Published in final edited form as:

Obstet Gynecol. 2013 June ; 121(6): 1255–1262. doi:10.1097/AOG.0b013e318291b15c.

Risk of Large-for-Gestational-Age Newborns in Women With Gestational Diabetes by Race and Ethnicity and Body Mass Index Categories

Sneha B. Sridhar, MPH, Assiamira Ferrara, MD, PhD, Samantha F. Ehrlich, PhD, Susan D. Brown, PhD, and Monique M. Hedderson, PhD

Division of Research, Kaiser Permanente Northern California, Oakland, California

Abstract

OBJECTIVE—To compare the prevalence of large-for-gestational-age (LGA) newborns across categories of body mass index (BMI) in five racial and ethnic groups.

METHODS—This cohort study examined 7,468 women with gestational diabetes mellitus (GDM) who delivered a live newborn between 1995 and 2006 at Kaiser Permanente Northern California. The racial and ethnic groups were non-Hispanic white, African American, Hispanic, Asian, and Filipina. The BMI was classified using the World Health Organization International guidelines (normal, 18.50–24.99; overweight, 25.00–29.99; obese, 30.00–34.99; obese class II, 35.00 or higher). Having an LGA newborn was defined as birth weight more than 90th percentile for the study population's race or ethnicity and gestational age-specific birth weight distribution. Logistic regression was used to estimate odds of having an LGA newborn by BMI and race and ethnicity.

RESULTS—Overall prevalence of LGA newborns was highest in African American women (25.1%), lowest in Asians (13.9%), and intermediate among Hispanic (17.3%), white (16.4%), and Filipina women (15.3%). The highest increased risk of LGA newborns was observed among women with class II obesity in most racial and ethnic groups, and African American and Asian women with class II obesity had a four-fold increased risk of LGA newborns compared with women of normal weight in the same racial and ethnic group.

CONCLUSIONS—African American women with GDM have a greater risk of LGA newborns at a lower BMI than other racial and ethnic groups. Clinicians should be aware that among women with GDM, there may be significant racial and ethnic differences in the risk of LGA newborns by BMI threshold.

Gestational diabetes mellitus (GDM), defined as carbohydrate intolerance with onset or first recognition during pregnancy, affects approximately 7% of all pregnancies in the United

Corresponding author: Sneha Sridhar MPH, Division of Research, 2000 Broadway, Oakland, CA 94612-2304; Sneha.x.Sridhar@kp.org.

Presented in abstract form at the 24th Annual Meeting of the Society for Pediatric and Perinatal Epidemiologic Research, June 20–21, 2011, Montreal, Quebec, Canada.

Financial Disclosure

The authors did not report any potential conflicts of interest.

LEVEL OF EVIDENCE: II

States.^{1,2} It is associated with short-term and long-term health implications for the mother and her newborn, including cesarean delivery and subsequent type 2 diabetes for the mother and macrosomia, being large for gestational age (LGA), and subsequent childhood obesity for the newborn.³ The prevalence of GDM has increased by 35% in recent years and varies significantly by racial and ethnic groups; it is highest in Asian and Hispanic women and lowest in white and African American women.^{2,4} These racial and ethnic disparities are surprising given that obesity is the strongest known risk factor for GDM, and the prevalence of obesity is highest in African Americans and lowest in Asians.⁵

It is less clear whether there are also racial and ethnic disparities in the risk of complications most commonly associated with GDM. Having an LGA newborn is one such perinatal complication, with consequences for both the mother and the newborn. Mothers face increased risks of complications during delivery because of large fetal size, whereas LGA newborns are at higher risk for shoulder dystocia, injury during birth, hypoglycemia after delivery, and development of obesity and type 2 diabetes later in life.⁶⁻⁸ Risk of having an LGA newborn is known to vary by race and maternal body mass index (BMI, calculated as weight (kg)/[height (m)]²), yet variation in the risk of LGA newborns by racial and ethnic groups and BMI category has not been thoroughly explored in women with GDM.⁹⁻¹¹ In a large cohort of women with GDM, we sought to compare the prevalence of race-specific and ethnicity-specific LGA (more than 90th percentile of birth weight) newborns across categories of BMI for the following racial and ethnic groups: non-Hispanic white, African American, Hispanic, Asian, and Filipina.

