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Comparison of the clinical characteristics, glycemic control, and pregnancy outcomes between women with gestational diabetes mellitus in waves I and III of the COVID-19 pandemic: a reference center report

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ABSTRACT

Objectives: The medical care of patients with gestational diabetes mellitus (GDM) during the COVID-19 pandemic was influenced by changing epidemiological conditions and government regulations. Aim — to compare the clinical pregnancy data of GDM women between waves I and III of the pandemic.

Material and methods: We performed a retrospective analysis of medical records from the GDM clinic and compared the periods of March–May 2020 (wave I) and March–May 2021 (wave III).

Results: Women with GDM during wave I (n = 119) compared to wave III (n = 116) were older (33.0 ± 4.7 vs 32.1 ± 4.8 years; p = 0.07), booked later (21.8 ± 8.4 vs 20.3 ± 8.5 weeks; p = 0.17), and had their last appointment earlier (35.5 ± 2.0 vs 35.7 ± 3.2 weeks; p < 0.01). Telemedicine consultations were used more frequently during wave I (46.8% vs 24.1%; p < 0.01), while insulin therapy was used less often (64.7% vs 80.2%; p < 0.01). Mean fasting self-measured glucose did not differ (4.8 ± 0.3 vs 4.8 ± 0.3 mmol/L; p = 0.49), but higher postprandial glucose was reported during wave I (6.6 ± 0.9 vs 6.3 ± 0.6 mmol/L; p < 0.01). Pregnancy outcome data were available for 77 wave I pregnancies and 75 wave III pregnancies. The groups were similar in terms of gestational week of delivery (38.3 ± 1.4 vs 38.1 ± 1.6 weeks), cesarean sections (58.4% vs 61.3%), APGAR scores (9.7 ± 1.0 vs 9.7 ± 1.0 pts), and birth weights (3306.6 ± 457.6 g vs 3243.9 ± 496.8 g) (p = NS for all). The mean wave I neonate length was slightly higher (54.3 ± 2.6 cm vs 53.3 ± 2.6 cm; p = 0.04).

Conclusions: We identified differences between wave I and wave III pregnancies for several clinical characteristics. However, nearly all pregnancy outcomes were found to be similar.

Key words: diabetes; gestational diabetes mellitus; GDM; coronavirus; pregnancy

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has required the rapid transformation and adaptation of healthcare systems worldwide to ensure adequate and uninterrupted medical care for many patient groups [1]. This applies particularly to pregnant women with gestational diabetes mellitus (GDM) [2]. The prevalence of GDM is steadily increasing, especially in developed countries [3]. Diabetes with predominant GDM is the most common disease complicating pregnancy, as it affects more than 10% of pregnant women worldwide and, most importantly, increases the risk of unfavorable pregnancy outcomes. Effective glycemic control during pregnancy complicated by GDM is essential to improve maternal and neonatal outcomes [4]. Two essential components of diabetes care during the COVID-19 pandemic and its accompanying social isolation measures were proper education of newly diagnosed pregnant women with GDM and immediate introduction of appropriate

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treatment [1, 5, 6]. This treatment (diet alone or diet together with insulin) required ongoing and precise modifications based on either glucometer measurements or continuous glucose monitoring systems (CGMS). Thus, there is a need for frequent consultations in a specialized diabetes center. However, during the COVID-19 pandemic, it was vital to limit the transmission of the virus through physical distancing and minimizing close contact. Women with GDM are more likely to have severe courses of COVID-19 due to predisposing factors, such as hyperglycemia and common comorbidities (e.g., obesity and hypertension) [7]. Therefore, there was a need to define a model of GDM care that balanced the importance of preventing diabetes-related complications of pregnancy and reducing the risk of transmission of the virus to the future mother [2, 5]. The model of healthcare delivery evolved with subsequent waves of the COVID-19 pandemic. As in many other countries, Poland experienced substantial differences in the severity of the measures associated with successive COVID-19 waves. The state of the epidemiological threat related to wave I was announced on 12 March 2020; most institutions were closed at that time. This wave of COVID-19 was characterized by very limited access to healthcare and a large proportion of teleconsultations, which included GDM care [8, 9]. Public compliance with government pandemic regulations was high at this early stage. Of note, no COVID-19 vaccines or specific antiviral treatments were available at this point. Conversely, during wave III, which began on 28 February 2021, COVID-19 restrictions were less limiting, and in-person medical consultations became more common [8]. In addition, COVID-19 vaccines and antiviral drugs, such as remdesivir and tocilizumab, were available. At this point, the degree of public compliance with COVID-19 regulations was lower than at the beginning of the pandemic. Thus, it is interesting to investigate the impact of the different healthcare delivery models during wave I and wave III on diabetes care and pregnancy outcomes in women with GDM.

