Published in final edited form as:

Am J Obstet Gynecol. 2014 September ; 211(3): 259.e1–259.e8. doi:10.1016/j.ajog.2014.02.030.

Maternal gestational weight gain and offspring risk for childhood overweight or obesity

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Abstract

OBJECTIVE—The objective of the study was to evaluate the association between gestational weight gain, per the 2009 Institute of Medicine (IOM) recommendations, and offspring overweight/obesity at 2–5 years of age.

STUDY DESIGN—This was a prospective cohort study of 4145 women who completed a health survey (2007–2009) and subsequently delivered a singleton at Kaiser Permanente Northern California (2007–2010). Childhood overweight/obesity was defined as a body mass index (BMI) z-score of the 85th percentile or greater of the Centers for Disease Control and Prevention child growth standards. Gestational weight gain was categorized according to the 2009 IOM recommendations. Logistic regression was used; meeting the IOM recommendations was the referent.

RESULTS—Exceeding the IOM recommendations was associated with a 46% increase in odds of having an overweight/obese child (odds ratio [OR], 1.46; 95% confidence interval [CI], 1.17–1.83), after adjusting for maternal prepregnancy BMI, race/ethnicity, age at delivery, education, child age, birthweight, gestational age at delivery, gestational diabetes, parity, infant sex, total metabolic equivalents, and dietary pattern. The OR (95% CI) for childhood overweight/obesity among women gaining below the IOM recommendations was 1.23 (0.88–1.71). The associations between gaining outside the IOM recommendations and childhood obesity were stronger among women with a normal prepregnancy BMI (OR, 1.63; 95% CI, 1.03–2.57) (below); OR, 1.79; 95% CI, 1.32–2.43) (exceeded).

CONCLUSION—Gestational weight gain outside the IOM recommendations is associated with increased odds of childhood overweight/obesity, independent of several potential confounders and mediators. Gestational weight gain had a greater impact on childhood overweight/obesity among normal-weight women, suggesting that the effect may be independent of genetic predictors of obesity.

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The authors report no conflict of interest.

Presented in poster format at the 140th annual meeting of the American Public Health Association, San Francisco, CA, Oct. 27–31, 2012.

Keywords

childhood obesity; gestational weight gain

Gestational weight gain has significant health implications for both the mother and her infant. Excess gestational weight gain has been associated with increased risk of gestational diabetes, cesarean section, medically indicated preterm delivery, and maternal postpartum weight retention,¹⁻⁴ whereas inadequate gestational weight gain increases the risk of small for gestational age infants, low birthweight, and spontaneous preterm birth.⁵⁻⁷ In the short term, gestational weight gain is associated with fetal growth and appears to be positively correlated with birthweight, independent of genetic factors.⁸

Intrauterine exposure to inadequate or excess gestational weight gain may also have a lasting impact on offspring body weight in childhood and beyond. Gestational weight gain may result in developmental programming of later childhood weight because of permanent alterations in metabolism, similar to what has been observed for maternal diabetes mellitus.⁹

Obese children are more likely to have a myriad of health problems in childhood, and they are more likely to remain obese into adulthood.¹⁰ Efforts to prevent overweight and obesity should start early in life to prevent potential adverse effects on multiple organ systems in children.¹¹ Given that the prevalence of obesity among children has more than tripled since 1980 and currently in the United States, approximately 17% of children and adolescents aged 2–19 years are obese,¹² there is a clear need to identify modifiable risk factors.

Out of growing concern for the obesity epidemic, in 2009 the Institute of Medicine (IOM) set new guidelines for gestational weight gain based on prepregnancy body mass index.¹³ The guidelines include ranges for both total weight gain and trimester-specific weekly rates of weight gain for women carrying a single baby. The IOM report identified specific areas of focus to fill major gaps in research, and 1 such area was more studies assessing the impact of gestational weight gain on child health outcomes using the updated guidelines.