MATERIALS AND METHODS

The study setting was Kaiser Permanente Northern California, a large group practice prepaid health plan that provides comprehensive medical services to members residing in a 14-county region of Northern California (approximately 30% of the surrounding population). The demographic, racial and ethnic, and socioeconomic make-up of the Kaiser Permanente Northern California membership is well-representative of the population residing in the same geographic area, except that the very poor and the very wealthy are under-represented.^{12,13}

Women with GDM were identified through the Kaiser Permanente Northern California Gestational Diabetes Registry, which previously has been described in detail.² In brief, the registry searches the Kaiser Permanente Northern California electronic databases to identify pregnancies among women without recognized pre-existing diabetes and classifies them based on glucose values obtained from a 50-g, 1-hour glucose challenge test, also referred to as the screening test. Women with an abnormal screening test result (140 mg/dL or higher) undergo a 100-g, 3-hour oral glucose tolerance test (OGTT) for follow-up and are further classified according to the results of the OGTT. In this setting, 94% of women delivering liveborn singletons undergo the recommended 50-g, 1-hour glucose challenge test screening for GDM.¹⁴ Among those who screened positive on the glucose challenge test, 98.2% then undergo the 100-g, 3-hour OGTT.² Maternal glucose values from the 50-g glucose challenge test and 100-g, 3-hour OGTT were obtained from the Kaiser Permanente Northern California regional laboratory database. Information on prescription of glyburide or insulin

after the GDM diagnosis was obtained from the Kaiser Permanente Northern California pharmacy database.

Gestational diabetes was defined as having at least two plasma glucose values on the 100-g, 3-hour OGTT meeting or exceeding the Carpenter-Coustan thresholds (fasting, 95 mg/dL; 1-hour, 180 mg/dL; 2-hour, 155 mg/dL; 3-hour, 140 mg/dL).¹⁵ As a surrogate measure of severity of GDM, we used the fasting value from the OGTT because previous research has shown it to be the most predictive of risk of having an LGA newborn.¹⁶

Maternal age at delivery, height, pregnancy body weight (assessed on average at 17 weeks of gestation, ranging from 7 to 26 weeks of gestation; 98.6% of the study cohort had the maternal weight measured between 15 and 20 weeks of gestation), and gestational age at the weight measurement were obtained from the Kaiser Permanente Northern California electronic medical records. The State of California electronic birth certificate records were used to obtain information on self-reported maternal level of education, parity, and race and ethnicity. The maternal race and ethnicity categories were non-Hispanic white (hereafter referred to as white), African American, Hispanic, Asian, and Filipina. Having an LGA newborn was defined as any birth weight more than the 90th percentile for the study population's race and ethnicity and gestational age-specific birth weight distribution.

Among women without recognized pregravid diabetes, we identified 21,336 live birth deliveries to women 18 to 45 years of age at delivery who matched a California birth certificate record between 1995 and 2006 and had a diagnosis of GDM (a prevalence of 6.2%). Among these, 10,202 women had complete data for height and pregnancy weight (48%). For women with more than one pregnancy during the study period, we selected the first pregnancy. We then excluded women whose gestational age at delivery was less than 35 weeks (n=316; 1.5%) or unknown (n=68; 0.3%). Finally, we excluded women missing information for race and ethnicity (n=26; 0.1%), birth weight (n=66; 0.3%), and those with a BMI less than 18.5 (n=75; 0.4%), leaving a final analytic cohort of 7,468 women. This study was approved by the Kaiser Foundation Research Institute Institutional Review Board and the State of California Committee for the Protection of Human Subjects.

