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Cardiac Diagnoses in Obstetric Patients: An Observational Trimester-Based Analysis from Patients Undergoing Cardiology Consultations

Obstetrik Hastalarda Kardiyak Tanılar: Kardiyolojiye Konsülte Edilen Hastalardan Gözlemsel Trimester Bazlı Analiz

ORIGINAL ARTICLE
KLİNİK ÇALIŞMA

ABSTRACT

Objective: The aim of this study is to evaluate the frequency of cardiac complaints and diagnosed cardiovascular diseases across trimesters in pregnant women referred for cardiology consultations.

Methods: This retrospective observational study was conducted at a second-level state hospital. Pregnant women referred to the cardiology clinic between September 2020 and March 2022 were included. Data collected included demographic information, clinical presentations, trimester of pregnancy, blood pressure, heart rate, anemia status, electrocardiography (ECG), and echocardiographic findings. Cardiac diagnoses were based on clinical evaluation, ECG, and echocardiographic findings.

Results: A total of 658 pregnant women were included, with a mean age of 28.18 (± 4.28) years. Most consultations occurred in the third trimester (49.1%). Primary reasons for consultation were palpitations (48%), chest pain (21.3%), leg edema (13.1%), and high blood pressure (11.6%). Anemia was present in 28.7% of the women, and 20.2% had hypertension (HT). Significant differences across trimesters included higher rates of chest pain and presyncope/syncope in the first trimester, and higher rates of palpitations and anemia in the second and third trimesters. The most common cardiac diagnoses were arrhythmias (16.6%), high blood pressure (15.2%), and mitral regurgitation (MR) (12.5%). Hypertension was most frequently diagnosed in the second trimester ($P = 0.04$). Infective endocarditis, myocarditis, and pericarditis were more common in the third trimester.

Conclusion: Cardiac consultations are most frequent in the third trimester, with palpitations, chest pain, and high blood pressure being the most common complaints. Hypertension and MR are the most common cardiac diagnoses. Early and ongoing cardiologic assessment during pregnancy is crucial for managing cardiovascular risks.

Keywords: Cardiology consultation, cardiovascular diseases in pregnancy, obstetric cardiology, trimester-based analysis

ÖZET

Amaç: Bu çalışmanın amacı kardiyoloji konsultasyonu için sevk edilen gebe kadınlarda trimesterlere göre kardiyak şikayetlerin ve teşhis edilen kardiyovasküler hastalıkların sıklığını değerlendirmektir.

Yöntem: Bu retrospektif gözlemsel çalışma, ikinci basamak bir devlet hastanesinde yürütülmüştür. Eylül 2020 ile Mart 2022 arasında kardiyoloji kliniğine konsulte edilen gebe kadınlar çalışmaya dahil edilmiştir. Toplanan veriler demografik bilgiler, klinik sunumlar, gebeliğin trimesteri, kan basıncı, kalp hızı, anemi durumu, elektrokardiyografi (EKG) ve ekokardiyografik bulguları içermektedir. Kardiyak tanılar klinik değerlendirme, EKG ve ekokardiyografik bulgulara dayanmaktadır.

Bulgular: Toplam 658 gebe kadın çalışmaya dahil edilmiş olup, ortalama yaşları 28,18 (±4,28) yıldır. Konsültasyonların çoğu üçüncü trimesterde gerçekleşmiştir (%49,1). Konsültasyonun birincil nedenleri çarpıntı (%48), göğüs ağrısı (%21,3), bacak ödemi (%13,1) ve yüksek tansiyon (%11,6) idi. Kadınların %28,7'sinde anemi ve %20,2'sinde hipertansiyon (HT) saptanmıştır. Trimesterdeki istatistiksel anlamlı sonuçlar incelendiğinde, ilk trimesterde göğüs ağrısı ve presenkop/senkop oranlarının daha yüksek olduğu, ikinci ve üçüncü trimesterde ise çarpıntı ve anemi oranlarının daha yüksek olduğu görülmüştür. En sık görülen kardiyak tanılar aritmiler (%16,6), yüksek kan basıncı (%15,2) ve mitral yetmezlik (MR) (%12,5) idi. HT en sık ikinci trimesterde teşhis edildi ($P = 0,04$). Enfektif endokardit, miyokardit ve perikardit üçüncü trimesterde daha yaygındı.

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Sonuç: Kardiyak konsültasyonlar en sık üçüncü trimesterde gerçekleşmiştir. Çarpıntı, göğüs ağrısı ve yüksek tansiyon en sık görülen şikayetlerdir. HT ve MY en sık görülen kardiyak tanılardır. Gebelikte erken ve devam eden kardiyolojik değerlendirme, kardiyovasküler riskleri yönetmek için çok önemlidir.

Anahtar Kelimeler: Kardiyoloji konsültasyonu, gebelikte kardiyovasküler hastalıklar, obstetrik kardiyoloji, trimester bazlı analiz

Heart disease ranks as the second leading cause of maternal mortality in developed countries during pregnancy.[1] Pregnancy can exacerbate pre-existing conditions or lead to new cardiac issues, often detected late in gestation, significantly complicating the prognosis. Advances in treatment have enabled more women with heart disease to reach reproductive age and become pregnant. Approximately 1% to 4% of pregnancies involve diagnosed cardiovascular disease (CVD), a figure that increases when hypertensive disorders, which affect up to 8% of pregnancies, are included.[2,3]

Cardiovascular adaptations during pregnancy can exacerbate latent heart conditions.[4] Neurohumoral changes due to circulatory insufficiency further impact fetal development.[5] While some heart conditions are well-tolerated with close monitoring, others pose serious risks to both mother and baby. Pre-pregnancy conditions such as hypertension, diabetes, and congenital heart disease elevate the risk of CVD during pregnancy.[6]

Understanding physiological cardiovascular adaptations during pregnancy is crucial.[7] These adaptations include a significant increase in maternal blood volume, up to 40-50%, peaking by the 28th week, accompanied by decreased systemic vascular resistance and a slight drop in blood pressure, countered by an elevated heart rate.[8] While generally well-tolerated in healthy women, these changes can pose challenges for those with pre-existing CVD.

