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Gestational Weight Gain in Adolescents: A Comparison to the New Institute of Medicine Recommendations

I.D. Fernandez, MD, MPH, PhD^{1,*}, C.A. Hoffmire, BS¹, and C.M. Olson, PhD²

¹ Division of Epidemiology, Department of Community and Preventive Medicine, University of Rochester School of Medicine and Dentistry, Rochester, NY

² Division of Nutritional Sciences, Cornell University, Ithaca, NY

Abstract

Study Objective—To examine the gestational weight gain distributions of healthy adolescents with optimal birth outcomes and compare them to the current 2009 Institute of Medicine (IOM) recommendations.

Design—Secondary data analysis to conduct a population-based, cross-sectional study.

Setting—The Central and Finger Lakes regions of New York state (Perinatal Database System).

Participants—6995 adolescents with healthy singleton pregnancies (1996 to 2002).

Main Outcome Measures—Percentiles of the gestational weight gain distributions were compared within body mass index (BMI) groups categorized using 2 different classification schemes: adolescent BMI percentiles and adult BMI cut-points. We compared these distributions overall and within racial and age groups.

Results—The gestational weight gain distribution does not differ considerably when BMI is classified using adolescent or adult cutoffs. Adolescents have good birth outcomes across a wider gestational weight gain range than recommended by the Institute of Medicine regardless of how pre-pregnancy weight status is categorized. For example, overweight adolescents by adult cutoffs have a range of gestational weight gain from 5.0 kg to 30.0 kg, and overweight adolescents by percentile cutoffs have a range from 5.4 kg to 29.5 kg, whereas the IOM range is 7.5–11.5 kg. Black and young adolescents have a similar distribution to their white and older counterparts.

Conclusion—Practitioners can safely use the new IOM gestational weight gain ranges to monitor weight gain in pregnant adolescent patients using adult BMI classifications. Future research should examine the range of gestational weight gain in adolescents considering a broader scope of birth and maternal outcomes.

Keywords

Adolescent; Pregnancy in adolescence; Pregnancy; Gestational weight gain; Body mass index; Pre-pregnancy weight status; Recommendations

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* Address correspondence to: Isabel D. Fernandez, MD, MPH, PhD, Division of Epidemiology, Department of Community and Preventive Medicine, University of Rochester School of Medicine and Dentistry, 265 Crittenden Blvd., CU 420644, Rochester, NY 14642-0644; phone: (585) 275-9554; fax: (585) 461-4532. Diana_Fernandez@urmc.rochester.edu (I.D. Fernandez)..

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Introduction

To date, there are no empirically derived gestational weight gain (GWG) recommendations for adolescents. In 1990, the Institute of Medicine (IOM) recommended increases in GWG for all women in order to prevent intrauterine growth retardation. For the first time, the recommendations took into account pre-pregnancy weight status since previous studies had found different effects of weight gain during pregnancy on fetal growth according to maternal pre-pregnancy body mass index (BMI).^{1–5} In 2009, updated IOM recommendations were published based on a comprehensive review of published and commissioned research. The research assessed important short- and long-term health consequences for mother and child believed to be related to GWG.⁶ The differences between the old and new IOM recommendations are: (1) the 2009 recommendations considered maternal and infant outcomes (namely, cesarean deliveries, postpartum weight retention, preterm birth, large and small for gestational age, and childhood obesity), whereas the 1990 recommendations only considered low birthweight; (2) the 2009 recommendations used the WHO criteria for adult BMI categories, whereas the 1990 recommendations used the Metropolitan Life Insurance Company classification from 1959¹; (3) the 2009 recommendations added a GWG range for obese women that was lacking in the previous guidelines; and (4) the new recommendations do not call for a modification of the GWG for adolescents and black women as the 1990 recommendations did. The lower and upper end of the recommended GWG ranges for all but the obese BMI group are the same as those set in 1990, since subsequent research supported the robustness of those guidelines.⁶

