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The Influence of Gestational Diabetes Mellitus on Maternal and Neonatal Outcomes: A Retrospective Study in Rzeszów, Poland

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Statistical Analysis C
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Background: Gestational diabetes mellitus (GDM) affects 5.8-12.9% of pregnant women, while pre-gestational diabetes mellitus (PGDM) affects 0.4-1.1%. GDM increases the risk of perinatal complications and long-term health issues. This retrospective study from a single centre in Rzeszów, Poland aimed to evaluate maternal and neonatal outcomes of pregnancy of 65 women with gestational diabetes mellitus.

Material/Methods: The study group consisted 65 women with GDM. The control group consisted 60 women without. GDM were diagnosed with carbohydrate metabolism disorders during pregnancy based on the results of the oral glucose tolerance test (OGTT). Methods of evaluation of the mothers: age, body mass before pregnancy, body height, body mass index (BMI), gravidity, parity, the number of miscarriages, length of stay (LOS) of mother, gestational weight gain (GWG), duration of pregnancy, type of delivery, treatment of diabetes. Methods of evaluation of the child: LOS, birth weight, Apgar points.

Results: Women with diabetes stayed in hospital longer than women without, similarly applies the length of stay (LOS) of the child ($p<0.001$). It turned out that the women with GDM were significantly more likely to deliver by caesarean section (CS) ($p=0.024$) and these women most often had gestational weight gain (GWG) within the recommended range ($p<0.001$). Body mass index (BMI) before pregnancy was significantly higher in the women with GDM ($p=0.023$).

Conclusion: The above study confirms that the occurrence of GDM has an undoubted impact on prolonged LOS of the mother and child, more frequent CS delivery and normal GWG.

Keywords: Infant Health • Gestational Diabetes Insipidus • Fetal Macrosomia • Muscle Hypotonia

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Introduction

Diabetes is defined as a group of chronic metabolic disorders leading to hyperglycemia and characterized by relative or absolute insulin deficiency [1-3]. Gestational diabetes mellitus (GDM) is one of several types of diabetes and is defined as any condition of abnormal carbohydrate metabolism first diagnosed during pregnancy [1-3]. GDM is diagnosed in 5.8-12.9% of pregnant women. Pre-gestational diabetes mellitus (PGDM) occurs in 0.4-1.1% of pregnant women [1-3]. In Poland, the incidence of GDM is 6.2%, while for PGDM it is 1% [4].

According to the current recommendations of the Polish Diabetes Association (PDA), diagnosis of gestational diabetes is carried out at 24-28 weeks of pregnancy [5]. The recommendations of the PDA also indicate groups of women in whom diagnosis for diabetes should be performed by the time of diagnosis of pregnancy [6].

Hyperglycemia during pregnancy has a negative effect on both the developing fetus and the pregnant woman [7]. The state of chronic hyperglycemia to which the fetus is exposed in utero leads to a number of metabolic disorders, the consequence of which may be macrosomia and related perinatal complications [7], intrauterine deaths, respiratory disorders, polycythemia, hypoglycemia, hypomagnesemia, and postnatal hypocalcemia of the newborn [8]. There is increasing discussion of long-term consequences occurring in children of diabetic mothers in the form of obesity, overweight, more frequent occurrence of glucose metabolism disorders, and psychomotor and intellectual disorders [9]. Pregnant women with GDM are more likely to develop gestational hypertension or pre-eclampsia than the general population, and this group is also at high risk of developing type 2 diabetes later in life [10]. Hyperglycemia is a major risk factor for neoplastic transformation because it affects various mechanisms, causing deoxyribonucleic acid (DNA) damage [11]. Cellular alterations of hyperglycemia lead to adaptations that can result in conditions that favor neoplastic transformation [11].

