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Prevalence of gestational diabetes and identification of associated factors and maternal-perinatal outcomes in Colombia following the implementation of the IADPSG criteria

Prevalencia de diabetes gestacional e identificación de factores y resultados materno-perinatales asociados en Colombia, tras la implementación de los criterios de la IADPSG

Socorro Andrea España-Dorado[1] **Yenny Cristina González-Dagua**[1] **John Jairo Riascos-Melo**[1] **Roberth Alirio Ortiz-Martínez**[1] **José Enrique Chagüendo-García**[1]

[1] Universidad del Cauca - Faculty of Health Sciences - Gynecology and Obstetrics Department - Popayán - Colombia.
Corresponding author: Roberth Alirio Ortiz-Martínez. Departamento de Ginecología y Obstetricia, Facultad de Ciencias de la Salud, Universidad del Cauca. Popayán. Colombia. Email: roberthnico@gmail.com.

Abstract

Introduction: Timely diagnosis and treatment of gestational diabetes (GD), as well as adequate control of associated risk factors, allows reducing its negative impact on maternal and perinatal health.
Objectives: To determine the prevalence of GD in a tertiary care hospital in Colombia and identify the risk factors associated with this condition, as well as the maternal-perinatal outcomes in this population, following the implementation of the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria.
Materials and methods: Cross-sectional study in which a secondary data analysis was carried out. By means of consecutive sampling, 533 pregnant women with GD who gave birth at the Hospital Universitario San José in Popayán, Colombia, between July 2017 and March 2018, were included. Social, biological, and psychological variables were analyzed. To identify risk factors and associated maternal-perinatal outcomes, the Odds Ratio was used as a measure of association (CI:95%). In addition, a multivariate analysis was performed to control for confounding factors.
Results: The prevalence of GD was 16.32% (95%CI:13.28-19.73). The following risk factors associated with GD were identified: age >35 (OR=2.26; 95%CI:1.23-4.14), indigenous race (OR=6.60; 95%CI:1.17-37.15), BMI >25 (OR=2. 26; 95%CI:1.23-4.14), history of fetal macrosomia (OR=10.07; 95%CI: 1.50-67.34), and family history of diabetes mellitus (OR=3.17; 95%CI:1.39-7.22). Regarding maternal-perinatal outcomes, a significant association was found with labor induction (OR=4.41; 95%CI:1.71-11.39), emergency cesarean section (OR=2.22; 95%CI:1.33-3.73), elective cesarean section (OR=2.79; 95%CI:1.51-5.18), fetal weight >90th percentile (OR=2.78; 95%CI:1.29-5.98), and neonatal hospitalization (OR=8.1; 95%CI:4.48-18.62).
Conclusions: The prevalence of GD reported here is higher than the prevalence described in other studies conducted in Colombia, but similar to most studies that have followed the IADPSG criteria. Likewise, risk factors and maternal-perinatal outcomes that had a statistically significant association with GD here are similar to those described in most of the studies that were consulted.
Keywords: Gestational Diabetes; Prevalence; Risk; Maternal Health (MeSH).

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Resumen

Introducción. El diagnóstico y manejo oportuno de la diabetes gestacional (DG) y el adecuado control de factores de riesgo asociados permiten disminuir su impacto negativo en la salud materna y perinatal.
Objetivos. Determinar la prevalencia de DG en un hospital de tercer nivel de Colombia e identificar los factores asociados a esta condición, así como los resultados materno-perinatales en esta población, tras la implementación de los criterios de la Asociación Internacional de Grupos de Estudio de Diabetes y Embarazo (IADPSG).
Materiales y métodos. Estudio transversal en el que se realizó un análisis de datos secundarios. Mediante muestreo consecutivo se incluyeron 533 gestantes con reporte de prueba diagnóstica de DG y que dieron a luz en el Hospital Universitario San José de Popayán, Colombia, entre julio de 2017 y marzo de 2018. Se analizaron variables sociales, biológicas y psicológicas. Para la identificación de los factores y resultados materno-perinatales asociados se utilizó el Odds Ratio como medida de asociación (IC: 95%). Además, se realizó un análisis multivariado para controlar las variables de confusión.
Resultados. La prevalencia de DG fue del 16.32% (IC95%:13.28-19.73). Se identificaron los siguientes factores asociados a DG: edad >35 (OR=2.26; IC95%: 1.23-4.14), raza indígena (OR=6.60; IC95%: 1.17-37.15), IMC preconcepcional >25 (OR=2.26; IC95%: 1.23-4.14), antecedente de feto macrosómico (OR=10.07; IC95%: 1.50-67.34) y antecedente familiar de diabetes *mellitus* (OR=3.17; IC95%: 1.39-7.22). Respecto a los resultados materno-perinatales, se encontró una asociación significativa con inducción del trabajo de parto (OR=4.41; IC95%: 1.71-11.39), cesárea de urgencia (OR=2.22; IC95%: 1.33-3.73) y electiva (OR=2.79; IC95%: 1.51-5.18), macrosomia por percentil >90 (OR=2.78; IC95%: 1.29-5.98) y hospitalización neonatal (OR=8.1; IC95%: 4.48-18.62).
Conclusiones. La prevalencia de DG en el presente estudio es mayor a la reportada en investigaciones realizadas en Colombia, pero similar a la descrita en la mayoría de estudios que han seguido los criterios de la IADPSG. Los factores y los resultados maternos-perinatales en los que se observó una asociación estadísticamente significativa con la DG son similares a los reportados en la mayoría de la literatura consultada.
Palabras clave: Diabetes gestacional; Prevalencia; Riesgo; Salud materna (DeCS).

