# Gestational Diabetes Mellitus Outcome in 394 Patients

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## Abstract

**Objective:** To determine whether women with gestational diabetes mellitus (GDM) and their offspring have pregnancy outcomes and complications of pregnancy that are different from those in the general obstetric population.

**Methods:** Through medical record coding, we identified women with GDM and a singleton pregnancy with cephalic presentation who delivered at St. Paul's Hospital between January 1, 1995, and December 31, 2001. In total, 394 births were analyzed and their outcomes compared with those of a control group of 100 non-diabetic women with the same gestational age (38 weeks) at delivery.

**Results:** Women with gestational diabetes were of lesser parity ($P < 0.05$), appreciably older ($P < 0.05$), and less likely to be Caucasian ($P < 0.005$) than the general obstetric population. Women with GDM also had a higher risk of Caesarean section ($P < 0.05$), gestational hypertension ($P < 0.05$), and large for gestational age (LGA) deliveries ($P < 0.005$). Of women with GDM, those treated with insulin had a higher incidence of LGA deliveries than those on diet therapy alone. The incidence of respiratory distress syndrome and of need for phototherapy was similar in babies whose mothers had GDM and in those whose mothers did not.

**Conclusion:** Although the rate of complications remains low, GDM creates a predisposition to increased maternal and neonatal complications.

## Résumé

**Objectif** : Déterminer si les femmes qui présentent un diabète sucré gestationnel (DSG) et leur progéniture connaissent des issues et des complications de grossesse différentes de celles que connaissent les femmes de la population obstétricale générale.

**Méthodes** : Nous avons identifié, par l'intermédiaire du codage des dossiers médicaux, les femmes présentant un DSG et une grossesse unique à présentation céphalique qui ont accouché au *St. Pauls Hospital* entre le 1er janvier 1995 et le 31 décembre 2001. En tout, 394 naissances ont été analysées et leurs issues ont été comparées à celles d'un groupe témoin de 100 femmes non diabétiques du même âge gestationnel (38 semaines) au moment de l'accouchement.

**Résultats** : Les femmes présentant un diabète gestationnel étaient d'une parité moindre ($P < 0,05$), nettement plus âgées ($P < 0,05$) et avaient moins tendance à être de race blanche ($P < 0,005$) que les femmes de la population obstétricale générale. Les femmes présentant un DSG couraient également un risque accru de subir une césarienne ($P < 0,05$), de connaître une hypertension gestationnelle ($P < 0,05$) et d'accoucher d'enfants présentant une hypertrophie fœtale ($P < 0,005$). Des femmes présentant un DSG, celles qui ont été traitées à l'insuline ont connu une incidence accrue d'accouchements d'enfants présentant une hypertrophie fœtale, par comparaison avec les femmes n'ayant été traitées qu'au moyen d'une thérapie alimentaire. L'incidence du syndrome de détresse respiratoire et de la nécessité du recours à la photothérapie était semblable chez les nouveaux-nés dont la mère présentait un DSG et chez ceux dont la mère n'en présentait pas.

**Conclusion** : Bien que le taux de complications demeure faible, le DSG engendre une prédisposition à des complications maternelles et néonatales accrues.

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**Key Words:** Gestational diabetes mellitus, neonatal complications, large for gestational age, Caesarean section

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## INTRODUCTION

Gestational diabetes mellitus (GDM), a form of carbohydrate intolerance diagnosed only during pregnancy, complicates 2% to 5% of pregnancies and is associated with both neonatal morbidity and obstetric complications.[1–5] The relationship between the onset of GDM and complications in pregnancy and increased perinatal morbidity and mortality has been well documented.[1,2,6–18] The correlation between GDM and birth weight has proven to be complex and multi-faceted.[8] In addition, the reported prevalence and incidence rates of GDM vary widely among populations, largely because much of the documented information on these patients has originated from referral clinics.[9]

The condition has been implicated as a risk factor for future diabetes and obesity in women as well as for impaired carbohydrate metabolism in their offspring.[8,11–13] Recently, the effect of screening and clinical management of GDM on

