

# Pregnancy weight gain: still controversial<sup>1-4</sup>

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**ABSTRACT** During the 20th century, recommendations for maternal weight gain in pregnancy were controversial, ranging from rigid restriction to encouragement of ample gain. In 1990, the Institute of Medicine (IOM) recommended weight-gain ranges with the primary goal of improving infant birth weight. These guidelines were widely adopted but not universally accepted. Critics have argued that the IOM's recommendations are unlikely to improve perinatal outcomes and may actually increase the risk of negative consequences to both infants and mothers. We systematically reviewed studies that examined fetal and maternal outcomes according to the IOM's weight-gain recommendations in women with a normal prepregnancy weight. These studies showed that pregnancy weight gain within the IOM's recommended ranges is associated with the best outcome for both mothers and infants. However, weight gain in most pregnant women is not within the IOM's ranges. All of the studies reviewed were observational and there is a compelling need to conduct experimental studies to examine interventional strategies to improve maternal weight gain with the objective of optimizing health outcomes. *Am J Clin Nutr* 2000;71(suppl):1233S-41S.

**KEY WORDS** Weight gain, pregnancy, birth weight, postpartum weight, preterm delivery, maternal health, Institute of Medicine

## INTRODUCTION

During the past 50 y, recommendations for pregnancy weight gain have been highly controversial in the United States. During the first half of the century, American obstetricians restricted weight gain during pregnancy to prevent toxemia, difficult births, and maternal obesity. *Williams' Obstetrics* (1), a prestigious American textbook, stated in 1966 that "Excessive weight gain in pregnancy is highly undesirable for several reasons; it is essential to curtail the increment in gain to 25 lb (12.5 kg) at most or preferably 15 lb (6.8 kg). The experienced obstetrician is convinced of the complications, both major and minor, caused by excessive weight gain in pregnancy. Although restriction of the gain in weight to 20 lb (9.1 kg) may be difficult in many cases, requiring careful dietary control and discipline, it is a highly desirable objective."

This policy of severe weight restriction was challenged in the 1960s, when experts began to recognize that the relatively high rates of infant mortality, disability, and mental retardation seen in the United States were a function of low birth weight. In 1970, a review of the scientific evidence by the National Academy of Sciences concluded that the usual practice of restricting maternal

weight gain was associated with increased risk of low birth weight. The National Academy of Sciences Committee on Maternal Nutrition concluded that a weight-reduction program that distorts normal prenatal gain should not be followed during pregnancy and increased the formal recommendation for pregnancy weight gain to 9–11.4 kg (2).

A few years after the policy of weight-gain restriction was lifted, average prenatal weight gain in US women increased from ≈9 to ≈12 kg; in some settings, averages were as high as 14 kg. The results of studies conducted from 1942 to 1983 of mean pregnancy weight gain and mean birth weight in full-term infants are shown in **Figure 1** (3, 4). These crude data clearly show that after weight-gain recommendations were liberalized, there was an increase in the means of both pregnancy weight gain and infant birth weight.

This increase, combined with a need to reassess the burgeoning scientific literature addressing the relation between pregnancy weight gain and various maternal and fetal outcomes, led to a new report from the Institute of Medicine (IOM) of the National Academy of Sciences that reexamined maternal nutrition (4). Published in 1990, the report confirmed a strong association between pregnancy weight gain and infant size and provided target ranges of recommended weight gains by prepregnancy body mass index (BMI; in kg/m<sup>2</sup>). These recommendations are known as the "IOM's recommended weight-gain ranges" and are shown in **Table 1**. For example, a gain of 11.5–16 kg is recommended for pregnant women who start pregnancy with a normal prepregnant BMI (ie, 19.8–26).