We sought to prospectively evaluate the association between gestational weight gain, per the 2009 IOM recommendations, and subsequent overweight/obesity among children aged 2–5 years in a large multiethnic cohort study of 4145 women who had completed a detailed health survey before pregnancy (between 2007 and 2009) and had a subsequent singleton live birth at Kaiser Permanente Northern California (between 2007 and 2010).

Materials and Methods

The study setting was Kaiser Permanente Northern California (KPNC), a large group practice prepaid health plan that provides comprehensive medical services to members residing in a 14 county region of Northern California (approximately 30% of the surrounding population). The demographic, racial/ethnic, and socioeconomic makeup of the KPNC membership is well representative of the population residing in the same geographic area, except that the very poor and the very wealthy are underrepresented.^{14,15}

Cohort identification

The cohort consisted of KPNC members who completed a survey as part of the Kaiser Permanente Research Program on Genes, Environment, and Health (RPGEH) between 2007 and 2009 and subsequently delivered a live-born singleton at KPNC between 2007 and 2010. Pregnancies were identified through the KPNC Pregnancy Glucose Tolerance Registry, an ongoing registry that identifies all pregnancies reaching the second trimester and that has previously been described in detail.¹⁶

The RPGEH survey was initially mailed to adult members (aged >18 years) of KPNC in February 2007. Approximately 400,000 members completed the survey and provided consent for linking the survey data to their electronic medical record (EMR), of which 57,100 were reproductive-aged women. The survey contained detailed information on pregravid factors including body mass index (BMI), alcohol consumption, medical and reproductive history, smoking, diet, and physical activity.

In general, this cohort of RPGEH survey responders who became pregnant was representative of the pregnancies occurring within Kaiser Permanente Northern California membership: 53% of the RPGEH cohort were from racial/ethnic minority groups compared with 58% among all KPNC pregnancies. There was slightly lower representation of African Americans (4.4% vs 6.6% in the KPNC pregnant population).

Among women who completed the RPGEH survey and had a subsequent pregnancy in KPNC, we identified 5967 mother/child pairs resulting in a singleton live birth with a child's height and weight measurements taken at 13 months of age or older. If a woman had more than 1 pregnancy, we selected the first one after the RPGEH survey. We then restricted to mother/child pairs in which the child was aged 2 years or older at the time of the most recent weight and height measurement ($n = 4505$). We excluded pairs if the mother was missing data on gestational weight gain ($n = 4151$). We then limited the cohort to those who had complete data on gestational age at delivery, resulting in a final analytic cohort of 4145 mother/child pairs.

This study was approved by the Kaiser Foundation Research Institute Institutional Review Board and the State of California Committee for the Protection of Human Subjects.

Maternal characteristics

We obtained the following maternal characteristics from the RPGEH survey: self-reported maternal race/ethnicity ([1], non-Hispanic white, [2] African American, [3] Asian, [4] Hispanic, and [5] unknown) and educational attainment (in years).

Prepregnancy dietary pattern

The RPGEH survey included 20 food categories, including sugar-sweetened beverages. To identify major prepregnancy dietary patterns, principal components analysis was used on the 20 foods to identify factors that accounted for much of the variance. The food groups (factors) were rotated using an orthogonal transformation, resulting in uncorrelated, independent factors. The factor score for each factor (pattern) was calculated by summing intakes of food groups weighted by factor loading, and each individual was assigned a score

for each identified pattern. Individuals with a high score for a pattern compared with individuals with lower scores have a stronger tendency to follow that pattern. The scores were then categorized by tertiles.

We identified 2 distinct dietary patterns: prudent and Western. Prudent diet is characterized by consumption of the following food groups: vegetables, fruits, whole grains, nuts/seeds, and beans. A Western diet is characterized by the consumption of processed meats, baked goods, whole eggs, beef, pork, lamb, deep-fried foods, margarine, and soft drinks.

Prepregnancy physical activity

The volume of total metabolic equivalent (METs) was calculated as minutes per week based on 4 questions.

