

Influence of gestational diabetes mellitus on the birth condition of full-term newborns – a preliminary study

Katarzyna Szymoniak^{1, A} ✉, Nikola Olejnik², Małgorzata Zimny^{1, B}, Olimpia Sipak-Szmigiel^{1, C}

¹ Pomeranian Medical University in Szczecin, Department of Obstetrics and Pathology of Pregnancy, Żołnierska 48, 71-210 Szczecin, Poland

² Pomeranian Medical University Hospital No. 2, Department of Neonatal Pathology, Powstańców Wlkp. 72, 70-111 Szczecin, Poland

^A ORCID: 0000-0003-3941-7340; ^B ORCID: 0000-0003-1695-6966; ^C ORCID: 0000-0002-3410-1809

✉ katarzyna.szymoniak@pum.edu.pl

ABSTRACT

Introduction: Gestational diabetes mellitus (GDM) is defined as abnormal glucose tolerance, whose symptoms are first detected during pregnancy. Gestational diabetes mellitus is the cause of abnormalities in pregnancy and fetal development. It can be diagnosed by analyzing blood glucose levels and performing mandatory screening tests. This paper describes the general concept of GDM, its risk factors and complications that may occur in the newborn.

The aim of this study was to assess the effect of GDM on the birth condition of full-term newborns.

Materials and methods: The study included 104 women divided into 2 groups: study and control. A retrospective method was used to analyze the medical records of the women and their children. The research analysis was performed by calculating the number and percentage of occurrences of each response. The comparison of the qualitative variables between the groups was performed using the χ^2 test or Fisher's exact test where low expected numbers appeared in the tables. A significance level of 0.05 was adopted.

Results: The majority of newborns in both groups got an Apgar score of 8–10 at 1 and 5 min. The results of a pulse oximetry test on the 1st day of life showed that all children had normal saturation of 95–100%, irrespective of whether their mother had diabetes or not. Considering the birth weight, it was shown that neonates from the study group significantly more often were born heavier than their counterparts from the control group ($p < 0.001$). Analysis of the newborns' health on successive days of life did not reveal any statistically significant differences in the studied parameters between the groups ($p > 0.05$). Analysis of congenital anomalies revealed a heart defect in 1 neonate and a kidney defect in 2 neonates from the study group.

Conclusions: 1. Newborns of mothers with GDM are usually born on time by Cesarean section, in good general condition, and with normal blood glucose levels and saturation. 2. Gestational diabetes mellitus affects neonatal birth weight. Babies of mothers with GDM were born heavier than those of healthy mothers. 3. Gestational diabetes mellitus has little effect on neonatal activity and muscle tone, as well as on the incidence of congenital defects.

Keywords: gestational diabetes; neonate; complications; congenital defects.

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as abnormal glucose tolerance, whose abnormal glucose levels are first detected in pregnancy. Early diagnosis and treatment of this disease are essential for the prevention of its complications. Gestational diabetes mellitus is the cause of abnormalities in pregnancy and fetal development. It can be diagnosed by analyzing blood glucose levels and performing mandatory screening tests. Depending on glucose concentration, its normal levels can be achieved through diet and/or insulin, which reduces the risk of fetal abnormalities. Women's awareness of this disease and the possibility of complications in their newborn and adult children is very important. This paper describes the general concept of GDM, its risk factors and complications, macrosomia and intrauterine hypotrophy, hypoglycemia, and congenital anomalies that may occur in the newborn of a mother with GDM.

The aim of this study was to assess the effect of GDM on the birth condition of full-term newborns.

MATERIALS AND METHODS

The study included 104 women. The study group consisted of 73 women with GDM, and the control group comprised 31 healthy women. The research was carried out in the Department of Neonatal Pathology, Pomeranian Medical University Hospital No. 2 in Szczecin, Poland. Prior to the study, the consent of the head of the Department of Neonatal Pathology was obtained. It was a retrospective study based on an analysis of the medical records of the patients and their children. The thus-created database was divided into 3 parts. The 1st part covered the patient's sociodemographic data (age, employment status, marital status, place of residence, gestational age at delivery, and delivery method). The 2nd part concerned the birth condition of the full-term newborn (the Apgar score at 1 and 5 min, cord blood glucose, birth weight, blood saturation, and postpartum glycemia). The 3rd part concerned the health of the newborn on the subsequent days of life (blood glucose level, heart rate, respiratory rate, skin color, muscle tone, behavior of the newborn, blood bilirubin level, and congenital anomalies).