In the almost 10 y since the IOM's report was published, a large body of literature has continued to accrue, addressing not only birth weight but also other outcomes related to labor, delivery, and

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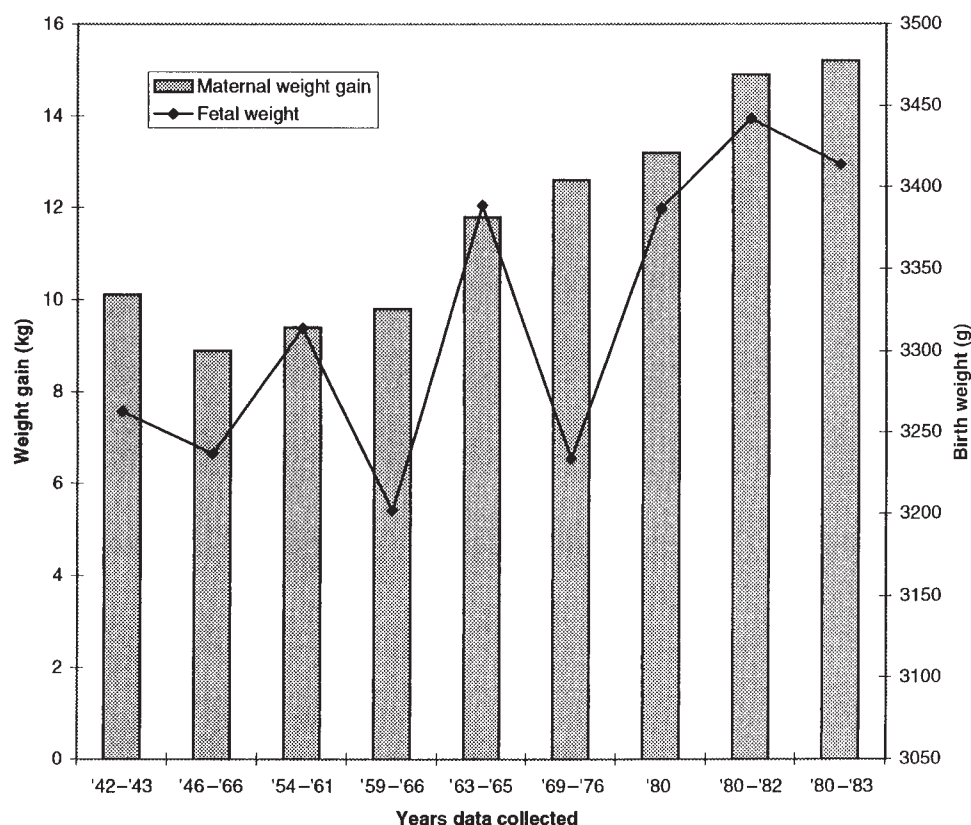


FIGURE 1. Studies reporting pregnancy weight gain and birth weight by the range of years in which the data were collected. Adapted from reference 4.

maternal postpartum weight status. In the same period, average pregnancy weight gain in some settings has continued to increase.

This new national recommendation concerning pregnancy weight gain was widely adopted, but not universally accepted. In 1996, Johnson and Yancey (5) critiqued the IOM's recommendations, arguing that these recommendations were unlikely to improve perinatal outcomes and would increase negative consequences to both infant and mother (5). Feig and Naylor (6), who contend that evidence of benefit of the IOM's recommendations is weak and that wide dissemination of these recommendations could do more harm than good, recently echoed these concerns. They recommend a weight-gain range of 7–11.5 kg for women with a normal prepregnant BMI, which is roughly equivalent to recommendations from 30 y ago.

It is important to consider the underlying issues in this controversy. Those who question the IOM's weight-gain recommendations believe that the goal of the IOM's Committee on Maternal Nutritional Status during pregnancy and lactation to increase the upper limit of acceptable maternal weight gain to increase birth weight is misguided. Instead, they fear that weight gains within the IOM's recommended ranges will produce overgrown newborns at increased risk of being born by cesarean delivery and obese mothers (5, 6).

