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Claudia Marcela Angulo Seijas
claudia_7771@hotmail.com
Hospital Belén de Trujillo
Luis Enrique Castañeda Cuba
Hospital Belén de Trujillo
Javier Ernesto Vásquez Alvarado
Hospital Belén de Trujillo
Zoraida Haydee Alva Huaylla
Hospital Belén de Trujillo
Katherine Yolanda Lozano Peralta
Hospital Belén de Trujillo
Claudia Paola Liviapoma Rodríguez
Hospital Belén de Trujillo
Mariangella Susan Lau Raza
Hospital Belén de Trujillo
Darwin Paul Ayala Cespedes
Hospital Belén de Trujillo

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Maternal and Perinatal Morbidity in Women with Pregestational and Gestational Diabetes: A Retrospective Cohort Study from a Tertiary Referral Hospital in Peru

Claudia Marcela Angulo Seijas, MSc[1,2]*, Luis Enrique Castañeda Cuba, MD, MBA[1,2], Javier Ernesto Vásquez Alvarado, MD, MSc[1,2], Zoraida Haydee Alva Huaylla, MD[1,2], Katherine Yolanda Lozano Peralta MD, MSc[1], Claudia Paola Liviapoma Rodríguez MSc[1,2], Mariangella Susan Lau Raza MSc[1,2], Darwin Paul Ayala Cespedes MSc[1,2]

[1]Maternal–Fetal Medicine Unit, Hospital Belén de Trujillo, Trujillo, Peru

[2] School of Medicine, Universidad Privada Antenor Orrego, Trujillo, Peru

***Corresponding author: Claudia Marcela Angulo Seijas,** Department of Obstetrics and Gynecology, Hospital Belén de Trujillo, Trujillo, Peru, E-mail: claudia_7771@hotmail.com; Telephone: 0051948190212 ORCID: **orcid.org/0009-0008-2549-3004**

ORCID IDs

Claudia Marcela Angulo Seijas orcid.org/0009-0008-2549-3004

Luis Enrique Castañeda Cuba orcid.org/0000-0002-2768-2449

Javier Ernesto Vásquez Alvarado orcid.org/0009-0002-3688-2685

Zoraida Haydee Alva Huaylla orcid.org/0009-0007-6286-783X

Katherine Yolanda Lozano Peralta orcid.org/0000-0002-9011-6116

Claudia Paola Liviapoma Rodríguez orcid.org/0000-0003-2958-8162

Mariangella Susan Lau Raza orcid.org/0009-0000-2154-5366

Darwin Paul Ayala Cespedes orcid.org/0000-0001-8739-0491

ABSTRACT

Background

Diabetes in pregnancy is one of the most common metabolic disorders worldwide and remains a major cause of maternal and perinatal morbidity. Although both pregestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM) are associated with adverse pregnancy outcomes, women with pre-existing diabetes are exposed to chronic hyperglycaemia from early pregnancy, placing them at greater risk of severe maternal and neonatal complications. However, comparative evidence from low- and middle-income countries remains limited.

Methods

We conducted a retrospective cohort study including all eligible women with diabetes who delivered at Hospital Belén de Trujillo, Peru, between January 2021 and December 2025 (n = 254). Participants were identified through the institutional obstetric database and classified as having PGDM (n = 114) or GDM (n = 140). Maternal outcomes included preeclampsia and preterm birth, whereas perinatal outcomes comprised macrosomia, congenital malformations, post-term pregnancy, and fetal death. Relative risks (RRs) and adjusted relative risks (aRRs) with 95% confidence intervals (CIs) were estimated using generalized linear Poisson regression models with robust variance, adjusting for maternal age, body mass index, parity, and mean maternal glucose concentration. Missing covariate data (<5%) were handled using multiple imputation by chained equations.

Results

Compared with women with GDM, those with PGDM had a significantly higher incidence of preeclampsia (21.9% vs 11.4%; RR 1.92, 95% CI 1.08–3.40). After multivariable adjustment, PGDM remained independently associated with preeclampsia

(aRR 2.05, 95% CI 1.13–3.73; $P = 0.018$) and preterm birth (aRR 1.68, 95% CI 1.01–2.81; $P = 0.047$). Although macrosomia, congenital malformations, post-term pregnancy, and fetal death occurred more frequently in the PGDM group, none of these associations reached statistical significance.

