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## Gestational weight gain recommendations in the context of the obesity epidemic

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### Abstract

The impact of the obesity epidemic on women of childbearing age has been of particular concern in recent years as a result of studies linking maternal weight status to long-term adverse outcomes for obese mothers and their offspring. The US Institute of Medicine developed new gestational weight gain guidelines based on this literature that attempts to strike a balance between the known risks and benefits of weight gain during pregnancy. More studies that include large numbers of obese women, examine outcomes beyond the perinatal period, and identify safe and effective pregnancy weight gain interventions are needed before lower weight gain recommendations can be made for obese women.

### Introduction

The World Health Organization (WHO) formally recognized obesity as a global epidemic in 1997 and, an estimated 500 million adults worldwide were obese by 2008.<sup>1,2</sup> The prevalence of obesity continues to rise in industrialized nations and, in many cases, developing nations are observing even more rapid increases. Furthermore, a large proportion of the global disease burden is attributed to the rise in obesity because of its pervasiveness relative to other risk factors and the diversity of its associated health consequences. Its impact on childbearing age women has been of particular concern in the past decade due, in part, to an improved understanding of the role maternal weight status plays on the health of subsequent generations.

In the United States (US), the prevalence of obesity among adult women has more than doubled since the 1970s, but the rate of increase has slowed considerably in the past decade.<sup>3,4</sup> According to the National Health and Nutrition Examination Survey (NHANES), a surveillance system designed to monitor the health status and behaviors of adults in the US, the age-adjusted obesity prevalence among adult females 20 years rose from 16.5% during the 1976–1980 survey to 33.2% during the 1999–2002 survey.<sup>3,5</sup> In contrast, the prevalence increased by less than 3% between the 1999–2002 and 2009–2010 surveys.<sup>4,5</sup> Although nearly all subpopulations have experienced increases, the obesity burden has not

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been evenly distributed across racial/ethnic groups. Among women 20–39 years, the prevalence was greatest among non-Hispanic black women (56.2%) compared to Hispanic (34.4%) and non-Hispanic white (26.9%) women.<sup>4</sup> Of additional concern is the prevalence of obesity among US adolescent girls approaching childbearing age. The prevalence of obesity among US females aged 12–19 years is an estimated 17.1% and the racial/ethnic trends in this age group mirror those observed in adult women.<sup>6</sup>

In the context of the US obesity epidemic, the US Institute of Medicine (IOM) developed new gestational weight gain guidelines in 2009 based on the most recent literature available.<sup>7,8</sup> The revised guidelines differ from those issued in 1990 by providing a weight recommendation specifically for obese women and, in general, using prepregnancy weight status categories that are aligned with the WHO definition. Despite recommending a lower weight gain for obese women, the report was criticized by some health care providers saying the recommendation was still too high for this sub-group.<sup>9</sup> However, given that women who are overweight and obese prior to pregnancy tend to exceed even the 2009 IOM weight gain recommendation, widespread adoption of successful interventions will be needed to shift the weight gain distributions downward for these groups to meet the new guidelines and to warrant their further revision. This paper will briefly review the evidence that led to the 2009 IOM weight gain guidelines, lessons learned from intervention studies that may help achieve targeted weight gains, and where we as a scientific community need to go to refine the guidelines for the future.

## Review of the evidence that led to the 2009 IOM weight gain guidelines

Obesity is known to play a role in the causal mechanisms of many adverse outcomes that may influence a woman's reproductive health including reduced fecundity and fertility, hypertension, sleep disorders, and some cancers.<sup>10</sup> The health risks associated with obesity are further compounded during pregnancy when excess weight poses additional risks to the mother as well as risks to the infant. Pregravid obesity is associated with increased risk of pregnancy complications (e.g. gestational hypertension, preeclampsia, gestational diabetes mellitus [GDM], thromboembolic diseases), intrapartum outcomes (e.g. cesarean delivery), and fetal and infant outcomes (e.g. fetal macrosomia, late fetal death, birth defects, early neonatal death).<sup>11</sup> Obese women also retain more weight and are at greater risk of anemia postpartum. Furthermore, for infants born to mothers who were obese before pregnancy, the protective effects of breast milk may be eliminated or diminished because these mothers are less likely to initiate breastfeeding and tend to breastfeed for shorter durations.<sup>12,13</sup> Given the potential consequences of carrying excess weight during pregnancy, achieving optimal weight gain becomes critically important for pregnant women.

