Gestational weight gain trajectories in primary care

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Abstract

Objective To identify gestational weight gain trajectories, stratified by prepregnancy body mass index (BMI), of women with singleton pregnancies who received prenatal care in a primary care setting, and to compare these trajectories with the 2009 Institute of Medicine gestational weight gain recommendations.

Design Retrospective cohort study.

Setting Halifax, NS.

Participants Women who received prenatal care at the Dalhousie Family Medicine clinics in Halifax from 2009 to 2013.

Main outcome measures For each prenatal visit, gestational age and weight measurements were obtained. Multilevel modeling was used to analyze the gestational weight gain trajectories. The upper limit of the guideline-recommended weekly gestational weight gain was compared with the 95% CI of the observed mean weekly gestational weight gain for each prepregnancy BMI category.

Results A total of 280 women were included in the analyses. There was a significant interaction between prepregnancy BMI category and gestational weight gain over time ($P<.001$), with gestational weight gain being significantly lower among women with prepregnancy BMI of 30.0 kg/m^2 or greater compared with those with BMI of 18.5 to less than 25.0 kg/m^2 and 25.0 to less than 30.0 kg/m^2. When comparing women's weight gain with the recommendations, women with prepregnancy BMI of 25.0 to less than 30.0 kg/m^2 had the most guideline discordance, deviating from the weight gain recommendations at 20 weeks' gestation.

Conclusion These results are relevant and of benefit to women and clinicians wishing to address excess gestational weight gain, and to researchers and policy makers developing interventions aimed at curbing gestational weight gain in primary care. Although our results showed women with prepregnancy BMI of 25.0 to less than 30.0 kg/m^2 gained the most excess, guideline-discordant weight, interventions should target all women planning or experiencing a pregnancy.

EDITOR'S KEY POINTS

- Studies have shown that 50% to 60% of women gain more than the recommended amount of weight during pregnancy. This study aimed to understand how prepregnancy body mass index (BMI) influenced gestational weight gain trajectories among women who received their prenatal care in a primary care setting.

- The authors found a significant interaction between prepregnancy BMI category and gestational weight gain over time ($P<.001$). There was no significant direct or interactive effect of age, parity, or smoking status. Women who were overweight before pregnancy deviated from the weight gain recommendations most often and earlier (from 20 weeks' gestation). Women who were of normal weight or obese before pregnancy deviated from the guidelines later, from approximately 35 weeks' gestation onward. Underweight women had to be excluded owing to low numbers.

- The implication for clinical practice is that women with prepregnancy BMI of 25.0 to less than 30.0 kg/m^2 are in particular need of advice and support to achieve appropriate gestational weight gain; however, interventions should target all women planning or experiencing pregnancy.

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Trajectoires du gain pondéral gestationnel en soins primaires

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Résumé

Objectif Déterminer les trajectoires de gain pondéral gestationnel, stratifiées en fonction de l'indice de masse corporelle (IMC) des femmes avant la grossesse, chez des femmes à grossesse unique qui recevaient des soins prénatals en milieu de soins primaires, et comparer ces trajectoires avec les recommandations de 2009 en matière de gain pondéral gestationnel de l'Institute of Medicine.

Conception Étude rétrospective de cohortes.

Contexte Halifax, N.-É.

Participantes Des femmes recevant des soins prénatals dans des cliniques de médecine familiale à Halifax, de 2009 à 2013.

Principaux paramètres à l'étude À chaque visite prénatale, on consignait l'âge gestationnel et la mesure du poids. Une modélisation à niveaux multiples a servi à analyser les trajectoires du gain pondéral gestationnel. La limite supérieure du gain pondéral gestationnel par semaine recommandée dans les lignes directrices était comparée à la moyenne du gain pondéral gestationnel hebdomadaire observé avec un IC à 95 % pour chaque catégorie d'IMC avant la grossesse.

Résultats Au total, 280 femmes ont été incluses dans les analyses. Il y avait une interaction significative entre la catégorie d'IMC avant la grossesse et le gain pondéral gestationnel avec le temps ($p < ,001$), ce gain de poids gestationnel étant considérablement plus faible chez les femmes dont l'IMC était de 30 kg/m^2 ou plus en comparaison de celles dont l'IMC situait entre 18,5 et moins de 25 kg/m^2 et celles chez qui l'IMC variait entre 25 et moins de 30 kg/m^2. Dans la comparaison entre le gain pondéral des femmes et les recommandations, les femmes dont l'IMC se situait entre 25 et moins de 30 kg/m^2 se conformaient le moins aux lignes directrices, et la déviation aux recommandations sur le gain pondéral commençait à 20 semaines de gestation.