The research analysis was performed by calculating the number and percentage of occurrences of each response. The comparison of the qualitative variables between the groups was performed using the χ^2 test (with Yates's correction for 2 x 2 tables) or Fisher's exact test where low expected numbers appeared in the tables. A significance level of 0.05 was adopted.

RESULTS

The results of the study showed that the highest number of women in both groups were aged between 20–35 years (76.03% vs. 74.19%). The largest number of respondents, from both the study group (81.69%) and the control group (87.10%) were employed. Analysis of the respondents' marital status revealed that 63.73% of them were married, including 66.20% of the study group and 58.06% of the control group. The largest number of respondents (91.18%) came from urban areas, including 94.37% of the study group and 83.87% of the control group. There were no statistically significant differences between the groups ($p > 0.05$). However, when analyzing gestational age at delivery, it was shown that respondents with GDM significantly more often gave birth between the 37th–39th week of gestation (95.77%), while healthy women – between the 40th–42nd weeks of gestation (61.29%; $p < 0.001$). Furthermore, women from the study group had a Cesarean section significantly more often (50.70%), and those from the control group were significantly more likely to give birth naturally (74.19%; $p = 0.026$) – Table 1.

More than 67.00% of the women with gestational diabetes were diagnosed with type 1 GDM. More than 95% of the respondents managed their disease with their doctor and the majority did not take insulin during pregnancy (67.61%) – Table 2.

TABLE 1. Sociodemographic data

Parameters	Study group	Control group	Total	p	
Age	up to 19 years	3 (4.23%)	0 (0.00%)	3 (2.94%)	0.552
	20–35 years	54 (76.06%)	23 (74.19%)	77 (75.49%)	
	over 35 years	14 (19.72%)	8 (25.81%)	22 (21.57%)	
Employment status	student	4 (5.63%)	0 (0.00%)	4 (3.92%)	0.591
	employed	58 (81.69%)	27 (87.10%)	85 (85.33%)	
	unemployed	9 (12.68%)	4 (12.90%)	13 (12.75%)	
Marital status	married	47 (66.20%)	18 (58.06%)	65 (63.73%)	0.574
	unmarried	24 (33.80%)	13 (41.94%)	37 (36.27%)	
Place of residence	urban	67 (94.37%)	26 (83.87%)	93 (91.18%)	0.126
	rural	4 (5.63%)	5 (16.13%)	9 (8.82%)	
Gestational age at delivery	37th–39th week	68 (95.77%)	10 (32.26%)	78 (76.47%)	0.001
	40th–42nd week	3 (4.23%)	19 (61.29%)	22 (21.57%)	
	over 42 weeks	0 (0.00%)	2 (6.45%)	2 (1.96%)	
Delivery method	vaginal	35 (49.30%)	23 (74.19%)	58 (56.86%)	0.026
	Cesarean section	36 (50.70%)	8 (25.81%)	44 (43.14%)	

p – Fisher's exact test

TABLE 2. Course of gestational diabetes in female respondents

Study group	n	%	
Type of diabetes	type 1 GDM	48	67.61
	type 2 GDM	23	32.39
Medical care	yes	68	95.77
	no	3	4.23
Insulin	yes	23	32.39
	no	48	67.61

GDM – gestational diabetes mellitus

Assessment of neonatal health after delivery

The majority of the newborns in both groups got an Apgar score of 8–10 at 1 min. There were no statistically significant differences between the groups ($p = 0.102$). Both the children from the study group (88.73%) and those from the control group (100%) received maximum scores. Neonatal assessment at 5 min also showed that most of the newborns were in generally good condition, irrespective of whether the mother had diabetes (94.37%) or not (100%; $p = 0.311$) – Table 3.

The results of the neonatal pulse oximetry test on the 1st day of life showed that all the newborns had normal saturation (95–100%), regardless of whether the mother had diabetes or not ($p = 1$) – Table 4.

Analysis of the level of glycemia after delivery revealed that almost 90% of newborns of diabetic mothers had normal blood glucose levels. Also on the following days, blood glucose levels remained within the normal range in over 80% of these newborns ($p = 0.276$) – Table 5.