Common CVDs during pregnancy include hypertension, cardiomyopathy, coronary artery disease, and heart valve diseases.[3] Viral myocarditis, autoimmune factors, and hemodynamic shifts contribute to cardiomyopathy during pregnancy.[9] Risk factors for coronary artery disease in pregnant women mirror those in non-pregnant women, including hypertension, hyperlipidemia, diabetes mellitus, and smoking.[10] Valve diseases typically worsen rather than arise de novo during pregnancy.[3]

This observational study aims to assess the prevalence of cardiac complaints and diagnosed CVD across trimesters in pregnant women seen at a cardiology clinic.

ABBREVIATIONS

ANOVA	Analysis of variance
AR	Aortic regurgitation
AV	Atrioventricular
BMI	Body mass index
CHD	Congenital heart disease
ECG	Electrocardiography
HFmrEF	Heart Failure with Mid-Range Ejection Fraction
HFrEF	Heart Failure with Reduced Ejection Fraction
HT	Hypertension
LVH	Left ventricular hypertrophy
MR	Mitral regurgitation
MRI	Magnetic resonance imaging
PFO	Patent foramen ovale
PH	Pulmonary hypertension
PPCM	Postpartum cardiomyopathy
RAP	Right atrial pressure
sPAP	Systolic pulmonary artery pressure
SVT	Supraventricular tachycardia
VES	Ventricular extrasystoles
VT	Ventricular tachycardia

Materials and Methods

This study is a retrospective, observational analysis conducted at a second-level state hospital. The study included pregnant women who were referred from the gynecology and obstetrics clinic to the cardiology clinic between September 2020 and March 2022. The inclusion criteria were having a cardiology consultation during the study period, being a pregnant woman referred from the same center, and being over 18 years of age. Exclusion criteria included incomplete medical records and a known history of congenital heart disease (CHD) without any recent cardiac evaluation. Data were collected from electronic medical records, including demographic information such as age, pre-pregnancy body mass index (BMI), and medical history. Clinical presentations leading to cardiology consultations were recorded, including palpitations, chest pain, leg edema, and high blood pressure. Additional data collected included the trimester of pregnancy at the time of consultation, blood pressure measurements, heart rate, presence of anemia, electrocardiography (ECG) findings, and echocardiographic parameters. All patients underwent a standard clinical evaluation, including history taking, physical examination, and 12-lead ECG. Echocardiography was performed using standard techniques. Hemoglobin levels, transferrin saturation, ferritin levels, and urinalysis for proteinuria were also recorded. Cardiac diagnoses were made based on clinical evaluation, ECG, and echocardiographic findings.

Anemia was defined as hemoglobin levels below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester.

Hypertension (HT) was diagnosed if blood pressure was ≥ 140/90 mmHg on at least two separate measurements or if there was a history of HT prior to pregnancy.

Pulmonary hypertension (PH) was diagnosed using several echocardiographic criteria. Key indicators included the estimation of systolic pulmonary artery pressure (sPAP), derived from the peak tricuspid regurgitant jet velocity (TRV) using the modified Bernoulli equation: $4 \times TRV^2$ + right atrial pressure (RAP). An sPAP greater than 35 mmHg suggested elevated pulmonary pressures. Additional echocardiographic findings supporting the diagnosis included right heart chamber enlargement, right ventricular hypertrophy, and interventricular septal flattening. These indicators, along with clinical symptoms and physical examination, provided a comprehensive assessment of PH.[11] It is important to note that no right heart catheterization was

performed on any pregnant woman in this study for definitive PH diagnosis.

Heart Failure with Reduced Ejection Fraction (HFrEF) was characterized by an ejection fraction (EF) of less than 40%, while Heart Failure with Mid-Range Ejection Fraction (HFmrEF) was defined as an EF between 40% and 49%. Heart Failure with Preserved Ejection Fraction (HFpEF) was identified when the EF was ≥ 50%. Heart Failure with Preserved Ejection Fraction and HFmrEF were further characterized by elevated pro–B-type natriuretic peptide (Pro-BNP) levels, diastolic dysfunction (evidenced by echocardiographic signs such as impaired relaxation, altered mitral inflow patterns, and a high E/E' ratio), and left ventricular hypertrophy (LVH), indicated by increased left ventricular wall thickness or mass due to chronic pressure overload.[12]

Mitral regurgitation (MR) was classified as primary (e.g., mitral valve prolapse [MVP]) when identified by the prolapse of one or both mitral valve leaflets > 2 mm beyond the long-axis annular plane during systole; secondary, resulting from left ventricular dysfunction or dilation without intrinsic mitral valve pathology; and rheumatic, characterized by thickening and restricted motion of the mitral leaflets with commissural fusion. Aortic regurgitation (AR) was categorized into two groups: rheumatic valve, characterized by valve thickening, retraction, and restricted movement; and congenital bicuspid aortic valve. Arrhythmias were classified into subtypes: frequent ventricular extrasystoles (VES), defined as more than 10 premature ventricular contractions per hour on Holter monitoring; frequent supraventricular extrasystoles (SVES), defined as more than 10 premature atrial contractions per hour on Holter monitoring; supraventricular tachycardia (SVT), defined as narrow complex tachycardia with a heart rate greater than 100 beats per minute originating above the ventricles; ventricular tachycardia (VT), defined as wide complex tachycardia with a heart rate greater than 100 bpm originating from the ventricles; bradycardia, characterized by a heart rate below 60 bpm; and atrioventricular (AV) block, classified as first-degree (PR interval greater than 200 ms), second-degree (Mobitz I or Mobitz II), or third-degree (complete heart block).