One unanswered question in both the 1990 and the 2009 recommendations is whether adult criteria (pre-pregnancy BMI and GWG recommendations) are appropriate for adolescents. The 1990 report suggested that young adolescents (within 2 years of menarche) gain on the upper end of the recommended ranges for adults to prevent intrauterine growth retardation. In 2006, a National Research Council and IOM workshop⁷—Influence of Pregnancy Weight on Maternal and Child Health—recognized the lack of evidence regarding the appropriateness of the adult criteria for adolescents. Consequently, the 2009 report considered the effect of using adult BMI categories and GWG ranges for adolescents and found insufficient evidence to support a modification of the GWG guidelines for this age group. The report recognized that some adolescents would be misclassified into lower pre-pregnancy BMI categories and assigned into larger target weight gain ranges when adult BMI categories were used instead of the Center for Disease Control and Prevention (CDC) age- and sex-specific BMI percentile categories for children and adolescents.⁸ The report concluded that this was a tolerable risk, since adolescents need to gain more weight than adults to achieve comparable infant birth weights. Additionally, obstetric practices may find it difficult to use pediatric growth charts.

Research on adolescents has documented an increased risk of poor birth outcomes (low birthweight, small for gestational age, prematurity, and perinatal mortality),^{9–13} although evidence is contradictory regarding the role of gestational weight gain on those outcomes.^{14–20} Additionally, 18- and 19-year-old adolescents may be at an increased risk of postpartum weight retention compared to adult women,²¹ a problem that could be exacerbated by gaining more than the recommended amount of weight during pregnancy.

To assess the appropriateness of the GWG recommendations for adolescents, we examine the distributions of GWG by pre-pregnant weight status, determined using both adolescent and adult BMI criteria, in a sample of healthy adolescents with optimal birth outcomes. Specifically, we (1) compare the GWG distributions in BMI groups determined by CDC age- and sex- specific BMI percentiles to the GWG distributions in BMI groups determined

using adult BMI cut-points; (2) examine the GWG distributions within race and age groups; and (3) compare the GWG distributions by BMI group determined by using adolescent and adult criteria to the IOM GWG recommended ranges.

Materials and Methods

Database

We obtained data from the Central and Finger Lakes Regions Perinatal Data System (PDS) of New York (1996-2002 and 1998-2002, respectively). This population registry includes all live births within the 23 counties of Upstate New York.²² Perinatal Data System data are retrospectively extracted from perinatal medical records and personal interviews after delivery. During the time frame studied, 18,098 adolescents gave birth.

Eligibility Criteria

There were 18,098 adolescents less than 20 years of age in the database. We restricted our sample to live singleton pregnancies with a gestational age between 39 and 41 weeks (N = 12,495). We excluded 3171 adolescents whose infants' birthweight were outside the optimal range (3000 and 4000 g). Furthermore, we excluded 1616 subjects with medical conditions prior to pregnancy (eg, renal disease) or conditions that developed during pregnancy (eg, hydramnios) that may influence GWG. Adolescents who had infants with congenital anomalies were also excluded (n = 110). We included mothers who smoked during or 3 months prior to pregnancy and those who delivered by cesarean section, as neither GWG nor birthweight (among smokers only) differed significantly by these variables after other exclusion criteria were applied. Comparing the eligible sample (n = 6995) to excluded adolescent pregnancies in the database (n = 11,103), we found that although our sample is similar in many respects to all other adolescents giving birth, it contains fewer black, underweight, and obese adolescents and more healthful-weight, and nulliparous adolescents compared to the excluded adolescents (data not shown). To ensure independent observations, 1 pregnancy per adolescent was randomly selected for adolescents who had more than 1 child over the time span of the dataset.

