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Obesity, Diabetes, and Birth Outcomes Among American Indians and Alaska Natives

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Abstract *Objectives* To examine the relationships between prepregnancy diabetes mellitus (DM), gestational diabetes mellitus (GDM), and prepregnancy body mass index, with several adverse birth outcomes: preterm delivery (PTB), low birthweight (LBW), and macrosomia, comparing American Indians and Alaska Natives (AI/AN) with other race/ethnic groups. *Methods* The sample includes 5,193,386 singleton US first births from 2009–2013. Logistic regression is used to calculate adjusted odds ratios controlling for calendar year, maternal age, education, marital status, Kotelchuck prenatal care index, and child's sex. *Results* AI/AN have higher rates of diabetes than all other groups, and higher rates of overweight and obesity than whites or Hispanics. Neither overweight nor obesity predict PTB for AI/AN, in contrast to other groups, while diabetes predicts increased odds of PTB for all groups. Being overweight predicts reduced odds of LBW for all groups, but obesity is not predictive of LBW for AI/AN. Diabetes status also does not predict LBW for AI/AN; for other groups, LBW is more likely for women with DM or GDM. Overweight, obesity, DM, and GDM all predict higher odds of macrosomia for all race/ethnic groups. *Conclusions for Practice* Controlling diabetes in pregnancy, as well as prepregnancy weight gain, may help decrease preterm birth and macrosomia among AI/AN.

Keywords American Indians/Alaska Natives · Gestational diabetes · Overweight · Obesity · Macrosomia · Preterm delivery · Low birthweight

Significance

This study, the first to examine pregnancy outcomes as a function of both overweight/obesity and diabetes simultaneously among AI/AN, found that in contrast with other race/ethnic groups, AI/AN maternal BMI does not predict preterm delivery and AI/AN diabetes status does not predict low birthweight. In other respects, the relationships for AI/AN are similar to those for other groups: diabetes increases the odds of preterm delivery; overweight reduces the odds of low birthweight; and overweight, obesity, and diabetes are all associated with increased odds of macrosomia. These results suggest interventions that address maternal health disparities among AI/AN can have important impacts on children's health in this neglected population.

Introduction

Health disparities contribute to racial/ethnic variation in morbidity and mortality in the US, with many minority populations frequently experiencing greater prevalence of poor health outcomes compared to non-Hispanic whites (Howard et al. 2014; Zilanawala et al. 2014). American Indians and Alaska Natives (AI/AN) experience particularly high rates of morbidity, including overweight and

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obesity (Cobb et al. 2014; Shah et al. 2011), Type II diabetes mellitus (DM), and gestational diabetes mellitus (GDM) (Barnes et al. 2010; Bryant et al. 2010; Schiller et al. 2012). Diabetes is the fifth leading cause of death among AI/AN ages 45–54, and the ratio of diabetes deaths among AI/AN to whites is 3.4 (U.S. Department of Health and Human Services 2014). Perinatal and infant mortality among AI/AN also exceeds that of other race/ethnic groups (Shah et al. 2011). These comorbidities contribute to AI/AN experiencing lower life expectancy than any other American race/ethnic group (Arias et al. 2014).

The reasons for these health disparities are complex and pervasive. Understanding the social determinants of health, which include social, economic, and behavioral factors that influence health outcomes, can help in the development of meaningful interventions to reduce health inequalities (Marmot et al. 2008). These health disparities may perpetuate themselves across generations, with the health conditions of mothers influencing children's health outcomes. Adult morbidity is hypothesized to be influenced by uterine environments, so that the prenatal period and early childhood may have profound impacts on later health outcomes (the so-called Barker hypothesis) (Barker 2007). Mothers who are obese or who have DM or GDM are more likely to have high birthweight or macrosomic babies (>4000 g), who in turn are more likely to be overweight or obese, or to have DM or GDM (Whincup et al. 2008; Leddy et al. 2008; Lindberg et al. 2012). Low birthweight (LBW) (<2500 g) and preterm delivery (<37 weeks) can also predispose children to adult obesity, DM, and GDM, as well as to other health problems including infant mortality (Whincup et al. 2008; Goldenberg and Culhane 2007).