**Table 1. Demographic comparison of women with gestational diabetes mellitus and a control group without gestational diabetes mellitus**

| | GDM group (n = 394) | Control group (n = 100) | *P* |
|---|---|---|---|
| Family history of DM | 47.5% | 30.0% | < 0.001 |
| Multiparity | 45.7% | 50% | < 0.05 |
| Ethnicity | 54% non-Caucasian | 39% non-Caucasian | < 0.005 |
| Age at delivery | 32.6 ± 4.9 | 31.5 ± 5.5 | < 0.05 |

GDM: Gestational diabetes mellitus; DM: diabetes mellitus.

antenatal, neonatal, and perinatal outcome has been deemed beneficial.[13] The purpose of the screening, treatment, and management of GDM is two-fold: to prevent stillbirths and to decrease the number of large for gestational age births, ultimately reducing neonatal and maternal morbidity and mortality.[16] Although stillbirth rates have decreased dramatically over the last 20 years, the rates of Caesarean section and of large for gestational age birth weight have remained high and in some cases are unchanged among women with GDM despite the introduction of prophylactic insulin therapy.[5,16]

The objective of this retrospective study was to assess recent therapies and outcomes in pregnancies complicated by GDM at a large urban Canadian teaching hospital.

## METHODS

We reviewed the obstetric outcomes of patients who delivered at St. Paul's Hospital (SPH), Vancouver, BC, between January 1, 1995 and December 31, 2001, using antenatal and perinatal data derived from the patients' medical records. Specifically, we reviewed data from patients classified in the medical records computer system as having gestational diabetes mellitus (GDM type A1 and A2, indicating whether insulin was prescribed) within the specified dates, excluding all non-singleton pregnancies. Patients with type 1 and type 2 diabetes mellitus were excluded. We also excluded all transport pregnancies (those in which some antenatal care was provided at SPH, with the actual delivery performed elsewhere). Screening for GDM involved each woman undergoing a plasma glucose assay one hour after an oral 50 g glucose load at 28 weeks' gestation; if this assay showed an abnormal result, a glucose tolerance test (GTT) was performed. The screening following the 50 g glucose load (given orally at any time of day) was considered abnormal if the plasma glucose value was 7.8 mmol/L or greater. The subsequent GTT was considered positive when any two of the three plasma glucose determinations over a 3-hour period (at 1-hour intervals) after the ingestion of 100 g glucose showed abnormal results (fasting plasma glucose > 5.8 mmol/L; 1-hour > 10.5 mmol/L; 2-hour > 9.2 mmol/L; 3-hour > 8.0 mmol/L).

Gestational hypertension was defined as two or more diastolic readings of 90 mm Hg or one reading 110 mm Hg. We checked the records of patients involved in the study against the hospital database to determine whether or not they had seen an endocrinologist for management of their gestational diabetes. The antenatal record, dietitian's notes, and endocrinologist's letters were used to determine whether or not insulin was used for management of GDM and whether other identifiable prenatal abnormalities such as polyhydramnios and oligohydramnios were present.

Neonatal outcomes identified included small for gestational age (SGA) and large for gestational age (LGA), respectively defined as birth weights below the 10th percentile and above the 90th percentile of expected birth weight for the gestational age according to a Canadian birth weight distribution plot.[9] Neonates were considered jaundiced if they required phototherapy. Other fetal outcomes, specifically hypoglycemia, hypocalcemia, respiratory distress syndrome (RDS), and stays of > 24 hours in the neonatal intensive care unit (NICU) were obtained quantitatively from the clinicians' notes recorded during admission. A stay in NICU of > 24 hours indicated neonatal morbidity. Apgar scores for 1, 5, and 10 minutes were obtained from the birth record.

The control group comprised 100 randomly selected women who delivered between January 1, 1995 and December 31, 2001 and who were not classified in the SPH medical record coding system as having GDM. The controls and the GDM group had the same gestational age at delivery (± 0.5 weeks).

