ORIGINAL RESEARCH

Correlation Between Risk or Severity of Heart Failure and Outcome of Pregnancy

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Background: The incidence of heart failure in pregnancy increases by 1–4% every year and causes 9% of maternal mortality worldwide. Determinant factors, characteristics, and risk factors influence the incidence of heart disease in pregnancy, so the early detection of determinant factors can reduce the incidence of heart disease in pregnancy. This study aimed to find the relationship between determinant factors of maternal and fetal outcomes with the severity of heart disease in pregnancy.

Methods: This was an observational cross-sectional analytical study. We used 342 cases of heart disease in pregnancy that were recorded in medical records at Dr. Hasan Sadikin Hospital, Bandung, Indonesia, from January 2014 to December 2018. The data were grouped based on the severity of heart disease according to the New York Heart Association (NYHA) classification. The relationship of maternal determinant factors with the severity of heart disease was analyzed based on the NYHA classification.

Results: Maternal occupation was significantly associated with a higher risk of NYHA class III–IV heart disease. Most of the patients with NYHA class III-IV were housewives. The severity of heart disease was also influenced by severe preeclampsia ($p<0.05$) as a risk factor. Maternal outcome with heart disease of severity NYHA class III–IV was worse than with NYHA class I–II. The risk of maternal death was higher, and the mother's length of stay in hospital and her need for monitoring were also increased. There were no significant differences in the outcome of the fetus, but the incidence of fetal mortality increased in patients with heart disease severity III–IV.

Conclusion: Maternal determinant factors did not correlate with the severity of heart disease in pregnancy. Maternal outcomes were worse with increasing severity of heart disease. Fetal mortality was correlated with severity of heart disease but other outcomes were not affected.

Keywords: determinant factor, heart disease, maternal and fetal outcomes

Introduction

Heart disease in pregnancy is dangerous because pregnancy increases the work of the cardiovascular system, as it causes changes in the cardiovascular system to accommodate the increased metabolism of the mother and fetus. Pregnancy is associated with hemodynamic stress in the cardiovascular system, and if the mother's adaptation to pregnancy is not optimal this can lead to cardiovascular disease. The incidence of heart disease in pregnancy in the third trimester is 86%.[1,2] In Indonesia between 2005 and 2006, it was around 1.2%, with an unknown mortality rate.[3] Mogos et al found that more than 9% of deaths related to pregnancy in hospital were caused by heart disease. In addition, there was a significant increase in mortality due to heart disease in pregnancy from 548 in 2001 to 1318 in 2011, or around 9.8% per year.[9,10]

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Heart disease in pregnancy is determined by the maternal condition, consisting of characteristics and risk factors. Characteristics that affect heart disease are maternal age, occupation, education, and antenatal care (ANC).[4] The risk factors for heart disease can be related to obstetric or non-obstetric conditions.[5,6] The most common risk factors, according to the Registry of Pregnancy and Cardiac Disease (ROPAC), are a history of heart disease, chronic hypertension, hypertension in pregnancy, diabetes mellitus, multiparity, obesity, maternal age >35 years, and multifetal pregnancy.[5,7]

This research aimed to determine the relationship between characteristics, maternal risk factors, and maternal and fetal outcomes based on the severity of heart disease in pregnancy. It is important to increase awareness of the possibility of severe heart disease in pregnancy so that maternal and infant morbidity and mortality can be reduced.

Subjects and Methods

This study was an observational analytical study with a cross-sectional design. Data were collected retrospectively from medical records.[11–13] Subjects were recruited based on a total sampling method. Study subjects included all obstetric patients who were diagnosed with heart disease or cord decompensation during pregnancy, as noted in in their medical records, at Dr. Hasan Sadikin Hospital, Bandung, Indonesia, from January 2014 to December 2018. All subjects who had complete medical records for age, education, occupation, ANC history, parity, obesity, multifetal pregnancy, comorbidity of pregnancy (diabetes mellitus, hypertension, and congenital heart disease), and maternal and fetal outcome were included in this study. Patients without these characteristics and risk factors were excluded. The data were then grouped based on the severity of heart disease according to the New York Heart Association (NYHA) classification.

All data were analyzed with SPSS 24.0 for Windows. The chi-squared test was used to analyze the differences in characteristics and risk factors based on the severity of heart failure in pregnancy. The risk factors associated with severity of heart failure were tested by logistic regression, with variables from bivariate analysis with $p<0.25$ being included as the independent variables. The magnitudes of the risks were analyzed by odds ratios (ORs), with $p\leq0.05$ considered statistically significant.

