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Body Mass Index as a Measure of Obesity: Racial Differences in Predictive Value for Health Parameters During Pregnancy

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Abstract

Background: As a measure of obesity, body mass index (BMI; kg/m^2) is an imperfect predictor of health outcomes, particularly among African Americans. However, BMI is used to guide prenatal care. We examined racial differences in the predictive value of maternal BMI for physiologic correlates of obesity, serum interleukin (IL)-6 and C-reactive protein (CRP), as well as cesarean section and infant birth weight.
Methods: One hundred five pregnant women (40 European American, 65 African American) were assessed during the second trimester. BMI was defined as per prepregnancy weight. Electrochemiluminescence and enzyme-linked immunosorbent assays were used to quantify IL-6 and CRP, respectively. Birth outcomes were determined by medical record review.
Results: Women of both races classified as obese had higher serum IL-6 and CRP than their normal-weight counterparts ($ps \leq 0.01$). However, among women with overweight, elevations in IL-6 ($p < 0.01$) and CRP ($p = 0.06$) were observed among European Americans, but not African Americans ($ps \geq 0.61$). Maternal obesity was a significantly better predictor of cesarean section among European Americans versus African Americans ($p = 0.03$) and BMI was associated with infant birth weight among European Americans ($p < 0.01$), but not African Americans ($p = 0.94$). Effects remained after controlling for gestational age at delivery, gestational diabetes, and gestational weight gain as appropriate.
Conclusions: BMI may be a less valid predictor of correlates of overweight/obesity among African Americans versus European Americans during pregnancy. This should be considered in epidemiological studies of maternal–child health. In addition, studies examining the comparative validity of alternative/complementary measures to define obesity in pregnancy are warranted to inform clinical care.

Keywords: health status disparities, obesity, inflammation, pregnancy, birth weight, cesarean section

Introduction

In the United States, 33.3% and 35.9% of adults meet criteria for overweight and obesity, respectively, as per the World Health Organization (WHO) standard of body mass index (BMI; kg/m^2).[1,2] Obesity rates are particularly high among African Americans (*i.e.*, 49.6% of adults).[2] Obesity is associated with a myriad of poor health outcomes, including cancer, cardiovascular disease, type II diabetes mellitus, and all-cause mortality.[3,4] In the context of pregnancy, obesity is associated with heightened risk for preeclampsia, gestational diabetes, and fetal death.[5–7] Maternal obesity also heightens risk for cesarean section, elevated infant birth weight, and increased risk of obesity in the offspring.[8–12]

Although the negative effects of obesity are clear, it is increasingly recognized that the manner in which obesity is defined has important implications for the prediction of health outcomes. In particular, although BMI is widely used to define overweight and obesity (*i.e.*, 25–29.9 and ≥30, respectively[1]), it has been criticized as a less valid indicator than other measures. For example, in a sample of 6123 adults, 29% of individuals classified as normal weight and 80% classified as overweight as per BMI were classified as obese as per air displacement-determined body fat percentage; these ''missed'' cases showed a cardiometabolic profile consistent with obesity.[13] Alternative anthropometric measures have also superiorly identified individuals at risk for various obesity-related health outcomes. For example, waist-to-height

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ratio better predicts risk for hypertension and diabetes as compared with BMI.[14]

There is growing evidence that BMI may be a particularly poor predictor for health outcomes among African Americans. For instance, data from the Jackson and Framingham Heart Studies showed significantly stronger associations of BMI with hypertension and diabetes among European Americans versus African Americans.[15] In another sample of 14,343 adults, BMI was a significant predictor of all-cause mortality among European Americans, but not African Americans.[16] Few studies have evaluated racial differences in the ability of maternal BMI to predict risk for pregnancy-related outcomes. Some,[17–19] but not all,[19–21] studies support the notion that maternal BMI is a superior predictor among European American versus African American women.

