

Pregnancy and perinatal outcomes in women with pre-gestational diabetes before and during the COVID-19 pandemic

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Objective: This study compared the compliance with scheduled antenatal visits as well as pregnancy and perinatal outcomes of pregnant women with pre-gestational diabetes before and during the COVID-19 pandemic.

Methods: Medical records of women with singleton pregnancies and pre-gestational type I or type II diabetes who attended antenatal care at Tuen Mun Hospital between 1 September 2017 and 31 March 2022 were retrieved. Modifiable and non-modifiable risk factors associated with adverse pregnancy outcomes were analysed, including glycated haemoglobin levels, body mass index, smoking status, attendance of antenatal follow-up, maternal age, parity, ethnicity, diabetes type, pre-pregnancy medical conditions, Caesarean section rate, hypertensive disorders complicating pregnancy, preterm birth (birth at <37 weeks of gestation), and large and small for gestational age.

Results: Of 152 women included in the analysis, 74 attended between 4 January 2020 and 31 March 2022 (the pandemic group) and 78 attended between 1 September 2017 and 31 March 2020 (the pre-pandemic group). The two groups were comparable in terms of compliance with their scheduled antenatal visits and all pregnancy and perinatal outcomes, except that the pandemic group had higher rates of emergency Caesarean sections (44.6% vs 23.5%, $p=0.010$) and neonatal hypoglycaemia (51.6% vs 34.3%, $p=0.046$). Both groups had good glycaemic control.

Conclusion: In women with pre-gestational diabetes, the rate of emergency Caesarean sections significantly increased during the pandemic, although compliance with scheduled antenatal visits and maternal and neonatal outcomes were similar before and during the pandemic. This suggests that the quality and accessibility of maternity care were not compromised by the pandemic.

Keywords: COVID-19; Pregnancy, high-risk; Pregnancy in diabetics; Pregnancy outcome

Introduction

In March 2020, the World Health Organization declared the emergence of the novel coronavirus SARS-CoV-2 (also known as COVID-19) a pandemic and major international health emergency, replete with the associated socio-economic, political, and emotional impacts¹. This may have affected women's perception of the risk of catching COVID-19 in hospital and their health-seeking behaviour. For example, in the United Kingdom, pregnant women were reluctant to attend fetal monitoring appointments because of concerns about potential exposure to the virus while in hospital². Similarly, the rate of loss to antenatal appointments increases from 18% to 51.9% during the pandemic in middle- and low-income countries due to fear of the virus, a lack of transportation, and the social pressure to isolate^{3,4}. Likewise, in Hong Kong, 30.4% of the interviewed subjects reported avoiding medical consultation for fear of catching COVID-19⁵. Since Hong Kong government activated the 'serious response level', attendance at emergency departments decreased by 37%⁶.

is associated with an increased risk of adverse fetal and maternal outcomes, as fetal glucose uptake is directly related to maternal glucose concentration. Maternal hyperglycaemia stimulates fetal insulin secretion, which leads to hypertrophy of insulin-sensitive tissues (adipose tissue, skeletal muscle, and myocardium) and accelerated fetal growth^{7,8}. In particular, women with type I diabetes and suboptimal glucose control have a higher risk of perinatal morbidity⁹. Maternal hyperglycaemia is associated with a greater likelihood of adverse pregnancy outcomes such as macrosomia, primary Caesarean section, clinical neonatal hypoglycaemia, shoulder dystocia or birth injury, preterm delivery, intensive neonatal care admission, hyperbilirubinemia, stillbirth, pre-eclampsia, and maternal mortality¹⁰. Therefore, pregnant women with pre-gestational diabetes require more intense care to improve their glycaemic control and pregnancy outcomes^{11,12}.

Pregnancy in women with pre-gestational diabetes

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During the COVID-19 pandemic, the general population was less physically active and more sedentary¹³⁻¹⁵. This lifestyle changes, together with the disruption to essential healthcare services, restrictions on social interaction, and changes to health-seeking behaviour particularly affect pregnant women with diabetes. Rates of maternal mortality and stillbirths are reported to increase in low- and middle-income countries during the pandemic¹⁶. This study compared the compliance with scheduled antenatal visits as well as pregnancy and perinatal outcomes of pregnant women with pre-gestational diabetes before and during the pandemic.

Materials and methods

Medical records of women with singleton pregnancies and pre-gestational type I or type II diabetes who attended antenatal care at Tuen Mun Hospital between 1 September 2017 and 31 March 2022 were retrieved through the Hospital Obstetrics Specialty Clinical Information System and the Antenatal Record System. Management for these women was standardised, involving early diabetic complication screening, shorter follow-up intervals, universal prescription of aspirin, and close monitoring of blood glucose levels.