In addition to prepregnancy weight status, maternal gestational weight gain is also an important determinant of health for the mother and child. Studies done from 1990–2007 in the US show that more than 40% of women gained excessively and between 30–40% achieved weight gain within the recommended range according to the 1990 IOM gestational weight gain guidelines.<sup>14</sup> The Agency for Healthcare Research and Quality (AHRQ) funded a systematic review of 150 studies that assessed the short- and long-term effects of maternal weight gain on maternal and infant outcomes. Among the report's key findings was a strong association between high maternal weight gain and increased fetal growth, birthweight, and postpartum weight retention. The review also confirmed that gaining too little weight during pregnancy can be problematic. Low maternal weight gain was associated with poor fetal growth, lower birthweight, and an increased risk of preterm birth. The evidence in support of an association between gestational weight gain and childhood weight status was considered weak at that time. However, recent publications,<sup>15–17</sup> including our own,<sup>18</sup> add further support for an association with childhood weight status. The AHRQ systematic review

served as the scientific basis for the IOM committee's 2009 report that re-evaluated the gestational weight gain guidelines. The committee considered all the evidence from the systematic review in its deliberations, followed a conceptual model, and for the first time considered balancing the short and long-term risks for the mother and infant in determining the appropriate weight gain ranges. This latter part was done by commissioning analyses in which outcomes were evaluated simultaneously for women with varying classes of obesity that extended previously published work and through a quantitative analysis of risk trade-offs between maternal and child health outcomes associated with gestational weight gain.<sup>7</sup>

The weight gain guidance provided by the IOM is individualized to the woman's pregravid BMI (Table 1). It is important to note that the amount and rate of weight gain for obese women was primarily based on data from women in the BMI range of 30–35kg/m<sup>2</sup>, Obesity Grade I. Women with a BMI >35kg/m<sup>2</sup>, receiving good prenatal care and appropriate nutritional counseling may be able to gain less weight, however, at the time of the report, and still today, we do not have sufficient evidence to make this a public health guideline for all obese women.

A [graphic](#) comparing gestational weight gain during 2002–2003 using Pregnancy Risk Assessment Monitoring System (PRAMS) data from multiple states, to the 2009 weight gain recommendations, highlighted the gaps that exist for our field in helping women achieve the targeted weight gains for their respective weight groups.<sup>7</sup> The median weight gain among underweight and normal weight women is close (within ± 2.0lbs) to the midpoint of the range of recommended weight gains for their respective weight classes although the distribution is shifted slightly downward for underweight women and is wider than recommended (with weight gains exceeding the upper limit) for normal weight women. The biggest gaps, however, are observed among women who are overweight and obese prior to pregnancy. The median weight gain for these women exceeds the midpoint of the recommended range by 10.0lbs for overweight women and 9.5lbs for obese women. Similar evidence was found from other population-based data sources. Thus, the results of the IOM 2009 report concluded that there is a great need for randomized trials to help women gain appropriately given the associations between gestational weight gain and several maternal and child health outcomes.<sup>7</sup>

## Studies published since the release of the 2009 IOM guidelines

Since the release of the updated gestational weight gain guidelines in 2009, there has been an increase in the number of published articles describing weight gain patterns for women from various countries, socio-economic statuses, and obese classes.<sup>19–30</sup> According to the Pregnancy Nutrition Surveillance System (PNSS), which monitors health status and nutrition indicators in low-income women enrolled in selected public programs in the US, the gestational weight gain distribution has remained fairly constant over time in this population.<sup>31</sup> In 2010, 21.5% of PNSS-eligible women gained less than the recommended amount of weight based on these guidelines, 30.6% gained within the recommended amount of weight, and 48.0% gained more than the recommended. However, overweight (58.8%) and obese (55.6%) women were significantly more likely to gain more than the recommended amount of weight than underweight (26.2%) and normal weight (38.6%) mothers. One recent US study examining gestational weight gain by obesity classes included several, but not all, perinatal outcomes considered in the IOM 2009 report and concluded that obese women with a BMI >35kg/m<sup>2</sup> can gain no weight, or even lose weight, without having a significant detrimental effect on perinatal outcomes.<sup>20</sup> A large cohort study of women with GDM also found improvements on several maternal and neonatal health indicators among women who lost weight during the third trimester of pregnancy, however, their infants had a higher risk of preterm birth and SGA.<sup>32</sup>