These findings have important implications for AI/AN, as diabetes, overweight, and obesity are at epidemic levels in this population. Prevalence of DM among AI/AN is 14.1 %, as opposed to 7.9 % among non-Hispanic whites and 12.6 % among African Americans (Schiller et al. 2012). GDM is also elevated among AI/AN, with 8.9 % of pregnant AI/AN women diagnosed with diabetes during pregnancy, as opposed to 6.8 % of non-Hispanic whites (DeSisto et al. 2014). AI/AN also exhibit high body mass index (BMI), with 71.6 % overweight or obese, compared with 61.8 % of non-Hispanic whites who are overweight or obese (Schiller et al. 2012). These health trends begin early in life: by childhood, AI/AN are already more likely to be to be overweight or obese than other groups (Zilanawala et al. 2014; Weedn et al. 2012).

Adverse birth outcomes are also common among AI/AN. In 2013, 7.46 % of AI/AN births were low birthweight, slightly higher than the rate of 6.97 % observed for non-Hispanic whites (Hamilton et al. 2014). Macrosomia is more common among AI/AN than other race/ethnic groups (Chamberlain et al. 2013); for example, 5 % of an AI/AN sample in Wisconsin had been macrosomic at birth (Lindberg et al. 2012). Preterm delivery is also higher among AI/AN (12.2 % of births), compared with non-AI/AN (11.2 %) (Castor et al. 2006). A meta-analysis comparing global birth outcomes between indigenous and non-indigenous people included four studies from the US, and found that the prevalence of both preterm delivery and neonatal mortality was significantly higher among AI/AN (Shah et al. 2011). Macrosomia was not examined in any of the US studies included in the meta-analysis, though the authors reported that in Canada, macrosomia is more common among First Nations people than non-indigenous populations (Shah et al. 2011).

Despite the high prevalence of obesity, diabetes, and adverse birth outcomes among AI/AN, few studies have examined the relationships between these variables using AI/AN samples. The aforementioned meta-analysis identified 38 studies that examined pregnancy and neonatal outcomes among indigenous populations around the world (Shah et al. 2011). Of these, only one controlled for diabetes status of the mother using an AI/AN sample, and no US-based studies controlled for maternal weight or body mass index. A separate comprehensive literature review identified 42 studies that examined diabetes in pregnancy among global indigenous women (Porter et al. 2012). Ten of these studies used data from the US, but only one (Pettitt et al. 1980) examined birth outcomes such as birthweight or preterm delivery as a function of maternal diabetes status among American Indians. Six more studies from Canada and Alaska were identified, but only one (Murphy et al. 1993) used data from Alaska Natives.

Thus, information about the relationship between maternal diabetes and weight and subsequent birth outcomes among AI/AN comes from only a few studies, and the results are inconsistent. This may result from variance across study design, or actual differences across the populations being studies. Among the Pima of Arizona, women with DM are more likely to have macrosomic or premature babies, while women with GDM have increased likelihood of macrosomia (Pettitt et al. 1980). A study in Washington state found that AI/AN women with GDM were more likely to give birth to low birthweight babies (Williams et al. 1999). Among the Yup'ik in Alaska, babies from women with GDM had heavier birthweight than those whose mothers did not have GDM (Murphy et al. 1993). Among First Nations people in Canada, women with GDM are more likely to have babies experiencing macrosomia but not low birthweight, while women with DM are more likely to have macrosomic or preterm babies (Godwin et al. 1999; Dyck et al. 2002).

Obesity is associated with GDM in American populations (Leddy et al. 2008), but this relationship has been less well-studied among AI/AN. Among aboriginal women in Saskatoon District, Canada, the odds ratio associated with overweight and obesity (combined) and GDM was 8.56 (compared with 1.41 for the non-aboriginal sample) (Dyck et al. 2002). In both California and Florida, overweight and obese AI/AN women were significantly more likely to experience GDM than women of normal weight (Kim et al. 2012, 2013).

