronounced morphometric and morphological changes in the placenta resulting in inappropriate placental functioning and low birth weight of the fetus.

Keywords: Placenta, Hypertensive pregnancy disorders, Preeclampsia, Placental morphometry, Placental morphology, Fetoplacental ratio, Fetal growth, Pregnancy induced hypertension.

Received: 28 September 2025 **Revised: 26 October 2025** **Accepted: 10 November 2025** **Published: 10 December 2025**

Introduction

The placenta is a unique organ that is extremely specialized and temporary in its function of preserving the pregnancy and maturing of the fetus. It is the main point of communication between the mother and the fetus and makes sure that facts of the nutrition, gases, hormones, and waste products are exchanged during the gestation period. Any change in the maternal physiological status has the potential of causing significant changes in the placental structure and functions hence fetal development and pregnancy success. Among the most frequent and severe medical complications, which can be experienced during pregnancy, hypertensive disorders of pregnancy (HDP) are leading causes of maternal and perinatal morbidity and mortality in the world.[1,2]

The hypertensive conditions during pregnancy are chronic hypertension, gestational hypertension, preeclampsia, and eclampsia. The conditions make about 5-10 percent. of all pregnancies across the world, causing a significant percentage of maternal and neonatal morbidity, including intrauterine growth restriction (IUGR), preterm labour, placental abruption, low birth weight, and stillbirth.[3,4] The incidence of pregnancy-induced hypertension in India is between 7 and 15 percent, and this is a severe health aspect of the population.[5] The fact that the placenta is the first organ, which is exposed to changes in uteroplacental circulation, which occur during hypertensive conditions, gives naive data on the pathophysiology of such conditions through detailed morphometric and morphological analysis of the placenta.

The normal stage of placental development involves complex mechanisms such as trophoblastic invasion, maternal spiral artery remodelling, angiogenesis and vasculogenesis. They allow an adequate blood flow to satisfy the metabolic needs of the growing fetus which are on the rise.[6] In hypertensive pregnancies, failure in trophoblastic invasion causes failure of conversion of spiral arteries to high resistance uteroplacental circulation and low placental perfusion.[7] This hypoperfusion of the placenta triggers a sequence of ischemic and inflammatory events which result in gross and microscopic abnormalities of the placenta.

Morphometric measurements including the placental weight, diameter, thickness, surface area, and volume are said to be very important measures of efficacy of a placenta. Such parameters are an indicator of the placenta reserve and its capacity to support

Address for correspondence: Dr. Raj Kumar Raman, Assistant Professor, Department of Anatomy, Geetanjali Medical College, Udaipur, India
E-mail: ramanrajkumar2005@gmail.com

DOI:
10.21276/amit.2025.v12.i3.233

How to cite this article: Raj Kumar Raman. A Comparative Study of Morphometric and Morphological Changes in the Placenta of Hypertensive and Normotensive Pregnancies. Acta Med Int. 2025;12(3):1087-1092.

the fetal development.[8] Fetal growth restriction and poor perinatal outcomes have always been linked to a decrease in placental weight and surface area.[9] Research has shown that placental weight and fetoplacental ratio is greatly reduced in hypertensive pregnancies which also implies impaired placenta functioning and diminished transportation ability.[10,11] The changes in placenta morphology are therefore valuable indices in the status of the unborn.

Gross placenta morphology in hypertensive disorders is often found to be abnormally shaped, small, infarcted, calcified, retroplacental hematomas and more often than not, there is high rate of placenta separation.[12] One of the most typical lesions of the placenta in hypertension is infarction which indicates the inability of the uterus to be supplied with blood properly because of a lack of blood in the mother.[13] Extensive infarction is negatively associated with fetal oxygenation and has been highly linked with adverse perinatal outcomes. Another frequent observation that has been linked with hypertensive pregnancies is increased placental calcification that is believed to indicate an increased rate of placental aging and degeneration.[14]