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Introduction

Gestational diabetes (GD) is defined as a carbohydrate intolerance with onset or first recognition during pregnancy; this is the most common metabolic disorder in pregnant women.[1]

The prevalence of GD ranges between 1.4-2.8% in low-risk populations and 20-25% in high-risk populations.[2-12] It should be noted that the prevalence of this condition also varies depending on the criteria used to diagnose it. For example, in Bangladesh, Jesmin *et al.*[4] reported that it is 9.7% when using the World Health Organization criteria and 12.9% with the American Diabetes Association (ADA) criteria.

Multiple studies around the world have established the prevalence of GD and found that it is 14% in China;[5] 10.1% in East and South Asia;[6] 2.6% in Sweden;[7] 7.6% in the USA;[8] and 23.7% in Mexico.[9] In South America, Chile reports prevalence rates ranging from 3.18% to 11.2%,[10] and in Colombia the figures are lower, ranging from 0.34% to 2.03%.[11,12]

Given this variability in the results, Brown & Wyckoff[13] performed a review aimed at determining changes in GD prevalence using the one-step screening test for GD, that is, the criteria of the International Association of Diabetes and Pregnancy Study Groups (IADPSG), or the two-step test. They found that studies demonstrate a 1.03- to 3.78-fold increase when using the IADPSG criteria.

The diagnosis of GD has varied over time. In 2008, the IADPSG recommended that pregnant women who met criteria for diagnosis with diabetes at their first follow-up appointment and were classified as being at high risk for developing this disease should be considered non-gestational diabetic patients.[14] Then, in 2011, the ADA took into account the IADPSG criteria and recommended the oral glucose tolerance test (OGTT) with a load of 75g between weeks 24 and 28,[14,15] and currently supports both one-step and two-step diagnostic tests as appropriate for the diagnosis of GD.[15] In Colombia, the used approach involves the one-step test.[16]

In the HAPO study, an OGTT was performed to pregnant women between 24 and 32 weeks with a load of 75g, showing that the risk of adverse maternal-perinatal outcomes increased based on blood glucose levels, even for ranges previously considered normal, and that those outcomes were also associated with large-for-gestational-age newborns (birth weight >90th percentile), need for primary cesarean section, neonatal hypoglycemia, and C-peptide in blood serum >90th percentile in the umbilical cord.[3]

Other studies have shown the relationship between high levels of glycemia and prematurity, shoulder dystocia, increased need for neonatal intensive care, hyperbilirubinemia, preeclampsia, neonatal hypoglycemia, and newborn respiratory distress syndrome, and also reported that they may cause heart disease and predisposition to type 2 diabetes, obesity and metabolic syndrome in the mother.[17-27]

Another relevant aspect to consider regarding elevated glycemia levels in pregnant women is long-term risks. On this topic, Bellamy *et al.*,[28] through a meta-analysis, concluded that women with GD have an increased risk of developing type 2 diabetes (relative risk: 7.43; 95%CI: 4.79-11.51) compared to pregnant women with normal levels. However, Ratner *et al.*[29] stated that this progression to type 2 diabetes can be reduced with lifestyle modification programs and metformin therapy in the postpartum period.

Similarly, in different studies GD is associated with several risk factors such as a previous history of GD (OR=3.00; 95%CI: 1.73-5.19), family history of diabetes *mellitus* (OR=0.71: 95%CI: 0.48-1.06), overweight (OR=1.02; 95%CI: 0.97-1.07) and pregestational obesity (OR=1.06; 95%CI: 1.02-1.11).[18,24-27]

The need to carry out the present study stems from a lack of knowledge of the prevalence of GD in the region, the increase in obesity rates globally, and the fact that the complications in pregnant women due to this condition are severe. As a result, the objectives of the study were to determine the prevalence of GD in a tertiary care hospital in Colombia and to identify the factors associated with this condition, as well as the maternal-perinatal outcomes in this population, following the implementation of the IADPSG criteria to close the knowledge gap and establish preventive measures.