Pregnancy BMI was calculated as the maternal pregnancy weight (kg) divided by height (m²). The BMI categories were created based on the World Health Organization International Classification of adult underweight, overweight, and obesity according to BMI (normal, 18.5–24.99; overweight, 25.0–29.99; obese, 30.00–34.99; obese class II, 35.0 or higher).¹⁷ The age-adjusted prevalence of having an LGA newborn and 95% confidence intervals were calculated within each racial and ethnic group and were further stratified by BMI category. Estimates were standardized using the direct method in which the age distribution of the entire study cohort was used as the reference.¹⁸ A one-way analysis of variance was used to compare the means of continuous variables by race, whereas a χ^2 test was used to assess categorical variables. Unconditional logistic regression analysis was used to estimate odds of delivering an LGA newborn. The model was adjusted for race and ethnicity (white as the referent), parity (0 as the referent, 1, and 2 or more births), education (high school graduate or less as the referent, partial college, college graduate or higher, and unknown), maternal age at delivery, gestational age (in weeks) at the pregnancy weight

measurement, neonatal sex (male as the referent), pregnancy BMI category (normal as the referent, overweight, obese, and obese class II), medication use during pregnancy (insulin or glyburide use, or both compared with no medication use), and the fasting glucose value from the 100-g, 3-hour OGTT. To estimate effect modification by race and ethnicity, we included an interaction term (race and ethnicity× BMI) in this model. The interaction term achieved borderline significance (P value for interaction term=.056); therefore, we decided to perform the fully adjusted model stratified by each of the five racial and ethnic groups to further estimate differences in risk of having an LGA newborn by race and ethnicity and BMI. SAS 9.1 was used for all analyses.

RESULTS

We first compared women who had complete electronic data for height and pregnancy weight compared with those who did not. Women who were excluded from the analytic cohort because of missing BMI were significantly more likely to have had two or more previous live births (31.0% compared with 26.6%), were more likely to be white (32.9% compared with 27.5%), and were slightly older at delivery (32.7 years old compared with 31.2 years old) ($P<.001$). Women missing BMI did not differ significantly from the analytic cohort on educational attainment or prevalence of having an LGA newborn (17.9% compared with 17.3%, respectively).

The characteristics of the analytic cohort are displayed by racial and ethnic group in Table 1. Mean maternal age at delivery was similar for all racial and ethnic groups. Hispanic women had fewer years of education compared with other racial and ethnic groups. White and Asian women were more likely to be nulliparous than African American, Hispanic, and Filipina women. The majority of Asian, Hispanic, and Filipina women were born outside of the United States compared with less than 20% of the white and African American women.

Asian women were more likely to be of normal weight, whereas Filipina women were more likely to be overweight, and African American and Hispanic women were more likely to be obese (Table 1). The age-adjusted prevalence of having an LGA newborn among women with GDM was highest among African American women (25.1%), intermediate among Hispanic, white, and Filipina women (17.3%, 16.4%, and 15.3%, respectively), and lowest among Asian women (13.9%). African American women were more likely to be prescribed insulin or glyburide during pregnancy.

Figure 1 displays the prevalence of LGA newborns by race and BMI, adjusted for maternal age. Among all racial and ethnic groups, the prevalence of LGA newborns was higher among overweight, obese, and obese class II women as compared with normal weight women in the same racial and ethnic groups. African American women who were overweight or obese had a higher prevalence of LGA newborns compared with other racial and ethnic groups after adjusting for maternal age. Among those with class II obesity, Asian women had the highest age-adjusted prevalence of LGA newborns.

In the fully adjusted multivariable model (Table 2), African American women were 30% more likely to have an LGA newborn after adjusting for racial and ethnic group, parity, age

at delivery, gestational age at the pregnancy weight measurement, education, BMI, newborn gender, glyburide or insulin use, and the fasting glucose value from the 100-g, 3-hour OGTT.

Table 3 shows the association between BMI categories and having an LGA newborn, stratified by race and ethnicity. Compared with normal weight women with GDM, all racial and ethnic groups had an increased risk of having an LGA newborn with increasing BMI category. The odds ratios for having an LGA newborn associated with BMI category varied by racial and ethnic groups; the greatest increases in risk for each BMI category above normal (referent) were among African American women.

The highest increased risk of having an LGA newborn was observed among women with class II obesity in most racial and ethnic groups, and both African American and Asian women with class II obesity had a four-fold increased risk of having an LGA newborn compared with women of normal weight in the same racial and ethnic group.

DISCUSSION

In this cohort study of women with GDM, having a pregnancy BMI greater than normal was associated with an increased the risk of delivering an LGA newborn in all racial and ethnic groups. The prevalence of LGA newborns among women with GDM was highest in African American and Hispanic women, and lowest in Asian, Filipina, and white women. Our results also indicate that the risk of having an LGA newborn associated with increased pregnancy BMI was particularly high for African American women. Asian women with class II obesity also appeared to have a more pronounced increase in risk.