Patent foramen ovale (PFO) was detected using transthoracic echocardiography with agitated saline contrast. During the procedure, patients were instructed to perform a Valsalva maneuver, which enhances the sensitivity of PFO detection by transiently increasing right atrial pressure and facilitating right-to-left shunting through the PFO. Agitated saline contrast was injected intravenously to visualize any passage of microbubbles from the right to the left atrium, indicative of the presence of a PFO. The diagnosis was confirmed if bubbles were observed in the left atrium within three cardiac cycles after opacification of the right atrium, consistent with established diagnostic criteria.

In this study, myocarditis was diagnosed using a comprehensive diagnostic approach that included symptom assessment, physical examination, ECG, and cardiac biomarkers such as Pro-BNP and troponin. Echocardiography played a crucial role in evaluating cardiac function and structure. Cardiac magnetic resonance imaging (MRI) was employed in cases where adequate echocardiographic evaluation was not feasible or when symptoms persisted despite initial assessments. The diagnosis of myocarditis was considered in patients presenting with symptoms such as chest pain, fever, signs of infection, and elevated inflammatory markers.[13] Patients exhibiting symptoms of heart failure and an EF less than 50% were primarily classified as having postpartum cardiomyopathy (PPCM). This diagnostic algorithm ensured a thorough evaluation and appropriate differentiation between myocarditis and PPCM, guiding tailored management strategies based on accurate diagnoses.

The research followed the ethical guidelines specified in the Declaration of Helsinki. The study received approval from the Yeni Yüzyıl University Scientific, Social and Non-Interventional Health Sciences Research Ethics Committee (Approval Number: 2023/01-1021, Date: 09.01.2023), under the supervision of the Scientific Research Applications Review Commission. Written informed consent was obtained from all participants involved in the study. No artificial intelligence-powered (AI-powered) tools, such as Large Language Models (LLMs), chatbots, or image generators, were used in developing this article.

Statistical Analysis

Descriptive statistics were used to summarize the baseline characteristics of the study population. Continuous variables were expressed as means and standard deviations for normally distributed data, and medians with interquartile ranges for non-normally distributed data. Categorical variables were expressed as frequencies and percentages. Comparisons between trimester subgroups were performed using one-way analysis of variance (ANOVA) for continuous variables with a normal distribution and the Kruskal-Wallis test for non-normally distributed variables. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Logistic regression analysis was used to identify factors associated with the presence of specific cardiac conditions such as HT, arrhythmias, and valvular diseases. Variables with a p-value < 0.10 in the univariate analysis were included in the multivariate model. All statistical analyses were conducted using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). A p-value < 0.05 was considered statistically significant.

Results

A total of 658 pregnant women referred from the obstetrics and gynecology clinic to the cardiology clinic were included in the study. The mean age of the participants was 28.18 years (± 4.28). Most consultations occurred in the third trimester (49.1%) (Figure 1). The primary reasons for consultation were palpitations (316

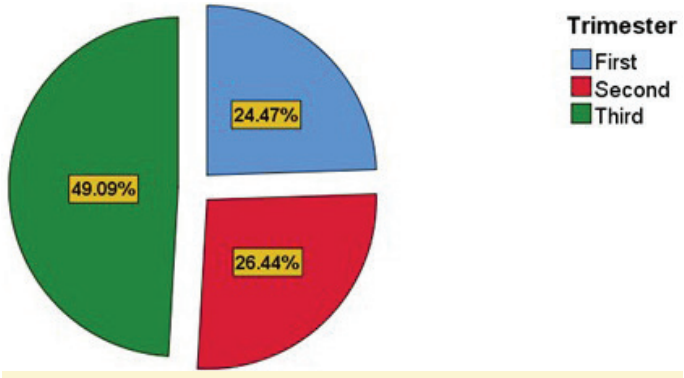

Figure 1. Pie chart showing the distribution of pregnant women referred to the cardiology department across trimesters.

Table 1. Baseline Clinical Characteristics of the Study Population

Patient Characteristics	***n* = 658** **n (%)**
Age (years)	28.18 ± 4.28
Trimester	
First	161 (24.5%)
Second	174 (26.4%)
Third	323 (49.1%)
Symptoms and Findings	
Chest pain	140 (21.3%)
Dyspnea	36 (5.5%)
Palpitation	316 (48%)
Syncope or near-syncope	4 (0.6%)
Pretibial edema	86 (13.1%)
High blood pressure	76 (11.6%)
Sinus rhythm on ECG	645 (98.0%)
EF on echocardiography	59.86 ± 3.04
Pulmonary artery systolic pressure (mmHg)	24.38 ± 7.17
Comorbidities	
Diabetes mellitus	16 (2.4%)
Hypertension	133 (20.2%)
Coronary artery disease	5 (0.8%)
Atrial fibrillation	7 (1.1%)
Heart failure	12 (1.8%)
Pre-pregnancy obesity	160 (24.3%)
Hypo or hyperthyroidism	71 (10.8%)
Asthma	46 (7.0%)
Anemia	189 (28.7%)
Vital Findings	
Systolic blood pressure (mmHg)	115.62 ± 14.14
Diastolic blood pressure (mmHg)	71.00 ± 11.77
Heart rate (beat per minute)	89.41 ± 14.63
Laboratory Biochemistry of Blood and Urine	
Hemoglobin (g/dL)	11.64 ± 0.96
Transferrin saturation (mg/dL)	13 (8-20)
Ferritin (ng/mL)	20 (13.9-135)
GFR (mL/min/1.73 m^2)	125.31 ± 80.55
Protein in urine (urinalysis)	90 (13.7%)

ECG, Electrocardiography; EF, Ejection Fraction; GFR, Glomerular Filtration Rate. *Values are presented as mean ± SD, median (IQR), or n [n/N if missing data] (%). *Interquartile range [25th percentile-75th percentile].

patients, 48%), chest pain (140 patients, 21.3%), leg edema (86 patients, 13.1%), and high blood pressure (76 patients, 11.6%). At the time of consultation, 28.7% of the women had anemia, 98% had sinus rhythm on ECG, the mean systolic blood pressure (SBP) was 115.62 mmHg (± 14.14), the mean diastolic blood pressure (DBP) was 71.00 mmHg (± 11.77), and the mean heart rate was 89.41 beats per minute (± 14.63). Approximately 20.2% of the women had HT, and 24.3% had pre-pregnancy obesity. Proteinuria was detected in 13.7% (90 patients) during urinalysis. All clinical and biochemical baseline characteristics of the participants are detailed in Table 1.