Conclusions

Pregestational diabetes was independently associated with an increased risk of preeclampsia and preterm birth compared with gestational diabetes. These findings underscore the importance of distinguishing diabetes subtype during pregnancy and support comprehensive preconception counselling, optimisation of glycaemic control before conception, and multidisciplinary antenatal care for women with pre-existing diabetes. Large prospective multicentre studies are needed to validate these findings and evaluate strategies to reduce adverse maternal and perinatal outcomes.

Keywords: Pregestational diabetes mellitus; Gestational diabetes mellitus; Pregnancy complications; Preeclampsia; Preterm birth; Maternal morbidity; Perinatal outcomes; Retrospective cohort study.

INTRODUCTION

Diabetes mellitus in pregnancy is one of the most prevalent metabolic disorders affecting maternal and perinatal health worldwide. The increasing prevalence of obesity, delayed childbearing, sedentary lifestyles, and type 2 diabetes has contributed to a steady rise in both pregestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM), making hyperglycaemia during pregnancy an important global public health challenge. According to the International Diabetes Federation, approximately one in six live births is affected by hyperglycaemia during pregnancy, most commonly due to GDM, although the proportion attributable to pre-existing diabetes continues to increase among women of reproductive age [1].

Although both PGDM and GDM are characterised by maternal hyperglycaemia, they differ substantially in their pathophysiology, timing of fetal exposure, and associated maternal and neonatal risks. Women with PGDM enter pregnancy with established metabolic disease and are therefore exposed to chronic hyperglycaemia from conception onwards, whereas GDM usually develops during the second half of pregnancy as physiological insulin resistance increases. Consequently, fetuses of women with PGDM are exposed to hyperglycaemia during critical stages of embryonic and placental development, increasing the risk of congenital malformations, placental dysfunction, hypertensive disorders of pregnancy, fetal overgrowth, and perinatal mortality [2,3].

The adverse effects of maternal hyperglycaemia are mediated through oxidative stress, endothelial dysfunction, chronic inflammation, and abnormal placental vascular development. Glucose freely crosses the placenta, stimulating fetal pancreatic β-cell hyperplasia and hyperinsulinaemia, thereby increasing the risk of macrosomia, neonatal hypoglycaemia, respiratory complications, and admission to neonatal intensive care units. The landmark **Hyperglycemia and Adverse Pregnancy Outcome (HAPO)** study

demonstrated a continuous association between maternal glycaemia and adverse pregnancy outcomes, providing the basis for the diagnostic criteria subsequently adopted by the International Association of Diabetes and Pregnancy Study Groups (IADPSG), the World Health Organization (WHO), and the International Federation of Gynecology and Obstetrics (FIGO) [2,3,6,7].

These biological differences have important clinical implications because the management of PGDM differs substantially from that of GDM. Women with PGDM require preconception counselling, optimisation of glycaemic control before conception, folic acid supplementation, screening for diabetes-related complications, and close multidisciplinary antenatal surveillance. In contrast, GDM is generally diagnosed after 24 weeks of gestation and is frequently managed with lifestyle modification and pharmacological treatment when required [1,3].

Accumulating evidence indicates that PGDM is associated with a greater burden of maternal and neonatal morbidity than GDM. Recent systematic reviews and meta-analyses have consistently reported higher risks of hypertensive disorders, preterm birth, congenital malformations, fetal overgrowth, and perinatal mortality among women with pre-existing diabetes [8,9]. In addition, the increasing prevalence of type 2 diabetes among women of reproductive age has changed the epidemiology of diabetic pregnancies, with type 2 diabetes accounting for an increasing proportion of pregnancies previously dominated by type 1 diabetes [10].

