Pregnancy Experience Among Women With and Without Gestational Diabetes in the U.S., 1995 National Survey of Family Growth

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OBJECTIVE — To compare the pregnancy experience among women with and without gestational diabetes mellitus (GDM) using a nationally representative survey.

RESEARCH DESIGN AND METHODS — We analyzed data from the 1995 National Survey of Family Growth conducted by National Center for Health Statistics on 3,088 women age 15–44 years with at least one pregnancy between 1991 and 1995 to compare demographics, fecundity, and pregnancy experience by GDM ($n = 116$) or nondiabetes ($n = 2,969$) status.

RESULTS — Among women with a pregnancy during 1991–1995, 3.6% reported GDM history. Women with GDM were older at age of delivery (31.8 years) than women without diabetes (29.0 years, $P < 0.001$). There was no significant difference between the groups by race/ethnicity. Compared with women without diabetes, women with gestational diabetes were more likely to report being currently surgically sterile (20.4 vs. 32.6%) or having impaired fecundity (12.6 vs. 19.7%, $P < 0.001$). GDM patients were more likely to have had a caesarean section than those without diabetes (31.7 vs. 20.9%, $P = 0.02$) and were more likely to report at least one of six additional nonroutine medical complications during pregnancy than nondiabetic patients (48.8 vs. 17.1%, $P < 0.001$). The odds ratio of a maternal medical complication during pregnancy for women with GDM compared with nondiabetic women, after adjusting for age at pregnancy and nongestational hypertension, was 4.3 (95% CI 2.7–6.8).

CONCLUSIONS — These findings suggest that pregnancies in women with GDM are more likely to be associated with maternal medical complications compared with pregnancies in women without diabetes.

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Gestational diabetes mellitus (GDM) is estimated to occur in 2.8% of hospital deliveries in the U.S. (1). The prevalence of diabetes in pregnancy, either GDM or preexisting, was 25.3/1,000 births in the U.S. for the period 1993–1995 (2). Based on projected demographic changes in the U.S. and worldwide, there is a projected 120% rise in the total number of cases of GDM by 2025 (3).

Diabetes in pregnancy is associated with increased risk of adverse outcomes for both the mother and the infant (4–11). These adverse outcomes include increased likelihood of birth defects, congenital abnormalities, preterm birth, caesarean delivery, macrosomnia, hypertension, and preeclampsia (4–8,10,12).

Risk factors for GDM include increasing age at pregnancy and being overweight or obese before pregnancy, a family history of diabetes, and belonging to a race/ethnic group (e.g., African American, Native American, Hispanic, South or East Asian, Pacific Islanders) with a high prevalence of GDM (3,13,14). These risk factors are often used in selective screening for GDM. Screening and diagnosis of GDM is thought to lead to reduced birth defects, complications, and macrosomina among women who are found to have GDM (13,15–17).

Most studies of GDM have focused on birth outcomes using vital records or are based in specific clinic populations (4–8,10–12). There are no large-scale population-based studies comparing the maternal pregnancy experience for women with and without GDM. Therefore, we analyzed the 1995 National Survey for Family Growth (NSFG) to compare maternal complications and pregnancies among women with and without GDM in the U.S.

RESEARCH DESIGN AND METHODS

— We analyzed data from the 1995 NSFG. The 1995 NSFG, conducted by the National Center of Health Statistics, is a nationally representative survey of women 15–44 years of age and was designed to provide estimates of factors affecting pregnancy and birth rates and the health of women and infants (18). Survey respondents were selected from a national probability sample of 14,000 women 15–44 years of age from households that participated in the 1993 National Health Interview Survey (NHIS).

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Abbreviations: GDM, gestational diabetes mellitus; NHIS, National Health Interview Survey; NSFG, National Survey of Family Growth.

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

The NHIS is a continuous multistage household survey of the U.S. civilian noninstitutionalized population and is conducted by the National Center of Health Statistics. To obtain sufficient numbers of minority women in the 1995 NSFG, all households with Hispanic and non-Hispanic black women in the NHIS were included in the NSFG sample. Sample weights were used to adjust for different sampling rates for Hispanic, non-Hispanic black, and non-Hispanic white women; for nonresponse; and for undercoverage by age, race, and parity. Of the 14,000 sampled women, 94.6% were successfully located and 10,847 completed interviews for an overall response rate of 78.2%. Interviews were conducted in person by trained interviewers and took on average 105 min to complete. The survey included questions on demographic characteristics, sterilization operations, fecundity impairment, use of family planning and other medical services, use of infertility services, detailed pregnancy history, pregnancy outcomes, and prenatal care.

