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Original article

Effect of Gestational Weight Gain and Prepregnancy Body Mass Index in Adolescent Mothers on Weight and Body Mass Index of Adolescent Offspring

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A B S T R A C T

Purpose: The purpose of the study was to examine the association of the gestational weight gain and prepregnancy body mass index (BMI) of low-income adolescent mothers with the risk of their children being overweight and/or obese in late adolescence.
Methods: Study subjects were low-income, primiparous adolescents (n = 360) who self-identified as black and participated in the New Mothers Study in Memphis, Tennessee, and their children. Gestational weight gain was examined as a continuous variable and also categorized into overgain, recommended gain, and undergain following the 2009 Institute of Medicine guidelines. The effects of maternal prepregnancy BMI percentiles and calculated BMI were also considered. Multivariable logistic and linear regression models were used. The main outcome measures were offspring overweight, obesity, and BMI.
Results: Thirty-nine percent of offspring were overweight or obese. Higher maternal gestational weight gain increased the risk for offspring overweight and obesity. There was an interaction between gestational weight gain and prepregnancy BMI: offspring of mothers with a BMI percentile ≤76 were at greater risk of obesity with higher maternal weight gain. If mothers with a BMI percentile between the 29th and 83rd percentiles overgained, offspring were at greater risk for overweight. Using calculated BMIs, if a mother's BMI was ≤26 kg/m^2, offspring risk for obesity was greater with higher gestational weight gain.
Conclusions: High gestational weight gain had a larger effect on offspring overweight and obesity if maternal prepregnancy BMI percentile was ≤76. The gestational weight gain of primiparous adolescents who self-identified as black had an effect on offspring weight.

IMPLICATIONS AND CONTRIBUTION

Higher maternal prepregnancy body mass index and greater gestational weight gain in primiparous adolescents who identified as black were detrimental to their adolescent offspring. Offspring of underweight and normal weight mothers appeared to have a greater risk of overweight/obesity when their mothers had a higher pregnancy weight gain. Absolute gestational weight gain, as opposed to categories based on prepregnancy body mass index, may be a better predictor of offspring obesity.

High gestational weight gain and maternal prepregnancy body mass index (BMI) contribute to long-term weight retention in women [1,2]. Evidence is mounting that they also contribute to an unhealthy BMI in offspring [3–5] and consequently the obesity epidemic. Maternal obesity and excessive gestational weight gain result in a state of overnutrition for the fetus [6] and

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their association with offspring obesity may be through genetic and epigenetic (in utero programming) effects [7–9], thus establishing a lifelong predisposition to obesity [7,8]. Such programming, in conjunction with an increased birth weight due to high gestational weight gain and shared genetic and environmental factors (e.g., diet), can influence long-term body weight [8]. Given that gestational weight gain and prepregnancy BMI are modifiable factors that affect risk for overweight or obesity in offspring, it is important that we increase our understanding of how these factors differ depending on maternal factors such as age, racial group, and parity.

Studies examining the long-term effects of gestational weight gain have primarily included adult women, although a small percentage of adolescents have been incorporated in some studies [10,11]. Adolescents are as likely as adults to experience excessive gestational weight gain [12,13] and if they gain excessively during pregnancy they are also at risk of having large for gestational age infants [13]. In addition, adolescents are at greater risk of preterm births [14], smaller babies, and pregnancy complications compared with adults [2].

Adolescents continue to grow while they are pregnant [15–17]. Bone growth [16,18], leptin surge [15], and bone loss [17] differences found in pregnant adolescents compared with adult women provide evidence that physiological changes in pregnancy are different for adolescents than for adults. Hence, it is plausible that excessive gestational weight gain affects the pregnancy and fetal environment differently in adolescents than in adults. Although there appear to be differences, findings are conflicted on whether adolescent continued growth influences fetal outcomes [16,18]. It is unknown if these apparent differences might alter how prepregnancy BMI and excessive gestational weight gain affect offspring obesity.

The effects of maternal gestational weight gain differ by race [19]. While race and ethnicity have been adjusted for in some studies that examined offspring outcomes [9,10,20] none have specifically considered a minority group. Fetal growth differs depending on racial group, with black women delivering smaller infants [21], and small infants are at increased risk for adult obesity and metabolic diseases [22]. Whether the effect of excessive gestational weight gain on offspring outcomes later in life differs by racial group has not been reported.

