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Obesity Trends and Perinatal Outcomes in Black and White Teenagers

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Abstract

Objective—Our objective was to explore the trends in prepregnancy BMI for Black and White teenagers over time and the association between elevated BMI and outcomes based on race.

Study Design—This was a retrospective cohort study of singleton infants (n=38,158) born to Black (34%) and White teenagers (< 18 years of age). We determined the prevalence of elevated prepregnancy BMI between 1993 and 2006 and the association between elevated prepregnancy BMI (primary exposure) and maternal and perinatal outcomes based on race (2000–2006).

Results—The percent of White teenagers with elevated prepregnancy BMI increased significantly from 17% to 26%. White and Black overweight and obese teenagers were more likely to have pregnancy-related hypertension than normal weight teenagers while postpartum hemorrhage was only increased in obese Black teenagers and infant complications only in overweight and obese White teenagers.

Conclusion—As the percent of elevated prepregnancy BMI has increased in White teenagers, specific risks for poor maternal and perinatal outcomes in the overweight and obese teenagers varies by race.

Keywords

Adolescents; Obesity; Outcomes

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INTRODUCTION

Although the rate of teenage pregnancies in the United States has declined from its peak of 61.8 per 1000 in 1991, recent data suggests that teenage pregnancy is still a sizable problem with 34.3 births per 1000 teenagers.^{1,2} Black/White racial disparities in teenage pregnancy are well-described with a rate of 51.5 per 1000 Black teenagers versus 23.5 per 1000 White teenagers. In addition to the well-described negative psychological and socioeconomic impact on the teenagers themselves, infants born to teen mothers are more likely to be born preterm and/or low birth weight and have an increased risk of infant mortality.^{3,4}

Although more than sixteen percent of teenage females are overweight or obese,⁵ racial differences in obesity have also been identified with 15.4% of White and 25.4% of Black teenagers being overweight or obese.⁶ Regardless of race, the implications of being overweight or obese in the teenage years has been described as a critical time leading to long term physiologic and behavioral changes.⁷ As the obesity epidemic continues, obesity among pregnant teenagers is becoming increasingly common with one study finding that 40% of teenage mothers were overweight or obese.⁸

Overweight and obese pregnant teenagers are more likely to have obstetric complications including: primary cesarean delivery, induction of labor, gestational hypertension, preeclampsia, and gestational diabetes mellitus.^{8,9} Evidence suggests that infants born to these teenagers are also more likely to have complications including postterm delivery, low birth weight, or macrosomia.

In light of the known racial disparities in obesity and teenage pregnancy, we sought to explore the trends in pre-pregnancy body mass index (BMI) for Black and White teenagers and the association between increasing BMI and maternal and perinatal outcomes. We hypothesized that overweight and obesity has increased in both Black and White teenagers and that these teenagers with elevated prepregnancy BMI are more likely to have perinatal complications. In addition, we hypothesize that increasing BMI will have a greater detrimental impact in Black versus White teenagers explaining, to some extent, ongoing disparities in outcomes for this teenagers.

MATERIALS AND METHODS

We conducted a population-based retrospective cohort study of all singleton live infants born in Missouri between 1993 and 2006. Data were obtained from Missouri birth certificate records linked to hospital discharge data. We included nulliparous Black and White teenagers 11–17 years of age to allow for sufficient sample size to assess racial disparities. Exclusion criterion was major congenital anomalies (295, 1.3%). We excluded from the analyses all births that were missing information on maternal prepregnancy BMI (2105, 5.2%). Finally, we excluded mothers who were 18 and 19 years of age. Although this is designed as an assessment of teenage pregnancy, these older teenagers were less likely to be white ($p<0.001$) and have higher BMI ($p<0.001$). In addition, they were more likely to be on Medicaid, smoke, and be married; therefore, we chose to provide an analysis of a more conservative definition of teenage pregnancy.

The primary predictor of interest was prepregnancy BMI categorized using the Centers for Disease Control and Prevention (CDC) growth charts for BMI-for-age.¹⁰ Prepregnancy BMI is based on birth certificate documentation of prepregnancy weight and height which is generally based on self-report and shown to be valid.¹¹ BMI is calculated as the weight in kilograms divided by the height in meters squared. Growth charts identify percentiles based on BMI for children 2 to 20 years of age. Fernandez et al. suggested that the IOM criteria for prepregnancy weight categories are inappropriate for adolescents;^{12,13} therefore, we have

chosen to report findings using the CDC age-specific body mass index classification. Teenagers were classified as underweight (BMI <5th percentile), normal (BMI 5th and <85th percentile), overweight (BMI 85th and <95th percentile), and obese (BMI 95th percentile).