Statistical significance was analyzed using 2-sample, equal variance 2-tailed *t* tests for demographic characteristics (family incidence of diabetes mellitus, multiparity, ethnicity, age at delivery), and 1-tailed *t* tests for the analysis of complications. The level of significance was set at $P < 0.05$. Rates of pregnancy and neonate risk factors were

**Table 2. Comparison of maternal and fetal outcomes between the group with gestational diabetes mellitus and the general obstetric population**

| | GDM group (n = 394) | Control group (n = 100) | *P* |
|---|---|---|---|
| Seen by an endocrinologist (%) | 82.0 | 0 | |
| Caesarean section (%) | 36.3 | 23 | < 0.01 |
| Mean gestational week at delivery | 38.8 ± 0.7 | 38.8 ± 1.3 | |
| Mean birth weight (g) | 3450.0 ± 566.1 | 3326.4 ± 442.7 | < 0.05 |
| Birth weight 4000 g (%) | 13.2 | 5.0 | < 0.05 |
| Birth weight 2500 g (%) | 3.8 | 3.0 | NS |
| Mean birth weight (insulin) | 3441.3 ± 497.2 | N/A | |
| Mean birth weight (diet) | 3452.6 ± 586.2 | N/A | |
| Gestational hypertension (%) | 24.6 | 9 | < 0.05 |
| Polyhydramnios (%) | 3.0 | 0 | NS |
| Oligohydramnios (%) | 2.8 | 0 | NS |
| LGA neonates (%) | 15.5 | 5.0 | < 0.005 |
| Insulin | 18.8 | N/A | |
| Diet | 14.6 | N/A | |
| SGA neonates (%) | 8.1 | 8.0 | NS |
| Hypoglycemic neonates (%) | 0 | 0 | |
| Hypocalcemic neonates (%) | 0 | 0 | |
| Phototherapy required (%) | 7.1 | 4.0 | NS |
| Neonates with RDS (%) | 1.3 | 0 | NS |

GDM: Gestational diabetes mellitus; NA: not applicable; NS: not significant; LGA: large for gestational age; SGA: small for gestational age; RDS: respiratory distress syndrome.

calculated, and 95% confidence intervals were determined using standard deviation (SD) values.

The study was given ethical approval by the University of British Columbia/Providence Health Care Ethical Review Board.

## RESULTS

During the study period, 394 women who delivered at SPH were diagnosed as having GDM. For each study year we randomly selected as controls a proportional number of non-diabetic women who delivered at the same gestational age. The GDM group was significantly older (mean age 32.6 ± 4.9 [SD] years versus 31.5 ± 5.5 years, $P < 0.05$) and included a significantly greater number of women who were non-Caucasian (54% vs. 29%, $P < 0.005$). Table 1 shows maternal demographics and parity for both groups.

Pregnancy outcomes are compared in Table 2. Statistically important differences between the two groups were found in rates of Caesarean section (CS), birth weight > 4000 g, maternal hypertension, and LGA neonates, and in mean birth weight. Rates of CS (36.3% vs. 23%, $P < 0.05$) and gestational hypertension (24.6% vs. 9.0%, $P < 0.05$) were significantly higher in GDM women than in the general obstetric population. Rates of polyhydramnios (3.0% in GDM vs. 0% in controls; $P$ = NS) and oligohydramnios (2.8% in GDM versus 0% in controls; $P$ = NS) were not significantly increased in women with GDM. The incidence of RDS following delivery (1.3% in GDM vs. 0% in controls; $P$ = NS) and of neonates requiring phototherapy (7.1% in GDM vs. 4.0% in controls; $P$ = NS) were not significantly different. Of the 394 women with GDM, 82% were seen by an endocrinologist for diabetes management, and 23% subsequently began insulin therapy. All women treated with insulin were seen by an endocrinologist or visited a diabetes training centre.