Social determinants of health such as economic stability, social and community context, and health care utilization have been shown to impact glycemic control, cholesterol (LDL), and blood pressure among adult diabetics (Walker et al. 2014). Access to prenatal care, a measure of health care utilization, influences birth outcomes and displays significant race/ethnic disparities (Bryant et al. 2010). AI/AN often have less access to health care, and are more likely to enter prenatal care later during pregnancy or to have greater unmet medical need (Barnes et al. 2010; Bryant et al. 2010). For example, 13.9 % of AI/AN women receive late or no prenatal care, versus 8.8 % of non-AI/AN women (Castor et al. 2006). AI/AN populations also have higher levels of other risk factors: they are less likely to have a college degree and are more likely to live in poverty than other race/ethnic groups (US Census Bureau 2007). Health-promoting behaviors, such as physical activity and the consumption of fruits and vegetables, are lower among AI/AN than other American racial/ethnic groups, while risky health behaviors, such as smoking and alcohol consumption, are more common (Cobb et al. 2014; Barnes et al. 2010; Bryant et al. 2010).

In summary, many questions remain about the relationship between obesity, diabetes and birth outcomes among AI/AN. The present study will examine all of these using a large representative sample of American births, comparing AI/AN women with women from other race/ethnic groups.

Methods

This study used a population-based retrospective sample of births in the US, drawn from all live births registered in the 50 states, the District of Columbia, and New York City (which is an independent reporting area from New York state). Births to US citizens outside the US are not included. The 2003 revision of the US Standard Certificate of Live Birth provides many health-related variables not present in earlier versions, and thus only states using this version of the birth certificate were included in the analysis. In 2009, 28 states plus the District of Columbia used the 2003 birth certificate, representing 66.0 % of US births in that year (National Center for Health Statistics 2010). By 2013 this had increased to 41 states plus the District of Columbia and New York City, representing 90.2 % of US births (National Center for Health Statistics 2014). On average, 80.3 % of US births were recorded using the 2003 birth certificate during the period 2009 through 2013. The 2003 certificate of live birth collects data from two different sources (National Center for Health Statistics 2014): the mother's worksheet (including self-reported data such as maternal age, education, weight, height, race, and Hispanic ethnicity) and the facility worksheet (obtaining from medical records such variables as gestational age, birthweight, plurality, and timing and frequency of prenatal care).

The analytical sample was further restricted to singleton first births. The focus on prepregnancy weight of primiparous women thus excludes the effect of weight gain during previous pregnancies, as well as the tendency of women who experience GDM during an earlier pregnancy to develop GDM in subsequent pregnancies (Williams et al. 1999; Dyck et al. 2002). Multiple births are excluded because they are more likely to be low birthweight or premature.

Study Variables

The analysis focuses on women who self-identified as American Indian or Alaska Native and did not identify as Hispanic. (Hispanic origin is a separate question from race on the birth certificate.) The final sample contains 44,570 AI/AN births. Comparisons are made between AI/AN and other racial/ethnic groups, which are categorized as non-Hispanic white ($n = 3{,}182{,}835$), non-Hispanic African American ($n = 742{,}387$), and Hispanic ($n = 1{,}223{,}594$). Other racial/ethnic groups, including missing or unknown, were excluded from the analytical sample. The final sample includes 5,193,386 births.

All variables used in the analysis are dichotomous, measured as yes or no, or present or absent. Prepregnancy BMI was made available in the data files, pre-coded as underweight (BMI < 18.5 kg/m^2), normal weight (BMI of 18.5–25.0 kg/m^2), overweight (BMI of 25.0–30.0 kg/m^2), or obese (BMI ≥ 30.0 kg/m^2). Diabetes status was coded as three indicator variables: non-diabetic, prepregnancy diabetes, or gestational diabetes. (The 2003 birth certificate does not distinguish between T1DM and T2DM for prepregnancy diabetes.) Preterm birth was coded as gestational age <37 weeks. Birthweight was recoded as low birthweight if the baby weighed less than 2500 g, and macrosomia if the baby weighed more than 4000 g.