Baseline characteristics of the consulted pregnant women were compared according to trimester subgroups. No significant differences were observed between trimesters in terms of age.

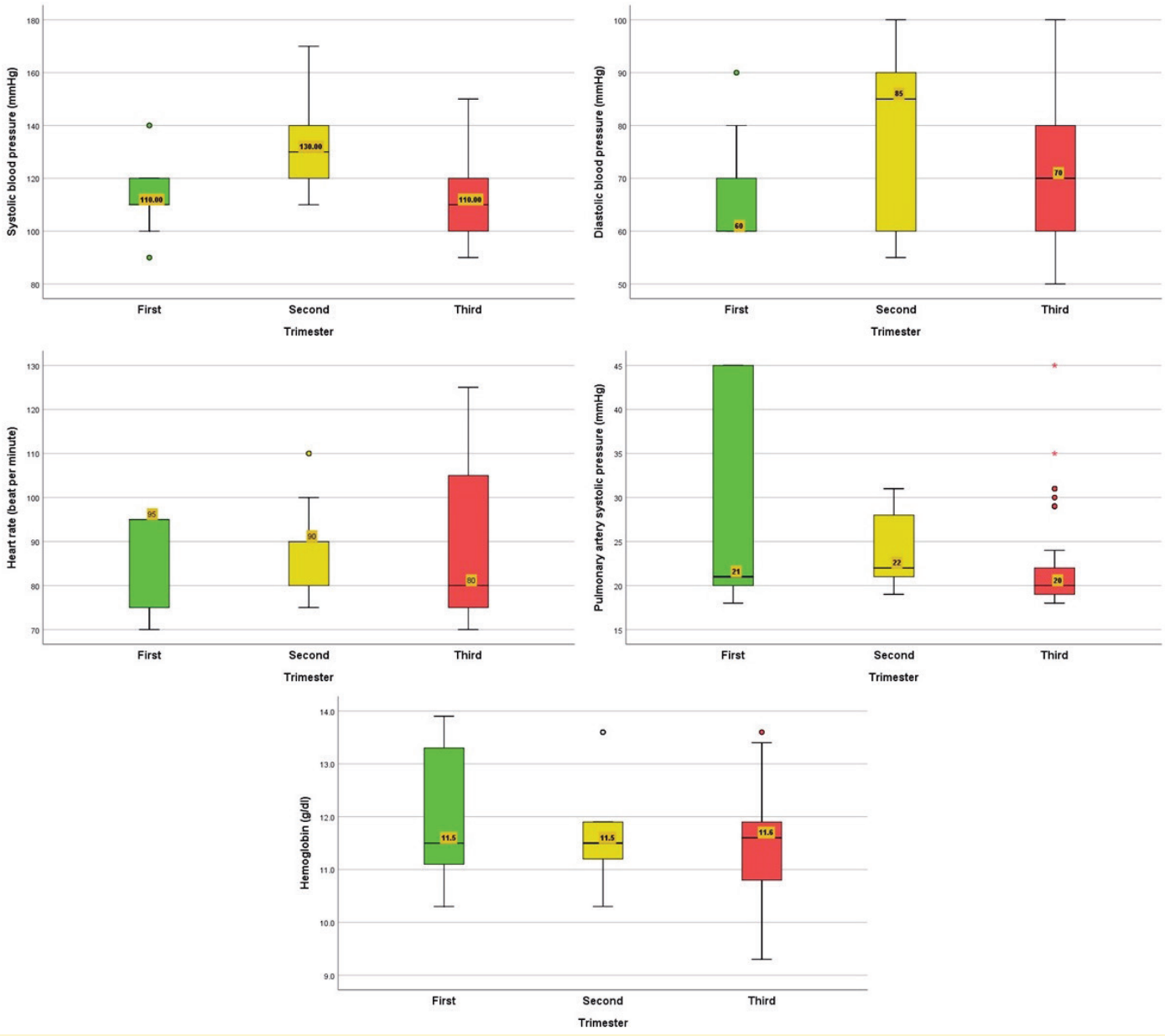

Figure 2. Boxplot illustrating the distribution of systolic blood pressure, diastolic blood pressure, heart rate, pulmonary artery systolic pressure, and hemoglobin levels by trimester.

Chest pain and presyncope/syncope were more common in pregnant women consulted in the first trimester (for chest pain: 44.7% in the first trimester, 23.0% in the second trimester, and 8.7% in the third trimester, $P < 0.001$; for presyncope/syncope: three patients in the first trimester, 1% in the second trimester, one patient in the third trimester, $P = 0.04$). Palpitations were more common in pregnant women consulted in the second and third trimesters compared to the first trimester (first trimester: 22.4%, second trimester: 59.8%, and third trimester: 54.5%, $P = 0.03$). Dyspnea, leg edema, and high blood pressure were similar across all three trimester subgroups. Similarly, sinus rhythm on ECG, EF, and estimated pulmonary artery systolic pressure on echocardiography were consistent across all trimester subgroups. The distribution of comorbidities was also similar among the trimester groups.

