



Gestational and Previous Diabetes in Pregnancy: Perinatal Results

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Abstract

Objective: Evaluating the association between gestational diabetes and fetal/maternal complications such as poor obstetric outcomes.

Methods: Historical cohort comprising patients from the High-Risk Service of Federal University of Juiz de Fora (UFJF,) who were diagnosed with diabetes (exposed), as well as patients from the Low-Risk Service of UFJF (non-exposed). Data generated through anamnesis, physical examination and medical conduct, as well as data of newborns such as fetal weight, ICU admission and fetal/neonatal death), were collected and stored in the Epi Info software (version 6.0); $p < 0.05$.

Results: 176 patients treated in the aforementioned services, 108 diabetic, and 68 non-diabetics, were investigated in the current study. In total, 92 (52.2%) of them were diagnosed with Gestational Diabetes Mellitus (GDM); 6 had DM type 1 (3.4%) and 10 had DM type 2 (5.6%). Therefore, 68 patients (38.6%) presented normal glucose metabolism. The mean age of the patients was 30.27 ± 6.77 years, the mean number of births was 1.06 ± 1.20 . Macrosomia was diagnosed in 6.81% ($n = 6$) of the cases; it was associated with maternal glycemia ($p < 0.05$). D- and F-class pregnant women, who had been previously diagnosed with diabetes, presented lower fetal weight than other pregnant women ($p = 0.03$). Treatment was based on diet, insulin or metformin, whenever necessary. Fasting glycemia levels decreased throughout the gestational trimesters. Eighteen (10.2%) preterm fetuses were identified; 12 were born from diabetic mothers and 6 were born from non-diabetic ones ($p = 0.01$; $X^2 = 10.51$). All infants hospitalized in the neonatal ICU ($n = 10$) were born from diabetic mothers; their mean gestational age was 36.28 ± 2.9 weeks, whereas the mean gestational age of infants who were not hospitalized in the ICU was 38.31 ± 1.5 ($p = 0.005$; $T = 12.58$). Cesarean section was the most common way of delivery adopted for diabetic pregnant women ($p = 0.04$).

Conclusion: Based on the results, gestational diabetes (GDM) is a predisposing factor to fetal macrosomia, prematurity, and hospitalization in neonatal ICUs. Pregnant women subjected to proper glycemic control in the current study presented lower complication rates in comparison to other studies in the literature.

Keywords

Gestational and Previous Diabetes in Pregnancy; Macrosomia; Glycaemia; Diabetes Mellitus

Introduction

Nowadays, approximately 415 million adults around the world have Diabetes mellitus (DM), whereas 318 million adults have glucose intolerance and present a high risk of developing the disease in the future. DM and its complications are among the leading causes of death in most countries – based on estimates, DM is responsible for 1 out of 12 adult deaths worldwide [1]. Obstetric history of gestational diabetes mellitus (GDM) is the major risk factor for the development of type 2 diabetes and metabolic syndrome among women [1,2].

GDM is one of the most common gestational complications; this condition leads to considerable perinatal risk when it remains undiagnosed or is not properly treated. Fetal macrosomia, neonatal birth injuries, neonatal hypoglycemia and hyperbilirubinemia, neonatal respiratory distress syndrome, hypocalcemia, prematurity, and intrauterine fetal death stand out among fetal complications [3-5]. Also, GDM is believed to determine complications such as increased incidence of obesity, hypertension, metabolic syndrome and diabetes in these newborns' adulthood. A possible explanation for this outcome is based on epigenetics [6].

Epigenetic inheritance enables different organisms to adjust their gene expression, based on the environment they live in, without changing their genome. For example, experiences lived by parents (e.g., diets) can be passed on to future generations; thus, fetuses who grow in environments with an excess of sugars would get used to hyperinsulinemia and lipid storage, and this process could result in the development of metabolic syndrome in their adult life. Another interesting and contradictory finding is that fetuses subjected to lack of nutrients could also develop type 2 diabetes in the future because they get used to store energy to survive. Therefore, the intrauterine environment can modulate one's adult life, regardless of genomic coding. This reasoning is

the basis of the theory known as intrauterine programming [6-8].

