The effect of race/ethnicity on adverse perinatal outcomes among patients with gestational diabetes mellitus

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OBJECTIVE: The purpose of this study was to determine racial/ethnic differences in perinatal outcomes among women with gestational diabetes mellitus.

STUDY DESIGN: We conducted a retrospective cohort study of 32,193 singleton births among women with gestational diabetes mellitus in California from 2006, using Vital Statistics Birth and Death Certificate and Patient Discharge Data. Data were divided by race/ethnicity: white, black, Hispanic, or Asian. Multivariable logistic regression was used to analyze associations between race/ethnicity and adverse outcomes that were controlled for potential confounders. Outcomes included primary cesarean delivery, preeclampsia, neonatal hypoglycemia, preterm delivery, macrosomia, fetal anomaly, and respiratory distress syndrome.

RESULTS: Compared with women in other races, black women had higher odds of preeclampsia (adjusted odds ratio [aOR], 1.57; 95% confidence interval [CI], 1.47–1.95), neonatal hypoglycemia (aOR, 1.79; 95% CI, 1.07–3.00), and preterm delivery <37 weeks' gestation (aOR, 1.56; 95% CI, 1.33–1.83). Asian women had the lowest odds of primary cesarean delivery (aOR, 0.75; 95% CI, 0.69–0.82), large-for-gestational-age infants (aOR, 0.40; 95% CI, 0.33–0.48), and neonatal respiratory distress syndrome (aOR, 0.54; 95% CI, 0.40–0.73).

CONCLUSION: Perinatal outcomes among women with gestational diabetes mellitus differ by race/ethnicity and may be attributed to inherent sociocultural differences that may impact glycemic control, the development of chronic comorbidities, genetic variability, and variation in access to prenatal care, and quantity and quality of prenatal care.

Key words: gestational diabetes mellitus, perinatal outcomes, race/ethnicity

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Gestational diabetes mellitus (GDM) is defined as glucose intolerance with onset or first recognition during pregnancy.[1] GDM affects approximately 7-14% of all pregnant women[2] and is associated with multiple obstetric and neonatal complications, which includes cesarean delivery (CD),[3] preeclampsia,[4] preterm delivery (PTD),[5] fetal macrosomia,[6] shoulder dystocia,[7] neonatal jaundice,[8] and neonatal hypoglycemia.[9] The incidence of GDM has increased dramatically in the past decade in all racial/ethnic groups.[10] Studies of the racial/ethnic distribution of GDM have shown significant variation in its prevalence. Studies have found higher rates of GDM among Asian, Hispanic, Native American, and African American women, compared with non-Hispanic white women.[11] Asian women, with a reported rate as high as 15%, are more likely to have GDM than any other race, particularly when the data are controlled for body mass index and socioeconomic status.[12] Variations in the distribution of GDM by race/ethnicity may be related to genetic factors that affect insulin resistance, diet, lifestyle, sociocultural factors, healthcare access/use, or even provider discrimination. Because maternal hyperglycemia is associated with increased birthweight and insulin levels in the offspring, lifestyle modifications or medical treatment may lower the risk of adverse perinatal outcomes.[13-15]

Yet under the same treatment regimens, significant disparities persist in the analysis of adverse perinatal outcomes by race and ethnicity.[16] Given that Hispanic women are projected to be California's racial/ethnic majority within the next 3 decades,[17] research and subsequent clinical recommendations should be culturally sensitive and appropriately tailored to their risk. Understanding racial/ethnic differences in GDM diagnosis, management, and outcomes is thus an im-

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portant step towards the resolution of disparity and widespread improvement of maternal and child health.

A recent study of GDM compared outcomes among the most common racial/ethnic groups in the United States (white, black, Latina/Hispanic, Asian). After data were controlled for maternal age, parity, obesity, gestational age (GA) at delivery, weight gain during pregnancy, maternal education, and primary language, the findings confirmed an increased risk of primary CD, PTD, and fetal death in black women compared with other groups. GDM was still most common, however, among Asian and Latinas/Hispanic women.[18] Unfortunately, this study was not detailed enough to capture many of the neonatal complications that are associated with GDM, such as shoulder dystocia, neonatal jaundice, respiratory distress, and neonatal hypoglycemia and examined only neonatal intensive care unit admission rates. Neonatal complications that are associated with maternal hyperglycemia are important factors for both patient and provider for counseling and decision-making, because infants who are born with neonatal hypoglycemia are up to 3.5 times more likely to have neurodevelopmental impairment at ≤5 years of age.[19,20] Given this background, we sought to study perinatal outcomes among women with GDM. Specifically, we compared a broad range of maternal and neonatal outcomes by race/ethnicity.