Gestational diabetes

Gestational diabetes (GDM) was assessed through the KPNC Pregnancy Glucose Tolerance Registry¹⁷ and defined as having at least 2 plasma glucose values on the 100 g, 3 hour oral glucose tolerance test meeting or exceeding the Carpenter-Coustan thresholds (fasting: 95 mg/dL, 1 hour: 180 mg/dL, 2 hours: 155 mg/dL, 3 hours: 140 mg/dL).

Exposure ascertainment

Prepregnancy weight was a measured weight obtained before pregnancy (within 12 months of the last menstrual period) when available in the EMR (90%) or self-reported prepregnancy weight assessed at the first prenatal visit, also assessed via EMR. Prepregnancy BMI was calculated as prepregnancy weight (kilograms) divided by height (meters) squared. BMI categories were created in accordance with the 2009 IOM gestational weight gain recommendations as follows: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²). Given the small proportion of women who were underweight (1.9%), the underweight and normal-weight categories were combined into 1 category (<24.9 kg/m²).

Total gestational weight gain was calculated as the difference between the last measured pregnancy weight and prepregnancy weight, in kilograms. The last pregnancy weight, obtained from the EMR, was the final predelivery weight and had to be measured no more than 4 weeks before delivery to be included in the analysis. Total gestational weight gain was categorized according to the 2009 IOM gestational weight gain recommendations (below, met, exceeded).¹³ The total rate of gestational weight gain per week during pregnancy (in kilograms) was calculated as the total gestational weight gain divided by the weeks of gestation attained at the last pregnancy weight measurement.

Offspring characteristics

Birthweight for gestational age was categorized according to the study population's race/ethnicity- and gestational age-specific birthweight distribution as follows: large for gestational age if birth weight greater than the 90th percentile, small for gestational age if birthweight was less than the 10th percentile, and appropriate for gestational age if birthweight between the 10th and 90th percentiles, inclusive. Sex, height, and weight data

for the children were obtained from the EMR. Children were classified as overweight or obese if their BMI z-score met or exceeded the 85th percentile of the Centers for Disease Control and Prevention child growth standards, based on age and sex.¹⁸ *International Classification of Diseases*, ninth revision, delivery codes (764.x or 565.x [possible intrauterine growth restriction]) in our EMR were used to identify infants with intrauterine growth restriction.

Statistical analysis

Unconditional logistic regression analysis was used to obtain odds ratios (ORs) and confidence intervals (CIs) estimating the odds of subsequent childhood overweight-obesity associated with gestational weight gain. For models examining the IOM recommendations as the exposure, we estimated the odds of childhood overweight/obesity associated with exceeding and gaining below the recommendations, as compared with meeting the recommendations. For total gestational weight gain per week, we also categorized women into tertiles; those in the lowest tertile served as the reference group.

Variables evaluated for confounding included those of a priori interest (maternal age at delivery, race/ethnicity, prepregnancy BMI (kilograms per square meter), child age, preterm birth (<37 weeks' gestation), maternal education, parity, infant sex, volume of physical activity [mean MET minutes per week], and maternal prudent pattern diet).

To assess confounding, we entered covariates into a logistic regression model one at a time and then compared the adjusted and unadjusted ORs.¹⁹ Final logistic regression models included the variables that were evaluated for confounding and further adjusted for birthweight and maternal pregnancy glycemia (defined as GDM [yes or no]), which may be mediators of the gestational weight gain and childhood overweight/obesity association.²⁰

We initially examined associations stratified by the 4 levels of BMI category used for the IOM recommendations; however, given that results were similar for overweight and obese women when stratifying by prepregnancy BMI, the 2 categories were combined. In addition, we had a very small percentage of women who were in the underweight category (1.9%).

To assess the potential modifying effects of prepregnancy BMI (≥ 25 kg/m² vs <25 kg/m²), we included appropriate cross-product (interaction) terms in regression models. Finally, the following sensitivity analyses were conducted: (1) restricting to those with an appropriate for gestational age infant, and (2) excluding those with self-reported weights. SAS version 9.1 (SAS Institute Inc, Cary, NC) was used for all analyses.