Diabetic pregnant women presenting poor metabolic control are prone to higher miscarriage, infection, high blood pressure, pre-eclampsia, preterm delivery, and cesarean delivery rates. These women will be at increased risk of developing type 1 or 2 diabetes after pregnancy; however, such risk can be minimized or postponed by providing them lifestyle-changing guidelines [1]. Congenital malformations, IUGR (Intrauterine Growth Restriction), oligohydramnios and fetal death stand out among the consequences faced by pregnant women who were diagnosed with diabetes before pregnancy and who did not present proper blood glucose control [8,9].

It is necessary to screen DM during pregnancy due to the substantial number of maternal and fetal complications that may happen; however, several criteria are reported and used in different healthcare services in Brazil and abroad. According to the HAPO (Hyperglycemia and Adverse Pregnancy Outcomes) study [10] conducted in 2008, there is not a single cutoff point for glycemia levels above which the risk of adverse outcomes would increase, and it means that unfavorable events happen even at normal blood glucose levels. The American Diabetes Association (ADA) [11] endorsed this diagnostic criterion in 2011, based on studies carried out by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) [12], which defined the following cutoff values: 92 mg/dl for fasting, 180 mg/dl for 1 h after the intake of 75g of dextrosol (anhydrous glucose) and 153 mg/dl for 2 hours after the intake of the same dextrosol dose.

The service in the assessed hospital has been using these criteria since then and it was possible noticing an increased number of GDM cases. Therefore, it is necessary for assessing diabetic pregnant women in Brazil, as well as investigating the association between GDM and unfavorable maternal/fetal outcomes.

Methods

The current study analyzed a historical cohort comprising patients treated in the low- and high-risk services of the Medical School of Federal University of Juiz de Fora (BRAZIL). Pregnant women diagnosed with diabetes were considered exposed patients, whereas non-diabetic pregnant women were considered non-exposed patients. They were referred from the low obstetric risk centers of the two aforementioned services. It was possible comparing the pregnant women because the outpatient clinics adopted the protocol by FEBRASGO [13] for clinical follow-up [14-16].

The sample calculation was based on statistics from the UFJF Obstetrics Service. After signing an agreement with Juiz de Fora City Hall, the service at UFJF took the responsibility of providing care to diabetic pregnant women who live in Juiz de Fora city and its surrounding region; consequently, the frequency of these patients in our facilities was extremely high. If one takes into consideration the frequency of “exposed” patients (40%) and the possible existence of “non-exposed” patients (10%), the sample size required for the current study comprised 51 patients per group, at 5% alpha error and 20% beta error, but we selected 176 patients for this study - 108 were diabetic and 68 were metabolically healthy.

Patients, who had agreed to participate in the study, as well as to be subjected to the protocol adopted by the healthcare service, were included in the study. Those who did not allow their data to be evaluated or who did not agree with the protocol of the aforementioned service were excluded from it. Primary outcomes comprised fetal and neonatal death, newborn weight (NB), NB hospitalization in neonatal ICU and prematurity and secondary outcomes comprised pre-eclampsia, other interurrences in prenatal care and interurrences responsible for pregnancy interruption.

All anamnesis data (age, gestational age, gestation, miscarriage, history of DM and interurrences in the current and previous pregnancies - intrauterine fetal death, fetal macrosomia, polyhydramnios,

hypertensive syndromes), physical examination (blood pressure, weight gain), medical conduct (insulin therapy and diet) and newborns (weight) were also collected. Fasting blood glucose was measured in the three gestational trimesters.

Blood glucose measurements were taken in the 3 gestational trimesters based on the enzymatic method by using fluoridated plasma kept at 2-8°C for at most two days after patients fasted for 8 hours. Values ranging from 60 to 91 mg/dl were normally based on criteria set by ADA [11]. Glycaemia ranging from 92 and 125 mg/dl were considered abnormal and compatible with GDM, whereas glycemia higher than 126 mg/dl was considered abnormal and compatible with DM before pregnancy [17,18].

The oral glucose tolerance test with 75g of dextrosol (OGTT75g) was applied to all pregnant women who presented normal fasting glycemia (< 92 mg/dl) from the 24th to the 28th gestational week. The herein adopted cutoff values were ≥ 92 mg/dl (at fasting), ≥ 180 mg/dl (1h after the intake of 75g of dextrosol) and ≥ 153 mg/dl (2 h after the intake of 75g of dextrosol). Abnormal values in the glycemic curve were diagnosed as GDM. The test was performed with fluoridated plasma, which was kept at 2-8°C for at most two days [17,18].

