Cardiac disease complicates around 1–4% of all pregnancies. This study has been conducted to know the incidence of cardiac diseases complicating pregnancy in our institution and to identify the spectrum of various cardiac diseases and their associated maternal and fetal complications. 

**Objectives of the Study:**
1. To evaluate the maternal and fetal outcome in patients with cardiac disease in pregnancy.
2. To identify any significant association between the modified World Health Organisation (WHO) risk classification of maternal cardiovascular diseases and the maternal and fetal outcomes.

**Methods:** This study was conducted in the Department of Obstetrics and Gynecology at Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu.

**Study Design:** Retrospective and Prospective observational study.

**Study Period:** April 2017–April 2020.

**Inclusion Criteria:** Rheumatic heart disease, congenital heart disease, arrhythmias, and conduction disorders.

**Exclusion Criteria:** Cardiomyopathy.

**Results:** The incidence of heart disease complicating pregnancy in our study was 0.5%. The ratio of RHD: CHD in our study was 4:1. There was no statistically significant association between the modified WHO risk classification of heart disease and the mode of delivery. 36.1% patients of the study group developed complications related to their cardiac disease, of which 96.3% belonged to the rheumatic heart disease (RHD) group.

**Conclusions:** According to our study, there was a statistically significant association between the maternal complications, namely, congestive cardiac failure and acute pulmonary edema and the modified WHO risk assessment class of maternal cardiovascular diseases in pregnancy. There was no statistically significant association between the perinatal morbidity and the modified WHO risk assessment class of maternal cardiovascular disease in pregnancy.

**Keywords:** Cardiac disease, foetomaternal outcome, pregnancy
Methods

This study was conducted in the Department of Obstetrics and Gynecology at Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil nadu.

STUDY DESIGN: Retrospective and prospective observational study

STUDY PERIOD: April 2017–April 2020

SAMPLE SIZE: 72 patients satisfying the inclusion criteria admitted from April 2017 to April 2020.

Inclusion criteria
Rheumatic heart disease, congenital heart disease, arrhythmias and conduction disorders

Exclusion criteria
Cardiomyopathy

Methodology
All women admitted to the Department of Obstetrics and Gynaecology, at Sri Ramachandra Institute of Higher Education and Research Institute, who fulfilled the inclusion criteria were taken up for the study. Institutional ethics committee approval was obtained prior to the initiation of the study. Informed consent was obtained after explaining the study. A thorough history was taken from all cases and a complete clinical examination performed. Details such as age, parity, type of lesion, duration of disease, time of diagnosis, prior surgical intervention, etc., were obtained. Foetal condition was assessed clinically and by ultrasonography. Continuous cardiotocogram monitoring was done. Mode of delivery and indication for caesarean section, maternal complications, neonatal outcome, and admission to Neonatal Intensive Care Unit (NICU) were noted. Medical records of all patients with heart disease who had delivered in our institution during the study period were reviewed. The demographic information, diagnosis, the course in the hospital, management, maternal, and fetal outcome of all the patients were obtained from these records. In case of the maternal mortality, the cause of death was to be noted.

Plan for analysis
Maternal outcome was analysed using the following criteria: New York Heart Association (NYHA) functional class, modified WHO class of cardiac disease, maternal cardiac complications, cardiac intervention during pregnancy, and mode of delivery. Fetal outcome was analysed using the following criteria: Development of congenital heart disease if any, occurrence of intrauterine fetal demise and still births if any, gestational age at birth, birth weight, perinatal morbidities if any and the duration of NICU stay. All patients were analysed statistically for the association between their modified WHO risk class of cardiac disease [Table 1] and the maternal and the fetal outcomes. To test the hypothesis, Yate’s chi square test was used, and $P$ value < 0.05 was taken as statistically significant.

Results

During the study period, the total number of cardiac diseases complicating pregnancy was 76 among which 4 cases of cardiomyopathy were excluded from the study. The incidence of heart disease complicating pregnancy was 0.5%. Among the 72 patients admitted for delivery, there were 54 (75%) cases of rheumatic heart disease, 13 (18.1%) cases of congenital heart disease, and 5 (6.9%) cases of other types of heart diseases (miscellaneous group).

