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Research Article

Maternal Risk Factors for Adverse Neonatal Outcomes in Pregnancies Complicated by Cardiovascular Disease: A Multivariate Logistic Regression Analysis at Baghdad Teaching Hospital

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Abstract

Background: Heart disease in pregnancy is associated with significant maternal and fetal risks, but data from Iraq are scarce.

Methods: This prospective cross-sectional study included 81 pregnant women with echocardiographically confirmed heart disease at Baghdad Teaching Hospital (May 2023–May 2024). Maternal cardiac and obstetrical complications, fetal outcomes, and predictors of adverse neonatal outcomes were analysed.

Results: The incidence of heart disease in pregnancy was 0.95%. Valvular disease (59.3%) was the most common. Preterm delivery occurred in 24.7%, low birth weight in 19.8%, IUGR in 9.8%, and Stillbirth in 4.9%. Cardiac complications occurred in 17.25% (heart failure 12.30%), and obstetrical complications in 16.1%. No maternal deaths occurred. Valvular disease (OR = 4.46) and congenital heart disease (OR = 3.83) were independent predictors of adverse neonatal outcomes, while antenatal care registration was protective (OR = 0.18).

Conclusion: Pregnancy in women with heart disease carries substantial risks, particularly with valvular and congenital lesions. Antenatal care significantly improves outcomes.

Keywords: Pregnancy, Heart disease, Maternal complications, Fetal outcomes, Iraq

Introduction

Cardiovascular Disease (CVD) complicating pregnancy has emerged as a leading cause of maternal morbidity and mortality worldwide, particularly in low- and middle-income countries [1]. While rheumatic heart disease remains predominant in developing nations, congenital heart disease accounts for the majority of cardiac conditions in pregnancy within high-income settings [2]. The global burden of rheumatic heart disease remains substantial, with an estimated 33.4 million cases in 2015, disproportionately affecting young women in resource-limited regions [3]. Pregnancy

induces significant physiological changes, including increased blood volume, cardiac output, and heart rate, which can unmask or exacerbate underlying cardiac conditions [4]. Women with heart disease face heightened risks of adverse maternal outcomes such as heart failure, arrhythmias, pulmonary embolism, and even mortality [5]. Similarly, fetal and neonatal complications, including preterm delivery, Intrauterine Growth Restriction (IUGR), low birth weight, Stillbirth, and Neonatal Intensive Care Unit (NICU) admission, are substantially increased in this population [6,7].

Several risk stratification tools have been developed to predict maternal cardiac events, most notably the CARPREG (Cardiac Disease in Pregnancy) and ZAHARA risk scores, which identify predictors such as prior cardiac events, poor functional class (NYHA ≥ II), left ventricular dysfunction, and valvular pathology [8,9]. Despite these advances, data from Iraq and other conflict-affected regions remain limited, where healthcare infrastructure, antenatal care access, and disease surveillance face unique challenges [10]. Understanding the local epidemiology, complication patterns, and predictors of adverse outcomes is essential for developing targeted preconception counselling, antenatal surveillance protocols, and multidisciplinary care models [11]. To date, few prospective studies have examined pregnancy outcomes in Iraqi women with heart disease, and none have systematically analysed both maternal cardiac complications and neonatal risk factors in a single-centre cohort from Baghdad.

Aim of the Study

This study aimed to analyse pregnancy outcomes in women with cardiovascular disease at Baghdad Teaching Hospital, specifically to:

a) Determine the incidence and types of heart disease among pregnant women in our setting.

b) Assess the frequency of maternal cardiac and obstetrical complications.

c) Evaluate fetal and neonatal outcomes, including preterm delivery, low birth weight, IUGR, Stillbirth, and NICU admission.

d) Identify independent predictors and risk factors for adverse neonatal outcomes using multivariate logistic regression analysis.

Patients and Methods

Study Design, Setting, and Period

This prospective cross-sectional study was conducted at Baghdad Teaching Hospital, Baghdad, Iraq, from May 2023 to May 2024. During the study period, a total of 8,521 deliveries were recorded at the hospital. All pregnant women with echocardiographically confirmed heart disease who delivered at or after 28 weeks of gestation were enrolled. The study was carried out through collaborative management by the Departments of Obstetrics and Gynaecology and Cardiology.

Study Population

All pregnant women with pre-existing or newly diagnosed heart disease confirmed by echocardiography were eligible for inclusion. The diagnosis and classification of heart disease were based on clinical assessment and transthoracic echocardiography performed by a consultant cardiologist.