Demographic variables controlled for include maternal age at the time of birth (as 5 year age classes, from 14 and under through 50 and older) and the baby's sex ($1 = $ male). We also control for several variables that are likely to reflect social determinants of health. Socioeconomic status is measured using maternal education (coded as a set of indicator variables: less than high school, high school only, some college, college degree, and postgraduate degree). Social support is measured through marital status (1 = married). Health care utilization is measured using the Kotelchuck prenatal care index (Kotelchuck 1994), which assesses the adequacy of prenatal care using the date of initiation of care, the number of prenatal care visits, and gestation length. The Kotelchuck index evaluates prenatal care as either inadequate, intermediate, adequate or adequate plus. Lastly, the analysis will control for calendar year (separate dummies for each year).

Statistical Analysis/Analytic Methods

The dependent variables of interest are birth outcomes: preterm delivery, low birthweight, and macrosomia. Because low birthweight can result from either preterm delivery or restricted fetal growth (Goldenberg and Culhane 2007), low birthweight is analyzed with and without preterm deliveries. Initial comparisons of birth outcomes and control variables are made by race/ethnicity and evaluated for statistical significance using the Pearson Chi squared test. Adjusted odds ratios for maternal BMI category and diabetes status predicting birth outcomes are calculated using logistic regression, controlling for calendar year, maternal age, maternal education, Kotelchuck prenatal care index, marital status and child's sex. Most analyses are run separately by race/ethnic group. All analyses are conducted using Stata/SE 14.1 for Windows (StataCorp LP, College Station, TX), using the Stata versions of the Centers for Disease Control and Prevention's publically available National Center for Health Statistics natality files (available at http://www.nber.org/data/vital-statistics-natality-data.html).

Results

Table 1 presents descriptive statistics for the sample of singleton first births. Percentages for every variable differ significantly by race/ethnicity. Low birthweight among AI/AN is 6.6 %, higher than for whites but lower than for African Americans; LBW decreases by more than half for all groups when preterm deliveries are excluded, though a substantial number of full term births are low birthweight, suggesting that risk of restricted prenatal growth is still widespread even when pregnancies are full term. Macrosomia is more common among AI/AN (8.7 %) than among other groups.

A majority of both AI/AN (51.7 %) and African American (52.0 %) mothers are overweight or obese. Prepregnancy and gestational diabetes, while relatively uncommon, are most prevalent among AI/AN (1.1 and 4.3 %, respectively). AI/AN mothers tend to be young, with 72.6 % being age 24 or less, a higher proportion than that of any other group. Among both AI/AN and Hispanics, just over 60 % have only a high school diploma or less. Nonmarital births occur to 73.5 % of first-time AI/AN mothers, second only to African Americans (79.8 %). AI/AN are the most likely to report inadequate prenatal care (25.3 %) and the least likely to report adequate plus prenatal care (28.2 %); although the majority (62.1 %) of AI/AN report adequate or better prenatal care, they are less likely to do so than any other group.

Table 2 presents adjusted odds ratios for birth outcomes predicted by race/ethnic group, with American Indian/Alaska Native being the omitted comparison group. These logistic regression models control for calendar year, maternal age, education, BMI, and diabetes status, Kotelchuck prenatal care index, marital status, and child's sex. Compared with AI/AN, whites and Hispanics are less likely to have preterm births, though African Americans are more likely. There is no significant difference between AI/AN, whites, and Hispanics in terms of low birthweight, though blacks are substantially more likely than AI/AN to have a low birthweight baby. When preterm births are excluded, all groups are more likely than AI/AN to have a low birthweight delivery, suggesting that restricted fetal growth in utero is less likely to be a problem among AI/AN. Macrosomia, in contrast, is significantly less likely among all groups, compared to AI/AN.

The subsequent analyses present regression models separately by race/ethnic group, to examine whether the relationships between prepregnancy BMI or diabetes status and birth outcomes differ by race/ethnicity. Table 3 shows that for all groups, preterm delivery is more common if the mother is underweight (OR 1.16–1.21). However, among AI/AN only, neither overweight nor obesity predict preterm delivery. For African Americans, preterm delivery is less likely among overweight mothers (OR 0.95), while preterm delivery is more common among both white (OR 1.06) and Hispanic (OR 1.09) obese women.

