Rates and Risk Factors for Recurrence of Gestational Diabetes

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OBJECTIVE — To determine the recurrence rate of gestational diabetes (GDM) during a subsequent pregnancy among women who had GDM during an index pregnancy and to identify factors associated with the probability of recurrence.

RESEARCH DESIGN AND METHODS — A retrospective longitudinal study was performed in Nova Scotia, Canada, of women who were diagnosed as having GDM during a pregnancy between the years of 1980 and 1996 and who had at least one subsequent pregnancy during this time period. When only the index and first subsequent pregnancy were analyzed, the cohort included 651 women. The recurrence rate of GDM in the pregnancy after the pregnancy with the initial diagnosis of GDM was determined. Multivariate regression models were constructed to model the recurrence of GDM in a subsequent pregnancy as functions of potential predictors to estimate RRs and CIs.

RESULTS — The rate of recurrence of GDM in the pregnancy subsequent to the index pregnancy was found to be 35.6% (95% CI = 31.9–39.3%). Multivariate regression models showed that infant birth weight in the index pregnancy and maternal prepregnancy weight before the subsequent pregnancy were predictive of recurrent GDM.

CONCLUSIONS — In this large cohort of women, slightly more than one-third of the subjects had diabetes in a subsequent pregnancy, which is consistent with recurrence rates in other predominately white populations. Strategies to reduce the occurrence of neonatal macrosomia and maternal prepregnancy obesity may help lower the rate of recurrence of GDM.

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It is estimated that gestational diabetes (GDM) recurs in 30–69% of subsequent pregnancies after a pregnancy with GDM (1–6). One of the major risk factors for developing GDM is having had a previous pregnancy complicated by the disease. Other factors that have been identified as predictive of recurrent GDM include obesity, multiparity, early diagnosis of GDM during the initial pregnancy, need for insulin during the initial pregnancy, macrosomia during the initial pregnancy, advanced maternal age, maternal prepregnancy weight during the initial pregnancy, and an increase in prepregnancy weight between the initial and subsequent pregnancies.

Whereas previous studies have provided useful information regarding recurrence rates and factors predictive for recurrent GDM, they have been limited by relatively small numbers of subjects. The purpose of this study was to examine the recurrence rates of GDM in a large population-based cohort of women who had GDM during an initial pregnancy and to examine factors associated with recurrence.

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Abbreviations: GDM, gestational diabetes; NSAPD, Nova Scotia Atlee Perinatal Database.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

RESEARCH DESIGN AND METHODS

— The cohort was identified from the Nova Scotia Atlee Perinatal Database (NSAPD) and included Nova Scotia residents who delivered an infant weighing >500 g between 1980 and 1996. In Nova Scotia, there are ~10,000 births per year. The NSAPD includes information on all Nova Scotia hospital deliveries as well as out-of-province deliveries among Nova Scotia residents. Between 1980 and 1987, the study cohort included only Halifax County residents, but since 1988, all residents of Nova Scotia have been included. Data in the NSAPD are abstracted from hospital medical records by trained health records personnel after discharge from hospital. Standardized data collection forms, developed as clinical tools for the prenatal, intrapartum, and postpartum periods, are used throughout the province and ensure that information is collected consistently. The database includes extensive information on maternal medical conditions, labor and delivery events, and neonatal outcomes and some information on lifestyle and demographic factors. Periodic reabstraction studies and validation studies (7) are conducted as part of an ongoing data quality assurance program and have shown that the information in the database is reliable.

Women included in this study had a pregnancy with a diagnosis of GDM and at least one subsequent pregnancy. Women with preexisting diabetes diagnosed before their index pregnancy were not considered to have GDM and were not included in this study. Information pertaining to all pregnancies subsequent to the pregnancy with the initial diagnosis of GDM (referred to as the index pregnancy) was collected. In Nova Scotia, pregnant women are screened for GDM between 24 and 28 weeks' gestation using a 50-g glucose challenge with a 1-h venous plasma glucose. Women with known risk factors, including history of GDM in a previous pregnancy, are often screened earlier. A plasma glucose level of ≥7.8 mmol/l is considered positive and warrants the diagnostic test for GDM. The diagnosis of GDM is made if a woman has

two or more abnormal values on a 3-h 100-g oral glucose tolerance test using the O'Sullivan criteria (8). Diagnostic criteria for the oral glucose tolerance test include the following: fasting ≥ 5.3 mmol/l; 1 h ≥10.6 mmol/l; 2 h ≥ 9.2 mmol/l; 3 h ≥8.1 mmol/l. Women with GDM in an index pregnancy who developed diabetes in the interval between pregnancies were included in this study.