TABLE 3. Apgar scores in the 1st and the 5th min of life

Apgar score		Study group	Control group	Total	p
Score at 1 min	8–10	63 (88.73%)	31 (100.00%)	94 (92.16%)	0.102
	4–7	8 (11.27%)	0 (0.00%)	8 (7.84%)	
	0–3	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Score at 5 min	8–10	67 (94.37%)	31 (100.00%)	98 (96.08%)	0.311
	4–7	4 (5.63%)	0 (0.00%)	4 (3.92%)	
	0–3	0 (0.00%)	0 (0.00%)	0 (0.00%)	

p – Fisher's exact test

TABLE 4. A pulse oximetry test

Saturation	Groups			p
	study group	control group	total	
95–100%	71 (100.00%)	31 (100.00%)	102 (100.00%)	1
Below 95%	0 (0.00%)	0 (0.00%)	0 (0.00%)	

p – Fisher's exact test

TABLE 5. Blood glucose levels in newborns of diabetic mothers

Glycemic levels on various days	Study group		p	
	n	%		
Postpartum glycemia	normal	62	87.32	0.276
	hypoglycemia	9	12.68	
Glycemia on the following days	normal	58	81.69	
	hypoglycemia – single episodes	11	15.49	
	recurring hypoglycemia	2	2.82	

p – Fisher's exact test

Most of the newborns did not have a bilirubin blood test as there were no indications. The rest of the neonates in both groups had elevated bilirubin levels (9.86% vs. 12.90%) – Table 6.

TABLE 6. Blood bilirubin levels in the newborns

Bilirubin levels	Study group	Control group	Total	p
Normal	0 (0.00%)	0 (0.00%)	0 (0.00%)	0.732
Elevated (hepatitis)	7 (9.86%)	4 (12.90%)	11 (10.78%)	
No test	64 (90.14%)	27 (87.10%)	91 (89.22%)	

p – Fisher's exact test

Considering birth weight, it was shown that neonates from the study group were significantly heavier than their counterparts from the control group ($p < 0.001$). Over 50% of newborns in the study group were born with a weight of 3600–4000 g, and over 70% of those in the control group were born with a weight of 2500–3500 g (Tab. 7).

TABLE 7. Birth weight

Weight	Study group	Control group	Total	p
Below 2500 g	6 (8.45%)	0 (0.00%)	6 (5.88%)	0.001
2500–3500 g	15 (21.13%)	22 (70.97%)	37 (36.27%)	
3600–4000 g	39 (54.93%)	9 (29.03%)	48 (47.06%)	
Over 4000 g	11 (15.49%)	0 (0.00%)	11 (10.78%)	

p – Fisher's exact test

Analysis of the newborns' health on successive days of life did not reveal any statistically significant differences in the studied parameters between the groups ($p > 0.05$). When assessing the newborns' heart rate, we found that over 67% of neonates from the study group and over 87% of those from the control group did not have this test due to good health, and that only 1 child of a diabetic mother had tachycardia. All the newborns breathed normally (100%) irrespective of which group they belonged to. Assessment of the color of the skin demonstrated that the majority of newborns in the study group were pink (91.55%), and only 8.45% were pale. Analysis of the muscle tone in newborns of diabetic mothers showed that 2.82% of them had decreased muscle tone and 9.86% had tremors, while the rest of the study group and the entire control group had normal muscle tone. Furthermore, the activity of the newborns was assessed, and it was found that 78.87% of neonates from the study group exhibited normal behavior, 11.27% were apathetic, and 8.45% were anxious. In the control group, only 6.45% of babies were lethargic, while the rest behaved normally (93.55%) – Table 8.

Out of all examined babies, only 1 in the study group was diagnosed with a heart defect and 2 had kidney defects. The rest of the children were born without any birth defects ($p = 1$) – Table 9.

DISCUSSION

Pregnancy is a unique state, but it does not always proceed without complications. In obstetrics, there are many pregnancy-related problems that may worry women. One of them is gestational diabetes, which can be associated with age-related complications for both mother and fetus. These, however, can be avoided, provided that diabetes is detected early and appropriate (diet or insulin) treatment is implemented.