Hospital discharge data on outcomes was only available for deliveries from 2000 to 2006. Therefore, we limited outcome analyses to this subpopulation. Maternal outcomes included method of delivery, pregnancy-related hypertension, and postpartum hemorrhage based on previous literature.^{14–17} Method of delivery is categorized on the Missouri birth certificate record as vaginal, vaginal birth after previous cesarean section, repeat cesarean, primary elective cesarean, and primary emergency cesarean. The birth certificate also includes data on use of outlet/low forceps, mid/high forceps, and vacuum extraction; all of which were categorized as “operative” vaginal delivery. Pregnancy-related hypertension included gestational hypertension, pregnancy-induced hypertension, pre-eclampsia, and eclampsia. We were unable to examine gestational diabetes as a primary outcome as the Missouri birth certificate does not clearly differentiate between gestational, type I, and type II diabetes. Maternal outcomes were considered present if documented in either the birth certificate or the hospital discharge data.

Gestational age at birth was based on the clinical estimate of gestational age on the birth certificate and categorized as preterm (24 to <37 weeks), term (37 to 40 weeks), and prolonged (41/42 weeks).^{18,19} Other perinatal outcomes were limited to term infants and included birth weight categorized as macrosomic (≥ 4000 grams) or low birth weight (< 2500 grams). We also created a composite infant complication score including: low Apgar score (< 7 at 5 minutes), birth trauma, shoulder dystocia, prolonged length of hospital stay (> 5 days), infection, hypoglycemia, polycythemia, respiratory distress syndrome, meconium aspiration syndrome, and seizures. Infant outcomes were obtained exclusively from the birth certificate.

Several maternal socio-demographic characteristics have been shown to be associated with maternal obesity and were evaluated as potential confounders in this study. Given the increasing risk of complications associated with decreasing age, maternal age was left as a continuous variable.^{20,21} Maternal education was categorized as high, average, or low based on age and years of education.²² Using the R-GINDEX, prenatal care was categorized as no care, inadequate, adequate, intermediate, intensive, or missing based on when prenatal care was initiated, total number of prenatal care visits, and gestational age at delivery.²³ Other potential confounders included smoking status (yes versus no/unknown), marital status (married versus not married), insurance status (Medicaid versus private), and infant gender (male versus female). Both chronic hypertension (ICD-9 code 401, 642.0, 642.1, or 642.2) and diabetes (ICD-9 code 250 or 648.0) were present if documented in either the birth certificate record or the hospital discharge data.

Assessment of trend over time was determined using Cochran-Armitage test of trend. Bivariate analyses were completed using Chi-square or Fisher’s exact tests as appropriate. Multivariable logistic regression was used to calculate adjusted odds ratios (aOR) and 95% confidence intervals (CI) for various outcomes stratified by maternal race. Regression models were adjusted *a priori* for maternal age, education, smoking status, marital status, level of prenatal care, insurance status, maternal diabetes, maternal chronic hypertension, and infant gender unless otherwise indicated. Multivariate analyses for method of delivery were performed using multinomial logistic regression analyses. All analyses were completed using SAS version 9.1 (SAS Institute Inc., Cary, NC). Approval for human subjects research and a waiver of informed consent were received from the Institutional Review Board at

Saint Louis University and the Missouri Department of Health and Senior Services, Section for Epidemiology for Public Health Practice.

RESULTS

The final study cohort included 34,648 teenagers with 68% White and 32% Black. White teenagers were more likely to be older, nulliparous, and report tobacco use while Black teenagers were more likely to have poor prenatal care, be unmarried, and have lower education (Table 1). Black teenagers with diabetes were more likely to have chronic hypertension (0.4% in White versus 0.7% in Black, $p=0.007$) and less likely to have diabetes (1% in White versus 0.7% in Black, $p=0.05$). Overall, Black teenagers were more likely to be overweight (19.2%) and obese (11.4%) than White teenagers (12.6% and 6.6%, respectively) (p -value <0.001).