Materials and methods

Study type and population

Cross-sectional study in which a secondary data analysis was performed. Pregnant women with reported GD diagnostic test in their medical records and who gave birth at the Hospital Universitario San José Empresa Social del Estado de Popayán (HUSJ) between July 1, 2017, and March 5, 2018, were included. Patients whose medical records were incomplete or with data loss >20% were excluded.

Sample size was calculated taking into account the number of live births in the hospital the year immediately prior to the study (n=1 970 for 2016) with an expected GD frequency of 15%,[1-11] a tolerated margin of error of 3%, and a confidence level of 95%. The formula $n=PxQ/(E/Z)^2$ was used, thus obtaining a sample size of 533 pregnant women. Participants were recruited using consecutive sampling.

It is worth mentioning that the HUSJ is a highly complex institution (tertiary, level of care) and a reference center in the department of Cauca and the south-west of Colombia, which serves the population of both the contributory and the subsidized health scheme.

Procedures

Data were collected using a semi-structured instrument developed by the researchers for this purpose, which was reviewed by experts (professors from the Department of Gynecology and Obstetrics of the Universidad del Cauca) and adjusted through a pilot test carried out between May and June 2017 with 20 participants.

Subsequently, data were entered in a spreadsheet created in Microsoft Excel and, to ensure quality, an entry control was performed using validation rules. Finally, the database was entered into Stata V10.0 and the final analysis was made considering the following variables:

Social: type of residence (urban or rural), type of relationship with the partner (stable and non-stable; the first group included the mothers who had a

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couple, were married or in a domestic partnership, and the second group included the remaining pregnant women), educational attainment (at the time of the analyzed pregnancy), race, occupation, type of affiliation to the health system (contributory or subsidized scheme), socioeconomic status (low and middle), preconception care, adequate antenatal care (≥4 total visits and initiation of follow-up in the first trimester) and psychoprophylaxis course attendance (childbirth preparation course).
Psychological: planning for current pregnancy, alcohol or psychoactive substance use, and passive smoking.
Biological: age; preconception body mass index (BMI); history of GD, fetal macrosomia, endocrinopathy (thyroid disease) or hypertensive disease of pregnancy; first-degree relative with diabetes *mellitus*; gestational age at delivery; delivery method; health status of the newborn at birth; composite neonatal adverse outcome (necrotizing enterocolitis, intraventricular hemorrhage, neonatal sepsis, bronchopulmonary dysplasia, perinatal asphyxia, APGAR score <7, hypoglycemia, jaundice, polyglobulia, and newborn respiratory distress syndrome); intrauterine growth restriction; hospitalized neonate; diabetic fetopathy; composite maternal adverse outcome (hypertensive disorder of pregnancy, premature delivery, chorioamnionitis, premature rupture of membranes, and injury to the birth canal); obstetric history (which summarizes obstetric history in one line); labor onset (spontaneous or induced emergency cesarean section); and indication of cesarean section.

Statistical analysis

The prevalence of GD was determined by taking into account the total number of pregnant women with a positive GD test as numerator and the total number of pregnant women analyzed in whom the diagnostic test for GD was performed, that is, with both positive and negative results, as denominator.

The results obtained with both the one-step and the two-step diagnostic tests were considered to establish the diagnosis of GD. However, it should be noted that the results were obtained with the one-step GD screening test in the majority (97.93%) of patients.

The one-step test is recommended by the Colombian Ministry of Health and Social Protection and establishes that all pregnant women should be tested with a 75g-load OGTT test between week 24 and 28 of pregnancy, taking into account the following normal values: baseline: <92 mg/dL, 1 hour: <180 mg/dL, 2 hours: <153 mg/dL. Pregnant women with altered results were diagnosed with GD using this test.[16]

The two-step test, on the other hand, is based on a first screening in which an oral glucose solution with a load of 50g is administered between weeks 24 and 28, followed by a measurement of blood glucose levels one hour later. After this, pregnant women with levels >140 mg/dL receive another glucose solution with a load of 100g and then, fasting blood glucose levels and one-, two- and three-hour post-load blood glucose levels are measured with limit values of 95 mg/dL, 180 mg/dL, 155 mg/dL and 140mg/dL, respectively; pregnant women with two or more altered values were diagnosed with GD using this test.[1]

For the descriptive analysis of the data, absolute frequencies and percentages were used for categorical variables, and means and standard deviation for quantitative variables. Student's t-test was used for continuous variables with normal distribution (determined with the Shapiro-Wilk test) after analyzing variance, and the Mann-Whitney U test for variables with non-normal distribution. On the other hand, Chi-square or Fisher's exact tests were used for categorical variables, as appropriate. Continuous variables were categorized into groups, for example, age, to be entered into logistic regression analyses.