Based on a review of the available literature, it was found that pancreatic cancer was more common in women who had gestational diabetes during pregnancy [12]. The pathomechanism of the development of diabetes in pregnancy is complex and not fully understood [13]. The main background of the disorder concerns an increase of insulin resistance as pregnancy progresses and an associated increase in the secretion of placental hormones and cortisol [13]. The adverse effects of hyperglycemia on the developing fetus vary depending on the week of pregnancy [13]. In the early period it can cause miscarriages and birth defects, while excessive glucose levels in the second and third trimesters cause hypertrophy and hyperstimulation of fetal pancreatic beta cells, which leads to increased insulin production, and consequently to excessive fetal growth, respiratory immaturity, and a range of metabolic disorders [14]. Even mild hyperglycemia has a negative impact on fetal development, and its severity in the final weeks of pregnancy may be a cause of intrauterine deaths [15].

Postprandial hyperglycemia consists of subtle impairment of insulin secretion, abnormal pulsatile insulin profiles, increased release of immature insulin, and, consequently, impaired secretion in the first phase [16,17], which contribute to the development of the initial postprandial hyperglycemia observed in the early stages and milder forms of GDM [16,17]. These mechanisms explain why fasting hyperglycemia is more dangerous for the developing fetus [16,17].

Therefore, this retrospective study from a single center in Rzeszów, Poland aimed to evaluate maternal and neonatal outcomes of pregnancy of 65 women with gestational diabetes mellitus (GDM).

Material and Methods

Ethics Approval

This study was approved by the Bioethics Committee of the District Medical Chamber (number 70/2021/B, date of approval: July 1, 2021).

Informed Consent

All patients in the test group were informed about the purpose of the study and its course, and eligibility for the study was possible only after they provided informed written consent.

Study Design and Participants

This multi-stage research project started with determination of the minimum sample size. The study included patients of the Fryderyk Chopin University Clinical Hospital in Rzeszów. An average of 1500 babies are delivered in this facility each year. Assuming a significance level $P<0.05$, a maximum error of 10%, and a prevalence of GDM in Poland of 6.2%, the minimum sample size of 23 women as calculated. Total number of subjects enrolled amounted to 125 women, including 65 with GDM (the study group) and 60 without GDM (the control group).

The next stage consisted in gathering a test group that met the criteria for inclusion and was diagnosed by the oral glucose tolerance test (OGTT) with disorders of carbohydrate metabolism in pregnancy (diabetes of pregnant women, diabetes in pregnancy). Next, the course of pregnancy was assessed: the method of normalization of glucose level (diet/insulin),

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manifestation of comorbidities during pregnancy, duration of pregnancy, and method of delivery.

The endpoint was comparison of the data obtained to assessment of the newborn for the presence or absence of macrosomia and comorbidities.

Participant Inclusion and Exclusion Criteria

Inclusion criteria:
- age 20-45 years,
- diagnosis in the OGTT test of carbohydrate disorders in pregnancy (diabetes in pregnancy, gestational diabetes).

Exclusion criteria:
- lack of consent to participate in the study,
- systemic diseases that can affect test results (eg, kidney failure, blood diseases, epilepsy). Both the disease itself and the treatment applied in each therapy can affect the course of pregnancy, fetal growth, and the perinatal period.

No complications were found in the newborns, probably because all deliveries took place in a tertiary referral hospital (the highest level of reference in Poland).

Women were provided with perinatal care from the beginning of pregnancy, while pregnant women with GDM reported for delivery, in accordance with the recommendations of the Polish Society of Gynecologists and Obstetricians, 7 days before the date of delivery. This practice reduces the risk of complications in newborns.

Assessment

Glycemia data were based on data from a screening test conducted between 24 and 28 weeks of pregnancy. Other data on the course of pregnancy – age, body mass before pregnancy, body height, body mass index (BMI), gravidity, parity, the number of miscarriages – were obtained from the patient's medical documentation and pregnancy card. Data on the method of delivery, length of stay (LOS) of mother and child, birth weight of child, assessment of newborn in pregnant women, both with GDM and healthy, were obtained from data in the Asseco Medical Management Solutions – AMMS computer program (Asseco Poland S.A., Poland).