Low-grade, systemic inflammation is often witnessed in the context of obesity, including during pregnancy.[22–27] In fact, the inflammatory proteins interleukin (IL)-6 and C-reactive protein (CRP) are adipokines released directly by adipose tissue.[28,29] While a large literature implicates obesity-associated inflammation as a likely causal mechanism in the development of obesity-associated conditions, it is largely unknown whether there are racial differences in the predictive value of BMI for inflammation.[30–32] One study reports that BMI plus race significantly better predicts CRP levels than BMI alone.[33] However, another study reports no difference in the association between BMI and CRP among European Americans versus African Americans.[34] A better understanding of racial differences in relationships among BMI and inflammation may advance understanding of racial differences in the predictive value of BMI for various conditions, including outcomes unique to pregnancy.

Given the dearth of evidence regarding racial differences in the predictive value of BMI for obesity-associated inflammation, particularly among pregnant women, the primary aim of this study was to determine whether the relationships among: (1) maternal prepregnancy BMI and second trimester serum IL-6, and (2) maternal prepregnancy BMI and second trimester serum CRP differed among European American versus African American women. To appraise biological results alongside relevant clinical outcomes, we also examined racial differences in the relationships among: (1) maternal prepregnancy BMI and cesarean section, and (2) maternal prepregnancy BMI and infant birth weight. It was hypothesized that higher BMI would be associated with higher IL-6, higher CRP, greater odds of cesarean section, and greater infant birth weight in the overall sample, but these relationships would be significantly stronger among European American versus African American women.

Methods

Study design and participants

This study included 105 pregnant women (40 European American, 65 African American) who were each assessed during the second trimester of pregnancy. Participants were drawn from two concurrent cohort studies. The first study examined associations among race, stress, periodontal disease, and obstetric outcomes among 101 women assessed during the second trimester. The second study examined associations among race, stress, immune activation, and obstetric outcomes among 56 women assessed longitudinally during each trimester of pregnancy and postpartum. For the present analyses, data from the second trimester assessment were used from all women.

The current analyses focus on racial differences between European American and African American women; thus, women of other races/ethnicities (*e.g.*, Asian, Hispanic) were excluded due to low representation ($n = 15$). Women were also excluded if second trimester serum samples or birth weight data were unavailable ($n = 18$). The current analyses focus on maternal prepregnancy BMI; underweight women were underrepresented and therefore excluded ($n = 7$). Women participating in both studies were analyzed only once ($n = 11$). One woman with an outlying IL-6 level (≥3 SD from the mean) was excluded. Thus, the final sample utilized in these analyses included 105 women (40 European American, 65 African American).

Women were recruited from The Ohio State University Wexner Medical Center and surrounding community of Columbus, Ohio. Exclusion criteria included multifetal gestation, diagnosed fetal anomaly, chronic conditions (*e.g.*, cancer, systemic lupus erythematosus) or use of medications (*e.g.*, progesterone) with implications for immune function, illicit drug use other than marijuana, and consumption of >2 alcoholic beverages per week as per self-report or medical record at the time of enrollment.

Women reporting acute illness, such as cold- or flu-like symptoms, or antibiotic use within 10 days of a study visit were rescheduled. Blood samples were obtained between 8:00 AM and 4:00 PM. Studies were approved by The Ohio State University Biomedical Institutional Review Board. Informed consent and HIPAA authorizations were obtained from all participants and modest compensation provided.

Demographics, health, and birth outcomes

Race, ethnicity, age, education, annual household income, smoking status, gravidity, and parity were determined by self-report. Weight gain by the second trimester study visit was calculated according to self-reported prepregnancy weight and weight measured at the second trimester study visit. Total gestational weight gain was calculated according to self-reported prepregnancy weight and weight at the final prenatal visit as extracted from the medical record. Occurrence of gestational diabetes as diagnosed by the healthcare provider, method of delivery, and infant birth weight were determined by medical record review. Gestational age at delivery was determined according to the expected date of delivery (84.8% ultrasound-determined or -confirmed as per self-report) and the actual date of delivery extracted from the medical record.