Microscopic changes in placentas of hypertensive mothers are yet another signifier of the extent to which uteroplas is compromised. The typical histopathological changes are an augmentation of syncytial knots, fibrinoid necrosis, villous hypovascularity, augmented of the villous basement membrane augmentation, diminished intervillus space, and expanded stromal fibrosis.[15,16] The syncytiat personality knots that are groups of syncytium in the syncytiotrophoblast are regarded as indicators of placental hypoxia and oxidative stress. They camp excessively which is a sign of high turnover of villi and placent stress.[17]

When a woman is living with hypertension, placental angiogenesis is also shown to be impaired. VEGF and PlGF represent angiogenic mediators which are essential in the development of placental vascularity. The result of the imbalance between proangiogenic and antiangiogenic factors during preeclampsia is endothelial dysfunction and the hindrance of placental perfusion.[18,19] Mentioned molecular changes are associated with the gross and microscopic changes of the hypertensive placentas.

The effectiveness of the placental activity is directly proportional to fetal development and birth weight. Some of the researchers have reported a strong positive association between placental weight and birth weight and inverse association between placental pathology and neonatal outcomes.[20,21] Intrauterine growth restriction, prematurity, and low Apgar scores have been strongly linked with low placental weight and surface area in the hypertensive pregnancies.[22] Consequently, as a non-invasive outcome measure of fetal health and perinatal risk prediction, placenta morphometry has been utilized.

Even with the current developments in antenatal care and obstetric practice, the hypertensive disorders are a challenging issue to detect and treat. Despite the fact that clinical condition of maternal blood pressure and proteinuria still continues to be the basis of diagnosis HDP, the elaborations can not be used individually to measure the extent of placenta compromise. Delivery-based placement examination provides a special chance to utilize clinical severity with structural and functional placenta alterations.[23] These correlations are useful in the explanation of the disease progression and in the establishment of preventive measures of high-risk pregnancy.

Previous research has done in various population groups has identified large divergences in the parameters of the placental morphometrics in the case of hypertensive pregnancies compared to the normotensive controls.[24-26] Nevertheless, genetic, environmental, nutritional, and socioeconomic factors may cause these differences. The field of Indian studies does not offer many studies, and regional statistics on it are a rarity. This gap in knowledge thus needs to be filled by a close morphometric and morphological examination of the placenta of hypertensive females to help give region specific reference standards.

In addition, the placenta is currently credited with the role of not just passive transfer organ but also active endocrine and immunological organ the malfunction of which is one of the key factors in the development of hypertensive diseases.[27] Learning placental pathology may therefore provide helpful evidence of the processes that result in dysfunction of maternal endothelium, systemic inflammation and compromise of fetuses. Placental insufficiency can be detected early and prevent complications.

Besides their impacts on the fetus, the implications of abnormal placental development on the health of the mothers have long-term effects. Women that had a history of preeclampsia turn out to be highly vulnerable to cardiovascular disease, high blood pressure and metabolic syndrome in their later life.[28] The abnormality of the placenta in pregnancy can be indicative of the maternal vascular pathology, thus the placenta, as a window to the future maternal health.

Thus, understanding the morphometric and morphological nature of the placenta during a hypertensive pregnancy can have a very great impact on the clinic and academics. It is not only able to improve our knowledge about the disease process, but also able to lay down clinicopathological correlation, which can be used to implement obstetric management. Comparing such parameters of the placenta as hypertensive and normotensive mothers, it is possible to come to important conclusions concerning the extent of placental involvement and its effects on fetal outcome.

Materials and Methods

Population and Selection Criteria of the study.

Pregnant women aged 23 to 37 years were used in the study. The hypertensive control group included primigravida women with gestational hypertension diabetes and preeclampsia or eclampsia. The control group comprised of mothers whose pregnancy was uncomplicated and with normotensive pregnancy.

The inclusion criteria of both the hypertensive and the control group included: multiparty, preexisting or past systemic disease, previous or current substance or drug abuse as well as bad obstetric history. And in accordance with these criteria, there were two groups among the participants:

Control group 90 normotensive pregnant women.

Group of hypertensive patients: 90 pregnant women with hypertensive diseases.