An individual exploratory analysis of all variables was performed to evaluate the normality of their distribution and to identify extreme or missing values that could influence the result; then, the pregnant women with GD were compared with those without GD. Odds Ratio (OR) with a 95% confidence interval (CI) was used as an association measure.

Subsequently, a multivariate analysis was performed using a logistic regression model to control for confounding variables and establish the possible factors associated with the onset of GD. The stepwise regression method was used with an input probability of 0.20 and exit probability of 0.05. The selection of the variables included in the multivariate analysis was made considering both statistical and clinical criteria for the selection of variables. The final model of the multivariate analysis was evaluated using the Hosmer-Lemeshow test and it was established that the test had a good fit.

Ethical considerations

The study took into account the ethical principles for medical research involving human subjects established by the Declaration of Helsinki[30] and the scientific, technical and administrative standards for health research of Resolution 8430 of 1993 of the Colombian Ministry of Health.[31] This research was approved by the Ethics Committee of the HUSJ according to Minutes 4 of June 7, 2017, and the participants signed an informed consent before enrolling in the study.

Results

The prevalence of GD was 16.32% (95%CI: 13.28-19.73). The average age of the participants was 26 years (±7.1 years), and it was established that of those who presented GD (n=87), 74.71% were mestizo, 19.54% indigenous, and 5.75% black.

Of the total number of participants, 57.97% came from an urban area, 83.11% had a low socioeconomic status, 68.29% were enrolled in the subsidized health scheme, 66.60% were housewives, 69.04% had 10 or more years of schooling, 66.79% had a stable relationship with their partner, and 49.34% had between 1 and 3 pregnancies and 7.60% had 4 or more pregnancies. Similarly, it was established that between 95.50% and 99.60% of patients did not attend antenatal consultations, did not use alcohol while pregnant, and were not passive smokers. 93.43% had 4 or more antenatal consultations. It was also found that 51.97% had presented GD in previous pregnancies and that between 3.30% and 6.60% had a history of endocrinopathies, hypertensive disorder and relatives with diabetes *mellitus*.

Regarding the type of test used to diagnose GD, it was found that the one-step test was used in 97.93% (n=522) of the cases. The most frequently altered

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value in diabetic pregnant women was pre-prandial blood glucose levels in 54 cases (62.06%). Of the 87 participants with GD, 53 (60.91%) controlled the condition with lifestyle changes only (diet and exercise), 20 (22.98%) required oral hypoglycemic medications, and 1 (1.40) needed insulin treatment; the remaining 13 (14.94) received other type of management.

In 13 (14.94%) pregnant women, an altered diagnostic test for GD (both one-step and two-step) was reported in the second trimester; however, they were only diagnosed with the disease at the time of delivery. In addition, 19 (21.83%) of the patients diagnosed with GD required hospitalization during pregnancy for management.

When analyzing baseline —social, biological, and psychological— variables, which could be factors associated with the development or not of GD, it was found that age, marital status, type of health system affiliation, race, gravidity, having had at least one delivery previously, history of stillbirth and fetal macrosomia, preconception BMI, and family history of diabetes *mellitus* were statistically significant (Tables 1 and 2).

The logistic regression analysis found that the variables age over 35 years, indigenous race, having at least one previous delivery, history of stillbirth, altered preconception BMI, history of fetal macrosomia and family history of diabetes *mellitus* were positively associated with the development of GD (Table 3).

Table 1. Social characteristics of the study population at baseline.

Characteristics		Non-gestational diabetes (n=446)	Gestational diabetes (n=87)	p
Age (years)	20-34	296 (66.36)	47 (54.02)	0.00
	<20 years	88 (19.73)	10 (11.50)	
	≥35	62 (13.90)	30 (34.48)	
Type of relationship with the partner	Stable	290 (65.02)	66 (75.86)	0.04
	Not stable	156 (34.98)	21 (24.14)	
Type of affiliation to the health system	Contributory	149 (33.41)	20 (22.99)	0.05
	Subsidized	297 (66.59)	67 (77.01)	
Type of residence	Urban	263 (58.97)	46 (52.87)	0.29
	Rural	183 (41.03)	41 (47.13)	
Education	≥10 years	312 (66.96)	56 (64.37)	0.30
	<9 years	134 (30.04)	31 (35.63)	
Race	Mestizo	382 (85.65)	65 (74.71)	0.03
	Indigenous	46 (10.31)	17 (19.54)	
	Black	18 (4.04)	5 (5.75)	
Socioeconomic status	Middle	78 (17.49)	12 (13.79)	0.40
	Low	368 (82.51)	75 (86.21)	

Source: Own elaboration.

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Table 2. Biological and psychological characteristics of the study population at baseline.