Results

Table 1 displays the characteristics of the cohort by being below, meeting, or exceeding the IOM gestational weight gain recommendations; 10.9% fell below, 22.8% met, and 66.2% exceeded the recommendations. Women were, on average, 33 years old at delivery. The cohort was racially diverse; only 51% were non-Hispanic white. Women who exceeded the IOM recommendations were more likely to be white, nulliparous, and to be overweight prior to pregnancy. Women who were below the IOM recommendations were more likely to be

Asian or African American, to have 2 or more children, and to be obese before pregnancy. Children were, on average, approximately 3 years old when height and weight were assessed.

Children of mothers who exceeded the IOM recommendations were larger at birth, on average, than those whose mothers met or were below the recommendations (3475 g vs 3344 and 3231 g, respectively; $P < .01$) and were more than twice as likely to be macrosomic (15.0% among women who exceeded, compared with 8.3% who met and 6.2% who were below the recommendations).

Children of women who exceeded the IOM recommendations were more likely to be overweight or obese at 2–5 years of age (20.4% vs 14.5% [met] and 19.5% [below]; $P < .01$). There were more children with intrauterine growth restriction born to mothers who were below the IOM recommendations compared with those who met or exceeded the recommendations (3.9% vs 1.7% [met] and 1.2% [exceeded]; $P < .01$).

Table 2 shows the ORs and 95% CIs for childhood overweight/obesity at 2–5 years of age. Women whose gestational weight gain exceeded the IOM recommendations were more likely to have an overweight/obese child, after adjusting for maternal age at delivery, education, prepregnancy BMI, and race/ethnicity (OR, 1.51; 95% CI, 1.23–1.87), compared with women who met the IOM recommendations.

After further adjusting for child age, parity, infant sex, exercise (tertile of total MET minutes per week), and diet (tertile of prudent dietary pattern score) as well as factors that may be mediators between gestational weight gain and childhood obesity (maternal glucose tolerance status [GDM (yes vs. no)], birthweight, and gestational weeks at delivery), the association was attenuated but remained significant (OR, 1.46; 95% CI, 1.17–1.83). The association between gaining below the IOM recommendations and increased odds of childhood overweight/obesity did not reach statistical significance.

Women in the middle and highest tertile of gestational weight gain (compared with the lowest tertile, respectively) were also more likely to have an overweight/obese child after adjusting for maternal age at delivery, education, prepregnancy BMI, and race/ethnicity (OR, 1.32, 95% CI, 1.07–1.62 [middle]; OR, 1.53, 95% CI, 1.25–1.88 [highest]). In the fully adjusted model, the results were again attenuated but remained significant.

There was significant interaction by prepregnancy BMI (≥ 25 kg/m² vs <25 kg/m²) ($P = .017$), and the associations with being below and exceeding the IOM recommendations were stronger for women who were of normal weight (BMI <25 kg/m²) before pregnancy than in overweight/obese women (BMI ≥ 25 kg/m²) (Figure), after adjusting for maternal age at delivery, education, and race/ethnicity.

When stratified by the category of birthweight (small for gestational age, appropriate for gestational age, and large for gestational age), the association between the excess gestational weight gain and childhood overweight/obesity remained significant among offspring born appropriate for gestational age ($n = 3351$; OR, 1.57; 95% CI, 1.23–2.01) (data not shown).

Results were also similar for the sensitivity analysis that was restricted to women with a measured weight ($n = 3890$) and for the sensitivity analysis that restricted to the 811 mother/child pairs whose child was 4 years old or older (data not shown).

