

Impact of Diabetes on Cardiovascular Function in Pregnant Women

Impact du diabète sur la fonction cardiovasculaire chez la femme enceinte

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ABSTRACT

Pregnancy induces major cardiovascular adaptations that may be altered in women with diabetes, potentially affecting myocardial performance. This prospective cross-sectional study evaluated the impact of diabetes on cardiovascular function in pregnancy using transthoracic echocardiography. Seventy-six pregnant women were included, comprising 40 with diabetes and 36 healthy controls. Echocardiographic assessment compared systolic and diastolic parameters between groups. Diabetic women demonstrated a modest but statistically significant reduction in left ventricular ejection fraction compared with controls (62.4% vs. 64.7%, $p = 0.032$), although values remained within normal limits. Diastolic function and longitudinal systolic indices, including S' and TAPSE, were preserved. A subtle tendency toward increased ventricular dimensions was also observed in the diabetic group. These findings suggest that diabetes in pregnancy is associated with early subclinical alterations in cardiac performance. Echocardiography emerges as a valuable tool for detecting such changes and could be considered in the routine cardiovascular evaluation of pregnant women with diabetes.

Key-words: Diabetes, Pregnancy, Echocardiography, Cardiovascular Function

RÉSUMÉ

La grossesse induit d'importantes adaptations cardiovasculaires qui peuvent être modifiées chez les femmes diabétiques, pouvant potentiellement affecter les performances du myocarde. Cette étude transversale prospective a évalué l'impact du diabète sur la fonction cardiovasculaire pendant la grossesse à l'aide d'une échocardiographie transthoracique. Soixante-seize femmes enceintes étaient incluses, dont 40 diabétiques et 36 témoins en bonne santé. L'évaluation échocardiographique a comparé les paramètres systoliques et diastoliques entre les groupes. Les femmes diabétiques ont montré une réduction modeste mais statistiquement significative de la fraction d'éjection du ventricule gauche par rapport aux témoins (62,4 % contre 64,7 %, $p = 0,032$), bien que les valeurs soient restées dans les limites normales. La fonction diastolique et les indices systoriques longitudinaux, incluant S' et TAPSE, ont été préservés. Une tendance subtile à une augmentation des dimensions ventriculaires a également été observée chez les diabétiques. Ces résultats suggèrent que le diabète pendant la grossesse est associé à des altérations subcliniques précoces de la performance cardiaque. L'échocardiographie s'avère un outil précieux pour détecter de tels changements et pourrait être envisagée dans l'évaluation cardiovasculaire de routine des femmes enceintes diabétiques.

Mots clés: Diabète, Fonction cardiovasculaire, Échocardiographie, Grossesse

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INTRODUCTION

Pregnancy induces major cardiovascular adaptations, including increased cardiac output and plasma volume, alongside reduced vascular resistance and arterial pressure. While typically well tolerated in healthy women, these changes may be disrupted by comorbidities. Beyond preexisting heart disease, a growing proportion of pregnancy-related cardiovascular complications are now linked to acquired conditions such as obesity, hypertension, and diabetes (1,2).

Gestational diabetes, defined as hyperglycemia first diagnosed during pregnancy, affects between 6% and 25% of pregnant women depending on the diagnostic criteria and population characteristics (3,4). Without proper management, it is associated with severe maternal and fetal complications (5). Two-dimensional transthoracic echocardiography (TTE) is a non-invasive and widely used tool for assessing cardiac function during pregnancy, particularly left ventricular ejection fraction (LVEF). However, LVEF has some limitations. In this context, the aim of this study was to compare echocardiographic parameters between diabetic and non-diabetic pregnant women in order to identify potential subclinical alterations in cardiac function (6,7).

METHODS

This was a prospective cross-sectional, single-center study. The study included pregnant women referred to our cardiology and gynecology departments for routine prenatal evaluation between (October 2024 -February 2025).

A total of 76 pregnant women in their second or third trimester were enrolled and divided into two equal groups:

- Group 1: 40 pregnant women with diabetes (either gestational or pre-gestational).
- Group 2: 36 healthy pregnant women without diabetes, matched for age and gestational age.