We used the 1995 NSFG Pregnancy-Based file (18). Of those respondents who had information on at least one pregnancy after 1991 (n = 3,539), we identified the most recent pregnancy that occurred after 1991 and before date of interview in 1995 as the index pregnancy. Pregnancies that occurred after 1991 were selected for analysis because respondents were only asked about complications during pregnancy, such as GDM, for pregnancies that ended after 1991. Respondents who were pregnant at the time of interview (n = 427) were excluded from the analysis; of these, only 4 had established diabetes and none reported GDM. Respondents were classified as having GDM or no diabetes. GDM was defined as reporting diabetes during the pregnancy (n = 116) and not reporting established diabetes. Respondents who reported not knowing if they had had GDM or who had missing information for GDM were excluded (n = 3). Established diabetes was defined for respondents who answered "yes " to "Has a doctor or other medical care provider ever told you that you had diabetes (when you were not pregnant)?" (n = 24). Due to the small sample size, we excluded respondents who reported established diabetes, leaving 3,085 respondents available for analysis.

We compared respondents with GDM and without diabetes by demographics, health status, and fecundity. Demographics included age at interview, age at last pregnancy, race/ethnicity, education, and poverty index. Education level was defined as less than high school, high school, or some college and was only included for women >25 years of age (n = 2,314). Poverty index was reported as at or above poverty threshold or below federal poverty threshold and was based on survey response in the NHIS in 1993. Information on poverty index was missing for 7.1% of women with GDM and 8.3% of women without diabetes, and missing poverty information did not differ significantly by GDM status (P = 0.102).

Fecundity status in 1995 was defined as surgically sterile (which includes contraceptively and noncontraceptively surgical sterilization), impaired fecundity (which includes nonsurgically sterile, subfecund, and an interval of at least 36 months of unprotected sex without contraception), and fecund. Pregnancy outcome was categorized as live birth, induced abortion, or spontaneous loss (which includes stillbirth, miscarriage, and ectopic pregnancy).

Among respondents who reported a single live birth for the pregnancy (n = 2,347), we compared maternal complications during pregnancy, mode of delivery, and infant outcomes for respondents with GDM and no diabetes. Pregnancies resulting in multiple live births were excluded from analysis of maternal and birth outcomes. There were 39 respondents who reported more than one baby in the index pregnancy; 38 respondents reported having twins (GDM n = 2, nondiabetes n = 36), and 1 respondent reported having triplets (nondiabetes). Maternal complications, defined as nonroutine medical problems in pregnancy, were in addition to reports of GDM and included anemia in pregnancy, preeclampsia, toxemia, weak or incompetent cervix, water retention or edema, vaginal bleeding or spotting in the first 6 months, vaginal spotting or bleeding after the first 6 months, or other nonspecified problems. Infant outcomes were recorded as gestational age and baby's weight. Preterm birth was defined as a live birth <37 weeks' gestational age. Birth weight was converted to grams and categorized as low birth weight for infants <2,500 g, normal for infants 2,500 to <4,000 g, and macrosomia for infants ≥4,000 g. Size for gestational age was used to adjust birth weight for gestational age. Small for gestational age was defined as less than the 10th percentile weight for gestational age. Large for gestational age was defined as greater than the 90th percentile weight for gestational age (19).

Information on maternal height and weight was not collected during the NSFG survey. Therefore, BMI was calculated from self-reported height and weight collected during the 1993 NHIS (~2 years before the NSFG survey) as weight (in kilograms) divided by the square of height (in meters) . To address the concern that recent pregnancy might affect reported weight, we excluded BMI values for women who reported a pregnancy ending within 6 months of the 1993 NHIS (from July 1992 to June 1994, n = 1,791) from the analysis of BMI.

All analysis was completed using SUDAAN version 8.0 (Research Triangle Institute, Research Triangle Park, NC) with appropriate sampling weights to account for the complex survey design and provide nationally representative estimates. Estimates are weighted to the April 1995 population of women age 15–44 years in the U.S. GDM and nondiabetic groups were compared using ANOVA or Pearson's χ^2. Logistic regression was used to calculate unadjusted and age-at-pregnancy– and nongestational hypertension–adjusted odds ratios (ORs) for pregnancy outcomes and maternal complications. Further adjustment included demographic confounders, and the most parsimonious models are presented. We did not include BMI as a confounder in the logistic regression model because approximately half of the participants' BMI values were excluded.

RESULTS

Demographics

Among women with a pregnancy during 1991–1995, 3.6% reported a history of GDM. Women with GDM were older at the time of interview and at the time of pregnancy than women without diabetes (P < 0.001). There was no difference between the groups by race/ethnicity, education, or poverty index (Table 1).