Variables

Total GWG was calculated by subtracting the pre-pregnancy weight from the pre-delivery weight in kilograms. Pre-pregnancy BMI was calculated by dividing the pre-pregnancy weight by the squared height in meters [$\text{pre-pregnancy weight in kg}/(\text{height in meters})^2$]. We categorized pre-pregnancy BMI using both BMI-for-age and sex percentiles derived from the Centers for Disease Control and Prevention (CDC) growth charts^{8,23} and the adult BMI categories.²⁴ For the adolescent classification scheme, the growth charts consist of a series of percentile curves that illustrate the distribution of BMI in United States children. According to the CDC percentile cut-offs, adolescents' pre-pregnancy BMI was classified as underweight (<5th percentile), healthful weight ($\geq 5^{\text{th}}$ -<85th percentile), overweight ($\geq 85^{\text{th}}$ -<95th percentile), and obese ($\geq 95^{\text{th}}$ percentile). According to the adult criteria used for the IOM GWG recommendations, BMI was classified as underweight (<18.5 kg/m²), normal weight (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obese (≥ 30 kg/m²).

Other descriptive variables used included parity (0, 1, or ≥ 2 previous live births) and maternal race. Gestational weight gain has previously been shown to vary by both of these variables.²⁵⁻²⁷ Maternal race is self-reported in the PDS; for the purposes of this study, race was coded as black, white, and Other (Asian, Amerindian, Chinese, Japanese, Hawaiian, Filipino, Asian, Indian, and Korean). To examine the distribution of GWG by age, we divided the sample into 2 age groups: young adolescents under 16 years of age and adolescents 16 and older. Young adolescents are those within approximately 3-4 years of

menarche,¹ because the average age of menarche in the United States is between 12-13 years.²⁸

Analysis

We examined measures of central tendency and variability for GWG in the whole sample, by parity, race, pre-pregnancy BMI, and age group. Overall differences in means between groups were tested using analysis of variance. Significance was established at an alpha level of .01 to be conservative. We then compared the percentile distribution (5th, 10th, 15th, 25th, 50th, 75th, 85th, 90th, and 95th) of GWG by maternal pre-pregnancy BMI percentile-for-age groups and adult pre-pregnancy BMI groups for the sample as a whole, and within race and age group. Observations regarding percentile trends were made on a descriptive basis; statistical tests for trend are not reported. Small sample sizes in 3 categories (underweight adolescents < 16 years and underweight adolescents of Other and black race) limit the conclusions that can be drawn for these groups. Finally, we compared the observed GWG distributions by BMI categories to the currently recommended IOM GWG ranges. The IOM reports (1990, 2009) do not specify the exact parameters used to set up the lower and upper end of the recommended weight gain ranges. Thus, we compared the middle 70% (Pc 15th-85th) and 50% (Pc 25th-75th) of our adolescent distribution with the current IOM ranges. Analysis was done using SAS software, version 9.1 (Cary, NC). This study was exempted for human subject review by the Research Subjects Review Board of the University of Rochester because it used secondary data.

Results

Descriptive Statistics

Our sample includes 6995 adolescents who delivered singleton infants with a birthweight between 3000-4000 g and a gestational age between 39-41 weeks. The mean maternal age was 17.8 years (SD 1.27), the mean infant birthweight was 3456.9 g (SD 261.96), and the mean pre-pregnancy BMI was 23.65 (SD 4.85).

The descriptive statistics for GWG are presented in Table 1. Mean GWG was found to vary significantly by parity, race, and both adolescent and adult pre-pregnancy BMI, but not by age. Adolescents giving birth to their first child gained, on average, 3 kg more than adolescents with 1 or more previous births. Black adolescents, on the other hand, gained 1.4 kg less, on average, than both white and Other race adolescents, while still achieving good birth outcomes. Additionally, black adolescents also had the greatest amount of GWG variation (coefficient of variation = 44.8%).

Mean GWG decreased as pre-pregnancy BMI increased (Table 1), regardless of which BMI classification scheme was used. Underweight adolescents had the highest mean GWG, whereas obese adolescents had the lowest. Among BMI groups, obese adolescents showed the highest variability and underweight adolescents showed the lowest variability.