All patients perform examinations with obstetric ultrasound from the 34th to the 36th gestational weeks were used to diagnose polyhydramnios and macrosomia. Amniotic fluid index (AFI) higher than 18 cm was diagnosed as polyhydramnios, oligohydramnios was diagnosed when the largest pocket was smaller than 2 cm and macrosomia was diagnosed when the waist circumference was higher than the 80th percentile of the gestational age [19-21].

All the diabetic patients were classified based on the criteria suggested by Priscilla White (PW) classification [22] (**Fig-1**).

Information collected during the study was exported to a system that was specifically developed for this research in the Access platform and processed

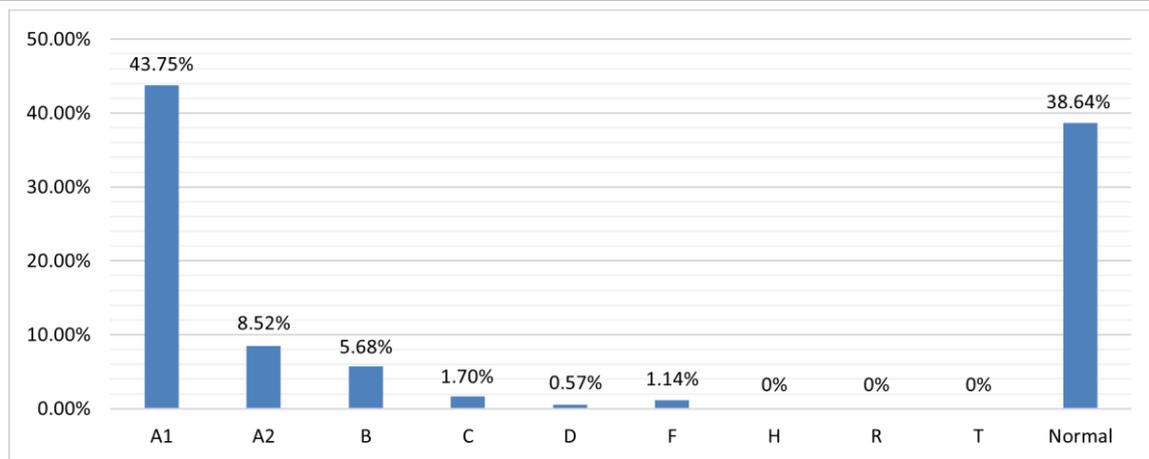


Fig-1: Priscilla White's classification for diabetic patients identified in the study

There are 2 classes of gestational diabetes (diabetes which began during pregnancy): Class A₁: gestational diabetes; diet controlled; Class A₂: gestational diabetes; medication controlled. The second group of diabetes which existed before pregnancy can be split up into these classes: Class B: onset at age 20 or older or with duration of less than 10 years; Class C: onset at age 10-19 or duration of 10-19 years; Class D: onset before age 10 or duration greater than 20 years; Class E: overt diabetes mellitus with calcified pelvic vessels; Class F: diabetic nephropathy; Class R: proliferative retinopathy; Class H: ischemic heart disease; Class T: prior kidney transplant

in the computer through statistical processing resources available in the Epi-Info software, version 6.04. The frequency of the examined variables was distributed, and the prevalence rates indicated for each case were calculated. The means and standard deviations of variables expressed in numerical scale were also calculated. The comparison between groups identified among participants was performed in contingency tables type R x C (in the case of categorical variables) or through comparison of means (in the case of numerical variables). The Chi-square and/or Student's t-tests were used to analyze the statistical significance of differences observed in the analysis, depending on the nature of data to be compared. Linear regression was used to associate numerical variables such as weight, blood pressure, AFI, fasting and postprandial glycemia, and fetal weight. The significance level adopted in the analysis was 5%.

The present study is part of the project approved by the Ethics and Research Commission of Minas Gerais State Hospital Foundation, (country), under Opinion n. 44281815.3.0000.5147.

Results

We investigated 176 patients, in 108 (61.36%) were

diabetic and 68 (38.63%) were metabolically healthy. The mean age of the patients was 30.27 ± 6.77 years. Clinical and epidemiological data are shown in (Table-1) and (Table-2).