Clinical Evaluation

Motherly measurements such as height and the weight of the

mothers as well as the vital signs and anemia parameters such as hemoglobin status were estimated in both groups. An elaborate history on past medical disease and obstetric events was taken. Hypertension among hypertensive population was determined as systolic blood pressure 140mmHg and/or diastolic blood pressure 90mmHg. To rule out the diagnosis, blood pressure was measured at least three times per day at 8 hours intervals.

All the neonates were investigated after delivery with regard to any congenital anomalies and birth weight recorded in weights in kilograms. The control and hypertensive groups were compared using the unpaired t-test to compare the fetal weights.

Within Placental Collection and Processing, only the placental cord, umbilical cord, and their associated tissues are included.<|human|>The placental cord, umbilical cord and related tissues are all included within Placental Collection and Processing.

The placenta of every baby was taken as a clean tray as soon as the baby was born. The location where the umbilical cord was inserted and the way the fetal membranes were attached were recorded. Umbilical cords and membranes were then clipped off. Placenta was squished to release unnecessary blood, washed commonly by running tap water, and dried using a clean towel before examination.

Morphometric and Morphologic Evaluation.

Comparison occurred between the two groups of morphometric and morphological parameters of the placenta that were recorded as follows:

- Placental weight (g)
- Placental diameter (cm)
- Placental thickness (cm)

Surface area of placenta (mm 2)

- Placental volume (mm³)
- Cotyledons of maternal surface number.
- Fetoplacental ratio
- Placental shape
- Existence of areas of infarction and fibrin deposition.

Measurement Techniques

Before weighing the umbilical cord and the membranes were carefully removed. The placenteras were once as washes and dried out in order to extract the remaining blood. The placental weight was determined through a weighing scale with the accuracy of 10 g.

The thickness and diameter of the placenta were measured through a digital Vernier caliper (precision, 0.1 mm). In order to remove instrumental error, the use of the ABS button was to reset the caliper after which a measurement was taken.

Results

[Table 1] compares the fetal and placenta measurements that are the key in the control and hypertensive groups. The hypertensive group had a significant decrease in the mean fetal weight, and placental weight than the control group, which signifies the failure of fetal development and placental growth in hypertension. There was also a significant decrease in placental thickness, surface area volume, and mean number of cotyledons in hypertensive pregnancies. The statistical difference between all parameters was highly significant ($p < 0.001$), indicating that hypertensive disorders of pregnancy impact negatively on placental structure and function to a great extent.

Table 1: Placental and Fetal Morphometric and Morphological parameter (N = 180).

Parameters	Group Control MeanSD (n=90)	Group Hypertensive MeanSD (n=90)	p value
Fetal weight (kg)	3.08 ± 0.35	2.48 ± 0.44	<0.001
Placental weight (g)	512 ± 32	382 ± 85	<0.001
Placental thickness (cm)	2.46 ± 0.36	1.98 ± 0.40	<0.001
Placental surface area (sq cm)	252 ± 28.5	168 ± 30.2	<0.001
Placental volume (cubic mm)	520 ± 60.4	348 ± 78.6	<0.001
Mean number of cotyledons	16.6 ± 1.7	12.1 ± 1.5	<0.001

Table 2: the mean Fetoplacental Ratio (N = 180)

Group	Neonatal weight (kg)	Placental weight (g)	Fetoplacental ratio.
ControlGroup (n=90)	3.08 ± 0.35	512 ± 32	6.01 ± 0.78
Hypertensive Group (n=90)	2.48 ± 0.44	382 ± 85	6.49 ± 1.10

[Table 2] shows the correlation between the weight of neonals and placental weight in the two groups. Even though the fetal and placental weights were considerably lower in the hypertensive group, fetoplacental ratio was marginally greater in contrast to the control group. This shows that there is a relative compensation mechanism that is a smaller placenta trying to sustain fetal development in poor conditions. Greater ratio, however, does express placental inefficiency in hypertensive pregnancies.