An additional concern relates to the routine monitoring of maternal weight gain as part of clinical practice. Despite the widespread measurement of maternal weight gain during pregnancy, almost no data have been published assessing the usefulness or negative consequences of weighing women. Two studies that retrospectively assessed the sensitivity and specificity of this indicator concluded that maternal weight gain alone is neither a

sensitive nor a specific predictor of poor pregnancy outcome (7, 8). Because the amount of total weight gain is widely variable among women with good pregnancy outcomes (9, 10), and because the perinatal outcomes of interest are multifactorial in origin, no one should expect that weight gain alone is a perfect diagnostic or screening tool. Nonetheless, as will be discussed below, weight gains outside the IOM's recommended ranges are associated with twice as many poor pregnancy outcomes than are weight gains within the ranges. In addition, the results of numerous studies suggest that deviations in maternal weight gain can act as useful markers of biological and social factors that relate to poor pregnancy outcome.

In a study of the determinants of pregnancy weight gain in 3870 women, Caulfield et al (11) found that women with low weight gains are more likely to be young, short, thin, less educated, smokers, and black than are women with weight gains within the IOM's recommended ranges, and that women with excessive weight gains are more likely to be tall, heavy, primiparous, hypertensive, and white. Hickey et al (12), who studied 806 high-risk women in Alabama, reported an increased risk of low weight gain in white women who had poor scores on psychosocial scales measuring trait anxiety, depression, mastery, and self-esteem, although they found no such effect in black women. Other studies showed that physical abuse, poor financial support, alcohol consumption, smoking, poor diet, and poor compliance with prenatal care are associated with low or high weight gain in pregnancy (13–15). These findings suggest that monitoring weight gain in pregnancy might help clinicians to target nutritional, medical, and social services to women at high

risk of poor pregnancy outcome. Unfortunately, we could identify no published experimental studies that examined whether it is possible to manipulate pregnancy weight gains and change pregnancy outcomes. Without the results of well-designed experimental trials, clinical protocols for managing weight gain in pregnancy cannot easily satisfy the criteria for evidence-based medicine. Whatever the arguments, the IOM's weight-gain recommendations have been widely adopted in the United States. However, published studies suggest that only 30–40% of American women actually have weight gains within the IOM's recommended ranges (11, 16, 17).

In this article, we focus on only one aspect of the controversy surrounding optimal maternal weight-gain ranges, namely the relation between the 1990 IOM guidelines and infant and maternal health outcomes. The data cited come from a systematic review of all studies published between 1990 and 1997 that specifically examined birth weight, preterm delivery, cesarean delivery, or postpartum weight retention relative to the IOM's recommended weight-gain ranges. Although there are many other groups who deserve consideration, we concentrated primarily on mature women who began pregnancy with a normal BMI and carried one fetus.

## PREGNANCY WEIGHT GAIN AND FETAL OUTCOMES

### Preterm birth

Small infant size at birth is a function of both poor growth and shortened gestation, with most adverse outcomes occurring in the most immature infants. At the time the IOM report was published in 1990, there was some evidence that a low rate of pregnancy weight gain was associated with preterm birth (4). Since the report was published, much more evidence has emerged to support this finding.

A study of low-income women in Alabama used the lower limit of the IOM's recommended range to define low weight gain during the third trimester in nonobese women (18). After a variety of other risk factors were controlled for, women with a low rate of weight gain during the third trimester had a statistically significant higher risk of spontaneous preterm delivery than did women without a low weight gain in the third trimester (odds ratio: 2.46; 95% CI: 1.53, 3.92). When the data were stratified by race, the odds ratio was 1.98 (95% CI: 1.16, 3.41) for African American women and 4.05 (95% CI: 1.41, 11.66) for white women. A similar relation between a low rate of gain and preterm birth was reported in a primarily Hispanic cohort in Los Angeles (19).