Despite these findings, comparative evidence from low- and middle-income countries remains limited. In Latin America, particularly in Peru, few studies have directly compared maternal and perinatal outcomes according to diabetes subtype. Consequently, clinical decision-making often relies on evidence generated in populations with different

demographic characteristics, healthcare systems, and baseline risks, which may limit the applicability of international recommendations to local practice.

Generating robust local evidence is essential to improve risk stratification, optimise antenatal surveillance, support evidence-based allocation of healthcare resources, and strengthen national clinical guidelines. Therefore, this study aimed to compare maternal and perinatal morbidity between women with pregestational diabetes mellitus and those with gestational diabetes mellitus who delivered at a tertiary referral hospital in northern Peru. We hypothesised that pregnancies complicated by PGDM would be associated with a higher risk of adverse maternal and perinatal outcomes than pregnancies complicated by GDM.

METHODS

Study design and setting

We conducted a retrospective cohort study to compare maternal and perinatal outcomes between women with pregestational diabetes mellitus (PGDM) and those with gestational diabetes mellitus (GDM). The study was reported in accordance with the **Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)** Statement to ensure transparent and comprehensive reporting of the study design, conduct, statistical analyses, and findings [14,15].

The study was carried out at **Hospital Belén de Trujillo**, a tertiary referral teaching hospital in northern Peru that serves as the principal referral centre for high-risk pregnancies in the La Libertad region. The hospital provides specialised multidisciplinary care through maternal–fetal medicine, endocrinology, neonatology, and obstetric critical care services. Clinical information was obtained from women who delivered between **1 January 2021 and 31 December 2025**.

Participants

Eligible participants were identified from the institutional electronic obstetric database and the Hospital Information System, which prospectively record all deliveries and pregnancy-related diagnoses. The database was searched to identify women diagnosed with diabetes during pregnancy who delivered during the study period.

Eligibility was confirmed through a detailed review of antenatal records, delivery registries, and neonatal medical records to verify diabetes classification and ensure compliance with the predefined inclusion and exclusion criteria. All eligible women were consecutively included in the study cohort.

Because this retrospective study included all eligible patients managed during the predefined study period, no formal sample size calculation was performed. Instead, a **census sampling strategy** was adopted, and the study size was determined by the total number of eligible women available for analysis.

Exposure and outcome definitions

The exposure of interest was the type of diabetes during pregnancy.

Pregestational diabetes mellitus (PGDM) was defined as previously diagnosed type 1 diabetes mellitus, type 2 diabetes mellitus, or overt diabetes first identified during early pregnancy according to the **American Diabetes Association (ADA) Standards of Care 2025** and the recommendations of the **International Federation of Gynecology and Obstetrics (FIGO)** for hyperglycaemia in pregnancy [1,5].

Gestational diabetes mellitus (GDM) was defined as glucose intolerance first diagnosed during the second or third trimester in women without evidence of overt diabetes before

pregnancy, according to the recommendations of the **International Association of Diabetes and Pregnancy Study Groups (IADPSG)** and the ADA [1,13].

Women who underwent a **75-g oral glucose tolerance test** between 24 and 28 weeks of gestation were diagnosed with GDM if one or more of the following thresholds were met:

- fasting plasma glucose ≥92 mg/dL;
- 1-hour plasma glucose ≥180 mg/dL; or
- 2-hour plasma glucose ≥153 mg/dL [13].

Women with fasting plasma glucose ≥126 mg/dL, random plasma glucose ≥200 mg/dL accompanied by classic symptoms, or glycated haemoglobin (HbA1c) ≥6.5% were classified as having overt diabetes and were included in the PGDM group according to ADA criteria [1].

The primary maternal outcomes were **preeclampsia** and **preterm birth**. Preeclampsia was defined according to **ACOG Practice Bulletin No. 222**, whereas preterm birth was defined as delivery before **37 completed weeks of gestation** [11].

Primary perinatal outcomes included **macrosomia**, **congenital malformations**, **post-term pregnancy**, and **fetal death**.

Macrosomia was defined as birth weight ≥4000 g [8]. Congenital malformations comprised major structural anomalies diagnosed either prenatally or during the neonatal period [6]. Post-term pregnancy was defined as delivery at or beyond **42 completed weeks of gestation** according to ACOG recommendations [11], whereas fetal death was defined as intrauterine fetal demise occurring after **20 weeks of gestation** according to ACOG criteria [12].

