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GNB3 and *FTO* Polymorphisms and Pregnancy Weight Gain in Black Women

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Abstract

Background—Gestational weight gain (GWG) is a modifiable risk factor for obesity in women. Increased understanding of genetic influences on GWG has implications for the health of women. The purpose of this study was to explore the association of *GNB3* and *FTO* risk alleles in pregnant women and prepregnancy body mass index (BMI), GWG, postpartum and infant birth weights.

Research design and methods—This was an observational, prospective candidate gene association study. Pregnant, low-income black women (N = 97) were enrolled in early pregnancy and followed until 6-months postpartum.

Results—GWG differed depending on number of *FTO* risk alleles. The mean 6-month postpartum BMI differed, although not significantly, by 4 kg/m^2 between homozygous women. There was an interaction between the *FTO* risk allele and prepregnancy BMI (p = .022), with obese homozygote AA women having significantly higher mean GWG than obese TT women. Controlling for age and smoking the *FTO* gene and physical activity predicted GWG (p =.032). Although not statistically significant, women who carried the *GNB3* T risk allele gained 6 pounds more than non-carriers, and mean 6-month postpartum BMI differed by 2.2 kg/m^2 between homozygous women. Neither *GNB3* nor *FTO* genes predicted prepregnancy BMI, infant birth weight or postpartum weight.

Conclusion—Obese women homozygote for the *FTO* risk allele were at greater risk for excessive GWG compared to non-risk allele homozygote obese women or non-obese women. This study provides evidence of the *FTO* gene's effect on GWG in black women.

Obesity is an expanding epidemic that threatens the morbidity and mortality of women. The weight gained with childbearing contributes to the obesity epidemic and disease risk (Gunderson et al., 2009). Excessive gestational weight gain (GWG) based on the Institute of Medicine (IOM) recommendations, and prepregnancy body mass index (BMI), are known contributors to postpartum weight retention (Rasmussen & Yaktine, 2009). Gestational weight gain is a modifiable risk factor for obesity in women and genetic variants linked to

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excessive gain could be markers for metabolic disease (Stuebe et al., 2010). The GWG of black women has a long-term effect on BMI increase 18 years after a first pregnancy (Groth, Holland, Meng, & Kitzman, 2013). Over 50% of pregnant women gain above the IOM recommendations (Simas et al., 2011) and therefore are at risk for long-term obesity, which is associated with negative health consequences such as hypertension, cardiovascular disease (CVD), diabetes mellitus, and osteoarthritis (Centers for Disease Control and Prevention (CDC), 2011). The IOM recommends a reduction in targeted GWG as a woman's prepregnancy BMI increases: BMI < 18.5 kg/m^2 should gain 28–40 pounds; BMI 18.5–24.9 kg/m^2 should gain 25–35 pounds; BMI 25–29.9 kg/m^2 should gain 15–25 pounds, and BMI ≥ 30 kg/m^2 should gain 11–20 pounds (Rasmussen & Yaktine, 2009). The racial/ethnic group in the US with the highest prevalence of overweight/obesity is black women (Flegal, Carroll, Kit, & Ogden, 2012). Over 82% of black women are overweight or obese and nearly 59% are obese (Flegal et al., 2012). Furthermore, over 33% of low-income black women are obese prior to pregnancy (Hinkle et al., 2012). Obesity is also known to increase the risk for poor pregnancy outcomes such as maternal (Huda, Brodie, & Sattar, 2010) and infant (Ruager-Martin, Hyde, & Modi, 2010) metabolic complications, infant small for gestational age (SGA) and preterm birth (Ruager-Martin et al., 2010). Development of obesity prior to the end of the childbearing years has a further detrimental effect because maternal obesity is accompanied by an increase in pregnancy complications (Nohr et al., 2005; Robinson, O'Connell, Joseph, & McLeod, 2005) and offspring are at increased risk for childhood overweight (Whitaker, 2004). Low-income black women experience more weight-related risks postpartum (i.e., weight retention and overweight/obesity) than low-income white women (Walker, Fowles, & Sterling, 2011). Additionally, black women consistently deliver more LBW infants than white women, even with similar gestational weight gains (Caulfield, Witter, & Stoltzfus, 1996; Schieve, Cogswell, & Scanlon, 1998).