Studies of gestational weight gain conducted in Canadian and Mexican populations that utilize the 2009 IOM guidelines have also been published. In fact, Canada formally adopted the updated IOM gestational weight gain guidelines soon after their release.<sup>33</sup> Kowal et al.<sup>34</sup> published the first study of gestational weight gain trends by weight class using the newly adopted guidelines with data from the 2006–2007 Canadian Maternity Experiences Survey (MES). According to the 2006–2007 MES, the weight distribution of Canadian women delivering singleton, live infants was as follows: 6.1% underweight, 59.4% normal weight, 21.0% overweight, and 13.5% obese. These mothers gained an average of 15.8kg, however, the proportion of women gaining inadequate or excessive weight during pregnancy varied significantly by prepregnancy body mass. Women who were underweight prior to pregnancy gained an average of 17.4kg, more than any other BMI group, but the greatest proportion of women with excessive weight gain was observed among women who were overweight prior to pregnancy. The distribution of maternal weight gain also varied significantly by maternal age, ethnicity, and education level. To our knowledge, there are no ongoing, nationally representative surveillance systems that collect data on weight gain in pregnant or postpartum Mexican women. It is possible, however, to gain some insight on trends in gestational weight gain from hospital- or community-based studies. For example, in a recent study of women seeking prenatal care for singleton pregnancies at the National Institute of Perinatology in Mexico from during 2007–2008, 17% of normal weight women gained above the recommended amount of weight compared to 35.7% of overweight women and 22.4% of obese women. The odds of poor maternal outcomes including GDM, pre-eclampsia, and lack of spontaneous initiation of labor was greatest for obese women in the sample.<sup>35</sup>

### **Lessons learned from intervention studies that may help achieve targeted gestational weight gain goals**

Intervention studies have provided some information about potential mechanisms that help women achieve a healthy weight before, during, and after pregnancy. Interventions during the interconception period generally aim to help women achieve a healthy weight prior to a subsequent pregnancy to decrease their risk of recurrent or new pregnancy complications associated with being at a higher weight status. Since weight loss during pregnancy is not recommended, interventions during pregnancy focus on helping women gain the proper amount of weight based on their prepregnancy weight status.

There are two major types of weight loss interventions during the interconception period: lifestyle (or behavioral) interventions and medical interventions. The results from lifestyle interventions are mixed, yet some studies have demonstrated modest success in helping women lose weight or achieve a healthy weight following pregnancy.<sup>36</sup> On the other side of the spectrum, bariatric surgery is a highly successful weight loss intervention available to women who are the most severely affected by obesity and its associated consequences. Studies comparing pre- and post-surgery perinatal outcomes have reported decreases in the prevalence of pre-eclampsia from 1.5 to 6-fold.<sup>37</sup> A Canadian study also reported a 3-fold decrease in severe obesity, greater insulin sensitivity, and improved lipid profile among children born post-surgery compared to their pre-surgery siblings.<sup>38</sup>

In a systematic review of 88 studies reporting results from lifestyle interventions during pregnancy, Thangaratinam et al.<sup>39</sup> concluded diet, exercise, and combination (diet plus exercise) interventions can be effective in helping women lose weight during pregnancy. The most success, however, was observed in diet-only interventions, which were also effective in decreasing a woman's risk of poor obstetric outcomes (e.g. gestational hypertension, pre-eclampsia, shoulder dystocia). Additionally, there was strong evidence

that neither diet nor physical activity interventions increased the risk of low birthweight or small-for-gestational age.

In another recent systematic review, Brown et al.<sup>40</sup> found that 5 gestational weight gain intervention studies incorporating goal-setting into the program design were successful in significantly restricting weight gain among all intervention group members compared to controls. Furthermore, the majority of these studies exhibited high retention rates, which is encouraging for future studies in this field. On the other hand, due to the wide variability in the interventions examined in this, and interventions of this nature, in general, it is unclear which program aspects are responsible for the weight management success in pregnant women.