Diabetic pregnant women recorded higher glycemic levels in the first, second and third gestational trimesters than the non-exposed group. However, the mean glycemia levels recorded for the exposed group decreased as the gestational trimesters progressed. The mean glucose levels are shown in (Table-3).

The oral glucose tolerance test was applied to only 127 patients because the remaining ones had been screened through fasting glycemia and did not require OGTT application, based on previously established criteria [11]. Based on fasting glycemia and the OGTT with 75 g of dextrosol, 52.27% (n = 92) of patients were diagnosed with gestational diabetes; however, 3.41% (n = 6) of pregnant women were known to be diabetic patients type 1 and 5.68% (n = 10) were type 2. Also, 38.64% (n = 68) of the patients were considered metabolically healthy in the glucose test. DM cases were classified based on criteria set by Priscilla White (PW), as shown in (Fig-1).

The treatment was based on diet developed for

Table-1: Epidemiological and Clinical Aspects of the Studied Patients

	Total	Exposed	Not Exposed	P	X ² /F
Age (years)	30,27 ± 6,77	31,72 ± 6,16	27,41 ± 7,06	0,0008	16,48
Number of Pregnancies	2,29 ± 1,48	2,62 ± 1,57	1,63 ± 1,05	0,0003	18,69
Number of Deliveres	1,06 ± 1,20	1,39 ± 1,25	0,43 ± 0,77	0,0000	28,43
Miscarriage	0,27 ± 0,69	0,31 ± 0,74	0,18 ± 0,57	0,26	1,27
Prenatal Weight Gain	16,39 ± 5,5	11,81 ± 18,79	25,45 ± 9,26	0,17	1,87
Systolic Pressure Initial	116,60 ± 13,14	117,30 ± 13,0	106,66 ± 12,11	0,05	3,7
Diastolic Pressure Final	72,01 ± 12,90	72,26 ± 12,91	68,33 ± 13,29	0,47	0,51
Systolic Pressure Final	123,56 ± 15,37	123,74 ± 15,74	120,0 ± 0,10	0,63	0,22
Diastolic Pressure Final	78,60 ± 12,21	78,66 ± 12,48	77,50 ± 5,0	0,85	0,03

Table-2: Previous Mothers' Diseases

	%	N		P Value	X ²
Chronic Hypertension					
Yes	9,41%	15	1	0,02	4,8
No		97	57		
Intrauterine Fetal Death					
Yes	2,96%	5	0	0,24	1,35
No		106	58		
Preeclampsia					
Yes	4,71%	7	1	0,18	1,73
No		105	57		
Thyroid Disease					
Hypothyroidism					
Yes	5,33%	9	0		
No		101	58	0,06	5,55
Node		1	0		
Thrombophilia					
Yes		10	0		
No	5,0%	106	60	0,019	5,8
Previous Diabetes					
Yes		16	0	0,002	10,2
No	9,0%	90	60		

Table-3: Mean of Blood Glucose in the Three Gestational Trimesters

Bood Glucose	Total	Exposed	Not Exposed	P Value	X ² /F
First Trimester	91,30 ± 23,42	98,66 ± 25,14	76,58 ± 7,72	0,0000	40,4
Second Trimester	84,89 ± 20,24	91,15 ± 22,57	74,01 ± 7,26	0,00000	30,92
Third Trimester	83,41 ± 20,12	87,56 ± 22,73	74,51 ± 7,93	0,00027	13,98

diabetic patients, as well as on the use of sweeteners, and of insulin associated with metformin, whenever necessary. Exercising was encouraged; however, 100% of patients reported to practice only routine exercises throughout the day. No patient practiced yoga, pilates or aqua aerobics. There was no case of exclusive metformin use. The treatment users are shown in (Table-4) and glucose means are shown in (Table-5).

The mean weight of infants born from diabetic mothers was 3215.08 ± 551.34 g, whereas the mean weight of those born from non-diabetic mothers was 3146.44 ± 547.49 g ($p = 0.47$; $T = 1.97$). Macrosomia was diagnosed in 6.81% ($n = 6$) of newborns. The mean weight of newborns of diabetic mothers who used insulin was 3390.41 ± 467.71 g, whereas the

mean weight of newborns of non-insulin users was 3282 ± 505.0 g ($p = 0.287$; $T = 1.9$). The newborn weight classification and its association with PW's classification are shown in (Table-6). D and F class pregnant women presented lower fetal weight than the other pregnant women ($p = 0.03$). There was an association between macrosomia and mean glycemic level of 115.33 ± 42.74 in the third gestational trimester ($p = 0.03$). There was a single case of intrauterine fetal death involving a patient diagnosed with GDM, who presented good dietary-based glycemic control (A1 of PW in Table-6); true umbilical cord knot was identified after labor induction.