Materials and Methods

This was a retrospective cohort study of 32,193 singleton births among women with GDM in California from 2006 whose information could be found in the Vital Statistics Birth and Death Certificate files that are linked with California Patient Discharge Data. Institutional Review Board approval was obtained from the University of California, San Francisco, Oregon Health & Science University, and the State of California. Because the linked dataset did not contain patient privacy and identification information, informed consent was exempted.

Inclusion criteria included women with singleton pregnancies who delivered in California. Diagnosis of GDM was obtained through a review of International Classification of Diseases–9 codes from hospital discharge data. Patients with pre-GDM (type 1 or 2) were excluded.

Outcomes that were analyzed were those that were associated with increased maternal or neonatal morbidity and the use of hospital resources, which included preeclampsia, primary CD, PTD at <37 weeks' gestation, PTD at <32 weeks' gestation, small for gestational age, large for gestational age, macrosomia, intrauterine fetal death, fetal anomaly, neonatal hypoglycemia, neonatal jaundice, and respiratory distress. Some of these outcomes are defined specifically with little expected variation in diagnosis, such as PTD at <37 or <32 weeks' gestation or macrosomia as birthweight of <4000 g. However, other outcomes are designated by the clinicians who care for the parturients or their neonates. *Neonatal jaundice* is variably defined by a total bilirubin level in the 95th percentile (13-18 mg/dL).[21] Similarly, practitioners may adopt varying thresholds for the diagnosis and treatment of neonatal hypoglycemia, which ranges from 36–50 mg/dL.[22] Shoulder dystocia is a subjective clinical diagnosis that is made when the routine practice of gentle, downward traction of the fetal head fails to deliver the anterior shoulder. Often underreported, it has been described as the need for ancillary maneuvers to deliver the shoulder and/or a head-to-body delivery time >60 seconds.[23]

Demographic information and maternal characteristics (such as parity, history of CD, and gestational age at delivery) were obtained from either birth certificate entries or hospital discharge information. Maternal race/ethnicity was self-reported by patients and categorized into 4 groups: white, black, Hispanic/Latina, and Asian.

Outcomes were coded and entered into STATA software (version 10; StataCorp, College Station, TX). Multiple variables were collapsed from continuous or categoric into binary variables and included age (>35 years) and education (college attendance). Chi-squared tests were used to compare dichotomous outcomes. Statistical significance was indicated by a probability value < .05. Multivariable logistic regression analyses were then performed to determine associations between race/ethnicity and perinatal outcome, when controlled for the following potential covariates: advanced maternal age, college education, initiation of prenatal care in the first trimester, prepregnancy obesity, parity, gestational age at delivery, and chronic hypertension. The results were reported as adjusted odds ratios with 95% confidence intervals.

Results

Of the 516,837 women who delivered within the reviewed timeframe (2006), 6.2% women (n = 32,193) received a diagnosis of GDM and had sufficient records for inclusion in the data analysis. The largest proportion was Hispanic (47.9%), as compared with white (34.6%), black (5.5%), and Asian (12.0%). The unadjusted prevalence of GDM by race/ethnicity, however, showed a greater proportion of Asian women with GDM (10.0%), compared with white (4.6%), black (4.5%), and Hispanic (6.9%) women. Maternal characteristics that were separated by race are shown in Table 1. The proportion of women with maternal age ≥35 years at the time of delivery was higher in both white and Asian women (35.8-38.0%) than in black and Hispanics women (approximately 29.5%; $P <$ .01). The Hispanic women with less than a college education comprised the highest proportion at 76.2%, compared with, at most, 41.2% in other groups. Obesity was more prevalent among black women (11.5%), compared with white (5.1%), Hispanic (4.8%), and Asian women (1.2%). Nulliparity was most common among Hispanic women (76.1%). Chronic hypertension was present in 3.5% of the sample population; however, black women made up the greatest proportion of this group (11.6%; $P <$ .01). All groups had an average gestational age at delivery of at least 38 weeks (Table 1).