Anemia was more common in pregnant women consulted in the second and third trimesters compared to the first trimester (18.0% in the first trimester, 36.8% in the second trimester, and 29.7% in the third trimester, $P = 0.02$). Systolic and diastolic blood pressures were highest in the second trimester, while they were at similar levels in patients consulted during the first and third trimesters. The median systolic and diastolic blood pressures were 110/60 mmHg in the first trimester, 130/85 mmHg in the second trimester, and 110/70 mmHg in the third trimester, ($P = 0.03$ and $P = 0.04$, respectively). Heart rate tended to increase with advancing trimesters, but no statistically significant difference was observed. In laboratory tests, hemoglobin levels tended to decrease as the trimesters progressed, although this was not statistically significant (Figure 2).

Table 2. Patient Characteristics According to Pregnancy Trimester

Patient Characteristics	Pregnancy Trimester			*P*
	First Trimester n = 161	Second Trimester n = 174	Third Trimester n = 323	
Age (years)	29.00 ± 4.55	31.43 ± 4.81	28.07 ± 3.27	0.78
Symptoms and Findings, n (%)				
Chest pain	72 (44.7)	40 (23.0)	28 (8.7)	<0.001
Dyspnea	10 (6.2)	11 (6.3)	15 (4.6)	0.08
Palpitation	36 (22.4)	104 (59.8)	176 (54.5)	0.03
Syncope or near-syncope	3 (1.9)	1 (0.5)	0 (0.0)	0.04
Pretibial edema	19 (11.8)	23 (13.2)	44 (13.6)	0.11
High blood pressure	15 (9.3)	21 (12.1)	40 (12.4)	0.68
Sinus rhythm on ECG	156 (96.9)	168 (96.6)	321 (99.4)	0.92
EF on echocardiography	58.42 ± 3.60	60.55 ± 1.56	60.20 ± 3.11	0.44
Pulmonary artery systolic pressure (mmHg)	28.81 ± 10.44	25.03 ± 4.43	21.83 ± 4.86	0.06
Comorbidities, n (%)				
Diabetes mellitus	3 (1.9)	5 (2.9)	8 (2.5)	0.80
Hypertension	27 (16.8)	34 (19.5)	72 (22.3)	0.77
Coronary artery disease	1 (0.6)	2 (1.1)	2 (0.6)	0.92
Atrial fibrillation	1 (0.6)	2 (1.1)	4 (1.2)	0.66
Heart failure	2 (1.2)	3 (1.7)	7 (2.2)	0.62
Pre-pregnancy obesity	39 (24.2)	53 (30.5)	68 (21.1)	0.09
Hypo or hyperthyroidism	14 (8.7)	22 (12.6)	35 (10.8)	0.25
Asthma	8 (5.0)	19 (10.9)	19 (5.9)	0.24
Anemia during pregnancy	29 (18.0)	64 (36.8)	96 (29.7)	0.02
Vital Findings				
Systolic blood pressure (mmHg)	113.17 ± 7.54	128.22 ± 13.33	110.01 ± 12.82	0.03
Diastolic blood pressure (mmHg)	65.16 ± 7.75	76.72 ± 14.60	70.80 ± 10.17	0.04
Heart rate (beats per minute)	85.93 ± 10.24	89.11 ± 10.17	91.32 ± 17.88	0.18
Laboratory Biochemistry of Blood and Urine				
Hemoglobin (g/dL)	11.83 ± 1.06	11.74 ± 0.81	11.48 ± 0.97	0.15
Transferrin saturation (mg/dL)	20 (18-26)	13 (16-29)	12 (8-14)	0.05
Ferritin (ng/mL)	68 (35-168)	39 (17-120)	14.5 (11-70)	0.02
GFR (ml/min/1.73 m^2)	129.82 ± 8.72	123.70 ± 4.47	123.93 ± 10.12	0.52
Protein in urine (urinalysis)	31 (19.3)	24 (13.8)	35 (10.8)	0.17

ECG, Electrocardiography; EF, Ejection Fraction; GFR, Glomerular Filtration Rate. *Values are presented as mean ± SD, median (IQR), or n [n/N if missing data] (%). *Interquartile range [25th percentile-75th percentile].

Transferrin saturation and ferritin levels decreased significantly as pregnancy advanced. Median transferrin saturation was 20 mg/dL in the first trimester, 13 mg/dL in the second trimester, and 12 mg/dL in the third trimester. Median ferritin levels were 68 ng/mL in the first trimester, 69 ng/mL in the second trimester, and 14.5 ng/mL in the third trimester (P = 0.05 and P = 0.02, respectively). The incidence of proteinuria in urine analysis was similar across all trimesters. All clinical and biochemical baseline characteristics of the pregnant women according to trimester are shown in Table 2.

Cardiac diagnoses were determined based on consultations with pregnant women at the cardiology clinic. High blood pressure was detected in 15.2% of the pregnant women (100 individuals), of whom 89 were diagnosed with HT and 11 with preeclampsia. Echocardiographic examination revealed that 7.4% of the pregnant women (49 individuals) had an estimated pulmonary artery pressure of 35 mmHg or higher. Patent foramen ovale was detected in 17% (112 individuals), while atrial septal defect (ASD) was found in 11 individuals. Arrhythmias were present in 16.6% of the pregnant women, with the most common being