Conclusion Ces résultats sont pertinents et susceptibles d'être utiles pour les femmes et les cliniciens qui souhaitent éviter un gain pondéral gestationnel excessif ainsi qu'aux chercheurs et aux décideurs qui élaborent des interventions en soins primaires visant à freiner le gain de poids gestationnel. Même si nos résultats ont démontré que les femmes ayant un IMC de 25 à moins de 30 kg/m^2 avaient pris le plus de poids excessif par rapport aux lignes directrices, les interventions devraient cibler toutes les femmes enceintes ou prévoyant une grossesse.

POINTS DE REPÈRE DU RÉDACTEUR

- Des études ont démontré que de 50 à 60 % des femmes prennent plus de poids que recommandé durant la grossesse. Cette étude visait à comprendre comment l'indice de masse corporelle (IMC) avant la grossesse influençait les trajectoires du gain pondéral gestationnel chez des femmes qui recevaient leurs soins prénatals en milieu de soins primaires.

- Les auteurs ont cerné une interaction significative entre la catégorie d'IMC avant la grossesse et le gain pondéral gestationnel avec le temps ($p < ,001$). Il n'y avait pas d'effet direct ou interactif significatif selon l'âge, la parité ou le tabagisme. Les femmes qui avaient un surpoids avant la grossesse déviaient des recommandations sur le gain de poids plus souvent et plus tôt (à partir de la 20^e semaine de gestation). Les femmes de poids normal ou obèses avant la grossesse déviaient des lignes directrices plus tard, à partir environ de la 35^e semaine de gestation. Les femmes de poids insuffisant ont été exclues en raison de leur faible nombre.

- Pour la pratique clinique, ces constatations signifient que les femmes dont l'IMC avant la grossesse se situe entre 25 et moins de 30 kg/m^2 ont particulièrement besoin de conseils et de soutien pour atteindre un gain pondéral gestationnel approprié; toutefois, les interventions devraient cibler toutes les femmes prévoyant une grossesse ou enceintes.

Cet article a fait l'objet d'une révision par des pairs.
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Guidelines for optimal gestational weight gain have been evolving over the past half century. Owing to the observation that the amount of weight gained by women was correlated with the size of their babies, and delivery of bigger babies was associated with an increased risk of intrapartum difficulties, earlier recommendations were for women to limit weight gain to a maximum of 6.8 kg.[1] However, concerns about low birth weight began to surface, prompting a review of the scientific evidence in 1970.[2] This work showed that low birth weight, a risk factor for infant morbidity and mortality, was associated with restricted gestational weight gain. As a result, the gestational weight gain recommendation was increased to 9 to 11.4 kg. A subsequent reexamination of the epidemiologic data by the Institute of Medicine (IOM) led to a new report, published in 1990.[3] This report balanced the risks of inadequate and excessive gestational weight gain and considered the outcomes for both mothers and babies. It contained recommendations for gestational weight gain that were, for the first time, based on a woman's prepregnancy body mass index (BMI), and specified higher weight gains compared with earlier recommendations. Although the evidence for these guidelines was controversial,[4-6] proponents argued that a substantial body of literature demonstrated that gestational weight gain concordant with the guidelines was consistently associated with better outcomes than guideline-discordant gestational weight gain.[7-20]

The 1990 guidelines were revised in 2009 by the IOM,[21] primarily to reflect a demographic shift to a larger percentage of women (49%) entering pregnancy at elevated BMIs.[22] The 2009 IOM guidelines align with the World Health Organization categories to define prepregnancy BMI, rather than the Metropolitan Life Insurance tables used in the 1990 IOM guidelines. As a result, fewer women are now categorized as *underweight* and more are categorized as *overweight*.

These most recent guidelines provide weekly and total gestational weight gain recommendations, the latter assuming a term pregnancy (≥37 weeks' gestation). Women entering pregnancy with a low BMI (ie, <18.5 kg/m^2) are advised to gain an average of 0.5 kg per week for a total of 12.5 to 18.0 kg over the course of the pregnancy. At the other end of the spectrum, women with a prepregnancy BMI of 30.0 kg/m^2 or higher should limit their weekly weight gain to 0.2 kg and their total weight gain to 5.0 to 9.0 kg.

