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Effect of revised IOM weight gain guidelines on perinatal outcomes

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Abstract

Objective—We sought to examine perinatal outcomes in women with a body mass index (BMI) of 25 kg/m² comparing those whose weight gain met 2009 IOM guidelines to women meeting 1990 IOM guidelines.

Methods—This is a retrospective cohort study utilizing birth records linked to hospital discharge data for all term, singleton infants born to overweight, Missouri residents (2000–2006) with a BMI of 25 kg/m². We excluded congenital anomalies, mothers with diabetes, hypertension, or previous cesarean delivery.

Results—Fourteen thousand nine hundred fifty-five women gained 25–35 lbs (1990 guidelines); 1.6% delivered low birth weight (LBW) infants and 1.1% delivered macrosomic infants. Eight thousand three hundred fifty women gained 15–25 lbs (2009 guidelines); 3.4% delivered LBW infants and 0.6% delivered macrosomic infants. Women who gained 15–25 lbs were 1.99 (95% CI 1.67, 2.38) times more likely to have a LBW infant and 0.59 (95% CI 0.40, 0.76) times less likely to deliver a macrosomic infant.

Conclusion—Limiting weight gain in women with a BMI of 25 kg/m², per the 2009 guidelines, increases the risk of LBW deliveries and decreases the risk of macrosomia but does not reduce associated adverse perinatal outcomes. Further studies should explore the optimal weight gain to reduce these outcomes.

Keywords

Gestational weight gain, infant outcomes

Introduction

More than 33% of women of child-bearing age in the United States were obese in 2004, and the World Health Organization (WHO) estimates that the obesity epidemic is worsening every year, which is expected to lead to an estimated 2.3 billion overweight and another 700 million obese adults by the year 2015 [1,2]. Women who are overweight or obese are at an increased risk for pregnancy complications including gestational diabetes [3], hypertension

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[4], and thromboembolism [5,6]. These women also suffer from increased labor and delivery complications such as postpartum hemorrhage [7] and infections [8,9]. In addition to these maternal complications, infants born to overweight or obese women are more likely to be preterm [10], have congenital anomalies [11], or be large-for-gestational-age (LGA) [12,13].

Regardless of maternal obesity, excessive maternal weight gain is also associated with increased risk to infants, including macrosomia [14] and NICU admissions [15]. In 1990, the Institute of Medicine (IOM) developed guidelines for appropriate weight gain during pregnancy based on prepregnancy weight [16]. These guidelines were revised in 2009, changing the categories of prepregnancy body mass index (BMI) to conform to WHO standards and to adjust weight gain recommendations for certain categories [17]. Women with a BMI of 25 kg/m² were considered overweight by the 2009 revised guidelines and were, therefore, advised to gain 15–25 pounds (lbs) rather than 25–35 lbs as recommended in 1990 when these women would have been categorized as normal weight.

Despite IOM recommendations, the proportion of women gaining more than the recommendations appears to be increasing, with 37% of normal-weight and 64% of overweight women gaining more than the recommendations [18,19]. We sought to determine whether women with a BMI of 25 kg/m² whose weight gain met 2009 IOM guidelines had better infant outcomes than women meeting 1990 IOM guidelines.

Materials and methods

We conducted a population-based retrospective cohort study of all live infants born in Missouri between 1 January 2000 and 31 December 2006 ($n=1,049,732$). We focused on women with a BMI ≥ 25 kg/m² and 526 kg/m² ($n=53,492$) who delivered singleton infants at term. Data were obtained from Missouri birth certificate records linked to hospital discharge data. Exclusion criteria were (1) major congenital anomalies ($n=727$, 1.4%), (2) maternal diabetes mellitus ($n=1,643$, 3.1%) or chronic hypertension ($n=349$, 0.7%), or (3) previous cesarean delivery ($n=6,488$, 12.1%). Because we were unable to conclusively differentiate between gestational diabetes and type I/type II diabetes on the birth certificate data, we excluded all diabetics. Previous cesarean delivery may alter obstetric care and result in bias in certain outcomes; therefore, we excluded these women from this analysis. We excluded from the analyses all births that were missing information on maternal weight gain ($n=533$, 1%).