Table 3. Cardiac Diagnoses of Study Patients After Cardiology Consultation

Cardiac Diagnoses	***n* = 658** **n (%)**
High blood pressure	
Hypertension	89 (13.5%)
Preeclampsia	11 (1.7%)
Pulmonary hypertension on echocardiography	49 (7.4%)
Congenital heart diseases	
Patent foramen ovale	112 (17.0%)
Atrial septal defect	11 (1.7%)
Arrhythmias	
Frequent VES	46 (7.0%)
Frequent SVES	23 (3.5%)
Supraventricular tachycardia	10 (1.5%)
Ventricular tachycardia	5 (0.8%)
Atrial fibrillation	13 (2.0%)
Bradycardia or AV block	12 (1.8%)
Mitral regurgitation	
Secondary causes	28 (4.3%)
Rheumatic mitral valve	31 (4.7%)
Mitral valve prolapse	23 (3.5%)
Mitral stenosis	12 (1.8%)
Aortic regurgitation	
Rheumatic aortic valve	18 (2.7%)
Bicuspid aortic valve	12 (1.8%)
Tricuspid regurgitation	65 (9.9%)
Infective endocarditis	3 (0.5%)
Heart failure	
HFrEF	11 (1.7%)
HFmrEF	10 (1.5%)
HFpEF	20 (3.0%)
Pericarditis	8 (1.2%)
Myocarditis	11 (1.7%)
Acute myocardial infarction	
STEMI	10 (1.5%)
NSTE-ACS	4 (0.6%)

AV, Atrioventricular; HFmrEF, Heart Failure with Mid-Range Ejection Fraction; HFpEF, Heart Failure with Preserved Ejection Fraction; HFrEF, Heart Failure with Reduced Ejection Fraction; NSTE-ACS, Non-ST Segment Elevation Acute Coronary Syndromes; STEMI, ST-Elevation Myocardial Infarction; SVES, Supraventricular Extrasystole; VES, Ventricular Extrasystole. *Values are presented as mean ± SD, median (IQR), or n [n/N if missing data] (%). *Interquartile range [25th percentile-75th percentile].

frequent VES in 46 individuals (7.0%) and frequent SVES in 23 individuals (3.5%). The most common valvular disease above a mild level was MR, observed in 12.5% (82 individuals) of the pregnant women, with secondary MR being the leading cause (28 individuals). The second most common valvular disease was AR, seen in 30 individuals, with the primary etiology being rheumatic valve disease (18 individuals). Heart failure was diagnosed in 41 pregnant women (6.2%), with half diagnosed with HFpEF (20 individuals), 11 with HFrEF, and 10 with HFmrEF. Acute coronary syndrome was diagnosed in 14 individuals (2.1%), with 10 cases being ST-elevation myocardial infarction (STEMI). Additionally, infective endocarditis was diagnosed in three pregnant women, myocarditis in 11, and pericarditis in eight. Data regarding the cardiac diagnoses obtained after cardiology consultation are shown in Table 3.

Cardiac diagnoses of the consulted pregnant women were compared according to trimester subgroups. Hypertension was most frequently diagnosed in the second trimester (12.4% in the first trimester, 17.2% in the second trimester, and 12.1% in the third trimester, $P = 0.04$), while the incidence of preeclampsia was similar across all trimesters. Pulmonary hypertension, CHD, arrhythmias, valve diseases, heart failure, and acute coronary syndromes were detected at similar rates across the trimester subgroups (Figure 3).

All cases of infective endocarditis observed in the study (three pregnant women) were detected in the third trimester ($P < 0.001$). Pericarditis was not observed in the first trimester but was most frequently detected in the third trimester (zero cases in the first trimester, one case in the second trimester, and seven cases in the third trimester, $P = 0.04$). Similarly, myocarditis was

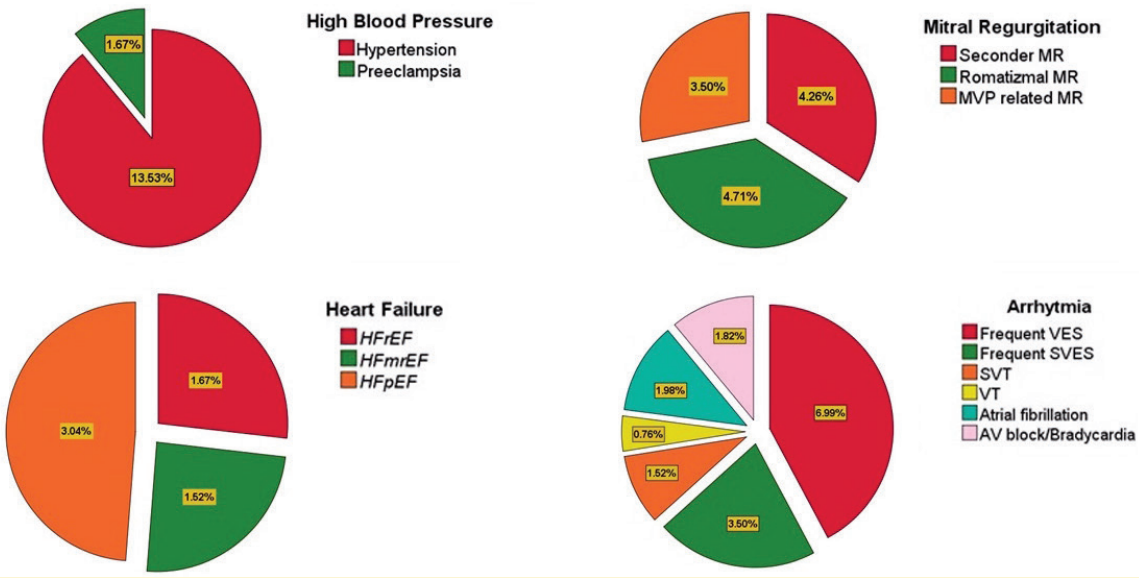

Figure 3. Pie chart depicting the frequency and causes of high blood pressure, mitral regurgitation, heart failure, and arrhythmia diagnosed in pregnant women referred to the cardiology department.