Genetic influence on pregnancy weight gain

Two genome wide association studies (GWAS) have assessed obesity and diabetes genes during pregnancy (Lawlor et al., 2011; Stuebe et al., 2010). The conclusions of the two studies are equivocal. Stuebe and colleagues cited evidence that several diabetes and obesity risk alleles are associated with GWG; these alleles interact with maternal prepregnancy BMI to predict GWG. Conversely, investigation in the United Kingdom by Lawlor et al. indicated obesity related risk genes are not associated with GWG. These two studies differed in sample size (N = 960; N = 6426 respectively) and sample composition (diverse sample of Caucasian and African American women; racial diversity not reported, respectively). Additionally, GWG was calculated as a difference between prepregnancy weight and final weight before delivery (Stuebe et al., 2010) vs. weight change calculated for three time points across pregnancy (Lawlor et al., 2011) resulting in different statistical modelling of GWG.

Candidate gene association studies of the *GNB3* C825T (rs5443) single nucleotide polymorphism (SNP) suggest an association of the T risk allele with GWG (Dishy et al., 2003), postpartum weight retention (Gutersohn, Naber, Muller, Erbel, & Siffert, 2000), and low birth weight (Hocher et al., 2000). One study suggested that women homozygous for the T allele are more likely to retain weight in the first year postpartum when physical activity

level is less than 1 hour/week, compared with women whose physical activity level is over 1 hour/week (Gutersohn et al., 2000). In the non-pregnant population this SNP appears to interact with physical activity (Grove et al., 2007; Gutersohn et al., 2000; Hauner, Meier, Jockel, Frey, & Siffert, 2003). It has also been associated with hypertension (Dong et al., 1999; Schunkert, Hense, Doring, Riegger, & Siffert, 1998; Siffert et al., 1998), obesity (Danoviz, Pereira, Mill, & Krieger, 2006; Grove et al., 2007), and metabolic syndrome (Siffert, 2005) in the non-pregnant population. A cross-sectional study that examined this SNP and physical activity in an African American sample reported a significant interaction between the T allele and physical activity on obesity (Grove et al., 2007); there was a 20% reduction in obesity for each T allele and conversely, with low levels of physical activity, obesity prevalence increased by 23%. Worldwide measurement of distribution of the 825T allele indicates the percent distribution in the US for Blacks is approximately 70–72% (Siffert et al., 1999). A second report indicates world-wide frequencies of 82% in Africans and 30% in Caucasians (Rosskopf et al., 2002).

Of the obesity related genes, the *FTO* (rs9939609) has been studied to a greater extent than the others. The A allele is the risk allele and for heterozygotes (AT) there appears to be an intermediate effect (Frayling et al., 2007; Song et al., 2008). Findings from extended studies suggest that the *FTO* gene affects insulin resistance (Do et al., 2008; Legry et al., 2009) and is associated with type 2 diabetes (Ng et al., 2008; Yajnik et al., 2009) and increased risk for gestational diabetes mellitus (Cho et al., 2009; Freathy et al., 2008; Huopio et al., 2013; Lauenborg et al., 2009; Yajnik et al., 2009). Furthermore, the *FTO* gene appears to influence eating patterns (Sonestedt et al., 2009; Tanofsky-Kraff et al., 2009; Timpson et al., 2008) and interact with physical activity (Andreasen et al., 2008; Sonestedt et al., 2009). It has also been associated with GWG in thin and obese Caucasian women homozygous for the high risk allele (Stuebe et al., 2010). In pregnant women from the United Kingdom it has been associated with prepregnancy weight and BMI (Lawlor et al., 2011).