Objectives

We aimed to compare the clinical and pregnancy outcome data from waves I and III of the COVID-19 pandemic for women with GDM who presented to the university reference center.

MATERIAL AND METHODS

We performed a retrospective analysis of the medical records of women diagnosed with GDM who registered at the GDM outpatient clinic at the Department of Metabolic Diseases and Diabetology, University Hospital in Krakow, during two three-month periods: March–May 2020 (corresponding to wave I of the COVID-19 pandemic) and March–May 2021 (corresponding to wave III). We identified 116 women with a diagnosis of GDM who registered during wave I and 119 who registered during wave III. These patients' postpartum outpatient clinic records were collected for up to 6 months after delivery. GDM was diagnosed based on the World Health Organization criteria, according to the algorithm recommended by the Polish Diabetes Association [10].

We gathered the following information for all women with GDM: age at GDM diagnosis, gestational week of diagnosis, anthropometric measurements (weight and body mass index [BMI] before pregnancy), weight before delivery, gestational weight gain (GWG), oral glucose tolerance test (OGTT) data from the GDM screening appointment, treatment (diet or insulin), week of pregnancy at the first and last GDM outpatient clinic appointment, and results of self-monitoring of blood glucose (SMBG). GDM women under our medical care were instructed to measure their blood glucose with a glucometer in the morning before eating (fasting) and one hour after each meal. During the patient's appointments, these data were available either from the patient's records or from the glucose-mated application. The patients were weighed, and their blood glucose and blood pressure were measured during each visit. All patients were individually trained in the principles of diabetic diet and SMBG. Patients who required insulin treatment were also trained in the principles of insulin administration. Dietary training was performed either in the clinic or remotely.

We also gathered information on insulin therapy at each visit. Specifically, we noted the pregnancy week when insulin was initiated, its model, and the patient's daily insulin dose. Pregnancy outcome data were also obtained from postpartum follow-up visits and telephone surveys. The following maternal and neonatal end-points were collected: birth weight and length of the newborn, gestational age at delivery, whether cesarean section was required, and APGAR score at 1 minute after delivery. Patients were routinely scheduled for follow-up approximately 6 weeks postpartum and were recommended to undergo an OGTT.

The study was approved by the local bioethics committee and conducted in accordance with the 1975 Declaration of Helsinki and its later revisions.

Differences between groups were analyzed using Student's t-test and nonparametric testing, including the Mann–Whitey U test when appropriate. The Shapiro-Wilk test was used to assess the normality of the distribution. The chi-squared test or Fisher's exact test were used to test for relationships between two categorical variables. All statistical analyses were conducted using Python 3.9.6 and Scipy.stats (SciPy: Scientific Library for Python) 1.8.0 [11]. All test listed above were used at a significance level of $\alpha = 0.05$.

RESULTS

We identified 119 women diagnosed with GDM during the wave I period of the study and 116 women diagnosed