Although there are inconsistencies, it appears as though a first pregnancy contributes to maternal weight retention more than subsequent pregnancies [23,24]. Whether the uterine environment, which appears to influence offspring outcomes, is different in an initial pregnancy as opposed to subsequent pregnancies is unknown. Thus, parity is an important consideration when examining the effects of maternal gestational weight gain and prepregnancy BMI.

Gestational weight gain is typically categorized into undergain, recommended gain, and overgain, using prepregnancy BMI categories as specified in the 2009 Institute of Medicine (IOM) recommendations [2]. The IOM indicates that during pregnancy women who are underweight (BMI $<$ 18.5 kg/m^2) should gain 28–40 pounds; women who are healthy weight (BMI $\geq$ 18.5–24.9 kg/m^2) should gain 25–35 pounds; women who are overweight (BMI $\geq$ 25–29.9 kg/m^2) should gain 15–25 pounds; and women who are obese (BMI $\geq$ 30 kg/m^2) should gain 11–20 pounds.

Alternatively, gestational weight gain can be used as a continuous measure assessing the effect of increasingly higher weight gain. The 2009 IOM guidelines do not differentiate between adolescents and adults [2]. However, some adolescents will be misclassified into a lower BMI category if adult BMI categories are used as opposed to adolescent age- and sex-specific BMI percentile ranges [12,25]. Consequently, those adolescents are advised to gain more than recommended for their true BMI category. The finding that most adolescents gain excessively and have greater postpartum weight retention than adults, even if BMI percentiles are used, suggests that utilizing adult cut points may be a disservice to adolescents. The objective of this study was to examine the association of the gestational weight gain and prepregnancy BMI of black adolescent mothers, using age- and sex-adjusted BMI percentiles and adult calculated BMI, with the risk of overweight and/or obesity in their adolescent children. This study was approved by the University of Rochester Institutional Review Board.

Methods

Secondary data analysis was conducted utilizing data from the New Mothers Study that began in 1990 and was conducted in Memphis, Tennessee [26]. Eighteen-year follow-up data were collected from 2009 to 2014. The New Mothers Study was a randomized controlled trial of the Nurse-Family Partnership home visiting program for primiparous mothers seeking prenatal care at a clinic primarily serving Medicaid-covered women. The nurse visiting period was from intake before 28 weeks of pregnancy through the child's second birthday. To participate in the New Mothers Study, mothers had to enroll before the 27th week of pregnancy and meet two of the following three high-risk criteria: less than high school education, unmarried, and unemployed. Women with chronic medical conditions related to fetal growth restriction or preterm birth were excluded. The resulting sample was primarily black (92%) and young (mean age of 18 years). Eighty-eight percent of the eligible women obtaining care at the Regional Medical Center in Memphis, Tennessee, were enrolled in the original study.

For these analyses, we used only the adolescents ($<$20 years old) who self-identified as black. We limited the sample to these adolescents because differences in gestational weight gain and health outcomes between racial groups have been reported [27,28]; also, there were few white adolescents in the sample. We limited the sample to adolescents because if these mothers were still growing the impact of gestational weight gain could be different from adult mothers: it has been documented that 35%–50% of adolescent pregnant females between 14 and 18 years of age continue to grow during pregnancy [18,29].

There were 516 black adolescent mothers in the original sample. We excluded those with preterm births (n = 83), because their gestational weight gain would be different due to the shorter gestation. One mother had an initial BMI $>$45 kg/m^2 and was excluded from these analyses, because the impact of gestational weight gain on someone already so obese may be different from those with lower BMIs. We also excluded mothers who were missing gestational weight gain data (n = 31), leaving a final sample of 399 adolescents. Data were collected on 360 of their children (90.2%) at an average age of 18 years old (range = 17.5–23.3; Table 1). Of these, 328 had sufficient information to calculate BMI. Only Aid to Families with Dependent Children receipt was missing in more than 5% of the observations (7%), so we dropped cases with missing data, resulting in a final sample size of 295.