Results

In total, 342 patients with heart disease in pregnancy gave birth at Dr. Hasan Sadikin Hospital in the period from January 2014 to December 2018. As shown in Table 1, most of the patients with heart failure were 21–34 years old, had senior high school as the highest educational level, were housewives, underwent at least four antenatal visits, and were cared for by midwives as the ANC provider. Most of the subjects suffered from heart failure during the third trimester of pregnancy and the stage of heart failure was mostly in the functional class NYHA I–II. Characteristics of patients that were statistically significantly associated with heart failure severity were ANC location and maternal occupation. Non-working mothers had more severe heart failure than working mothers. Patients who visited hospital also had more severe heart failure, since most of these patients had been referred from another health facility.

Severe preeclampsia was found to be statistically significantly associated with heart failure severity. Severe preeclampsia occurred more often in patients with heart failure in pregnancy with severity of NYHA class III–IV compared to those with heart failure in NYHA class I–II (Table 2).

Maternal outcomes that were statistically significantly associated with heart failure severity ($p<0.05$) were type of room needed in the hospital, length of hospital stay, and maternal death (Table 3). Patients who had NYHA class III–IV heart failure needed more intermediate and intensive care rooms, stayed in hospital longer than 7 days, and had higher rates of maternal death compared with NYHA class I–II heart failure patients.

Table 4 shows the outcomes of maternal and neonatal morbidity and mortality based on heart failure stage. Fetal asphyxia did not show any significant differences ($p>0.05$) between heart failure stages. Fetal birth weight did not show any significant differences ($p>0.05$) between heart failure stages (III–IV and I–II), whereas infant mortality showed a significant difference ($p<0.05$) between the two degrees of severity of heart failure (III–IV and I–II). Fetal mortality at heart failure stage III–IV was higher than at heart failure stage I–II (19.3% vs 11.7%, respectively).

Discussion
Relationship of Characteristics with the Degree of Severity of Heart Failure

These results are in accordance with a previous study in 2017, where the most common age for the occurrence of heart failure is at reproductive age, 20–34 years. This is because the woman begins to be exposed to pregnancy at this age. Adaptations to pregnancy include vascular remodeling; if the remodeling proceeds abnormally, it will pose a risk of vascular

Table 1 Relationship of Maternal Characteristics with Heart Disease Severity Based on NYHA Classification

Characteristic	N (%)	NYHA Class		p*
		I–II (n = 197)	III–IV (n = 145)	
Maternal age (years)				0.318
≤20	30 (8.8)	21 (10.66)	9 (6.20)	
21–34	192 (56.1)	110 (55.84)	82 (56.55)	
>35	120 (35.1)	66 (33.50)	54 (37.24)	
Education				0.132
Elementary school	46 (13.5)	20 (10.15)	26 (17.93)	
Junior high school	92 (26.9)	52 (26.40)	40 (27.58)	
Senior high school	184 (53.8)	111 (56.34)	73 (50.34)	
College	20 (5.8)	14 (7.10)	6 (4.14)	
Occupation				0.37
Working	46 (13.5)	33 (16.75)	13 (8.96)	
Not working	296 (86.5)	164 (83.25)	132 (91.03)	
Quantity of ANC				0.663
<4 times	31 (9.1)	19 (9.64)	12 (8.27)	
≥4 times	311 (90.9)	178 (90.36)	133 (91.72)	
ANC place				0.016
Midwife	242 (70.8)	146 (74.11)	96 (66.20)	
Primary health care	34 (9.9)	20 (10.15)	14 (9.65)	
Hospital	14 (4.1)	3 (1.52)	11 (7.58)	
Obstetricic clinic	31 (9.1)	20 (10.15)	11 (7.58)	
Others	21 (6.1)	8 (4.06)	13 (8.96)	
Gestational age (weeks)				0.27
0–14	0 (0)	0	0	
15–28	21 (6.14)	15 (7.6)	6 (4.2)	
29–40	321 (93.85)	182 (92.4)	139 (95.8)	

Note: Data are shown as n (%). *Based on chi-square analysis.
Abbreviations: ANC, antenatal care; NYHA, New York Heart Association.