Genetic effects on behavioral and health may differ across the life-course. The myriad of biological and behavioral changes that occur during pregnancy can also compound these genetic influences (Wehby & Scholder, 2013). Given the long-term detrimental effects of excessive GWG, increasing our understanding of genetic influences on GWG, a modifiable risk factor for obesity, has implications for the health of women. The purpose of this study was to explore the association of *GNB3* and *FTO* risk alleles in pregnant black women and their prepregnancy BMI, GWG, postpartum weight, and infant birth weights.

Methods

Design and Sample

This study was an observational, prospective candidate gene association study. Following IRB approval we enrolled 97 pregnant low-income black women and followed them from prior to 20 weeks gestation until six months postpartum. Women were included if they were over 18 years of age, entered prenatal care prior to 20 weeks gestation, had a singleton pregnancy and had a prepregnancy BMI greater than 18.5 kg/m^2 and less than 40.0 kg/m^2. Multiple fetuses influence total GWG and the recommendations for GWG are provisional and differ from singleton pregnancies (Rasmussen & Yaktine, 2009). The IOM

recommendations for obese women apply to all women who are obese, but the data are limited for supporting application to women at the highest obesity levels. The prevalence of underweight women in this population is small and they are unlikely to gain excessively during pregnancy (Rassmussen & Yaktine, 2009). Women were excluded if they had a medical or psychiatric condition that could preclude informed consent or medical conditions that could influence weight gain or loss (i.e., diabetes, gastrointestinal problems, hypertension treated with medications). Data were collected prior to 22 weeks gestation, 24–29 weeks gestation, 32–37 weeks gestation during pregnancy and post-pregnancy at 6 weeks and 6 months postpartum.

Measures

Investigators collected demographic characteristics, prepregnancy or early pregnancy weight and height at baseline, and final pregnancy weight. Weight and physical activity were obtained at all data collection time points. Pregnancy and delivery data, along with newborn weights, were abstracted from the medical records after delivery. Prepregnancy BMI was calculated using the medical record abstracted weights and measured heights (kg/m^2).

Gestational weight gain was calculated by subtracting the prepregnancy/early pregnancy weight from the final weight before delivery. If there was a recent weight in the medical record (within 3 months prior to pregnancy) it was used. Alternatively, the first weight obtained after the initiation of prenatal care was used if it was prior to 14 weeks gestation. Although the usual amount of weight gain in the first trimester is relatively small (~1 kg) (Rasmussen & Yaktine, 2009), using early pregnancy weight might slightly underestimate actual gestational weight gain. If the initial weight was obtained after 14 weeks gestation, it was adjusted downward by the estimated average weekly GWG during the second trimester of pregnancy (Rasmussen & Yaktine, 2009).

Physical activity during pregnancy was measured using the Pregnancy Physical Activity Questionnaire (PPAQ), which has been tested in pregnant women and found to have high reliability (r = 0.78–0.93) and established validity (Chasan-Taber et al., 2004). Whether women reported smoking during pregnancy was dichotomized as yes/no.

Genetic data—Oragene DNA self-collection kits (DNA Genotek Corporation, Ottawa, Canada) were used to collect saliva samples at the time of study enrollment. The saliva was purified using the prepIT-L2P plate purification protocol from DNAgenotek. The extracted DNA was then quantified on a NanoDrop 1000 Spectrophotometer and normalized to 15ng/uL for SNP genotyping. 30ng was used for each polymerase chain reaction (PCR). Samples were run in single reactions for each *FTO* and *GNB3* TaqMan SNP genotyping assay. TaqMan Universal PCR Master Mix (No AmpErase UNG), and TaqMan SNP genotyping assays were plated automatically into a 384-well plate using the CAS 1200 robotics system. The real-time PCR reaction was run on Applied BioSystem's (Life Technologies) 7900HT real-time instrument using the software SDS 2.4.1. Immediately after the real-time PCR finished, a post read was completed. SDS 2.4.1 was also used to perform analysis and auto-call genotypes.