Body mass index

Maternal prepregnancy BMI (kg/m^2) was calculated using self-reported prepregnancy weight and height measured at a study visit. The plausibility of self-reported prepregnancy weight was confirmed by comparing this to weight by scale at a study visit. Women were categorized as normal weight (BMI = 18.5–24.9), overweight (BMI = 25–29.9), or obese (BMI = ≥30) as per the WHO.[1]

IL-6 and CRP

Following venipuncture, vacutainers were centrifuged, serum aspirated, and samples stored at −80°C until assays were performed in batches using kits from the same lot across both studies. Serum was assayed in duplicate and IL-6 levels (pg/mL) determined by electrochemiluminescence using the Meso Scale Discovery Ultrasensitive Multiplex Kits and the Sector Imager 2400 (Meso Scale Discovery, Gaithersburg, MD) as per the manufacturer's instructions. The lower limit of detection was 0.26 pg/mL. Inter- and intra-assay coefficients of variation were 8.69% and 5.89%, respectively. Serum CRP levels (ng/mL) were determined in duplicate by solid phase chemiluminescence using the Quantikine High Sensitivity Immunometric Assay Kits (R&D Systems, Minneapolis, MN) and the IMMULITE 1000 (Siemens Healthcare Diagnostics, Inc., Deerfield, IL) as per the manufacturer's instructions. The lower limit of detection was 0.3 ng/mL. The inter- and intra-assay coefficients of variation were 7.3% and 3.1%, respectively.

Statistical analyses

First, descriptive statistics were examined according to distribution, mean/standard deviation, or count/frequency. Serum IL-6 and serum CRP were log transformed to better meet normality assumptions. To identify variables with potential for confounding, racial differences in demographics and health were assessed using *t*-tests or chi square analyses as appropriate. For the main analyses, a regression model was fit using maternal BMI categories, race, and maternal BMI category by race interactions as predictors and log-transformed serum IL-6 as the criterion. Each model was also examined controlling for gestational diabetes during the current pregnancy and weight gain by the second trimester study visit to determine if these variables were unduly contributing to observed effects of BMI (62.5% of women with gestational diabetes were classified as obese). Then, the relationship between maternal BMI categories and log-transformed serum IL-6 was tested using linear regression for each race separately. These same procedures were repeated with log-transformed serum CRP serving as the criterion. Next, a binary logistic regression model was fit using maternal prepregnancy BMI categories, race, and BMI category by race interactions as predictors, gestational age at delivery as a covariate, and cesarean section as the criterion. Each model was also examined controlling for gestational diabetes and total gestational weight gain. The relationship between BMI categories and odds of cesarean section was then tested using logistic regression for each race separately controlling for gestational age at delivery. These same procedures were repeated with infant birth weight serving as criterion (in this model, BMI was evaluated as a continuous variable and linear regression was used). All analyses were conducted using STATA 12.0 (College Station, TX) with alpha set at 0.05.

Results

Descriptive statistics and comparisons by race

Descriptive statistics and comparisons by race are shown in Table 1. European American and African American women did not significantly differ in age, education, annual household income, smoking status, gravidity, parity, gestational weight gain, gestational diabetes, gestational hypertension or preeclampsia, gestational age at delivery, maternal prepregnancy BMI, maternal BMI category, serum IL-6, serum CRP, or proportion of women undergoing cesarean section ($ps \geq 0.08$). European Americans with normal weight had a significantly lower mean BMI than African Americans with normal weight ($t_{1,34} = 12.31$, $p < 0.01$; X = 21.37, SD = 1.61; X = 23.19, SD = 1.44, respectively). Mean BMI did not differ among European Americans with overweight versus African Americans with overweight ($t_{1,26} = 0.37$, $p = 0.55$; X = 27.22, SD = 1.35; X = 26.91, SD = 1.24, respectively) or among European Americans with obesity versus African Americans with obesity ($t_{1,42} = 0.10$, $p = 0.76$; X = 37.87, SD = 8.54; X = 37.14, SD = 6.37, respectively). African American women delivered significantly lighter babies than European American women ($t_{1,104} = 8.76$, $p < 0.01$). As expected, gestational age at delivery was highly correlated with birth weight ($r = 0.69$; $p < 0.01$).