disease and increase the risk of heart failure.[10,14] The age of occurrence of heart failure in this study population was <35 years (Table 1) and the heart failure stage was less severe than in older age. This is because, at a young age, the power of remodeling and adaptation to vascular disease is better than in mothers who are >35 years old.[1,15]

Mothers who did not work had more heart failure in pregnancy. This result is in line with the study by Kurniawaty et al, which stated that housewives had a 9.8% greater risk of heart failure than working mothers.[10] In the study by Abraham et al, mothers who did not work had a higher risk of heart disease than working mothers; this may be due to the stress levels in mothers who do not work being higher and their level of awareness of health being lower than in working mothers.[16]

In this study, ANC was carried out regularly four or more times. In a previous study, ANC visits more than 4

times could decrease pregnancy complications. In this study the severity of NYHA class I–II heart failure was greater than class III–IV. Hospitals are the most common place for the control of patients with severity III–IV heart failure, because such cases must be handled by a multidisciplinary team so that the hospital can provide competent treatment.

In this study, the highest level of education was high school for 111 (56.34%) patients with NYHA class I–II severity, and 73 (50.34%) with class III–IV severity. According to Kurniawaty et al, the higher the educational level of patients, the more awareness they had about their pregnancy. In this study, the correlations of four or more ANC visits and patients' educational level with less severe heart failure were in accordance with previous studies.[10,14]

The pregnancy period during which heart failure with severity of NYHA class III–IV or I–II occurs most often is the third trimester. At 32 weeks' gestation, there is a rapid increase in cardiac output, so that if the patient already has a determinant factor (characteristics and/or risk factors) for heart failure, the risk of complications in heart failure stage >II is higher in the third trimester.[17]

Relationship Between Risk Factors and Heart Failure Stage

One risk factor that significantly affects the incidence of heart failure is severe preeclampsia. Mothers with preeclampsia have higher vascular resistance. High vascular resistance can cause systolic and diastolic dysfunction, which in turn will cause chronic hypertension and heart failure. In addition, endothelial damage and inflammatory stress in early onset preeclampsia are considered more severe and permanent, so cardiovascular disease is more common in preeclampsia.[18] Abassi et al stated that severe preeclampsia increased the risk of heart failure in pregnancy by 28.7%, with an OR of 11.4 (95% CI 10.4–12.4), in accordance with the results of this study (Table 2).[4]

Relationship of Heart Failure Stage in Pregnancy with Maternal Outcomes

Several maternal outcomes are statistically significantly related to heart failure stage, namely, >7 days of hospital stay, care in the intensive care room, and maternal mortality (Table 3). The results of this study are in accordance with the study of Abbasi et al, which stated that heart failure in pregnancy increases maternal morbidity, and

Table 2 Relationship Between Maternal Risk Factors and Heart Failure Severity

Variable	NYHA Class		p*
	I–II (n = 197)	III–IV (n = 145)	
History of heart disease Yes No	 53 (26.90) 144 (73.09)	 29 (20) 116 (80)	0.139
Diabetes mellitus Yes No	 0 197 (100)	 1 (0.69) 144 (99.31)	0.424
Obesity Yes No	 5 (2.54) 192 (97.46)	 7 (4.83) 138 (95.17)	0.255
Chronic hypertension Yes No	 11 (5.58) 186 (94.42)	 5 (3.45) 140 (96.55)	0.355
Multiparity Yes No	 126 (63.96) 71 (36.04)	 105 (72.41) 40 (27.59)	0.099
Multifetal pregnancy Yes No	 15 (7.61) 182 (92.39)	 14 (9.65) 131 (90.34)	0.503
Gestational diabetes Yes No	 0 197 (100)	 1 (0.69) 144 (99.31)	0.424
Gestational hypertension Yes No	 7 (3.55) 190 (96.44)	 10 (6.90) 135 (93.10)	0.160
Severe preeclampsia Yes No	 52 (26.40) 145 (73.60)	 59 (40.69) 86 (59.31)	0.005
Eclampsia Yes No	 5 (2.54) 192 (97.46)	 4 (2.76) 141 (97.24)	1.0
Chronic hypertension aggravated by preeclampsia Yes No	 27 (13.70) 170 (86.29)	 29 (20) 116 (80)	0.120

Note: Data are shown as n (%). *Based on chi-square analysis.
Abbreviation: NYHA, New York Heart Association.