There were 18 preterm fetuses (10.2%); 12 were born from diabetic mothers and 6 were born from non-diabetic mothers ($p = 0.01$; $X^2 = 10.51$). Thus, it is

Table-4: Distribution of Patients in PW classification and type of Diabetes Identified and Treatment Performed

Glucose Metabolism	N	%	Priscilla White	N	Drug Treatment
GDM	92	52,5	A1	76	Diet
			A2	16	Insulin
DM Type 1	6	3,41	C	3	Insulin
			D	1	Insulin
			F	2	Insulin
DM Type 2	10	5,6	B	10	Insulin
Normal	68	38,6	Normal	68	None

Table-5: Average Blood Glucose values per Trimester in Insulin users and non-users

	Insulin	Not insulin use	P Value / T
First Trimester	$117,33 \pm 35,64$	$90,66 \pm 12,46$	$p=0,00000$; $F=33,81$
Second Trimester	$106,93 \pm 30,05$	$83,95 \pm 13,15$	$p=0,00000$; $F=28,19$
Third Trimester	$94,70 \pm 29,52$	$83,45 \pm 16,64$	$p=0,02$; $F= 5,53$

Table-6: Association between PW Classification and Fetal Weight (grams)

Priscilla White's Classification (PW)							
A1	A2	B	C	D	F	Normal	p
3282,0	3390,41	2833,16	3051,66	2300,00	2470,00	3146,44	0,03
\pm	\pm	\pm	\pm	\pm	\pm	\pm	$X^2=13,26$
505,0	467,71	741,26	803,07	100,00	42,42	547,49	

possible saying that diabetes is a predisposing factor for prematurity. Ten (10) newborns were referred to the neonatal ICU and discharged in good health conditions. The mean weight of fetuses referred to the ICU was 2698.62 ± 504.78 g, whereas the mean weight of newborns who were directly referred to the rooming-in was 3207 ± 504.75 g ($p = 0.01$; $T = 6.69$). All infants hospitalized in the neonatal ICU ($n = 10$) were born from diabetic mothers; the mean gestational age of these infants was 36.28 ± 2.9 weeks, whereas the mean gestational age of infants who were not hospitalized in the ICU was 38.31 ± 1.5 ($p = 0.005$; $T = 12.58$).

Cesarean section was the delivery method most often applied to diabetic pregnant women ($p = 0.04$). The association between PW's classification and gestational age at the delivery time was performed; the worse the PW classification, the younger the gestational age at pregnancy interruption time ($p = 0.0019$; $X^2 = 20.87$). Thus, the most severe classifications were the ones that presented premature pregnancy interruption.

There was one case of congenital malformation (Tetralogy of Fallot) involving an NB of type 1 diabetic mother who presented good glucose control after the second gestational trimester, although the mother's

blood glucose levels were high when she got pregnant. This NB died 6 days after delivery; the infant presented hemodynamic instability and could not be subjected to surgery. We identified 10 cases of neonatal ICU admission, 18 cases of prematurity, 1 case of intrauterine fetal death and 1 case of neonatal death were identified. The (Fig-2) presents these results.

The secondary outcomes were pre-eclampsia, urinary tract infection, maternal hypoglycemia, polyhydramnios, vaginitis and chronic fetal distress. Urinary tract infection ($n = 3$; 3.4%), hypoglycemia ($n = 2$; 2.27%), polyhydramnios ($n = 2$; 2.27%), vaginitis ($n = 4$, 4.54%), pre-eclampsia ($n = 4$; 4.54%) and chronic fetal distress with IUGR ($n = 2$; 2.27%) stood out among prenatal complications.

Intrauterine fetal death (0.57%), intrauterine growth restriction (IUGR) (1.14%), fetal distress (3.9%) and pre-eclampsia (5.11%) were the main complications identified in pre-natal follow-ups that resulted in pregnancy interruption (delivery). The association between these variables and mean blood glucose levels in each gestational trimester was performed. There was no association among first, second and third trimester blood glucose levels and variables such as fetal death ($p = 0.3$), IUGR ($p = 0.2$), pre-eclampsia ($p = 0.8$) and fetal distress ($p = 0.7$).