The primary predictors of interest were weight gain within the IOM recommendations for 1990 *versus* 2009 [16,17]. Table I summarizes the original and revised recommendations. Women who gained 15–25 pounds, gained within the 2009 guidelines. Women who gained 25–35 pounds, gained within the 1990 guidelines. We randomly assigned women who gained exactly 25 pounds ($n=2,096$) to either weight gain category based on the 1990 or the 2009 IOM recommendations.

The outcomes were defined based on data from the birth certificate record and/or the hospital discharge data. The primary outcome of interest was birth weight. Birth weight was categorized as macrosomic (≥ 4500 g), low birth weight (<2500 g), very low birth weight (<1500 g), small-for-gestational-age (SGA) (3rd and 10th percentile), and LGA (3rd and 10th percentile). We also examined the following infant outcomes: low Apgar score (<7 at 5 min), very low Apgar score (<4 at 5 min), birth trauma, infection, hypoglycemia, respiratory distress syndrome, meconium aspiration syndrome, seizures, and length of hospital stay (>5 days, >10 days). A composite score was also created including low Apgar score, birth trauma, extended length of stay (>5 days), infection, hypoglycemia, respiratory distress syndrome, meconium aspiration syndrome, and seizures. If a diagnosis was documented in

either the birth certificate or the hospital discharge data, then the condition was considered present.

Several maternal socio-demographic characteristics have been shown to be associated with maternal obesity and were evaluated as potential confounders in this study. Maternal education was categorized as high, average, or low based on age and years of education [20]. More than 12 years of education was considered high regardless of age. Using the R-GINDEX, prenatal care was categorized as no care, inadequate, adequate, intermediate, intensive, or missing based on when prenatal care was initiated, total number of prenatal care visits, and gestational age at delivery [21]. Gestational age at birth was based on the clinical estimate of gestational age on the birth certificate [22,23].

Bivariate analyses were completed using χ^2 or Fisher's exact tests as appropriate. Multivariable logistic regression was used to calculate adjusted odds ratios (aOR) and 95% confidence intervals (95% CI) for the association. Regression models were adjusted for maternal race/ethnicity, maternal age, education, marital status, smoking status, prenatal care, insurance status (Medicaid *versus* private/ other), parity (nulliparous *versus* multiparous), and male gender. All analyses were completed using SAS version 9.2 (SAS Institute Inc., Cary, NC). Approval for human subjects research and a waiver of informed consent were received from the Institutional Review Board at Saint Louis University and the Missouri Department of Health and Senior Services, Section for Epidemiology for Public Health Practice.

Results

A total of 44,371 women had a BMI of 25 kg/m², with 23,305 meeting all study criteria. Fourteen thousand nine hundred fifty-five (33.7%) women gained 25–35 pounds (per 1990 guidelines) *versus* 8350 (18.8%) who gained 15–25 pounds (per 2009 guidelines). The remaining women gained either above or below these ranges and were excluded from further analyses. Of those meeting inclusion criteria, women who gained more weight were more likely to be white, to have lower education, and to be nulliparous (Table II). These women were also more likely to deliver a male infant.

Women who gained less weight were 2.13 times more likely to deliver a low birth weight infant (Table III). Conversely, women who gained less weight were 0.54 times less likely to deliver a macrosomic infant. There were five very low birth weight infants born to women who gained 25–35 pounds and four very low birth weight infants born to women who gained 15–25 pounds ($p=0.59$).