Data analysis

Data were analyzed using SPSS (Statistical Package for the Social Sciences) version 20.0. Descriptive statistics included means, standard deviations, frequencies, and percentages. Comparisons of GWG, infant birth weight and 6-month postpartum weight among gene allele combinations were made using Student's t-test. Body mass index was a continuous variable for all analyses and standard categories of underweight (BMI <18.5 kg/m^2), normal weight (BMI ≥ 18.5 kg/m^2 to 24.9 kg/m^2), overweight (BMI ≥ 25.kg/m^2-29.9), and obese (BMI ≥ 30 kg/m^2) were used to categorize prepregnancy BMI.

Following bivariate analyses of all demographic variables and their relationships to prepregnancy BMI, GWG, infant birth weight and 6-month postpartum BMI, linear regression models were used to explore differences based on genotype (controlling for physical activity, age, parity, and smoking), with prepregnancy BMI, GWG, infant birth weight and 6-month postpartum BMI as outcome variables. Level of significance was set at $p < 0.05$. Simple effects analysis was used to examine the *FTO* gene effect on GWG for women in each of the prepregnancy BMI categories.

The associations between the *FTO* gene and physical activity with GWG were estimated using linear regression. Three models were used that included physical activity for each of three measurement time points during pregnancy. Covariates described above were initially included in the models. However, the overall models were not significant with all covariates, so non-significant terms with the highest *p*-values were removed until model significance was reached.

Results

The sample included 97 women of which 89% delivered at term (≥ 37 weeks gestation). Maternal age ranged from 18–36 years old and over two-thirds of the sample were multiparous (Table 1). Mean GWG was 31.5 pounds; two women who were obese prior to pregnancy lost weight, and for those who gained weight during pregnancy the GWG ranged from 7–87 pounds. The SNP genotyping distribution for the *GNB3* and *FTO* alleles is provided in Tables 2. There was no deviation from Hardy-Weinberg equilibrium (HWE: *GNB3* X^2 = .09, df = 1, p = .76; *FTO* X^2 = 2.15, df = 1, p = 0.14). Of the initial bivariate analyses to determine the relationship of demographic factors to GWG, only age and parity were predictive of GWG (p = .017; p = .006 respectively). Bivariate models examining demographics and outcomes of prepregnancy BMI, infant birth weight and 6-month postpartum BMI were not significant.

Association between genotype and prepregnancy BMI, gestational weight gain, infant birth weight and 6-month postpartum BMI

GNB3 gene—Comparison of mean GWG among the *GNB3* allele combinations suggests the heterozygotes (TC) were similar to the risk allele homozygotes (TT) (Table 2). There was a 6-pound higher GWG for CT/TT women compared to CC women. However the difference was not significant (p = .363). When women homozygous for the risk allele (TT) were compared to women without the risk allele (CC) the relationship was non-significant (p

= .295). Six month postpartum BMI was not significantly different depending on genotype, although there was a 2.2 kg/m^2 BMI difference between TT and CC women, with the homozygotes for the risk T allele having a higher BMI. The relationships between genotype and prepregnancy BMI and infant birth weight were not significant.

FTO gene—Gestational weight gain differed depending on number of A alleles (Table 2). Women with two risk alleles (AA) gained more than women with a single or no risk allele. There was a non-significant difference when carriers of the risk allele (AT/AA) were compared to non-risk TT women (p = .17). When homozygotes (AA vs. TT) were compared the difference in GWG was not significant (p = .051).

FTO risk alleles were not associated with prepregnancy BMI. Nevertheless, we tested for an interaction between *FTO* homozygotes and prepregnancy BMI based on previous reports of an interaction effect (Stuebe et al., 2010), and noted that the mean GWGs for each prepregnancy BMI category were different: normal weight = 35 pounds; overweight = 35.1 pounds, and obese = 27 pounds. There was a significant interaction between the *FTO* gene and prepregnancy BMI (Table 3). Subgroup analysis of prepregnancy BMI categories showed a significant difference in the mean GWG of homozygotes for the A risk allele compared to homozygotes for the T allele in obese women (t = 3.03; p = .009); homozygotes (n = 8) for the A risk allele gained 41.5 pounds (SD = 15.8) compared to T homozygotes (n = 8) who gained 19 pounds (SD = 13.9). Yet for these obese women, there was not a statistically significant difference in BMI at 6-months postpartum based on genotype (p = .18), although the mean BMI for non-risk allele (TT) women was 35.8 kg/m^2 compared to 40.0 kg/m^2 for risk allele (AA) women.