Table 1. Clinical characteristics of the study groups

Variable	First COVID-19 wave n = 119 mean ± SD/n %	Third COVID-19 wave n = 116 mean ± SD/n %	p value x^2/U
Age at GDM diagnosis [years]	33.0 ± 4.7	32.1 ± 4.8	0.07
Pregnancy [n]	2.2 ± 1.3	2.1 ± 1.3	0.9
Pregnancy week at the last visit [weeks]	35.5 ± 2.0	35.7 ± 3.2	< 0.01
Pregnancy week at the first visit [weeks]	21.8 ± 8.4	20.3 ± 8.5	0.2
Time between first and last visit [weeks]	13.6 ± 8.3	15.4 ± 9.1	0.1
Prepregnancy body weight [kg]	71.5 ± 13.8	73.3 ± 18.2	0.9
Prepregnancy BMI [kg/m^2]	26.2 ± 5.0	26.7 ± 6.3	0.9
Predelivery visit body weight [kg]	80.4 ± 12.7	81.7 ± 16.1	0.9
Pregnancy weight gain [kg]	8.9 ± 5.6	8.4 ± 5.6	0.8
Teleconsultations [n, (%)]	280 (46.8%)	155 (24.1%)	< 0.01
Number of visits [n]	598, 5.0 ± 2.1	643, 5.5 ± 3.1	0.7
Postpartum check-ups [n, (%)]	17 (14.1%)	21 (18.1%)	0.4
Prepregnancy arterial hypertension [n, (%)]	4 (3.4%)	4 (3.4%)	0.9
Pregnancy Arterial Hypertension [n, (%)]	2 (1.6%)	10 (8.6%)	0.02

SD — standard deviation; GDM — gestational diabetes mellitus; BMI — body mass index

with GDM during the wave III period. GDM women treated during wave I compared to wave III were older (33.0 ± 4.7 vs 32.1 ± 4.8 years; p = 0.07), booked later (21.8 ± 8.4 vs 20.3 ± 8.5 weeks; p = 0.17), and had their last appointments earlier (35.5 ± 2.0 vs 35.7 ± 3.2 weeks; p < 0.01). Overall, women from wave I remained under the care of our clinic for 2 weeks less than women from wave III (13.6 ± 8.3 vs 15.4 ± 9.1; p = 0.13). GDM patients did not differ in terms of pre-pregnancy body weight (71.5 ± 13.8 vs 73.3 ± 18.2 kg; p = 0.94), pre-pregnancy BMI (26.2 ± 5.0 vs 26.7 ± 6.3 kg/m^2; p = 0.91), body weight at the last outpatient clinic visit (80.4 ± 12.7 vs 81.7 ± 16.1 kg; p = 0.91), and GWG (8.9 ± 5.6 vs 8.4 ± 5.6; p = 0.8). Patients treated during wave I used telemedicine consultations much more frequently (46.8% vs 24.1% of all visits; p < 0.01). All GDM patients were diagnosed based on OGTT results, which were also compared between groups. The groups did not differ in mean fasting blood glucose (minute 0 of OGTT). The mean fasting blood glucose was 5.0 ± 0.5 mmol/L for wave I patients and 5.1 ± 0.5 mmol/L for wave III patients (p = 0.06). The groups did not differ in glucose levels at 60 minutes of the test (9.3 ± 2.1 vs 9.2 ± 1.8 mmol/L; p = 0.48) and 120 minutes of the test (7.9 ± 1.9 vs 7.6 ± 1.8 mmol/L; p = 0.25). The mean fasting SMBG did not differ between the groups (4.8 ± 0.3 vs 4.8 ± 0.3 mmol/L; p = 0.49), but a higher mean postprandial glucose level was reported during wave I (6.6 ± 0.9 vs 6.3 ± 0.6 mmol/L; p < 0.01). None of the patients used CGMS. Women received insulin much more frequently during wave III (64.7% vs 80.2%; p < 0.01). No differences were observed in the gestational week when insulin was initiated (22.1 ± 9.1 vs 20.4 ± 9.1 weeks; p = 0.27) or the daily insulin dose at the last outpatient clinic visit (21.9 ± 23.0 vs 25.2 ± 25.6 units; p = 0.27). There were differences in the insulin therapy models among patients using insulin between the two groups. In the wave I group, 54 patients (45.4%) used basal insulin, 5 women (4.2%) were on a basal-plus model, and 18 (15.1%) were on intensive insulin therapy. In the wave III group, 73 patients (62.9%) used basal insulin, 13 women (11.2%) were on a basal-plus model, and 8 (6.9%) were on intensive insulin therapy. According to comorbidities, patients from wave III were treated more often for arterial hypertension in pregnancy (1.6% vs 8.6%, p = 0.02). The clinical characteristics of the study groups are shown in Table 1. Glycemic data are presented in Table 2.