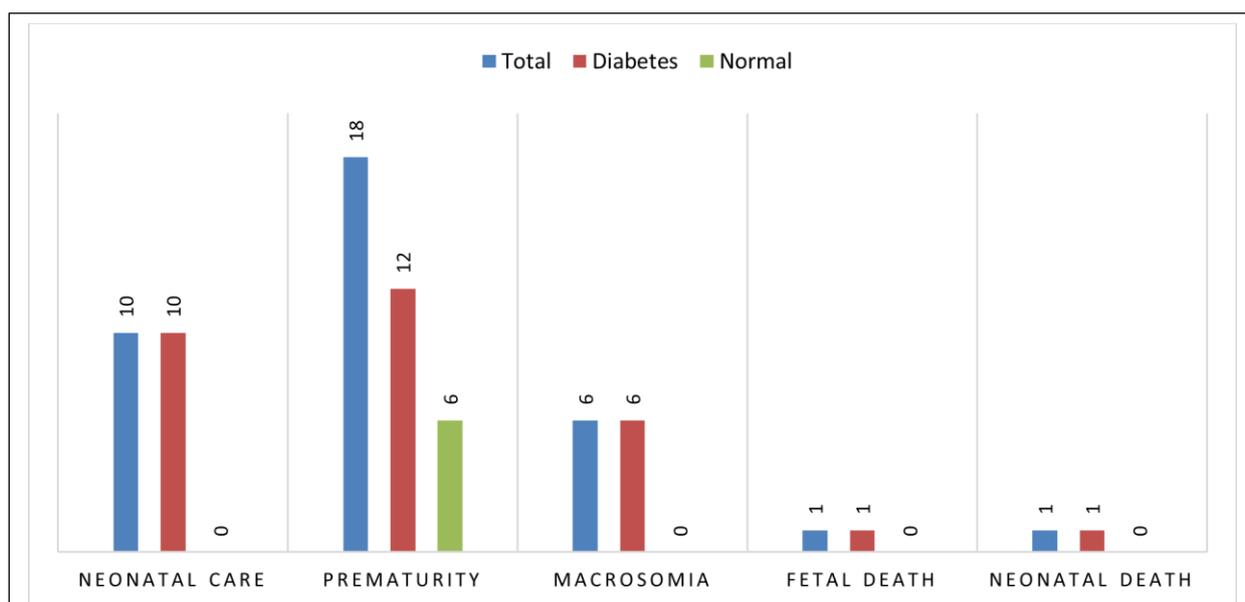


Fig-2: Frequency of primary outcomes: Admission to neonatal ICU, prematurity, macrosomia, fetal and neonatal death.

Discussion

The current study assessed 176 pregnant women (mean age = 30.27 ± 6.77 years; $p < 0.05$) - exposed pregnant women were the ones presenting the highest mean age, as well as the largest number of pregnancies and births. These data are compatible with the literature since older women also have longer menarche; consequently, they are more likely to experience more pregnancies and births [8,14,15]. It is worth emphasizing that these pregnant women were part of the exposed group; therefore, they experienced risk pregnancy and were more likely to present associated pathologies such as hypertension, hypothyroidism, thrombophilia, and diabetes before pregnancy. Thus, besides the pathology to be studied (DM), pregnant women in the exposed group presented other complicating risk factors such as CAH, thrombophilia, and hypothyroidism, which can affect the obstetric outcomes. According to a study carried out at IMIP (2012) with 35-to-39-year-old pregnant women, more than 70% of patients had some type of complication, including GDM. Thus, the association between age difference and pathologies that existed before pregnancy may be determinant factors for the worst maternal-fetal outcomes [23].

There was no significant association between the patient's weight before pregnancy and GDM. However, patients diagnosed with diabetes, either before or during pregnancy, had lower weight gain than patients in the non-exposed group. According to a study conducted in Kuwait with 868 mothers who did not have history of diabetes mellitus before pregnancy, 109 patients (12.6%, 95% CI: 10.4, 14.8) reported to have been diagnosed with GDM during their last pregnancy; GDM prevalence increased as maternal age and pre-gestational BMI increased [24].