## Next Steps to Help Refine the Weight Gain Recommendations

There is a need for more high-quality, randomized trials of lifestyle interventions in preconceptional and pregnant women. In particular, studies should investigate combined nutrition and exercise programs especially targeted to obese women. Current studies often include normal weight and overweight mothers who may differ from obese mothers in important ways that may influence adherence.<sup>36,39–40</sup> It is clear that intervention strategies should consider stages of change, tailored messaging, social cues, and built environment as well as food reward responsiveness and food reinforcement; evidence is growing that the latter two domains may be important in motivating behavior change.<sup>41</sup> The evidence also supports the need for frequent interaction and components that address parenting skills and the stressful lives women lead. These types of studies are often best implemented by an interdisciplinary team of professionals.

While, there is need for studies that include larger numbers of obese women, it is important that the outcomes examined go beyond the perinatal period such that the risks are balanced between the health of the mother and index child, especially given the growing evidence of fetal imprinting with nutritional exposures during the intrauterine environment.<sup>42</sup> Furthermore, without knowing how the obese women were able to lose weight we must question the public health impact of such a recommendation. Strategies such as long period of times without food, use of laxatives or other types of weight loss medications may pose long term health risks to the mother and child. Until we have proof of safe and effective interventions provided to obese women under the care of a prenatal provider that can achieve lower weight gain recommendations, we should not make blanket public health recommendations for all obese women. “Public health recommendations must do no harm” —this was the basic premise of the 2009 IOM weight gain committee and a key element of the public health field.

## Conclusions

Obesity among women of childbearing age is a major public health issue warranting additional studies that investigate its impact on short- and long-term maternal and child outcomes as well as best practices for weight management during pregnancy. In an attempt to strike a balance between the risks and benefits of weight gain during pregnancy for the mother and her offspring, the IOM Committee developed new gestational weight gain guidelines which recommend women in this weight class gain more than the minimum amount of weight necessary for the developing fetus. The recommendation was based on the best scientific evidence available at the time of the report and new evidence does not support a recommendation for weight loss during pregnancy for women of any weight class. The evidence in this area is, however, lacking and future studies should seek to overcome current limitations in this literature by including large numbers of obese women, examining



outcomes beyond the perinatal period, and identifying safe and effective ways to achieve weight loss during pregnancy.

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## References

1. Caballero B. The global epidemic of obesity: An overview. *Epidemiol Rev.* 2007; 29
2. Finucane MM, Stevens GA, Cowan MJ, et al. for the Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group (Body Mass Index). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet.* 2011; 377:557–567. [PubMed: 21295846]
3. Flegal K, Carroll M, Kuczmarski R, Johnson C. Overweight and obesity in the United States: prevalence and trends, 1960–1994. *Int J Obes.* 1998; 22:39–47.
4. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. *JAMA.* 2012; 307:491–497. [PubMed: 22253363]
5. Hedley A, Ogden C, Johnson C, Carroll M, Curtin L, Flegal K. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA.* 2004; 291:2847–2850. [PubMed: 15199035]
6. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *JAMA.* 2012; 307:483–490. [PubMed: 22253364]
7. Rasmussen, KM.; Yaktine, AL., editors. Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. *Weight gain during pregnancy: reexamining the guidelines.* Washington, DC: The National Academies Press; 2009.
8. Siega-Riz AM, Viswanathan M, Moos MK, et al. A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: birthweight, fetal growth, and postpartum weight retention. *Obstet Gynecol.* 2009; 201:339.e1–339.e14.
9. Artal R, Lockwood CJ, Brown HL. Weight gain recommendations in pregnancy and the obesity epidemic. *Obstet Gynecol.* 2010; 115:152–155. [PubMed: 20027048]
10. Bray G. Risks of obesity. *Endocrinol Metab Clin North Am.* 2003; 32:787–804. viii. [PubMed: 14711062]
11. Siega-Riz AM, King JC. American Dietetic Association, American Society of Nutrition. Position of the American Dietetic Association and American Society for Nutrition: obesity, reproduction, and pregnancy outcomes. *J Am Diet Assoc.* 2009; 109:918–927. [PubMed: 19412993]
12. Wojcicki JM. Maternal prepregnancy body mass index and initiation and duration of breastfeeding: A review of the literature. *J Womens Health (Larchmt).* 2011; 20:341–347. [PubMed: 21434834]
13. Amir LH, Donath S. A systematic review of maternal obesity and breastfeeding intention, initiation and duration. *BMC Pregnancy Childbirth.* 2007; 7:9. [PubMed: 17608952]
14. Viswanathan M, Siega-Riz AM, Moos MK, et al. Outcomes of maternal weight gain. *Evid Rep Technol Assess.* 2008; 168:1–223.
15. Oken E, Rifas-Shiman SL, Field AE, Frazier AL, Gillman MW. Maternal gestational weight gain and offspring weight in adolescence. *Obstet Gynecol.* 2008; 112:999–1006. [PubMed: 18978098]
16. Wrotniak BH, Shults J, Butts S, Stettler N. Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. *Am J Clin Nutr.* 2008; 87:1818–1824. [PubMed: 18541573]
17. Nehring I, Lehmann S, von Kries R. Gestational weight gain in accordance to the IOM/NRC criteria and the risk for childhood overweight: a meta-analysis. *Pediatr Obes.* 2013; 8:218–224. [PubMed: 23172639]