Table 2 gives data on peripartum adverse outcomes that have been stratified by race/ethnicity. Black women had the highest proportion of preeclampsia (11.6% vs 4.1-6.0%), primary cesarean delivery (29.3% vs 20.7-26.0%), PTD <37 weeks' gestation (19.4% vs 11.4-16.1%), and PTD at <32 weeks' gestation (2.8% vs 1.0-1.1%; Table 2) compared with the other racial/ethnic groups. Shoulder dystocia was most prevalent among black and Hispanic

TABLE 1
Maternal characteristics stratified by race/ethnicity, expressed in prevalence

Maternal characteristic	Race/ethnicity				*P* value
	White	Black	Hispanic	Asian	
Advanced age: ≥35 y, n (%)	2736 (35.9)	360 (29.8)	4916 (29.5)	2237 (38.0)	< .01
Education: at least some college, n (%)	5021 (65.8)	709 (58.7)	3967 (23.8)	4678 (79.5)	< .01
Prenatal care before the second trimester, n (%)	6882 (90.4)	1040 (86.6)	14,309 (86.1)	5311 (90.5)	< .01
Use of public health insurance, n (%)	2069 (27.1)	602 (49.9)	10,856 (65.1)	1045 (17.8)	< .01
Obesity, n (%)	386 (5.1)	139 (11.5)	801 (4.8)	71 (1.2)	< .01
Nulliparity, n (%)	4748 (62.3)	792 (65.7)	12,672 (76.1)	3355 (57.1)	< .01
Chronic hypertension, n (%)	318 (4.2)	140 (11.6)	499 (3.0)	185 (3.1)	< .01
Gestational age at delivery, wk[a]	38.62 ± 2.31	38.12 ± 2.95	38.58 ± 2.23	38.51 ± 2.18	< .01

[a] Data are given as mean ± SD.

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women at 1.9-2.1%, compared with Asian women at 1.5% (Table 2).

With respect to fetal/neonatal outcomes, black women again exhibited higher proportions of neonatal hypoglycemia (1.7% vs 0.5-0.8%), respiratory distress syndrome (3.5% vs 1.4-2.1%), and fetal anomalies (12.1% vs 7.2-8.2%; all $P < .01$; Table 3). Asian women had the highest proportion of small-for-gestational-age infants (14.0% vs 7.5-12.4%) and the accordingly lowest proportion of large-for-gestational-age infants (2.7% vs 5.4-6.6%; both $P < .01$; Table 3) compared with other groups. The proportion of women with intrauterine fetal death did not differ significantly between groups.

Multivariable logistic regression analysis controlled for potential confounders (advanced maternal age, college education, early prenatal care, prepregnancy obesity, parity, chronic hypertension, and gestational age at delivery) that affected associations of race/ethnicity with GDM-related peripartum outcomes (Table 4). White race was the designated reference group. The association of black race with greater GDM-related peripartum morbidity remained after logistic regression. Black race was associated with 1.6 times the risk of preeclampsia and PTD at <37 weeks' gestation, compared with white women (adjusted odds ratio, 1.57 and 1.56; 95% confidence interval, 1.47–1.95 and 1.33–1.83 respectively). No other race was associated significantly with PTD. Asian women were significantly less likely than both black and white women to undergo primary CD (Table 4).

Neonates who were born to black women had elevated odds of neonatal hypoglycemia, small for gestational age, and fetal anomalies compared with neonates who were born to white women (Table 4). After the data were controlled for gestational age at birth, white women had odds of neonatal respiratory distress syndrome that were higher than those of Hispanic and Asian women. Hispanic and Asian women did not experience any increased odds of neonatal hypoglycemia. Race did not affect odds of fetal death in women with GDM.

Comment

Despite the high prevalence of GDM among Asian (10.0%) and Hispanic (6.9%) women in our study population, they were the least likely to experience adverse perinatal outcomes compared with women from other racial/ethnicity groups. In our study of more than 32,000 GDM-affected pregnancies, we found that, although black women had increased odds of preeclampsia, PTD at <37 weeks' gestation, primary CD, and neonatal hypoglycemia compared with white women, Asian and Hispanic women had similar, if not decreased, odds. Differences in GDM-related outcomes in black women compared with women from other racial/ethnic groups, even when the data were controlled for demographic and socioeconomic factors, raise many questions about the origins of disparities.

That Hispanic and Asian women did not have a prominently increased risk of adverse perinatal outcomes compared

TABLE 2
Peripartum outcomes stratified by race/ethnicity, expressed in prevalence

Peripartum adverse outcome	Maternal race/ethnicity, n (%)				*P* value
	White	Black	Hispanic	Asian	
Preeclampsia	409 (5.4)	140 (11.6)	1003 (6.0)	242 (4.1)	< .01
Primary cesarean section delivery	1985 (26.0)	354 (29.3)	3454 (20.7)	1325 (22.5)	< .01
Preterm delivery, wk					
<37	916 (12.1)	233 (19.4)	2182 (13.2)	672 (11.4)	< .01
<32	80 (1.1)	34 (2.8)	192 (1.2)	64 (1.1)	< .01
Shoulder dystocia	136 (1.8)	23 (1.9)	348 (2.1)	86 (1.5)	.02