Inclusion Criteria

a) Pregnant women with echocardiographically confirmed heart disease (valvular, congenital, arrhythmic, or other cardiac conditions)

b) Gestational age at delivery ≥ 28 weeks

c) Delivery at Baghdad Teaching Hospital during the study period

Exclusion Criteria

a) Pregnancies ending before 28 weeks due to miscarriage, termination, or fetal death

b) Pregnancies occurring within six months of a previous delivery

c) Incomplete medical records or lack of echocardiographic confirmation

A total of 81 pregnant women with heart disease met the inclusion criteria and were enrolled in the study. The incidence of heart disease in pregnancy was calculated as the number of affected women divided by the total number of deliveries during the study period.

Data Collection

Baseline demographic and clinical data were recorded for each participant, including maternal age, gestational age at delivery, parity, and comorbid conditions (diabetes mellitus, hypertension, and thyroid disease). Antenatal care attendance, presenting symptoms during pregnancy, and the use of cardiac medications (e.g., beta-blockers, antihypertensives, anticoagulants, diuretics) were also documented. Follow-up data were obtained during labour, delivery, and the postpartum hospitalisation period through collaborative management by obstetricians and cardiologists. Mode of delivery (vaginal or cesarean section) and indications for cesarean section were recorded.

Maternal Outcomes

Maternal complications were classified into two categories:

a) **Cardiac complications**: admission to the Cardiac Care Unit (CCU), heart failure, arrhythmia, pulmonary embolism, and maternal mortality.

b) **Obstetric complications**: Postpartum Haemorrhage (PPH), placenta previa, pre-eclampsia, twin pregnancy, and infections.

All complications were documented during the antenatal, intrapartum, and postpartum periods.

Fetal and Neonatal Outcomes

Fetal and neonatal outcomes assessed included:

a) Preterm delivery (gestational age < 37 weeks)

b) Low birth weight (< 2500 grams)

c) Intrauterine Growth Restriction (IUGR)

d) Stillbirth (fetal death after 28 weeks of gestation)

e) Admission to the Neonatal Intensive Care Unit (NICU)

f) Congenital heart disease in the neonate

Ethical Considerations

The study protocol was approved by the Arab Board of Health Specialisation. Institutional approval was obtained from the hospital administration and the Department of Obstetrics and Gynaecology at Baghdad Teaching Hospital. Verbally informed consent was obtained from all participants after explaining the study's purpose and procedures. Confidentiality of patient data was maintained throughout the study.

Statistical Analysis

Data were analysed using SPSS version 21 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean±Standard Deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Comparisons between groups were performed using the chi-square test for categorical variables and Student's t-test for continuous variables. A p-value≤0.05 was considered statistically significant. Multiple logistic regression analysis (stepwise method) was used to identify independent predictors and risk factors for adverse neonatal outcomes. Odds ratios (ORs) with 95% Confidence Intervals (CIs) were calculated to estimate risk; ORs> 1 indicated a risk factor, and ORs < 1 indicated a protective effect. Results were presented in tables and figures with accompanying explanations.

Results

History of medications used by the studied group

Beta-blockers were the most frequently used medication among the studied group, used by 30/81 women (37%), followed by antihypertensive drugs (14/81; 17.3%) and anticoagulants (12/81; 14.8%). Other medications, such as diuretics and antibiotics, were less frequently used by the study participants (Table 1).

Table 1: Distribution of medications used by the studied group (N=81) *

Medication	No.	%
B-blocker	30	37.0
Antihypertensive	14	17.3
Anticoagulant	12	14.8
Diuretics	4	4.9
Antibiotics	2	2.5
Others**	2	2.5

***Note:** * Some women used more than one medication at the same time (combination)

** Others: Ca-channel blocker and Insulin

Fetal outcome parameters

Table 2 and Figures 1 & 2 show the parameters related to fetal outcome. The mean gestational age was 37.1 ± 2.5 (range: 27 - 42) weeks; on the other hand, 20 women (24.7%) were at a gestational age of< 37 weeks and 61 women (75.3%) at 37 weeks or more of gestation. The mean birth weight was 2890±650 (range:1250 - 4500) g; furthermore, the distribution of the birth weight into 4 categories revealed that the birth weight was< 2500 in 16 women (19.8%), 2500 - 3000 in 31 women (38.3%), 3100 - 3500 gin 26 women (32.1%) and> 3500 gin the remaining 8 women (9.8%). Intra-Uterine Growth Retardation (IUGR) was reported in 8 women (9.8%). The majority of women (77/81 (95.1%)) had a live fetus, while Still birth was reported in only 4women (4.9%). Sixteen (19.8%) neonates needed admission to the Neonatal Intensive Care Unit (NICU), and 3 neonates (3.7%) were born with congenital heart disease.