Unfortunately, adherence to these recommendations is suboptimal. Currently, in North America, 50% to 60% of women gain weight in excess of the guidelines.[18,23-29] While there is still concern regarding insufficient gestational weight gain, there is now considerable focus on the substantial adverse prenatal, intrapartum, and short- and long-term postpartum outcomes for mothers and their offspring associated with excess gestational weight gain.[30-36]

Efforts to understand excess gestational weight gain have been in part informed by studies exploring the patterns of women's weight gain in pregnancy. Such studies have demonstrated that gestational weight gain is typically lowest in the first trimester and greatest in the second trimester,[1,7,9,37-39] with similar gestational weight gain trajectories for women with prepregnancy BMIs in the overweight or obese range and lower and similar trajectories for women with prepregnancy BMIs in the normal or underweight range.[7,9] However, these studies were conducted before the shift in the demographic makeup of women entering pregnancy, the increase in incidence of excess gestational weight gain, and the change in the definition of prepregnancy BMI categories. We therefore believe it is time to reexamine these trajectories.

To our knowledge, an examination of gestational weight gain trajectories, stratified by prepregnancy BMI, of women with singleton pregnancies who received prenatal care specifically in a primary care setting, and the comparison of these trajectories to the minimum and maximum gestational weight gain trajectories within each prepregnancy BMI category as recommended in the 2009 IOM guidelines, has not been undertaken.

We aimed to answer the following research questions: Does prepregnancy BMI influence the trajectory of gestational weight gain among women with singleton pregnancies receiving prenatal care in primary care? and What is the discordance between actual and targeted weight gain by gestational age, based on the 2009 IOM guidelines, among women with singleton pregnancies receiving prenatal care in primary care?

METHODS

Approval was obtained from the Capital District Health Authority Research Ethics Board. In order to obtain a sufficient number of participants for this study, the prenatal forms in the electronic medical records (EMRs) of women who received prenatal care at the 2 Dalhousie Family Medicine clinics in Halifax, NS, from January 1, 2009, to December 31, 2013, were reviewed. The starting point was chosen because women's prenatal forms were integrated into the EMR on that date. Exclusion criteria were insufficient information to calculate prepregnancy BMI; a single prenatal visit; multiple-gestation pregnancy; anatomic or genetic abnormality; and the absence of prenatal visits beyond 20 weeks' gestation, as the lack of prenatal visits within primary care after this stage in pregnancy could be indicative of a problem with the pregnancy.

The following data were extracted from the charts: prepregnancy weight, height, age, parity, and smoking status. If the prepregnancy weight was not available, a weight measurement taken in the first trimester was

used as a surrogate for prepregnancy weight.[40] For each prenatal visit, gestational age and weight measurements were obtained.

Data were entered into an electronic spreadsheet; prepregnancy BMI was calculated from the prepregnancy weight (or surrogate) and height. This was then converted into prepregnancy BMI categories: less than 18.5 kg/m^2, 18.5 to less than 25.0 kg/m^2, 25.0 to less than 30.0 kg/m^2, and 30.0 kg/m^2 or greater.

Frequencies and means by prepregnancy BMI category were generated for the demographic variables (age, parity, and smoking status). For each prenatal visit, gestational weight gain was calculated by subtracting the prepregnancy weight from the weight at that visit.

Multilevel modeling (MLM) using Hierarchical Linear Modeling software 7.01 was used to analyze the gestational weight gain trajectories.[41] Using MLM has a number of advantages over other statistical methods for studying longitudinal data. It can model nonlinear processes, of which gestational weight gain is an example, and does not require the assumption of independence between measurements. Further, MLM is able to address the problem of combining data from participants who had measurements at different times, a scenario that results in a high percentage of missing data.[42,43]

First we tested a nonconditional model (without predictors) using both linear and nonlinear trajectories. Using robust standard errors, we found a significant effect for the linear (b = -0.1891, SE = 0.08868, $P < .05$), quadratic (b = 0.02594, SE = 0.00361, $P < .001$), and cubic (b = -0.0003, SE = 0.00005, $P < .001$) slopes. We examined possible predictors (age, parity, smoking status), adding them to each of the slopes. The final model examined the direct and interactive effect of significant ($P < .05$) predictors.