Table 4. Cardiac Diagnoses of Study Patients According to Trimester Subgroups After Cardiology Consultation

Cardiac Diagnoses	Pregnancy Trimester			*P*
	First Trimester *n* = 161 n (%)	Second Trimester *n* = 174 n (%)	Third Trimester *n* = 323 n (%)	
High blood pressure				
Hypertension	20 (12.4%)	30 (17.2%)	39 (12.1%)	0.04
Preeclampsia	4 (2.5%)	2 (1.1%)	5 (1.5%)	0.33
Pulmonary hypertension on echocardiography	13 (8.1%)	9 (5.2%)	27 (8.4%)	0.26
Congenital heart diseases				
Patent foramen ovale	30 (18.6%)	24 (13.8%)	58 (18.0%)	0.44
Atrial septal defect	1 (0.6%)	3 (1.7%)	7 (2.2%)	0.07
Arrhythmias				
Frequent VES	7 (4.3%)	12 (6.9%)	27 (8.4%)	0.08
Frequent SVES	6 (3.7%)	6 (3.4%)	11 (3.4%)	0.89
Supraventricular tachycardia	3 (1.9%)	0 (0.0%)	7 (2.2%)	0.09
Ventricular tachycardia	2 (1.2%)	1 (0.6%)	2 (0.6%)	0.16
Atrial fibrillation	2 (1.2%)	3 (1.7%)	8 (2.5%)	0.28
Bradycardia or AV block	2 (1.2%)	3 (1.7%)	7 (2.2%)	0.88
Mitral regurgitation				
Secondary causes	4 (2.5%)	8 (4.6%)	16 (5.0%)	0.09
Rheumatic mitral valve	7 (4.3%)	7 (4.0%)	17 (5.3%)	0.33
Mitral valve prolapse	3 (1.9%)	6 (3.4%)	14 (4.3%)	0.08
Mitral stenosis	3 (1.9%)	3 (1.7%)	6 (1.9%)	0.89
Aortic regurgitation				
Rheumatic aortic valve	3 (1.9%)	7 (4.0%)	8 (2.5%)	0.12
Bicuspid aortic valve	3 (1.9%)	2 (1.1%)	6 (1.9%)	0.16
Tricuspid regurgitation	10 (6.2%)	18 (10.3%)	37 (11.5%)	0.24
Infective endocarditis	0 (0.0%)	0 (0.0%)	3 (0.9%)	<0.001
Heart failure				
HFrEF	2 (1.2%)	4 (2.3%)	6 (1.9%)	0.27
HFmrEF	2 (1.2%)	3 (1.7%)	5 (1.5%)	0.33
HFpEF	4 (2.5%)	5 (2.9%)	10 (3.1%)	0.24
Pericarditis	0 (0.0%)	1 (0.6%)	7 (2.2%)	0.04
Myocarditis	1 (0.6%)	2 (1.1%)	8 (2.5%)	0.05
Acute myocardial infarction				
STEMI	2 (1.2%)	2 (1.1%)	6 (1.9%)	0.78
NSTACS	1 (0.6%)	1 (0.6%)	2 (0.6%)	0.98

AV, Atrioventricular; HFmrEF, Heart Failure with Mid-Range Ejection Fraction; HFpEF, Heart Failure with Preserved Ejection Fraction; HFrEF, Heart Failure with Reduced Ejection Fraction; NSTACS, Non-ST Segment Elevation Acute Coronary Syndromes; STEMI, ST-Elevation Myocardial Infarction; SVES, Supraventricular Extrasystole; VES, Ventricular Extrasystole. *Values are presented as mean ± SD, median (IQR), or n [n/N if missing data] (%). *Interquartile range [25th percentile-75th percentile].

most frequently detected in the third trimester (one case in the first trimester, two cases in the second trimester, and eight cases in the third trimester, $P = 0.05$). Data regarding cardiac diagnoses received by pregnant women after cardiology consultation according to trimester subgroups are shown in Table 4.

Discussion

A brief summary of our study results is as follows. Patients were most frequently consulted to the cardiology clinic in the third trimester. The most common cardiac complaints were palpitations, chest pain, pretibial edema, and high blood pressure, respectively. The most common comorbidities detected during pregnancy were anemia, obesity, HT, and diabetes, respectively. Asthma, thyroid disease, coronary artery disease (CAD), heart failure, and atrial fibrillation were detected less frequently. The most frequently diagnosed CVDs during pregnancy were arrhythmias, high blood pressure and MR, respectively.

Some CVDs can be well tolerated during pregnancy. A significant number of pregnant women with these conditions can have a successful pregnancy. Due to the decrease in systemic vascular resistance, mild aortic and mitral valve regurgitations are generally well tolerated. The most common valve disease detected in our study was MR, seen in 12.5% of pregnant women, and it was determined to be above mild severity. The most common etiology of MR was secondary MR. The second most common valve disease was AR. In our study, mitral stenosis was diagnosed in only 1.2% of pregnant women, while aortic stenosis was not detected. The lower detection rate of stenotic mitral and aortic valve diseases may be because these patients are often diagnosed before pregnancy and are advised against pregnancy due to the high risk of mortality and morbidity.[10] Another reason could be that aortic stenosis is often a disease of advanced age.[14] Unfortunately, treatment options for stenotic valve disease in pregnant women are limited. Beta-blocker therapy may be used to reduce the transvalvular gradient.[15] If signs of congestion are present, cautious use of diuretics may be considered. However, it is important to note that angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARB) are contraindicated during pregnancy.[16]

Patients with small ASD and small ventricular septal defect lesions can also have an uncomplicated pregnancy, provided they are not accompanied by severe PH.[17] In our study, PFO was detected in 17% of pregnant women, and ASD was found in 1.7%. Echocardiographic examination revealed pulmonary artery pressure of 35 mmHg or higher in 7.4% of the pregnant women. Echocardiographic evaluation is very important both before pregnancy and during follow-up. In cases of hemodynamically significant ASD detected before pregnancy, it should be closed percutaneously or surgically. If severe PH is detected, pregnancy is contraindicated. In pregnant women with mild PH and good functional capacity, close follow-up, targeted and timely treatments, and early planned delivery can reduce the risk to both mother and baby.[18]

Supraventricular and ventricular extrasystoles are frequently encountered during pregnancy.[19] In our study, arrhythmia was detected in 16.6% of pregnant women. The two most common arrhythmias were frequent VES in 7.0% and frequent SVES in 3.5% of the cases. Atrial fibrillation, SVT, and VT were detected less frequently. If there is no tachycardia that disrupts hemodynamics and no underlying heart disease or metabolic/endocrine cause, no treatment is required, and pregnancy is not affected.[20] However, if tachycardia episodes are frequent and have hemodynamic significance, medical treatment may be required. In such cases, before initiating arrhythmia treatment, it is important to investigate whether there is underlying organic heart involvement or other non-cardiac conditions that may be causing the arrhythmia.