Babies born to women with GDM had a significantly higher mean birth weight than those born to women in the control group (3450.1 ± 566.1 g vs. 3326.4 ± 442.7 g, $P < 0.05$). Women with GDM had an incidence of LGA neonates of 15.5%, a significantly higher rate than the 5.0% in controls ($P < 0.005$). In addition, women on insulin treatment had a higher incidence of LGA newborns than those on diet therapy alone (18.8% vs. 14.6%, $P < 0.05$). The mean birth

**Table 3. Comparison of perinatal outcomes among the group with gestational diabetes mellitus and the general obstetric population**

| | GDM | Control | *P* |
|---|---|---|---|
| Neonates sent to NICU > 24 hours (%) | 12.1 | 2 | < 0.005 |
| Mean 1-minute Apgar score | 8.5 ± 0.6 | 8.1 ± 1.3 | NS |
| Mean 5-minute Apgar score | 9.0 ± 0.4 | 9.0 ± 0.4 | NS |
| Mean 10-minute Apgar score | 9.1 ± 1.0 | 9.4 ± 0.7 | NS |

GDM: Gestational diabetes mellitus; NICU: neonatal intensive care unit.

weights of neonates in the GDM group whose mothers were treated with insulin (3441.3 ± 497.2 g) and of those whose mothers were treated with diet alone (3452.6 ± 586.1 g) were not significantly different. The frequency of SGA neonates was similar in the GDM and control groups (8.1% and 8.0%, respectively; *P* = NS). The proportion of babies born to women in each group that weighed > 4000 g and < 2500 g was reflected in the LGA and SGA rates. Of babies born to women with GDM, 13.2% were macrosomic (> 4000 g at birth) compared with 5.0% in the control group ($P < 0.05$). However, there was no difference in the incidence of babies weighing less than 2500 g in the GDM and control populations (3.8% and 3.0%, respectively; *P* = NS).

Abnormalities of antenatal development and labour resulted in significantly more neonates born to women with GDM (12.1%) being admitted to NICU for ≥ 24 hours than neonates in the control group ($P < 0.005$). Review of the Apgar scores at 1, 5, and 10 minutes showed no significant difference between the two groups. Mean Apgar scores for both the GDM and control groups are shown in Table 3.

## DISCUSSION

This review indicates that women with GDM are likely to have outcomes of pregnancy that are different from those in the general obstetric population, a relevant observation given that a recent study showed that serious perinatal morbidity associated with GDM can be reduced with treatment.[19] Compared with a control group of non-diabetic women with the same gestational age at delivery, women with GDM were at an increased risk to deliver heavier babies and to develop gestational hypertension. With a significantly increased mean birth weight and a labelling bias associated with their condition, women with GDM had a significantly higher rate of CS than the general obstetric population. These results reflect the findings of other studies indicating that GDM patients might have adverse pregnancy outcomes.[5,20–22] In this study our CS rate (36.3%) was greater than that reported in most previous studies, which described rates ranging from 19% to 30%.[1,7,9,21] However, our CS rate was remarkably lower than the 41.4% found in a study by Sendag et al.[20] The higher CS rate in women with GDM is independently and significantly associated with the increased incidence of LGA neonates in this group, as further demonstrated by Ostlund et al.[21]

Increased complications during pregnancy involving GDM were reported in a study by Casey et al.[1] These included increased rates of macrosomia, similar to the increased rate of LGA found in the present study.[1] As noted in other studies,[16,23–25] analysis of data related to LGA neonates within the GDM group provided information about interventions for control of maternal glucose levels. As maternal glucose levels rise, the rates of LGA neonates and CS increase.[16,25] As in the present study, increasing glucose intolerance in pregnancy was associated with higher frequencies of operative delivery and excessive somatic growth in the study by Sermer et al.[26]

The occurrence of LGA babies is not necessarily attributable to abnormal glycemic control alone; many identifiable risk factors may contribute to excessive fetal growth and hyperinsulinemia.[1] In addition to maternal hyperglycemia, potential risk factors for LGA neonates include maternal age, parity, ethnicity, obesity, and a history of prior CS.[1,9,25,27] Women with GDM in the present study were more often than not of non-Caucasian ethnicity and were significantly older than the general obstetric population, which is consistent with previous reports.[1,2,6,7,9,13,15,18,21,24] Previous studies presented age differences of approximately four years between GDM and control populations.[1,6,13,18] However, our study demonstrates that the age gap may be narrowing: the mean age of women with GDM (32.6 years) and controls (31.5 years) differed by only 1.1 years. Two prior studies reported mean ages of women with GDM and controls that were virtually the same.[8,20]