Table 3 Relationship Between Heart Failure Severity and Maternal Outcome

Outcome	NYHA Class		p*
	III–IV (n=145)	I–II (n=197)	
Delivery method Spontaneous Caesarean section Forceps extraction Fundus thrust Butt extraction Foot extraction	 0 112 (77.2) 23 (15.9) 7 (4.8) 0 3 (2.1)	 1 (0.5) 142 (72.1) 41 (20.8) 12 (6.1) 1 (0.5) 0	0.208
Type of room Normal Intermediate Intensive	 0 130 (89.7) 15 (10.3)	 29 (14.7) 162 (82.3) 6 (3.0)	<0.001
Length of stay (days) <7 7 >7	 69 (47.6) 14 (9.7) 62 (42.8)	 131 (66.5) 16 (8.1) 50 (25.4)	0.001
Maternal death	23 (15.9)	6 (3.0)	<0.001

Note: Data are shown as n (%). *Based on chi-square analysis.
Abbreviation: NYHA, New York Heart Association.

Table 4 Relationship Between Heart Failure Severity and Infant Outcome

Outcome	NYHA Functional Class		p*
	III–IV (n=145)	I–II (n=197)	
APGAR score Asphyxia Normal	 82 (56.6) 35 (24.1)	 116 (58.9) 58 (29.4)	0.122
Birth weight ≤2500 g >2500 g Infant death	 107 (73.8) 38 (26.2) 28 (19.3)	 129 (65.5) 68 (34.5) 23 (11.7)	0.101 0.001

Note: Data are shown as n (%). *Based on chi-square analysis.
Abbreviations: APGAR, activity, pulse, grimace, appearance, respiration; NYHA, New York Heart Association.

the length of hospital stay increases and requires monitored care rooms such as intensive care units because patients with heart failure need mechanical ventilation. In patients with heart failure, especially with severity of NYHA III–IV, this will be followed by complications of various organ failures, with the most common complications being pulmonary edema, stroke, and kidney failure, so that treatment will involve multidisciplinary science. Maternal mortality has been found to increase 16-fold in patients with heart failure in pregnancy.[4] Liu et al found that in India, patients with heart failure NYHA III–IV had an increased risk of maternal death. Maternal mortality due to heart failure was increased by 6.6% with acute pulmonary edema.[19]

Relationship of Heart Failure Stage in Pregnancy with Fetal Outcome

Heart failure in pregnancy is statistically significant in relation to infant mortality, with p=0.001. Infant mortality in mothers with heart failure during pregnancy is due to insufficient flow of oxygen and nutrients, resulting in tissue hypoxia which, if it occurs chronically, will cause organ failure in the baby and can cause death. In the Kurniawaty et al study, 75% of infant deaths due to heart failure in pregnancy resulted from heart failure with severity of NYHA III–IV compared to NYHA I–II.[10] Research by Silversides et al showed that compared to mothers in NYHA class I–II, mothers in NYHA class III–IV had lower birth weight, and higher incidences of preterm birth, small-for-gestational age infants, and infant mortality.[2,7]

In this study, the relationship of heart failure stage in pregnancy with low-birth-weight babies and asphyxia was not statistically significant. This can be interpreted as the outcomes of infants with mothers with NYHA class III–IV heart failure being not statistically significantly worse than the outcomes of infants with mothers with class I–II heart failure. This result is in accordance with a previous study which found that most of patients with heart failure in NYHA class I–II amounted to 83.3% and the baby's outcome remained good, with an average birth weight of 2869 g. At 38 weeks' gestation, asphyxia is found in only 3% of babies born to mothers with heart failure of NYHA class III–IV (Table 4).[2,8]

Conclusion

Maternal determinant factors did not have significant correlations with the severity of heart disease in pregnancy. Maternal outcomes were worse with increasing severity of heart disease. Fetal mortality was correlated with the severity of heart disease, but other outcomes were not affected.

Data Sharing Statement

The authors declare that the personal data from any patients involved in this study will not be shared as they are the patients' confidential information.

Ethics and Consent Statement

This study protocol was approved by the Ethics Committee Review Board of Dr. Hasan Sadikin General Hospital, Faculty of Medicine, Universitas Padjadjaran. All study participants gave written consentto participate. All authors declare that all patients were examined in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. All authors declare that written informed consent was obtained from every patient, regarding detailed information and images to be described in this publication.

Author Contributions

All authors contributed to data analysis, drafting and revising the article, gave final approval of version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors have declared that no competing interests exist.

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