Based on the pre-pregnancy and birth weight data, the gestational weight gain (GWG) was calculated. Small-for-gestational-age (SGA) infants are defined as less than the 10th birth weight percentile, appropriate-for-gestational-age (AGA) infants are defined as between the 10th and 90th birth weight percentile, and large-for-gestational-age (LGA) infants are defined as greater than the 90th percentile for gestational age, sex, and race [18].

Statistical Analysis

Statistical analysis of the collected material was performed in the Statistica 13.3 package (TIBCO Software, USA). The database and the graphical presentation of the results were prepared in Microsoft Excel and the description was prepared using Microsoft Word. The analysis used Pearson the chi-square test for nominal independent sample variables. Descriptive statistics were calculated: number, mean, median, minimum and maximum values, upper and lower quartile, and standard deviation. To assess the differences in the average level of a numerical feature due to the failure to meet the assumptions of the parametric test (lack of compliance of the distribution of the variable with the normal distribution verified by the Shapiro-Wilk W test), a non-parametric Mann-Whitney U test for 2 populations was used. The level of statistical significance was $P<0.05$.

Results

Characteristics of the Observation Group

Almost half (45.6%) of the women had normal body mass before pregnancy. In this regard, it was verified whether the GWG was in line with the recommendations of 11.5-16 kg, 7-11.5 kg, and 5-9 kg for women entering pregnancy with healthy body mass index (18.5-24.9 kg/m^2) – "normal BMI" in the World Health Organization (WHO) classification; overweight (25-29.9 kg/m^2) and obese (≥30 kg/m^2) respectively [19,20]. Only 36% of the women met these standards and 20% gained weight above the recommendations during pregnancy.

Almost 15% of the women had experienced miscarriage in their lifetime (from 1 to 3) and more than half (60.8%) of births were through cesarean section.

Considering the weight of the newborn [21], there were no small-for-gestational age (SGA) children born in the test group. Most (74.4%) babies were appropriate for gestational age (AGA), but almost one-quarter (22.4%) were large for gestational age (LGA) (**Table 1**).

The median age of the women in the study and control groups was 31.0 years. The body weights of mothers before delivery were similar between the 2 groups (Me=78.0 kg and 79.5 kg, respectively). The median LOS of diabetic mothers was 1 day longer. See **Table 2** for details. In the case of a normal distribution, data are presented as the mean value and standard deviation (SD). In the case of nonnormal distribution, the data are presented in the form of the median and the values of the quartiles).

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Table 1. Observation group – characteristics.

	N	%
GDM		
Yes	65	52.00
No	60	48.00
Diabetes treatment		
Diet	24	36.92
Insulin	41	63.08
Pre-pregnancy weight category		
Underweight	3	2.40
Normal	57	45.60
Overweight	35	28.00
Obesity	24	19.20
Lack of data	6	4.80
Compliance with GWG recommendations		
Yes	45	36.00
Below	47	37.60
Above	25	20.00
The number of miscarriages		
None	105	84.00
One	12	9.60
Two	5	4.00
Three	1	0.80
No data	2	1.60
Newborn type		
AGA	93	74.40
LGA	28	22.40
No data	4	3.20
Type of delivery		
Cesarean section	76	60.80
Vaginal birth	47	37.60
No data	2	1.60
Gender of the newborn		
Female	59	47.20
Male	66	52.80

N – number of observations;% – percent of observations; SGA - small for gestational age; AGA – appropriate for gestational age; LGA – large for gestational age; GWG – gestational weight gain; GDM – gestational diabetes mellitus.

Mother's and Child's Length of Stay

Statistical analysis showed that LOS of the mother significantly varied depending on the occurrence of GDM ($P<0.001$). Women with diabetes stayed in hospital longer than women without diabetes (median 4.0 vs 3.0). A similar situation occurred with the LOS of the child ($P<0.001$). However, GDM was not associated with the duration of pregnancy ($P>0.05$). The duration of pregnancy in the women with diabetes treated with diet was 1 week longer than in women treated with insulin ($P=0.022$) (**Table 3**).