After adjusting for potential confounders, there was no statistically significant change in any other infant outcomes regardless of gestational weight gain (Table IV). A composite variable representing all infant outcome complications that are included in Table IV was created. One thousand eight hundred eleven infants born to mothers who gained 25–35 pounds had a complication *versus* 1012 infants born to mothers who gained 15–25 pounds (cOR 1.00, 95% CI 0.92, 1.09). There was no statistically significant difference in risk after adjusting for potential confounders (aOR 1.02, 95% CI 0.94, 1.1).

Discussion

The maternal weight gain recommendations for women with a prepregnancy BMI of 25 kg/m² were reduced by the 2009 guidelines in order to minimize adverse outcomes. We found that infants born to women with a BMI of 25 kg/m² who adhered to the 2009 IOM weight gain guidelines were 2.13 times more likely to deliver a low birth weight infant and 0.54 times less likely to deliver a macrosomic infant than women who gained within the 1990

guidelines. The findings were consistent regardless of whether adverse birth weight measures were liberal (SGA and LGA at the 10th percentile) or conservative (SGA and LGA at the 3rd percentile). However, this did not translate into a change in other infant complications.

Our study uniquely identifies a specific BMI directly affected by the revised IOM guidelines and confirms previous studies which found that maternal weight gain has a significant impact on birth weight [15,24]. Low birth weight and macrosomia have both been associated with increased complications and increased cost of care [25]. Although our study did change birth weight outcomes, this did not result in a reduction (or increase) in other infant complications. For those who might be concerned about the increase in SGA infants seen with the 2009 guidelines, the lack of any increased neonatal outcomes should be reassuring. Additionally, the reduction in LGA infants was numerically greater than the increase in SGA infants, providing further reassurance regarding the tighter guidelines.

Similar to our study, Crane et al. found that women were 1.2–1.3 times more likely to deliver a macrosomic infant if they gained more than the recommendations and 2.5–3 times more likely to deliver a low birth weight infant if they gained less than the recommendations, regardless of BMI [26]. Similarly, Stotland et al. found that women who gained below the IOM guidelines were 1.7 times more likely to have a SGA infant and 42% less likely to have a LGA infant while women who gained above the guidelines were 49% less likely to have a SGA infant and two times more likely to have a LGA infant [27]. Bianco et al. did not find an increased risk of SGA deliveries in women who gained below the recommendations but limited the study to morbidly obese women [14]. Although reduced weight gain does appear to reduce adverse outcomes, the current IOM recommendations do not appear to have accomplished this. Rather, more significant weight gain restriction may be appropriate, which some studies even found that advocating limited or no weight gain in obese pregnant women to improve outcomes [24].

These analyses utilize a retrospective cohort of birth certificates and hospital discharge data; reliability and validity, therefore, are a concern. To minimize measurement error and misclassification bias, we used the clinical estimate of gestational age which has been validated by the State of Missouri [22,23]. Studies have also been performed to validate prepregnancy weight and height as self-reported on the birth certificate [28,29]. Although multivariable analyses were utilized to minimize the effect of confounders, potentially unknown or unidentified confounders may exist which may ultimately affect birth weight. A final limitation of this study concerns the generalizability of the study findings beyond the Midwest. Although the population of Asian-Americans in the study sample is fairly small, Hispanics and African-Americans are well-represented. In addition, obesity and low birth weight trends in the Midwest have been similar to those across the nation [30].

This study was limited to term infants, as appropriate weight gain for a preterm delivery has not been defined and studies cannot examine weight gain in term and preterm deliveries as gestational weight gain may not be linear. Future studies will need to independently examine weight gain in preterm deliveries.

The revised IOM guidelines were designed to reduce maternal and infant adverse outcomes. Although lower weight gain was associated with lower rates of macrosomia, this did not translate into a reduction in adverse infant outcomes. It remains unclear if more stringent weight gain requirements are necessary. Future studies must identify weight gain guidelines which will minimize adverse outcomes for both mothers and infants across prepregnancy BMI.