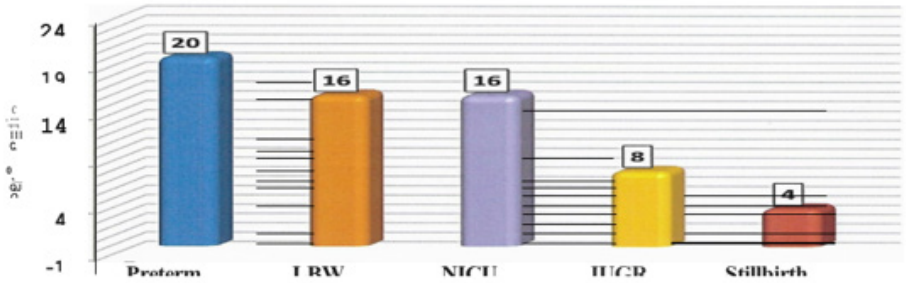

Figure 1: Adverse neonatal outcome of the studied group (N=81).

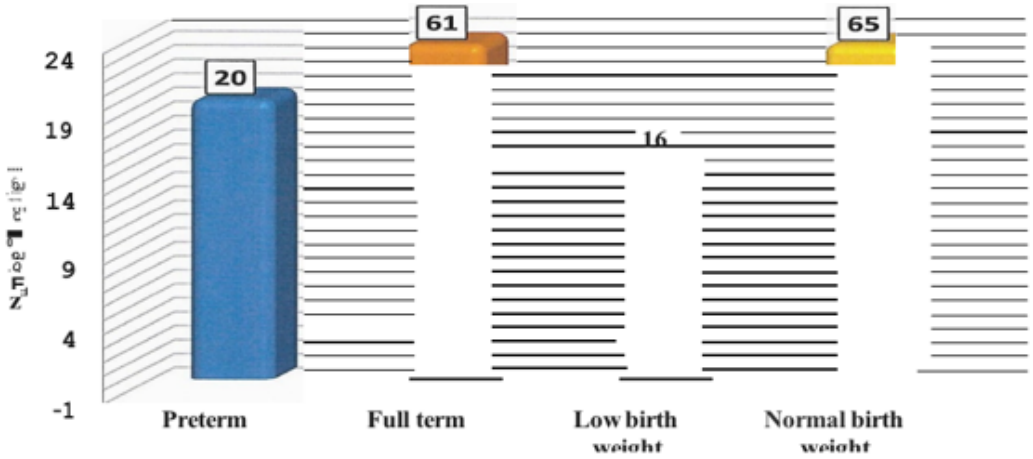

Figure 2: Distribution of the studied group according to the gestational age at delivery and birth weight.

Logistic Regression Test for the Predictors and Risk Factors of Adverse Neonatal Outcomes

To identify the predictors and risk factors of the adverse neonatal outcome, a multiple logistic regression test (stepwise) was conducted; the results of this regression test are shown in Table 3. It had been significantly found (P<0.05) that presence of maternal valvular and congenital heart diseases were the more predictors and risk factors for the adverse neonatal outcome, the odds ratio (estimator of the risk) was 4.46 regarding the presence of valvular diseases which indicated that neonates of women who had valvular diseases were about 4.5 folds more likely to have adverse outcome. Regarding the presence of maternal congenital heart diseases, the odds ratio was 3.83, which indicated that neonates of mothers with congenital heart diseases were about 3.8-fold more likely to have an adverse outcome, in both comparisons, P<0.05. Another significant finding in the regression test was the protective effect of antenatal care registration of mothers during the current pregnancy on adverse neonatal outcomes; neonates of antenatally registered mothers were about 82% less likely to have an adverse outcome (odds ratio = 0.18, P = 0.039). Other variables included in the regression analysis showed no significant effect on the prediction of risk for adverse neonatal outcomes (Table 2,3).

Table 2: Distribution of fetal outcome parameters in the studied group (N=81).