Gestational Weight Gain Percentile Distribution

By Pre-Pregnancy BMI—The GWG distribution by pre-pregnancy BMI does not differ considerably when BMI is classified using adolescent cutoffs compared to adult cutoffs (Table 2, Figure 1). In both cases, we observed a clear decreasing GWG trend with increasing BMI up to the 50th percentile. From the 75th percentile upward, GWG does not vary considerably between pre-pregnancy BMI categories and underweight adolescents do not always have the highest weight gain.

By overlaying the weight gain distributions resulting from the adolescent and adult BMI classification schemes (Figure 1), we observed that the shape and width of the distributions are nearly identical for the overweight and obese categories, whereas curves for the underweight and healthful-weight groups differ in the height of the distribution near the mid-point. The graphs show that the upper and lower ends of the IOM recommendations fall, for the most part, within the lower half of the distribution. The latter is more evident among the overweight and obese adolescents. The upper end of the IOM range falls near the middle of the distribution for only the underweight adolescents in both BMI classification schemes.

By Race and Pre-Pregnancy BMI—Stratifying the distribution by race, within each BMI category we observed a more complex relationship between BMI and GWG. Again, the weight gain distributions did not vary by the BMI classification scheme (Table 3). Among underweight adolescents, comparisons among racial groups could not be made because of small sample sizes in the black and Other race categories. Among the healthful-weight adolescents, Black adolescents had lower weight gains at each percentile of the distribution. Black, overweight adolescents also had lower weight gains at most percentiles, but differences among races were smaller and inconsistent. Within the obese category, clear racial differences in GWG did not emerge.

By Age Group—Regardless of the BMI classification scheme used, no consistent age-based trends in GWG by BMI were observed (Table 4). The small number of observations for young underweight adolescents precludes comparisons with the older group for this BMI category. There is little difference in weight gain between young and old adolescents who achieve good birth outcomes.

Comparison with the IOM Recommended Ranges—As shown in Tables 2-4 and Figure 1, the middle 70% (15th-85th Pc) and 50% (25th-75th Pc) of the GWG distributions for adolescent BMI groups were compared to the 2009 IOM-recommended ranges. The IOM recommendations by pre-pregnancy BMI are very narrow compared to the GWG distributions observed for adolescents in our sample overall, and also when the sample was subdivided into race and age groups. In the majority of the BMI groups, the IOM ranges are within the middle 70% and 50% of our distributions. The lower end of the IOM ranges falls below the lower end of the middle 70% (Pc 15th) for overweight and obese adolescents with both approaches to determining pre-pregnancy BMI. In no BMI groups do the upper end of the IOM ranges fall outside the upper end of the middle 70% or 50% of our distributions.

Discussion

Our data empirically support the use of adult BMI categories to recommend and monitor target weight gains for adolescent pregnancies, since GWG distributions are remarkably similar regardless of the way pre-pregnancy weight status is classified. We have shown that the recommended IOM weight gain ranges are considerably narrower than and shifted to the left of the actual distributions of GWG for adolescents. We found no evidence to support the use of specific GWG recommendations for adolescents of different race and age groups.

Our study addresses 2 limitations of previous GWG research. First, our sample involved only adolescents; therefore, inferences about adolescents' gestational weight gain could be made based on empirical data. Second, we classified the pre-pregnancy weight status of adolescents using the appropriate sex- and age-specific BMI percentiles to avoid misclassification.^{29,30} Although our data are not from a nationally representative sample, we used a population-based database of all births in the Central and Finger Lakes regions of New York so as to eliminate the potential for selection bias. We have no reason to believe

that adolescent mothers in New York are different from those across the nation. The racial distribution of all adolescents in the database is 74.8% white, 20.7% black, and 4.5% Other. We are unable to compare this racial distribution to national data on pregnant adolescents because of differences in race reporting. Despite this limitation, the generalizability of our findings should not be compromised by the racial distribution of our sample, since we did not find race to substantially alter the GWG distribution associated with optimal birth outcomes.

