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Higher infant body fat with excessive gestational weight gain in overweight women

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Abstract

Objective—Gestational weight gain (GWG) is positively associated with birth weight and maternal pre-pregnancy BMI is directly related to infant fat mass (FM). This study examined whether differences exist in infant body composition based on 2009 GWG recommendations.

Study Design—Body composition was measured in 306 infants and GWG was categorized as appropriate or excessive. Analysis of covariance was used to investigate the effects of GWG and pre-pregnancy BMI and their interaction on infant body composition.

Results—Within the appropriate group, infants from obese mothers had greater percent fat (%fat) and FM than offspring from normal and overweight mothers. Within the excessive group, infants from normal mothers had less %fat and FM than infants from overweight and obese mothers. A difference was found for %fat and FM within the overweight group between GWG categories.

Conclusions—Excessive GWG is associated with greater infant body fat and the effect is greatest in overweight women.

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Keywords

gestational weight gain; IOM recommendations; newborn body composition; pregnancy

Introduction

The prevalence of obesity has increased among obstetric populations ^{1, 2} and in the same decades the rates of overweight among children and adolescents have increased. The increasing prevalence of maternal obesity instigates a vicious cycle: obese women give birth to children who developed in an altered *in utero* environment predisposing them to develop childhood obesity, metabolic syndrome and diabetes. That is, as an adult a female offspring has a greater probability of being obese and developing diabetes thus exposing her fetus to an altered *in utero* environment that in turn pre-programs the fetus to become obese, insulin resistant and diabetic. ^{3, 4}

Pre-pregnancy body weight of the mother and total gestational weight gain (GWG) are recognized factors that contribute to infant size, fatness at birth, and future health risk. ⁵ As Figure 1 suggests, maternal obesity can directly and indirectly influence the future risk of obesity and disease development. Evidence suggests a direct relationship between mother's pre-pregnancy BMI and infant fat mass at birth ^{6, 7} and a positive relationship between gestational weight gain (GWG) and birth weight. ^{8, 9} An infant with a greater birth weight is more likely to be overweight in childhood ⁵ and have a greater BMI in adulthood. ^{10, 11} Further, research has found a direct relationship between infant body fat and childhood body fat. ¹²

The Institute of Medicine (IOM) and the National Research Council in collaboration with the Food Nutrition Board and Board on Children, Youth and Families recently updated the 1990 guidelines for weight gain during pregnancy. Two studies found direct relationships between maternal pre-pregnancy BMI and infant fat mass (FM) ^{6, 7} and one recent study has found an association between excessive weight gain in pregnancy and infant FM. ¹² To date, there has been no report of how infant FM differs from mothers that gain an appropriate or excessive amount of gestational weight gain when classified by their pre-pregnancy BMI. The purpose of this study was to determine if differences exist in infant body composition between women gaining an appropriate versus excessive amount of weight during pregnancy, based on the 2009 IOM GWG recommendations.

Materials and Methods

Subjects

Three-hundred and six full-term healthy infants (163 males and 143 females) participated in the study. The subjects were recruited at Roosevelt Hospital in midtown Manhattan. The study was approved by the St. Luke's-Roosevelt Hospital Institutional Review Board (IRB# 06-016; approval date: January 2007). A written consent was obtained from a parent before participation.

Race was determined by self identification of each subject from the following four categories: Asian, non-Hispanic Black (African American), non-Hispanic White, and Hispanic. Subjects were asked to select the category into which each parent and grandparent fell. When all categories were the same, the subject was identified by that category. When multiple categories were selected, the individual was classified as "other". In the current sample, the maternal race/ethnic distribution was as follows: 143 Caucasian, 37 African American, 70 Hispanics, 47 Asian and 9 "other".