18. Deierlein AL, Siega-Riz AM, Adair LS, Herring AH. Effects of pre-pregnancy body mass index and gestational weight gain on infant anthropometric outcomes. *J Pediatr.* 2011; 158:221–226. [PubMed: 20863516]
19. Hedderson MM, Gunderson EP, Ferrara A. Gestational weight gain and risk of gestational diabetes mellitus. *Obstet Gynecol.* 2010; 115:597–604. [PubMed: 20177292]
20. Hinkle SN, Sharma AJ, Dietz PM. Gestational weight gain in obese mothers and associations with fetal growth. *Am J Clin Nutr.* 2010; 92:644–651. [PubMed: 20631201]
21. Misra VK, Hobel CJ, Sing CF. The effects of maternal weight gain patterns on term birth weight in African-American women. *J Matern Fetal Neonatal Med.* 2010; 23:842–849. [PubMed: 20632908]
22. Zonana-Nacach A, Baldenebro-Preciado R, Antonio Ruiz-Dorado M. The effect of gestational weight gain on maternal and neonatal outcomes. *Salud Publica Mexico.* 2010; 52:220–225.
23. Choi S, Park I, Shin J. The effects of pre-pregnancy body mass index and gestational weight gain on perinatal outcomes in Korean women: A retrospective cohort study. *Reprod Biol Endocrinol.* 2011; 9:6. [PubMed: 21241516]
24. Ota E, Haruna M, Suzuki M, et al. Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. *Bull World Health Organ.* 2011; 89:127–136. [PubMed: 21346924]
25. Park S, Sappenfield WM, Bish C, Salihu H, Goodman D, Bensyl DM. Assessment of the Institute of Medicine recommendations for weight gain during pregnancy: Florida, 2004–2007. *Matern Child Health J.* 2011; 15:289–301. [PubMed: 20306221]
26. von Kries R, Ensenauer R, Beyerlein A, Amann-Gassner U, Hauner H, Rosario AS. Gestational weight gain and overweight in children: results from the cross-sectional German KiGGS study. *International Int J Pediatr Obes.* 2011; 6:45–52.
27. Carnero AM, Mejia CR, Garcia PJ. Rate of gestational weight gain, pre-pregnancy body mass index and preterm birth subtypes: a retrospective cohort study from Peru. *BJOG.* 2012; 119:924–935. [PubMed: 22607522]
28. Fernandes TA, Werneck GL, Hasselmann MH. Prepregnancy weight, weight gain during pregnancy, and exclusive breastfeeding in the first month of life in Rio de Janeiro, Brazil. *J Hum Lact.* 2012; 28:55–61. [PubMed: 22267319]
29. Rode L, Kjaergaard H, Ottesen B, Damm P, Hegaard HK. Association between gestational weight gain according to body mass index and postpartum weight in a large cohort of Danish women. *Matern Child Health J.* 2012; 16:406–413. [PubMed: 21431860]
30. Tsai I, Chen C, Sun F, Wu C, Yeh S. Associations of the pre-pregnancy body mass index and gestational weight gain with pregnancy outcomes in Taiwanese women. *Asia Pac J Clin Nutr.* 2012; 21:82–87. [PubMed: 22374564]
31. Dalenius, K.; Brindley, P.; Smith, B.; Reinold, C.; Grummer-Strawn, L. *Pregnancy Nutrition Surveillance 2010 Report.* Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2012.
32. Yee LM, Cheng YW, Inturrisi M, Caughey AB. Gestational weight loss and perinatal outcomes in overweight and obese women subsequent to diagnosis of gestational diabetes mellitus. *Obesity.* 2013 published online.
33. Health Canada. Canadian gestational weight gain recommendations. Available at <http://www.hc-sc.gc.ca.ezproxy.library.yorku.ca/fn-an/nutrition/prenatal/qa-gest-gros-qr-eng.php>.
34. Kowal C, Kuk J, Tamim H. Characteristics of weight gain in pregnancy among Canadian women. *Matern Child Health J.* 2012; 16:668–676. [PubMed: 21431862]
35. Reyes E, Martinez N, Parra A, Castillo-Mora A, Ortega-Gonzalez C. Early intensive obstetric and medical nutrition care is associated with decreased prepregnancy obesity impact on perinatal outcomes. *Gynecol Obstet Invest.* 2012; 73:75–81. [PubMed: 21893947]
36. Amorim Adegboye A, Linne Y, Lourenco P. Diet or exercise, or both, for weight reduction in women after childbirth. *Cochrane Database Syst Rev.* 2007; 3:CD005627. [PubMed: 17636810]
37. Vrebosch L, Bel S, Vansant G, Guelinckx I, Devlieger R. Maternal and neonatal outcome after laparoscopic adjustable gastric banding: a systematic review. *Obesity Surg.* 2012; 22:1568–1579.