Prespecified covariates included maternal age, body mass index, parity, gestational age at delivery, and mean maternal glucose concentration. These variables were selected a priori based on biological plausibility and previous evidence demonstrating their association with adverse maternal and perinatal outcomes in pregnancies complicated by diabetes [2–4,8,9].

Data collection and quality assurance

Clinical data were retrospectively extracted from maternal medical records, antenatal charts, delivery registries, and neonatal medical records using a standardised data collection form specifically designed for this study.

Before statistical analysis, all records underwent systematic quality control to verify data completeness, internal consistency, and the accuracy of exposure classification and outcome ascertainment. Personal identifiers were removed before construction of the analytical database to ensure complete anonymisation of participant information.

Bias

Several measures were implemented to minimise potential sources of bias.

Selection bias was reduced by adopting a census sampling strategy that included all eligible women meeting the predefined inclusion criteria during the study period.

Information bias was minimised through the use of standardised data abstraction procedures and internationally accepted diagnostic criteria for exposure and outcome classification.

Diabetes subtype and study outcomes were independently verified by trained investigators through review of antenatal records, delivery registries, and neonatal medical records.

Potential confounding was addressed by prespecifying clinically relevant covariates based on biological plausibility and previous evidence and by adjusting multivariable analyses accordingly.

Missing covariate data were handled using multiple imputation by chained equations.

Nevertheless, as with all retrospective observational studies, residual confounding and non-differential misclassification cannot be completely excluded because the analyses relied on routinely collected clinical data.

Statistical analysis

Continuous variables were assessed for normality using the **Shapiro–Wilk test**.

Normally distributed variables are presented as **mean ± standard deviation (SD)** and were compared using **Student's t test**. Variables with non-normal distributions were analysed using the **Mann–Whitney U test**.

Categorical variables are presented as frequencies and percentages and were compared using the **Pearson χ^2 test** or **Fisher's exact test**, as appropriate.

Associations between diabetes subtype and adverse pregnancy outcomes were quantified using **relative risks (RRs)** with corresponding **95% confidence intervals (95% CIs)**.

Adjusted relative risks (aRRs) were estimated using **generalised linear models with a Poisson distribution, log link, and robust variance estimator**.

Multivariable models were adjusted for maternal age, body mass index, parity, and mean maternal glucose concentration. Because gestational age at delivery defines the outcome of preterm birth, it was intentionally excluded from the corresponding regression model to avoid statistical overadjustment.

Medical records with incomplete information regarding diabetes classification or primary outcomes were excluded before analysis.

Missing covariate data (<5%) were assumed to be missing at random and were handled using **multiple imputation by chained equations (MICE)** through the Fully Conditional Specification algorithm implemented in **IBM SPSS Statistics version 29** (IBM Corp., Armonk, NY, USA).

Twenty imputed datasets were generated using ten iterations per imputation.

The imputation model included the exposure variable, all study outcomes, and all prespecified covariates. Parameter estimates were pooled according to **Rubin's rules**.

Statistical significance was defined as a two-sided **P value <0.05**.

No evidence of multicollinearity was observed among the covariates included in the adjusted models. No interaction terms were prespecified or evaluated. Because the proportion of missing data was low, no additional sensitivity analyses were performed.

Ethical considerations

The study was conducted in accordance with the ethical principles of the **Declaration of Helsinki** and the national regulations governing biomedical research involving human participants [16].

The study protocol was approved by the **Institutional Research Ethics Committee of Hospital Belén de Trujillo** (Approval No. **21-2026-HBT**).

Because of the retrospective study design and the exclusive use of anonymised secondary data, the requirement for informed consent was waived by the Ethics Committee.

All data were anonymised before analysis to ensure participant confidentiality.