TABLE 8. Neonatal health status on the subsequent days

Tested parameters	Study group	Control group	Total	p	
Heart rate	normal	22 (30.99%)	4 (12.90%)	26 (25.49%)	0.078
	bradycardia	0 (0.00%)	0 (0.00%)	0 (0.00%)	
	tachycardia	1 (1.41%)	0 (0.00%)	1 (0.98%)	
Breath	no	48 (67.61%)	27 (87.10%)	75 (73.53%)	1
	normal	71 (100.00%)	31 (100.00%)	102 (100.00%)	
Color of the skin	abnormal	0 (0.00%)	0 (0.00%)	0 (0.00%)	0.174
	pink	65 (91.55%)	31 (100.00%)	96 (94.12%)	
Muscle tone	pale	6 (8.45%)	0 (0.00%)	6 (5.88%)	0.179
	normal	62 (87.32%)	31 (100.00%)	93 (91.18%)	
	increased	0 (0.00%)	0 (0.00%)	0 (0.00%)	
	decreased	2 (2.82%)	0 (0.00%)	2 (1.96%)	
Newborn behavior	tremor of extremities	7 (9.86%)	0 (0.00%)	7 (6.86%)	0.437
	normal	56 (78.87%)	29 (93.55%)	85 (83.33%)	
	anxious	6 (8.45%)	0 (0.00%)	6 (8.45%)	
	apathetic	1 (1.41%)	0 (0.00%)	1 (0.98%)	
	lethargic	8 (11.27%)	2 (6.45%)	10 (9.80%)	

p – Fisher's exact test

TABLE 9. Congenital defects

Congenital defects	Study group	Control group	Total	p
Cardiac defects	1 (1.41%)	0 (0.00%)	1 (0.98%)	1
Defects of the central nervous system	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Kidney defects	2 (2.82%)	0 (0.00%)	2 (1.96%)	
Defects of the locomotor system	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Gastrointestinal defects	0 (0.00%)	0 (0.00%)	0 (0.00%)	
No	68 (95.77%)	31 (100.00%)	99 (97.06%)	

p – Fisher's exact test

When analyzing gestational age at delivery, we found that women with GDM significantly more often gave birth on time, i.e. between the 37th–39th week of gestation (95.77%). In a study by Olmos et al. pregnancy ended in the 37th week on average [1], while in a study by Sissala et al., women with GDM gave birth on average in the 39th week of gestation ($p = 0.001$) [2]. Different results were obtained by Yue et al., who reported that diabetes in pregnancy significantly frequently led to preterm delivery ($p = 0.002$) [3]. In our study, the majority of newborns of diabetic mothers got an Apgar score of 8–10 at 1 and 5 min (88.73%; 94.37%). This means that they were born in a generally good condition, similarly to newborns of healthy mothers, of whom 100% were in a generally good condition. This is in line with Yue et al. findings, who reported that newborns of

diabetic mothers were born in good condition, and only 6.9% of the babies had unfavorable test results [3]. Sissala et al. also informed that the condition of newborns, as assessed by the Apgar scores at 1 and 5 min did not statistically significantly differ between the groups with and without GDM ($p > 0.05$) [2].

Another factor analyzed in our study was the newborns' birth weight. It was noted that children from the study group were born heavier more often than children of healthy mothers. Over 50% of newborns in the study group were born with a weight of 3600–4000 g, while slightly over 15% of children were born with a weight of more than 4000 g, which is considered macrosomia. Sissala et al. also confirmed that newborns of mothers with GDM were heavier than those of mothers without GDM ($p = 0.004$) [2]. In the study by Olmos et al., macrosomia was found in 14.9% of neonates [1]. It was also reported by Yue et al. in children of diabetic mothers ($p = 0.001$) [3].

As stated by Pawlik and Radziszewska, hypoglycemia in the newborns of diabetic mothers was the most common abnormality (25–40%) observed in the postpartum period [4]. In our study, children of mothers with GDM had umbilical cord blood glucose measured, and 87.32% of them had normal levels. Only 15.49% of those neonates had hypoglycemia on the days following delivery. Alam et al. reported postpartum hypoglycemia in 35% of newborns [5].

Another GDM-related risk factor is the occurrence of hyperbilirubinemia in a newborn baby [6]. In our study, in both groups a similar percentage of newborns had elevated blood bilirubin levels (9.86% vs. 12.90); no statistically significant differences were observed between the groups. Lorenc and Otto-Buczowska noted bilirubin levels elevated by more than 15 mg/dL in 20% of newborns of mothers with GDM [7].