38. Smith J, Cianflone K, Biron S, et al. Effects of maternal surgical weight loss in mothers on intergenerational transmission of obesity. *J Clin Endocrinol Metab.* 2009; 94:4275–4283. [PubMed: 19820018]
39. Thangaratinam S, Rogoziska E, Jolly K, et al. Interventions to reduce or prevent obesity in pregnant women: a systematic review. *Health Technol Assess.* 2012; 16:iii–iv. 1–191. [PubMed: 22814301]
40. Brown MJ, Sinclair M, Liddle D, Hill AJ, Madden E, Stockdale J. A systematic review investigating healthy lifestyle intervention incorporating goal setting strategies for preventing excess gestational weight gain. *PLoS ONE.* 2012; 7:e39503. [PubMed: 22792178]
41. Burger KS, Stice E. Variability in reward responsivity and obesity: evidence from brain imaging studies. *Curr Drug Abuse Rev.* 2011; 4:182–189. [PubMed: 21999692]
42. Dyer JS, Rosenfeld CR. Metabolic imprinting by prenatal, perinatal, and postnatal overnutrition: A review. *Semin Reprod Med.* 2011; 29:266–276. [PubMed: 21769766]



**Table 1**

Gestational weight gain recommendations by maternal prepregnancy body mass index—US Institute of Medicine, 2009.

Prepregnancy BMI	Total weight gain (lb, kg)	Rate of weight gain in the 2 <sup>nd</sup> and 3 <sup>rd</sup> trimesters (lb/wk, kg/wk)
Underweight (< 18.5 kg/m <sup>2</sup> )	28–40, 12.5–18	1.0 (1.0–1.3), 0.51 (0.44–0.58)
Normal-weight (18.5–24.9 kg/m <sup>2</sup> )	25–35, 11.5–16	1.0 (0.8–1.0), 0.42 (0.35–0.50)
Overweight (25.0–29.9 kg/m <sup>2</sup> )	15–25, 7–11.5	0.6 (0.5–0.7), 0.28 (0.23–0.33)
Obese (≥ 30.0 kg/m <sup>2</sup> )	11–20, 5–9	0.5 (0.4–0.6), 0.22 (0.17–0.27)