RESULTS

Study population

Between **1 January 2021 and 31 December 2025**, 286 women with diabetes during pregnancy were identified from the institutional obstetric database. After application of the predefined eligibility criteria, 32 women were excluded, including 8 with multiple pregnancies, 13 with incomplete medical records, 6 with uncertain diabetes classification, and 5 who had been referred exclusively for delivery without receiving antenatal care at the study institution.

The final analytical cohort comprised **254 women**, including **114 (44.9%) with pregestational diabetes mellitus (PGDM)** and **140 (55.1%) with gestational diabetes mellitus (GDM)**.

Missing data accounted for less than 5% of the prespecified covariates and were handled using multiple imputation by chained equations before multivariable analyses. Pooled estimates were subsequently obtained according to Rubin's rules.

The participant selection process is presented in **Figure 1**.

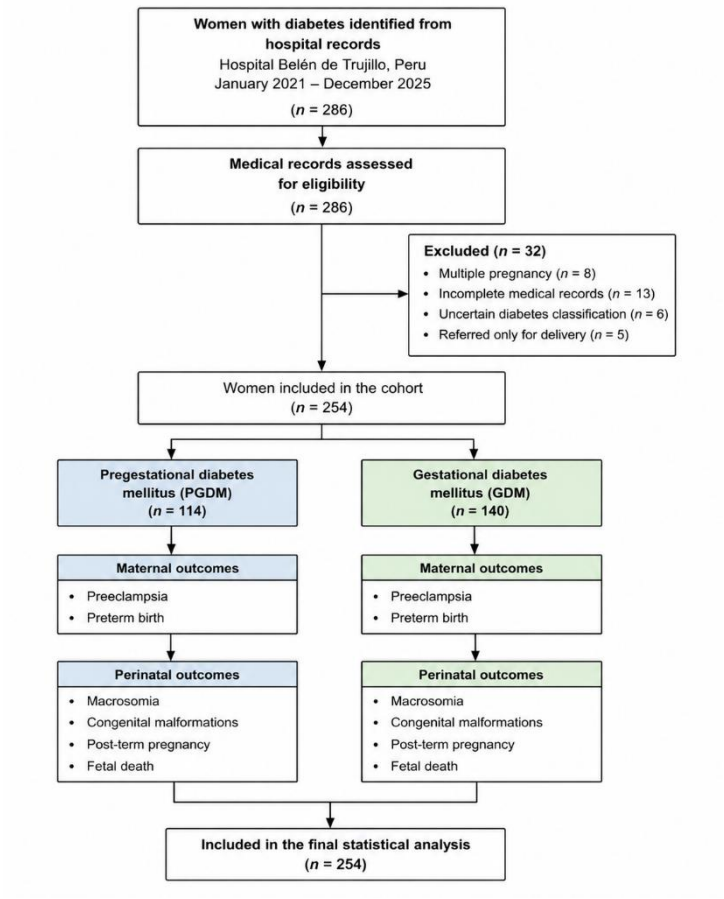


Figure 1. Flow diagram illustrating participant identification, eligibility assessment, exclusions, and final cohort selection. Hospital Belén de Trujillo, Peru, between January 2021 and December 2025

Baseline maternal and obstetric characteristics

Baseline maternal and obstetric characteristics are summarised in **Table 1**.

Compared with women with GDM, those with PGDM were slightly older (32 ± 4 vs 31 ± 2 years; $P = 0.016$) and had a higher mean body mass index (31 ± 2 vs 30 ± 1 kg/m²; $P < 0.001$).

Pregnancies complicated by PGDM resulted in earlier delivery than those complicated by GDM (35 ± 2 vs 37 ± 1 weeks; $P < 0.001$).

Parity distribution did not differ significantly between the two groups.

Women with PGDM also had higher mean maternal glucose concentrations (147.9 ± 56.5 vs 119.5 ± 36.8 mg/dL; $P = 0.007$) and a greater mean previous neonatal birth weight (3695 ± 100 vs 3533 ± 150 g; $P < 0.001$).

Overall, the PGDM group exhibited a less favourable baseline metabolic profile than the GDM group.