Comment

The majority of women in this cohort study exceeded the 2009 IOM gestational weight gain recommendations. Women who exceeded them were 46% more likely to have a child who was overweight or obese at 2–5 years of age, independent of several covariates and mediating factors. There was also a trend of increasing risk of childhood overweight/obesity with an increasing rate of gestational weight gain. The impact of inappropriate gestational weight gain, either above or below the IOM recommendations, on childhood overweight/obesity appeared to be stronger among women who were of normal weight before pregnancy.

The results of our study are generally consistent with previous studies of excess gestational weight gain and subsequent childhood overweight/obesity. A 2012 meta-analysis concluded that excess gestational weight gain results in at least a 21% increase in risk of childhood obesity.²¹ Greater gestational weight gain (based on the 1990 IOM recommendations) has also been associated with having offspring with a higher systolic blood pressure and a risk of overweight as well as increased adiposity at 3 years of age, as measured by skinfold thickness and BMI z-score.⁹ Results from another study found that the children of mothers who gained excess weight during pregnancy (per the 2009 IOM recommendations) had 48% greater odds of overweight at 7 years of age than the children of mothers who met the recommendations.²²

Research evaluating the relationship between low gestational weight gain and childhood overweight/obesity has produced mixed conclusions. Hinkle et al²³ found no association between low gestational weight gain and BMI z-score at 5 years of age in any prepregnancy BMI group, whereas Ehrenthal et al²⁴ found that low gestational weight gain was significantly related to BMI z-score at 4 years of age.

A recent review article found several studies that reported a U- or J-shaped association between gestational weight gain and child adiposity, in which the lowest maternal gains showed greater risk of childhood overweight.²⁵ The authors speculated that this may occur because of a survival phenotype in which infants with poor in utero nutrition experience accelerated weight gain early in life known as catch-up growth. Although this provides benefits for early life survival, it can have an adverse impact on outcomes in adolescence and childhood, such as obesity and metabolic disorders.²⁵ Evidence from the Dutch famine of 1944–1945 supports this hypothesis.²⁶ Our findings that low gestational weight gain, especially among normal-weight women, was associated with increased odds of subsequent childhood overweight/obesity, are intriguing and represent an avenue for future studies to explore.

It is well established that parental obesity is a strong risk factor for childhood obesity, especially between the ages of 3 and 5 years.²⁷ One study found a significant association

between excess gestational weight gain and child BMI z-score only among mothers who were not obese (prepregnancy BMI <30 kg/m²),²³ whereas a retrospective cohort study found that the impact of excess gestational weight gain was strongest among women who were underweight before pregnancy.^{22,23}

This lends support to the hypothesis that the impact of gestational weight gain on childhood overweight/obesity may be stronger among normal-weight women whose child is not already at increased risk because of genetic predisposition²⁸ or familial behavioral factors; for example, the child of an overweight or obese woman might share similar lifestyle habits or behaviors. Early childhood is a time when children internalize physical activity and eating behaviors demonstrated by their parental models.^{29,30}

It is hypothesized that excessive maternal body weight alone or gestational weight gain can both produce permanent changes in the fetal biological systems that regulate body weight.⁸ Weight gain is inversely related to insulin sensitivity, and obese women enter pregnancy highly insulin resistant; therefore, their decreases in insulin sensitivity are smaller, resulting in less gestational weight gain than normal-weight women.³¹ At the start of pregnancy, the fetus of an obese woman is already at risk for excessive nutrient intake because of the high insulin resistance in the mother. By contrast, excess gestational weight gain in normal-weight women (who have increased pregravid insulin sensitivity) could generate greater decreases in insulin sensitivity, resulting in excess nutrient intake and increased adiposity in the fetus.

