Exploring Potential Health Disparities in Excessive Gestational Weight Gain

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Abstract

Introduction: Although previous public health efforts have focused on redressing health disparities associated with insufficient gestational weight gain, examination of the impact of excessive gestational weight gain is warranted currently given the 2009 revision of the Institute of Medicine (IOM) gestational weight gain guidelines for obese women coupled with rising rates of obesity, particularly among African American women.

Materials and Methods: In the years 2004–2008, 4619 African American and Caucasian women gave birth to a single, live, and full-term infant, completed Arkansas Pregnancy Risk Assessment Monitoring System questions about gestational weight gain and prepregnancy weight status, and gained within or in excess of the guidelines. Logistic regression was used to identify sociodemographic and health variables associated with the odds of exceeding the 2009 IOM guidelines overall and by race.

Results: Regardless of race, overweight (odds ratio [OR]=3.21; 95% confidence interval [CI]: 2.64–3.91) and obese (OR=4.37; 95% CI: 3.50–5.46) women had significantly higher odds of gaining excessively, as compared with normal weight women. In the multivariate model, women who were overweight or obese prepregnancy and who were married had higher odds of exceeding the IOM guidelines, while lower odds of exceeding the guidelines were seen among African American women, those who had Medicaid at any point in their pregnancy, who were multiparous, and those of Hispanic ethnicity.

Discussion: These findings can inform efforts to promote appropriate gestational weight gain among those at highest risk (i.e., overweight/obese women) and facilitate targeting to produce greatest improvement in the health of mothers and children.

Introduction

THE PREVALENCE OF OBESITY is so widespread as to be epidemic, and this rampant obesity extends to women of childbearing age.¹ In 2007–2008, 60% of adult women of childbearing age (20–39 years) were overweight and 34% were obese. The burden of overweight and obesity among childbearing women is particularly apparent among African American and Hispanic women. In 2007–2008, 78% of African American women and 70% of Mexican American women of childbearing age were overweight and 47% of African American women and 40% of Mexican American women were obese. Prepregnancy obesity is a risk factor for complications during both pregnancy and delivery.^{2,3} Women who are overweight or obese prepregnancy are significantly more likely to develop gestational diabetes, preeclampsia, and labor and delivery complications (e.g., labor induction, caesarean delivery for infant distress, and postpartum hemorrhage).^{3–6}

Research using the earlier 1990 Institute of Medicine (IOM) guidelines indicated that many pregnant women gained in excess of the recommended gestational weight gains; specifically, 40%–49% of normal weight women and 59%–77% of overweight/obese women exceeded the 1990 IOM weight gain guidelines.^{7–9} Furthermore, revisions to the IOM gestational weight gain guidelines in 2009, which provide more restrictive weight gain recommendations for obese women than those offered in the 1990 recommendations, will likely make it more challenging for women who are obese prepregnancy to gain in compliance with the guidelines. The 2009 release of the IOM recommendations for gestational weight gain are essentially identical to those published in 1990, with the crucial exception that it is now recommended that obese women gain only 11–20 lbs compared with the previous recommendation of “at least a 15-lb weight gain.” This change not only provides a ceiling on the amount of weight recommended for obese women, it also provides the most

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restrictive goal of all the prepregnancy weight classes for the group which has historically demonstrated some of the greatest average gestational weight gains. The revised guidelines may represent a particular challenge for African American and Mexican American women who are more likely than Caucasian women to be obese prepregnancy;^{1,10,11} thus, it is possible that African American and Mexican American women will be at greater risk for excessive gestational weight gain since more of them are represented in the category with the most restricted range of recommended weight gains. However, the limited literature on racial and ethnic differences in excessive gestational weight gain is dated (e.g., Caulfield and colleagues¹² used data from 1987–1989), and thus may not fully reflect recent trends for increasing disparities in obesity status among racial/minority women.¹ Before the full impact of excessive gestational weight on health disparities among pregnant women and infants can be fully established, data in this arena need to be updated.