The highest incidence was found in the age group of 25–29 years accounting for 33.3% of cases. There was nearly equal distribution between primigravida (51.4%) and multigravida (48.6%). Among the study group, 11 (15.3%) cases had heart disease diagnosed in the antenatal period when they were evaluated for cardiac symptoms and 61 cases (84.7%) had pre-existing heart disease diagnosed before pregnancy.

Among the rheumatic heart disease patients, mitral valve lesions were the most common which constituted 71.8% of cases. Mitral

| Table 1: Modified who classification of maternal cardiovascular risk |
|-----------------------------------|
| Uncomplicated small or mild |
| Pulmonary stenosis |
| Patent ductus arteriosus |
| Mitral valve prolapse |
| Successfully repaired simple lesions (atrial or ventricular septal defect, anomalous pulmonary venous drainage) |
| Isolated atrial or ventricular ectopic beats |
| WHO RISK CLASS II (if otherwise well and uncomplicated) |
| Unoperated atrial or ventricular septal defect |
| Repaired Tetralogy of Fallot |
| Most arrhythmias |
| WHO RISK CLASS II-III (depending on the individual) |
| Mild left ventricular systolic function impairment |
| Hypertrophic cardiomyopathy |
| Native or tissue valvular heart disease not considered WHO I or IV |
| Marfan syndrome without aortic dilatation |
| Aorta <45 mm in aortic disease associated with bicuspid aortic valve |
| Repaired coarctation |
| WHO RISK CLASS III |
| Mechanical heart valve |
| Systemic right ventricle |
| Fontan circulation |
| Cyanotic heart disease (unrepaired) |
| Other complex congenital heart diseases |
| Aortic dilatation 40-45 mm in Marfan syndrome |
| Aortic dilatation 40-45 mm in aortic disease with bicuspid aortic valve |
| WHO RISK CLASS IV (Pregnancy contraindicated), Pulmonary artery hypertension of any cause. Severe systemic ventricular dysfunction (LVEF <30%, NYHA III-IV) Previous peripartum cardiomyopathy with any residual impairment of left ventricular function. Severe mitral stenosis with aortic root dilatation >45 mm. Aortic root dilatation >50 mm in aortic disease associated with bicuspid aortic valve. Native severe coarctation |
stenosis with mitral regurgitation was the most common lesion accounting for 29.7% of cases followed by isolated mitral stenosis which was present in 23.5% of cases and mitral regurgitation in 18.6% of cases. There was no case of isolated aortic stenosis. Aortic stenosis occurred in combination with aortic regurgitation in 3.8% of cases or with other valvular lesions like mitral stenosis, mitral regurgitation, and tricuspid regurgitation in 5.7% of cases. There were four cases of mitral valve prolapse, which constituted 7.4% of cases. [Figure 1]

Atrial septal defect was the most common congenital heart disease (46.2%) in our study group (6 out of 13 cases) followed by patent ductus arteriosus (15.3%). There was 7.7% incidence each of ventricular septal defect, Ebstein anomaly, congenital bicuspid aortic valve, and pulmonary stenosis. There was one case of complex cyanotic congenital heart disease comprising of Ventricular Septal Defect (VSD) with Transposition of Great Arteries (TGA) with pulmonary stenosis who had undergone a Blalock Taussig shunt with Rastelli procedure 18 years back. [Figure 2]

The miscellaneous group consisted of two cases of WPW syndrome and one case each of supraventricular tachycardia, Lutembacher’s syndrome (who had undergone mechanical mitral valve replacement with modified De Vega annuloplasty along with Atrial Septal Defect (ASD) patch closure 10 years back) and Marfan syndrome with aortic root dilatation along with mitral regurgitation with mild pulmonary artery hypertension.