In cases of newly diagnosed atrial fibrillation during pregnancy, the etiology should first be investigated, and a detailed examination should be conducted by a cardiologist. Electrical cardioversion is a safe and effective treatment option for pregnant women. In terms of medical treatment, amiodarone should be avoided, while beta-blockers and digoxin can be used for rate control. If necessary, warfarin may be administered after the first trimester. New oral anticoagulant treatment should not be used in pregnant women due to insufficient evidence.[21]

Hypertension affects approximately 5-10% of pregnancies, impacting maternal, fetal, and neonatal outcomes.[22] In our study, one of the most common comorbid conditions was HT (20.2%). Similarly, one of the frequent reasons for consultation was high blood pressure (11.6%). When trimesters were compared, systolic and diastolic blood pressures were significantly higher in the second trimester compared to the others. Chronic HT is defined as arterial pressure above 140/90 mmHg before pregnancy or in the first half of pregnancy. Gestational hypertension refers to arterial pressure rising above 140/90 mmHg after the 20th week of pregnancy, while arterial pressure was previously normal, and returning to normal values within 12 weeks after birth.[23] Gestational hypertension is distinguished from preeclampsia by the absence of proteinuria. Preeclampsia and eclampsia are serious clinical conditions in which HT during pregnancy is accompanied by proteinuria and, in the case of eclampsia, cerebral or metabolic complications.[24]

In managing cardiovascular diseases during pregnancy, current guidelines, such as those from the European Society of Cardiology (ESC), emphasize individualized care based on the type and severity of the heart condition. First-line treatment often includes lifestyle modifications, such as maintaining a healthy weight throughout pregnancy, along with the use of medications considered safe for both mother and fetus. For hypertension, drugs like nifedipine and labetalol are recommended, with aspirin (ASA) suggested for high-risk cases to reduce the risk of preeclampsia. Importantly, salt restriction is not recommended during pregnancy, particularly in the later trimesters, as it may interfere with the body's natural fluid balance. Close monitoring and interdisciplinary care involving obstetricians and cardiologists are essential for optimizing maternal and fetal outcomes. Integrating these strategies supports maternal cardiovascular health during this critical period.[25,26]

It is crucial to highlight the increased prevalence of HFpEF during pregnancy, influenced by several interrelated factors. Pregnancy inherently imposes physiological changes, including increased blood volume and cardiac output, placing a higher demand on the cardiovascular system. These changes

can exacerbate pre-existing conditions such as HFpEF, where impaired diastolic function and preserved systolic function lead to inadequate ventricular filling during relaxation. Additionally, the presence of anemia further complicates cardiac function by reducing oxygen-carrying capacity and increasing cardiac workload. The combination of these physiological stressors during pregnancy underscores the importance of vigilant monitoring and tailored management strategies for pregnant women with HFpEF. Moreover, comorbidities such as obesity, hypertension, diabetes, and a sedentary lifestyle contribute significantly to the development and progression of HFpEF, necessitating comprehensive multidisciplinary care to optimize maternal and fetal outcomes. Addressing these challenges requires a nuanced approach that balances therapeutic interventions with the unique physiological demands of pregnancy, aiming to mitigate risks and improve overall maternal health.

Some heart diseases necessitate avoiding pregnancy or, if pregnancy has already occurred, often terminating it. Severe PH, severe obstructive valve disease, dilated cardiomyopathy with severe heart failure, severe ischemic heart diseases, cyanotic CHD, and Marfan syndrome with a dilated aortic root are among these conditions. Volume overload during pregnancy may further worsen the clinical picture of patients with significant left ventricular systolic dysfunction (EF < 40%); therefore, pregnancy is not appropriate for these patients.[3]

As a result, cardiovascular symptoms are common during pregnancy, and CVDs are frequently detected. This situation can pose serious risks for both the mother and the fetus. The management and treatment of CVD during pregnancy are complex due to the limited options for medical treatment. Our study highlighted the symptoms and frequency of CVD in this specific population.

This study's primary limitation is its retrospective design, which may introduce selection and recall bias. Additionally, the study's sample size is relatively small, potentially limiting the generalizability of our findings to a broader population. The lack of a control group and the potential for missing or incomplete data in medical records further constrain the robustness of our conclusions. The heterogeneity in the types of cardiac complaints and the timing of consultations during pregnancy also poses challenges in drawing definitive correlations. Furthermore, since the main purpose of the study was to determine cardiac diagnoses during pregnancy, data on cardiac and non-cardiac medical treatments used by the patients were not collected, limiting our ability to evaluate the potential influence of treatments on outcomes. Future research should focus on prospective, larger-scale studies with standardized data collection to validate and expand upon these findings.

Conclusion

In conclusion, our study demonstrated that pregnant women are most frequently referred to the cardiology clinic during the third trimester, with palpitations, chest pain, leg edema, and high blood pressure being the primary complaints. Anemia, obesity, and HT were the most prevalent comorbidities identified. The most frequent cardiovascular diagnoses were arrhythmias, high blood pressure, and MR. Cardiac conditions such as infective endocarditis, pericarditis, and myocarditis were notably more common in the third trimester. These findings underscore the importance of vigilant cardiovascular monitoring and management throughout pregnancy, particularly in the later stages, to improve maternal and fetal outcomes.

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