Excessive gestational weight gain is a key modifiable risk factor for pregnancy complications (e.g., gestational diabetes, preeclampsia, caesarean delivery)^{13–18} and postpartum weight retention.^{19–22} Lifestyle interventions have the potential to help women gain the recommended amount of weight,^{23–27} through behavioral strategies, dietary intake recommendations and physical activity. The current research aims to identify sociodemographic and health characteristics of those at elevated risk for excessive gestational weight gain according to the updated 2009 IOM guidelines, with a particular focus on potential racial/ethnic disparities. These data will be critical for future research seeking to tailor interventions to populations most at risk for excessive gestational weight gain.

Materials and Methods

Data from the 2004–2008 Arkansas Pregnancy Risk Assessment Monitoring System (PRAMS) datasets were combined for the analyses. The PRAMS survey is an ongoing population-based surveillance system sponsored by the Centers for Disease Control and Prevention to capture information on maternal behaviors and experiences that occur before, during, and after pregnancy among women who had a live birth. The Arkansas PRAMS dataset merges data from three different sources: the PRAMS questionnaire, the birth certificate (1989 version), and survey operations data.

The PRAMS study methods have been described in detail elsewhere.²⁸ In brief, each month, over 200 Arkansas mothers who delivered a live born infant during the preceding 2–4 months are randomly selected from birth certificate records using stratified systematic sampling. Women are first contacted with a mailed survey and if the survey is not returned, women are contacted and interviewed by telephone. Data collection procedures and instruments are standardized to allow comparisons between states, and the weighted response rates ranged from 70.0% to 80.1% over the 5 years studied.

Measures

Maternal characteristics available in the Arkansas PRAMS dataset that were examined include age, race, ethnicity, height and prepregnancy weight, gestational weight gain, marital status, socioeconomic status (i.e., education level; Women,

Infants, and Children [WIC] program status; health care payment source), parity status, and prenatal care utilization. Race, ethnicity, gestational weight gain, educational level, marital status, and parity status were obtained from the birth certificate data, and age, height, prepregnancy weight, WIC status, health care payment source, and prenatal care utilization were obtained from the PRAMS questionnaire data.

A series of measures was constructed: A prepregnancy body mass index (BMI) variable was created for each subject using the self-reported height and prepregnancy weight measures, using the standard formula [weight (in kilograms) divided by height (in meters) squared²⁹]. Next, a categorical BMI variable was created using the National Institutes of Health, Heart, Lung, and Blood Institute BMI weight categories: underweight (<18.5 km/m²), normal (18.5–24.9 km/m²), overweight (25.0–29.9 km/m²), and obese (≥30.0 km/m²). Strong concordance between self-reported prepregnancy weight and measured prepregnancy weight has been previously demonstrated.⁹ Finally, a variable was created to indicate whether or not the PRAMS respondent gained above, within, or below the 2009 IOM weight gain guidelines for each prepregnancy BMI category. The 2009 guidelines recommend a weight gain of 28–40 lbs for underweight women, 25–35 lbs for normal weight women, 15–25 lbs for overweight women, and 11–20 lbs for obese women.

Maternal education was dichotomized as high school degree or less or greater than a high school degree. Marital status was dichotomized as married or unmarried (e.g., single, widowed, divorced). A woman was classified as enrolled in Medicaid if she reported being on Medicaid just before she got pregnant or if Medicaid was used to pay for prenatal care or for her delivery; otherwise, she was classified as not being enrolled in Medicaid. Parity was categorized as no previous live births (i.e., primiparous) or one or more previous live births (i.e., multiparous). Prenatal care utilization was characterized based on both gestational week at initiation of prenatal care as well as the number of prenatal care visits; the Adequacy of Prenatal Care Utilization (APNCU) index³⁰ was utilized to classify participants as receiving adequate/adequate-plus prenatal care, intermediate prenatal care, or inadequate prenatal care. The APNCU takes into account both the timing of prenatal care initiation as well as the frequency of visits received after initiation.