In Table 4, Panel A, which includes all births, underweight women in all groups are significantly more likely to have low birthweight babies (OR 1.46–1.62). Also for all groups, overweight women are less likely to have LBW (OR 0.81–0.95). However, among AI/AN only, obesity is not associated with LBW, in contrast to whites and Hispanics, for whom obesity increases the odds of LBW (OR 1.02 for whites, 1.06 for Hispanics), or African Americans, for whom obesity reduces the odds of LBW (OR 0.92). DM is associated with increased risk of LBW among whites (OR 1.45), blacks (OR 1.61) and Hispanics (OR 1.60), and GDM is associated with increased risk of LBW among

Table 1 Selected characteristics of US first births 2009–2013, by race/ethnicity

	American Indian/Alaska Native		White		African American		Hispanic	
	n	%	n	%	n	%	n	%
Birth outcomes								
Preterm (<37 weeks)	5016	11.3	278,768	8.8	104,617	14.1	125,489	10.3
Low birthweight (<2500 g)	2929	6.6	191,521	6.0	90,238	12.2	85,084	7.0
Low birthweight (full term only)	1111	2.8	75,415	2.6	35,933	5.6	34,545	3.2
Macrosomia (>4000 g)	3876	8.7	261,110	8.2	28,377	3.8	67,596	5.5
Prepregnancy body-mass index								
Underweight (<18.5 kg/m^2)	1913	4.3	143,145	4.5	34,531	4.7	56,699	4.6
Normal weight (18.5–25.0 kg/m^2)	19,611	44.0	1,699,643	53.4	321,862	43.4	623,226	50.9
Overweight (25.0–30.0 kg/m^2)	11,274	25.3	728,551	22.9	186,731	25.2	309,949	25.3
Obese (≥30.0 kg/m^2)	11,772	26.4	611,496	19.2	199,263	26.8	233,720	19.1
Diabetes status								
Non-diabetic	42,139	94.6	3,036,001	95.4	711,178	95.8	1,173,942	95.9
Prepregnancy diabetes	499	1.1	19,349	0.6	6060	0.8	6782	0.6
Gestational diabetes	1932	4.3	127,485	4.0	25,149	3.4	42,870	3.5
Calendar year								
2009	7718	17.3	529,774	16.6	116,604	15.7	237,704	19.4
2010	8379	18.8	595,488	18.7	137,222	18.5	242,347	19.8
2011	9443	21.2	673,331	21.2	158,150	21.3	247,990	20.3
2012	9273	20.8	689,217	21.7	162,995	22.0	248,566	20.3
2013	9757	21.9	695,025	21.8	167,416	22.6	246,987	20.2
Maternal age								
Under 15	235	0.5	3114	0.1	4258	0.6	5939	0.5
15–19	14,574	32.7	400,461	12.6	203,813	27.5	341,616	27.9
20–24	17,531	39.3	888,370	27.9	282,625	38.1	423,972	34.7
25–29	7520	16.9	961,011	30.2	136,947	18.5	248,479	20.3
30–34	3311	7.4	654,545	20.6	75,293	10.1	137,245	11.2
35–39	1161	2.6	222,884	7.0	31,012	4.2	54,085	4.4
40–44	219	0.5	48,909	1.5	7779	1.1	11,526	0.9
45+	19	0.0	3541	0.1	660	0.1	732	0.1
Maternal education								
Less than high school	11,744	26.4	294,931	9.3	155,932	21.0	374,618	30.6
High school	15,186	34.1	689,561	21.7	232,106	31.3	378,797	31.0
Some college	13,260	29.8	956,565	30.1	240,370	32.4	312,401	25.5
College graduate	3166	7.1	798,536	25.1	75,280	10.1	112,850	9.2
Postgraduate degree	1214	2.7	443,242	13.9	38,699	5.2	44,928	3.7
Marital status								
Unmarried	32,755	73.5	1189,327	37.4	592,281	79.8	771,288	63.0
Married	11,815	26.5	1,993,508	62.6	150,106	20.2	452,306	37.0
Kotelchuck prenatal care index								
Inadequate	11,263	25.3	378,527	11.9	175,863	23.7	251,953	20.6
Intermediate	5617	12.6	337,506	10.6	82,362	11.1	141,394	11.6
Adequate	15,123	33.9	1,278,302	40.2	232,351	31.3	439,003	35.9
Adequate plus	12,567	28.2	1,188,500	37.3	251,811	33.9	391,244	32.0
Baby's sex								
Female	21,847	49.0	1,548,627	48.7	363,972	49.0	597,684	48.9
Male	22,723	51.0	1,634,208	51.3	378,415	51.0	625,910	51.2
N	44,570		3,182,835		742,387		1,223,594	