Table 3: Distribution of placental shape (N 180). Shape Control Group (n=90) Percentage Hypertensive Group (n=90) Percentage

Discoidal	78	86.7%	72	80%
Circular	22	24.4%	10	11.1%
Oval	60	66.7%	68	75.6%
Irregular	08	8.9%	12	13.3%

[Table 3] presents the distribution of the different shapes of the placental forms in control and hypertensive groups. The most typical were discoidal and oval shapes; but the oval and irregular placentas were more types in hypertensive group. The

development of abnormal shapes in greater frequency observed in hypertensive pregnancies is a manifestation of abnormal development of the placenta as a result of abnormal development of the uteroplacental circulation and ischemic alterations.

Note: Table 4 illustrates the gross changes with placement at ages of 12, 15, 18, and 21 months of placenta- fibrin deposit (N = 180).

Group Subjects Number Characterized by Fibrin Deposition Current Number Characterized by Fibrin Deposition Absent

Control Group 90 06 84

Hypertensive Group 90 26 64

[Table 4] illustrates the fibrin deposition and the lack of fibrin deposition as a gross pathological finding. There was evidence of fibrin deposition in much more placentas in the hypertensive group than the control group. This observation reveals that hypertensive pregnancies have more placental injury, ischemia and villus damage, which leads to poor placental performance and defective fetal results.

Discussion

Hypertensive pregnancy disorders are known to have detrimental implications like poor placental structure and dysfunction thus resulting in retarded fetal development and poor perinatal outcomes. The current research paper assessed morphometric/morphological changes in the placentas in hypertensive women and compared them with the changes in normotensive mothers. This study has shown statistically significant decreases in fetal weight, placental weight, placental thickness, placental surface area, placental volume, and placental cottonyled no. in hypertensive group and increased numbers of irregular shaped placental forms and fibrin deposition which is evidence of high placental compromise.

Mean fetal weight in the present study was very low in the hypertensive group (2.48 ± 0.44 kg) compared to the control group (3.08 ± 0.35 kg), as observed by a number of previous studies.[29,30] This abnormal fetal weight can be explained by the fact that it is caused by uteroplacental insufficiency that leads to chronic fetal hypoxia and diminished nutrient supply. Findings that were similar were given by Kher and Zawar,[31] who also established a close relationship between hypertension in mothers and intrauterine growth restriction.

The average placental weight during hypertensive pregnancies (382 g 85) was also significantly less than that of the control group (512 g 32) and the difference was very large (P = 0.001). The decreased placental weight is indicative of impaired placental growth because of impaired trophoblastic invasion and disrupted spiral artery remodeling, which causes decreased perfusion.[32] Fox,[10] underlined that the weight of the placenta is a decisive factor that determines the efficiency of placenta and this weight decreases directly concerning unfavorable fetal outcomes. The results obtained by us are also in agreement with the results of Londhe and Mane and Rath et al.[24,25]

Placental thickness, surface area, and volume play an essential role as the signs of placental functional capacity. Placental thickness in the current research was lower in hypertensive pregnancy (1.98 cm 0.40 cm) than in controls (2.46 cm 0.36 cm). This decrease was observed in similar publications by Majumdar et al,[12] or Teasdale,[16] who explained this decrease by the presence of villous atrophy and stromal fibrosis, which resulted as the consequence of placental ischemia.

Mean placental surface area and volume were also greatly lower in the hypertensive group, which means that there is less maternal fetal exchange surface. Salafia et al,[8] have stated that reduced placental surface area is highly related to poor placental transport efficiency. The volume change in the present study indicates a lowered villous branching and a failure in the angiogenesis, which further restricts the nutrient diffusion and oxygen transportation.[33]

The current research showed a significant decrease in mean number of cotyledons in hypertensive placentas (12.1 +1.5) relative to the controls (16.6 + 1.7). The decreasing number of cotyledons is an indicator of incomplete segmentation of maternal placental surface owing to malformation of vascular development. Aherne and Dunnill,[22] also reported similar results and they added that cotyledon number directly correlates with the efficiency of the placental perfusion. The low cotyledon count also supports the existence of the case of chronic uteroplacental insufficiency in hypertensive pregnancies.