Characteristics and pregnancy and perinatal outcomes of these women were collected. Pregnancy outcomes included any antepartum complications, hypertension, diabetes type, pre-eclampsia, induction of labour, and mode of delivery. Fetal and perinatal outcomes included premature birth, gestational age at birth, stillbirth, neonatal death, sex, birth weight, Apgar scores, and admission to a neonatal intensive care unit.

Modifiable and non-modifiable risk factors associated with adverse pregnancy outcomes were analysed. Modifiable risk factors included glycated haemoglobin (HbA1c) levels, body mass index, smoking status, and attendance at antenatal follow-ups. Good compliance was defined as >75% attendance at scheduled antenatal visits. Non-modifiable risk factors included maternal age, parity, ethnicity, diabetes type, and pre-pregnancy medical conditions. Adverse pregnancy outcomes included undergoing a Caesarean section, hypertensive disorders complicating pregnancy, preterm birth (birth at <37 weeks of gestation), large and small for gestational age (LGA and SGA) as defined by the local growth chart, neonatal intensive care unit admission, birth asphyxia, and stillbirth. The composite adverse neonatal outcome included LGA, SGA, preterm birth, and birth asphyxia at 5 minutes.

Data analysis was performed using SPSS (Windows version 22.0; IBM Corp, Armonk [NY], US). Continuous variables for the two groups (before and during the pandemic) were compared using the unpaired *t* test or Wilcoxon rank-sum test, whereas categorical variables were compared using the Chi-squared test or Fisher's exact test. A *p* value of <0.05 was considered statistically significant.

Results

Of 216 pregnant women with pre-gestational diabetes identified, 32 with duplicated entries, 30 with no diabetes before pregnancy, and two with twin pregnancies were excluded. The remaining 152 women were included in the analysis. Of them, 74 attended between 4 January 2020 and 31 March 2022 after the declaration of the serious response level (the pandemic group) and 78 attended between 1 September 2017 and 3 January 2020 (the pre-pandemic group).

The two groups were comparable in terms of compliance with their scheduled antenatal visits and all pregnancy and perinatal outcomes, except that the pandemic group had higher rates of emergency Caesarean sections (44.6% vs 23.5%, *p*=0.010) and neonatal hypoglycaemia (51.6% vs 34.3%, *p*=0.046) [Table 1]. Both groups had good glycaemic control as evidenced by a reduction in women with suboptimal HbA1c and an increase in insulin usage during pregnancy.

During the pandemic, there was a non-significant increasing trend in the number of emergency Caesarean sections performed for hypertensive disorder, refusal of a trial of scar during labour, and placenta praevia (Table 2). None of the Caesarean sections was performed because of maternal medical conditions related to COVID-19; indeed, only one patient developed a COVID-19 infection during pregnancy. There was no increase in hypertensive disorder complicating pregnancy during the pandemic.

Pregnancy preparation was considered adequate when the pre-pregnancy HbA1c was <6.5%; by this measure, only 28.8% and 35.8% of women were well prepared before and during the pandemic, respectively. The two groups were comparable in terms of pre-pregnancy HbA1c and the proportion of pre-pregnancy body mass index >25 kg/m². There was no significant reduction of SGA or prematurity during the pandemic. Cases of congenital anomalies in babies were few (Table 3).

Table 1. Baseline characteristics and pregnancy and perinatal outcomes of women with diabetes before and during the COVID-19 pandemic