To analyze the divergence from recommended gestational weight gain, the upper limit of the guideline-recommended weekly weight gain was compared with the 95% CI of the mean weekly gestational weight gain for each prepregnancy BMI category.

RESULTS

A total of 356 women were identified using the ICD-9 code V221: "Supervision of other normal pregnancy." Seventeen women were excluded because we did not have sufficient information to calculate prepregnancy BMI; 7 women had only 1 weight measurement available; 1 woman was carrying twins; and 45 women did not have prenatal visits beyond 20 weeks' gestation. Of the remaining 286 women, 6 (2.1%) had prepregnancy BMI less than 18.5 kg/m^2. Although this is an important BMI category to consider, they had to be excluded from further analyses because of the low count.

The following frequencies and means were calculated for the remaining 280 participants. The mean (SD) age was 28.9 (5.3) years, ranging from 16 to 41 years. The mean (SD) prepregnancy BMI was 26.5 (5.9) kg/m^2, with a range of 18.5 to 52.6 kg/m^2. Half (n = 140) of the participants had prepregnancy BMI of 18.5 to less than 25.0 kg/m^2, 28.9% (n = 81) had prepregnancy BMI of 25.0 to less than 30.0 kg/m^2, and 21.1% (n = 59) had prepregnancy BMI of 30.0 kg/m^2 or greater. Most participants were non-smokers (87.5%); 47.5% were nulliparous, 37.5% were primiparous, and 15.0% were multiparous. These results were further calculated by prepregnancy BMI category (**Table 1**).

Prenatal visits (data points) began between 5 and 13 weeks' gestation for 213 (76.1%) of the participants. The total number of data points for the sample was 2883 (mean 10.3, range 2 to 17).

There was a significant interaction between prepregnancy BMI category and gestational weight gain over time (b = -0.08, SE = 0.02, $P < .001$), as illustrated in **Figure 1**, with a significant difference between prepregnancy BMI of 30.0 kg/m^2 or greater compared with prepregnancy BMI of 18.5 to less than 25.0 kg/m^2 and 25.0 to less than 30.0 kg/m^2. There was no significant difference between prepregnancy BMI of 18.5 to less than 25.0 kg/m^2 and 25.0 to less than 30.0 kg/m^2. The results showed a pattern wherein women with prepregnancy BMI of 30.0 kg/m^2 or greater had a slower rate of weight gain compared with women in the other prepregnancy BMI categories. There was no significant direct or interactive effect of the predictors (ie, age, parity, smoking status).

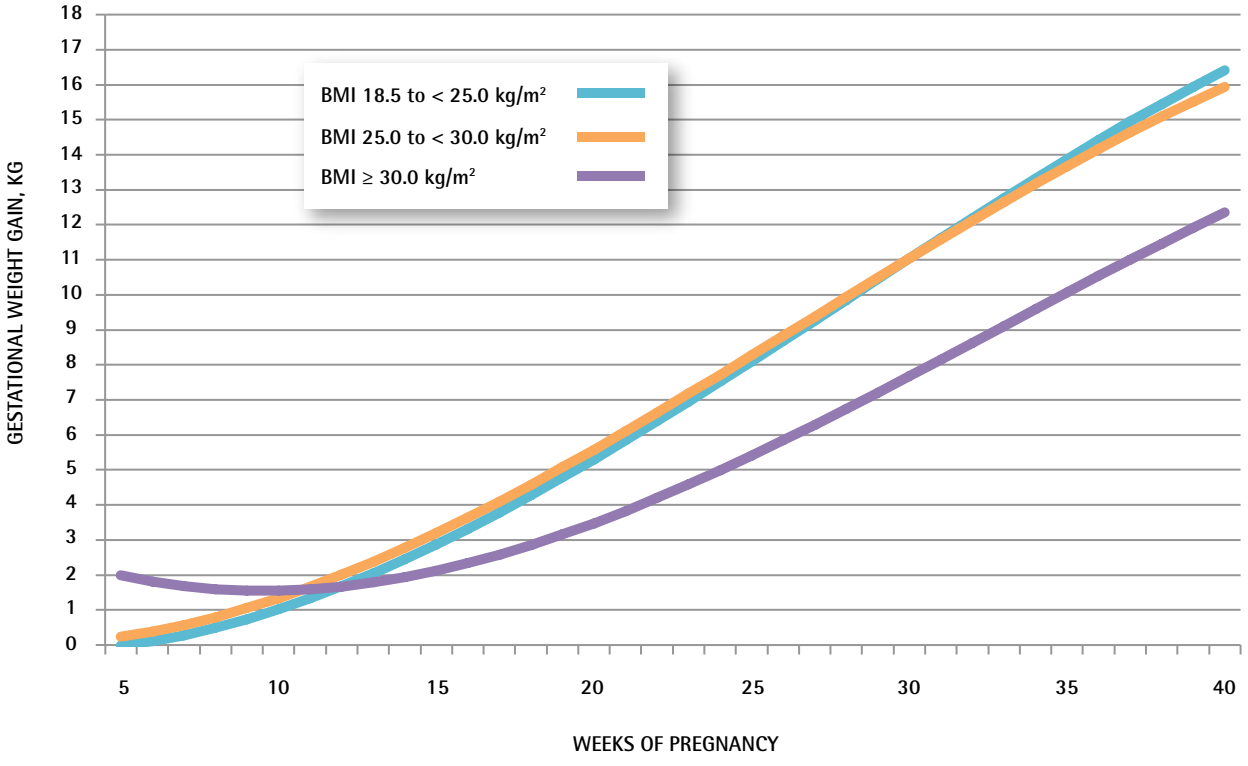
When comparing women's weight gain with the 2009 IOM weight gain recommendations, women with prepregnancy BMI of 25.0 to less than 30.0 kg/m^2 had the most discordance with the guidelines, as shown in **Figures 2** to **4**.[21] For this group, the lower limit of the