Sample

The study sample was selected from the 13,547 mothers responding to the PRAMS. The study sample included all Caucasian and African American PRAMS respondents in 2004–2008 who gave birth to a single live, full term (>37 weeks of gestation) infant and completed questions about gestational weight gain and their prepregnancy weight status as part of PRAMS. (Those Caucasian and African American respondents that identified ethnically as Hispanic were included in the sample.) Women with missing race, weight, or height and/or gestational weight gain were excluded due to missing data on key variables of interest (30% of the sample) (Fig. 1). Due to the focus of the current research, those who identified as a race other than Caucasian or African American were excluded from these analyses. In addition, we included only women giving birth to a single, live, and full-term infant

because the weight gain recommendations are different for women carrying multiple babies and because the recommendations are intended for full-term births. As it was not within the scope of the current research, women who gained less than the 2009 IOM guidelines were also excluded from these analyses. The final analytic sample consisted of 4619 women (Fig. 1). The study was determined to be exempt from University of Arkansas for Medical Sciences Institutional Review Board approval, because no identifiable private information was utilized.

Data analysis/statistical methods

All data were analyzed using SAS v9.3 survey procedures (SAS Institute) while incorporating survey design features like sampling weights and stratification variables in order to get unbiased estimates and their standard errors, and make correct inferences. For categorical variables we used Rao-Scott Chi-square test and simple logistic regression to test the equality of proportions between the groups (unadjusted). For continuous variables we estimated means for outcome levels of interest and applied simple (unadjusted) linear regression to determine the significance levels. All results were consid-

ered significant at the alpha level of 0.05. Multivariable logistic regression was used to identify sociodemographic and health variables associated with exceeding the 2009 IOM guidelines and to estimate odds ratios with 95% confidence intervals for those variables associated with exceeding the guidelines.

Results

Missing data

In order to explore potential bias based on missing data, those respondents who were excluded from the analyses due to missing prepregnancy weight, height, or gestational weight gain data were compared to those respondents without missing data on these variables with respect to sociodemographic and health parameters (see Table 1). The respondents without missing data on these key variables were similar to those with these missing data in maternal age and APNCU index category. However, respondents missing data on the key variables were significantly more likely to be African American or Hispanic, have education less than a high school degree, be multiparous, have presented for the first prenatal care visit later in pregnancy and have participated in

TABLE 1. A COMPARISON OF THOSE EXCLUDED FOR MISSING DATA ON PREPREGNANCY WEIGHT, HEIGHT, AND/OR GESTATIONAL WEIGHT GAIN WITH THE ANALYTICAL SAMPLE

	<i>Excluded due to missing data (n=2503)</i>	<i>Included in analytic sample (n=4619)</i>	<i>p value</i>
Maternal age (mean±SE)	24.9 (0.42)	25.5 (0.1)	0.16
Maternal race (% African American)	23.4	16.7	<0.05
Maternal ethnicity (% Hispanic)	55.2	6.2	<0.001
Maternal education (% with high school degree or less)	88.4	56.9	<0.001
Maternal marital status (% married)	49.8	61.4	<0.01
Previous live births (mean±SE)	1.2 (0.09)	1.0 (0.02)	<0.01
Gestational week at first prenatal visit (mean±SE)	11.8 (0.56)	9.9 (0.1)	<0.01
Number of prenatal visits (mean±SE)	10 (0.34)	11.2 (0.06)	<0.01
Adequacy of prenatal care utilization index (% adequate)	21.3	23.6	0.49
Medicaid participation (% with Medicaid)	18.9	43.6	<0.001
Women, infants and children (WIC) Program participation (% with WIC)	74.6	54.7	<0.001

SE, standard error of the mean; WIC, Women, Infants, and Children supplemental nutrition program.

WIC than were those respondents who provided full data on relevant variables. Those excluded from the final analytic sample due to missing data were also less likely to be married, tended to have presented for fewer prenatal care visits, and less likely to have health insurance other than Medicaid than were those respondents who provided full data on relevant variables.

Characteristics of the analytic sample

The sociodemographic and health-related characteristics of the final analytic sample are presented in Table 2. The sample included 5% underweight women, 45% normal weight women, 27% overweight, and 23% obese women. Overall, 53% of normal weight women in this sample gained excessive weight during pregnancy, while 77% of overweight women and 83% of obese women gained excessive weight during their pregnancy. In univariate analysis, 66% of Caucasian women and 68% of African American women gained excessively during their pregnancy.