All differences by race/ethnicity significant at $p < 0.001$

Table 2 Risk estimates for race/ethnicity, predicting birth outcomes for US first births 2009–2013

	Preterm (<37 weeks)		Low birthweight (<2500 g)		Low birthweight (full term only)		Macrosomia (>4000 g)	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
AI/AN	1.00		1.00		1.00		1.00	
White	0.77	0.75–0.80	0.97	0.94–1.01	1.07	1.01–1.14	0.86	0.83–0.89
Black	1.20	1.17–1.24	1.88	1.81–1.96	2.06	1.94–2.19	0.41	0.40–0.42
Hispanic	0.86	0.83–0.89	1.03	0.99–1.07	1.11	1.05–1.18	0.63	0.61–0.65
N		5,193,386		5,193,386		4,679,496		5,193,386
LR chi-sq.		354,510.85		140,353.00		39,538.96		104,496.41
p		0.0000		0.0000		0.0000		0.0000

Adjusted models control for calendar year, maternal age, maternal education, Kotelchuck prenatal care index, marital status, and child's sex

Table 3 Risk estimates for BMI and diabetes status, predicting preterm delivery (<37 weeks) by race/ethnicity for US first births 2009–2013

	AI/AN		White		African American		Hispanic	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Prepregnancy BMI								
Underweight (<18.5 kg/m^2)	1.20	1.03–1.38	1.21	1.19–1.24	1.16	1.12–1.20	1.17	1.13–1.20
Normal weight (18.5–25.0 kg/m^2)	1.00		1.00		1.00		1.00	
Overweight (25.0–30.0 kg/m^2)	0.94	0.87–1.02	1.00	0.99–1.01	0.95	0.94–0.97	1.00	0.98–1.01
Obese (≥30.0 kg/m^2)	0.95	0.88–1.03	1.06	1.05–1.08	0.99	0.97–1.00	1.09	1.08–1.11
Diabetes status								
Non-diabetic	1.00		1.00		1.00		1.00	
Prepregnancy diabetes	1.65	1.32–2.06	2.19	2.12–2.27	1.88	1.78–2.00	1.83	1.72–1.94
Gestational diabetes	1.17	1.02–1.34	1.09	1.07–1.11	1.13	1.10–1.17	1.10	1.06–1.13
N		44,570		3,182,835		742,387		1,223,594
LR chi-sq.		2783.56		191,418.31		57,602.77		85,445.76
p		0.0000		0.0000		0.0000		0.0000

Adjusted models control for calendar year, maternal age, maternal education, Kotelchuck prenatal care index, marital status, and child's sex

whites (OR 1.04) and Hispanics (OR 1.05), while for AI/AN, neither form of diabetes predicts LBW.

Panel B of Table 4 restricts the sample to full-term births. Underweight mothers of all groups are more likely to have low birthweight babies, relative to normal weight mothers (OR 1.62–1.99). However, in contrast to the full sample, overweight and obese mothers of all racial/ethnic groups are less likely to have LBW (OR 0.68–0.84 for overweight, 0.77–0.87 for obese), with AI/AN having the largest effect size for overweight (OR 0.68). The positive association between obesity and low birthweight observed for whites and Hispanics in the full sample has reversed, suggesting that high maternal BMI may be protective against restricted fetal growth among full-term pregnancies.

Lastly, Table 5 presents predictions of macrosomia. For all groups, underweight women were less likely to experience macrosomia (OR 0.45–0.56), while overweight or obese mothers were more likely to have macrosomic babies (OR 1.43–1.51 for overweight, 1.78–2.04 for obese). Both DM and GDM, in contrast, are associated with increased odds of macrosomia among infants for all race/ethnic groups (OR 1.77–2.21 for DM, 1.03–1.90 for GDM).