Associations between the *FTO* gene and physical activity with GWG were estimated using linear regression. Three models were used, one for each of the three different time points when physical activity was measured during pregnancy. Covariates described above were initially included in the models. However, the overall models were not significant with all covariates included, so non-significant terms with the highest p-values were removed until model significance was reached. For early pregnancy, significance was reached when age, total physical activity and *FTO* (AA or TT) variables were in the final model: 16.5% of the variance in GWG was explained (F [3, 36] = 3.58; p = .023). Controlling for age, the *FTO* gene (homozygotes only) predicted GWG (b = −13.48; p = .007) and physical activity was not significant (b = .053; p = .062).

Similarly, the initial model that included physical activity at mid-pregnancy was not significant. Statistical significance was identified when *FTO*, age, smoking, and physical activity were retained in the model (p = .032), explaining 24.4% of the variance in GWG (Table 4). Controlling for age and smoking, the *FTO* gene (homozygotes only) and physical activity predicted GWG. The model that included physical activity late in pregnancy did not reach statistical significance. There was no interaction between physical activity and the *FTO* homozygotes in any of the models tested.

Discussion

The interaction between the *FTO* gene and prepregnancy BMI suggests that the GWG of obese women homozygous for the A risk allele differs from other women. These women were at greater risk of excessive GWG than obese women who did not carry the risk allele, as well as non-obese women who carried the risk allele. The mean GWG for obese homozygote (AA) women was 22.5 pounds greater compared to non-risk obese homozygote (TT) women. This finding is consistent with that of Stuebe et al. (2010) who reported increased risk of excessive GWG in obese white women. These data suggest that excessive GWG may have contributed to longer-term BMI increase for women carrying the risk alleles since their mean BMI at 6-months postpartum was 4.2 kg/m^2 higher than women carrying the non-risk alleles. If so, for these women, there is an increased risk for the long-term negative health consequences associated with increasing obesity.

There appeared to be an intermediate effect of the *FTO* risk allele on GWG, which is similar to the findings for African American women as reported by Stuebe et al. (Stuebe et al., 2010). However, in our sample there was not an intermediate effect of the *FTO* risk allele on prepregnancy BMI as reported by Lawlor et al. (Lawlor et al., 2011). The sample in that study was from the United Kingdom and the report did not specify racial/ethnic composition. The non-significant finding ($p = .051$) of GWG difference depending on homozygosity for the risk allele as opposed to the non-risk allele suggests that there may be an effect of the *FTO* gene on GWG in black women that could be detected in a larger sample.

In this study, incorporating mid-pregnancy physical activity into the model examining the effects of the *FTO* gene on GWG, as well as controlling for age and smoking, explained the greatest amount of variance in GWG (24.4%). Levels of physical activity were highest earlier in pregnancy and declined from early to late pregnancy, which is consistent with literature regarding physical activity levels during pregnancy (Currie, et al., 2013; Pereira et al., 2007). Yet, mid-pregnancy is the one time point where physical activity had an effect on GWG. Of interest, the positive relationship between mid-pregnancy physical activity and GWG was not in the expected direction. As physical activity (MET-h/week) increased, GWG also increased. On average, women gain about one pound/week during mid-pregnancy and the level of physical activity in these women may have been low enough that it did not counteract the typical weight gain of pregnancy. Two-thirds of homozygote women with a measure of physical activity at mid-pregnancy were homozygous for the risk allele (AA). It is plausible that the genetic influence of this risk allele may have been stronger than the impact of physical activity on GWG. In bivariate analyses physical activity was not an independent predictor of GWG and the *FTO* gene neared significance, which suggests that there may be an interaction effect that could be detected in a larger sample.