	Pre-pandemic (n=78)*	Pandemic (n=74)*	p Value
Age, y	34.83±5.53	34.19±5.44	0.470
Smoker	8 (10.3)	8 (10.8)	0.911
In-vitro fertilisation	5 (6.4)	3 (4.1)	0.72
Nulliparous	42 (53.8)	36 (48.6)	0.522
Chinese	69 (89.6)	67 (90.5)	0.849
Diabetic mellitus			0.486
Type I	3 (3.8)	5 (6.8)	
Type II	75 (96.2)	69 (93.2)	
Readiness for pregnancy			
Pre-pregnancy body mass index >25 kg/m ²	57 (75)	52 (70.3)	0.584
Pre-pregnancy glycated haemoglobin (HbA1C) >6.5%	42 (71.2)	34 (64.2)	0.544
Pre-pregnancy HbA1c, %	7.55±1.61	7.70±2.23	0.680
Use of aspirin	43 (55.8)	51 (68.9)	0.098
Comorbidities			
Pre-existing hypertension	10 (12.8)	12 (16.2)	0.552
Retinopathy	10 (12.8)	9 (12.2)	0.902
Nephropathy	12 (15.4)	5 (6.8)	0.092
Weight gained during pregnancy, kg	10.81±6.84	9.63±5.19	0.251
HbA1c >6.5 % in the third trimester	25 (37.3)	25 (37.9)	0.946
Good compliance to scheduled antenatal visits	50 (70.4)	47 (67.1)	0.686
Glucose in range of <6 (fasting) to <8 (post meal) mmol/L	28 (40)	29 (42)	0.571
Insulin usage			
First trimester			
Short acting, unit/dose	6.68±6.65	5.50±5.03	0.233
Long acting, unit	8.34±10.86	7.96±9.48	0.822
Second trimester			
Short acting, unit/ dose	10.74±7.48	10.49±9.0	0.858
Long acting, unit	11.12±10.81	13.15±13.57	0.892
Third trimester			
Short acting, unit/dose	13.51±9.21	13.52±10.58	1.00
Long acting, unit	13.62±12.00	16.23±11.1	0.267
Pregnancy outcome		0.561	
Live birth	68 (87.2)	65 (87.8)	
Miscarriage	5 (6.4)	4 (5.4)	
Stillbirth	2 (2.6)	0	
Elective termination of pregnancy	3 (3.8)	2 (2.7)	
Induction of labour	27 (39.7)	28 (42.4)	0.861
Vaginal delivery	26 (36.6)	16 (23.5)	0.238
Assisted vaginal delivery	4 (5.6)	4 (5.9)	0.238
Emergency Caesarean section	16 (23.5)	29 (44.6)	0.010
Hypertensive disorder complicating pregnancy	24 (31.6)	25 (35.7)	0.085

* Data are presented as mean ± standard deviation or No. (%) of participants; total may not equal 100% because of missing data

Table 1. (cont'd)

	Pre-pandemic (n=78)*	Pandemic (n=74)*	p Value
Antepartum haemorrhage	4 (5.8)	8 (12.3)	0.187
Primary postpartum haemorrhage >500 ml	26 (33.3)	32 (43.2)	0.209
Baby sex	n=68	n=65	
Female	25 (36.8)	26 (40.0)	0.701
Male	43 (63.2)	39 (60.0)	0.701
Large for gestational age	33 (45.8)	37 (53.6)	0.225
Small for gestational age	9 (12.5)	5 (7.2)	0.248
Fetal anomaly	7 (10.1)	6 (9.2)	0.858
Prematurity (<37 weeks)	14 (17.9)	12 (16.2)	0.777
Birth asphyxia (Apgar score <3 at 5 mins)	2 (3.0)	0	0.164
Neonatal intensive care unit care (>24 hours)	18 (26.9)	22 (34.4)	0.427
Neonatal sepsis	10 (14.9)	17 (26.6)	0.100
Neonatal hypoglycaemia	23 (34.3)	33 (51.6)	0.046
Shoulder dystocia	0	2 (2.7)	0.230
Composite adverse neonatal outcome (small for gestational age, birth asphyxia, and preterm delivery <37 weeks)	19 (26)	15 (25.4)	0.539
Composite adverse neonatal outcome (large and small for gestational age, birth asphyxia, and preterm delivery <37 weeks)	44 (60.3)	47 (66.2)	0.287

Table 2. Indications for emergency Caesarean section

Indication	No. (%) of women with emergency Caesarean section		p Value
	Pre-pandemic (n=16)	Pandemic (n=29)	
Hypertensive disorder	3 (18.7)	8 (27.5)	0.720
Refused trial of scar during labour	2 (12.5)	7 (24.1)	0.456
Placenta praevia	1 (6.3)	5 (17.2)	0.399
Fetal distress/suboptimal cardiotocography	3 (18.7)	5 (17.2)	1.000
No progress	1 (6.3)	3 (10.3)	1.000

Table 3. Congenital anomalies of babies

Congenital anomaly	No. of babies with congenital anomaly	
	Pre-pandemic	Pandemic
Cardiac	4	3
Renal	0	2
Multiple	1	1
Talipes	1	0

Discussion

The pregnancy outcomes of women with pre-gestational diabetes were similar before and during the COVID-19 pandemic, except that the rate of emergency

Caesarean sections increased from 23.5% to 44.6%, which concurs with a cohort study in England¹⁷ and a preliminary report on singleton non-diabetic pregnancies in the United Kingdom¹⁸, but the increase was 1.4% only in the English study, compared with 21.1% in our study. A higher rate of induced labour was observed in the English study. The centralisation of maternity services and potential delays due to virtual appointments noted in the Western world^{19,20} are unlikely the attributable factors in Hong Kong as the structure of maternity services remained largely unchanged. There was no significant reduction in in-person attendance of antenatal services in Hong Kong during the pandemic. In our study, the rate of refusal of a trial of scar during labour increased from 12.5% to 24.1% during the pandemic. The

increased rate could be due to the patients' anxiety or the attending doctors' anticipation of difficulties in arranging emergency operations during the pandemic. Occupational stress and burnout during the pandemic among maternity staff could also have resulted in a lower threshold for interventions to expedite births and avoid emergencies²¹.