Interleukin-6

Among the full sample, maternal prepregnancy BMI was positively correlated with serum IL-6 ($r = 0.475$; $p < 0.01$). However, the relationship between overweight, as compared with normal weight, and serum IL-6 differed by maternal race as demonstrated by a significant interaction in the full model ($\beta = -0.41$, $p = 0.01$). This interaction remained after controlling for both gestational diabetes and weight gain by the second trimester study visit ($\beta = -0.40$, $p = 0.02$). When analyzed separately by race, European American women with obesity and African American women with obesity each had significantly higher serum IL-6 than normal weight women of the same race ($\beta = 0.51$, $p < 0.01$; $\beta = 0.46$, $p < 0.01$, respectively). However, as shown in Figure 1a, among European Americans, women with overweight showed higher IL-6 than normal weight ($\beta = 0.46$, $p < 0.01$). In contrast, among African Americans, women with overweight did not differ in serum IL-6 from women with normal weight ($\beta = 0.02$, $p = 0.88$).

C-reactive protein

Results for serum CRP followed similar trends to those of serum IL-6. Among the full sample, maternal prepregnancy BMI was positively correlated with serum CRP ($r = 0.53$; $p < 0.01$). The relationship between overweight and CRP marginally differed according to race as per the unadjusted model ($\beta = -0.28$, $p = 0.08$) and model adjusted for gestational diabetes and weight gain by the second trimester study visit ($\beta = -0.29$, $p = 0.08$; Fig. 1b). When analyzed separately by race, obesity predicted significantly higher serum CRP as compared with normal weight among both European American and African American women ($\beta = 0.61$, $p < 0.01$; $\beta = 0.47$, $p < 0.01$, respectively). Among European Americans, women with overweight also showed marginally higher CRP versus women with normal weight ($\beta = 0.30$, $p = 0.06$). Among African Americans, serum CRP levels among women with overweight did not differ from women with normal weight ($\beta = -0.07$, $p = 0.61$).

Cesarean section

Controlling for gestational age at delivery, a racial difference in the association between maternal obesity and odds

Table 1. Descriptive Statistics and Comparisons by Maternal Race

	European American (n = *40*)	*African American* (n = *65*)	*ANOVA/χ2*
	Mean (SD) or n *[%]*	*Mean (SD) or* n *[%]*	p
Age	23.5 (4.5)	24.1 (3.9)	0.47
Education			0.15
<High school graduate	10 [25.0]	17 [26.2]	
High school graduate	10 [25.0]	24 [36.9]	
Some college	12 [30.0]	20 [30.8]	
≥College degree	8 [20.0]	4 [6.2]	
Annual household income			0.14
<$15,000	24 [60.0]	48 [73.9]	
≥$15,000	16 [40.0]	17 [26.2]	
Smoking status			0.08
Current smoker	11 [27.5]	9 [13.9]	
Current nonsmoker	29 [72.5]	56 [86.1]	
Gravidity			0.96
1	8 [20.0]	12 [18.5]	
2	6 [15.0]	8 [12.3]	
3	20 [50.0]	36 [55.4]	
≥4	6 [15.0]	9 [13.8]	
Parity			0.89
0	12 [30.0]	18 [27.7]	
1	22 [55.0]	35 [53.8]	
≥2	6 [15.0]	12 [18.5]	
Weight gain by second trimester study visit (lbs)	12.8 (11.7)	11.0 (17.7)	0.58
Total gestational weight gain (lbs)[a]	29.7 (14.2)	25.0 (15.2)	0.16
Gestational diabetes	3 [7.3]	5 [7.7]	0.97
Gestational hypertension/preeclampsia	4 [10.0]	5 [7.7]	0.68
Gestational age at delivery	273.9 (10.0)	271.4 (12.2)	0.28
Maternal prepregnancy BMI	28.5 (8.6)	30.5 (7.7)	0.22
BMI category			0.38
Normal weight	15 [37.5]	20 [30.8]	
Overweight	12 [30.0]	15 [23.1]	
Obese	13 [32.5]	30 [46.1]	
Serum IL-6 (pg/mL)	2.02 (1.63)	1.70 (0.84)	0.19
Serum C-reactive protein (ng/mL)	8.72 (10.22)	8.49 (8.31)	0.90
Cesarean section			0.68
Yes	15 [37.5]	27 [41.5]	
No	25 [62.5]	38 [58.5]	
Birth weight (g)	3362.4 (492.6)	3076.0 (474.5)	0.004*