Gestational diabetes mellitus may entail a risk of birth defects in newborn babies. According to Skarsgard, the incidence of congenital malformations in the offspring of diabetic women ranges 2.7–16.8%, and such variation results from different levels of perinatal and diabetic care [8]. In our study, only 1 infant from the study group had a heart defect, and 2 newborns from the same group had kidney defects. The rest of the children were born without any congenital anomalies. Sheffield et al. observed birth defects in 1.2% of babies born by diabetic mothers with normal fasting glycemia, and in 4.8% born by those with elevated fasting glycemia [9]. Łagoda et al. noted congenital malformations in 0.8% of neonates of women with normoglycemia during organogenesis compared to 7.5% of those born by women with uncontrolled diabetes during this period [10].

One more factor analyzed in our study was the infant's breathing after birth. It was shown that all of the babies were breathing properly. Mannan et al. noted respiratory disorders in 11.1% of newborns of mothers with GDM [11]. Bartha et al., on the other hand, informed that with proper glycemic control during pregnancy, there were no differences in fetal lung development between mothers with GDM and healthy ones [12]. Similar results were presented by Sissala et al., who provided evidence that only a small percentage of children of diabetic (13%) and healthy mothers (9.2%) needed oxygen therapy after delivery ($p = 0.010$) [2]. Also, Yue et al. demonstrated that neither severe morbidity nor mortality was observed in babies of mothers with GDM [3].

CONCLUSIONS

1. Newborns of mothers with GDM were generally born on time by Cesarean section, in good general condition, with normal blood glucose levels and saturation.

2. Babies of mothers with GDM were born heavier than those of healthy mothers.
3. Gestational diabetes mellitus had little influence little effect on neonatal activity and muscle tone.

REFERENCES

1. Olmos PR, Borzone GR, Olmos RI, Valencia CN, Bravo FA, Hodgson MI, et al. Gestational diabetes and pre-pregnancy overweight: possible factors involved in newborn makrosomia. *J Obstet Gynaecol Res* 2012;38(1):208-14.
2. Sissala N, Mustaniemi S, Kajantie E, Väärasmäki M, Koivunen P. Higher hemoglobin levels are an independent risk factor for gestational diabetes. *Sci Rep* 2022;12(1):1686. doi: 10.1038/s41598-022-05801-y.
3. Yue S, Thi VTK, Dung LP, Nhu BTH, Kestelyn E, Thuan DT, et al. Clinical consequences of gestational diabetes mellitus and maternal obesity as defined by asian BMI thresholds in Viet Nam: a prospective, hospital-based, cohort study. *BMC Pregnancy Childbirth* 2022;22(1):195. doi: 10.1186/s12884-022-04533-1.
4. Pawlik D, Radziszewska R. Cukrzyca u matki i jej konsekwencje dla dziecka. *Endokrynol Ped* 2015;14(1):43-51.
5. Alam M, Raza SJ, Sherali AR, Akhtar AS. Neonatal complications in infants born to diabetic mothers. *J Coll Physicians Surg Pak* 2006;16(3):212-5.
6. Alfadhli EM. Gestational diabetes mellitus. *Saudi Med J* 2015;36(4):399-406. doi: 10.15537/smj.2015.4.10307.
7. Lorenc A, Otto-Buczowska E. Maternal diabetes mellitus – risk factor for fetus and infant. *J Endocrinol Diab* 2018;5(3):1-7. doi: 10.15226/2374-6890/5/3/001107.
8. Skarsgard E. Neonatal small left colon syndrome. *Medscape*; 2021. <https://emedicine.medscape.com/article/937183-overview> (24.01.2022).
9. Sheffield JS, Butler-Koster EL, Casey BM, McIntire DD, Leveno KJ. Maternal diabetes mellitus and infant malformations. *Obstet Gynecol* 2002;100(5 Pt 1):925-30.
10. Łagoda K, Kobus G, Bachórzewska-Gajewska H. Wpływ cukrzycy ciąży na rozwój płodu i noworodka. *Endokrynol Otył Zab Przem Mat* 2008;4(4):168-73.
11. Mannan MA, Rahman MH, Ara I, Afroz H. Prevalence and pregnancy outcome of gestational diabetes mellitus among Bangladeshi Urban pregnant women. *J Med* 2012;13(2):147-51.
12. Bartha JL, Martinez-Del-Fresno P, Comino-Delgado R. Early diagnosis of gestational diabetes mellitus and prevention of diabetes-related complications. *Eur J Obstet Gynecol Reprod Biol* 2003;109(1):41-4.