In this study the *GNB3* gene was not significantly related to prepregnancy BMI, GWG, infant birth weight, or 6-month postpartum BMI,. nor was there an interaction with physical activity during pregnancy. Yet, in this sample of black women we documented a 6-pound difference in mean GWG between women homozygous for the TT vs. CC alleles, suggesting there may be a relationship between the *GNB3* gene and GWG. This is the only study of the

GNB3 C825T gene that has focused on black women and GWG. In a similar study of white nulliparous women the *GNB3* gene and GWG were significantly related (Gutersohn et al., 2000). In that study the TC/CC combination was compared to homozygous TT women and in our sample GWG in TC women was more similar to TT women than CC women, thus it was not helpful to combine the sample in a similar manner.

Limitations

The limitations of this study warrant consideration. The findings are limited to black women and cannot be generalized to a larger population. The sample size is relatively small for a genetic study and reduced our ability to detect differences in women with different genotypes. However, we did find associations specific to the *FTO* gene consistent with what has been reported in the literature in other populations (Lawlor et al., 2011; Stuebe et al., 2010). By including only homozygotes in our statistical models we were able to identify differences not seen when the intermediate effect of heterozygotes was present. Findings related to the *GNB3* gene were limited by the small number of homozygote women with the non-risk allele although a non-significant difference in GWG was evident. Furthermore, results for 6-months postpartum were questionable due to the limited sample size of *GNB3* CC and *FTO* TT women at 6-months postpartum (n=4).

Conclusion and Implications for Clinical Practice

In summary, we identified that obese women homozygote for the *FTO* risk allele were at greater risk for excessive GWG compared to either non-risk allele homozygote obese women or non-obese women. Furthermore, in models examining the *FTO* gene effect on GWG, the addition of physical activity in mid-pregnancy improved the explanation of GWG.

Obese women are known to be at greater risk of gaining excessively during pregnancy (Rasmussen & Yaktine, 2009) although it is not known why this is so. Knowing that excessive GWG could be related to *FTO* risk allele status, as opposed to behavioral influences alone, can help to guide how nurses approach and manage GWG in obese women. The opportunity to create specific GWG guidelines for obese women homozygous for the *FTO* risk allele could improve management of their GWG and consequently decrease their pregnancy-related health risks. The possibility of predicting which obese women are more likely to gain excessively during pregnancy could allow nurses and other care providers to provide the best targeted guidance on GWG for each woman, thereby improving outcomes for both mother and infant. Personal health planning, or individual guidance, has been found to be effective for weight reduction with postpartum women following excessive GWG (Yang, Wroth, Parham, Strait, & Simmons, 2013) and individual guidance based on genetic information may be useful during pregnancy to prevent excessive weight gain. Black women perceive a need for information on appropriate GWG and safe physical activity (Shieh & Weaver, 2011). Nurses could provide this information and guidance based on genetic predisposition.

Physical activity, specifically during mid-pregnancy, influenced GWG but not as expected. Further research is warranted to understand the relationship of physical activity with the

FTO gene, as well as its clinical relevance to GWG. Physical activity may affect GWG depending on genetic risk, but is recommended during pregnancy for all women (ACOG, 2002) and improves pregnancy outcomes (Currie, et al., 2013). Prior work suggests low-income women would welcome learning how to increase their physical activity from care providers (Yeo & Logan, 2014). Nurses are positioned to motivate pregnant women and provide information on how they can stay active.

The ability to detect genetic associations with complex disease entities such as obesity has proved to be challenging, with a relatively small amount of the overall genetic risk of obesity being explained. The risk alleles that have been identified in candidate gene association studies and in genome wide association studies (GWAS) have proven to have small effect sizes. Building evidence of genetic effects on obesity requires replication of findings across multiple samples and populations. This study adds to the science by providing evidence of the *FTO* gene's effect on GWG in black women.