With regard to trends, the mean prepregnancy BMI for the entire population increased from 22.4 (± 4.3) in 1993 to 23.4 (± 4.8) in 2006. In 1993, 14.3% of all teenagers were overweight and another 7.0% were obese. By 2006, 16.9% of all teenagers were overweight and another 10.8% were obese ($p<0.001$). The percent of Black teenagers with elevated BMI rose from 29.1% in 1993 to 33.2% in 2006, but this was non-significant with p -value of 0.08 (Figure 1). Specifically, while the mean BMI in Black teenagers was stable over time ($p=0.161$), the percent of overweight Black teenagers rose from 20.1% to 20.8% ($p=0.94$) and the percent of obese Black teenagers rose from 10.0% to 12.7% ($p=0.02$). Meanwhile, the percent of White teenagers with elevated prepregnancy BMI increased significantly between 1993 and 2006 from 17.9% to 26.1%, respectively ($p<0.001$). Specifically, the mean BMI increased over time ($p<0.001$) with the percent of overweight and obese White teenagers increased from 11.3% to 15.7% ($p<0.001$) and 5.7 to 10.4% ($p<0.001$), respectively.

Complications were evaluated for deliveries between 2000 and 2006 during which there was no significant increase in the percent of Black teenagers with elevated BMI ($p=0.64$) and a significant increase in percent of White teenagers with elevated BMI ($p<0.001$). Overweight and obese White and Black teenagers were more likely to have certain maternal and perinatal complications than normal weight teenagers (Tables 2 and 3). We assessed for interaction between race and prepregnancy BMI. Significant interactions were certain outcomes (eg. pregnancy-induced hypertension ($p<0.01$) and postpartum hemorrhage ($p=0.07$)); therefore, we present outcomes stratified by race (Tables 2 and 3).

Overweight and obese White teenagers were more likely to have pregnancy-related hypertension than normal weight White teenagers (aOR 1.7 and 2.3, respectively). Overweight and obese White teenagers were also more likely to be induced and, ultimately, give birth by cesarean section than normal weight white teenagers. Whether by elective or emergency cesarean section, obese White teens were two times more likely to have a cesarean delivery than normal weight White teenagers (elective aOR 2.05 and emergency aOR 2.00). Infants born to these overweight and obese White teenagers are more likely to experience a complication (birth trauma, meconium aspiration syndrome, respiratory distress syndrome, length of stay > 5 days, and/or low Apgar score). Infants born to overweight White teenagers were more likely to be born both preterm and prolonged gestation. Further, infants born to obese White teenagers three times more likely to be macrosomic than infants born to normal weight White teenagers.

Similar to White teenagers, overweight and obese Black teenagers were also more likely to have pregnancy-related hypertension than normal weight Black teenagers (Table 3). However, only obese Black teenagers were more likely to have postpartum hemorrhage (aOR 1.74) than normal weight Black teenagers. Overweight and obese Black teenagers

were also more likely to be induced (aOR 1.54). Obese and overweight Black teenagers were also more likely to undergo cesarean section than normal weight Black teenagers with obese Black teenagers 2.1 times more likely to have an emergency cesarean section than normal weight Black teenagers. There were very few infants born macrosomic to Black teenagers, so we were unable to assess adjusted risk. Although infants born to overweight and obese Black teenagers were more likely to deliver infants following prolonged gestation, there was no statistically significant increase in overall neonatal complications for overweight and obese Black teenagers compared to normal weight Black teenagers.

COMMENT

To our knowledge, this is the first study to look at outcomes of teenage pregnancies based on race in light of the obesity epidemic. In this study, we found that the percent of White teenagers with elevated prepregnancy BMI increased from 17.9% in 1993 to 26.1% in 2006 ($p < 0.001$) and began to approximate the percent in Black teenagers (33%) by the end of the study period. We also found that although both overweight *and* obese teenagers are at increased risk for *both* maternal and newborn complications, there was significant variability by race. For instance, postpartum hemorrhage was almost two times more likely in Black obese teenagers than Black normal weight teenagers but not in White obese teenagers while there was increased risk of gestational hypertension with elevated prepregnancy BMI regardless of race.