Parameter	Category	No.	%
Gestational age at labor	< 37 weeks	20	24.7
	≥ 37 weeks	61	75.3
	Mean±SD	37.1±2.5 weeks	
	Range	27 – 42 weeks	

Birth weight (grams)	< 2500	16	19.8
	2500 – 3000	31	38.3
	3100 – 3500	26	32.1
	> 3500	8	9.8
	Mean±SD	2890±650 g	
	Range	1250 – 4500 g	
IUGR	Present	8	9.8
Fetal outcome	Alive	77	95.1
	Stillbirth	4	4.9
NICU admission	Yes	16	19.8
Congenital heart disease in a neonate	Yes	3	3.7

Table 3: Multiple logistic regression results for predictors of adverse neonatal outcome.

Variable	Odds ratio	P. value
Valvular diseases	4.46	0.001 sig
Congenital heart disease	3.83	0.012 sig
Arrhythmias	1.00	0.98 NS
Other heart diseases	1.50	0.31 NS
Old age	0.084	0.16 NS
Antenatal care registration	0.18	0.039 sig
Cesarean section	1.029	0.975 NS
PIH	0.392	0.433 NS
Chronic hypertension I	1.34	0.41 NS I
Cardiac surgery	0.438	0.467 NS
NYHA	1.01	0.97 NS
Gestational age of the neonate	1.22	LONS

Distribution of Complications

Table 4 summarises the complications that developed among women with heart disease. In total, cardiac complications developed in 14 women (17.25%); of these, 6 women (7.4%) needed admission to the CCU.

Table 4: Distribution of complications of heart disease in women (N=81).

Complication	No.	%	Mortality (No.)	CCU Admission
				No. (%)
Cardiac complications				
Heart failure	10	12.30	0	4(4.9%)
Arrhythmia	3	3.70	0	1(1.25%)
Pulmonary embolism	1	1.25	0	1(1.25%)
Obstetrical complications				
Pre-eclampsia	2	2.50	0	1(1.25%)
Postpartum haemorrhage (PPH)	2	2.50	0	0(0%)
Twin pregnancy	4	4.90	0	0(0%)
Placenta previa	5	6.20	0	0(0%)

The total obstetrical complications developed in 13 women (16.1%), of whom only one woman (1.25%) needed admission to CCU. Fortunately, none of the women died (0 mortality).

Table 5 shows the further analysis of the cardiac and obstetrical complications according to the types of maternal heart diseases, as it shown in this table, cardiac complications were more frequent than obstetrical complications in all types of heart diseases, on the other hand, both cardiac and obstetrical complications had been reported in 5 women (6.2%) who had valvular disease, one woman (1.25%) with congenital heart disease and 2 women (2.5%) other heart diseases.

Table 5: Distribution of obstetrical and cardiac complications according to underlying maternal heart disease (N=81).

Maternal Heart Disease	Obstetrical Complication		Cardiac Complication		Both Complications	
	No.	%	No.	%	No.	%
Valvular disease	8	9.9	12	14.80	5	6.25
Congenital heart disease	1	1.25	6	7.40	1	1.25
Arrhythmias	0	0.0	1	1.25	0	0.0
Other heart diseases	3	3.75	7	8.60	2	2.5

Discussion

The present study, conducted over one year at Baghdad Teaching Hospital, aimed to analyse pregnancy outcomes in women with cardiovascular disease. The incidence of heart disease in pregnancy in our hospital was 0.95% (81 out of 8,521 deliveries), which is comparable to the 0.98% reported by *Asghar et al*. in Pakistan [12]. This similarity reflects the shared epidemiological profile of developing countries where rheumatic heart disease remains prevalent [3,6]. Beta-blockers were the most used medications (37.0%), followed by antihypertensives (17.3%) and anticoagulants (14.8%). The high frequency of beta-blocker use is consistent with their role in managing arrhythmias, heart failure, and hypertensive disorders in pregnant women with heart disease [5,8,13]. Anticoagulant use (14.8%) is particularly notable, as pregnant women with mechanical prosthetic valves or atrial fibrillation require careful thromboprophylaxis; however, balancing maternal and fetal risks remains challenging [9,14]. The relatively low rate of anticoagulant use in our cohort may reflect underdiagnosis of certain high-risk conditions or limited access to specialised care [10].

The mean gestational age was 37.1±2.5 weeks, with preterm delivery (<37 weeks) occurring in 24.7% of pregnancies. This preterm delivery rate is higher than the 12% reported by *Drenthen et al*. [15] but similar to that of other developing-country cohorts [12]. The mean birth weight was 2890±650 g, and low birth weight (<2500 g) was observed in 19.8% of neonates. IUGR occurred in 9.8% pregnancies, which is comparable to the 14% reported by *Drenthen et al*. [16]. Stillbirth occurred in 4.9% of cases, closely matching the 4% fetal mortality reported in the same study [17]. The high rate of preterm delivery and low birth weight in our study may be attributed to inadequate antenatal care registration (only 27.2% of women were registered), as well as the severity of underlying maternal heart disease [6,7]. NICU admission was required for 19.8% of neonates, reflecting the increased need for neonatal support in this high-risk population [12].