Study Procedures

Subjects were recruited while inpatient at Roosevelt Hospital from the maternity floors. Inclusion criteria for the study included newborns that were healthy with no known birth defects, congenital abnormality or an admission to the NICU, a singleton birth and full term (>37 weeks). Mothers diagnosed with gestational diabetes, hypertension or pre-eclampsia were excluded. Anthropometric measurements and body composition assessment were conducted prior to infant discharge between 1-2 days after birth. Measurements were not taken during the first twenty-four hours (day 0) because pilot data from eight infants collected in our laboratory suggests that there may be an initial weight loss during this period. For these eight infants, the mean (standard deviations) weights measured during days 0, 1, and 2, were 3286 g (680 g), 3163 g (669 g), and 3136 g (682 g), respectively. Using a repeated measures analysis of variance, the mean weights at days 1 and 2 were significantly less than the mean weight at day 0 ($p < 0.0001$), however, the mean weights at days 1 and 2 were not significantly different from each other ($p=0.2679$). Our sample size was not sufficient to include women who had a pre-pregnancy underweight BMI or who gained below what was recommended for weight during pregnancy. Twenty-two mothers had an underweight pre-pregnancy BMI of which 8 gained below recommended weight during pregnancy, 9 gained an appropriate amount and 5 gained an excessive amount. For a pre-pregnancy BMI of normal, overweight and obese, 70 (21%), 2 (2%) and 10 (16%), respectively, gained below recommended weight during pregnancy.

Presented in Table 1 are the IOM 2009 GWG recommendations. Based on their pre-pregnancy BMI, women were classified as gaining an appropriate or excessive amount of weight. When a woman gained within the recommended range for their pre-pregnancy BMI, she was classified as appropriate. When she gained greater than the recommended amount of weight, she was classified as gaining an excessive amount of weight. Gestational weight gain was calculated using inpatient-chart extracted pre-pregnancy weight when possible or self reported pre-pregnancy weight and the self reported highest weight measured during pregnancy. Good agreement has been reported between maternal recall of pre-pregnancy weight and medical records for pre-pregnancy weight^{13, 14} such that recall of maternal pre-pregnancy weight is considered a satisfactory substitute when chart extraction is incomplete.¹⁴

Air Displacement Plethysmography (PEA POD®)

An infant board (Shorr Productions) was used to measure body length to the nearest 0.1 centimeter. Two measurements of body length were taken for each infant and an average of the measurements was used. The Pea Pod® Body Composition System (Life Measurement Instruments, Concord, CA) was used to measure body volume. The Pea Pod® was calibrated once daily prior to beginning testing. A calibration cylinder with a known volume was used to calibrate the chamber and a 5000 g weight was used to calibrate the scale. Testing procedures have been described in detail elsewhere¹⁵. Infants were undressed and wore a standard tight fitting hat (Allentown Scientific Associates, INC.) to minimize air trapped in the hair, for body volume and body weight measurements. The infant was placed naked on the scale and a body weight was obtained to the nearest 0.0001 kg. Any irremovable items such as the umbilical clamp and identification bands were tared for the body weight and body volume measurements. After body weight was measured, the infant was placed inside the Pea Pod® wearing a wig cap, and a body volume measurement was performed. Assessment of the body volume required approximately 2 minutes. Body density was then converted to percent fat (%fat) using gender specific equations by Foman.¹⁶

Prior studies^{17, 18} have shown the Pea Pod is a valid tool to measure %fat when compared to the gold standard 4 compartment model (4C)¹⁷ and deuterium¹⁸, where no differences

were found for %fat between the Pea Pod and the 4C model ($16.9 \pm 6.5\%$ and $16.3 \pm 7.2\%$, respectively) or between the Pea Pod and deuterium dilution ($20.32 \pm 6.87\%$ and $20.39 \pm 6.68\%$, respectively). Ellis explored the contribution of the variation in hydration, protein and bone mineral fractions on the differences between %fat from the Pea Pod versus a 4C model.¹⁷ The bone mineral fraction explained the greatest variation (16%); the protein and hydration fractions explained an additional 0.2% and 0.1%, respectively. The mean age of the infants in these prior validation studies was ~8 weeks (range 0.4 to 23.0 weeks) which is older than the current study population.