Health status and pregnancy history

Over 90% of respondents in each group reported receiving prenatal care during

Table 1—*Comparisons by demographics for women with GDM and no diabetes for most recently reported pregnancy in the 1995 NSFG*

	GDM	No diabetes	*P*
n	116	2,969	
Percent	3.6	96.4	
Age at interview (years)	31.8	29.0	< 0.001
Age at pregnancy (years)	30.3	27.7	< 0.001
Race/ethnicity (%)			
Hispanic	13.6	15.1	
Non-Hispanic white	68.2	65.2	
Non-Hispanic black	11.8	15.0	
Non-Hispanic other	6.4	4.7	0.659
Education (%)*			
<High school	9.4	12.8	
High school	33.8	38.7	
Some college	56.8	48.5	0.226
Poverty index (%)†			
At or above poverty threshold	81.3	73.6	
Below poverty threshold	11.6	18.1	0.102

All estimates are weighted to the U.S. population of women age 15–44 years at 15 April 1995. *P* values are based on χ^2 for proportions and ANOVA for means. *Only women >25 years old at time of interview were included (GDM *n* = 105, no diabetes *n* = 2,209). †Respondents missing information on poverty status were not included (GDM *n* = 9, no diabetes *n* = 233).

the first trimester for the index pregnancy (Table 2). Respondents with GDM were more likely to report hypertension outside of pregnancy (12.9%) compared with those without diabetes (5.1%, *P* = 0.019). There was a difference in the fecundity status of respondents with GDM and without diabetes; respondents with GDM history were more likely to report being surgically sterile or to have impaired fecundity at the time of interview than respondents without diabetes (*P* = 0.003). We also looked at other factors that can affect fecundity, such as pelvic inflammatory disease and endometriosis, but there was no difference in the reported history between the two groups (data not shown).

The lifetime number of completed pregnancies (including spontaneous loss and live births), lifetime number of pregnancies ending in a spontaneous loss, and lifetime number of pregnancies ending in a live birth did not differ between the groups. Respondents with GDM were more likely to seek medical help to get pregnant (12.4%) and to prevent a miscarriage (23.7%) than respondents without diabetes (4.3%, *P* = 0.013 and 11.3%, *P* = 0.007, respectively). Respondents with GDM were less likely to report that the index pregnancy resulted in a spontaneous loss (3.9%) compared with women without diabetes (11.9%, *P* < 0.001).

Pregnancy outcomes

There were 2,238 single live births to respondents without diabetes and 109 to respondents with GDM (Table 3). Respondents with GDM were significantly more likely to report a nonroutine medical problem during pregnancy, in addition to GDM, with 21.2% reporting one problem and 27.6% reporting two or more problems compared with respondents without diabetes, with only 6.9% reporting one problem and 10.2% reporting two or more problems (*P* < 0.001). The most common nonroutine medical problem reported during pregnancy was preeclampsia, which was reported for 20.7% of respondents with GDM compared with 6.0% for respondents without diabetes (*P* = 0.002).

Respondents with GDM were also more likely to report a caesarean delivery than respondents without diabetes (31.7 vs. 20.9%; *P* = 0.024). Although there was no difference in the mean gestational age of infants between the groups, respondents with GDM were more likely to report a preterm birth (16.1%) than respondents without diabetes (8.2%, *P* = 0.042). There was no difference in mean birth weight or birth weight category. Respondents with GDM tended to have a large-for-gestational-age baby (18.7% compared with 12.1% for nondiabetes),

Table 2—*Comparisons by health status and pregnancy history for women with GDM and no diabetes for most recently reported pregnancy in the 1995 NSFG*

	GDM	No diabetes	*P*
n	116	2,969	
Hypertension, nongestational (%)	12.9	5.1	0.019
BMI (kg/m^2)*	25.3	23.8	0.008
Fecundity status (%)			
Surgically sterile	32.6	20.4	
Impaired fecundity	19.7	12.6	
Fecund	47.3	67.0	0.003
Received prenatal care in first trimester (%)	94.3	92.4	0.380
Lifetime number of completed pregnancies	2.7	2.7	0.769
Lifetime number completed pregnancies ending in spontaneous loss	0.5	0.5	0.508
Lifetime number completed pregnancies ending in live birth	2.0	1.8	0.242
Received medical help to get pregnant (%)	12.4	4.3	0.013
Received medical help to prevent miscarriage (%)	23.7	11.3	0.007
Pregnancy outcome (%)†			
Live birth	96.1	76.7	
Spontaneous loss	3.9	11.9	<0.001

All estimates are weighted to the U.S. population of women age 15–44 years on 15 April 1995. *P* values are based on χ^2 for proportions and ANOVA for means. *Participants who reported a pregnancy that ended within 6 months of the 1993 NHIS interview (July 1992 to June 1994) were excluded from the BMI estimate (GDM *n* = 50, no diabetes *n* = 1,732). †Percents may not sum to 100% since results for participants who reported pregnancy outcome as induced abortion (GDM *n* = 0, no diabetes *n* = 335) were not presented due to concerns of underreporting.