Characteristics		Non-gestational diabetes (n=446)	Gestational diabetes (n=87)	p
Pregnancy	Nulliparous	202 (45.29)	30 (34.48)	0.03
	1- 3 pregnancies	216 (48.43)	47 (54.02)	
	≥4 pregnancies	28 (6.28)	10 (11.49)	
Births	None	294 (65.92)	45 (51.72)	0.01
	At least 1	152 (34.08)	42 (48.28)	
Previous cesarean sections	No	380 (85.20)	72 (82.76)	0.56
	Yes	66 (14.80)	15 (17.24)	
Abortions	None	362 (81.17)	73 (83.91)	0.42
	1	72 (16.14)	11 (12.64)	
	≥2	12 (2.69)	3 (3.45)	
Stillbirth	No	438 (98.21)	82 (94.25)	0.02
	Yes	8 (1.79)	5 (5.75)	
Adequate antenatal care	Yes	333 (74.66)	58 (66.67)	0.12
	No	113 (25.34)	29 (33.33)	
Preconception care	Yes	19 (4.26)	5 (5.75)	0.54
	No	427 (95.74)	82 (94.25)	
Alcohol use	No	435 (97.53)	83 (95.40)	0.27
	Yes	11 (2.47)	4 (4.60)	
Passive smoking	No	4.14 (92.83)	83 (95.40)	0.38
	Yes	32 (7.17)	4 (4.60)	
Use of psychoactive substances	No	445 (99.78)	87 (100)	NA
	Yes	1 (0.22)	0 (0)	
Psychopropvhylactic course	Yes	26 (5.83)	2 (2.30)	0.17
	No	420 (94.17)	85 (97.70)	
Planned pregnancy	Yes	48 (10.76)	7 (8.05)	0.44
	No	398 (89.24)	80 (91.95)	
History of gestational diabetes *	No	212 (99.53)	53 (98.15)	0.29
	Yes	1 (0.47)	1 (1.85)	
History of polycystic ovary	No	440 (98.65)	84 (96.55)	0.16
	Yes	6 (1.35)	3 (3.45)	
Gestational age	Full term	401 (89.91)	78 (89.66)	0.45
	34- 36.6 weeks	37 (8.30)	5 (5.75)	
Preconception body mass index	<25	285 (63.90)	34 (39.08)	<0.001
	25.1-29.9	129 (28.92)	41 (47.13)	
	>30	32 (7.17)	12 (3.79)	
History of fetal macrosomia *	No	210 (98.59)	50 (92.59)	0.01
	Yes	3 (1.41)	4 (7.41)	
History of endocrinopathy	No	432 (96.86)	83 (95.40)	0.49
	Yes	14 (3.14)	4 (4.60)	
History of hypertensive disorder of pregnancy *	No	192 (90.14)	46 (85.19)	0.29
	Yes	21 (9.86)	8 (9.20)	
Family history of diabetes mellitus	No	426 (95.52)	71 (81.61)	0.00
	Yes	20 (4.48)	16 (18.39)	

* These variables included only pregnant women who had had at least a previous viable pregnancy.
Source: Own elaboration.

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Table 3. Logistic regression analysis of the study population.

Possible factors associated with the development of gestational diabetes		OR	95%CI
Average age	20- 34 years	Ref.	
	<20 years	0.71	0.34-1.47
	≥35 years	3.04	1.78-5.19
The type of relationship with the partner	Stable	Ref.	
	Not stable	0.59	0.34-1.00
Type of affiliation to the health system	Contributory	Ref.	
	Subsidized	1.68	0.98-2.87
Type of residence	Urban	Ref.	
	Rural	1.28	0.80-2.03
Education	≥10 years	Ref.	
	<9 years	0.77	0.47-1.25
Race	Mestizo	Ref.	
	Indigenous	2.17	1.17-4.01
	Black	1.63	0.58-4.55
Socioeconomic status	Middle	Ref.	
	Low	0.75	0.39-1.45
Births	None	Ref.	
	At least 1	1.8	1.13-2.87
Previous cesarean sections	No	Ref.	
	Yes	1.19	0.64-2.21
Abortions	None	Ref.	
	1	0.75	0.38-1.49
	≥2	1.23	0.34-4.50
History of stillbirths	No	Ref.	
	Yes	3.33	1.06-11.8
Adequate antenatal care	Yes	Ref.	
	No	1.47	0.89-2.41
Preconception care	Yes	Ref.	
	No	0.72	0.26-2.00
Alcohol use	No	Ref.	
	Yes	1.9	0.59-6.12
Passive smoking	No	Ref.	
	Yes	0.62	0.21-1.81
Use of psychoactive substances	No	Ref.	
	Yes	Not applicable	
Psychoprophylactic course	Yes	Ref.	
	No	2.63	0.61-11.29
Planned pregnancy	Yes	Ref.	
	No	1.37	0.60-3.15
History of polycystic ovary	No	Ref.	
	Yes	2.61	0.64-10.67
Preconception body mass index	<25	Ref.	
	25.1-29.9	2.66	1.61-4.39
	>30	3.14	1.48-6.67
History of fetal macrosomia	No	Ref.	
	Yes	5.60	1.21-25.82
History of endocrinopathy	No	Ref.	
	Yes	1.48	0.47-4.63
History of hypertensive disorder of pregnancy	No	Ref.	
	Yes	1.59	0.66-3.81
Family history of diabetes mellitus	No	Ref.	
	Yes	4.8	2.37-9.70
History of gestational diabetes	No	Ref.	
	Yes	4.00	0.24-65.00