Multivariate logistic regression identified maternal valvular disease (OR = 4.46, p = 0.001) and congenital heart disease (OR = 3.83, p = 0.012) as the strongest independent predictors of adverse neonatal outcomes. These findings are consistent with those of *Jankowska et al*. [10], who reported that maternal cardiac lesion type significantly influences perinatal outcomes. The strong association with valvular disease may be explained by the hemodynamic burden imposed by stenotic or regurgitant lesions, which reduces utero-placental perfusion and leads to fetal growth restriction and preterm delivery [4,5]. Congenital heart disease, particularly when associated with cyanosis or reduced ventricular function, similarly compromises fetal oxygenation [13,12]. Importantly, antenatal care registration emerged as a protective factor (OR = 0.18, p = 0.039), reducing the risk of adverse neonatal outcome by 82%. This finding underscores the critical role of regular antenatal follow-up in improving pregnancy outcomes among women with heart disease, as previously emphasised by *Siu et al*. [8] and *Canobbio et al.,* [13].

Cardiac complications occurred in 17.25% of women, with heart failure being the most frequent (12.30%). This is comparable to the 11% incidence of heart failure reported by *Pratibha D et al*. [18] in India. The development of heart failure in pregnancy is often precipitated by the increased hemodynamic load of the second and third trimesters, particularly in women with mitral stenosis or left ventricular dysfunction [4,5]. Arrhythmias occurred in 3.70% of patients, which aligns with the 3–5% incidence reported by

Shotan et al. [189] in pregnant women without heart disease and is expected to be higher in those with structural cardiac lesions. Pulmonary embolism occurred in 1.25% of our patients, which is lower than the 2.2% thrombotic event rate reported by *Stangl et al*. [20], possibly due to differences in anticoagulation practices and patient selection. Obstetrical complications occurred in 16.1% of women, with placenta previa (6.2%) and twin pregnancy (4.9%) being the most common. Cardiac complications were more frequent than obstetrical complications across all types of heart disease. Women with valvular disease had the highest rates of cardiac complications (14.80%), obstetrical complications (9.9%), and both complications combined (6.25%) [21]. This pattern is consistent with the findings of Elkayam and Bitar [22] and Reimold and Rutherford [23], who noted that valvular lesions, particularly mitral stenosis, pose the greatest hemodynamic challenge during pregnancy.

The findings of this study confirm that pregnancy in women with heart disease is associated with substantial maternal and fetal risks, which vary according to the type and severity of the underlying cardiac lesion. Valvular heart disease, particularly rheumatic mitral valve disease, remains the predominant cause of cardiac complications in our setting, reflecting the ongoing burden of rheumatic fever in developing countries [3,6]. The strong protective effect of antenatal care registration highlights the need to improve access to and utilisation of antenatal services for high-risk pregnant women in Iraq [10]. The absence of maternal mortality in our cohort is encouraging. Still, it should be interpreted with caution, given the predominance of low-risk (NYHA I–II) patients and the single-Centre design.