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References

1. World Health Organization. [Last accessed 28 November 2009] Statistical Information System. Core Health Indicators Database. [Internet]. 2008. Electronic citation. http://apps.who.int/whosis/database/core/core_select_process.cfm
2. World Health Organization. [Last accessed 28 November 2009] Media Centre Fact Sheets. Obesity and overweight [Internet]. 2006. Electronic citation. <http://www.who.int/mediacentre/factsheets/fs311/en/index.html>
3. Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, Stampfer MJ, Speizer FE, Spiegelman D, Manson JE. A prospective study of pregravid determinants of gestational diabetes. *J Am Med Assoc*. 1997; 278:1078–1083.
4. O'Brien TE, Ray JG, Chan W. Maternal body mass index and the risk of preeclampsia: a systematic overview. *Epidemiology*. 2003; 14:368–374. [PubMed: 12859040]
5. Davis EM, Zyzanski SJ, Olson CM, Stange KC, Horwitz RI. Racial, ethnic, and socioeconomic differences in the incidence of obesity related to childbirth. *Am J Public Health*. 2009; 99:294–299. [PubMed: 19059856]
6. Satpathy H, Fleming A, Frey D, Barsoom M, Satpathy C, Khandalaval J. Maternal obesity and pregnancy. *Postgrad Med*. 2008; 120:e01–e09. [PubMed: 18824817]
7. Bhattacharya S, Campbell DM, Liston WA, Bhattacharya S. Effect of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies. *BMC Public Health*. 2007; 7:168–175. [PubMed: 17650297]
8. Myles TD, Gooch J, Santolaya-Forgas J. Obesity: an independent risk factor for infectious morbidity in patients undergoing cesarean delivery. *Obstet Gynecol*. 2002; 99:S11.
9. Lynch CM, Sexton DJ, Hession M, Morrison JJ. Obesity and mode of delivery in primigravida and multigravida women. *Am J Perinatol*. 2008; 25:163–168. [PubMed: 18300188]
10. Ehrenberg HM, Iams JD, Goldenberg RL, Newman RB, Weiner SJ, Sibai BM, Caritis SN, Miodovnik M, Dombrowski MP. Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Maternal–Fetal Medicine Units Network (MFMU). Maternal obesity, uterine activity, and the risk of spontaneous preterm birth. *Obstet Gynecol*. 2009; 113:48–52. [PubMed: 19104359]
11. Stothard KJ, Tennant PW, Bell R, Rankin J. Maternal overweight and obesity and the risk of congenital anomalies: a systematic review and meta-analysis. *J Am Med Assoc*. 2009; 301:636–650.
12. Getahun D, Ananth CV, Peltier MR, Salihu HM, Scorza WE. Changes in prepregnancy body mass index between the first and second pregnancies and risk of large-for-gestational-age birth. *Am J Obstet Gynecol*. 2007; 196:530.e1–530.e8. [PubMed: 17547882]
13. Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstet Gynecol*. 2004; 103:219–224. [PubMed: 14754687]
14. Bianco AT, Smilen SW, Davis Y, Lopez S, Lapinski R, Lockwood CJ. Pregnancy outcome and weight gain recommendations for the morbidly obese woman. *Obstet Gynecol*. 1998; 91:97–102. [PubMed: 9464729]
15. Viswanathan M, Siega-Riz AM, Moos MK, Deierlein A, Mumford S, Knaack J, Thieda P, Lux L, Lohr K. Outcomes of maternal weight gain. *Evid Rep Technol Assess*. 2008; 168:1–223.
16. IOM (Institute of Medicine) Nutrition during pregnancy. Washington, DC: National Academy Press; 1990.
17. IOM (Institute of Medicine) Weight gain during pregnancy: reexamining the guidelines. Washington, DC: The National Academy Press; 2009.
18. Schieve LA, Cogswell ME, Scanlon KS. Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine in a WIC population. *Matern Child Health J*. 1998; 2:111–116. [PubMed: 10728266]