Statistical analyses were performed using S-Plus (Statistical Sciences, Seattle, WA) and Epi Info (Centers for Disease Control and Prevention, Atlanta, GA) software. Possible predictors were initially analyzed in a univariate fashion by estimating RRs and 95% CIs. Next, potential predictors were modeled using stepwise logistic regression. From the index pregnancy, birth weight of the infant, weight gain during the pregnancy, maternal age, and breast-feeding were considered. Variables from the subsequent pregnancy included smoking, maternal age, prepregnancy weight, and predelivery weight. Weight change between the two pregnancies (defined as the change in prepregnancy weight between the index and subsequent pregnancies) and the time interval between the two pregnancies (defined as the number of months between the date of delivery of the index pregnancy and the date of delivery of the subsequent pregnancy) were also evaluated. Because the recurrence of GDM is estimated to be >30%, odds ratios calculated from a logistic model will overestimate the RR. Therefore, odds ratios were converted to RRs using log-linear models with a binary error term (9).

Table 1—*Univariate associations between recurrence of GDM and factors from the index and subsequent pregnancy*

Variable	*n**	Recurrence of GDM *n* (%)	RR (unadjusted)	95% CI
Prepregnancy weight: index pregnancy				
<120 lb	108	30 (27.8)	1.00	—
120–149 lb	190	60 (31.6)	1.14	(0.79–1.64)
150–189 lb	163	55 (33.7)	1.21	(0.84–1.76)
≥190 lb	86	44 (51.2)	1.84	(1.28–2.66)
Prepregnancy weight: subsequent pregnancy				
<120 lb	83	22 (26.5)	1.00	—
120–149 lb	206	62 (30.1)	1.14	(0.75–1.72)
150–189 lb	158	56 (35.4)	1.34	(0.88–2.03)
≥190 lb	113	57 (50.4)	1.90	(1.27–2.85)
Birth weight: index pregnancy				
2,500–3,999 g	473	152 (32.1)	1.00	—
<2,500 g	39	12 (30.8)	0.96	(0.59–1.56)
≥4,000 g	139	68 (48.9)	1.52	(1.23–1.89)
Breast-feeding: index pregnancy				
Yes	347	117 (33.7)	1.00	—
No	293	109 (37.2)	1.10	(0.89–1.36)
Predelivery weight: index pregnancy				
<145 lb	83	21 (25.3)	1.00	—
145–179 lb	197	59 (29.9)	1.18	(0.77–1.81)
180–219 lb	178	68 (38.2)	1.51	(1.00–2.28)
≥220 lb	82	38 (46.3)	1.83	(1.18–2.84)
Predelivery weight: subsequent pregnancy				
<145 lb	75	20 (26.7)	1.00	—
145–179 lb	204	67 (32.8)	1.23	(0.81–1.88)
180–219 lb	176	62 (35.2)	1.32	(0.86–202)
≥220 lb	97	47 (48.5)	1.82	(1.18–2.79)
Smoking: index pregnancy				
No	396	139 (35.1)	1.00	—
Yes	166	61 (36.7)	1.05	(0.82–1.33)
Weight change between pregnancies				
<0 lb	141	48 (34.0)	1.00	—
0–4 lb	103	36 (35.0)	1.03	(0.72–1.46)
5–19 lb	174	53 (30.5)	0.89	(0.65–1.23)
≥20 lb	72	30 (41.7)	1.22	(0.86–1.75)
Weight gain during pregnancy: index pregnancy				
<15 lb	58	25 (43.1)	1.00	—
15–29 lb	210	76 (36.2)	0.84	(0.59–1.19)
30–44 lb	179	59 (33.0)	0.76	(0.53–1.10)
≥45 lb	74	18 (24.3)	0.56	(0.34–0.93)

*Numbers do not add up to total for some factors because of missing values.