Table 3—*Comparisons of pregnancy experience and outcomes for women with GDM and no diabetes for most recently reported pregnancy resulting in a single live birth* in the 1995 NSFG*

Pregnancy complication and outcome	GDM	No diabetes	P
n	109	2,238	
Report of nonroutine medical problems during pregnancy (%)†			
One	21.2	6.9	
Two or more	27.6	10.2	<0.001
Preeclampsia during pregnancy (%)	20.7	6.0	0.002
Mode of delivery (%)			
Vaginal	68.3	79.1	
Caesarian	31.7	20.9	0.024
Gestational age (weeks)	38.4	38.8	0.071
Preterm birth (%)	16.1	8.2	0.042
Baby's weight (g)	3,455.0	3,400.5	0.453
Birth weight category (%)			
Low birth weight	7.0	4.5	
Normal birth weight	78.2	83.8	
Macrosomia	14.8	11.7	0.424
Small for gestational age (%)	4.5	4.6	0.992
Large for gestational age (%)	18.7	12.1	0.110

All estimates are weighted to the U.S. population of women age 15–44 years at 15 April 1995. P values based on χ^2 for proportions and ANOVA for means. *Pregnancies that resulted in a single live birth (n = 2,347; GDM n = 109, no diabetes n = 2,238). Pregnancies resulting in multiple births were excluded: 39 participants reported more than one baby in last pregnancy; 38 participants reported having twins (GDM n = 2, no diabetes n = 36), and 1 participant reported having triplets (no diabetes). †Nonroutine medical problems in pregnancy were in addition to the report of GDM and included any of the following: anemia in pregnancy, preeclampsia, toxemia, weak or incompetent cervix, water retention or edema, vaginal bleeding or spotting in the first 6 months, vaginal spotting or bleeding after the first 6 months, or other nonspecified problem.

but this difference was not statistically significant (P = 0.110).

Logistic regression

Since age at pregnancy and nongestational hypertension are associated with maternal complications and other pregnancy outcomes, we completed logistic regression for maternal pregnancy outcomes adjusting for age at pregnancy and nongestational hypertension (Table 4). After adjusting for age at pregnancy and nongestational hypertension, the OR of a maternal medical complication during pregnancy for women with GDM compared with women without diabetes was 4.30 (95% CI 2.71–6.82). Women with GDM had an OR of 2.05 (1.17–3.57) for preterm birth compared with women without diabetes after adjusting for age at pregnancy and nongestational hypertension. The association of caesarean delivery for women with GDM was only slightly attenuated after adjusting for age at pregnancy and nongestational hypertension. There was no significant association among women with GDM and large- or small-for-gestational-age babies compared with women without diabetes. Further adjustment for other potential confounders, such as race/ethnicity or education, did not significantly change the results (data not shown).

Subsidiary analysis

Since women with GDM and women without diabetes differed significantly by nonpregnancy hypertension status, we conducted a subsidiary analysis to determine whether the observed differences between the groups could be explained by nonpregnancy hypertension. We reanalyzed the data presented in Tables 2–4 after excluding women with nonpregnancy hypertension. There was only one difference in the results. After excluding women with nonpregnancy hypertension, the difference in the percent of preterm births between women with GDM and women with no diabetes was no longer statistically significant (GDM 12.9%, nondiabetes 8.0%; P = 0.153).

CONCLUSIONS— Women with GDM were more likely to experience medical complications in addition to having GDM during pregnancy, specifically preeclampsia, compared with women in pregnancies without diabetes. In addition, they were more likely to have a caesarean delivery or preterm birth but were not significantly more likely to have a large-for-gestational-age or marcosomia infant compared with women without diabetes. The strength of these findings is that they are based on data from a large nationally representative sample. Furthermore, the NSFG is comprehensive and includes information on pregnancy outcomes, demographics, and health history and allows comparison of pregnancy with and without GDM.