Previous studies have similarly reported that maternal diabetes and GDM increase newborn birth weight more in African American women than in white women. Kieffer et al¹⁹ found that maternal diabetes increased the likelihood of macrosomia to a greater degree in African American women than in white women. Among white women, the risk of extreme macrosomia (more than 4,500 g) was 2.5-times greater for those with diabetes as compared with women without diabetes; in African American women, the risk of extreme macrosomia was six-times greater for those with diabetes.¹⁹ However, in this study, authors did not distinguish between GDM and pre-existing diabetes. Another study found that African American women with pregnancy-impaired glucose tolerance (a hyperglycemic condition not severe enough to be classified as GDM) had higher rates of newborns with macrosomia and LGA compared with white women with impaired glucose tolerance during pregnancy.²⁰

Less research has been performed assessing the effect of GDM on birth weight by race and ethnicity and BMI. Hunt et al²¹ found that GDM had a greater effect on birth weight in non-Hispanic African American women than non-Hispanic white women, particularly in combination with obesity. In our study, African American women with GDM had a greater prevalence of LGA newborns at lower BMIs than other racial and ethnic groups. We observed a suggestion that the highest prevalence of LGA newborns was among African American women at a BMI of 30.0–34.9, whereas other racial and ethnic groups had a further increase in risk of LGA newborns observed among those with class II obesity.

However, this observation did not reach statistical significance, perhaps because of a small sample size. Further research is needed to determine if there is, in fact, a BMI threshold effect among African American women with GDM.

Previous studies have shown that there may be racial and ethnic disparities in glycemic control during pregnancy. Holcomb et al²² found that African American women entering prenatal care with pre-existing diabetes had poorer glycemic control than white women. African American women with GDM in our study had the highest mean fasting glucose levels and were more likely to be prescribed glyburide or insulin, suggesting that African American women had more severe GDM. We found the increased risk of having an LGA newborn remained after adjusting for GDM treatment and fasting glucose value from the OGTT; however, we were unable to adjust for glycemic control.

Our results also indicated that Asian and Filipina women with GDM and class II obesity (BMI 35 or higher) had the highest overall prevalence of having an LGA newborn. Reasoning behind this finding is unclear, although previous research has indicated that the underlying mechanisms and genetics of obesity and diabetes may be different among Asians as compared with other racial and ethnic groups. Asian women may have a greater percentage of subcutaneous body fat than white women, even at a lower BMI.²³ Dornhorst et al²⁴ found that more Asian women with GDM delivered LGA newborn compared with white women with GDM. In addition, there appears to be variation in risk of having an LGA newborn by Asian subgroup. One study found that after treatment, Native Hawaiian, Pacific Islander, and Filipina women with GDM each had a higher prevalence of neonates with macrosomia than Japanese, Chinese, and white mothers with GDM.²⁵ More research needs to be conducted to ascertain the cause of increased risk among heterogeneous subgroups of Asian women with class II obesity.

Racial and ethnic differences in factors such as lifestyle and gestational weight gain also may influence the risk of LGA newborns among women with GDM. One study of pregnant women found no differences between white women and African American women in diet quality during the first trimester;²⁶ however, we are unaware of previous studies examining racial and ethnic differences in diet among women with GDM diagnosed. Gestational weight gain is associated with increased birth weight;²⁷ however, the few studies able to examine racial and ethnic differences in gestational weight gain have shown that African American women gain less weight during pregnancy than do white women.^{28,29}

One of the strengths of this study is that our study population reflects the general population and is quite diverse. Previous studies typically have been limited to comparing two or three racial and ethnic groups, such as white and African American women, or white and Asian women. Given that there is significant racial and ethnic variation in birth weight and gestational age-specific newborn mortality rates, it is important to use race-specific cut-offs to determine risk of having an LGA newborn.³⁰ We had the ability to examine variation in race-specific risk of having an LGA newborn between multiple racial and ethnic groups of women with GDM by pregnancy BMI, given our large sample size and diverse population. Another strength is that we were able to exclude women with recognized pre-existing diabetes.