One limitation of this dataset, however, is that pre-pregnancy weight, used to calculate GWG and pre-pregnancy BMI, is often self-reported. With self-reported pre-pregnancy weight, there is a potential for misclassification.³¹ High correlations ($r = 0.96-0.98$) were found, however, between self-report and measured pre-pregnancy weight.^{31,32} A second limitation of this study is that we restricted our sample to adolescents having optimal birthweight infants, but in clinical settings, birthweight is classified according to gestational age. The 1990 IOM report also based recommendations on a sample of women with optimal birthweight infants. Although it is not apparent whether the 2009 report considered birthweight to define weight gain ranges, the lower and upper end of the 2009 ranges do not differ from the 1990 ones. Additionally, based on a nationally representative sample, the 10th and 90th percentile for birthweights appropriate for 39-41 weeks gestation are close to 3000 and 4000 g, respectively (optimal birthweight as defined here).³³ In our sample, 74.6% of adolescents with live singletons born between 39-41 weeks gestation gave birth to infants between 3000-4000 g. Likewise, although not a perfect comparison, the CDC national vital statistics system for 2008 indicates that 75% of US adolescents who gave birth at 40 or 41 weeks gestation had infants weighing between 3000-4000 g. Finally, we were unable to stratify by parity which could have confounded some of our results, because a significant difference in weight gain was observed for this variable. Nevertheless, neither the 1990 nor the 2009 IOM recommendations suggests using parity to modify target weight gain.

Our data concur with observations in the adult literature that GWG varies according to pre-pregnancy BMI.³⁴⁻³⁶ This observation does not hold, however, in the upper quartile of our GWG distributions, where we found little difference in weight gain by pre-pregnancy BMI overall. Additionally, the IOM recommendations are narrow compared to the adolescent weight gain distributions for all BMI categories, and they fall to the left side of the distribution rather than in the middle. Although this finding suggests that the upper limit of the IOM recommendations may be too restrictive for pregnant adolescents, our study did not take into account maternal outcomes such as postpartum weight retention, so we cannot conclude that adolescents could gain above the upper end of the IOM guidelines. Furthermore, these differences in the adolescent GWG distribution may reflect either a true difference between adolescents and adults or the effect of the 1990 GWG recommendations, which encouraged greater weight gain among all women and, in particular, among younger adolescents. In support of the latter explanation, the 2009 report⁶ cites data from the National Center for Health Statistics indicating a 31% increase in the proportion of women under 20 years of age with singleton pregnancies who gained at least 18 kg (above the upper end of weight gain guidelines for all BMI categories). Further research is needed to incorporate knowledge on maternal outcomes, such as postpartum weight retention, when setting the upper limits for the target weight gains. The latter was done for adults in the updated 2009 IOM recommendations, but adolescent-specific information is still too limited.

Based on our data, the use of adult BMI categories for pregnant adolescents does not appear to be problematic because the GWG distribution did not vary based on how BMI is determined. It is true, however, that some misclassification occurs when using adult BMI categories for adolescents. In our sample, among healthful-weight adolescents, 7.2% are misclassified as underweight, and 5.8% are misclassified as overweight using adult BMI

cutoffs. Similarly, among overweight adolescents, 4.3% are misclassified as healthful weight, and 6.6% are misclassified as obese. Finally, 6% of obese adolescents are misclassified as overweight using the adult criteria. Thus, although there is currently no evidence to suggest that it is inappropriate to use adult BMI criteria for pregnant adolescents in clinical practice, further research should address this issue when considering maternal outcomes associated with GWG among adolescents. Making recommendations without empirical data could put those adolescents at unnecessarily higher risk for postpartum weight retention and future overweight and obesity.^{5,7,37,38}

In conclusion, we found that the current IOM recommendations using adult BMI cut off-points to assign GWG ranges can be applied to adolescents to target and monitor weight gain in the clinical setting. With evidence indicating that excessive GWG is associated with fetal growth and obesity later in life and given the current obesity epidemic, future research should determine the best weight gain ranges that both maximizes fetal growth and minimizes postpartum weight retention.