Six (23.4%) patients had balloon mitral valvotomy and three (11.5%) patients had closed mitral commissurotomy done prior to conception with mean time interval between valvotomy and pregnancy of 9.08 ± 2.67 years. Three out of five patients with ASD had undergone patch closure in their childhood. Two patients were diagnosed with ASD antenataly at 30 weeks and 32 weeks, respectively. One patient with VSD had spontaneous closure of the defect at young age and both the patients with PDA had PDA ligation being done earlier. One patient with a congenital bicuspid aortic valve with severe aortic stenosis, for which mechanical aortic valve replacement was done six years back. The mean time interval between patients getting operated for congenital heart disease and pregnancy was 22.57 ± 2.87 years. Five patients entered pregnancy with prosthetic valve replacement among which three patients had mechanical valve replacement and two patients had bioprosthetic valve replacement done. All patients who had undergone valve replacement conceived within 10 years. None of the patients underwent any surgical interventions during their pregnancy.

The European Society of Cardiology guidelines on the management of cardiovascular disease during pregnancy recommends the use of modified WHO classification for maternal risk assessment which also predicts adverse perinatal outcome.[2] In our study group, there were 39 (54.2%) patients in WHO class II–III followed by 11 (15.5%) patients in class I, 10 (13.3%) patients in class IV, 8 (11.2%) patients in class III, and 4 (5.8%) patients in WHO class II. [Table 2]

In our study group of 72 women, 42 (58.3%) were delivered by cesarean section and 30 (41.7%) were delivered by vaginal delivery. 26 cases had spontaneous vaginal delivery with four cases of assisted vaginal delivery. There were two cases of intrauterine fetal demise in the RHD group of which one expelled vaginally (at 32 weeks) and the other was delivered by emergency cesarean section (at 34 weeks) as patient was a case of previous two Lower Segment Cesarean Section (LSCS). Among the 42 patients who were delivered by cesarean section, 13 cases (30.9%) were done for the cardiac disease per se. All

| WHO class | No. of cases | Percentage |
|-----------|--------------|------------|
| I         | 11           | 15.5       |
| II        | 4            | 5.8        |
| II - III  | 39           | 54.2       |
| III       | 8            | 11.2       |
| IV        | 10           | 13.3       |
| Total     | 72           | 100        |
Pulmonary hypertension was present in 14 (53.9%) patients among which one patient had severe pulmonary hypertension, two patients had moderate pulmonary hypertension and all other 11 patients had mild pulmonary hypertension. 12 patients belonged to RHD group. One patient each with ASD and Marfan syndrome with aortic root dilatation had mild pulmonary hypertension. Among the 14 patients, six (42.8%) patients delivered vaginally and eight (57.2%) patients delivered by cesarean section and all of them recovered uneventfully.

One (3.8%) patient with Lutembacher’s syndrome developed mitral valve thrombus on second postoperative day following emergency caesarean section for severe preeclampsia at 34 weeks gestation and an emergency redo mitral valve replacement was done. [Table 3]

Arrhythmias complicated two (7.7%) patients in our study group. One patient had supraventricular tachycardia diagnosed at 35 weeks gestation and was managed medically with calcium channel blockers. The other patient was a primigravida who had undergone mitral valve replacement for severe MS with MR with pulmonary hypertension 12 years back and was on oral anticoagulants. At 34 weeks, the patient was diagnosed with mitral restenosis with atrial fibrillation which was managed medically and delivered by planned cesarean section.

Two (7.7%) patients with rheumatic heart disease and mitral valve replacement developed mitral restenosis. Apart from one patient with mitral restenosis and atrial fibrillation mentioned above, the other was a primigravida, known case of severe mitral stenosis with regurgitation who had undergone mitral valve replacement four years back, was diagnosed as mitral restenosis with moderate pulmonary hypertension at 37 weeks gestation and was delivered by emergency cesarean section. Among the 26 patients who had complications associated with heart disease, 11 had ICU stay for less than five days. There were no cases of maternal mortality in our study.

There was significant association between the disease risk assessed by modified WHO classification of cardiovascular diseases and the occurrence of acute pulmonary edema and congestive cardiac failure. There were 40% of patients in class IV who developed acute pulmonary edema and 30% of patients in class IV who developed congestive cardiac failure. The association between the occurrence of other complications like pulmonary hypertension, atrial fibrillation, mitral valve restenosis, mitral valve thrombosis, and the risk of disease assessed by modified WHO classification was not significant. [Table 4]

There were 71 live births from 70 deliveries and there were 69 singleton deliveries and one twin delivery. There were no cases of still birth in our study. In the study population, out of 71 live babies born, 40 (56.3%) babies were term, 21 (29.5%) babies were late preterm and 10 (14.2%) babies were early preterm and there were no babies born as extreme preterm at less than 28 weeks of gestational age.