[a]Data available for 91/105 (86.7%) participants; *$p < 0.01$.
ANOVA, analysis of variance; BMI, body mass index; SD, standard deviation.

of cesarean section was evidenced by a significant interaction in the full regression model (OR = 0.06, 95% CI = 0.004, 0.78; Hosmer–Lemeshow $\chi^2 = 6.27$, $p = 0.62$; Table 2 and Fig. 2). This interaction remained after controlling for gestational diabetes and total gestational weight gain (OR = 0.03, 95% CI = 0.002, 0.57). After stratification by race, among European Americans, maternal obesity was significantly associated with increased odds of cesarean section (OR = 31.85, 95% CI = 3.00, 337.70) and maternal overweight was marginally associated with increased odds of cesarean section as compared with normal weight (OR = 10.09, 95% CI = 0.97, 104.72). Among African Americans, neither women with obesity nor overweight had increased odds of cesarean section versus women with normal weight (OR = 1.77, 95% CI = 0.53, 5.89; OR = 2.68, 95% CI = 0.66, 10.83, respectively).

Birth weight

Controlling for gestational age at delivery, a racial difference in the association between maternal prepregnancy BMI and infant birth weight was evidenced by a significant BMI by race interaction in the full regression model ($\beta = -0.604$, $p = 0.03$; Fig. 3). Specifically, one unit greater maternal prepregnancy BMI was associated with 19.19 g greater birth weight among European Americans, but only 0.42 g greater birth weight among African Americans. The interaction