Table 1. Participant characteristics by prepregnancy BMI category

CHARACTERISTIC	PREPREGNANCY BMI CATEGORY		
	18.5 TO 24.9 kg/m^2 (N = 140)	25.0 TO 29.9 kg/m^2 (N = 81)	≥ 30.0 kg/m^2 (N = 59)
Mean (SD) age, y	29.2 (5.4)	28.3 (5.3)	29.5 (5.1)
Age range, y	17-41	16-40	19-41
Mean (SD) BMI, kg/m^2	22.0 (1.7)	26.9 (1.3)	35.8 (4.5)
Nulliparous, %	50.0	44.4	45.8
Non-smokers, %	89.3	86.4	84.7
Mean (SD) weight gain at term, kg	16.1 (4.6)*	15.8 (6.6)†	11.4 (6.8)‡

BMI—body mass index.
*N = 105.
†N = 70.
‡N = 48.

Figure 1. Gestational weight gain trajectories by prepregnancy BMI category: *There was a significant interaction between prepregnancy BMI category and gestational weight gain over time (b = -0.08, SE = 0.02, P < .001), with a significant difference between prepregnancy BMI of 30.0 kg/m² or greater compared with prepregnancy BMI of 18.5 to less than 25.0 kg/m² and 25.0 to less than 30.0 kg/m².*



BMI—body mass index.

95% CI for mean gestational weight gain was higher than the maximum guideline-recommended amount from 20 weeks' gestation onward. In comparison, the gestational weight gain trajectories of women with prepregnancy BMI of 18.5 to less than 25.0 kg/m² and 30.0 kg/m² or greater deviated from the guidelines later, from approximately 35 weeks' gestation onward.