Table 1. Baseline maternal and obstetric characteristics according to diabetes subtype

Characteristic, mean ± SD or n (%)	Pregestational diabetes (n = 114)	Gestational diabetes (n = 140)	P value
Maternal age (years), mean ± SD	**32 ± 4**	**31 ± 2**	**0.016**
Body mass index (kg/m²), mean ± SD	**31 ± 2**	**30 ± 1**	**<0.001**
Nulliparity, n (%)	**28 (24.6)**	**32 (22.9)**	**0.750**
Multiparity, n (%)	**32 (28.1)**	**48 (34.3)**	**0.289**
Gestational age at delivery (weeks), mean ± SD	**35 ± 2**	**37 ± 1**	**<0.001**
Mean maternal glucose (mg/dL), mean ± SD	**147.9 ± 56.5**	**119.5 ± 36.8**	**0.007**
Previous neonatal birth weight (g), mean ± SD	**3695 ± 100**	**3533 ± 150**	**<0.001**

Abbreviations: SD, standard deviation.

Footnote. Continuous variables are presented as mean ± standard deviation (SD) and categorical variables as n (%). Continuous variables were compared using Student's t test or the Mann–Whitney U test, as appropriate. Categorical variables were compared using Pearson's χ^2 test or Fisher's exact test, as appropriate. Statistically significant P values are shown in bold.

Maternal and perinatal outcomes

Maternal and perinatal outcomes are presented in **Table 2**.

Women with PGDM experienced a significantly higher incidence of preeclampsia than women with GDM (21.9% vs 11.4%; RR 1.92, 95% CI 1.08–3.40; $P = 0.023$).

Preterm birth also occurred more frequently in the PGDM group (25.4% vs 15.7%; RR 1.62, 95% CI 0.99–2.66), although the association did not reach conventional statistical significance ($P = 0.053$).

Across all evaluated perinatal outcomes, pregnancies complicated by PGDM consistently showed higher event frequencies than those complicated by GDM. However, none of these differences reached statistical significance.

Macrosomia occurred in **14.0%** of pregnancies among women with PGDM compared with **10.7%** among women with GDM (RR 1.31, 95% CI 0.68–2.52; $P = 0.410$).

Congenital malformations were also more common in the PGDM group (8.8% vs 3.6%), corresponding to an estimated RR of 2.46 (95% CI 0.87–6.98). Although the point estimate suggested an increased risk, the association was not statistically significant ($P = 0.074$).

Similarly, post-term pregnancy (3.5% vs 1.4%; RR 2.46, 95% CI 0.46–13.12; $P = 0.260$) and fetal death (2.6% vs 0.7%; RR 3.68, 95% CI 0.39–34.78; $P = 0.330$) occurred more frequently among women with PGDM, although these differences were likewise not statistically significant.

Overall, pregnancies complicated by PGDM demonstrated a consistent pattern of increased maternal and perinatal risk compared with pregnancies complicated by GDM.

Statistically significant differences were observed only for preeclampsia, whereas preterm birth showed a borderline association.

Table 2. Crude associations between diabetes subtype and adverse maternal and perinatal outcomes

Outcome	**Crude RR (95% CI)**	**P value**
Maternal outcomes		
Preeclampsia	1.92 (1.08–3.40)	0.023
Preterm birth	1.62 (0.99–2.66)	0.053
Perinatal outcomes		
Macrosomia	1.31 (0.68–2.52)	0.410
Congenital malformations	2.46 (0.87–6.98)	0.074
Post-term pregnancy	2.46 (0.46–13.12)	0.260
Fetal death	3.68 (0.39–34.78)	0.330

Abbreviations: CI, confidence interval; RR, relative risk.

Note. Unadjusted relative risks (RRs) were calculated using women with gestational diabetes mellitus as the reference group. Categorical variables were compared using Pearson's χ^2 test or Fisher's exact test, as appropriate. Statistically significant P values are shown in bold.

Multivariable analysis

Results of the multivariable analyses are presented in **Table 3**.

After adjustment for maternal age, body mass index, parity, and mean maternal glucose concentration, PGDM remained independently associated with an increased risk of preeclampsia (adjusted RR 2.05, 95% CI 1.13–3.73; $P = 0.018$).