Inclusion Criteria

- Singleton pregnancy
- Gestational age ≥ 24 weeks
- Confirmed diagnosis of gestational diabetes mellitus (for Group 1) according to WHO criteria
- Willingness to participate and provide informed consent

Exclusion Criteria

Participants were excluded if they had:

- Pregnancy-related complications (e.g., preeclampsia, eclampsia, placental abnormalities)
- Chronic comorbidities (e.g., chronic hypertension, renal insufficiency)

- Known structural or congenital heart disease
- Acute or chronic infection

Clinical Assessment

All participants underwent a complete clinical evaluation, including:

- Measurement of blood pressure and heart rate
- Hemoglobin level
- Calculation of body mass index (BMI) and body surface area (BSA)

Echocardiographic Evaluation

All transthoracic echocardiographies were performed by a senior cardiologist using a Philips iE33 within the first 24 hours of admission, while the patients were in a stable hemodynamic condition and breathing spontaneously. In the left lateral decubitus position, following standard imaging protocols of the American Society of Echocardiography (ASE).

The following parameters were assessed:

- Left ventricular systolic function: Ejection fraction (LVEF) using Simpson's biplane method; end-systolic volume (ESV); cardiac output (CO)
- Right ventricular function: Right ventricular fractional shortening (RVFS)
- Preload estimation: Inferior vena cava (IVC) diameter and collapsibility
- Global cardiac structure: Left atrial size, ventricular wall thickness (when measurable), and chamber dimensions

All measurements were averaged over three consecutive cardiac cycles and interpreted by two independent cardiologists blinded to the clinical status of participants.

Statistical Analysis

Descriptive statistics were performed for all variables. Continuous variables are summarised as mean $\pm$ standard deviation (SD). Normality was verified with the Shapiro–Wilk test. Equality of variances between groups was assessed with Levene's test. When both assumptions were met, group means were compared with the Student t-test; otherwise, the unequal-variance Welch t-test was applied. If a variable was non-normally distributed, the Mann–Whitney U test was used. Categorical data (would have been evaluated with the χ^2 test. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

A total of 76 pregnant women were enrolled in the study, including 40 with gestational diabetes (GD) and 36 healthy controls. The aim was to assess the impact of diabetes on cardiovascular structure and function using

echocardiographic evaluation. The results are presented in two parts: demographic and anthropometric characteristics, followed by echocardiographic findings. Mean systolic blood pressure was 110 ± 20 mmHg, mean diastolic blood pressure was 70 ± 10 mmHg, and mean heart rate was 70 ± 10 bpm.

Hemoglobin levels were recorded for all participants as part of the routine clinical evaluation. Mean hemoglobin values were within normal pregnancy-adjusted ranges in both groups, and no participant met the WHO criteria for anemia. This confirms that differences in cardiac function between groups were not influenced by underlying anemia.

The demographic characteristics of the GD and control groups are summarized in Table 1.

Table 1. Demographic Comparison between Diabetes and Control Groups

Variable	Diabete mean	Temoin mean	p value
Age	29,92	29,26	0,57
BMI	32,93	28,81	0,003
BSA	1,88	1,77	0,17
Parity	2,07	1,94	0,54
GW	35,4	36,22	0,32

BMI : Body Mass Index, **BSA** : Body Surface Ratio, **GW** : Gestational term weeks

Both groups were comparable in terms of age, body surface area (BSA), and parity, with no statistically significant differences observed. However, the diabetic group had a significantly higher body mass index (BMI) compared to controls (mean $\pm$ SD: $33 \pm X$ kg/m² vs $29 \pm X$ kg/m²; $p = 0.003$), indicating a higher prevalence of obesity among women with GD.

Echocardiographic parameters are presented in Table 2. The left-ventricular end-diastolic diameter (LVEDD) was greater in the GD group compared to controls (50 ± 4 mm vs 47 ± 5 mm), although this difference did not reach statistical significance ($p = 0.07$). Similarly, the left-ventricular end-systolic diameter (LVESD) was slightly increased in diabetic patients (34 ± 5 mm) versus the control group (32 ± 6 mm), without a statistically significant difference ($p = 0.22$). The left-ventricular mass index (LVMI) also tended to be higher in the GD group (61 ± 14 g/m²), but this trend was not statistically significant ($p = 0.17$). These trends are illustrated in Figure 1A–C, showing a tendency toward increased cardiac dimensions and mass in diabetic pregnancies.