RESULTS — This study included 651 women who had a diagnosis of GDM during an index pregnancy and then had a subsequent pregnancy. For 68% of these women, the index pregnancy was the first pregnancy, and for 20% of these women, the index pregnancy was the second pregnancy. Of the 651 women in the study who had GDM during an index pregnancy, 232 (35.6%) had diabetes during the subsequent pregnancy (95% CI 31.9–39.3%). Of the 232 women, 16 developed diabetes in the interval between the index and subsequent pregnancies.

A comparison of potential risk factors among women who had a GDM recurrence and those who did not are shown in Table 1. In a univariate analysis, all of the variables related to maternal weight, except weight change between pregnancies, were significantly associated with GDM recurrence, regardless of whether they pertained to the index or subsequent pregnancy. The mean age of the mother at either the time of the index pregnancy or at the time of the subsequent pregnancy was not different among those who had recurrent GDM and those who did not, as tested by Student's *t* test. In addition, there was no difference in the mean number of months between pregnancies among those in whom GDM recurred and those in whom it did not. When all potential predictors were analyzed in a logistic model, only infant birth weight from the index pregnancy and maternal prepregnancy weight from the subse-

Table 2—*Predictive factors for recurrence of GDM from the multivariate model*

Variable	Recurrence of GDM *n* (%)	Adjusted RR (95% CI)*
Prepregnancy weight (subsequent pregnancy)		
<120 lb	22 (26.5)	1.0
120–149 lb	62 (30.1)	1.1 (0.7–1.6)
150–189 lb	56 (35.4)	1.2 (0.8–1.9)
≥190 lb	57 (50.4)	1.7 (1.2–2.6)
Infant birth weight (index pregnancy)		
2,500–3,999 g	152 (32.1)	1.0
<2,500 g	12 (30.8)	0.9 (0.5–1.5)
≥4,000 g	68 (48.9)	1.4 (1.1–1.8)

*Adjusted for other term in model.

quent pregnancy significantly contributed to the fit of the model predicting GDM recurrence. As shown in Table 2, women who had a macrosomic infant (≥4,000 g) from their index pregnancy were 40% more likely to have a recurrence compared with women whose infant was 2,500–3,999 g. Women whose prepregnancy weight at the start of the subsequent pregnancy was ≥190 lb were 70% more likely to have a recurrence of GDM, adjusting for infant birth weight in the index pregnancy. A statistically significant trend was seen with both prepregnancy weight and infant birth weight when they were modeled as continuous variables.

Further analysis involved an examination of the first and second subsequent pregnancies after the index pregnancy. As shown in Fig. 1, the rate of recurrence in the second subsequent pregnancy was 72.4% among those who had GDM during both the index pregnancy and the first subsequent pregnancy and 21.5% among those who had GDM during an initial pregnancy but did not have GDM recurrence during the first subsequent pregnancy.

CONCLUSIONS — This study describes the recurrence rates of GDM among a large cohort of women who had GDM during an initial pregnancy. The recurrence rates found in this study (35.6%) are comparable with results seen in three previous studies (3–5) but lower than the recurrence rates found in three others (1,2,6). The various rates of GDM recurrence seen in the different studies could reflect differences in the underlying population or differences in the diagnostic criteria. In the three previous studies with recurrence rates of ≥50% (3–5), the study populations were largely nonwhite. This is in contrast to the studies that reported recurrence rates of ~30–35% (1, 2,6), including the present study, in which the study populations were predominately white. Thus, race is likely a risk factor for GDM as well as a risk factor for the recurrence of GDM (10).