We assessed whether the presence of GDM in the mother affected the method of delivery, her compliance with recommendations regarding GWG, and size of the newborn in relation to gestational age. Women with GDM were significantly more likely to deliver by CS ($P=0.024$) and these women more often had GWG within the recommended range ($P<0.001$). However, there was no increased incidence of LGA in mothers with GDM ($P>0.05$).

Mother's and Child's Outcomes in Relation to Incidence of GDM and Type of Treatment

There were also no differences in the analyzed parameters depending on the treatment applied (**Table 4**).

There were no statistically significant differences in Apgar scores assessed at 1, 3, and 5 min in children of mothers with and without GDM. In all cases, the test probability was greater than 0.05. There were also no differences in the analyzed parameters depending on the treatment applied (**Table 5**).

The analysis showed that the women with GDM were older than the women without GDM, which was confirmed by quartile values ($P=0.049$). Among women with GDM, 25% were aged 36 years and over (compared to 33 years and over for women without GDM) and the maximum age of women with GDM was 45 years versus 43 years for women without GDM.

BMI before pregnancy was significantly higher in women with GDM ($P=0.023$). The median value was 2 points higher than for women without GDM (26.4 vs 24.4) and 25% of women

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Table 2. Descriptive statistics for the study and control group.

Variables	Study group		Control group	
	N	$\bar{\chi}$±SD[a] Me (Q1-Q3)[b]	N	$\bar{\chi}$±SD[a] Me (Q1-Q3)[b]
Age [years]	65	31.0 (29.9-36.0)[b]	60	31.0 (27.0-33.0)[b]
Pre-pregnancy body mass [kg]	60	73.6±18.62[a]	60	68.0 (60.5-72.5)[b]
Body mass to delivery [kg]	61	78.0 (68.0-95.0)[b]	60	79.5 (73.2-85.0)[b]
Body height [cm]	61	165.0 (160.0-169.0)[b]	60	166.1±5.6[a]
Pre-pregnancy BMI	59	27.25 (22.8-32.2)[b]	60	24.8±3.2[a]
GWG	58	6.6±6.0[a]	60	11.0 (10.0-13.0)[b]
Gravidity	63	2.0 (1.0-3.0)[b]	60	2.0 (1.0-2.0)[b]
Parity	63	1.0 (1.0-2.0)[b]	60	2.0 (1.0-2.0)[b]
The duration of pregnancy	61	38.0 (37.0-39.0)[b]	60	38.5 (38.0-39.0)[b]
Apgar in 1st minute	58	10.0 (9.0-10.0)[b]	60	10.0 (9.0-10.0)[b]
Apgar in 3rd minute	57	10.0 (10.0-10.0)[b]	60	10.0 (10.0-10.0)[b]
Apgar in 5th minute	57	10.0 (10.0-10.0)[b]	60	10.0 (10.0-10.0)[b]
Birth body mass	63	3195.0 (2830.0-3560.0)[b]	60	3234.9±442.7[a]
Mother's LOS	65	4.0 (3.0-7.0)[b]	60	3.0 (2.0-4.0)[b]
Child's LOS	65	3.0 (3.0-5.0)[b]	60	3.0 (2.0-3.0)[b]

N – number of observations; $\bar{\chi}$ – mean; Me – median; Min. – minimum value; Max. – maximum value; Q1 – lower quartile; Q3 – upper quartile, SD – standard deviation, GWG – gestational weight gain, BMI – body mass index; LOS - Length of stay. [a] $\bar{\chi}$±SD; [b] Me(Q1-Q3).

with GDM had a BMI of 31.6 or more (in women without GDM it was 26.5).

It was also noted that women with GDM had significantly lower GWG values than women without GDM (Me=7.0 vs 11.0; *P*<0.001). In addition, 7 of the women with GDM reported weight loss, which ranged from 1 to 8 kg. In this group, 2 women had normal body mass, 2 were overweight, and 3 were obese. This shows the positive impact of education and the use of an appropriate diet during pregnancy. Taking into account the type of treatment applied, women treated with insulin had less weight gain (*P*=0.020).