Statistical Analysis

Analysis of covariance was used to investigate the main effects of GWG category and pre-pregnancy BMI category and their interaction on infant body composition (percentage body fat, fat mass (FM) and fat-free mass (FFM)). Percentage body fat (%fat) is defined as the percentage of body mass comprised as fat mass; i.e., the relative amount of fat mass taking body mass into consideration ($100 \times [\text{FM g} / \text{Body mass (g)}]$). For all models, the covariates were infant gender, infant age (days), gestational age, maternal race/ethnicity and maternal age. Infant weight was not considered as a covariate for the analyses of the effects of GWG category and pre-pregnancy BMI category on FM and FFM, as infant weight itself may be affected by these two variables. That is, if the analysis were to adjust for infant weight, it could artificially remove the effects of the GWG and pre-pregnancy BMI on FM or FFM. Covariates should never be influenced by the factors being studied. By definition, %fat is the proportion of the infant's weight that is fat; therefore, %fat was also analyzed to determine the effects of GWG and pre-pregnancy BMI on the composition of the infant's weight. Significant main effects and interactions were investigated further using pair wise comparisons. Fisher's Protected Least significant difference (LSD) was used to test differences for multiple comparisons. For each model, a residual analysis was performed to determine if the distribution of the residuals were consistent with the assumptions required to perform the analysis of covariance. Data were analyzed using SPSS (version 17; SPSS Inc, Chicago, IL). Statistical significance was set at $p < 0.05$.

Results

Maternal characteristics are presented in Table 2 and infant characteristics are presented in Table 3. The maternal race/ethnic distribution was 47% Caucasian, 12% African American, 23% Hispanic, 15% Asian, and 3% classified as other. Presented in Table 4 are descriptive statistics for gestational weight gain by pre-pregnancy BMI group and by GWG category (appropriate versus excessive). Overall, 53% of the sample gained an excessive amount of weight which varied by pre-pregnancy BMI category. Approximately 40% of normal weight mothers gained an excessive amount of weight whereas over 70% of overweight and obese mothers gained an excessive amount of weight.

Percent body fat

There was a significant interaction between GWG category and pre-pregnancy BMI ($p = 0.0163$); therefore, pair wise comparisons among the adjusted means of the GWG categories are reported for each pre-pregnancy BMI category and pair wise comparisons among the pre-pregnancy BMI categories are reported for each GWG category. The adjusted mean %fat by GWG category and pre-pregnancy BMI category are given in Table 5a. Differences in %fat between pre-pregnancy BMI categories for each GWG category were found. For women within the appropriate GWG category, infants born to obese mothers had greater %fat (14.6%) than infants born to normal weight (11.2%; $p = 0.014$) and overweight mothers (9.2%; $p < 0.002$). For women within the excessive GWG category, infants born to normal weight mothers had lower %fat (11.8%) than infants born to overweight mothers

(13.7%; $p=0.019$) and obese mothers (14.2%; $p=0.011$). Table 5b presents the adjusted differences in %fat between GWG categories for each pre-pregnancy BMI category. For women classified as overweight by pre-pregnancy BMI, infants born to mothers gaining an excessive amount of weight had greater %fat (13.7%) than infants born to mothers with an appropriate weight gain (9.2%; $p=0.001$).

Fat mass

There was a significant interaction between GWG category and pre-pregnancy BMI ($p=0.0337$); therefore, pair wise comparisons among the adjusted means of the GWG categories are reported for each pre-pregnancy BMI category and pair wise comparisons among the pre-pregnancy BMI categories are reported for each GWG category. The adjusted mean FM by GWG category and pre-pregnancy BMI category are given in Table 6a. Differences in FM between pre-pregnancy BMI categories for each GWG category were found. For women within the appropriate GWG category, infants born to obese mothers had greater FM (472.9 g) than infants born to normal weight (355.5 g; $p=0.041$) and overweight mothers (303.6 g; $p<0.018$). For women within the excessive GWG category, infants born to normal weight mothers had lower FM (388.9 g) than infants born to overweight mothers (484.4 g; $p=0.004$) and obese mothers (486.4 g; $p=0.012$). Table 6b presents the adjusted differences in FM between GWG categories for each pre-pregnancy BMI category. For women classified as overweight by pre-pregnancy BMI, infants born to mothers gaining an excessive amount of weight had greater FM (484.4 g) than infants born to mothers with an appropriate weight gain (303.6 g; $p=0.001$).

Fat-free mass

There was no significant interaction between GWG category and pre-pregnancy BMI ($p=0.9338$). The adjusted mean FFM by GWG category and pre-pregnancy BMI category are given in Table 7. The main effect of pre-pregnancy BMI category was not significant ($p=0.1315$) which suggests that the adjusted mean FFM does not vary by pre-pregnancy BMI category. There was a significant main effect of GWG category ($p=0.0131$). Infants born to mothers gaining an excessive amount of weight have greater FFM (2912.8 g) than infants born to mothers with an appropriate weight gain (2797.0 g; $p=0.0131$).