Discussion

Using a sample of US births from 2009 through 2013, we found that rates of overweight and obesity, and prepregnancy and gestational diabetes, are high among American Indians and Alaska Natives, particularly when compared with non-Hispanic whites. AI/AN are more likely than whites or Hispanics to have preterm babies, less likely than African Americans to have preterm or low birthweight babies, less likely than all other groups to have full term

Table 4 Risk estimates for BMI and diabetes status, predicting low birthweight (<2500 g) by race/ethnicity for US first births 2009–2013

	AI/AN		White		African American		Hispanic	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
(A) All births								
Prepregnancy BM								
Underweight (<18.5 kg/m^2)	1.62	1.38–1.90	1.62	1.59–1.65	1.46	1.42–1.51	1.52	1.48–1.57
Normal weight (18.5–25.0 kg/m^2)	1.00		1.00		1.00		1.00	
Overweight (25.0–30.0 kg/m^2)	0.81	0.73–0.90	0.91	0.90–0.92	0.89	0.87–0.91	0.95	0.93–0.96
Obese (≥30.0 kg/m^2)	0.93	0.85–1.03	1.02	1.01–1.04	0.92	0.91–0.94	1.06	1.04–1.09
Diabetes status								
Non-diabetic	1.00		1.00		1.00		1.00	
Prepregnancy diabetes	1.26	0.95–1.68	1.45	1.39–1.52	1.61	1.51–1.71	1.60	1.49–1.71
Gestational diabetes	0.87	0.72–1.05	1.04	1.02–1.06	0.96	0.93–1.00	1.05	1.01–1.09
N		44,570		3,182,835		742,387		1,223,594
LR chi-sq.		828.63		66,478.90		21,862.30		23,092.56
p		0.0000		0.0000		0.0000		0.0000
(B) Full-term only								
Prepregnancy BMI								
Underweight (<18.5 kg/m^2)	1.99	1.59–2.48	1.84	1.79–1.89	1.62	1.55–1.69	1.69	1.62–1.76
Normal weight (18.5–25.0 kg/m^2)	1.00		1.00		1.00		1.00	
Overweight (25.0–30.0 kg/m^2)	0.68	0.58–0.80	0.81	0.80–0.83	0.81	0.78–0.83	0.84	0.82–0.87
Obese (≥30.0 kg/m^2)	0.80	0.68–0.93	0.87	0.86–0.89	0.77	0.75–0.79	0.86	0.83–0.88
Diabetes status								
Non-diabetic	1.00		1.00		1.00		1.00	
Prepregnancy diabetes	0.83	0.56–1.09	1.29	1.18–1.40	1.39	1.24–1.56	1.43	1.26–1.63
Gestational diabetes	0.78	0.78–1.15	1.12	1.08–1.17	0.97	0.91–1.04	1.07	1.00–1.13
N		39,554		2,904,067		637,770		1,098,105
LR chi-sq.		239.86		18,195.76		4834.89		3870.13
p		0.0000		0.0000		0.0000		0.0000

Adjusted models control for calendar year, maternal age, maternal education, Kotelchuck prenatal care index, marital status, and child's sex

Table 5 Risk estimates for BMI and diabetes status, predicting macrosomia (>4000 g) by race/ethnicity for US first births 2009–2013

	AI/AN		White		African American		Hispanic	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Prepregnancy BMI								
Underweight (<18.5 kg/m^2)	0.45	0.34–0.59	0.54	0.52–0.55	0.56	0.51–0.61	0.53	0.50–0.56
Normal weight (18.5–25.0 kg/m^2)	1.00		1.00		1.00		1.00	
Overweight (25.0–30.0 kg/m^2)	1.47	1.35–1.61	1.51	1.49–1.52	1.43	1.39–1.48	1.50	1.47–1.53
Obese (≥30.0 kg/m^2)	1.99	1.83–2.16	1.86	1.84–1.88	1.78	1.73–1.83	2.04	2.00–2.08
Diabetes status								
Non-diabetic	1.00		1.00		1.00		1.00	
Prepregnancy diabetes	2.21	1.75–2.79	1.92	1.84–2.00	2.08	1.89–2.28	1.77	1.64–1.91
Gestational diabetes	1.49	1.30–1.71	1.03	1.01–1.05	1.90	1.81–2.00	1.35	1.30–1.39
N		44,570		3,182,835		742,387		1,223,594
LR chi-sq.		845.20		54,812.13		8641.51		17,149.89
p		0.0000		0.0000		0.0000		0.0000

Adjusted models control for calendar year, maternal age, maternal education, Kotelchuck prenatal care index, marital status, and child's sex low birthweight babies, and more likely than all other groups to have high birthweight babies.