Additionally, women with GDM gave birth to more neonates clinically diagnosed as having RDS and had more neonates sent to the NICU for ≥ 24 hours than did women in the control group. It must be noted, however, that a diagnosis of RDS may be erroneous. In our study, mean weights of

the newborns were not different for those treated with insulin versus diet; this would suggest that hyperglycemia and thus hyperinsulinemia would not have been high. As hyperglycemia and hyperinsulinemia lead to delayed pulmonary maturity, RDS may have been diagnosed in neonates with wet lungs or transient tachypnea of the newborn (TTN), the latter being associated with higher rates of CS.[28] However, the Apgar scores at 1, 5, and 10 minutes showed no significant difference between the two groups and were on average higher at 1 and 5 minutes in the babies of GDM mothers.

Despite the similar Apgar scores, the babies of women with GDM spent significantly more time in the NICU than did the babies of women in the control group. Thus birth weight may be a greater predictor of admission to the NICU for ≥ 24 hours than Apgar score in this setting. Within the GDM group, increased numbers of pregnancy risk factors and fetal complications appeared to contribute to the significantly greater proportion of neonates sent to the NICU for ≥ 24 hours. Additionally, the neonatal course, if it included abnormalities such as respiratory difficulties and difficulties attaining a normal blood sugar, may also have contributed to greater NICU use. In spite of this, the rate of NICU admissions within the GDM group (12.1%) was much lower than that reported by Ostlund et al. (28.7%).[21]

The pregnancy outcomes of women with GDM who received no treatment versus those on insulin therapy were similar to those reported by Sendag et al.[20] Adverse outcomes such as CS, LGA neonates, and admission to the NICU for ≥ 24 hours were significantly more common in the group on insulin treatment. However, when the mean birth weights of the diet and insulin groups were compared, the difference was not significant.

Surprisingly, many complications of pregnancy that are typically associated with GDM were not more commonly identified in the GDM group than in the control population. Specifically, polyhydramnios and oligohydramnios occurred in 2.1% and 2.8% of women with GDM, and rates of SGA neonates and neonates requiring phototherapy were not significantly greater than in the general obstetric population. Furthermore, no instances of neonatal hypoglycemia and neonatal hypocalcemia, two conditions often linked to GDM births, were observed among the 394 GDM cases reviewed.

As our study was retrospective in nature, the inherent limitations of this study design, such as omission of data, must be taken into account. Our data analysis was limited by having to use only what was readily available in hospital records. Details regarding diabetes therapy, and even documentation of this treatment being given, may have been omitted. However, because our results reflect those reported by others, we conclude that this limitation has not had a profound effect on our results.[5]

## CONCLUSION

The findings of this study support the predicted increase in frequency of maternal and neonatal morbidity associated with GDM. Outcomes of the pregnancies in women with GDM showed an increased incidence of Caesarean section, gestational hypertension, LGA neonates, and NICU admission for ≥ 24 hours compared with the general obstetric population. The increased incidence of NICU admission may be linked to a labelling bias associated with GDM; that is, the neonates of women with GDM are expected to develop more neonatal complications. Gestational diabetes mellitus is a dynamic condition: increasing degrees of carbohydrate intolerance are associated with increased frequencies of complications in pregnancy. Although these complications of pregnancy occur significantly more often in women who are older and who have a greater number of risk factors, the gap between the mean age of the general obstetric population and the mean age of those with GDM is narrowing.

When we compared the study population with the control population, we found no significant increase in rates of classic complications of pregnancy associated with GDM, such as neonatal hypoglycemia and hypocalcemia, polyhydramnios, oligohydramnios, RDS, and neonates requiring phototherapy. We also found no difference in SGA pregnancies. Since no serious complications were observed, we believe this reflects improved care for women with GDM.

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