However, there are a number of limitations to this study. First, the number of women reporting a history of GDM is small. Furthermore, since women in the study were interviewed after the preg-

Table 4—*Logistic regression models for maternal pregnancy experience and infant outcomes for women with and without GDM for most recently reported pregnancy resulting in a live birth in the 1995 NSFG*

Outcome	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)	Adjusted OR† (95% CI)
Nonroutine medical complication	4.58 (2.89–7.25)	4.56 (2.87–7.25)	4.30 (2.71–6.82)
Caesarean delivery	1.75 (1.15–2.67)	1.58 (1.03–2.43)	1.50 (0.98–2.31)
Preterm birth	2.13 (1.22–3.74)	2.18 (1.24–3.84)	2.05 (1.17–3.57)
Large for gestational age	1.67 (0.98–2.86)	1.61 (0.95–2.74)	1.67 (0.98–2.86)
Small for gestational age	0.99 (0.33–3.00)	0.99 (0.95–1.03)	0.96 (0.30–3.04)

Each variable entered in separate logistic regression model. *Adjusted for age at pregnancy. †Adjusted for age at pregnancy and nongestational hypertension.

nancy ended, there is a potential for both recall bias and survival bias. Recall bias may exist if women with GDM were more likely to recall other nonroutine medical complications or be more familiar with these medical terms compared with women without diabetes. This would bias the result away from the null and may explain part of our finding of association with GDM and other medical complications. However, previous prospective studies have found similar magnitudes of association (5,7,11), giving us confidence that if bias is present, it is small. Survival bias may exist since we have no information on women who may have died or who would have been less likely to participate due to complications of pregnancy or delivery. As we observed, women with GDM were more likely to have other medical complications and may therefore be at higher risk of death or serious illness during delivery compared with women without diabetes. Therefore, complications and other pregnancy outcomes may be underreported in the study, biasing results toward the null. However, this is likely to have a minimal effect because the maternal mortality over the study period was 11.8 pregnancy-related deaths per 100,000 live births (20).

In this study, we found that women with GDM had a significantly lower risk of spontaneous loss than women without diabetes. This observation is most likely related to when GDM is typically diagnosed. GDM is not typically screened or tested for until the 24th to 28th week of pregnancy. This may explain why so few women with a history of GDM reported a spontaneous loss for the pregnancy. It is likely that women with GDM experience a spontaneous loss before being tested for GDM. A somewhat surprising finding was the higher percentage of women with GDM who reported seeking medical help to prevent miscarriage, suggesting that women who develop GDM during pregnancy may be experiencing a higher rate of spontaneous loss due to undiagnosed GDM in previous pregnancies and seek medical help to prevent miscarriages in subsequent pregnancies. Another possibility is that women who are diagnosed with GDM have other preexisting conditions that cause them to seek medical help to prevent miscarriages.

Previous studies have shown that GDM was associated with increased risk for adverse outcomes in pregnancy, including birth defects, large-for-gestational-age babies, and pregnancy-induced hypertension and preeclampsia (4–8,10–12). The majority of these studies were of pregnancies delivered in a limited geographic area (7,10,11) or limited hospital-based samples (5,8,12). In a retrospective cohort study of >111,000 pregnancies in Alberta, Canada, Xiong et al. (11) found that women with GDM were 2.5 times more likely to experience preeclampsia than women without diabetes. They also found that women with GDM were more likely to have a large-for-gestational-age baby and/or a caesarean delivery. In addition to the increased maternal complications during pregnancy, women who develop GDM during pregnancy are also likely to develop GDM in a subsequent pregnancy (21,22) and are at an increased risk of developing type 2 diabetes later in life (30–70% increased risk) (23, 24).

This study provides further evidence that GDM is associated with adverse maternal complications. It is unknown whether these women were more likely to be screened and diagnosed with GDM due to a diagnosis of one of the other complications during pregnancy or more likely to be diagnosed with another nonroutine medical complication because they had been diagnosed with GDM. It is difficult to disentangle the cause-effect relationship or the possible temporal associations or causality.

Currently, organizations differ on recommendations for screening for GDM. The U.S. Preventative Services Task Force concludes that there are insufficient data to recommend for or against screening (15). The American Diabetes Association recommends targeted screening in the first trimester among women who have at least one of the six risk factors for GDM and again at 24–28 weeks (13). The American College of Obstetricians and Gynecologists acknowledges that there is lack of strong evidence supporting universal screening but recommends that the American Diabetes Association guidelines be followed (25).

GDM is estimated to occur in 2.8% of hospital deliveries in the U.S. (1). Based on changing demographics in the U.S. (for example the growing populations of African Americans, Hispanics, and Asians) and the increase in obesity and delayed childbearing of women, it is predicted that GDM will continue to increase (3). The above-mentioned factors, along with the findings of this study, suggest that women with GDM are more likely to experience maternal medical complications and that occurrence of these complications can also be expected to increase in the coming years.

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