In our study, the stillbirth rate remained similar before and during the pandemic. Interestingly, a study in Ireland observed an unprecedented reduction in infants born at a very low birth weight during the COVID-19 lockdown²². In our cohort, although there was a reduction in SGA babies from 11.4% before the pandemic to 5.9% during the pandemic, the impact of the pandemic is less evident because there was no lockdown in Hong Kong and the decrease in the antenatal attendance rate was not apparent. However, our sample was from a single centre in a short time frame; the findings may not be generalised to the entire population. For example, a significant increase in the stillbirth rate was observed at St George's University Hospital in London, but the stillbirth rate reached a record low of 3.8 stillbirths per 1000 births in 2020 in the United Kingdom²³.

During the pandemic, there was a reduction in both routine and unscheduled pregnancy care across different healthcare settings in high- and low-income countries²⁴⁻²⁶. Concern and anxiety about the risk of contracting COVID-19 in healthcare settings, lockdowns, and reduced public transport provision might have led to this reduction²⁴. However, in our study, the antenatal attendance rate remained largely unchanged because there was no lockdown in Hong Kong. Moreover, women with high-risk pregnancies such as those with pre-gestational diabetes have no option but have to comply with the management from tertiary-level centres in public hospitals as the care provided by the private sector can be limited. Priority is also given to high-risk pregnancies. These women are followed up in a designated clinic with multidisciplinary inputs in accordance with protocols.

In our study, diabetic control in pregnant women with pre-gestational diabetes was not deteriorated during the pandemic, as evidenced by patients' in-range HbA1c and glucose levels. These findings align with those in studies of patients with diabetes during the pandemic^{27,28}. Maintenance of diabetic control may be due to more time for self-care and diabetic management, including eating a balanced diet and exercising, during the pandemic.

In our study, the miscarriage rate was similar

before and during the pandemic, in contrast to a review of women with pre-gestational diabetes in Ireland in 2021²⁹. Compared with the Irish study, our study had much higher rates of SGA (9.9% vs 0.4%) and congenital anomalies (7.7% vs 4.8%). According to the 2014 territory-wide audit published by the Hong Kong College of Obstetricians and Gynaecologists, 6.6% of singletons were born with a low birth weight (<2500 g)³⁰. Our study defined SGA as a birth weight less than the tenth percentile for gestational age instead of <2500 g, which can explain the apparently lower incidence of SGA in our cohort than in the general population of Hong Kong. In our study, most congenital anomalies involved non-life-threatening and surgically correctable conditions such as small atrial or ventricular septal defects, dilated renal pelvis, and talipes.

Limitations to our study include its retrospective nature, small sample size, and short time frame. In Hong Kong, most women with pre-gestational diabetes attend public hospitals for antenatal care. Thus, data for pre-gestational diabetic control were comprehensive and accessible despite the study being retrospective. The sample size during the COVID-19 pandemic was small. However, our sample is predominantly Chinese and is specifically relevant to Hong Kong. There were potential associations between changes in healthcare and society during the COVID-19 pandemic and the pregnancy outcomes of women with pre-gestational diabetes. A territory-wide prospective study to delineate healthcare needs in Hong Kong during the pandemic, for example to assess whether face-to-face care or telemedicine would better cater to pregnant women with pre-gestational diabetes, is warranted.

Conclusion

In women with pre-gestational diabetes, the rate of emergency Caesarean sections significantly increased during the pandemic, although compliance with scheduled antenatal visits and maternal and neonatal outcomes were similar before and during the pandemic. This suggests that the quality and accessibility of maternity care were not compromised by the pandemic.

Contributors

All authors designed the study, acquired the data, analysed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Data availability

All data generated or analysed during the present

study are available from the corresponding author on reasonable request.

Ethics approval

The study was approved by the New Territories West Cluster Research Ethics Committee (reference: NTWC/REC/22022). The patients were treated in accordance with the tenets of the Declaration of Helsinki. The patients provided written informed consent for all treatments and procedures and for publication.

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