Until 1989, the rates of GDM in Nova Scotia were <2%; since 1989, the yearly GDM rates have ranged from 2.1 to 3.4%. Since the late 1980s, universal screening for GDM has been the recommended standard of care in Nova Scotia. The increase in the rates of GDM likely reflects increased compliance with this recommendation. Before 1989, when universal screening became the standard of care, it is possible that some diagnoses of GDM during index pregnancies had been missed. However, the relatively low recurrence rates observed in this study are not likely explained by the changes in screening during the study period. More complete population screening would detect women with less severe cases of glucose intolerance who are probably less prone to recurrence of GDM during a subsequent pregnancy. In addition, the criteria for diagnosing GDM have not changed in Nova Scotia during the study period.

The data from this study cannot directly explain the relatively low recurrence rate found in this and other studies. Because the perinatal database does not include information on severity or control of GDM, we could not assess the relationship between these factors and the likelihood of recurrence. However, if women with very severe cases of GDM during the initial pregnancy had been deterred from having a subsequent pregnancy, potential cases of recurrent GDM may have been avoided. Another possible explanation for the relatively low recurrence rates is that women with GDM during an index pregnancy may have been motivated to make dietary modifications before and during the subsequent pregnancy, thereby lowering their risk of recurrent GDM.

The factors that were identified in this study as predictive of recurrent GDM, large infant birth weight and prepregnancy weight ≥190 lb, have been found in previous studies. Large infant birth weight during the index pregnancy may be indicative of poor control and/or poor maternal diet or may reflect GDM severity, which may then predispose women to recurrent GDM. Prepregnancy weight is based on self-report at the time of the first prenatal visit, which makes it susceptible to misclassification. It has been suggested that women underreport their prepregnancy weight by 0.8 kg, on average (11). This degree of misclassification is not

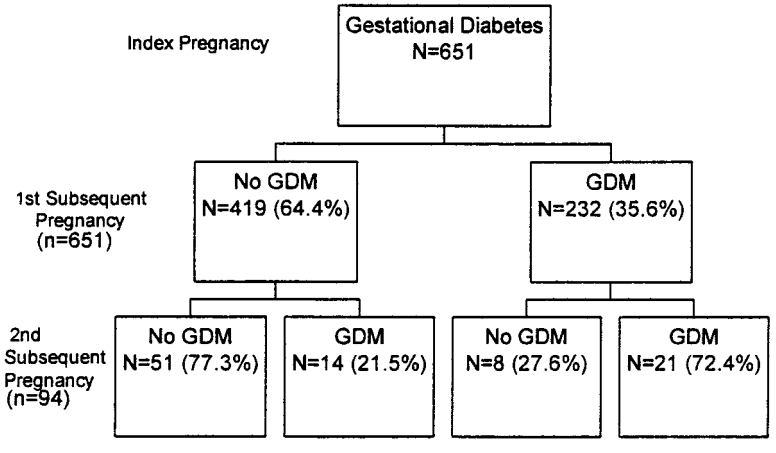

Figure 1—*Recurrence of gestational diabetes in subsequent pregnancies*

likely to have a large effect on the relationship between prepregnancy weight of ≥190 lb and recurrent GDM. Other studies have found that weight gain between pregnancies is an important predictor of recurrent GDM, but in this study, weight gain did not predict recurrence independently of prepregnancy weight. In a recent Nova Scotia study evaluating the perinatal effects of weight changes between pregnancies, it was found that weight gain between pregnancies was a risk factor for GDM during the subsequent pregnancy, whether it was recurrent GDM or an initial diagnosis (12).

Moses et al. (13) found that women with recurrent GDM during a subsequent pregnancy had higher fat intake compared with women in whom GDM did not recur. This finding was based on a small number of women, and the dietary assessment was conducted several years after the subsequent pregnancy. However, it is consistent with our finding that maternal weight ≥190 lb at the start of the subsequent pregnancy is a factor for recurrence. These findings raise further hypotheses to be tested and suggest that dietary manipulation is a potential direction for research aimed at reducing the recurrence of GDM.

Because of the large sample size of this study, we were able to provide stable estimates of recurrence of GDM in a predominately white population. In addition, several risk factors for developing recurrent GDM have been confirmed. This information will assist health care providers in counseling women with GDM about their recurrence risk and the importance of appropriate prenatal screening in subsequent pregnancies. Consequently, early detection and management of recurrent GDM may be enhanced.

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