The higher percentage of elevated BMI in Black versus White teenagers is not surprising given findings from the National Health and Nutrition Examination Survey which found that 46.3% of Black 12–19 year old females were overweight or obese versus 29.9% in White 12–19 year olds.²⁴ However, the increasing trend in elevated BMI in White teenagers is in contrast to NHANES data which showed no change in BMI between 1999 and 2008 across racial groups. This statistically significant rise in the percent of White teenagers with elevated BMI, in contrast to the stable rate of BMI among Black teenagers, suggests a narrowing of racial disparities. Obesity is likely a result of exposure to numerous biologic, social, cultural, and environmental factors.^{25–28} Our findings may, therefore, reflect a stable exposure to certain negative effects such as limited opportunities for physical activity and inadequate exposure to healthy foods in Black teenagers while White teenagers are increasingly experiencing barriers to physical activity and healthy food. It is unclear, however, if the White teenagers who are becoming pregnant differ from the general population in which there was no increase in overall trends in elevated BMI. It also may be that the rates of obesity in Black teenagers represent an upper bound that will not significantly worsen, whereas the White teenagers continue to have room to worsen with less physical activity and poorer diets.

Although extensive literature has identified complications related to being overweight and obese prior to pregnancy adults,^{29,30} only a few studies have examined the influence of obesity in pregnant adolescents, and this is the first, based on our review of the literature, to examine findings based on race. We noted, for instance, an increase in complications in infants born to only overweight or obese White teenagers. Interestingly, Sukalich et al. and Haeri et al. both looked briefly at infant outcomes following non-reassuring fetal heart tones.^{9,8} Sukalich found an association between overweight and obese teenagers and non-reassuring fetal heart tones when assessing a population of >50% white teenagers. Conversely, Haeri et al. found no such association when examining a primarily African-American population. This suggests that race does, in fact, interact with elevated BMI in altering the risk of poor outcomes for infants. In addition, we confirmed previous work which identified African Americans at higher rate of preterm delivery,^{31,32} although we did not consistently find a protective effect of elevated prepregnancy BMI on preterm delivery.

across race. Many of the differences described above are likely to be due to the populations studied and the analytic methods used. Although Sukalich examined a largely White population and Haeri a primarily African-American population,^{9,8} each only controlled for race which may be inappropriate given the interactions identified here. Each also included 18 and/or 19 year olds which as we discussed in the methods have many different risk factors.

We also confirmed an increased risk of cesarean delivery in both Black (Haeri et al.) and White (Sukalich et al.) teenagers.^{9,8} Specifically, our study found an increase in *both* elective and emergency cesarean delivery in White overweight and obese teenagers and emergency cesarean delivery in Black overweight and obese teenagers. In addition, we found that elevated prepregnancy BMI was associated with an increase in inductions. This is particularly concerning given the large number of fertile years ahead for teenagers and the potential for morbidity linked to not only initial but future cesarean deliveries, particularly multiple cesarean deliveries.^{33,34}

Finally, we found an increase in risk of postpartum hemorrhage in obese Black teenagers. Postpartum hemorrhage is most often attributed to uterine atony.³⁵ Stimulating uterine muscle tone through uterine massage reduces the incidence of postpartum hemorrhage.³⁶ Therefore, it is possible that uterine massage is less effective in obese teenagers. Another possibility is increased volume of distribution of uterotonic medications.³⁷ Sebire et al. also noted an increase in postpartum hemorrhage in obese women and proposed that more bleeding occurs due to the larger area of implantation of the placenta.³⁸ None of these explanations, however, account for the racial disparities noted here, but our findings are similar to studies conducted in adults which found that although there is increased risk of maternal complications with obesity, the effect varies among different ethnicities.^{39,40}

Limitations

These analyses utilized birth certificates and hospital discharge data; therefore, we were unable to adjust for known confounders such as a history of sexual abuse, intimate partner violence, or low gynecologic age which have been shown to be associated with adverse outcomes.^{41,42} In addition, there are concerns about the validity of the primary predictor, prepregnancy BMI. We did not have access to any medical records and were, therefore, unable to perform any validation; however, multiple studies suggest that although adolescents, particularly < 16 years of age, do not accurately self-report height and weight with a tendency toward underestimating BMI.^{43–45} One study found that self-report yields a sensitivity of 60.5% but a specificity of 98%.^{46,47} Although this would result in a systematic bias in our findings, we would expect it to be toward the null which would underestimate the relationship between elevated BMI and outcomes we identified. Similarly, there may be misclassification or reporting bias in outcomes; however, several studies suggest that outcomes which were examined here have high accuracy.⁴⁸ Although indications for the method of delivery may be poorly identified in birth certificates, studies have shown that the actual method of delivery is accurately reported.^{49,50} Hospitals in Missouri are provided with instructions on reporting that defines a primary elective c-section as “a first-time cesarean section planned for in the future” and an emergency c-section as “a first-time cesarean section done out of medical necessity because it is believed that further delay in delivery would seriously compromise the fetus, the mother, or both and/or vaginal delivery is unlikely to be accomplished safely.”⁵¹