As can be seen in Table 2, those who gained within the guidelines and those who exceeded guidelines differed significantly with respect to ethnicity, marital status, BMI, Medicaid participation, and WIC participation. Specifically, those women who exceeded the guidelines were more likely to be non-Hispanic, nonmarried, have a higher BMI, have health insurance other than Medicaid, and participate in WIC. There were no significant differences for age, race, education, number of previous live births, gestational age at first prenatal visit, number of prenatal visits, or APNCU categorization.

Multivariate logistic regression model

As can be seen in Table 3, women who were overweight (odds ratio [OR]=3.21; 95% confidence interval [CI]: 2.64–3.91) or obese (OR=4.37; 95% CI: 3.50–5.46) prepregnancy, and who were married (OR=1.25; 95% CI: 1.03–1.52) had higher odds of exceeding the IOM guidelines in the multivariate model, while African American women (OR=0.69; 95% CI: 0.54–0.88), those who had Medicaid at any point in

TABLE 2. SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY SAMPLE, OVERALL AND BY GAINING WITHIN OR EXCEEDING THE 2009 IOM GESTATIONAL WEIGHT GAIN GUIDELINES

	<i>Overall analytic sample (n=4619)</i>	<i>Gained within the guidelines (n=1626)</i>	<i>Exceeded the guidelines (n=2993)</i>	<i>p value*</i>
Maternal age [mean (SE)]	25.5 (0.1)	25.7 (0.18)	25.3 (0.12)	0.08
Maternal race (% African American)	16.7	16.0	17.0	0.48
Maternal ethnicity (% Hispanic)	6.2	8.3	5.1	<0.01
Maternal education (% with high school degree or less)	56.9	56.5	57.1	0.93
Maternal marital status (% married)	61.4	65.2	59.5	<0.01
Maternal body mass index [mean (SE)]	26.3 (0.12)	24.2 (0.16)	27.3 (0.15)	<0.001
Previous live births [mean (SE)]	1.0 (0.02)	1.0 (0.04)	1.0 (0.03)	0.47
Gestational week at first prenatal visit [mean (SE)]	9.9 (0.1)	9.9 (0.2)	9.9 (0.12)	0.95
Number of prenatal visits [mean (SE)]	11.2 (0.06)	11.1 (0.1)	11.3 (0.07)	0.16
Adequacy of prenatal care utilization index (% adequate)	23.6	22.1	24.4	0.15
Medicaid participation (% with Medicaid)	43.6	48.6	41.1	<0.001
WIC program participation (% with WIC)	54.7	50.0	57.1	<0.001

*Comparison between those who gained within the guidelines and those who exceeded the guidelines.
IOM, Institute of Medicine.

TABLE 3. PREDICTOR VARIABLES FOR EXCESSIVE GESTATIONAL WEIGHT GAIN

	Odds ratio	95% CI
Body mass index category		
Normal weight	1	
Underweight	0.83	0.59–1.15
Overweight	3.21	2.64–3.91
Obese	4.37	3.50–5.46
Race		
Caucasian	1	
African American	0.69	0.54–0.88
Marital status		
Not Married	1	
Married	1.25	1.03–1.52
Health care		
Health care other than Medicaid	1	
Medicaid	0.76	0.63–0.91
Parity		
0	1	
>1 (Multiparous)	0.79	0.67–0.92
Hispanic		
No	1	
Yes	0.50	0.35–0.70

CI, confidence interval.

their pregnancy (OR=0.76; 95% CI: 0.63–0.91), who were multiparous (OR=0.79; 95% CI: 0.67–0.92), and those of Hispanic descent (OR=0.50; 95% CI: 0.35–0.70) had lower odds of exceeding the IOM guidelines in the multivariate model. The strongest predictor of excessive gestational weight gain was BMI category pre-pregnancy.