The two groups were comparable regarding age, body surface area (BSA), and parity, with no statistically significant differences. However, body mass index (BMI) was significantly higher in the diabetic group (≈ 33 kg/m² vs ≈ 29 kg/m²), with a p -value of 0.003.

Echocardiographic data are reported in table 2.

Table 2. Echocardiographic Parameter Comparison between Diabetes and Control Cohorts

Parameter	Diabetic Group (GD) (mean $\pm$ SD)	Control Group (mean $\pm$ SD)	p-value
LVEDD (mm)	50 ± 4	47 ± 5	0.07
LVESD (mm)	34 ± 5	32 ± 6	0.22
LVMI (g/m ²)	61 ± 14	56 ± 12	0.17
FEVG (%)	62 ± 3.9	64 ± 4.3	0.032
S' (cm/s)	10.9 ± 1.9	11.3 ± 1.8	0.39
TAPSE (mm)	23 ± 3	24 ± 4	0.51
E/A Ratio	1.17 ± 0.25	1.18 ± 0.31	0.92
E/E' Ratio	6.0 ± 1.2	5.8 ± 1.5	0.42

LVEDD : LV End-Diastolic Diameter, **LVESD** : LV End-Systolic Diameter, **LVMI** : Left-Ventricular Mass Index, **FEVG** : Ejection Fraction, **S'** : Tissue Doppler Systolic Velocity, **TAPSE** : Tricuspid Annular Plane Systolic Excursion, **E/A ratio** : Mitral E/A ratio

The left-ventricular end-diastolic diameter (LVEDD) was larger in the GD group (mean $\pm$ SD = 50 ± 4 mm) than in controls (47 ± 5 mm), although the difference did not reach statistical significance ($p = 0.07$). Systolic diameter (LVESD) showed a similar, non-significant trend (34 ± 5 mm vs 32 ± 6 mm, $p = 0.22$).

Left-ventricular mass index (LVMI) tended to be higher in diabetics (61 ± 14 g·m⁻²) but with wide scatter and again no significant group separation ($p = 0.17$). These distributions are depicted in Figure 1,2,3.

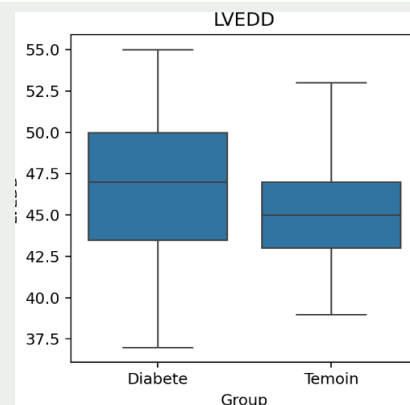


Figure 1. Boxplot illustrating the distribution of left-ventricular end-diastolic diameter (LVEDD) in the diabetic and control groups.

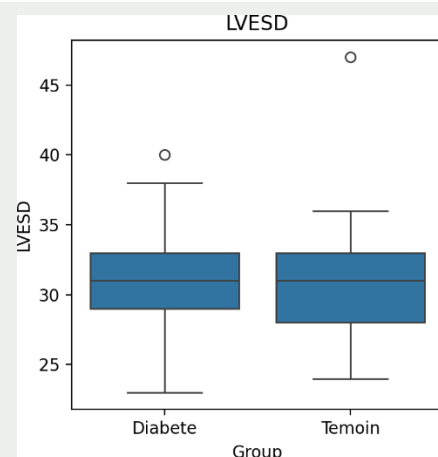


Figure 2. Boxplot illustrating the distribution of left-ventricular end-systolic diameter (LVESD) in the diabetic and control groups.