Source: Own elaboration.

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Table 4 presents the multivariate analysis by which, after adjusting for confounding variables, it was found that being older than 35 years, being of indigenous race, having a preconception BMI >25, having a history of fetal macrosomia and having a family history of diabetes *mellitus* continued to be statistically significant factors for the development of GD. When evaluating the multivariate model, it was found that it had a good fit using the Hosmer-Lemeshow test: HL=4.13 (df=8; p=0.84).

Regarding maternal outcomes, GD was found to be associated with induction of labor (OR=4.41; 95%CI: 1.71-11.39) and emergency (OR=2.22; 95%CI: 1.33-3.73) and elective cesarean section (OR=2.79; 95%CI: 1.51-0.005) (Table 5).

Table 4. Multivariate analysis of the study population.

Variables		OR a	95%CI
Age	20- 34 years	Ref.	
	<20 years	0.61	0.26-1.40
	≥35 years	2.26	1.23-4.14
Type of affiliation to the health system	Contributory	Ref.	
	Subsidized	1.33	0.71-2.48
Race	Mestizo	Ref.	
	Indigenous	6.60	1.17-37.15
	Black	3.98	0.61-25.86
Births	None	Ref.	
	At least 1	1.16	0.52-2.60
History of stillbirths	No	Ref.	
	Yes	1.97	0.51-7.50
Adequate antenatal care	Yes	Ref.	
	No	1.11	0.63-1.94
Psychoprophylactic course	Yes	Ref.	
	No	1.91	0.41-8.69
History of polycystic ovary	No	Ref.	
	Yes	3.38	0.70-16.31
Preconception body mass index	<25	Ref.	
	25.1-29.9	1.71	1.18-2.48
	>30	2.26	1.23-4.14
History of fetal macrosomia	No	Ref.	
	Yes	10.07	1.50-67.34
Family history of diabetes mellitus	No	Ref.	
	Yes	3.17	1.39-7.22

Source: Own elaboration.

Table 5. Maternal outcomes of the multivariate analysis.

Variables		OR	95%CI
Gestational age	Full term	Ref.	
	34- 36.6 weeks	0.69	0.20-1.85
	28- 33.6 weeks	2.57	0.75-8.74
Start of labor	Spontaneous	Ref.	
	Induced	4.41	1.71-11.39
	Emergency cesarean section	2.22	1.33-3.73
Type of delivery	Vaginal	Ref.	
	cesarean section	2.79	1.51-5.18
Composite maternal outcome	No	Ref.	
	Yes	1.3	0.82-2.06

Source: Own elaboration.

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Concerning perinatal outcomes, GD was associated with a birth weight >4 000g (OR=3.22; 95%CI: 1.14-9.13) and macrosomia >90th percentile (OR=2.78; 95%CI: 1.29-5.98). In addition, an increased risk of developing composite neonatal morbidity scores (OR=2.88; 95%CI: 1.78-4.68), fetopathy (OR=9.14;95%-CI: 4.48-18.62) hypoglycemia (OR=2.92; 95%CI: 1.05-8.14) and requiring newborn hospitalization (OR=8.1; 95%CI: 4.87-0.005) was found (Table 6).

Table 6. Perinatal outcomes of the multivariate analysis.

Variables		OR	95%CI
Composite neonatal outcome	No	Ref.	
	Yes	2.88	1.78-4.68
Newborn hospitalization	No	Ref.	
	Yes	8.1	4.87-13.45
Fetopathy	No	Ref.	
	Yes	9.14	4.48-18.62
Birth weight	<3 999g	Ref.	
	>4 000g	3.22	1.14-9.13
Macrosomia >90th percentile	No	Ref.	
	Yes	2.78	1.29-5.98
Intrauterine growth restriction	No	Ref.	
	Yes	0.65	0.19-2.23
Respiratory distress syndrome	No	Ref.	
	Yes	0.88	0.39-2.05
Neonatal sepsis	No	Ref.	
	Yes	1.17	0.54-2.51
Perinatal asphyxia	No	Ref.	
	Yes	1.02	0.29-3.62
Necrotizing enterocolitis	No	Ref.	
	Yes	0	0
Hypoglycemia	No	Ref.	
	Yes	2.92	1.05-8.14
Neonatal jaundice	No	Ref.	
	Yes	5.21	2.99-9.07
Polyglobulia	No	Ref.	
	Yes	15.89	1.63-154.62
APGAR after 5 minutes	Suitable >7	Ref.	
	Not adequate	1.28	0.26-6.17
APGAR at one minute	Adequate >7	Ref.	
	Not adequate	2.34	0.70-7.77

Source: Own elaboration.