Discussion

This is one of the first studies to examine potential racial and ethnic differences among pregnant women using the newly issued 2009 IOM gestational weight gain guidelines. Although African American and Hispanic women are more likely to be overweight and obese (and thus at risk for excessive gestational weight gain) based on previous research,¹ overweight and obese African Americans and Hispanics in this study were no more likely and in fact were less likely than their Caucasian and non-Hispanic counterparts, respectively, to gain an excessive amount of weight during pregnancy, after accounting for other variables in the multivariate model. This is consistent with another recent study³¹ that demonstrated that African American women who were normal weight, overweight, and obese were less likely to gain excessively than Caucasian women in the same weight categories.

Although the initially examined health disparities did not emerge in the analyses, it is important to note, consistent with previous research, the propensity of obese women (regardless of race or ethnicity) to gain in excess of recommended gestational weight was observed. Obese women were over four times more likely to gain excessively as compared to normal weight women and were the subgroup most likely to exceed the guidelines. Overweight women are also at significantly elevated risk of excessive gains, with approximately three-fold increases in excessive gestational weight gains as compared with normal weight women. These findings, in

conjunction with other similar findings, indicate that a more pronounced focus on obese and overweight women may be needed for interventions to promote appropriate gestational weight gain.

This is also one of the first studies to be able to examine excessive gestational weight gain specifically for obese women because the earlier 1990 IOM guidelines did not have an upper-limit that is required to categorize excessive gain for obese women. Thus previous studies had to define an arbitrary upper-limit for this weight category^{8,9,12,32} or could not determine excessive weight gain for obese women.⁷ Consistent with previous research using the 1990 IOM gestational weight gain recommendations, in which 40%–49% of normal weight women and 59%–77% of overweight/obese women exceeded the guidelines,^{7–9} the current study found that 53% of normal weight women gained excessive weight during pregnancy, while 77% of overweight women and 83% of obese women gained excessive weight during their pregnancy.

The pattern of excessive gestational weight gain in the current study is similar, albeit slightly higher, than that reported in one of the first studies to examine excessive gestational weight gain based on the 2009 IOM guidelines.³³ Simas and colleagues reported that 44% of normal weight women, 69% of overweight women, and 60% of obese women in their sample gained in excess of the guidelines. Discrepancies in the rates observed in that study and in the current report may be explained by differences in the samples examined; specifically, Simas and colleagues had over double the number of women self-identifying as Hispanic, and our results suggest that fewer gestational weight gain excursions may be seen within this group. Further, all women in the Simas et al. study gave birth in tertiary care hospitals in the northeast, whereas the current study represents a statewide sampling frame of births to women across a southern state.

The current study also demonstrates important similarities with previous research on sociodemographic variables and gestational weight gain. While previous research on the influence of socioeconomic status variables on excessive gestational weight gain has been limited,³⁴ research demonstrating the association between low birth weight/insufficient gestational weight gain and variables indicative of low socioeconomic status (e.g., low educational attainment, unmarried status, public assistance for healthcare) among pregnant women is abundant.³⁵ Consistent with this previous body of literature, married women in the current sample had significantly higher odds of excessive gestational weight gain compared with unmarried women, and women who have Medicaid as their health insurance during their pregnancy have lower odds of an excessive gestational weight gain. It may be that women with lower socioeconomic status (such as the unmarried women and women that have Medicaid as their health insurance in this sample) are more likely to have lower gestational weight gain that would be classified as insufficient or within the guidelines depending on the amount of weight gained. In addition, consistent with previous research,⁷ being multiparous appeared to be protective against excessive gestational weight gain.

This study has several key strengths and limitations. First, our research has the strength of using a large, statewide data source with data from multiple years, allowing for an adequate sample size for examining the effects of several sociodemographic and health variables. However, the limitation

that 30% of the original sample was excluded for missing data on either prepregnancy weight/height or gestational weight gain should be noted, as well as the fact that there were significant sociodemographic differences between those with missing data on mentioned variables and the rest of the sample. In addition, the degree to which the results would be broadly generalizable to other populations of women in other states and countries is unknown. However, given the similarities in obesity rates among southern states³⁶ and the importance of prepregnancy weight in predicting gestational weight gain, the weight gain trajectories of women of child-bearing age in Arkansas likely resemble those of other women in the south, suggesting that any health disparity data are likely to be relevant to other women in the region. Furthermore, the data utilized in these analyses from the PRAMS questionnaire, birth certificate, and survey operations were self-reported and thus are subject to the limitations of self-reported data; however, BMI categorization using self-reported weight has a strong concordance with measured weight.³⁷