Additionally, we utilized aggregate data to allow for sufficient sample size to examine rare outcomes in teenage pregnancy although differences in race still may have been related to small sample sizes. We limited the outcome analyses to 2000–2006 to minimize the effect of other secular trends which may have had a significant impact on our findings. For instance,

the American College of Obstetricians and Gynecologists published first practice bulletin for the diagnosis and management of preeclampsia in 2002, and we are unable to determine what effect this had on the diagnosis of preeclampsia in our population during the study period.⁵²

Conclusions

Unfortunately, the decreasing gaps in elevated prepregnancy BMI between Black and White teenagers is being driven by increasing rates of overweight and obesity in White teenagers. In addition, although specific risks vary by race, the overall risk of poor maternal and perinatal outcomes in these overweight and obese teenagers is higher than normal weight teenagers in both White and Black teenagers. Therefore, interventions which focus on overweight and obese teens will have the added benefit of improving the health of both the teenagers and the infant. Adolescent prevention programs to reduce the prevalence of obesity have been shown to be effective.⁵³ When we assess the impact of such programs, we must not only take into account the impact on the adolescent's physiology and behavior but also their reproductive health and the health of infants born to overweight and obese teenagers.

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Figure 1.
Percent of Teenagers who had Elevated Prepregnancy BMI (Overweight or Obese) from 1993 to 2006

Table 1

Population Characteristics (N=34,648) by Race

Characteristic	White (N=23,576)		Black (N=11,072)	
	N	(%)	N	(%)
Maternal Age (years) *				
14	671	(2.9)	942	(8.5)
15	2473	(10.5)	1890	(17.1)
16	6703	(28.4)	3467	(31.3)
17	13,729	(58.2)	4773	(43.1)
Medicaid *	18,348	(78.1)	8424	(76.4)
Maternal Education *				
High	7330	(31.3)	2195	(20.2)
Average	15,888	(67.9)	8558	(78.7)
Low	194	(0.8)	123	(1.1)
Smoking *	7193	(30.5)	571	(5.2)
Married *	3082	(13.1)	57	(0.5)
Prenatal Care Utilization *				
Missing	315	(1.4)	305	(2.8)
None	1361	(5.8)	1182	(11.0)
Inadequate	4696	(20.1)	2211	(20.5)
Adequate	10,621	(45.5)	4252	(39.4)
Intermediate	5554	(23.8)	2177	(20.2)
Intensive	820	(3.5)	653	(6.1)
Prepregnancy BMI *				
Under	1197	(5.1)	232	(2.1)
Normal	17,856	(75.7)	7451	(67.3)
Overweight	2974	(12.6)	2123	(19.2)
Obese	1549	(6.6)	1266	(11.4)
Male infant	12,061	(51.2)	5658	(51.1)

*
p<0.001

Table 2

Maternal and perinatal outcomes for overweight and obese **White** teenagers (n=10,266)