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TABLE 3
Fetal/neonatal outcomes stratified by race/ethnicity, expressed in prevalence

Fetal/neonatal adverse outcome	Maternal race/ethnicity, n (%)				*P* value
	White	Black	Hispanic	Asian	
Neonatal hypoglycemia	61 (0.8)	20 (1.7)	101 (0.6)	29 (0.5)	< .01
Small for gestational age	503 (7.5)	122 (12.4)	1240 (8.5)	735 (14.0)	< .01
Macrosomia (birthweight, >4000 g)	1151 (15.1)	164 (13.6)	2546 (15.3)	355 (6.0)	< .01
Large for gestational age	504 (6.6)	65 (5.4)	972 (5.8)	159 (2.7)	< .01
Neonatal jaundice	1638 (21.5)	246 (20.4)	3330 (20.0)	1727 (29.3)	< .01
Respiratory distress syndrome	161 (2.1)	42 (3.5)	282 (1.7)	80 (1.4)	< .01
Intrauterine fetal death	14 (0.2)	3 (0.3)	50 (0.3)	14 (0.2)	.41
Fetal anomalies	552 (7.2)	146 (12.1)	1365 (8.2)	485 (8.2)	< .01

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with white and black women, despite a higher prevalence of GDM, has been supported in previous studies[24] and is explained potentially by the "Healthy Immigrant" hypothesis. Immigrants to the United States may be self-selected for prepregnancy health through official screening and employability. Immigrants are also less likely to be exposed to unfavorable Western behaviors such as drinking, smoking, drug use, overeating, consuming high fat and high sugar diets, and adopting sedentary lifestyles.[25,26] A study of supermarket sales confirmed that goods purchased by black women contained almost 25% more products with a high sugar content than those purchased by Hispanic women.[27] Immigrants may also retain extended families that may provide financial, social, and emotional support for healthy pregnancy care. Over time, this discrepancy might become less significant with acculturation. These lifestyle factors may also add to the risk of black women experiencing other chronic comorbidities (such as hypertension, hyperlipidemia, and renal dysfunction), thereby differentially increasing their observed risk of preeclampsia and possibly iatrogenic PTD. Although pre-GDM is associated with the development of preeclampsia and congenital anomalies, the association of these 2 outcomes and actual GDM is more controversial.[28,29] Our data that suggest that black women have increased odds of both preeclampsia and fetal anomalies support the possibility that these women are more likely to have undiagnosed pre-GDM and unmeasured chronic comorbidities. Because our findings controlled for early enrollment in prenatal care, more efforts should be directed towards preconception counseling, the performance of early glucose tolerance tests, and blood pressure monitoring for high risk groups, such as black women. We note also that, although the odds of fetal anomalies were increased among Asian women with GDM, the odds of preeclampsia were decreased. Asian women are at increased risk for type 2 diabetes mellitus; thus, it may be that they also had greater rates of undiagnosed pre-GDM.

Although women with GDM have uniformly set treatment guidelines in California and are counseled by trained physicians and dieticians, their comprehension of treatment plans and ability to comply may be affected by discrepant health literacy. One study that examined racial disparity in scores on the Test of Functional Health Literacy in Adults found that only 64% of black women and 47.1% of Hispanic women achieved

TABLE 4
Peripartum and fetal outcomes stratified by race/ethnicity, controlled for potential confounders[a]

Adverse outcome	Maternal race[b]		
	Black	Hispanic	Asian
Peripartum			
Preeclampsia	1.57 (1.47–1.95)	1.18 (1.04–1.34)	0.78 (0.66–0.93)
Primary cesarean delivery	1.20 (1.04–1.39)	0.93 (0.87–1.00)	0.75 (0.69–0.82)
Repeat cesarean delivery	0.74 (0.49–1.12)	1.08 (0.87–1.34)	0.73 (0.56–0.94)
Preterm delivery, wk			
<37	1.56 (1.33–1.83)	1.06 (0.97–1.15)	0.94 (0.85–1.05)
<32	0.45 (0.30–0.68)	0.96 (0.73–1.26)	0.99 (0.71–1.36)
Shoulder dystocia	1.07 (0.69–1.68)	1.00 (0.81–1.23)	0.84 (0.64–1.10)
Fetal			
Neonatal hypoglycemia	1.79 (1.07–3.00)	0.69 (0.50–0.96)	0.64 (0.41–1.00)
Small for gestational age[c]	1.76 (1.42–2.17)	1.22 (1.09–1.37)	1.98 (1.76–2.23)
Large for gestational age[c]	0.75 (0.57–0.97)	0.84 (0.74–0.94)	0.40 (0.33–0.48)
Macrosomia	0.82 (0.69–0.98)	0.90 (0.83–0.97)	0.39 (0.34–0.44)
Neonatal jaundice	0.80 (0.69–0.94)	0.94 (0.88–1.01)	1.47 (1.36–1.59)
Respiratory distress syndrome	0.94 (0.63–1.39)	0.69 (0.55–0.87)	0.54 (0.40–0.73)
Intrauterine fetal death	1.42 (0.29–7.05)	1.99 (0.86–4.62)	1.52 (0.53–4.43)
Fetal anomalies	1.51 (1.24–1.84)	1.11 (1.00–1.23)	1.15 (1.02–1.31)