Similarly, PGDM remained independently associated with preterm birth (adjusted RR 1.68, 95% CI 1.01–2.81; $P = 0.047$).

No statistically significant adjusted associations were identified between PGDM and the evaluated perinatal outcomes, including macrosomia, congenital malformations, post-term pregnancy, and fetal death.

Table 3. Adjusted associations between diabetes subtype and adverse maternal and perinatal outcomes

Outcome	Adjusted RR (95% CI)*	P value
Maternal outcomes		
Preeclampsia	2.05 (1.13–3.73)	0.018
Preterm birth	1.68 (1.01–2.81)	0.047
Perinatal outcomes		
Macrosomia	1.24 (0.66–2.36)	0.490
Congenital malformations	2.18 (0.82–5.81)	0.120
Post-term pregnancy	2.11 (0.39–11.40)	0.380
Fetal death	3.21 (0.34–31.60)	0.310

Abbreviations: CI, confidence interval; RR, relative risk.

*Adjusted relative risks were estimated using generalized linear models with a Poisson distribution, log link, and robust variance estimator. Models were adjusted for maternal age, body mass index, parity, and mean maternal glucose concentration. For the model evaluating preterm birth, gestational age at delivery was not included because it constitutes the outcome definition.

DISCUSSION

Principal findings

In this retrospective cohort study conducted at a tertiary referral hospital in Peru, pregnancies complicated by pregestational diabetes mellitus (PGDM) were associated with a significantly higher risk of adverse maternal outcomes than those complicated by gestational diabetes mellitus (GDM). After adjustment for clinically relevant maternal characteristics, PGDM remained independently associated with preeclampsia and preterm birth. Although pregnancies in the PGDM group also showed higher frequencies of macrosomia, congenital malformations, post-term pregnancy, and fetal death, these associations did not reach statistical significance.

These findings support the concept that the timing and duration of maternal hyperglycaemia are key determinants of pregnancy outcomes. Because women with PGDM are exposed to chronic hyperglycaemia from conception, both embryonic and placental development occur in an adverse metabolic environment, providing a plausible biological explanation for the greater burden of maternal complications observed compared with GDM.

Comparison with previous studies

Our findings are consistent with previous international evidence showing that PGDM confers a substantially greater risk of pregnancy complications than GDM. Systematic reviews and meta-analyses have consistently reported increased risks of hypertensive disorders, preterm birth, congenital anomalies, fetal overgrowth, and perinatal mortality among women with pre-existing diabetes [3,4,8,9].

The independent association between PGDM and preeclampsia observed in our cohort is biologically plausible and agrees with previous reports. Endothelial dysfunction,

oxidative stress, chronic inflammation, impaired angiogenesis, and abnormal placentation are recognised mechanisms linking pre-existing diabetes with hypertensive disorders of pregnancy [7,9].

Similarly, the higher risk of preterm birth is consistent with previous studies reporting increased rates of medically indicated preterm delivery among women with PGDM because of maternal complications, suboptimal glycaemic control, fetal growth abnormalities, or concerns regarding fetal wellbeing [10]. Although the confidence interval was close to the null value, the consistency of our findings with previous evidence supports the clinical relevance of this association.

Congenital malformations and macrosomia also occurred more frequently among women with PGDM, although statistical significance was not reached. The direction of these associations is consistent with established biological mechanisms linking chronic maternal hyperglycaemia during organogenesis with fetal structural anomalies and prolonged fetal hyperinsulinaemia with excessive fetal growth [2,6]. The lack of statistical significance probably reflects the relatively small number of events.

Clinical implications

These findings highlight the importance of distinguishing between PGDM and GDM during antenatal care, as both conditions differ substantially in maternal risk profile and clinical management.

Women with PGDM require comprehensive preconception counselling, optimisation of glycaemic control before conception, early fetal assessment, screening for diabetes-related complications, and multidisciplinary antenatal care. In settings where specialised maternal–fetal medicine services are limited, identifying women at highest risk may facilitate more appropriate surveillance and resource allocation. The present findings also

provide locally generated evidence that may support future updates of national clinical guidelines for diabetes during pregnancy.