Maternal and neonatal outcome data were available for 77 wave I pregnancies and 73 wave III pregnancies. The groups did not differ in birth weight (3306.6 ± 457.6 g vs 3243.9 ± 496.8 g; p = 0.32), while the length of the newborns was 54.3 ± 2.6 cm during wave I and 53.3 ± 2.6 cm during wave III (p = 0.04). The groups did not differ in gestational week at delivery (38.2 ± 1.4 vs 38.1 ± 1.6 weeks), proportion of cesarean sections (58.4% vs 61.3%), APGAR scores (9.7 ± 1.0 vs 9.7 ± 1.0 points), and preterm births [8 (11.1%) vs 17 (22.7%)] (p = NS for all comparisons). Maternal and neonatal outcomes are shown in Table 3.

DISCUSSION

In this article, we report the results of our retrospective analysis from the reference outpatient GDM clinic comparing the clinical characteristics, glycemic control,

Table 2. Gestational diabetes mellitus (GDM) screening, glucose control and treatment			
Variable	**First COVID-19 wave n = 119 mean ± SD, n %**	**Third COVID-19 wave n = 116 mean ± SD, n %**	**p value x^2/U**
OGTT 0 min. [mmol/L]	5.0 ± 0.5	5.1 ± 0.5	0.06
OGTT 60 min. [mmol/L]	9.3 ± 2.1	9.2 ± 1.8	0.5
OGTT 75 g 120 min [mmol/L]	7.9 ± 1.8	7.6 ± 1.8	0.3
Mean fasting glucose level on SMBG [mg/dL]	86.9 ± 5.1	87.0 ± 5.2	0.5
Mean postprandial glucose level on SMBG [mg/dL]	118.6 ± 15.3	112.8 ± 11.1	< 0.01
Week of pregnancy during insulin administration [weeks]	22.1 ± 9.0	20.4 ± 9.0	0.3
Daily insulin dose [units]	21.9 ± 23.0	25.2 ± 25.6	0.3
Treatment [n, %]			
Overall therapy			0.01
I — basal insulin	I — 54 (45.4%)	I — 73 (62.9%)	
II— basal plus	II — 5 (4.2%)	II — 13 (11.2%)	
III — basal bolus	III — 18 (15.1%)	III — 8 (6.9%)	
IV — diabetic diet only	IV — 42 (35.3%)	IV — 22 (19%)	
Insulin Therapy [n, %]	77 (64.7%)	93 (80.2%)	< 0.01

SD — standard deviation; OGTT — oral glucose tolerance test; SMBG — self-monitoring of blood glucose

Table 3. Perinatal outcomes			
Variable	**First COVID-19 wave n = 77 mean ± SD, n %**	**Third COVID-19 wave n = 75 mean ± SD, n %**	**p value x^2/U**
Pregnancy week at birth [week]	38.3 ± 1.4	38.1 ± 1.6	0.6
Newborn's body weight [grams]	3306.6 ± 457.6	3243.9 ± 496.8	0.3
Newborn's body length [cm]	54.3 ± 2.6	53.3 ± 2.6	0.04
Gender, male [n, %]	43 (55.8%)	37 (49.3%)	0.5
Caesarian sections [n, %]	45 (58.4%)	46 (61.3%)	0.8
APGAR scale (1st minute)	9.7 ± 1.0	9.7 ± 1.0	0.6
Preterm births [n, %]	8 (11.1%)	17 (22.7%)	0.06

SD — standard deviation

and pregnancy outcomes between wave I and wave III of the COVID-19 pandemic. We found several differences, includingduration of GDM care, use of telemedicine, glycemic control, and proportion of patients who required insulin. However, this did not translate into differences in most clinical pregnancy outcomes. Next, we discuss the possible reasons for these findings and their implications for the future.

The early introduction of restrictive precautions in the initial phase of the COVID-19 pandemic in Poland significantly slowed transmission of the virus and minimized the scale of the first wave in 2020 [8, 12, 13]. However, these precautions resulted in substantial changes in social life and healthcare service delivery, which seems to be reflected in our data. For example, GDM women in wave I remained under our prenatal diabetes care two weeks fewer than nthose in wave III, as they presented later and ended their diabetes care earlier. This may be due to both governmental COVID-19 regulations and patients' fears of visiting an in-person outpatient clinic, especially directly before delivery.