There are several limitations to the current study. First, use of a single Asian group, although distinct from Filipinas, may not provide an accurate representation of all Asian women with GDM. There may be considerable heterogeneity in perinatal outcomes among Asian subgroups, highlighting the importance of disaggregation to assess ethnic differences. Next, we lacked detailed information on the degree of glycemic control achieved; racial and ethnic differences in adherence with GDM treatment may partially explain the observed differences. Additionally, electronic data on diet, lifestyle, and weight gain during pregnancy, which may be factors underlying the racial differences in risk of having an LGA newborn, were unavailable during the study time period. Finally, missing data on height and weight resulted in the loss of a large number of patients; however, missing cases were similar in demographics to those with information on BMI.

Our findings suggest that among women with GDM, there are racial and ethnic differences in the risk of having an LGA newborn, both overall and when stratified by BMI category. African American women (at all BMI categories above normal) and Asian and Filipina women with class II obesity exhibited a particularly high risk of having an LGA newborn. However, more research is needed to clarify whether our findings are attributable to racial and ethnic differences in GDM sequelae or whether they are attributable to racial and ethnic differences in glycemic control, lifestyle, genetics, or other underlying risk factors. Proper diagnosis and treatment of GDM early in the course of the pregnancy, as well as behavioral counseling and treatment of prediabetes before conception, will likely play a crucial role in reducing the number of LGA newborn cases. Clinicians should be aware that the BMI threshold for increased prevalence of LGA newborns among women with GDM may vary by race and ethnicity.

Acknowledgments

Supported by R01HD065904.

References

1. Metzger BE. Summary and recommendations of the Third International Workshop- Conference on gestational diabetes mellitus. *Diabetes*. 1991; 40(Suppl 2):197–201.
2. Ferrara A, Kahn HS, Quesenberry C, Riley C, Hedderson MM. An increase in the incidence of gestational diabetes mellitus: Northern California, 1991–2000. *Obstet Gynecol*. 2004; 103:526–33. [PubMed: 14990417]
3. Reece EA. The fetal and maternal consequences of gestational diabetes mellitus. *J Matern Fetal Neonatal Med*. 2010; 23:199–203. [PubMed: 20121460]
4. Hedderson MM, Darbinian JA, Ferrara A. Disparities in the risk of gestational diabetes by race-ethnicity and country of birth. *Paediatr Perinat Epidemiol*. 2010; 5:441–8.
5. Wang Y, Beydoun MA. The obesity Epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev*. 2007; 29:6–28. [PubMed: 17510091]
6. Carlo, WA. Large for gestational age infants. In: Kliegman, RM.; Behrman, RE.; Jenson, H.; Stanton, B., editors. *Nelson textbook of pediatrics*. 19. Philadelphia (PA): Saunders Elsevier; 2011.
7. Catalano PM. Obesity and pregnancy—the propagation of a viscous cycle? *J Clin Endocrinol Metab*. 2003; 88:3505–6. [PubMed: 12915626]
8. Eriksson J, Forsen T, Osmond C, Barker D. Obesity from cradle to grave. *Int J Obes Relat Metab Disord*. 2003; 27:722–7. [PubMed: 12833117]