Conclusions

These results demonstrate that, while there may not be racial or ethnic health disparities in excessive gestational weight gain, many African American and Caucasian women are gaining in excess of the 2009 gestational weight gain guidelines, with overweight or obese prepregnancy weight status being the strongest predictor of excessive gestational weight gain. Consistent with previous research, it is clear that efforts to promote appropriate gestational weight gain among overweight and obese women, regardless of race/ethnicity, are necessary given that excessive gestational weight gain is a major risk factor for pregnancy complications and postpartum weight retention. It will be important to develop effective interventions (e.g., behavior change programs, methods to improve clinician-patient communication about gestational weight gain, or social marketing campaigns to influence maternal expectations) that can be broadly disseminated to reduce the rates of excessive weight gain.

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Disclosure Statement

No competing financial interests exist.

References

1. Flegal KM, Carroll MD, Odgen CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *J Am Med Assoc* 2010;303:235–241.
2. Baeten JM, Bukusi EA, Lambe M. Pregnancy complications and outcomes among overweight and obese nulliparous women. *Am J Public Health* 2001;91:436–440.
3. Doherty DA, Magann EF, Francis J, Morrison JC, Newnham JP. Pre-pregnancy body mass index and pregnancy outcomes. *Int J Gynecol Obstet* 2006;95:242–247.
4. Chu SY, Callaghan WM, Kim SY, et al. Maternal obesity and risk of gestational diabetes mellitus. *Diabetes Care* 2007;30:2070–2076.
5. Sebire NJ, Jolly M, Harris JP, et al. Maternal obesity and pregnancy outcome: A study of 287 213 pregnancies in London. *Int J Obesity* 2001;25:1175–1182.
6. Magann E, Doherty D, Chauhan S, Klumpel J, Huff S, Morrison J. Pregnancy, obesity, gestational weight gain, and parity as predictors of peripartum complications. *Arch Gynecol Obstet* 2011;284:827–836.
7. Chu SY, Callaghan WM, Bish CL, D'Angelo D. Gestational weight gain by body mass index among US women delivering live births, 2004–2005: Fueling future obesity. *Am J Obstet Gynecol* 2009;200:271.
8. Herring SJ, Oken E, Haines J, et al. Misperceived prepregnancy body weight status predicts excessive gestational weight gain: findings from a US cohort study. *BMC Pregnancy Childbirth* 2008;8:54.
9. Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. *Am J Obstet Gynecol* 2007;196:322.e1–8.
10. Boardley DJ, Sargent RG, Coker AJ, Hussey JR, Sharpe PA. The relationship between diet, activity, and other factors, and postpartum weight change by race. *Obstet Gynecol* 1995;86:834–838.
11. Solomon CG, Willett WC, Carey VJ, et al. A prospective study of pregravid determinants of gestational diabetes mellitus. *JAMA* 1997;278:1078–1083.
12. Caulfield LE, Witter FR, Stoltzfus RH. Determinants of gestational weight gain outside the recommended ranges among black and white women. *Obstet Gynecol* 1996;87:760–766.
13. DeVader SR, Neeley HL, Myles TD, Leet TL. Evaluation of gestational weight gain guidelines for women with normal prepregnancy body mass index. *Obstet Gynecol* 2007;110:745–751.
14. Kiel DW, Dodson EA, Artal R, Boehmer TK, Leet TL. Gestational weight gain and pregnancy outcomes in obese women: how much is enough? *Obstet Gynecol* 2007;110:752–758.
15. Parker JD, Abrams B. Prenatal weight gain advice: An examination of the recent prenatal weight gain recommendations of the Institute of Medicine. *Obstet Gynecol* 1992;79:664–669.
16. Thorsdottir I, Torfadottir JE, Birgisdottir BE, Geirsson RT. Weight gain in women of normal weight before pregnancy: Complications in pregnancy or delivery and birth outcome. *Obstet Gynecol* 2002;99(5 Pt 1):799–806.
17. Cheng YW, Chung JH, Kurbisch-Block I, Inturrisi M, Shafer S, Caughey AB. Gestational weight gain and gestational diabetes mellitus: Perinatal outcomes. *Obstet Gynecol* 2008;112:1015–1022.
18. Tovar A, Must A, Bermudez O, Hyatt R, Chasan-Taber L. The impact of gestational weight gain and diet on abnormal glucose tolerance during pregnancy in Hispanic women. *Matern Child Health J* 2009;13:520–530.
19. Amorim AR, Rossner S, Neovius M, Lourenco PM, Linne Y. Does excess pregnancy weight gain constitute a major risk for increasing long-term BMI? *Obesity* 2007;15:1278–1286.
20. Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: Implications of the 1990 Institute of Medicine guidelines. *Am J Public Health* 1993;83:1100–1103.