Our study finds that the relationship between body mass index, diabetes and birth outcomes is similar for AI/AN and other race/ethnic groups for most, but not all, outcomes. DM and GDM predict higher odds of preterm delivery for all groups, which may indicate that physicians are more likely to induce early labor for diabetic mothers. Unfortunately the natality files contain no information about the physician intention or other circumstances of the birth, so we cannot evaluate this explanation. While overweight predicts reduced odds of LBW for all groups, obesity is not significant for AI/AN only. When examining full term births only, both overweight and obesity predict reduced odds of LBW for all groups, suggesting that the driving factor behind LBW in AI/AN is restricted fetal growth rather than preterm birth. However, diabetes, while predictive of higher odds of LBW for all other groups, is not a significant predictor of LBW for AI/AN. Lastly, overweight, obesity, DM, and GDM predict higher odds of macrosomia for all groups.

Our results for AI/AN both mirror and expand upon those of earlier studies, though because the sampling methodology varies greatly across these studies, direct comparison may be difficult. Among the Pima, DM predicts premature birth and macrosomia, while GDM predicts macrosomia (Pettitt et al. 1980); our results are identical except that in our sample, GDM also predicts premature birth. Native American women in Washington State with GDM are more likely to have low birthweight babies (Williams et al. 1999), a result we failed to replicate. Our results echo studies in Canada (Godwin et al. 1999; Dyck et al. 2002) reporting that DM and GDM among First Nations women predict preterm delivery and macrosomia but not low birthweight. We found only one study that examined birth outcomes as a function of maternal BMI among AI/AN, and reported that overweight or obese women were more likely to have macrosomic babies (Rockhill et al. 2015).

Several public health implications can be drawn from our results. First, we find that the social determinants of health, where they could be measured in the natality files, vary greatly across race/ethnic groups, and that AI/AN are particularly disadvantaged. AI/AN have high rates of overweight, obesity, DM, and GDM, yet they are the most likely to have inadequate prenatal care. Although our regression models control for prenatal care, these maternal health risk factors argue for better access to prepregnancy and prenatal care in this population. While attempting to lose weight during pregnancy is not advisable, proper medical care can assist diabetic women in controlling their diabetes, which may prevent both preterm delivery and macrosomia—two outcomes that are particularly common among AI/AN. Increased access to quality health care may thus have tangible, positive impacts on the lives of AI/AN women and their babies.

Several limitations to the data and the results should be noted. The birth certificate files are cross-sectional, leading us to exercise caution when inferring causality between variables of interest. While many items reported on the birth certificate have substantial or high sensitivity (i.e., exact agreement), including birthweight and gestational age, some items have low sensitivity, including number of prenatal care visits and GDM (Martin et al. 2013). There is also great variance across hospitals in the accuracy of reporting data (Martin et al. 2013). The natality data may therefore underreport some health and medical variables. Since 2005, the US public release natality file has not included any geographic identifiers (National Center for Health Statistics 2014), nor data on rural versus urban location, so we cannot control for state of residence or regional location. There is also no information about tribal identity among the American Indian/Alaska Native population, which is unfortunate as AI/AN are not culturally homogeneous. One important strength of the natality files is their large sample size, particularly for American Indian and Alaska Native respondents, who are typically undersampled in nationally representative health datasets.

Conclusion

This paper examined the relationship between maternal BMI and diabetes status with several deleterious birth outcomes: preterm delivery, low birthweight, and macrosomia, comparing across racial/ethnic groups. We found that American Indians/Alaska Natives experience numerous disparities, both in terms of social determinants of health and health outcomes. Improved access to prepregnancy and prenatal care with a goal towards diabetes management among AI/AN might help reduce both preterm delivery and macrosomia among this population.

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