However, there was no statistically significant difference in body mass of the child in women with GDM compared to women without GDM (*P*>0.05). See **Table 6** for details.

Discussion

We found that GDM has clinical implications not only for the mother, but also for the baby. More frequent CS were found but also economic consequences due to the longer LOS of both, which is confirmed by the results of our study, where women with GDM (and their children) were hospitalized significantly longer. Women with GDM were found to be older and had higher BMI before pregnancy.

Untreated diabetes can cause miscarriages, fetal death, malformations, and hyperinsulinemia manifested by macrosomia, fetal hypertension, myocardial hypertrophy, hypertension, and associated prolonged jaundice [6,22].

We found that GDM is more common in older women. This is confirmed by data from the literature. GDM, as well as many other medical conditions complicating pregnancy, are more common in older women [23,24]. GDM in advanced age is a high-risk condition, more specifically an age-related risk, and the risk of GDM appears to increase in cases of preeclampsia [25].

More often, obese pregnant women are at risk of developing gestational diabetes, which is due to abnormal glucose metabolism [23]. Overweight/obesity is associated with a grouping of metabolic risk factors in early pregnancy that is correlated

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Table 3. LOS of mother and child and duration of pregnancy depending on GDM.

GDM	Mother's LOS									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Yes	65	7.5	4.0	2.0	69.0	3.0	7.0	10.90	1209.50	<0.001
No	60	3.1	3.0	2.0	12.0	2.0	4.0	1.67		
GDM	**Child's LOS**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Yes	65	6.4	3.0	2.0	69.0	3.0	5.0	9.77	1134.50	<0.001
No	60	2.6	3.0	2.0	5.0	2.0	3.0	0.65		
GDM	**The duration of pregnancy**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Yes	61	37.7	38.0	26.0	41.0	37.0	39.0	2.47	1632.50	0.307
No	60	38.3	38.5	32.0	40.0	38.0	39.0	1.49		
Treatment	**Mother's LOS**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Diet	24	4.6	3.0	2.0	20.0	3.0	5.0	3.83	420.50	0.335
Insulin	41	9.2	4.0	2.0	69.0	3.0	10.0	13.18		
Treatment	**Child's LOS**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Diet	24	4.2	3.0	2.0	20.0	3.0	4.0	3.84	429.00	0.396
Insulin	41	7.7	3.0	2.0	69.0	3.0	7.0	11.80		
Treatment	**The duration of pregnancy**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Diet	21	38.5	39.0	31.0	41.0	38.0	40.0	2.04	268.00	0.022
Insulin	40	37.3	38.0	26.0	40.0	37.0	39.0	2.60		

N – number of observations; $\bar{\chi}$ – mean; Me – Median; Min. – minimum value; Max. – maximum value; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; U – value of the Mann-Whitney U test; *P* – test probability value; GDM – gestational diabetes mellitus, LOS – length of stay.

with a higher risk of GDM. Research by Yen et al suggests that metabolic risk factors in early pregnancy should be assessed in overweight/obese women [26]. In our own study, the results obtained in the literature were confirmed. In our group, women with GDM before pregnancy had a higher BMI than women without GDM, indicating that they were overweight.

Appropriate control of glycemia (patients were cared for and treated at the Diabetes Clinic of the University Clinical Hospital No. 1 in Rzeszów) also contributed to the appropriate weight of the mother and the newborn. The literature strongly links macrosomia to GDM [27]. According to the latest data, it is very important to analyze the relationship between GDM and fetal macrosomia, while correcting for the mother's obesity. In this way, one can show the true nature of the relationship between these 2 factors, without considering the co-relationship of maternal obesity [28]. GWG of women diagnosed with gestational diabetes fell within the normal range compared to women without GDM, which proves that they were receiving appropriate control of glycemia, and the effectiveness of diet and treatment of hyperglycemia.

The LOS of GDM patients was longer compared to the healthy women because patients were admitted to the hospital at an

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Table 4. The relationship between the method of delivery, GWG in accordance with the recommendations, type of newborn, and GDM.