21. Claesson I, Sydsjo G, Brynhildsen J, et al. Weight gain restriction for obese pregnant women: A case-control intervention study. *Br J Obstet Gynecol* 2008;115:44–50.
22. Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. *Int J Obes Relat Metab Disord* 2003;27:117–127.
23. Olson CM, Strawderman MS, Reed RG. Efficacy of an intervention to prevent excessive gestational weight gain. *Am J Obstet Gynecol* 2004;191:530–536.
24. Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes* 2002;26:1494–1502.
25. Wolff S, Legarth J, Vangsgaard K, Toubro S, Astrup A. A randomized trial of the effects of dietary counseling on gestational weight gain and glucose metabolism in obese pregnant women. *Int J Obes* 2008;32:495–501.
26. Mottola M, Giroux I, Gratton R, et al. Nutrition and exercise prevent excess weight gain in overweight pregnant women. *Med Sci Sports Exerc* 2010;42:265–272.
27. Phelan S, Phipps MG, Abrams B, Darroch F, Schaffner A, Wing RR. Randomized trial of a behavioral intervention to prevent excessive gestational weight gain: The Fit for Delivery study. *Am J Clin Nutr* 2011;93:772–779.
28. Shulman, BH, Gilbert, CB, Lansky, A. The pregnancy risk assessment monitoring system (PRAMS): Current methods and evaluation of 2001 response rates. *Public Health Rep* 2006; 121:74–83.
29. NHLBI Expert Panel on the Identification Evaluation, and Treatment of Overweight and Obesity in Adults. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report. *Obes Res* 1998;6(Suppl 2):51S–209S.
30. Kotelchuck M. An evaluation of the Kessner Adequacy of Prenatal Care Index and a proposed adequacy of prenatal care utilization index. *Am J Public Health* 1994;84:1414–1420.
31. Fontaine PL, Hellerstedt WL, Dayman CE, Wall MM, Sherwood NE. Evaluating body mass index-specific trimester weight gain recommendations: Differences between black and white women. *J Midwifery Wom Health* 2012;57:327–335.
32. Cogswell ME, Scanlon KS, Fein SB, Schieve LA. Medically advised, mother's personal target, and actual weight gain during pregnancy. *Obstet Gynecol* 1999;94:616–622.
33. Simas TAM, Liao X, Garrison A, Sullivan GMT, Howard AE, Hardy JR. Impact of updated Institute of Medicine guidelines on prepregnancy body mass index categorization, gestational weight gain recommendations, and needed counseling. *J Womens Health* 2011;20:837–844.
34. Rasmussen KM, Yaktine AL. Committee to Reexamine IOM Pregnancy Guidelines. Weight gain during pregnancy: Re-examining the guidelines. Washington, DC: U.S. Institute of Medicine and National Research Council; 2009.
35. Chomitz VR, Cheung LWY, Lieberman E. The role of lifestyle in preventing low birth weight. *Future Child* 1995;5:121–138.
36. Centers for Disease Control and Prevention. Overweight and obesity: Adult obesity facts. Available at: www.cdc.gov/obesity/data/adult.html. Accessed August 20, 2012.
37. Lederman SA, Paxton A. Maternal reporting of pre-pregnancy weight and birth outcome: Consistency and completeness compared with the clinical record. *Matern Child Health J* 1998;2:123–126.

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