19. 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. [PubMed: 8342716]
20. Peterson DJ, Alexander GR. Seasonal variation in adolescent conceptions, induced abortions, and late initiation of prenatal care. *Public Health Rep*. 1992; 107:701–706. [PubMed: 1454982]
21. Alexander GR, Cornely DA. Prenatal care utilization: its measurement and relationship to pregnancy outcomes. *Am J Prev Med*. 1987; 3:243–253. [PubMed: 3452362]
22. Qin C, Hsia J, Berg CJ. Variation between last-menstrual-period and clinical estimates of gestational age in vital records. *Am J Epidemiol*. 2008; 167:646–652. [PubMed: 18182378]
23. [Last accessed 30 September 2009] State of Missouri Department of Health and Senior Services. Data and Statistical Reports. [Internet]. 2009. Electronic citation. <http://www.dhss.mo.gov/LiveBirths/DataElements.html>
24. 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. [PubMed: 17906005]
25. Galtier-Dereure F, Boegner C, Bringer J. Obesity and pregnancy: complications and cost. *Am J Clin Nutr*. 2000; 71(Suppl):1242S–1248S. [PubMed: 10799397]
26. Crane JMG, White J, Murphy P, Burrage L, Hutchens D. The effect of gestational weight gain by body mass index on maternal and neonatal outcomes. *J Obstet Gynaecol Can*. 2009; 31:28–35. [PubMed: 19208280]
27. Stotland NE, Cheng YW, Hopkins LM, Cuaghey AB. Gestational weight gain and adverse neonatal outcome among term infants. *Obstet Gynecol*. 2006; 108:635–643. [PubMed: 16946225]
28. Lederman SA, Paxton A. Maternal reporting of prepregnancy weight and birth outcome: consistency and completeness compared with the clinical records. *Matern Child Health J*. 1998; 2:123–126. [PubMed: 10728268]
29. Rowland ML. Self-reported weight and height. *Am J Clin Nutr*. 1990; 52:1125–1133. [PubMed: 2239790]
30. Martin JA, Hamilton BE, Sutton PD, Ventura SJ, Menacker F, Munson ML. Division of Vital Statistics. Births: final data for 2003. *Natl Vital Stat Rep*. 2005; 54:1–116.

Table I

Original and revised recommendations IOM recommendations for weight gain during pregnancy

Pre-pregnancy BMI	Weight gain (lbs)
2009 IOM Recommendations	
Underweight (<18.5 kg/m ²)	28–40
Normal (18.5–24.9 kg/m ²)	25–35
Overweight (25–29.9 kg/m ²)	15–25
Obese (≥ 30 kg/m ²)	11–20
1990 IOM Recommendations	
Underweight (<19.8 kg/m ²)	28–40
Normal (19.8–26.0 kg/m ²)	25–35
Overweight (26.1–29 kg/m ²)	15–25
Obese (>29 kg/m ²)	15

Table II

Population characteristics

Characteristic	25–35 lbs (1990 Guidelines)		15–25 lbs (2009 Guidelines)	
	N	(%)	N	(%)
Maternal race *				
Hispanic	690	4.6	499	6.0
White	12068	80.8	6382	76.6
African American	1835	12.3	1246	15.0
Asian/PI	263	1.8	153	1.8
Other	71	0.5	52	0.6
Maternal Age (years)				
<18	376	2.5	238	2.9
18–34	12841	85.9	7142	85.5
35	1738	11.6	970	11.6
Medicaid *	5289	35.5	3480	41.8
Maternal education *				
High	8576	57.6	4119	49.8
Average	4594	30.9	2769	33.4
Low	1706	11.5	1390	16.8
Nulliparous *	6184	41.6	2719	32.8
Smoking status *				
Yes	2094	14.0	1426	17.1
No	12807	85.6	6876	82.3
Unknown	54	0.4	48	0.6
Married *	10717	71.7	5664	67.8
Prenatal care utilization *				
Missing	458	3.1	271	3.2
None	72	0.5	61	0.7
Inadequate	606	4.1	464	5.6
Adequate	7437	49.8	3965	47.6
Intermediate	5515	36.9	3130	37.6
Intensive	847	5.7	440	5.3
Male infant *	7546	50.5	4022	48.2

* $p < 0.001$.