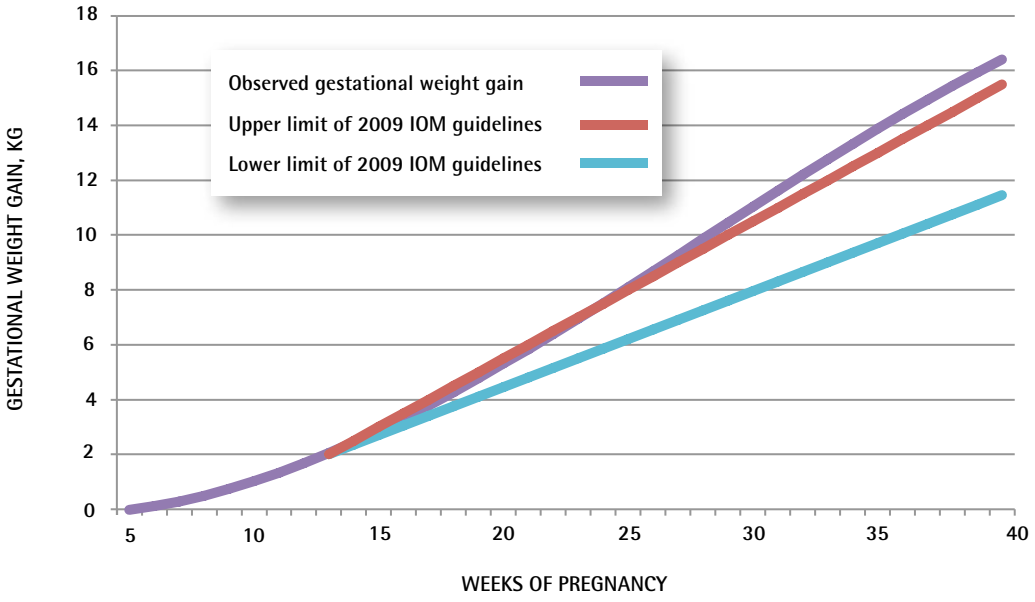
DISCUSSION

Consistent with previous research,[7,9,25,26,44-46] women with prepregnancy BMI of 25.0 to less than 30.0 kg/m² gained excess weight more frequently than women in other prepregnancy BMI categories did. Women with prepregnancy BMI of 30.0 kg/m² or greater gained weight at a slower rate than all other women, and the slope of their weight gain trajectory was significantly different from the slopes of women in other prepregnancy BMI categories.

Of importance, and to our knowledge new to the literature, we demonstrated that women with prepregnancy BMI of 25.0 to less than 30.0 kg/m² began to deviate from the 2009 IOM recommendations as early as 20 weeks' gestation, much earlier than all other women. Compared with women with prepregnancy BMI of 18.5 to less than 25.0 kg/m², these women have more difficulty managing their weight outside of pregnancy and their recommended gestational weight gain is lower. So perhaps it is understandable that they would be more likely to gain in excess of the guidelines and do so at an earlier point in pregnancy. However, it is difficult to explain why women in the highest prepregnancy BMI category did not have similar results.

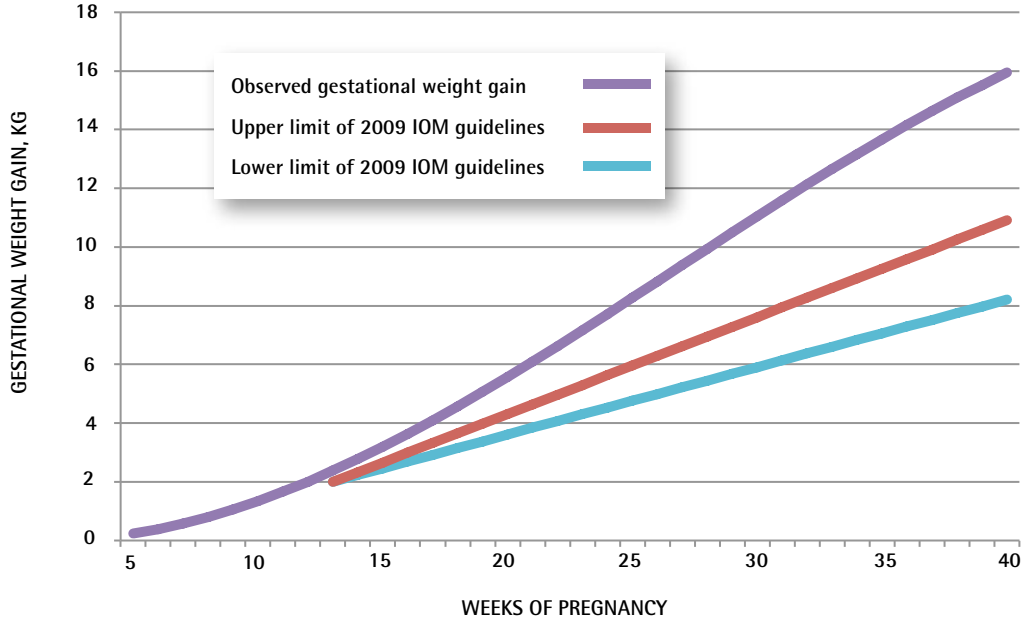
The implication for clinical practice, given that provider advice has been shown to influence gestational weight gain,[47,48] is that women with prepregnancy BMI of 25.0 to less than 30.0 kg/m² are the ones who are in particular need of advice and support, preferably from credible sources such as their prenatal care providers, to achieve guideline-concordant gestational weight gain. Based on these results and on positive predictive values for excess gestational weight gain found in previous