Fetoplasental ratio was observed to be bigger in the hypertensive group (6.49 + 1.10) than in the control group (6.01 + 0.78). Despite the fact that both fetal and placental weights were lower than normal, the proportional difference between them was higher in placental weight, which led to a higher proportionality. It means that this leads to compensatory overuse of a placenta that has already been undermined to maintain the growth of the fetus. The findings are similar as Naeye,[34] and Yetter,[14] proposed similar findings indicating that fetal metabolic stress and placental inefficiency are observed as a result of increased fetal-placenta ratio.

The current research noted that, oval and irregular release of the placenta was common amongst hypertensive pregnancy and discoidal shape among normotensive controls. Abnormal placenta shapes have been linked with disproportionate villous maturation and focal placental infarction, and indicate aberrant placental morphogenesis.[35] Rath et al,[25] as well were able to find a greater number of abnormal placental shapes among hypertensive mothers which they attributed to the change in uterine blood flow and ischemic damage.

The fibrin deposition rate was found to be much higher in hypertensive placentas (26 cases) than in controls (6 cases). Fibrin deposition is considered to be ischemic placental injury and villous decline thus adding further impairments to maternal fetal exchange. In a study by Benirschke et al,[13] fibrin deposition was found to be a cardinal study of hypertensive placental pathology. It has also been reported that an augmented fibrinoid necrosis is associated with diminished villous vascularization and adverse neonatal outcome.[36]

The discussion of the changes in structure of hypertensive placentas can be reduced to the major causes, which include the change in trophoblastic invasion that is associated with abnormality and the breakdown of the transformation of spiral arteries. This causes uteroplacental circulation of high resistance that results in placental hypoxia, oxidative stress and endothelial

dysfunction.[7,18] High concentrations of anti-angiogenic agents including sFlt-1 decrease placental vascular development and increase ischemic injury.[19] These changes in molecules can be the explanation why placental size was reduced, infarction was increased, fibrin deposition was high and villous architecture was affected as it is in the current study.

Results of this research are important in clinical implications. To a large extent, placental morphometric changes, as well as low fetal weight, has a strong relationship, and this accentuates the need to identify and do regular observations to hypertensive pregnancies. The importance of placental examination following delivery would be to offer important outcomes regarding the severity of uteroplacental insufficiency, which plays a role in predicting neonatal outcome. Besides, the reported placental pathology confirms the principle that the placenta reflects maternal vascular health, and thus its use in projecting future cardiovascular risk among the affected women is highlighted.[28,37]

The findings of this paper are consistent with the majority of previous Indian and global works.[24,25,29,31] Nevertheless, the differences in the parameters of the placental in the various studies might be explained by the differences in the nutritional condition, socioeconomic situation, antenatal care, genetic background and degree of hypertension. The current study contributes useful region-specific data, which can be used as a research standard in other researches with similar populations in the future.

Limitations

Even though the study sample size of 180 is quite large, it did not provide histopathological verification and biochemical assay of angiogenic markers in the current study. The above study can be enhanced by historic research of placenta dysfunction in hypertensive pregnancies using histology, Doppler flow research, and molecular markers.