[a] Controlled for advanced maternal age, college education, prenatal care within the first trimester, prepregnancy obesity, nulliparity, chronic hypertension, and gestational age at delivery; [b] Data are given as adjusted odds ratio (95% confidence interval); white population is the reference group; [c] Gestational age omitted from regression.

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an adequate score, compared with 100% of white women who took the test.[30] Because pregnancy is a period during which women are seen frequently, their development of a relationship with their care provider that allows communication and comprehension of treatment goals is also important. Among female diabetics, patient-provider communication may be the most significant factor to impact adherence.[31] Although non-Hispanic white patients are more likely to feel connected to their providers,[32] black women may have less trusting relationships with physicians. Because black physicians made up a mere 3.5% of the American physician population in 2008, increasing provider diversity may be a specific directed strategy to improve healthcare experiences for members of racial/ethnic minority groups.[33] Furthermore, because Hispanic women made up the largest group of California's pregnancies during the study period, it is likely that prenatal care providers have become more culturally sensitive and readily aware of their increased risk of GDM and have altered screening and treatment plans accordingly.[34] Provider bias may also contribute to higher rates of primary CD among black women compared with the other groups in our sample. However, black women with pre-GDM have an average hemoglobin A1C level that is 1% greater than their white counterparts,[35] which suggests that black women have poorer glycemic control even after receiving a diagnosis that potentially could lead to some of the differences in perinatal outcomes that were seen. Additionally, because black women may be perceived by clinicians to have comparably poorer glycemic control and to have a greater risk of delivery complications, they may be delivered at an earlier gestational age, which may, in turn, impact mode of delivery, gestational age, and neonatal outcomes.[36]

The large sample size of this study enabled us to look at the effect of race on relatively rare outcomes while adjusting for relevant confounding effects. We were limited, however, by the inability to obtain information on glycemic control and treatment with lifestyle modifications vs medications. We also recognize that discharge data likely underreport diagnoses of obesity, given that the highest rate of obesity in our sample was the 11.5% among black women, which was markedly lower than the national average of approximately 20%.[37] More accurate reporting of obesity might decrease the strength of association between black race and GDM-related adverse outcomes. In addition, the discharge data do not distinguish between iatrogenic and spontaneous preterm deliveries, thereby preventing any comment on the mechanism of increased PTD risk among black women. Furthermore, our data do not provide information on immigrant status or country of origin, which might be valuable for addressing the "fetal origins" hypothesis whereby immigrants from countries with high rates of malnutrition may have been born with low birthweights and thereby programmed in utero toward the development of GDM when in more resource plentiful contexts.[38] Without record of country of birth, our data do not permit us to remark on the effect of acculturation.

We recognize that, by only using the 4 most common race/ethnicity categories from birth certificates in California, some mixed-race and minority populations may have been overlooked; however, a validation study that compared reported race on California birth certificates with those obtained from face-to-face interviews showed a sensitivity from 94-99%, which indicates that the contribution of mixed race persons may be small.[39]

The study of race and ethnicity is valuable for being a complex marker of many difficult-to-measure influences on pregnancies that are complicated by GDM. Even when we controlled for demographic, anthropometric, and socioeconomic factors, disparities in race and ethnicity continued to be apparent in the study of GDM prevalence and GDM-related adverse perinatal outcomes. Although Asian women in our sample population had the highest rates of GDM, their pregnancies were at decreased risk for some of the most notable adverse perinatal outcomes of GDM (such as preeclampsia, CD, PTD, macrosomia, neonatal hypoglycemia, and neonatal respiratory distress). Black women with GDM, however, had an increased risk of preeclampsia, PTD, and neonatal hypoglycemia. Remaining explanations for such racial disparity include sociocultural support structures and traditions, healthcare use, patient-provider relations and biases, and inherent genetic predispositions. Given the variation in outcomes, future research should focus on whether there are racial/ethnic variations in the benefits from particular kinds of treatment for GDM. ■

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