Table III
Birth weight outcomes for infants born to mothers who gained 15–25 *versus* 25–35 pounds.

Birth weight definition	N	(%)	cOR	(95% CI)	aOR*	(95% CI)
Low birth weight (<2500 g)						
15–25 lbs	286	(3.4)	2.13	(1.79, 2.53)	1.99	(1.67, 2.38)
25–35 lbs	245	(1.6)				
SGA 3rd percentile						
15–25 lbs	313	(3.7)	1.88	(1.60, 2.21)	1.76	(1.49, 2.07)
25–35 lbs	303	(2.0)				
SGA 10th percentile						
15–25 lbs	1005	(12.0)	1.56	(1.43, 1.71)	1.57	(1.43, 1.72)
25–35 lbs	1203	(8.0)				
Macrosomia (≥ 4500 g)						
15–25 lbs	49	(0.6)	0.54	(0.39, 0.75)	0.55	(0.40, 0.76)
25–35 lbs	161	(1.1)				
LGA 3rd percentile						
15–25 lbs	109	(1.3)	0.58	(0.47, 0.72)	0.59	(0.47, 0.74)
25–35 lbs	332	(2.2)				
LGA 10th percentile						
15–25 lbs	486	(5.8)	0.60	(0.54, 0.67)	0.61	(0.55, 0.68)
25–35 lbs	1391	(9.3)				

* Adjusted for maternal age, race/ethnicity, education, smoking status, insurance, parity, level of prenatal care, and infant gender.

Table IV

Other infant outcomes.

Infant outcome	N	(%)	cOR	(95% CI)	aOR	(95% CI)
Low Apgar						
25–35 lbs	102	(0.7)				
15–25 lbs	62	(0.8)	1.09	(0.79, 1.50)	1.25	(0.88, 1.78)
Very low Apgar						
25–35 lbs	16	(0.1)				
15–25 lbs	10	(0.1)	1.12	(0.51, 2.47)	1.19	(0.49, 2.90)
Length of stay >5 days						
25–35 lbs	1231	(8.2)				
15–25 lbs	709	(8.5)	1.03	(0.94, 1.14)	1.05	(0.94, 1.16)
Extended length of stay > 10 days						
25–35 lbs	29	(0.2)				
15–25 lbs	19	(0.2)	1.17	(0.66, 2.10)	1.17	(0.61, 2.24)
Respiratory distress syndrome						
25–35 lbs	72	(0.5)				
15–25 lbs	44	(0.5)	1.09	(0.75, 1.59)	1.20	(0.82, 1.75)
Meconium aspiration syndrome						
25–35 lbs	18	(0.1)				
15–25 lbs	9	(0.1)	0.89	(0.40, 1.99)	0.71	(0.30, 1.72)
Birth trauma						
25–35 lbs	279	(1.9)				
15–25 lbs	124	(1.5)	0.79	(0.64, 0.98)	0.84	(0.68, 1.04)
Infection						
25–35 lbs	162	(1.1)				
15–25 lbs	87	(1.0)	0.96	(0.74, 1.25)	0.98	(0.75, 1.28)
Hypoglycemia						
25–35 lbs	66	(0.4)				
15–25 lbs	46	(0.5)	1.25	(0.86, 1.82)	1.22	(0.83, 1.78)
Seizures						
25–35 lbs	23	(0.1)				

Infant outcome	N	(%)	cOR	(95% CI)	aOR	(95% CI)
15–25 lbs	10	(0.1)	0.78	(0.37, 1.64)	0.79	(0.38, 1.68)

* Adjusted for maternal age, race/ethnicity, education, Medicaid, parity, level of prenatal care, and infant gender.