Conclusion

The current research indicates that hypertensive disorders of pregnancy has tremendous effects on the placental morphology, morphometry, and fetal growth. Hypertensive pregnancies compared to normotensive controls had a marked decrease in the fetal weight, placental weight, thickness, surface area, volume, and number of cotyledons. Such results show clearly that maternal hypertension causes structural and functional damage to placenta, which results to impaired uteroplacental circulation and decreased fetal nourishment.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Cunningham FG, Leveno KJ, Bloom SL, et al. Williams Obstetrics. 26th ed. New York: McGraw Hill; 2022.
2. World Health Organization. WHO recommendations for prevention and treatment of preeclampsia and eclampsia. Geneva: WHO; 2018.
3. Duley L. The global impact of pre-eclampsia and eclampsia. SeminPerinatol. 2009;33(3):130–7.
4. Roberts JM, Gammill HS. Preeclampsia: recent insights. Hypertension. 2005;46(6):1243–9.
5. National Family Health Survey (NFHS-5), India 2019–2021. Government of India.
6. Burton GJ, Jauniaux E. Pathophysiology of placental-derived fetal growth restriction. Am J Obstet Gynecol. 2018;218(2S):S745–61.
7. Pijnenborg R, Vercruysse L, Hanssens M. The uterine spiral arteries in human pregnancy. Am J Obstet Gynecol. 2006;194(2):558–67.
8. Salafia CM, Zhang J, Miller RK, et al. Placental surface shape and efficiency. Placenta. 2008;29(6):558–64.
9. Barker DJP. Fetal origins of coronary heart disease. BMJ. 1995;311(6998):171–4.
10. Fox H. Pathology of the placenta. 2nd ed. London: WB Saunders; 1997.
11. Kishwara S, et al. Morphological changes of placenta in preeclampsia. Bangladesh J Pathol. 2009;24(1):9–15.
12. Majumdar S, et al. Gross and histological changes of placenta in pregnancy induced hypertension. J AnatSoc India. 2005;54(1):17–20.
13. Benirschke K, Kaufmann P, Baergen RN. Pathology of the Human Placenta. 5th ed. New York: Springer; 2006.
14. Yetter JF. Examination of the placenta. Am Fam Physician. 1998;57(5):1045–54.
15. Soma H, et al. Histological changes in placentas from preeclamptic women. GynecolObstet Invest. 1982;14(2):97–104.
16. Teasdale F. Histomorphometry of the human placenta in preeclampsia. Am J Obstet Gynecol. 1985;152(1):25–31.
17. Fox H. Villous immaturity and syncytial knots. Placenta. 1997;18(7):537–8.
18. Maynard SE, et al. Excess placental sFlt1 in preeclampsia. J Clin Invest. 2003;111(5):649–58.
19. Levine RJ, et al. Circulating angiogenic factors in preeclampsia. N Engl J Med. 2004;350:672–83.
20. Kher AV, Zawar MP. Study of placental pathology in toxemia of pregnancy. J ObstetGynecol India. 1981;31:231–6.
21. Udainia A, Jain ML. Morphological study of placenta in pregnancy induced hypertension. Indian J PatholMicrobiol. 2001;44(1):61–5.
22. Aherne W, Dunnill MS. Quantitative aspects of placental structure. J PatholBacteriol. 1966;91:123–39.
23. Redline RW. Placental pathology. ClinObstet Gynecol. 2008;51(4):913–29.
24. Londhe PS, Mane AB. Morphometric study of placenta in hypertension. Int J Anat Res. 2015;3(3):1197–203.
25. Rath G, et al. Comparative study of placenta in normal and hypertensive pregnancy. J AnatSoc India. 2000;49(1):24–7.
26. Sharma P, et al. Placental morphology in preeclampsia. Indian J PatholMicrobiol. 2016;59(3):322–7.
27. Myatt L. Placental adaptive responses and fetal programming. J Physiol. 2006;572:25–30.
28. Bellamy L, et al. Risk of cardiovascular disease after preeclampsia. BMJ. 2007;335:974.
29. Naeye RL. Placental changes associated with preeclampsia. Am J Pathol. 1973;70(1):45–62.
30. Madazli R, et al. Placental morphometry in preeclampsia. Placenta. 2003;24(6):581–7.
31. Kher AV, Zawar MP. Study of placental pathology in toxemia of pregnancy. J ObstetGynecol India. 1981;31:231–6.
32. Mayhew TM. Stereology of placenta in preeclampsia. Placenta. 2009;30:168–74.
33. Kingdom JC, et al. Placental villous vascularity. Am J Pathol. 2000;157:1449–58.

34. Naeye RL. Disorders of placental structure. Hum Pathol. 1977;8:433–45.
35. Thompson ML, et al. Abnormal placental shape and fetal growth. Placenta. 2012;33(9):692–8.
36. Redline RW. Placental vascular disorders. ClinObstet Gynecol. 2010;53:234–44.
37. Smith GCS, et al. Preeclampsia and future maternal cardiovascular disease. Lancet. 2001;357:2002–6.