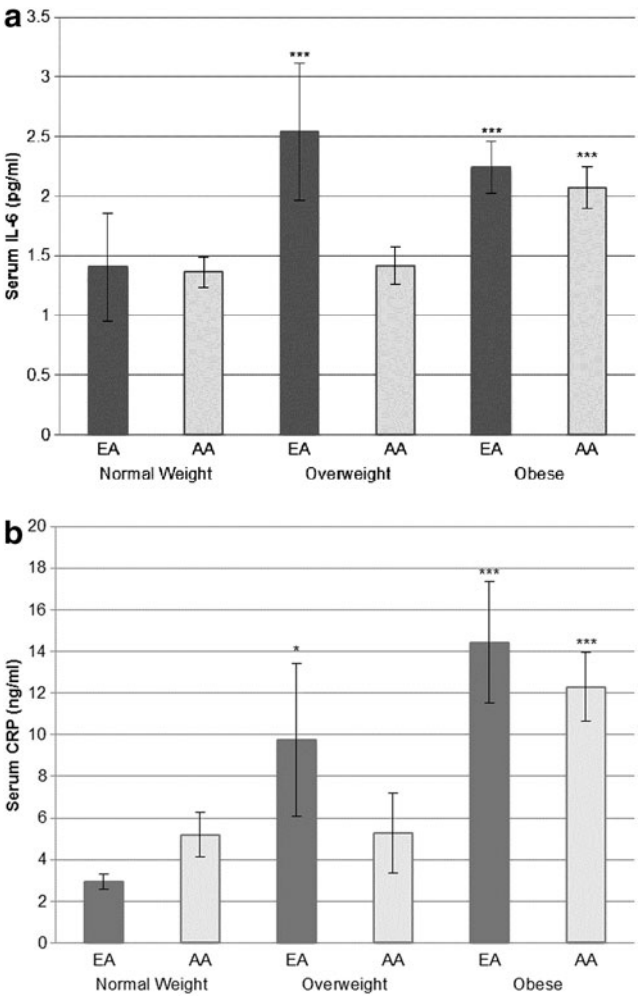

FIG. 1. Serum IL-6 and CRP by maternal BMI and race. **(a)** Women of both races who were classified as obese had higher serum IL-6 than their normal weight counterparts ($ps \leq 0.01$). Among women with overweight, elevations in IL-6 were observed among European Americans ($p = 0.01$), but not African Americans ($p = 0.88$). **(b)** Women of both races who were classified as obese had higher serum CRP than their normal weight counterparts ($ps \leq 0.01$). Among women with overweight, marginal elevations in CRP were observed among European Americans ($p = 0.06$), but not African Americans ($p = 0.61$). Log-transformed values were used in statistical analyses and nontransformed values for graphical purposes. AA, African American; BMI, body mass index; CRP, C-reactive protein; EA, European American; IL, interleukin. $^{*}p < 0.1$; $^{***}p < 0.01$ versus normal weight.

between maternal prepregnancy BMI and race in predicting birth weight was not meaningfully affected by the inclusion of gestational diabetes and total gestational weight gain as control variables ($\beta = -0.60$, $p = 0.06$). When analyzed separately, maternal prepregnancy BMI predicted infant birth weight among European Americans ($\beta = 0.33$, $p < 0.01$), but not among African Americans ($\beta = 0.007$, $p = 0.94$).

Discussion

In the current study, we found that weight classifications based on prepregnancy BMI in pregnant women showed differential patterns of association with two physiological correlates of obesity as well as two birth outcomes in European Americans versus African Americans. First, with relation to IL-6 and CRP, although BMI was positively associated with each among the full cohort, a higher dose of BMI was required among African Americans before significant elevations in serum IL-6 levels and serum CRP levels were observed. Specifically, European Americans classified as overweight showed significant elevations in IL-6 and marginal elevations in CRP relative to normal weight women, whereas such elevations were only observed among obese African American women. These findings add to a limited literature on racial differences in physiologic correlates of overweight/obesity and provide novel data in the context of pregnancy.

In addition, we examined cesarean section rates and birth weight in relation to BMI in this cohort. BMI was a better

Table 2. Logistic Regression Model for Odds of Cesarean Section According to Maternal BMI and Race

	OR (95% CI)
Normal weight	Reference
Overweight	10.10 (0.980, 104.12)
Obesity	31.91 (3.04, 334.33)
European American	Reference
African American	5.99 (0.64, 56.48)
Race × overweight	0.27 (0.02, 4.02)
Race × obese	0.06 (0.004, 0.78)
Gestational age at delivery	1.00 (0.96, 1.03)

Model likelihood ratio ($\chi^2 = 15.47$, $p = 0.02$), Pseudo $R^2 = 0.11$, Hosmer–Lemeshow ($\chi^2 = 6.27$, $p = 0.62$).