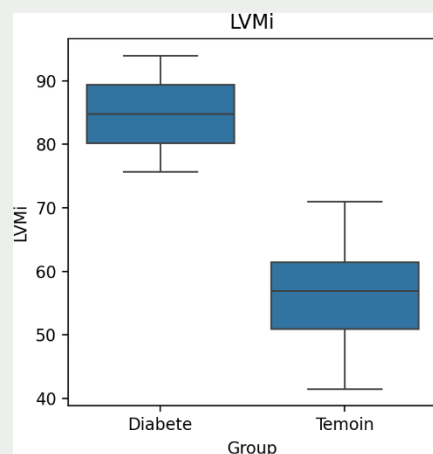


Figure 3. Ventricular size and mass

Ejection fraction (FEVG) was preserved in every subject. Nevertheless, the GD cohort displayed a subtle left-shift of the distribution, with a mean of $62.4 \pm 3.9\%$ versus $64.7 \pm 4.3\%$ in controls ($p = 0.032$). Tissue-Doppler systolic velocity S' ($10.9 \pm 1.9 \text{ cm}\cdot\text{s}^{-1}$ vs $11.3 \pm 1.8 \text{ cm}\cdot\text{s}^{-1}$, $p = 0.39$) and tricuspid-annular plane systolic excursion (TAPSE) ($23 \pm 3 \text{ mm}$ vs $24 \pm 4 \text{ mm}$, $p = 0.51$) were virtually identical between groups, underscoring normal longitudinal shortening (Figure 2A–C).

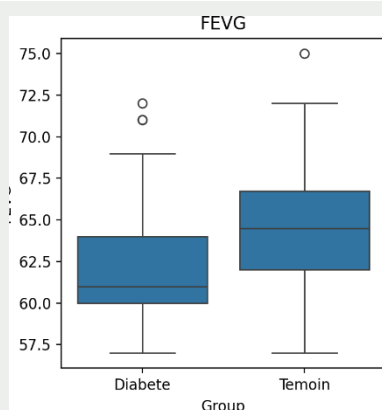


Figure 4. Boxplot representing the distribution of left ventricular ejection fraction (LVEF) in the diabetic and control groups

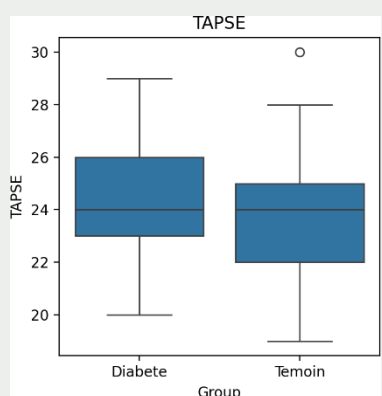


Figure 5. Tricuspid-annular plane systolic excursion

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averaged 1.17 ± 0.25 in GD and 1.18 ± 0.31 in controls ($p = 0.92$). Likewise, the tissue-Doppler surrogate of filling pressure E/E' was comparable (6.0 ± 1.2 vs 5.8 ± 1.5 , $p = 0.42$). No woman fulfilled criteria for diastolic dysfunction. Figure 3 shows the overlap of these indices.

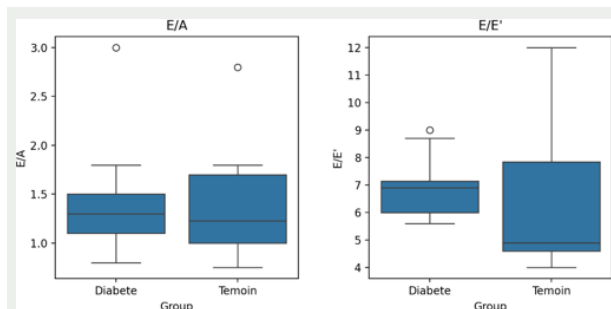


Figure 6. Conventional and tissue-Doppler diastolic indices.

DISCUSSION

This Prospective study shows that diabetes subtly influences maternal cardiac adaptation during pregnancy. Although overall cardiac function remained normal, diabetic women displayed a small but significant reduction in left ventricular ejection fraction and a tendency toward larger ventricular dimensions. Longitudinal systolic and diastolic markers were preserved, indicating early subclinical changes rather than overt dysfunction. These findings suggest that diabetes may affect myocardial performance even before clinical symptoms appear.

In this prospective cohort study, we observed a modest yet statistically significant reduction in left ventricular ejection fraction (LVEF) among pregnant women with diabetes compared to healthy controls (62.4% vs. 64.7% , $p = 0.032$). Although mean LVEF values remained within normal physiological limits, this decline may reflect early, subclinical systolic dysfunction that standard obstetric follow-up could fail to detect. These findings reinforce the hypothesis that diabetes, even during pregnancy, exerts subtle deleterious effects on myocardial contractility(8,9). The mechanisms underlying this systolic alteration likely include chronic hyperglycemia- induced oxidative stress and mitochondrial dysfunction, as shown in prior experimental studies (10). Elevated glucose levels contribute to the accumulation of reactive oxygen species (ROS), disrupting calcium handling and impairing contractile protein activity. Simultaneously, the activation of AGE–RAGE signaling and profibrotic mediators like TGF- β 1 may promote myocardial fibrosis, progressively undermining ventricular efficiency (11,12). In our study, the reduction in LVEF occurred despite preserved tissue Doppler systolic velocity (S') and TAPSE, suggesting a dissociation between global and longitudinal systolic function. This highlights the limitations of relying solely on LVEF as a marker, which may fail to capture early regional or functional myocardial abnormalities.