Results in the present study do not comply with studies available in the literature, according to which excessive weight gain is associated with gestational diabetes. This difference may be associated with the previous control applied to type I and II diabetic patients assessed in the current study. Nowadays, the assessed institution has a specific outpatient clinic focused on pre-gestational DM control; these patients are followed-up before pregnancy. Another study has

shown that promoting a healthy body mass index and lower gestational weight gain can help to reduce the number of patients with gestational complications, which seems to be the key to the success of our diabetic patients' pregnancies [25]. On the other hand, it is essential mentioning that the mean weight gain of low-risk pregnant women was extremely high. Based on data analysis, few patients presented excessive weight gain and increased the mean values recorded for this variable. Both groups presented similar median weight gain.

These results are consistent with the ones reported by Yan et al (2019) [26], who evaluated 13,738 patients, in total. They conducted a multivariate analysis and found that patients' systolic blood pressure (OR 1.015; 90% CI 1.011-1.02) was a risk factor associated with the incidence of GDM; this finding complies with the present study. The plasma glucose levels showed that diabetic pregnant women recorded increased glucose levels in the first, second and third gestational trimesters, which was expected if one takes into consideration the herein investigated pathology. However, according to the evaluation of the mean blood glucose recorded for the exposed group in each gestational trimesters, these patients presented a substantial decrease in this parameter throughout the gestational trimesters (from 98.66 ± 25.14 to 87.56 ± 22.73). Efficient prenatal follow-ups, trained staff, and test availability can make a difference in the prognosis of these patients. Insulin dose manipulation, dietary control and changes in dietary habits were the strategies adopted to control the blood glucose levels in these patients, who have presented reduced glycemic levels, based on the comparison between gestational trimesters. Thus, it is possible saying that efficient prenatal care works as a modulator of unfavorable maternal outcomes [27].

According to Priscila White's classification, most patients included in the present study were in the A1 category, which indicated predominantly dietary treatment and was compatible with the medical literature [10-12]. At the time the HAPO study was published, there was criticism regarding the excessive number of patients who would be considered diabetic when fasting glucose was abnormal, regardless of the

OGTT results. Later, ADA (2011) [11] has explained that the inclusion of pregnant women in the diabetic group did not necessarily mean that they would all be medicated. On the contrary, prenatal care, proper dietary guidelines, exercising, and diet would suffice for most patients and could change the maternal-fetal outcome. Therefore, the initial approach applied to all pregnant women comprised diet, orientations, clinical control and exercising [10-12].

The physical exercise indicated in the current study was not performed by patients. Despite the encouragement to do so, none of our patients was enrolled in yoga, pilates or aqua aerobics classes. These exercises have been reported to help to reduce excessive maternal weight gain and the incidence of fetal macrosomia [28]. Pregnant women who were subjected to dietary control in the current study presented adequate blood glucose levels throughout pregnancy. Those who used insulin did not always reach the ideal blood glucose value, despite the glucose reduction identified throughout the gestational trimesters. These patients needed adjustments in their insulin doses or the association between regular and NPH insulin. Therefore, it is believed that controlled physical exercises could help to achieve such control [28].

However, one cannot neglect that the economic factor may have been decisive in this regard since the service provided at the assessed institution does not provide free physical exercise classes for pregnant women. The social and economic features of the selected patients refer to people who predominantly earn one minimum wage per month and, therefore, who have unfavorable socioeconomic status. It is known that this population does not have easy access to nutrition and leisure, fact that overall jeopardizes pregnancy and conceptus. Thus, low purchasing power can lead to lower access to food, in quantitative and qualitative terms, as well as to the consumption of high energy density food products, which, in their turn, are cheaper and contribute to unsuccessful glycemic control. However, we have tried to control this variable by encouraging patients to eat legumes, vegetables, and seasonal fruits, which are economically easier to be purchased. One cannot

neglect the fact that, besides their low economic conditions, these patients also have low schooling. Although this association was not investigated in the current study, it can hinder patients' access to information about pregnancy and newborn care or even compromise their understanding about what is informed; both situations can affect the health of the mother-child binomial [29].

It is known that vasculopathy starts from category D; the fetal results recorded in the present study were close to IUGR, prematurity, and oligohydramnios [30]. Based on the comparison between fetal weight and PW categories, the fetuses of pregnant women with vasculopathy presented lower weight due to endothelial damages that extended towards the placental bed. On the other hand, categories A, B and C recorded the highest fetal weights, which were associated with maternal blood glucose levels. The highest likelihood of macrosomia development was observed in pregnant women with increased blood glucose levels ($p < 0.05$). These results are consistent with the ones reported by Rodrigues et al. [31], who found that high blood glucose levels are independent predictors of weight gain in infants born from diabetic mothers.