Figure 2. Observed gestational weight gain compared with the 2009 IOM guidelines[21] for those with prepregnancy BMI of 18.5 to < 25.0 kg/m²



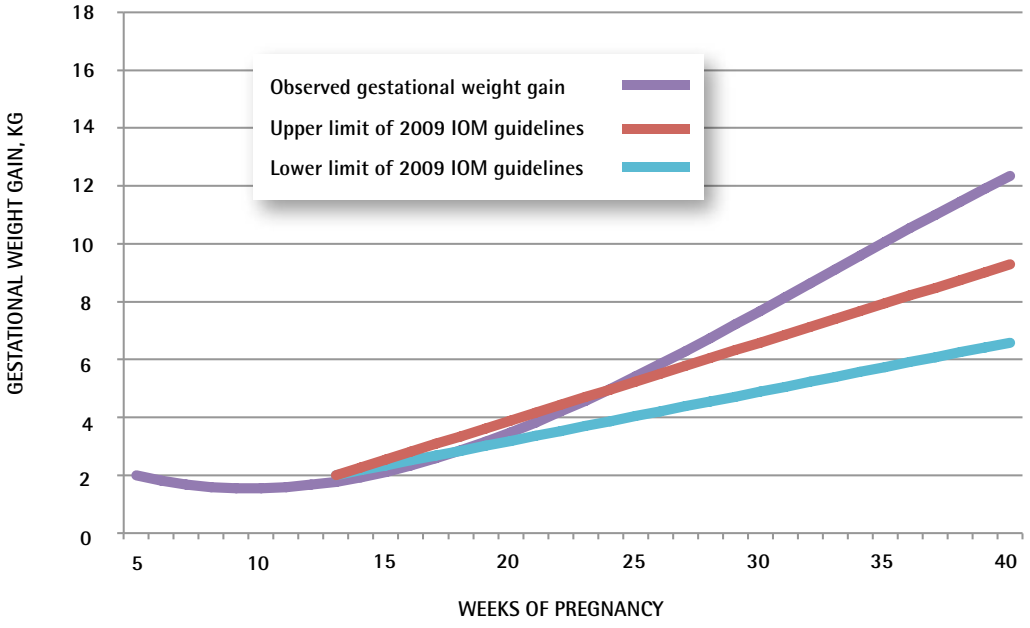
BMI—body mass index, IOM—Institute of Medicine.

Figure 3. Observed gestational weight gain compared with the 2009 IOM guidelines[21] for those with prepregnancy BMI of 25.0 to < 30.0 kg/m²



BMI—body mass index, IOM—Institute of Medicine.

Figure 4. Observed gestational weight gain compared with the 2009 IOM guidelines[21] for those with prepregnancy BMI ≥ 30.0 kg/m²



BMI—body mass index, IOM—Institute of Medicine.

research,[45,49] we suggest that this would be best initiated early in pregnancy.

Limitations

There are several limitations to this study. Specifically, all data were obtained from EMRs. We were therefore not able to determine with confidence that all the participants had low-risk pregnancies, and we could not obtain data on potential confounders pertaining to women's contexts, such as cultural background, physical activity level, and diet. In addition, some of the participants received prenatal care before the 2009 IOM guidelines were published and the gestational weight gain advice these women might have received would have pertained to the 1990 IOM guidelines.

Finally, it was unfortunate that we had to exclude women with prepregnancy BMI less than 18.5 kg/m² owing to their low numbers. This is a group that should be specifically addressed in future research comparing actual to recommended gestational weight gain.

Conclusion

The understanding of gestational weight gain trajectories by prepregnancy BMI category among women with singleton pregnancies receiving prenatal care in a primary care setting, and how these trajectories relate to the 2009 IOM recommendations, will be of benefit to researchers and policy makers developing contextually based interventions aimed at curbing gestational weight gain. Although our results showed women with prepregnancy BMI of 25.0 to less than 30.0 kg/m² gained the most excess, guideline-discordant weight, such interventions should target all women planning or undergoing a pregnancy.

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Contributors
All authors contributed to the concept and design of the study; data gathering, analysis, and interpretation; and preparing the manuscript for submission.

Competing interests
None declared

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