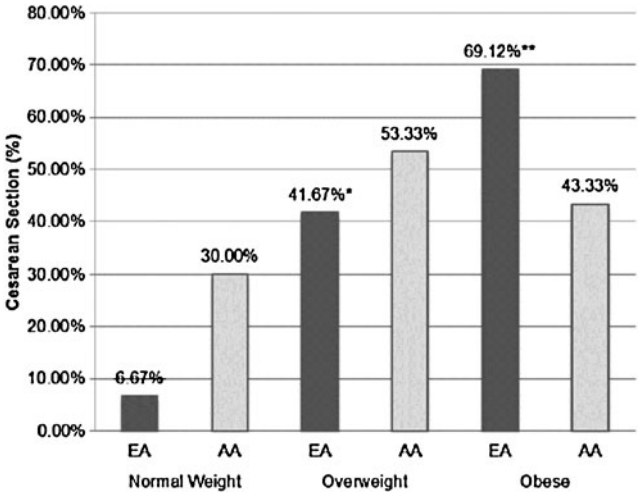

FIG. 2. Cesarean section by maternal BMI and race. Among European Americans, maternal obesity predicted increased odds of cesarean section (OR = 31.85, 95% CI = 3.00, 337.7) and maternal overweight was marginally associated with increased odds of cesarean section versus normal weight (OR = 10.09, 95% CI = 0.97, 104.72). Among African Americans, neither women with obesity nor overweight had increased odds of cesarean section versus women with normal weight (OR = 1.77, 95% CI = 0.53, 5.89; OR = 2.68, 95% CI = 0.66, 10.83, respectively). $^{*}p < 0.1$; $^{**}p < 0.05$ versus normal weight.

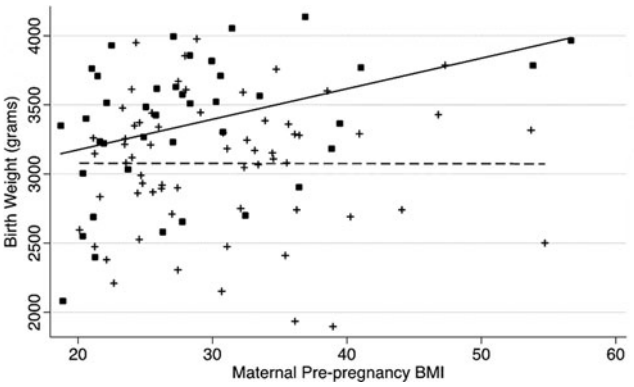

FIG. 3. Infant birth weight by maternal BMI and race. Maternal BMI predicted infant birth weight among European Americans ($p < 0.01$), but not African Americans ($p = 0.94$). One unit greater maternal BMI was associated with 19.19 g greater birth weight among European Americans, but only 0.42 g greater birth weight among African Americans. ■, European American; ——, European American fitted regression line; +, African American; - - - - -, African American fitted regression line.

predictor of cesarean section among European Americans versus African Americans and a positive association between BMI and infant birth weight was noted only among European Americans. The relationships between maternal BMI, cesarean delivery, and infant birth weight have been described in multiple studies.[6,35–38] The current findings are consistent with previously reported racial differences in the relationship between maternal obesity, as determined by prepregnancy BMI, and several perinatal health outcomes. For example, maternal BMI is a better predictor of macrosomia, preeclampsia, preterm birth, and child behavior problems among European American women compared with African Americans.[17,19] Together, our results suggest that, as a measure of obesity, BMI is a less valid predictor of physiological correlates of obesity (*i.e.*, IL-6 and CRP) as well as odds of cesarean section and infant birth weight among African American women than among European American women. These findings support the emerging evidence that BMI-derived weight classifications do not necessarily confer the same meaning in adults of different races.

These findings raise the question of what may underlie these racial differences. As a measure, BMI has been criticized for lacking information regarding overall fat mass and distribution. Importantly, visceral adiposity in particular is implicated in the development of multiple obesity-related outcomes.[39] Thus, it is notable that prior studies have shown that at similar or even lower BMI, European Americans exhibit greater visceral adiposity than African Americans.[40–43] Moreover, when evaluated as a linear relationship, BMI is more strongly associated with visceral adiposity among European Americans than African Americans.[44] Thus, measures that capture central adiposity may provide better or complementary information.

Consistent with this notion, although not found in all studies,[40,42,44] evidence suggests that waist circumference and waist-to-height ratio may be more valid than BMI across racial groups. For example, as described earlier, BMI differentially predicts all-cause mortality among African Americans versus European Americans; however, the same study demonstrated that waist circumference is a robust predictor among both races.[16] Similarly, a study of 382 youth found no racial difference in the relationship between waist circumference or waist-to-height ratio with visceral adiposity, whereas marked differences were observed with BMI as predictor.[41]