9. The Centers for Disease Control and Prevention. QuickStats: Percentage of large-for-gestational-age births, by race or Hispanic ethnicity—United States, 2005. Atlanta (GA): CDC; 2008. Report No. 57(46);1258
10. Ehrenberg HM, Mercer BM, Catalano PM. The influence of obesity and diabetes on the prevalence of macrosomia. *Am J Obstet Gynecol.* 2004; 191:964–8. [PubMed: 15467573]
11. Syngelaki A, Bredaki FE, Vaikousi E, Maiz N, Nicolaides KH. Body mass index at 11–13 weeks' gestation and pregnancy complications. *Fetal Diagn Ther.* 2011; 30:250–65. [PubMed: 22067258]
12. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health.* 1992; 82:703–10. [PubMed: 1566949]
13. Go AS, Hylek EM, Phillips KA, Chang Y, Henault LE, Selby JV, et al. Prevalence of diagnosed atrial fibrillation in adults: national implications for rhythm management and stroke prevention: the AnTicoagulation and Risk Factors in Atrial Fibrillation (ATRIA) Study. *JAMA.* 2001; 285:2370–5. [PubMed: 11343485]
14. Ferrara A, Weiss NS, Hedderson MM, Quesenberry CP Jr, Selby JV, Ergas IJ, et al. Pregnancy plasma glucose levels exceeding the American Diabetes Association thresholds, but below the National Diabetes Data Group thresholds for gestational diabetes mellitus, are related to the risk of neonatal macrosomia, hypoglycaemia and hyperbilirubinaemia. *Diabetologia.* 2007; 50:298–306. [PubMed: 17103140]
15. Carpenter MW, Coustan DR. Criteria for screening tests for gestational diabetes. *Am J Obstet Gynecol.* 1982; 144:768–73. [PubMed: 7148898]
16. Ehrlich SF, Crites YM, Hedderson MM, Darbinian JA, Ferrara A. The risk of large for gestational age across increasing categories of pregnancy glycemia. *Am J Obstet Gynecol.* 2011; 204:240, e1–6. [PubMed: 21247550]
17. World Health Organization. The International Classification of adult underweight, overweight and obesity according to BMI. Available at: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html. Retrieved May 8, 2012
18. Rothman, KJ.; Greenland, S. *Modern epidemiology.* 2. Philadelphia (PA): Lippincott-Raven Publishers; 1998.
19. Kieffer EC, Alexander GR, Kogan MD, Himes JH, Herman WH, Mor JM, et al. Influence of diabetes during pregnancy on gestational age-specific newborn weight among US black and US white infants. *Am J Epidemiol.* 1998; 147:1053–61. [PubMed: 9620049]
20. Saldana TM, Siega-Riz AM, Adair LS, Savitz DA, Thorp JM Jr. The association between impaired glucose tolerance and birth weight among black and white women in central North Carolina. *Diabetes Care.* 2003; 26:656–61. [PubMed: 12610017]
21. Hunt KJ, Marlow NM, Gebregziabher M, Ellerbe CN, Mauldin J, Mayorga ME, et al. Impact of maternal diabetes on birthweight is greater in non-Hispanic blacks than in non-Hispanic whites. *Diabetologia.* 2012; 55:971–80. [PubMed: 22237686]
22. Holcomb WL Jr, Mostello DJ, Leguizamon GF. African-American women have higher initial HbA1c levels in diabetic pregnancy. *Diabetes Care.* 2001; 24:280–3. [PubMed: 11213879]
23. Wang J, Thornton JC, Russell M, Burastero S, Heymsfield S, Pierson RN Jr. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparisons of anthropometric measurements. *Am J Clin Nutr.* 1994; 60:23–8. [PubMed: 8017333]
24. Dornhorst A, Nicholls JS, Welch A, Ali K, Chan SP, Beard RW. Correcting for ethnicity when defining large for gestational age infants in diabetic pregnancies. *Diabet Med.* 1996; 13:226–31. [PubMed: 8689842]
25. Silva JK, Kaholokula JK, Ratner R, Mau M. Ethnic differences in perinatal outcome of gestational diabetes mellitus. *Diabetes Care.* 2006; 29:2058–63. [PubMed: 16936153]
26. Rifas-Shiman SL, Rich-Edwards JW, Kleinman KP, Oken E, Gillman MW. Dietary quality during pregnancy varies by maternal characteristics in Project Viva: a US cohort. *J Am Diet Assoc.* 2009; 109:1004–11. [PubMed: 19465182]
27. Hedderson MM, Weiss NS, Sacks DA, Pettitt DJ, Selby JV, Quesenberry CP, et al. Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia. *Obstet Gynecol.* 2006; 108:1153–61. [PubMed: 17077237]

28. Fontaine PL, Hellerstedt WL, Dayman CE, Wall MM, Sherwood NE. Evaluating body mass index-specific trimester weight gain recommendations: differences between black and white women 1. *J Midwifery Womens Health*. 2012; 57:327–35. [PubMed: 22758355]
29. Caulfield LE, Witter FR, Stoltzfus RJ. Determinants of gestational weight gain outside the recommended ranges among black and white women. *Obstet Gynecol*. 1996; 87(5 Pt 1):760–6. [PubMed: 8677082]
30. Alexander GR, Kogan M, Bader D, Carlo W, Allen M, Mor J. US birth weight/gestational age-specific neonatal mortality: 1995–1997 rates for whites, hispanics, and blacks. *Pediatrics*. 2003; 111:e61–6. [PubMed: 12509596]

Fig. 1.