Characteristic	Normal N(%)	Overweight N(%)	Obese N(%)	aOR* (95% CI) Overweight vs Normal	aOR* (95% CI) Obese vs Normal
Maternal Complications					
Pregnancy-related hypertension	707 (8.8)	210 (14.6)	156 (18.8)	1.70 (1.44, 2.02)	2.34 (1.92, 2.84)
Postpartum hemorrhage	315 (3.9)	64 (4.5)	36 (4.3)	1.14 (0.87, 1.51)	1.10 (0.77, 1.56)
Induction	2519 (31.5)	541 (37.7)	318 (38.2)	1.31 (1.16, 1.47)	1.33 (1.15, 1.54)
Method of Delivery					
Vaginal	5210 (72.7)	902 (69.0)	464 (62.9)	-	-
Operative Vaginal	796 (11.1)	120 (9.2)	58 (7.9)	0.83 (0.68, 1.01)	0.79 (0.61, 1.03)
Elective cesarean delivery	401 (5.6)	104 (8.0)	81 (11.0)	1.46 (1.18, 1.81)	2.05 (1.61, 2.63)
Emergency cesarean delivery	683 (9.5)	171 (13.1)	129 (17.5)	1.36 (1.15, 1.62)	2.00 (1.65, 2.43)
Birthweight					
Macrosomia (≥ 4000 grams)	30 (0.4)	14 (1.0)	10 (1.0)	2.50 (1.32, 4.75)	2.96 (1.43, 6.14)
Low Birth Weight (<2500 grams)	723 (9.0)	101 (7.0)	50 (6.0)	0.75 (0.60, 0.93)	0.64 (0.47, 0.86)
Gestation					
Preterm (<37 weeks)	797 (10.0)	121 (8.5)	89 (10.8)	0.81 (0.66, 0.99)	1.05 (0.83, 1.33)
Prolonged gestation (≥ 41 weeks)	826 (10.4)	187 (13.1)	93 (11.3)	1.31 (1.10, 1.55)	1.14 (0.90, 1.43)
Infant Composite**	1344 (16.8)	278 (19.4)	183 (22.0)	1.19 (1.03, 1.37)	1.39 (1.17, 1.65)

* Adjusted odds ratio (aOR) for multivariable logistic regression adjusted for maternal age, insurance, education, tobacco use, level of prenatal care, maternal diabetes, maternal chronic hypertension and infant gender;

** Infant composite complications include birth trauma, meconium aspiration syndrome, respiratory distress syndrome, length of stay > 5 days, and 5-minute Apgar <7; **Bold** indicates statistical significance

Table 3

Maternal and perinatal outcomes for overweight and obese **Black** teenagers (n=4831)

Characteristic	Normal N(%)	Overweight N(%)	Obese N(%)	aOR* (95% CI) Overweight vs Normal	aOR* (95% CI) Obese vs Normal
Maternal Complications					
Pregnancy-related hypertension	442 (13.5)	171 (18.0)	122 (20.5)	1.40 (1.15, 1.70)	1.59 (1.27, 2.00)
Postpartum hemorrhage	97 (3.0)	41 (4.3)	30 (5.0)	1.47 (1.00, 2.13)	1.74 (1.14, 2.64)
Induction	630 (19.2)	251 (26.5)	162 (27.2)	1.54 (1.30, 1.83)	1.54 (1.26, 1.89)
Method of Delivery					
Vaginal	2443 (74.3)	663 (69.9)	386 (64.5)	-	-
Operative Vaginal	340 (10.3)	103 (10.9)	55 (9.2)	1.13 (0.89, 1.43)	1.04 (0.77, 1.41)
Elective cesarean delivery	208 (6.3)	71 (7.5)	57 (9.6)	1.28 (0.96, 1.69)	1.77 (1.30, 2.43)
Emergency cesarean delivery	296 (9.0)	111 (11.7)	98 (16.4)	1.37 (1.09, 1.74)	2.10 (1.63, 2.71)
Birthweight					
Macrosomia (≥ 4000 grams)	5 (0.2)	6 (0.6)	1 (0.2)	-	-
Low birth weight (<2500 grams)	457 (13.9)	105 (11.1)	58 (9.7)	0.75 (0.60, 0.94)	0.67 (0.50, 0.90)
Gestation					
Preterm (<37 weeks)	424 (13.3)	116 (12.3)	63 (10.8)	0.89 (0.71, 1.11)	0.78 (0.59, 1.03)
Prolonged gestation (≥ 41 weeks)	304 (9.3)	116 (12.3)	81 (13.9)	1.39 (1.10, 1.75)	1.51 (1.15, 1.97)
Infant Composite**	634 (19.3)	193 (20.4)	138 (23.2)	1.07 (0.89, 1.28)	1.25 (1.00, 1.54)

* Adjusted odds ratio (aOR) for multivariable logistic regression adjusted for maternal age, insurance, education, tobacco use, level of prenatal care, maternal diabetes, maternal chronic hypertension, and infant gender;

** Infant composite complications include birth trauma, meconium aspiration syndrome, respiratory distress syndrome, length of stay > 5 days, and 5-minute Apgar <7; **Bold** indicates statistical significance