Comment

The greatest difference in infant FM was found between overweight women gaining excessive weight versus overweight women gaining an appropriate amount of weight. Obese mothers regardless of whether they gained an appropriate or excessive amount of weight, had infants with greater FM than any other group in the sample. Infant FM did not differ between overweight or obese mothers that gained excessive weight. Interestingly, no difference in infant FM was found between overweight and normal weight mothers gaining an appropriate amount of weight. This is the first study to report on the interactive effect between GWG and pre-pregnancy BMI on infant body composition and results suggest the most effective and beneficial time to intervene varies by pre-pregnancy BMI.

Crozier and colleagues¹² reported an association between excessive GWG and fat mass at birth ($\beta=0.17$, $p=0.03$) in a sample of 566 mother-infant pairs participating in the Southampton Women's Survey. The analysis examined the relationship between infant FM and GWG as a continuous and categorical variable (inadequate, adequate and excessive). However, from their results it could not be concluded if the relationship between GWG and infant FM differed by each category of pre-pregnancy BMI. Our results build on Crozier and colleagues findings and suggest the relationship between infant FM and GWG varies by pre-pregnancy BMI.

Studies have reported a direct relationship between pre-pregnancy BMI and infant FM^{6, 7} however the independent or interactive effect of GWG was not reported. Both studies collapsed the overweight and obese categories into one group. One study⁶ tested 33 infants from normal weight mothers and 39 from overweight/obese mothers with infant body composition measured using the Pea Pod®. Infants born to overweight/obese mothers had greater %fat and FM but less FFM. Sewell and colleagues⁷ recruited 220 newborns (76 from normal weight mothers and 144 from overweight/obese mothers) and found infants born to overweight/obese mothers had greater %fat and FM but no difference between groups was found for FFM.

Evidence suggests a relationship between GWG and birth weight. Data¹⁹ from the Women, Infants and Children (WIC) program in Sioux City, Iowa found significant main effects for pre-pregnancy BMI and GWG. Dietz and colleagues²⁰ analyzed data from the Pregnancy Risk Assessment Monitoring System (PRAMS) and found as pre-pregnancy BMI and GWG categories increased so did the adjusted odd ratio for delivering a large for gestational age infant. Within the normal weight, overweight and obese pre-pregnancy BMI categories, those gaining excessive GWG had a 1.6-1.9 higher adjusted odd ratio of delivering a large for gestational age infant.

Previous research has studied an interactive effect of GWG and pre-pregnancy body weight on birth weight.^{8, 19, 21} Kanadys and colleagues⁸ found pre-pregnancy body weight and GWG to independently affect birth weight in a linear manner, although the influence of weight gain was diminished as pre-pregnancy body weight increased. Both the Sioux City, Iowa WIC¹⁹ and the PRAMS²⁰ datasets showed significant main effects for pre-pregnancy BMI and GWG, however no interaction was detected. Crane et al.²¹ reported within the normal weight, overweight and obese categories, gaining an excessive amount of weight increased the rate of birth weights >4000 g compared to women gaining an appropriate amount of weight.

In mother's who gained an excessive amount of weight, their infant FFM was greater than infants born to mother's that gained an appropriate amount of weight. Few data exists on how the compartments of weight gain change during pregnancy (fat, fat-free mass or water) and to our knowledge, no previous study has examined how changes in the compartments of weight gain relate to infant fat or FFM. Forsum et al.²² assessed maternal body composition in 23 women at pre-conception, at week 32 of pregnancy and 2 weeks postpartum. Skinfolds were measured at ten sites on the infant at birth and infant birth weight was recorded. Multiple regression was used to predict infant birth weight using maternal and infant characteristics. In one model, maternal total body fat and the average of the 10 infant skinfolds explained 61% of the variability in birth weight while a second model including maternal body fat at week 32 and the average of the 10 infant skinfolds explained 63% of the variability in birth weight. Infant body composition was not measured therefore relationships between maternal body composition and infant body composition were not reported. It is likely that the composition of maternal weight gain is related to infant body composition. Further research is needed to clarify this relationship.

Strengths and Weaknesses

There are several strengths of this study. First, direct relationships between infant FM and childhood FM¹² point to the need for an accurate assessment of body composition in the immediate postnatal period for a better understanding of growth and health. Our data were collected within the first few days of life and are devoid of the potential confounding influences of the post-natal environment on body composition, such as mode of feeding (breast or formula). The sample size is another strength of this study. We analyzed the overweight and obese categories as independent groups rather than collapsing them into one

group as prior studies have done.^{6,7} This is important when looking at the interaction between GWG and pre-pregnancy BMI as our results show that the effect of GWG is different for overweight versus obese women.