Diabetic pregnant women presented the following primary outcomes: fetal and neonatal mortality (1.8%), macrosomia (6.81%), prematurity (16.6%) and hospitalization in neonatal ICU (9 %). All these findings presented lower rates than the ones reported in many other services [32-35]. There was an association between diabetes and prematurity and between diabetes and hospitalization in neonatal ICU ($p < 0.05$).

Wang et al. (2019) [32] conducted a study aimed at identifying stillborn babies of diabetic pregnant women admitted at Westmead Hospital from 2006 to 2017. They identified 37 women (seven with type 1 diabetes [DM1], 11 with type 2 diabetes [DM2] and 19 with DMG) who had 38 stillborn babies. The main stillbirth causes comprised lethal congenital malformations ($n = 9$), placental and umbilical abnormalities ($n = 6$), intrauterine growth restriction (IUGR; $n = 6$) and obstetric factors ($n = 4$).

Malformations were predominantly cardiovascular (n = 7), musculoskeletal (n = 5) and gastrointestinal (n = 4). There was no difference in the proportion of stillborn infants with malformations between groups of patients diagnosed with diabetes before and during pregnancy (p = 0.22). The present study recorded the neonatal death of an infant born from a pregnant patient who had been diagnosed with diabetes before pregnancy (the fetus presented cardiac malformation - Tetralogy of Fallot), as well as the intrauterine fetal death (during labor) of an infant born from a patient diagnosed with gestational diabetes. True umbilical cord knot was identified after fetal expulsion through the vaginal route.

Hospitalization in neonatal ICU, macrosomia and prematurity presented increased association with diabetic pregnant women (p < 0.05). According to a study conducted by Stogianni et al (2019) [33] with 280 pregnant women, 48 patients had pre-gestational diabetes, 97 had DMG and 135 did not have diabetes. Patients in the diabetes group had higher BMI at the beginning of pregnancy (p = 0.0001), lower gestational weight gain (11.1 ± 6.7 kg vs 13.1 ± 7.1 kg, p = 0.005), larger number of preterm labors (p = 0.0001) and larger number of macrosomic newborns (p = 0.06) than the non-diabetic group. Mothers with GDM gained less weight (9.9 kg Vs 13.5 kg) (p = 0.006). Mothers with type 1 diabetes gave birth to a larger number of macrosomic babies (60%) than mothers with DM2 (27%). Urinary tract infection (n = 3; 3.4%), hypoglycemia (n = 2; 2.27%), polyhydramnios (n = 2; 2.27%), vaginitis (n = 4; 4.54%), pre-eclampsia (n = 4; 4.54%) and chronic fetal distress with IUGR (n = 2; 2.27%) were the secondary outcomes identified during prenatal follow-ups. These findings are compatible with data available in the medical literature [28-32,34,35].

This study was very important because it showed that a trained team can offer the population that uses the public service a quality service, even for high-risk pregnant women, even in a developing country. Our service to serve the needy population of the city and region and the university not only as a source of knowledge for students but also to the strong assistance that we have in public universities in our

country. In addition, glycemic control is largely responsible for the success of these pregnancies. We were unable to establish a cut-off point for the blood glucose level that would be at risk for fetal death or other perinatal complications and perhaps this could be considered a weak point in our study, but undoubtedly adequate blood glucose control was responsible for the good result. and this is also the great legacy of this study.

Conclusion

However, the current study recorded less complications than the ones reported in the medical literature. This result can be attributed to good glycemic control which is the best allied to favorable perinatal outcomes in pregnant women with diabetes mellitus. The methods adopted to achieve this outcome can change based on patients' treatment (diet, insulin, exercising); however, glycemia level close to normal values is the most important element in such control. The current study could not set a cut-off point capable of associating blood glucose levels and unfavorable outcomes; it may have happened because these levels are labile and change after food and medication intake. However, based on the collected data, diabetic pregnant women presented unfavorable fetal outcomes (prematurity and hospitalization in neonatal ICU) and increased blood glucose levels were associated with fetal macrosomia.

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