Discussion

The average age of the participants analyzed in the present study (26 years) was higher than that reported in other research conducted in Colombia; in Armenia, Ruiz *et al.*[32] found that it was 22 and, in Manizales, Burbano-Lopez[33] established that it was 23.5. However, the findings of those two studies are consistent with the present research in that most participants were housewives and in the number of antenatal consultations that pregnant women attended.

The prevalence of GD found here (16.32%) is similar to that reported by Groof *et al.*[34] in Kuwait (12.6%) and Tamayo *et al.*[35] in Germany (13.12%), but higher than that found in Europe by Eades *et al.*[36] (5.4%) and in the USA by Casagrande *et al.*[8] (7.6%); it is worth mentioning that the difference with the USA could be explained by the fact that the test used in that country is a two-step test. Likewise, the prevalence found here was within the range established in the HAPO study with the criteria of the IADPSG: 9.3-25.5%.[37]

In Colombia, Burbano-López *et al.*[33] reported a lower prevalence of GD in Manizales: 6.3% (95%CI: 5-7.9), which could be explained by the fact that the two-step test was used in their study. Moreover, the prevalence found by Ruiz *et al.*[32] in Armenia (4.7%) is also lower than in the present study, but in this case the difference could be that their research was carried out in a

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primary care institution, while the present study was carried out in a highly complex one, which may overestimate the prevalence.

However, the high prevalence reported here using the IADPSG criteria should draw attention to the costs that this disease can generate to the health system given the high number of patients requiring care. It is important to bear in mind the evidence provided by Brown & Wyckoff,[13] who reported that pregnant women with GD diagnosed with this test have more adverse outcomes than those with normal glucose tolerance and, therefore, their treatment may be more cost-effective.

Similarly, the diagnosis of carbohydrate metabolism disorders is more frequent in pregnant women diagnosed with GD according to the IADPSG criteria, which would support that the cost of diagnosis and treatment is lower in this population since it could be possible to implement measures such as the promotion of healthy lifestyles and adequate nutrition to avoid long-term risks.[13,29]

Regarding the factors associated with the development of GD, the present study found that being older than 35 had a positive association (OR=2.26; 95%CI: 1.23-4.14), which is consistent with the study by Melchior *et al.*,[38] where the prevalence of GD increased to 26% in women aged 45 years or older, and with the research by Lee *et al.*[39] and Njete *et al.*,[40] who found that being older than 25 and 35, respectively, was positively associated with the development of GD (OR=2.17; 95%CI: 1.96-2.41 and ORa=6.75; 95%CI: 1.62- 28.13, respectively).

Concerning race, being indigenous was positively associated with the development of GD (OR=6.60; 95%CI: 1.17-37.15). In this regard, Pu *et al.*[41] found a prevalence of this entity of 19.3% among Asian Indians, while Liu *et al.*[42] found an increased risk in Asians and Hispanics (OR=2.81; 95%CI: 2.28-3.48 and OR=1.27; 95%CI: 1.05-1.55, respectively) compared to African Americans (OR=0.64; 95%CI: 0.56-0.74).

Similarly, preconception BMI >25 was positively associated with the onset of GD (OR=2.26; 95%CI: 1.23-4.14). On this factor, Kim *et al.*[43] reported that 41.1% of cases of this disease in their study were attributed to overweight and obesity; Moreno-Martínez *et al.*[44] concluded that preconception BMI was higher in pregnant women who developed GD (p<0.01); and Njete *et al.*[40] found a significant association between preconception obesity and GD (ORa=2.22; 95%CI: 1.09-4.51).

Concerning family history of diabetes *mellitus,* it was found that this factor was also positively correlated to the development of GD (OR=3.17; 95%CI: 1.39-7.22), which is consistent with the study by Tabak *et al.*,[45] in which a family history of GD in the maternal line was positively associated with the development of this disease (OR=2.83; 95%CI: 1.16-6.89), and with Coetzee *et al.*,[46] who confirmed the association of this factor with GD (OR=7.45; 95%CI: 1.05-52.76).