In addition to prepregnancy BMI, metabolic changes that influence gestational weight gain may indirectly influence fetal growth and potentially childhood weight because the offspring of obese women may be predisposed to overconsume energy and lead a more sedentary lifestyle. Rapid growth in infancy has been associated with obesity later in life in multiple studies.³²

A limitation of this study is that we lacked information on breast-feeding practices or the child's diet after birth. However, we were able to control for maternal nutrition before pregnancy, which likely is related to diet during pregnancy and the child's dietary habits. One strength of this study is that the majority of the sample had measured prepregnancy weights. The remaining weights were self-reported, which may have underestimated actual weight; however, this was only a small proportion of the sample (10%), and we and other investigators have observed that self-reported prepregnancy weight approximates the true value.^{33,34} Furthermore, a sensitivity analysis excluding those with self-reported weights found no difference. This study is among the earliest to evaluate this relationship using the new 2009 IOM recommendations, which were updated to account for new research on pregnancy outcomes as well as increases in BMI and other changes in the child-bearing population. Our large cohort was also very racially diverse, making the results more generalizable and allowing us adequate power to assess effect modification by prepregnancy BMI.

Maternal gestational weight gain both below and above the IOM recommendations was associated with an increased risk of subsequent childhood overweight/obesity in young

children (aged 2–5 years), especially among normal-weight women. Future directions include developing lifestyle interventions that help women achieve appropriate weight gain during pregnancy and conducting clinical trials to evaluate the effectiveness of such interventions in achieving adequate gestational weight gain and reducing childhood obesity.

Acknowledgments

This research was supported by a research grant (R40MC21515) from the Health Resources and Services Administration (M.M.H.).

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FIGURE.

Gestational weight gain and childhood overweight/obesity, by prepregnancy BMI

^aAdjusted for maternal age at delivery, level of educational attainment, and race/ethnicity

Adjusted ORs and 95% CIs associated with childhood overweight/obesity, by prepregnancy BMI (BMI <25 kg/m² vs BMI ≥ 25 kg/m²).

BMI, body mass index; CI, confidence interval; OR, odds ratio.

Sridhar. Gestational weight gain and childhood obesity. *Am J Obstet Gynecol* 2014.

TABLE 1

Characteristics of the maternal/child cohort

Characteristic	Below IOM recommendations (n = 452)	Met IOM recommendations (n = 947)	Exceeded IOM recommendations (n = 2746)	P value
Maternal, mean $\pm$ SD or n (%)				
Age at delivery, y	33.4 $\pm$ 5.1	33.5 $\pm$ 4.7	32.5 $\pm$ 4.8	<.01
18–24	20 (4.4)	24 (2.5)	140 (5.1)	
25–29	80 (17.7)	163 (17.2)	567 (20.6)	
30–34	160 (35.4)	362 (38.2)	1060 (38.6)	
35–39	137 (30.3)	302 (31.9)	783 (28.5)	
40	55 (12.2)	96 (10.1)	196 (7.1)	
Education, y				<.01
12	59 (13.1)	57 (6.0)	227 (8.3)	
13–15	97 (21.5)	186 (19.6)	533 (19.4)	
16	275 (60.8)	657 (69.4)	1845 (67.2)	
Unknown	21 (4.6)	47 (5.0)	141 (5.1)	
Race/ethnicity				<.01
Non-Hispanic white	190 (42.0)	444 (46.9)	1492 (54.3)	
African American	33 (7.3)	31 (3.3)	107 (3.9)	
Asian	132 (29.2)	248 (26.2)	536 (19.5)	
Hispanic	77 (17.0)	178 (18.8)	460 (16.8)	
Unknown	20 (4.4)	46 (4.9)	151 (5.5)	
Parity				<.01
0	124 (27.4)	245 (25.9)	914 (33.3)	
1	210 (46.5)	482 (50.9)	1332 (48.5)	
2	118 (26.1)	216 (22.8)	484 (17.6)	
Unknown	0 (0.0)	4 (0.4)	16 (0.6)	
Prepregnancy BMI, kg/m ²	27.9 $\pm$ 7.9	25.2 $\pm$ 5.7	25.7 $\pm$ 5.2	<.01
<24.9	228 (50.5)	611 (64.6)	1,467 (53.4)	
25.0–29.9	80 (17.7)	173 (18.3)	817 (29.8)	
30.0	144 (31.9)	163 (17.2)	462 (16.8)	
Had gestational diabetes	76 (16.8)	75 (7.9)	139 (5.1)	<.01
Volume of physical activity, MET min/wk	637.7 $\pm$ 844.3	735.3 $\pm$ 891.8	785.3 $\pm$ 895.0	<.01
Child, mean $\pm$ SD or n (%)				
Male infant sex	216 (47.8)	481 (50.8)	1452 (52.9)	.10
Infant's gestational age at delivery	38.7 $\pm$ 1.7	38.8 $\pm$ 1.8	38.9 $\pm$ 1.7	.03
<37 wks of gestational age at birth	35 (7.7)	75 (7.9)	178 (6.5)	.25
Infant's birthweight, g	3231 $\pm$ 528.3	3344 $\pm$ 540.9	3475 $\pm$ 555.2	<.01
Macrosomia (birthweight >4000 g)	28 (6.2)	79 (8.3)	411 (15.0)	<.01