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Table 1

Demographic Data

Variable	N (%)
Age (years)	
• <20	23 (24)
• 20–30	66 (68)
• >30	8 (8)
Education (grade range = 3–16 years)	
• Some elementary school	4 (4)
• Some high school	39 (40)
• Completed high school	33 (34)
• Beyond high school	21 (22)
Parity	
• Primiparous	30 (31)
• Multiparous	67 (69)
Gestation	
• Preterm (< 37 weeks)	11 (11.3)
• Term (≥ 37 weeks)	86 (88.7)
Marital status	
• Married	7 (7)
• Single with partner	67 (69)
• Never married, no partner	22 (23)
• Separated	1 (1)
Insurance	
• Public	87 (90)
• Private	10 (10)
Smoked	23 (24)
Variable	**Mean (SD)**
Prepregnancy body mass index (BMI): kg/m^2	28.6 (5.5)
Gestational weight gain: pounds	31.5 (16.2)
Infant birth weight (full term): grams	3326 (423)
BMI change: 6 mo. postpartum BMI - prepregnancy BMI	2.1 (3.0)
Physical activity during pregnancy (MET-hours/week)	
• < 22 weeks gestation	286.3 (120.9)
• ≥ 22 & ≤ 29 weeks gestation	249.8 (96.3)
• ≥ 32 weeks gestation	233.3 (100.6)

Note. $N = 97$

Table 2

Distribution of GNB3 and FTO Genotype, Body Mass Index (BMI) and Weight Change

	***GNB3* alleles**		
	TT	**TC**	**CC**
Allele frequency	43	35	8
Prepregnant BMI (kg/m^2)	28.1 (4.9)	28.8 (5.9)	29.1 (7.3)
Gestational Weight Gain (pounds)	32.9 (15.5)	32.8 (18.1)	26.9 (9.0)
Infant birth weight (grams)	3363 (402)	3293 (438)	3276 (507)
6-month postpartum BMI (kg/m^2)	30.1 (5.9)	30.6 (7.3)	27.9 (11.5)
	FTO alleles		
	AA	AT	TT
Allele frequency	27	31	16
Prepregnant BMI (kg/m^2)	27.8 (5.7)	30.3 (4.9)	29.9 (4.8)
Gestational Weight Gain (pounds)	36.3 (13.2)	31.0 (18.1)	27.1 (16.6)
Infant birth weight (grams)	3353 (420)	3320 (442)	3416 (468)
6-month postpartum BMI (kg/m^2)	30.3 (7.9)	31.8 (6.2)	31.5 (5.1)

Note: Full-term deliveries only

Table 3

Prepregnancy BMI and FTO Gene Interaction

	Gestational weight gain		
		Model 2	
Variable	**Model 1 *B***	***B***	**95% CI**
Constant	48.76	32.48	[5.001, 59.95]
FTO AA vs. TT	−8.27	50.67	[−2.700, 104.035]
Prepregnancy BMI	.139	-.963	[-.829, 1.107]
FTO x prepregnancy BMI		−2.01*	[−3.805, −.216]
R^2 (adjusted)	.07		.16
F	2.58**		3.61*
ΔR^2 (adjusted)			.09
ΔF			1.03

Note: n = 42. CI = confidence interval

* p< .05;

** p < .10

Table 4

Predictors of Gestational Weight Gain in Women Homozygous for the FTO Gene

	Gestational weight gain		
		Model 2	
Variable	**Model 1 *B***	***B***	**95% CI**
Constant	39.87	37.551	[10.994, 64.108]
FTO	−16.53**	3.63	[−31.023, 38.290]
Age	-.739	-.963	[−2.115, 0.189]
Smoked during pregnancy	4.404	6.25	[−7.468, 18.456]
Physical activity (PA) mid-pregnancy	.069*	.102*	[0.019, 0.185]
PA mid-pregnancy x FTO		.214	[−0.216, 0.051]
R^2 (adjusted)	.244		.26
F	3.174*		2.936*
ΔR^2 (adjusted)			.02
ΔF			0.238

Note: n = 27. CI = confidence interval

* p< .05;

** p< .01