Type of delivery	GDM	
	Yes	No
CS	N=45 (36.6%)	N=31 (25.2%)
VB	N=18 (14.6%)	N=29 (23.6%)
All	N=63 (51.2%)	N=60 (48.8%)
	χ^2=5.083; *P*=0.024	

Type of delivery	Treatment	
	Diet	Insulin
CS	N=13 (20.6%)	N=32 (50.8%)
VB	N=9 (14.3%)	N=9 (14.3%)
All	N=22 (34.9%)	N=41 (65.1%)
	χ^2=2.521; *P*=0.112	

GWG (recommendation)	GDM	
	Yes	No
Yes	N=13 (11.1%)	N=32 (27.4%)
Below	N=34 (29.1%)	N=13 (11.1%)
Above	N=10 (8.5%)	N=15 (12.8%)
All	N=57 (48.7%)	N=60 (51.3%)
	χ^2=18.340; *P*<0.001	

GWG (recommendation)	Treatment	
	Diet	Insulin
Yes	**N=5 (8.8%)**	N=8 (14.0%)
Below	**N=11 (19.3%)**	N=23 (40.4%)
Above	**N=5 (8.8%)**	N=5 (8.8%)
All	**N=21 (36.8%)**	N=36 (63.2%)
	χ^2=1.053; *P*=0.591	

Type of newborn	GDM	
	Yes	No
AGA	N=46 (30.8%)	N=47 (38.8%)
LGA	N=15 (12.4%)	N=13 (10.7%)
All	N=61 (50.4%)	N=60 (49.6%)
	χ^2=0.145; *P*=0.703	

Type of newborn	Treatment	
	Diet	Insulin
AGA	N=17 (27.9%)	N=29 (47.5%)
LGA	N=4 (6.6%)	N=11 (18.0%)
All	N=21 (34.4%)	N=40 (65.6%)
	χ^2=0.531; *P*=0.466	

χ^2 – Chi-square test value; p – test probability value; GDM – gestational diabetes mellitus; GWG – gestational weight gain; CS – Cesarean section; VB – vaginal birth; AGA – appropriate-for-gestational age, LGA – large-for-gestational age.

earlier date for preinduction of labor and more frequent delivered by cesarean section.

None of the newborns had birth defects. This is explained, among other things, by the fact that detection of diabetes in early pregnancy is associated with more serious complications compared to diabetes detected at 24-28 weeks of gestation, even with early treatment [29]. This is due to the toxic effect of glucose metabolites on tissues during organogenesis. In the analyzed cases, diabetes was detected at 24-28 weeks of pregnancy.

According to the literature, adverse reactions are more common in women with pre-gestational diabetes than in those with gestational diabetes [23]. In the study group, all of the patients were diagnosed with diabetes during pregnancy.

Hartling et al performed a systematic review and meta-analysis for the U.S. Preventive Services Task Force and the National Institutes of Health Office of Medical Applications of Research. The study included pregnant women with GDM, and the results obtained indicate a slight reduction in the risk of preeclampsia, shoulder dystocia, and fetal macrosomia in the group of women undergoing treatment. The only adverse effect of diabetes treatment was a greater number of perinatal visits. The results presented are consistent with those obtained in our study. The authors also did not show differences in CS, labor induction, low neonatal weight, or admission to the neonatal intensive care unit. This is consistent with data from the Rzeszów center. In addition, researchers emphasize excessive GWG and baseline obesity, which are unfavorable for perinatal outcomes [30]. Similar data were obtained in our study.

Pillay et al reviewed GDM screening tests and their consequences to update the 2014 U.S. Preventive Services Task Force recommendation. Data analysis shows that treated GDM diagnosed at 24 weeks of gestation is associated with a lower risk of preterm birth, preeclampsia, and fetal macrosomia. There was no association with the risk of hypoglycaemia in newborns and an increased number of CS deliveries [31]. These data are consistent with the results obtained in our study.

A similar study was conducted at the Department of Obstetrics and Gynecology, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry, India. Hospitalized women

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Table 5. Effect of GDM on Apgar scores at 1, 3, and 5 minutes.