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Fig. 1.

Comparison of adolescent gestational weight gain distribution by pre-pregnancy weight status to Institute of Medicine recommended ranges. Vertical lines represent the lower and upper limit of the IOM gestational weight gain ranges for each pre-pregnancy body mass index (BMI) category. Adolescent CDC BMI categories: underweight (<5th Pc), healthful weight (≥5th - <85th Pc), overweight (≥85th - <95th), obese (≥95th Pc). Adult BMI categories: underweight (<18.5 kg/m²), healthful weight (18.5-24.9 kg/m²), over-weight (25.0-29.9 kg/m²), obese (≥30 kg/m²).

Measures of Central Tendency and Variability of Gestational Weight Gain by Maternal Characteristics among Adolescents^a with Optimal^b Pregnancy Outcomes

Table 1

Maternal characteristic	Sample, n (%)	Mean, kg	SD	Min/max	CV, %	P-Value ^e
Whole sample	6995 (100)	16.9	6.97	-20.9/57.6	41.3	
Parity (total live birth history)						
0 (nullipara)	6039 (86.3)	17.3	6.94	-20.9/57.6	40.2	
1 (primipara)	860 (12.3)	14.6	6.69	-19.1/40.4	45.9	
≥2 (multipara)	96 (1.4)	14.4	7.17	-0.9/38.1	49.8	< .001
Race						
White	5527 (79.0)	17.1	6.93	-20.9/57.6	40.6	
Black	1151 (16.5)	15.9	7.13	-7.7/50.8	44.8	
Other	317 (4.5)	17.5	6.92	-0.9/48.1	39.5	< .001
Age (y)						
<16	426 (6.1)	17.2	6.89	-0.5/50.8	40.1	
16-20	6569 (93.9)	16.9	6.98	-20.9/57.6	41.3	.357
Adolescent pre-pregnancy BMI class ^c						
Underweight	235 (3.4)	18.0	6.03	5.4/45.8	33.4	
Healthy weight	4851 (69.3)	17.4	6.51	-20.9/57.6	37.4	
Overweight	1190 (17.0)	16.4	7.49	-7.3/52.2	45.7	
Obese	719 (10.3)	13.9	8.40	-19.1/54.4	60.5	< .001
Adult pre-pregnancy BMI class ^d						
Underweight	584 (8.4)	17.7	6.01	-0.5/45.8	34.1	
Normal weight	4270 (61.0)	17.4	6.46	-3.6/57.6	37.1	
Overweight	1386 (19.8)	16.7	7.65	-20.9/52.2	45.8	
Obese	755 (10.8)	13.9	8.32	-19.1/54.4	59.7	< .001

Abbreviations: BMI, body mass index; CV, coefficient of variance; SD = standard deviation.

^a Adolescents are 12 to 19 years of age.

^b Optimal pregnancy outcomes include singleton infants without congenital abnormalities with a birthweight between 3,000-4,000 grams and a gestational age between 39-41 weeks.

^c BMI categories: Underweight (<5th Pc), Healthy weight (≥5th - <85th Pc), Overweight (≥85th - <95th), Obese (≥95th Pc).

^d BMI categories: Underweight (<18.5kg/m²), Normal weight (18.5-24.9kg/m²), Overweight (25.0-29.9kg/m²), Obese (≥30kg/m²).

^e P-value reported from ANOVA.