In addition to functional alterations, the diabetic group showed trends toward structural remodeling. Specifically, there was a non-significant increase in left ventricular end-diastolic diameter (LVEDD) and left ventricular mass

index (LVMI), suggesting a tendency toward eccentric hypertrophy. These findings are consistent with previous reports indicating that diabetes promotes cardiac remodeling through a combination of volume overload and metabolic stress (13). Although the differences did not reach statistical significance, the pattern aligns with known pathways of diabetic cardiac adaptation.

Interestingly, no differences were observed between groups in terms of diastolic function. This suggests that, unlike in non-pregnant populations where diastolic dysfunction is a hallmark of diabetic cardiomyopathy (14), such alterations may either emerge later in gestation or postpartum. The relatively young and otherwise healthy cohort may also explain the absence of significant diastolic impairment.

It is also important to consider body mass index (BMI) as a potential confounding factor. In our cohort, the diabetic group had a significantly higher BMI (32.9 vs. 28.8 kg/m², $p = 0.003$), a known contributor to cardiovascular dysfunction. However, stratified analyses suggest that diabetes may exert independent effects on systolic function, beyond the contribution of obesity alone.

A slight decline in systolic function seen in diabetic pregnancies, though not clinically alarming, deserves attention—especially in women with comorbidities like obesity or chronic hypertension, where even minimal changes in LVEF could reflect heightened cardiac vulnerability. While routine echocardiography for all diabetic pregnancies may not be feasible, targeted screening in high-risk groups could support earlier identification of dysfunction and guide interventions such as improved glycemic control or cardiology follow-up.

Several limitations should be acknowledged. First, its cross-sectional design does not allow assessment of temporal changes in cardiac function during or after pregnancy. Second, the relatively small sample size may have limited the detection of subtle but clinically meaningful differences, particularly in parameters such as left ventricular mass index or diastolic indices.

Third, although participants were matched for age and gestational age, residual confounding due to differences in body mass index cannot be entirely ruled out. Finally, myocardial strain analysis, which is more sensitive for detecting early systolic dysfunction, was not performed; its inclusion could have provided additional insights into subclinical myocardial changes.

Further prospective studies are essential to clarify whether these subtle cardiac changes persist after delivery or contribute to later heart conditions.

CONCLUSION

Pregnant women with diabetes exhibit subtle, subclinical alterations in systolic performance and early tendencies toward ventricular remodeling, despite maintained overall cardiac function. These discreet changes highlight the value of strict glycemic control and tailored cardiovascular follow-up to prevent the progression of underlying dysfunction and reduce long-term maternal risk.

Abbreviations

AGE	: Advanced Glycation End Products
ASE	: American Society of Echocardiography
BMI	: Body Mass Index
BSA	: Body Surface Area
CO	: Cardiac Output
E/A	: Mitral E/A Ratio
ESV	: End-Systolic Volume
GDM	: Gestational Diabetes Mellitus
GD	: Gestational Diabetes
GW	: Gestational Weeks
IVC	: Inferior Vena Cava
LVEF	: Left Ventricular Ejection Fraction
LVEDD	: Left Ventricular End-Diastolic Diameter
LVESD	: Left Ventricular End-Systolic Diameter
LVMI	: Left Ventricular Mass Index
RAGE	: Receptor for Advanced Glycation End Products
ROS	: Reactive Oxygen Species
RVFS	: Right Ventricular Fractional Shortening
S'	: Tissue Doppler Systolic Velocity
SD	: Standard Deviation
TAPSE	: Tricuspid Annular Plane Systolic Excursion
TGF-β1	: Transforming Growth Factor Beta 1
TTE	: Transthoracic Echocardiography
WHO	: World Health Organization

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