GDM	Apgar in 1st minute									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	*SD*	U	*P*
Yes	58	9.3	10.0	5.0	10.0	9.0	10.0	1.26	1696.00	0.815
No	60	9.5	10.0	8.0	10.0	9.0	10.0	0.65		
GDM	**Apgar in 3rd minute**									
	N	$\bar{\chi}$	**Me**	**Min.**	**Max.**	**Q1**	**Q3**	***SD***	**U**	***P***
Yes	57	9.6	10.0	6.0	10.0	10.0	10.0	1.09	1651.00	0.750
No	60	9.8	10.0	8.0	10.0	10.0	10.0	0.51		
GDM	**Apgar in 5th minute**									
	N	$\bar{\chi}$	**Me**	**Min.**	**Max.**	**Q1**	**Q3**	***SD***	**U**	***P***
Yes	57	9.8	10.0	7.0	10.0	10.0	10.0	0.79	1605.50	0.571
No	60	9.9	10.0	8.0	10.0	10.0	10.0	0.33		
Treatment	**Apgar in 1st minute**									
	N	$\bar{\chi}$	**Me**	**Min.**	**Max.**	**Q1**	**Q3**	***SD***	**U**	***P***
Diet	20	9.1	9.5	7.0	10.0	9.0	10.0	2.42	351.50	0.647
Insulin	38	9.2	10.0	5.0	10.0	9.0	10.0	1.32		
Treatment	**Apgar in 3rd minute**									
	N	$\bar{\chi}$	**Me**	**Min.**	**Max.**	**Q1**	**Q3**	***SD***	**U**	***P***
Diet	19	9.4	10.0	7.0	10.0	10.0	10.0	2.50	329.50	0.600
Insulin	38	9.5	10.0	6.0	10.0	10.0	10.0	1.11		
Treatment	**Apgar in 5th minute**									
	N	$\bar{\chi}$	**Me**	**Min.**	**Max.**	**Q1**	**Q3**	***SD***	**U**	***P***
Diet	19	9.5	10.0	8.0	10.0	10.0	10.0	2.46	321.50	0.509
Insulin	38	9.7	10.0	7.0	10.0	10.0	10.0	0.74		

N – number of observations; $\bar{\chi}$ – mean; Median; Min. – minimum value; Max. – maximum value; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; U – value of the Mann-Whitney U test; p – test probability value; GDM – gestational diabetes mellitus.

tended to have lower economic status, suggesting that their access to perinatal care and education was limited. This had consequences for the obstetric outcomes in the Indian population studied; they were worse than in the Polish population in the present study: 44% versus 36.6% of women required a cesarean section and 34% experienced complications during pregnancy or childbirth; 3 newborns had macrosomia; 20% required admission to the neonatal intensive care unit, and infant mortality was 3% versus 0%. Fewer complications were found in newborns from mothers whose GDM was compensated. This example highlights the role of compensated GDM in perinatal outcomes in both the mother and the fetus [32].

Data from the literature highlight the adverse role of factors that complicate pregnancy as a cause of cardiovascular complications later in women's lives. The pathophysiology of changes is multifactorial, occurring under the influence of both environmental and physiological factors. After accounting for confounding factors, including overweight, smoking, and comorbidities, large-cohort studies indicate that pregnancy complications were associated with all-cause mortality, cardiovascular mortality, and hospitalizations for cardiovascular disease. The study highlighted that less common complications of pregnancy, such as preterm birth and stillbirth, are also associated with cardiovascular diseases and mortality from cardiovascular diseases [33].

It is necessary to learn about these mechanisms and to distinguish a group of women at high risk of developing complications with vascular etiology to apply preventive measures in a timely manner.

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Table 6. Differences in maternal age, BMI, GWG, and birth weight of the child and the occurrence of GDM in the mother.