There are limitations to this study. When assessing the effect of gestational weight gain, the total weight gained throughout pregnancy was used however, this may mask more subtle relationships. This method does not allow for investigation of how the rate of weight gain or how weight gained during specific periods of development or trimesters impacts infant body composition. It has been suggested that weight gained during early pregnancy reflects an accumulation of maternal fat stores whereas weight gain late in pregnancy better reflects fetal growth.²³ Data from famine studies clearly show altered nutrition during critical windows of development in pregnancy have differing outcomes for the offspring.^{24,25} Women experience different patterns of weight gain during pregnancy and weight does not always increase linearly as pregnancy progresses.²⁶ It is unknown whether it is the specific time during pregnancy (early versus late) or the rate at which weight increases during pregnancy, is more important for determining infant body composition. Our study design does not allow for exploration of these questions. Future studies assessing weight change in pregnancy at pre-determined time points and including frequent assessments are needed.

Clinical Application

The cycle of maternal obesity influencing the development of childhood obesity is outlined in Figure 1. Pinpointing specific windows to intervene that could have the greatest potential to cease the perpetuation and impact the development of obesity is imperative. Our data suggests the critical window to intervene varies by pre-pregnancy BMI. Three groups of women are at risk of having infants with the greatest amounts of FM: overweight mothers gaining an excessive amount of weight and obese mothers gaining an appropriate or excessive amount of weight. In overweight women, the critical window to intervene would be during pregnancy to promote a healthy weight gain. For obese women the critical window to intervene would be prior to conception to promote a healthy body weight. The excessive weight gain in our overweight and obese mothers highlights the need for focused nutritional advice and care during pregnancy to promote an appropriate weight gain. Appropriate weight gain in these groups might lead to less FM and %fat in their infants, thus improving long term health.

Conclusion

As infant FM has been found to be related to FM in childhood, determining critical windows for intervention to positively influence infant body composition is important. Our data suggests the most beneficial time to intervene to influence infant body composition differs according to maternal pre-pregnancy BMI. Future research is needed to clarify the relationship between maternal and infant adiposity where mothers are phenotyped prior to pregnancy versus using pre-pregnancy BMI as a surrogate measure of maternal adiposity. Investigation of the effects of central versus peripheral fat patterning on infant adiposity is also needed.

Condensation

Gaining excessive weight is associated with greater infant body fat at birth and the effect is greatest in overweight women.

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Figure 1.
Flow chart depicting the relationships between maternal factors and offspring immediate and later health.

Table 1

2009 Institute of Medicine (IOM) gestational weight gain recommendations.

Pre-pregnancy body mass index (kg/m ²)	Gestational weight gain (kg) (lbs)
Underweight (<18.5 kg/m ²)	12.5 – 18 (28 – 40)
Normal (18.5 kg/m ² – 24.9 kg/m ²)	11.5 – 15.9 (25 – 35)
Overweight (25.0 kg/m ² – 29.9 kg/m ²)	7 – 11.5 (15 – 25)
Obese (≥30.0 kg/m ²)	5 – 9 (11 – 20)

Table 2

Maternal characteristics for the total sample and each pre-pregnancy BMI group.

	Total (n=306)	Normal (n=210)	Overweight (n=59)	Obese (n=37)
Age (years)	31.9 ± 5.4	32.0 ± 5.5	32.4 ± 5.2	30.0 ± 4.6
Height (cm)	163.6 ± 7.1	164.0 ± 6.8	163.7 ± 7.8	161.5 ± 7.3
Pre-pregnancy body weight (kg)	64.9 ± 12.7	58.5 ± 6.0	73.2 ± 8.2	87.6 ± 13.1
Pre-pregnancy BMI (kg/m²)	24.2 ± 4.4	21.7 ± 1.7	27.2 ± 1.4	33.4 ± 3.2
Gestational weight gain (kg)	15.9 ± 4.9	16.3 ± 3.8	15.5 ± 6.7	14.4 ± 6.7

Means ± standard deviation

Table 3

Infant characteristics for the total sample and each pre-pregnancy BMI group.