Strengths and limitations

This study has several strengths. It provides contemporary comparative evidence from a tertiary referral hospital in Peru, where direct comparisons between PGDM and GDM remain scarce. The use of a census sampling strategy reduced selection bias by including all eligible women during the study period. Furthermore, internationally recognised diagnostic criteria were used to define both exposure and outcomes, improving comparability with previous studies. Finally, robust Poisson regression and multiple imputation strengthened the validity of the adjusted estimates.

Several limitations should also be acknowledged. First, the retrospective observational design precludes causal inference and relies on the accuracy and completeness of routinely collected clinical records. Second, residual confounding from unmeasured variables cannot be excluded despite multiple imputation. Third, clinically relevant variables—including glycated haemoglobin (HbA1c), diabetes duration, gestational weight gain, treatment modality, treatment adherence, glycaemic variability, and socioeconomic characteristics—were unavailable for adjustment. Fourth, women with type 1 and type 2 diabetes were analysed together within the PGDM group, preventing subtype-specific analyses. Finally, the relatively small number of congenital malformations and fetal deaths reduced statistical power for these outcomes, increasing the possibility of type II error. Consequently, the absence of statistically significant associations should be interpreted cautiously. In addition, because the study was conducted at a single tertiary referral hospital, the findings may not be generalisable to other healthcare settings.

Future research

Future prospective multicentre studies should evaluate the differential effects of PGDM and GDM using more detailed measures of glycaemic control, diabetes duration, treatment strategies, and long-term maternal and neonatal outcomes. Such studies would strengthen the evidence base for personalised risk stratification and management of diabetes during pregnancy.

Conclusions

Pregestational diabetes mellitus was independently associated with an increased risk of preeclampsia and preterm birth compared with gestational diabetes mellitus. These findings highlight the greater obstetric vulnerability associated with diabetes present before conception and reinforce the importance of distinguishing diabetes subtype during antenatal care.

Comprehensive preconception counselling, optimisation of glycaemic control before conception, and multidisciplinary antenatal management may contribute to reducing adverse maternal and perinatal outcomes among women with pre-existing diabetes.

Further prospective multicentre studies are needed to confirm these findings, clarify the mechanisms underlying adverse pregnancy outcomes, and identify effective strategies to improve maternal and neonatal health.

DECLARATIONS

Ethics approval and consent to participate

The study was approved by the **Institutional Research Ethics Committee of Hospital Belén de Trujillo, Peru** (Approval No. **21-2026-HBT**).

The study was conducted in accordance with the ethical principles of the **Declaration of Helsinki** and applicable national regulations governing biomedical research involving human participants.

Because of the retrospective study design and the exclusive use of anonymised secondary clinical data, the requirement for informed consent was waived by the Ethics Committee.

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available because they contain confidential patient information.

However, anonymised data may be made available by the corresponding author upon reasonable request and with approval from Hospital Belén de Trujillo, in accordance with institutional policies and ethical requirements.

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Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

CMAS conceived the study, designed the research protocol, interpreted the findings, and drafted the manuscript.

LECC contributed to study design, supervised the research process, and critically revised the manuscript for important intellectual content.

JEVA performed the statistical analyses and contributed to data interpretation.

ZHAH and **KYLP** collected, verified, and curated the clinical data.

CPLR, **MSLR**, and **DPAC** contributed to interpretation of the results, critically revised the manuscript, and approved the final version.

All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

ABBREVIATIONS

Abbreviation	Definition
PGDM	Pregestational diabetes mellitus
GDM	Gestational diabetes mellitus
RR	Relative risk
aRR	Adjusted relative risk
CI	Confidence interval
BMI	Body mass index

Abbreviation Definition

SD	Standard deviation
ADA	American Diabetes Association
ACOG	American College of Obstetricians and Gynecologists
FIGO	International Federation of Gynecology and Obstetrics
WHO	World Health Organization
IADPSG	International Association of Diabetes and Pregnancy Study Groups
HAPO	Hyperglycemia and Adverse Pregnancy Outcome

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