The diagnosis of GD was also associated with perinatal complications such as birth weight >4 000g and macrosomia >90th percentile. These results were similar to those reported by Tavares *et al.*[47] in Brazil, who documented that pre-pregnancy obesity and a history of fetal macrosomia were associated with large-for-gestational-age newborns in women with GD (OR=11.6%; 95% CI: 1.40-95.9 and OR=34.7; 95%CI: 4.08- 295.3, respectively).

Similarly, GD was also associated with termination of pregnancy by emergency and elective cesarean section (OR=2.22; 95%CI: 1.33-3.73 and OR=2.79; 95%CI: 1.51- 5.18, respectively). In this regard, Billionnet *et al.*[48] reported that, compared to non-diabetic pregnant women, those with GD had a higher risk of cesarean section (OR=1.4; 95%CI: 1.4-1.9). In turn, Inocêncio *et al.*[49] established a cesarean section rate associated with GD of 47.8%, Boriboonhirunsarn *et al.*[50] found that GD significantly increased the risk of emergency cesarean section (ORa=1.9; 95%CI: 1.3-3.5; p=0,039) in nulliparous women, and Gascho *et al.*[51] and Aviram *et al.*[52] showed a higher probability of cesarean delivery in women with GD (OR=2.25; 95%CI: 1.49-2.39 and OR=1.82; 95%CI: 1.24- 2.66, respectively).

It was also shown that the patients with GD had higher rates in induction of labor (OR=4.41; 95%CI: 1.71-11.39), which coincides with the study by Erjavec *et al.*,[53] who found that GD is a significant predictive factor for labor induction (OR=2.06; 95%CI: 1.76-2.42; p<0.001) and cesarean section (OR=1.56; 95%CI: 1.36-1.80, p<0,001), and that of Bas-Lando *et al.*,[54] who reported that, in women with GD, elective induction at term was associated with increased risk of cesarean section compared with other elective labor inductions (p=0.02). It is worth mentioning that Nguyen *et al.*[55] reported similar results.

The present study also found that a significant number of neonates born to mothers with GD required hospitalization (OR=8.1; 95%CI: 4.48-18.62), which is consistent with studies by Melamed *et al.*[56] and Abdalrahman-Almarzouki,[57] who showed a higher probability of admission to the neonatal intensive care unit in infants of diabetic mothers (OR=1.36; 95%CI: 1.09-1.69 and OR=3.2; 95%CI: 1.1- 9.4, respectively).

In addition, the present investigation found a significant association between GD and macrosomia (OR=2.78; 95%CI: 1.29-5.98), which agrees with the studies of Billionnet *et al.*[48] and Gross *et al.*,[34] who established the following associations on this factor: OR= 1.8; 95%CI: 1.7-1.8 and ORa=2.36; 95%CI: 1.14- 4.89, respectively. Aviram *et al.*[52] also reported a significant association between GD and macrosomia (8.3% in pregnant women with GD and 2.5% in pregnant women without GD, p=0.001).

On the other hand, the HAPO Study Cooperative Research Group showed that macrosomia was associated with increased maternal blood glucose levels measured at fasting and one and two hours post-load (ORa=1.38; 95%CI: 1.32-1.44, ORa=1.46; 95%CI: 1.39-1.53 and ORa=1.38; 95%CI: 1.32-1.44, respectively).[58] In the same way, the present study showed a significant association between GD and neonatal hypoglycemia, which coincides with the findings of the HAPO Study Cooperative Research Group study, which found that blood glucose levels in children of diabetic mothers were elevated at both fasting and one and two hours post-load (ORa=1.08; 95%CI: 0.98-1.19, ORa=1.13; 95%CI: 1.03-1.26 and ORa=1.10; 95%CI: 1.00-1.12).[50] Esakof *et al.*[26] also reported a higher frequency of hypoglycemia in neonates born to mothers with GD.

The main strength of the present study is that it is one of the few that analyzes the prevalence of GD in Colombia according to the IADPSG criteria; in addition, confounding variables were managed by logistic

regression for the associated factors. Weaknesses include the possibility of selection bias since the study was carried out in a highly complex institution where most of the patients who consulted had high-risk pathologies, which could lead to an overestimation of the prevalence of GD.

Conclusions

The prevalence of GD found in the present study is higher than that reported in previous research conducted in Colombia, but similar to that described in most studies that have used the IADPSG criteria.

The factors (high preconception BMI, age older than 35 years, indigenous race, history of macrosomia, and family history of diabetes) and maternal-perinatal outcomes (induction of labor, termination of pregnancy by cesarean section, birth weight >4 000g, macrosomia >90th percentile, increased risk of developing at least one neonatal disorder, fetopathy and requiring neonatal hospitalization), in which a significant association with GD was observed, are similar to those reported in most of the literature consulted.

Conflicts of interest

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