GDM	Mother's age [years]									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Yes	65	32.3	31.0	23.0	45.0	29.0	36.0	4.77	1412.50	0.049
No	55	30.2	31.0	20.0	43.0	27.0	33.0	4.36		
GDM	**Pre-pregnancy maternal BMI [kg/m²]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Yes	59	27.5	27.3	17.9	48.1	22.8	32.2	6.83	1342.00	0.023
No	60	24.8	24.4	19.1	32.7	22.7	26.5	3.24		
GDM	**GWG [kg]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Yes	58	6.6	7.0	-8.0	23.0	3.0	11.0	6.03	768.00	<0.001
No	60	11.7	11.0	6.0	22.0	10.0	13.0	3.08		
GDM	**Child's birth body mass [g]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Yes	63	3146.7	3195.0	830.0	4650.0	2830.0	3560.0	700.41	1838.00	0.794
No	60	3234.9	3210.0	2300.0	4709.0	3000.0	3470.0	442.68		
Treatment	**Mother's age [years]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Diet	24	31.3	30.5	24.0	43.0	29.0	32.5	4.39	413.00	0.286
Insulin	41	32.8	31.0	23.0	45.0	29.0	36.0	4.95		
Treatment	**Pre-pregnancy maternal BMI [kg/m²]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Diet	22	26.4	24.7	18.3	41.9	21.1	28.7	6.58	329.50	0.227
Insulin	37	28.1	27.4	17.9	48.1	24.4	31.6	6.23		
Treatment	**GWG [kg]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Diet	21	9.0	9.0	-8.0	23.0	7.0	13.0	6.59	2.39	0.020
Insulin	37	5.3	5.0	-7.0	14.0	2.0	8.0	5.30		
Treatment	**Child's birth body mass [g]**									
	N	$\bar{\chi}$	Me	Min.	Max.	Q1	Q3	SD	U	P
Diet	22	3214.8	3210.0	1150.0	4650.0	2680.0	3600.0	741.76	411.50	0.574
Insulin	41	3110.2	3150.0	830.0	4400.0	2880.0	3510.0	683.83		

N – number of observations; $\bar{\chi}$ – mean; Median; Min. – minimum value; Max. – maximum value; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; *t* – *t* test for independent samples; U – value of the Mann-Whitney U test; *P* – test probability value; BMI – body mass index; GDM – gestational diabetes mellitus; GWG – gestational weight gain.

Strengths of the present study -are that it showed a positive effect of qualified specialist medical care on perinatal outcomes, and it was carried out in a medical center by a team of researchers using standardized pregnancy management.

By analyzing the modifiable and non-modifiable factors of the development of hyperglycemia in pregnancy, the study confirmed that through the education of patients it is possible to influence their dietary behavior and body mass regulation, thus reducing the negative impact of hyperglycemia on the health of the mother and child. The key here is a diet based on the patient's BMI, weight gain of up to 5-7 kg in obese patients, as well as intensive control of glycemia, preventing significant changes in glycemia during the day.

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The implementation of the FREE STYLE LIBRE [34] continuous monitoring system with the use of a telephone application may be key to meeting the above conditions. It also seems advisable to introduce recommendations for physical activity together with recording the number of steps walked each day.

The study may be limited by the small number of patients, which is the result of the parity that prevails in the center. This number is also influenced by the demographic decline and the lower number of births in Poland. Considering the results obtained, it is worth continuing the research results by expanding them with an additional assessment of the patients' physical activity and its relationship with GDM.

Conclusions

Our study confirms that GDM has a clear impact on prolonged LOS of the mother and child, more frequent CS delivery, and normal GWG.

Awareness of the occurrence of GDM as well as proper education and control of glycemia contribute to appropriate weight gain during pregnancy, which proves the great responsibility of future mothers and the importance of their knowledge. Efforts should be made to improve care and to develop education on the risks arising from the consequences of abnormal glycemic values.

In the analyzed group, fetal macrosomia was not found more often in the group of women with GDM, which may indicate that they were receiving appropriate treatment and thus there was no negative influence of hyperglycemia on fetal development. Therefore, it seems advisable to conduct education in the field of nutrition and appropriate weight gain for all pregnant women.

Institution Where Work Was Done

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