Out of 71 live babies born, there were 26 (36.6%) babies with low birth weight (<2.5 kg). The mean birth weight of babies was 2.67 ± 710 grams. The mean gestational age of delivery was 36.66 ± 2.44 weeks in our study population. 15 (21.1%) babies had neonatal hyperbilirubinemia and required single light phototherapy.

There was no statistically significant association between the different parameters of perinatal morbidity and the severity of disease risk assessed by the modified WHO classification. Though we had seven babies requiring prolonged NICU care (five had sepsis and two had extremely low birth weight), they had a good outcome and there were no cases of perinatal or neonatal mortality.

### Discussion

In India, research work by Konar H et al. had an incidence of rheumatic heart disease of 69.4% and congenital heart disease of 21.3% which was similar to our study. The ratio of RHD: CHD in our study was 4.1.

Chesley in his study stated that in patients with rheumatic heart disease, the cardiac condition worsens with age rather than the parity due to the progressive nature of the lesion. In the present study, 59.7% of patients were under the age of 30 years. Younger the patient better is the prognosis. Sixty percent of the cases who developed complications were above 30 years of age. This stresses the importance of pre conceptional counselling in cardiac patients and the prompt planning of pregnancy at the optimum maternal age. In our study group, there was near equal distribution between the primigravida (51.4%) and multigravida (48.6%) which correlates with the study by Konar H et al.

### Table 3: Complications associated with heart disease

| Complication                  | No. of cases | Percentage |
|-------------------------------|--------------|------------|
| Acute pulmonary edema         | 4            | 15.4       |
| Congestive cardiac failure    | 3            | 11.6       |
| Pulmonary hypertension        | 14           | 53.9       |
| Atrial fibrillation           | 1            | 3.8        |
| Mitral valve restenosis       | 2            | 7.7        |
| Mitral valve thrombosis       | 1            | 3.8        |
| Supraventricular tachycardia  | 1            | 3.8        |
| Total                         | 26           | 100        |
Compared to a similar study by Suwanrath et al.,¹ our study had relatively higher rates (58.3%) of cesarean sections. This could be attributed to the increased referrals of high-risk patients to our tertiary care institution. Though most of the cesarean sections were performed for obstetric indications, 30.9% had heart disease per se as the indication for the cesarean section which included severe mitral stenosis, acute pulmonary edema, severe aortic stenosis, severe pulmonary artery hypertension, and complex cyanotic congenital heart disease. According to the Japanese Circulation Society 2010 guidelines, cardiac indications for cesarean section include cardiac dysfunction, the patient at risk of hemodynamic instability, pulmonary hypertension, uncontrolled arrhythmias, mechanical valve prosthesis, and patients with cyanosis.²

In our study, the incidence of cardiac complications was 36% which was high compared to 7.4% in a study by Konar et al.³ which again could be attributed to the increased referrals of high-risk patients to our institution for multidisciplinary care. Cardiac failure, pulmonary edema, arrhythmias, and pulmonary hypertension were the various complications seen in these patients. There was statistically significant association between disease severity assessed by modified WHO classification of heart disease and the occurrence of cardiac failure and pulmonary edema. In our study, three (11.6%) patients had cardiac failure. All these patients improved with effective treatment in the intensive care unit by the multidisciplinary team comprising the obstetrician, cardiologist, intensivist, and the anesthesiologist. In our study group, four (11.6%) patients developed pulmonary edema and all patients had mitral stenosis. The risk of developing pulmonary edema coincides with the gestational age at which there is hemodynamic overload to the heart. Two out of the four patients developed pulmonary edema at 33–34 weeks of gestational age, one patient developed it in the intrapartum period and in one patient, it developed on the second postoperative day. All these patients were delivered by emergency cesarean section and recovered uneventfully with multidisciplinary care. This highlights the importance of prompt referral of these patients at the appropriate gestational age when the risk of cardiac failure is high. Two out of four patients who had undergone mitral valve replacement developed mitral restenosis which emphasize the importance of anticoagulation in these patients.