Importantly, in the context of pregnancy, BMI is easily calculated and is the commonly employed standard for directing clinical action. For example, the American College of Obstetricians and Gynecologists recommend that prepregnancy BMI be calculated at the initial prenatal visit and used to direct recommendations for weight gain, nutrition, and exercise throughout the pregnancy.[45] If BMI is inadequately predictive, a subset of patients with heightened risk may not receive appropriate attention. In contrast to BMI, data are limited with regard to waist circumference, waist-to-height ratio, or other measures as predictors of obesity-related outcomes during pregnancy.[46] Despite challenges with such measures in pregnancy, such an approach is warranted, with care taken to obtain measurements before fetal growth would meaningfully influence values obtained (*i.e.*, within the first trimester, at which point weight gain averages 4.2 pounds).[47]

Results from such studies would also be of great value for determining whether the observed racial differences stem primarily from inadequacies in BMI as a measure of obesity or additional factors. For example, African American women delivered significantly lighter babies in our study and have been found to be at increased risk for low birth weight deliveries compared with European Americans, even among women with only obesity.[19] These differences may be related to, for example, increased risk for various placental pathologies among African American versus European American women.[48,49] Therefore, it may be that, among African Americans, additional risk factors for low birth weight override the typical relationship between obesity and greater infant birth weight witnessed in other groups. This possibility requires exploration.

The strength of the current study is the prospective cohort design providing for longitudinal prediction. This study also included European American and African American women who were highly demographically similar, reducing the influence of confounds, which may influence the main effects of interest. In this sample, the average BMI among normal weight women was statistically lower among European Americans than African Americans ($X = 21.37 \pm 1.61$ vs. 23.19 ± 1.44). Given that this represents modest variation within the normal weight category, the clinical significance of this difference is likely negligible. However, replication of these findings in additional cohorts would provide confirmation.

The current study also took several steps to decrease error in our measure of prepregnancy BMI, including calculating the value according to measured height and verifying the plausibility of self-reported prepregnancy weight through comparison with measured weight at the first study visit. Further support for use of the measure stems from literature showing that prepregnancy self-reported weight is highly correlated with early pregnancy measured weight ($r = 0.95$); however, the two values do differ, highlighting

the need to consider the potential for measurement error.[50] Finally, the inclusion of physiologic correlates of obesity allowed for extension of the literature beyond what is typically possible with epidemiologic studies evaluating similar clinical outcomes.

A clear limitation of this study is the lack of comparative anthropometric measures, indices of depot-specific adiposity, and additional obesity-associated correlates such as leptin, omentin, adiponectin, and insulin resistance. This information would certainly be informative in future work, particularly in pregnant women for whom valid measurement of obesity and understanding of its biological correlates has unique implications in relation to health recommendations and obstetric outcomes. Furthermore, since adipocytes and immune cells infiltrating the adipose tissue directly produce IL-6 and CRP, we evaluated the ability of prepregnancy BMI to predict IL-6 and CRP levels at midpregnancy. It should be noted that excessive, chronic inflammation also appears to be capable of promoting development and progression of obesity. For example, *ex vivo* experiments have shown IL-6 administration and circulating levels to influence adipose tissue leptin production, glycerol release, and lipoprotein lipase activity.[51,52] While the current work is limited to the reporting of associations among BMI and inflammatory biomarkers, it would be informative to establish a time course through future longitudinal efforts. In addition, this study did not include women of other races (*e.g.*, Asian) or Hispanic ethnicity. Greater representation of diverse groups and appropriate analytic approaches to capture differential effects by race/ethnicity will significantly advance personalized approaches to healthcare.

In conclusion, these data suggest that while higher maternal BMI is associated with higher serum IL-6 and higher serum CRP among both European American and African American pregnant women, the nature of this relationship differs by race. Furthermore, in this cohort, obesity was a significantly better predictor of odds of cesarean section among European American versus African American women and a relationship between maternal BMI and infant birth weight was observed only among European Americans. If BMI is a poor predictor of risk among certain groups, patient care may be negatively affected. Additional research is needed to determine if alternate maternal anthropometric measures serve as superior or complementary predictors of health outcomes in the context of pregnancy. Such data could considerably impact clinical care.

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Author Disclosure Statement

No competing financial interests exist.

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