Conclusion

In women with heart disease, pre-pregnancy maternal characteristics can help to identify women at increased risk for late cardiac events. So, the incidence of maternal and fetal complications is related to the type and severity of the heart disease.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Cynthia J Berg, William M Callaghan, Carla Syverson, Zsakeba Henderson (2010) Pregnancy-related mortality in the United States, 1998 to 2005. Obstet Gynecol 116(6): 1302-1309.
2. (2004) Foley M Cardiac disease. In: Belfort MA, Saade GR, Phelan JP, et al, (eds). Critical Care Obstetrics. 4th ed. Australia: Blackwell Science 252-274.
3. Amr E Abbas, Steven J Lester, Heidi Connolly (2005) Pregnancy and cardiovascular system. Int J Cardiology 98(2): 179-189.
4. Stephanie L Curtis, Joanna Marsden Williams, Charlotte Sullivan, Susan M Sellers, Johanna Trinder, et al. (2009) Current trends in the management of heart disease and pregnancy. Int J Cardiol 133(1): 62-69.
5. Bonow RO, Carabello BA, Kanu C (2006) ACC/AHA 2006 Practice Guidelines for the Management of Patients with Valvular Heart Disease: in Collaboration with the Society of Cardiovascular Anesthesiologists Endorsed by the Society for Cardiovascular Angiography and Interventions and the Society of Thoracic Surgeons. J Am Coll Cardiol 48(3): el-e148.
6. (2011) Martins. Cardiac disease in pregnancy. In: Foley MR, Strong TH, Garite TJ. (eds). Obstetric Intensive Care Manual. 3rd ed., New York: McGraw-Hill PP: 91-117.
7. Uri Elkayam, Fahed Bitar (2005) Valvular Heart Disease and Pregnancy. Part I: Native Valves. J Am Coll Cardiol 46(2): 223-230.
8. C E G Head, S A Thorne (2005) Congenital heart disease m pregnancy Postgrad Med J 81: 292-298.
9. Byoung Jae Kim, So Jung An, Soon Sup Shim, Jong Kwan Jun, Bo Hyun Yoon, et al. (2006) Pregnancy outcomes in women with mechanical heart valves. J Reprod Med 51(8): 649-654.
10. Shaer Fayez El, Walid Hassan, Bendehiba Latroche, Sumaya Helaly, Hesham Hegazy, et al. (2005) Pregnancy has no effect on the rate of structural deterioration of bioprosthetic valves: long-tenn 18- year follow up results. J Heart Valve Dis 14(4): 481-485.
11. Ian A Greer, Catherine Nelson Piercy (2005) Low-molecular-weight heparins for thromboprophylaxis and treatment of venous thromboembolism in pregnancy: a systematic review of safety and efficacy. Blood 106(2): 401-407.
12. Farhana Asghar, Hina Kokab (2005) Evaluation and outcome of pregnancy complicated by heart disease. J Pak Med Assoc 55(10): 416-419.
13. Candice K Silversides, Louise Harris, Kym Haberer, Mathew Sermer, Jack M Colman, et al. (2006) Recurrence rates of arrhythmias during pregnancy in women with previous tachyarrhythmia and impact on fetal and neonatal outcomes. Am J Cardiol 97(8): 1206-1212.
14. Mary M Canobbio, Carole A Warnes, Jamil Aboulhosn, Heidi M Connolly, Amber Khanna, et al. (2017) Management of pregnancy in patients with complex congenital heart disease: a scientific statement for healthcare professionals from the American Heart Association. Circulation 135(8): e50-87.
15. Ali Balci, Willem Drenthen, Barbara J M Mulder, Jolien W Roos Hesselink, Adriaan A Voors, et al. (2011) Pregnancy in women with corrected tetralogy of Fallot: occurrence and predictors of adverse events. Am Heart J 161(2): 307-313.
16. Willem Drenthen, Eric Boersma, Ali Balci, Philip Moons, Jolien W Roos Hesselink, et al. (2010) Predictors of pregnancy complications in women with congenital heart disease. Eur Heart J 31(17): 2124-2132.
17. W S Chan, S Anand, J S Ginsberg (2000) Anticoagulation of pregnant women with mechanical heart valves: a systematic review of the literature. Arch Intern Med 160(2): 191-196.
18. Pratibha D, Kiramnai D, Usha Rani V, Geeta Vani N (2009) Pregnancy outcome in chronic rheumatic heart disease. J Obstet Gynecol India 59(1): 41-46.
19. A Shotan, E Ostrzega, A Mehra, J V Johnson, U Elkayam, et al. (1997) Incidence of arrhythmias in normal pregnancy and relation to palpitations, dizziness, and syncope. Am J Cardiol 79(8): 1061-1064.

20. Verena Stangl, Johanna Schad, Gabriele Gossing, Adrian Borges, Gert Baumann, et al. (2008). Maternal heart disease and pregnancy outcome: a single-centre experience. Eur J Heart Fail 10(9): 855-860.

21. T K Mishra, S Swain, S N Routray (2006) Peripartum cardiomyopathy. Int J Gynaecol Obstet 95(2): 104-109.

22. Uri Elkayam, Mohammed W Akhter, Harpreet Singh, Salman Khan, Fahed Bitar, et al. (2005) Pregnancy-associated cardiomyopathy: clinical characteristics and a comparison between early and late presentation. Circulation 11(16): 2050-2055.

23. Sharon C Reimold, John D Rutherford (2003) Clinical practice: valvular heart disease in pregnancy. N Engl J Med 349(1): 52-59.