Additionally, face-to-face visits occurred less often, and telemedicine was used more intensively during wave I of the COVID-19 pandemic than during wave III [9]. All of these factors likely resulted in fewer women receiving insulin therapy during wave I compared to wave III. This might explain the slightly higher mean postprandial glucose levels in women during wave I. It is notable that the frequency of insulin use in both GDM patient groups was rather high compared to data from other countries [14, 15]. One possible explanation is that our data were obtained from a tertiary reference center that is more often attended by GDM patients who require insulin therapy. International data collected before and during the COVID-19 pandemic showed that the use of telemedicine in the care of women with GDM was at least as effective as traditional in-person visits to diabetes centers [16, 17]. No previously published analysis has reported a deterioration in diabetes and obstetric outcomes as a result of the replacement of some in-person visits with remote consultations. We consider that although our study found only a small difference between wave I and wave III in terms of postprandial glucose levels, our observations are consistent with data from an earlier report [9]. It is important to note that the average glucose levels (both fasting and postprandial) showed excellent glycemic control during both waves of the pandemic and met the recommended targets. Therefore, it is advisable to quickly implement remote access to prenatal diabetic care during future pandemic crises like the COVID-19 pandemic to enable direct contact with medical staff and to achieve optimal glycemic control while at the same time reducing the risk posed by the disease. This will reduce the number of in-person visits needed by pregnant women with GDM by carrying out consultations effectively using telemedicine. A prerequisite is the patient's ability to provide clinical observations, laboratory results, and home glucose monitoring records during her telemedicine consultations. It should be emphasized that the therapeutic glycemic goals for both periods of our study were the same as the generally accepted diabetes recommendations. This corresponds to recommendations published during the COVID-19 pandemic [5, 10, 18]. Additionally, the total number of in-person and remote visits during pregnancy should be consistent with general diabetes recommendations, particularly those published by local diabetes organizations.

There were no differences between the groups for most of the examined clinical maternal and neonatal outcomes. This applies to gestational age at delivery, proportion of patients requiring cesarean sections, neonatal APGAR scores, and birth weight. The only borderline difference was for newborn length. While hyperglycemia has been reported to affect neonatal length at birth [19], we are cautious about attributing this observation to the small difference in postprandial glucose between the groups in our study, particularly considering that both mean postprandial glucose values were within the target range. We tend to consider this slight difference in neonatal length to be a random observation.

Common glycemic criteria and GDM screening algorithms were used during both study periods. A small difference was identified, as the mean fasting glucose level (time 0 of the OGTT) was slightly higher during wave III. However, as this was an unadjusted comparison, the significance of this difference should be considered with caution.

Of note, according to current diabetes recommendations in Poland, all pregnant women in the third trimester of pregnancy and those from risk groups with elevated fasting glucose in the first trimester are subject to a three-point standard OGTT [10]. This requires the patient to remain in a medical facility for several hours. However, during the COVID-19 pandemic, it would be reasonable to simplify screening for GDM and reduce the number of in-person specialist consultations. During the COVID-19 pandemic, several countries proposed modified algorithms and criteria for GDM screening [20, 21]. These criteria used fasting or random glucose levels and HbA1c values. However, retrospective analyses failed to show that these criteria had adequate sensitivity and specificity compared to standard management, so they cannot be recommended at present for use in future pandemics. Therefore, there is a need to develop and validate new methods for diagnosing GDM in order to prepare the healthcare system for future pandemics.

There are limitations to this study that should be discussed. First, the number of patients was limited in both groups. Second, the pregnancy outcomes of this study were partially based on self-reported data. Third, the comparison data were from unadjusted analyses. Finally, we included data from only two waves of the COVID-19 pandemic.

CONCLUSIONS

In summary, we identified particular differences in the clinical data of women with GDM who were treated at a diabetes reference center during wave I or wave III of the COVID-19 pandemic. Pregnancy outcomes, however, were found to be similar between the two groups.

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Conflict of interest

The authors declare no conflict of interest.

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