Table 2

Distribution of Gestational Weight Gain by Pre-pregnancy BMI among Adolescents^a with Optimal^b Pregnancy Outcomes

Subgroup (n)	Gestational weight gain (kg) by percentile							Reference IOM ranges
	5 th	15 th	25 th	50 th	75 th	85 th	95 th	
All (6995)	6.4	10.4	12.2	16.3	21.3	23.6	28.6	
Adolescent pre-pregnancy BMI class ^c								
Underweight (235)	9.1	11.8	14.1	18.1	20.9	23.1	28.1	12.5 - 18.0
Healthful weight (4851)	8.2	10.9	13.2	16.8	21.3	24.0	28.6	11.5 - 16.0
Overweight (1190)	5.4	9.1	11.3	15.9	20.9	23.6	29.5	7.0 - 11.5
Obese (719)	0.5	5.4	8.6	13.6	18.6	22.7	28.6	5.0 - 9.0
Adult pre-pregnancy BMI class ^d								
Underweight (584)	9.1	11.8	13.6	17.2	20.9	23.1	28.1	12.5 - 18.0
Normal weight (4270)	8.2	10.9	13.2	16.8	21.3	24.0	28.6	11.5 - 16.0
Overweight (1386)	5.0	9.5	11.8	15.9	21.3	24.0	30.0	7.0 - 11.5
Obese (755)	0.9	5.9	8.6	13.6	18.6	22.7	28.6	5.0 - 9.0

Note: Shaded areas represent the 2009 IOM gestational weight gain ranges.

Abbreviations: BMI, body mass index; IOM, Institute of Medicine.

^a Adolescents are 12 to 19 years of age.

^b Optimal pregnancy outcomes include singleton infants without congenital abnormalities with a birth weight between 3000-4000 g and a gestational age between 39-41 weeks.

^c BMI categories: underweight (<5th P_C), healthful weight (≥5th - <85th P_C), overweight (≥85th - <95th), obese (≥95th P_C).

^d BMI categories: underweight (<18.5kg/m²), normal weight (18.5-24.9kg/m²), overweight (25.0-29.9kg/m²), obese (≥30kg/m²).

Table 3Distribution of Gestational Weight Gain by Race and Pre-Pregnancy BMI among Adolescents^a with Optimal^b Pregnancy Outcomes

Subgroup (n)	Gestational weight gain (kg) by percentile						Reference IOM ranges
	5 th	15 th	25 th	50 th	75 th	95 th	
Adolescent pre-pregnancy BMI by race ^c							
Underweight							12.5-18.0
White (208)	9.1	12.2	14.3	18.1	21.3	23.1	28.1
Black (16)	9.1	11.3	12.2	14.7	18.6	20.0	24.5
Other (11)	9.5	10.9	15.0	16.8	22.7	30.8	34.0
Healthful weight							11.5-16.0
White (3894)	8.2	11.3	13.2	17.2	21.3	24.0	28.6
Black (747)	6.4	10.0	11.3	15.4	20.4	22.7	27.2
Other (210)	8.2	12.2	13.6	17.2	21.8	25.0	30.4
Overweight							7.0-11.5
White (885)	5.0	9.1	11.3	15.9	20.9	23.6	29.5
Black (238)	5.0	8.6	11.3	15.4	20.0	22.2	27.7
Other (67)	7.7	11.3	12.2	15.9	22.2	23.6	26.8
Obese							5.0-9.0
White (540)	0.9	5.4	8.6	13.2	18.6	22.7	27.2
Black (150)	0.0	5.4	7.7	14.3	19.1	23.1	31.3
Other (29)	0.9	5.0	9.1	15.0	21.8	24.0	27.7
Adult pre-pregnancy BMI by race ^d							
Underweight							12.5-18.0
White (487)	9.1	12.2	14.1	17.7	21.3	23.6	28.1
Black (68)	6.4	9.5	11.8	14.7	18.6	21.3	24.9
Other (29)	8.2	13.2	15.0	17.2	20.4	22.7	30.8
Normal weight							11.5-16.0
White (3418)	8.2	11.3	13.2	17.2	21.3	24.0	28.6
Black (665)	6.8	10.0	11.8	15.4	20.4	22.7	27.2
Other (187)	8.2	12.2	13.6	17.2	21.8	24.9	29.5
Overweight							7.0-11.5