Among the 26 patients who had complications associated with heart disease, 11 had ICU stay for less than five days. There were no cases of maternal mortality in our study. The wide spectrum of varied complications that were correctly diagnosed and timely managed in our study group reemphasises the

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| Table 4: Distribution of complications in different WHO class |
|-------------------------------------------------------------|
| Complications | WHO class | Total |
|                | I         | II    | II-III | III   | IV |
| Pulmonary edema | No | %   | No | %   | No | %   | No | %   | No | %   |
| Yes          | 1 | 2.6 | 1      | 2.6 | 4 | 40 | 5 | 6.9 |
| No           | 11 | 100 | 4 | 100 | 38 | 97.4 | 8 | 100 | 6 | 60 | 67 | 93.1 |
| P=0.011 significant |

| Cardiac failure | WHO class | Total |
|-----------------|-----------|-------|
| Yes             | - | - | - | - | 1 | 2.6 | - | - | 4 | 40 | 5 | 6.9 |
| No              | 11 | 100 | 4 | 100 | 38 | 97.4 | 8 | 100 | 6 | 60 | 67 | 93.1 |
| P=0.0141 significant |

| Pulmonary hypertension | WHO class | Total |
|------------------------|-----------|-------|
| Yes                    | - | - | - | - | 9 | 23.1 | 1 | 12.5 | 4 | 40 | 14 | 19.4 |
| No                     | 11 | 100 | 4 | 100 | 30 | 76.9 | 7 | 87.5 | 6 | 60 | 58 | 80.6 |
| P=0.498 not significant |

| Atrial fibrillation | WHO class | Total |
|---------------------|-----------|-------|
| Yes                 | - | - | - | - | - | - | 1 | 10 | 1 | 1.4 |
| No                  | 11 | 100 | 4 | 100 | 39 | 100 | 8 | 100 | 9 | 90 | 71 | 98.6 |
| P=0.150 not significant |

| Mitral Valve Restenosis | WHO class | Total |
|-------------------------|-----------|-------|
| Yes                     | - | - | - | - | - | - | - | 2 | 20 | 2 | 2.7 |
| No                      | 11 | 100 | 4 | 100 | 39 | 100 | 8 | 100 | 8 | 80 | 70 | 97.3 |
| P=0.1016 not significant |
importance of close monitoring of high-risk pregnant cardiac patients, and the need for multidisciplinary team work in a tertiary care set up for optimising the maternal and neonatal outcome in these patients.

In our study group, 15 (21.4%) patients had co-existing anemia, 2 patients with severe anemia, 6 patients with moderate anemia, and 7 patients with mild anemia. All patients had the hemoglobin status improved in the antenatal period and had optimum maternal outcome. This highlights the importance of proper antenatal assessment, diagnosis, and prompt correction of anemia in these patients.

Unlike the study by Suwanrath et al[5] who showed a significant association between parameters of adverse perinatal outcome (preterm status, low birth weight, fetal growth restriction, and duration of NICU stay) and WHO class in both rheumatic and congenital heart disease, our study did not show a significant association between adverse perinatal outcome and WHO class probably because of the low incidence of heart disease. In this study, no inherited neonatal congenital heart disease was observed, though 18.1% of women had a congenital type of cardiac lesion. In our study, there were no cases of neonatal mortality.

Those who have a prior history of cardiac disease should display increased vigilance in pregnancy and should be under the constant care of a qualified care provider. Treatment modalities for cardiac disease of pregnancy vary based upon the disease process and require an individualised approach.[7]

Conclusions

According to our study, there was a statistically significant association between the maternal complications, namely, congestive cardiac failure and acute pulmonary edema and the modified WHO risk assessment class of maternal cardiovascular diseases in pregnancy. There was no statistically significant association between the perinatal morbidity and the modified WHO risk assessment class of maternal cardiovascular disease in pregnancy. There were no cases of maternal and neonatal mortality in our study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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