Age-adjusted prevalence of large-for-gestational age (LGA) newborns by race and body mass index (BMI, calculated as kg/m^2).

Sridhar. Race, BMI, and LGA Risk in Women With GDM. *Obstet Gynecol* 2013.

Table 1

Characteristics of the Cohort (N=7,468) by Maternal Racial and Ethnic Group

Characteristic	Racial and Ethnic Group					P
	Non-Hispanic White (n=2,055)	Asian (n=1,752)	African American (n=452)	Hispanic (n=2,236)	Filipina (n=973)	
Age at delivery (y)	30.9±4.8	31.0±4.3	30.4±5.4	30.7±5.3	32.0±5.0	<.001 [*]
Gestational age at pregnancy weight measurement (wk)	16.7±1.3	16.9±1.3	17.0±1.3	16.9±1.4	16.9±1.3	<.001 [*]
Male newborn	1,018 (49.5)	929 (53.0)	232 (51.3)	1,153 (51.6)	481 (49.4)	.208 [†]
Parity						<.001 [†]
0	1,182 (57.5)	1,133 (64.7)	187 (41.4)	825 (36.9)	478 (49.1)	
1	518 (25.2)	440 (25.1)	129 (28.5)	600 (26.9)	308 (31.7)	
2 or more	355 (17.3)	179 (10.2)	136 (30.1)	810 (36.2)	187 (19.2)	
Educational attainment						<.001 [†]
High school graduate or lower	819 (39.9)	601 (34.3)	197 (43.6)	1,499 (67.0)	265 (27.2)	
Partial college	616 (30.0)	326 (18.6)	161 (35.6)	449 (20.1)	323 (33.2)	
College graduate or higher	603 (29.3)	807 (46.1)	90 (19.9)	266 (11.9)	377 (38.8)	
Unknown	17 (0.8)	18 (1.0)	4 (0.88)	22 (1.0)	8 (0.8)	
Gestational age when prenatal care began (mo)						<.001 [†]
1	727 (27.9)	522 (23.8)	123 (21.7)	632 (22.0)	265 (21.2)	
2	1,136 (43.5)	977 (44.6)	263 (46.4)	1,214 (42.2)	609 (48.7)	
3	556 (21.3)	529 (24.2)	133 (23.5)	754 (26.2)	288 (23.0)	
4 or more	128 (4.9)	145 (6.6)	41 (7.2)	227 (7.9)	63 (5.0)	
BMI (kg/m ²)						<.001 [†]
Normal (18.5–24.9)	490 (23.8)	1,021 (58.3)	47 (10.4)	398 (17.8)	433 (44.5)	
Overweight (25.0–29.9)	626 (30.5)	523 (29.9)	134 (29.7)	776 (34.7)	362 (37.2)	
Obese (30.0–34.9)	459 (22.3)	158 (9.0)	122 (27.0)	606 (27.1)	133 (13.7)	
Obese class II (35.0 or higher)	480 (23.4)	50 (2.9)	149 (33.0)	456 (20.4)	45 (4.6)	
Large for gestational age [‡]	330 (16.4)	242 (13.9)	118 (25.1)	396 (17.3)	154 (15.3)	<.001 [†]
Born outside of the United States	260 (12.7)	1,561 (89.3)	80 (17.8)	1,327 (59.4)	859 (88.3)	<.001 [†]
50-g glucose challenge test (screening test), 1-h value (mg/dL)	165.5±20.1	171.4±23.1	167.3±20.6	168.5±22.4	171.4±24.8	<.001 [*]