Characteristic	Below IOM recommendations (n = 452)	Met IOM recommendations (n = 947)	Exceeded IOM recommendations (n = 2746)	P value
Birthweight for gestational age				<.01
Small for gestational age	58 (12.8)	96 (10.1)	194 (7.1)	
Appropriate for gestational age	368 (81.4)	777 (82.0)	2206 (80.3)	
Large for gestational age	21 (4.6)	63 (6.7)	329 (12.0)	
Intrauterine growth restriction	16 (3.9)	15 (1.7)	31 (1.2)	<.01
Overweight child (85th percentile BMI or less z-score <95th percentile)	51 (11.3)	74 (7.8)	365 (13.3)	<.01
Obese child (BMI z-score ≥95th percentile)	37 (8.2)	63 (6.7)	196 (7.1)	<.01
Child's age at height/weight measurement, mo	37.2 ± 8.7	37.8 ± 9.1	38.0 ± 9.1	.29
BMI z-score	0.1 ± 1.2	0.0 ± 1.1	0.2 ± 1.1	<.01

BMI, body mass index; IOM, Institute of Medicine; MET, metabolic equivalent.

Sridhar. Gestational weight gain and childhood obesity. *Am J Obstet Gynecol* 2014.

TABLE 2

ORs and 95% CIs for childhood overweight/obesity at 2–5 years of age associated with maternal gestational weight gain

Pregnancy risk factor	Unconditional logistic regression models, OR (95% CI)		
	Crude	Multivariable adjusted ^a	Multivariable adjusted ^b
IOM gestational weight gain recommendations			
Below	1.43 (1.06–1.92)	1.12 (0.82–1.53)	1.23 (0.88–1.71)
Met	1.00	1.00	1.00
Exceeded	1.52 (1.24–1.86)	1.51 (1.23–1.87)	1.46 (1.17–1.83)
Rate of gestational weight gain, kg/wk			
Tertile 1 (–0.43 to 0.30)	1.00	1.00	1.00
Tertile 2 (0.30–0.42)	0.93 (0.77–1.13)	1.32 (1.07–1.62)	1.27 (1.02–1.58)
Tertile 3 (0.42–0.99)	1.11 (0.92–1.34)	1.53 (1.25–1.88)	1.38 (1.10–1.72)

BMI, body mass index; *CI*, confidence interval; *IOM*, Institute of Medicine; *MET*, metabolic equivalent; *OR*, odds ratio.

^a Adjusted for maternal age at delivery, education, prepregnancy BMI (kg/m²), and race/ethnicity;

^b Adjusted for maternal age at delivery, education, prepregnancy BMI, race/ethnicity, child's age, birthweight (small for gestational age, appropriate for gestational age [referent], large for gestational age), gestational weeks at delivery (<37 weeks vs >37 weeks), maternal glucose tolerance status (gestational diabetes [yes vs no]), parity, infant sex, tertile of total MET minutes per week, and tertile of dietary pattern score.

Sridhar. Gestational weight gain and childhood obesity. Am J Obstet Gynecol 2014.