Subgroup (n)	Gestational weight gain (kg) by percentile						Reference IOM ranges
	5 th	15 th	25 th	50 th	75 th	95 th	
White (1047)	5.0	9.5	11.8	15.9	21.3	24.5	30.4
Black (268)	5.0	8.6	11.3	15.9	20.4	22.7	27.7
Other (71)	8.6	11.3	12.2	15.9	22.2	23.6	30.8
Obese							5.0-9.0
White (575)	1.8	5.9	9.1	13.2	18.6	22.2	27.2
Black (150)	0.0	5.4	7.7	14.1	18.6	23.1	31.3
Other (30)	0.9	5.9	9.1	15.0	21.8	24.0	27.7

Note: Shaded areas represent the 2009 IOM gestational weight gain ranges.

Abbreviations: BMI, body mass index; IOM, Institute of Medicine.

^a Adolescents are 12-19 years of age.

^b Optimal pregnancy outcomes include singleton infants without congenital abnormalities with a birth weight between 3000-4000 g and a gestational age between 39-41 weeks.

^c BMI categories: underweight (< 5th Pc), healthful weight (≥ 5th - <85th Pc), overweight (≥ 85th - < 95th Pc), obese (≥ 95th Pc).

^d BMI categories: Underweight (< 18.5kg/m²), Normal weight (18.5-24.9kg/m²), Overweight (25.0-29.9kg/m²), Obese (≥30kg/m²).

Table 4

Distribution of Gestational Weight Gain by Age and Pre-pregnancy BMI among Adolescents^a with Optimal^b Pregnancy Outcomes

Subgroup (n)	Gestational weight gain (kg) by percentile						Reference IOM ranges
	5 th	15 th	25 th	50 th	75 th	95 th	
Adolescent pre-pregnancy BMI by age (y) ^c							
Underweight	Too few adolescents for meaningful statistics						12.5-18.0
< 16 (6)		11.8	14.1	18.1	20.9	23.1	28.1
Healthful weight							
< 16 (279)	7.3	10.9	12.7	17.2	21.8	24.5	29.9
16-20 (4572)	8.2	10.9	13.2	16.8	21.3	24.0	28.6
Overweight							
< 16 (96)	5.4	10.0	12.7	16.3	21.3	23.1	29.0
16-20 (1094)	5.0	9.1	11.3	15.4	20.9	23.6	29.5
Obese							
< 16 (45)	4.1	7.7	11.3	15.4	19.5	23.1	26.8
16-20 (674)	0.5	5.4	8.6	13.6	18.6	22.7	28.6
Adult pre-pregnancy BMI by age ^d							
Underweight							
< 16 (37)	7.7	11.8	13.6	18.1	24.9	30.8	35.4
16-20 (547)	9.1	11.8	13.6	17.2	20.9	23.1	27.2
Normal weight							
< 16 (287)	7.3	10.4	12.7	16.3	21.3	23.1	27.7
16-20 (3983)	8.2	10.9	13.2	16.8	21.3	24.0	28.6
Overweight							
< 16 (76)	5.0	10.0	12.2	16.8	21.3	24.0	29.5
16-20 (1310)	5.0	9.5	11.8	15.9	21.3	24.0	29.9
Obese							
< 16 (26)	4.1	7.7	8.2	15.2	19.5	22.7	23.1
16-20 (729)	0.5	5.9	8.6	13.6	18.6	22.7	28.6

Shaded areas represent the 2009 IOM gestational weight gain ranges.

^b Optimal pregnancy outcomes include singleton infants without congenital abnormalities with a birthweight between 3,000-4,000 grams and a gestational age between 39-41 weeks

^c BMI categories: Underweight (< 5th Pc), Healthy weight (≥ 5th - < 85th Pc), Overweight (≥ 85th - < 95th), Obese (≥ 95th Pc)

^d BMI categories: Underweight (< 18.5kg/m²), Normal weight (18.5-24.9kg/m²), Overweight (25.0-29.9kg/m²), Obese (≥ 30kg/m²).

^a Adolescents are 12 to 19 years of age