

Quantitative associations between maternal diabetes and fetal multi-organ ultrasound parameters

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Objective

The effects of maternal pre-existing diabetes mellitus (PGDM) and gestational diabetes (GDM) on fetal biometric, cardiac, and placental hemodynamic parameters—and whether these effects vary by obstetric risk and glycemic control—remain unclear. We assessed these associations, including dose–response relationships with maternal fasting plasma glucose (FPG) and the effects of glycemic control on fetal ultrasound parameters.

Methods

This retrospective observational study included two populations from Beijing Anzhen Hospital: a routine antenatal population (12,681 cases, low-risk population) and a tertiary referral population undergoing fetal echocardiography (15,415 cases, high-risk population). Women were classified as normal glucose tolerance (NGT), GDM, or PGDM. Gestational-age-adjusted biometric Z-scores and natural-log-transformed multiples of the median (InMoM) for cardiac parameters were compared among groups within each population. Linear regression, restricted cubic splines (RCS), and glycemic- control subgroup analyses (well- controlled vs poorly- controlled PGDM/GDM vs NGT, poor control defined as maximum recorded FPG>5.3mmol/L per diabetescare 2025 criteria) were performed only in the low- risk population, as FPG data were available for this population.

Results

In the low-risk population, maternal GDM was associated with a higher UA S/D ratio than NGT (p<0.05). In the high-risk population, GDM-exposed fetuses had larger HC and FL but smaller diameters of descending aorta, right pulmonary artery, and right atrium; PGDM-exposed fetuses showed smaller cardiac area and foramen ovale. Per 1 mmol/L absolute increase in continuous FPG was associated with lower descending aorta diameter, higher aortic isthmus diameter, and lower aortic valve velocity. Non-linear associations were identified via RCS: an inverted-U shape for AC Z-score (inflection point 4.89 mmol/L), and U-shapes for PV systolic velocity (4.86 mmol/L) and UA S/D ratio (4.69 mmol/L). Cardiac changes persisted despite good control in PGDM but occurred only with poor control in GDM.

Conclusion

Maternal diabetes correlates with fetal cardiac alterations stratified by diabetes type, risk status and glycemic control, with more pronounced changes in PGDM, even under adequate glycemic control. These findings highlight the potential relevance of fetal cardiovascular health when discussing maternal glycemic control targets.

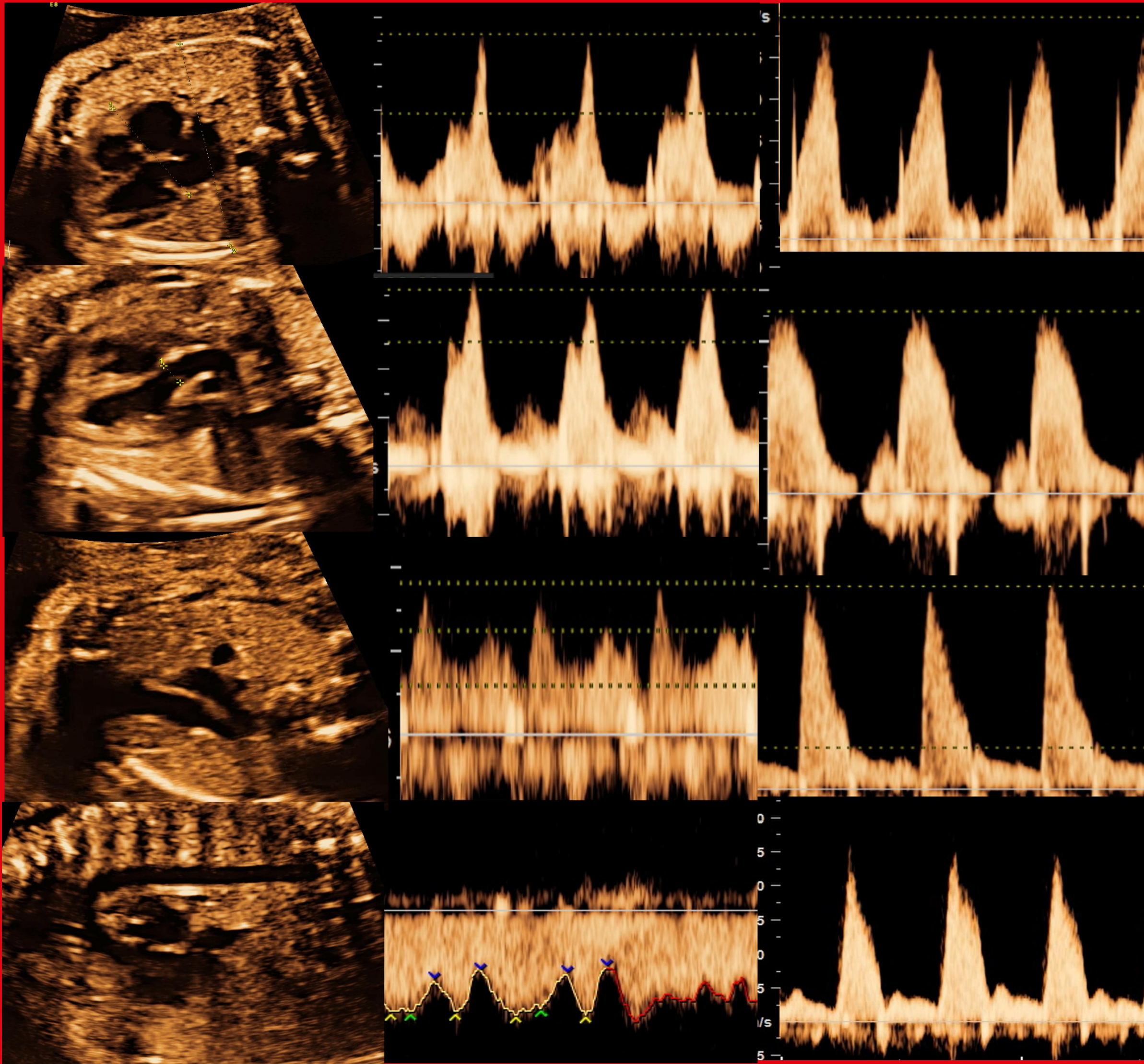


Figure 1. Fetal parameters from fetal echocardiography

Variable	Category	Estimate	lower	upper	p Value
InMoM(DV-A)	NGT as reference	-	-	-	-
InMoM(DV-A)	Well-controlled PGDM	-0.314	-0.566	-0.061	0.015
InMoM(DV-A)	Poorly-controlled PGDM	0.107	-0.073	0.287	0.243
InMoM(RA)	NGT as reference	-	-	-	-
InMoM(RA)	Well-controlled GDM	0.001	-0.013	0.015	0.892
InMoM(RA)	Poorly-controlled GDM	-0.047	-0.077	-0.017	0.002
InMoM(DA-Vd)	NGT as reference	-	-	-	-
InMoM(DA-Vd)	Well-controlled GDM	-0.013	-0.041	0.014	0.345
InMoM(DA-Vd)	Poorly-controlled GDM	-0.062	-0.122	-0.001	0.046

Table 1 Effects of glycemic control levels of PGDM and GDM on fetal ultrasound parameters

DV-A: Ductus venosus end diastolic velocity; RA: Right atrium; DA-Vd: Ductus arteriosus diastolic velocity.