	Total (n=306)	Normal (n=210)	Overweight (n=59)	Obese (n=37)
Age (weeks)	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
Gestational age (weeks)	39.6 ± 1.3	39.7 ± 1.2	39.3 ± 1.4	39.4 ± 1.4
Body mass (g)	3250.7 ± 451.8	3208.8 ± 422.6	3354.3 ± 559.9	3323.2 ± 392.3
Length (cm)	49.7 ± 2.5	49.6 ± 2.5	49.9 ± 2.5	50.0 ± 2.5
Body fat (%)	12.3 ± 4.4	11.7 ± 4.1	13.0 ± 4.7	14.6 ± 4.3
Fat mass (g)	408.5 ± 179.7	382.4 ± 165.7	450.9 ± 216.3	489.6 ± 158.7
Fat-free mass (g)	2842.2 ± 346.8	2826.5 ± 330.4	2903.3 ± 407.4	2833.6 ± 332.1

Means ± standard deviation

Table 4

Gestational weight gain (GWG) for the overall group and by pre-pregnancy maternal BMI.

	Appropriate n (%)	Excessive n (%)
	GWG (kg)	
Total Group	144 (47%) 12.9 ± 2.4	162 (53%) 18.6 ± 4.9
Normal	119 (57%) 13.7 ± 1.5	91 (43%) 19.7 ± 3.2
Overweight	15 (25%) 9.7 ± 1.1	44 (75%) 17.5 ± 6.6
Obese	10 (27%) 7.4 ± 1.2	27 (73%) 17.1 ± 5.9

Means ± standard deviation

Table 5a

Infant percent body fat (%) Adjusted Means ($\pm$ Standard Error) by pre-pregnancy BMI and gestational weight gain categories.

Pre-pregnancy BMI	Gestational Weight Gain	
	Appropriate	Excessive
Normal	11.2 $\pm$ 0.5	11.8 $\pm$ 0.5
Overweight	9.2 $\pm$ 1.1	13.7 $\pm$ 0.7
Obese	14.6 $\pm$ 1.4	14.2 $\pm$ 0.8

Adjusted for infant gender, gestational age, infant age, maternal race/ethnicity and maternal age

Table 5b

Adjusted difference (Standard Error) for infant percent body fat (%) between gestational weight gain categories by pre-pregnancy BMI categories

Pre-pregnancy BMI	Gestational Weight Gain Comparison	
	Appropriate - Excessive	
	Difference	P value
Normal	-0.6 (0.6)	0.293
Overweight	-4.4 (1.3)	0.001
Obese	0.4 (1.6)	0.789

Adjusted for infant gender, gestational age, infant age, maternal race/ethnicity and maternal age

Table 6a

Infant body Fat (g) adjusted means ($\pm$ Standard Error) by prepregnancy BMI and gestational weight gain categories.

Pre-pregnancy BMI	Gestational Weight Gain	
	Appropriate	Excessive
Normal	355.5 $\pm$ 20.1	388.9 $\pm$ 21.9
Overweight	303.6 $\pm$ 46.1	484.4 $\pm$ 28.8
Obese	472.9 $\pm$ 56.0	486.4 $\pm$ 33.5

Adjusted for infant gender, gestational age, infant age, maternal race/ethnicity and maternal age

Table 6b

Adjusted difference (Standard Error) for infant fat mass (g) between gestational weight gain categories by pre-pregnancy BMI categories

Pre-pregnancy BMI	Gestational Weight Gain Comparison	
	Appropriate - Excessive	
	Difference	P value
Normal	-33 (24)	0.160
Overweight	-181 (52)	0.001
Obese	-13 (64)	0.834

Adjusted for infant gender, gestational age, infant age, maternal race/ethnicity and maternal age

Table 7

Infant fat free mass (g) adjusted means ($\pm$ Standard Error) by prepregnancy BMI and gestational weight gain categories.

Pre-pregnancy BMI	Gestational Weight Gain	
	Appropriate	Excessive
Normal	2758.7 $\pm$ 32.8	2856.6 $\pm$ 35.7
Over Weight	2839.7 $\pm$ 75.3	2968.8 $\pm$ 47.0
Obese	2792.5 $\pm$ 91.5	2913.2 $\pm$ 54.7

Adjusted for infant gender, gestational age, infant age, maternal race/ethnicity and maternal age