Characteristic	Racial and Ethnic Group					P
	Non-Hispanic White (n=2,055)	Asian (n=1,752)	African American (n=452)	Hispanic (n=2,236)	Filipina (n=973)	
100-g 3-h OGTT (diagnostic test) (mg/dL)						
Fasting value	91.2±13.8	89.6±13.2	97.5±17.0	93.4±14.3	89.7±13.7	<.001 [*]
1-h value	197.5±24.5	202.2±27.1	201.2±28.1	200.5±27.0	203.6±26.6	<.001 [*]
2-h value	177.0±27.4	180.7±28.2	187.0±36.1	177.9±29.9	181.5±26.3	<.001 [*]
3-h value	127.6±35.2	135.1±32.5	137.5±37.1	133.5±34.1	131.2±32.0	<.001 [*]
Insulin use only during pregnancy	206 (10.0)	116 (6.6)	49 (10.8)	161 (7.2)	63 (6.5)	<.001 [‡]
Glyburide use only during pregnancy	94 (4.6)	113 (6.5)	34 (7.5)	113 (5.1)	61 (6.3)	.025 [‡]
Insulin and glyburide use during pregnancy	10 (0.5)	14 (0.8)	0 (0.0)	18 (0.8)	9 (0.9)	.236 [‡]

BMI, body mass index; OGTT, oral glucose tolerance test.

Data are mean±standard deviation or n (%) unless otherwise specified.

^{*} Analysis of variance.

[‡] χ^2 test.

[‡] Adjusted for maternal age.

Table 2

Multivariable-Adjusted* Associations With Large-for-Gestational-Age Newborns Among Women With Gestational Diabetes

Characteristic	Odds Ratio	95% CI
Racial and ethnic group		
White	1.00	
Asian	1.19	0.98–1.46
African American	1.30	1.01–1.68
Hispanic	0.90	0.75–1.06
Filipina	1.20	0.96–1.50
Parity		
0	1.00	
1	1.53	1.31–1.79
2 or more	2.13	1.79–2.53
Age at delivery	0.98	0.97–1.00
Gestational age at pregnancy weight measurement	1.11	1.06–1.16
Educational attainment		
High school graduate or lower	1.00	
Partial college	1.02	0.87–1.20
College graduate or higher	1.02	0.86–1.20
Unknown	0.66	0.32–1.38
BMI (kg/m ²)		
Normal (18.5–24.9)	1.00	
Overweight (25.0–29.9)	1.58	1.31–1.90
Obese (30.0–34.9)	2.13	1.73–2.61
Obese class II (35.0 or higher)	2.56	2.05–3.19
Newborn sex		
Male	1.00	
Female	0.66	0.58–0.75
Medication use (insulin or glyburide or both)		
No	1.00	
Yes	1.20	1.01–1.43
Fasting glucose value from 100-g, 3-h OGTT (mg/dL)	1.02	1.01–1.02

CI, confidence interval; BMI, body mass index; OGTT, oral glucose tolerance test.

* Adjusted for all characteristics simultaneously.

Table 3

Adjusted* Odds Ratios And 95% Confidence Intervals for Delivering a Large-for-Gestational-Age Newborn Associated With Maternal Body Mass Index Category Among Women With Gestational Diabetes by Racial and Ethnic Group

BMI (kg/m ²)	Racial and Ethnic Group				
	White [†] (330 of 2,055)	Asian [†] (242 of 1,752)	African American [†] (118 of 452)	Hispanic [†] (396 of 2,236)	Filipina [†] (154 of 973)
18.5–24.9	1.0	1.0	1.0	1.0	1.0
25.0–29.9	1.75 (1.14–2.70)	1.27 (0.91–1.76)	4.04 (1.15–14.13)	1.93 (1.26–2.94)	1.22 (0.80–1.86)
30.0–34.9	2.83 (1.84–4.36)	1.86 (1.19–2.92)	5.36 (1.53–18.75)	2.34 (1.52–3.59)	1.15 (0.65–2.02)
35.0 or higher	3.38 (2.20–5.21)	4.13 (2.16–7.88)	4.59 (1.31–16.12)	2.66 (1.71–4.14)	1.62 (0.74–3.55)

* Adjusted for parity (as three categories: zero births (referent), one birth, two or more births), educational attainment (as four categories: high school graduate or less (referent), partial college, college graduate or higher, unknown), maternal age at delivery, gestational age at pregnancy weight measurement, newborn sex (male as referent), body mass index, medication use during pregnancy (insulin or glyburide [or both] use compared with no medication use), and fasting glucose value from the 100-g, 3-hour oral glucose tolerance test.

[†] Large for gestational age out of total for group.