A critical review of the relation between pregnancy weight gain and spontaneous preterm delivery concluded recently that 11 of the 13 methodologically sound studies published between 1980 and 1996 showed an association between a low rate of pregnancy weight gain and an increased risk of preterm birth (20). Although the biological mechanism underlying this association is unknown, it appears that a rate of pregnancy weight gain below the lower limit of the IOM's recommended ranges, especially in late pregnancy, may be related to a higher risk of preterm birth.

### Fetal growth

Weight gain in pregnancy is also related to fetal growth. Too little gain is associated with reduced fetal growth, ie, low birth weight (<2500 g) or small-for-gestational-age infants (<10th percentile of weight for a given gestation). Excessive maternal weight gain is

**TABLE 1**

Recommended total weight gain in pregnant women by prepregnancy BMI (in kg/m<sup>2</sup>)<sup>1</sup>

Weight-for-height category	Recommended total gain (kg)
Low (BMI <19.8)	12.5–18
Normal (BMI 19.8–26.0)	11.5–16
High (BMI >26.0–29.0) <sup>2</sup>	7–11.5

<sup>1</sup>Adolescents and black women should strive for gains at the upper end of the recommended range. Short women (<1.57 cm) should strive for gains at the lower end of the range. Adapted from reference 4.

<sup>2</sup>The recommended target weight gain for obese women (BMI >29.0) is  $\geq 6.0$ .

associated with large infants, ie, macrosomia (defined as >4000 or >4500 g) or large-for-gestational age infants (defined as >10th percentile of weight for a given gestation) who have a higher risk of birth injury and other problems. In **Figure 2**, the association between birth weight and pregnancy weight gain is illustrated according to self-reported total pregnancy weight gain in low-income women with a normal prepregnancy weight included in the US Centers for Disease Control and Prevention's Pregnancy Nutrition Surveillance System (21). The data in **Figure 2** show a steady decrease in the incidence of low birth weight as mean pregnancy weight gain increases. In addition, these data provide evidence that the incidence of high birth weight, defined in this case as >4500 g, did not dramatically increase until pregnancy weight gains exceeded 16 kg, the upper limit of the IOM's recommended ranges. Overall, the best birth weight outcomes were found in women whose weight gains were within the IOM's ranges.

Other studies looked more closely at the association between pregnancy weight gain, birth weight, and rates of cesarean delivery. In a published study of 7000 Floridian women, the incidence of high birth weight (>4000 g) and cesarean delivery increased with increasing maternal weight gains, but the increases were not statistically significant until the weight gain exceeded 16 kg (22). In this study (**Figure 3**), there were no statistically significant differences in the incidence of low birth weight, macrosomia, or cesarean delivery between women with weight gains in the ranges of 7–11.5 and 11.5–16 kg and women with weight gains <7 kg. Multivariate adjustment of other risk factors did not change this finding for women with cesarean deliveries, but women with weight gains in the 11.5–16-kg range had a moderately higher risk of macrosomia than did women with weight gains <7 kg (OR: 1.77; 95% CI: 1.24, 2.52); for women who gained >16 kg, the multivariate OR was 2.86 (95% CI: 2.02, 4.02).

In a study of 1343 obese and normal-weight women who gave birth at a Minnesota hospital, Hellerstadt et al (23) found a statistically significant linear trend in increasing incidence of macrosomia with increasing pregnancy weight gain, although these data were unadjusted for other risk factors. A study at the University of California, San Francisco, assessed birth outcomes according to the IOM's recommended weight-gain ranges in  $\approx 7000$  women who delivered at term (**Figure 4**) (17). After other risk factors were adjusted for, pregnancy weight gain below the IOM's recommended ranges was associated with a statistically significantly increased risk of delivering a small-for-gestational-age infant. Pregnancy weight gain above the IOM's upper limit was associated with an almost doubled risk of delivering a large-for-gestational-age infant. Excessive weight gain was also associated with a significantly increased risk of cesarean delivery and this finding



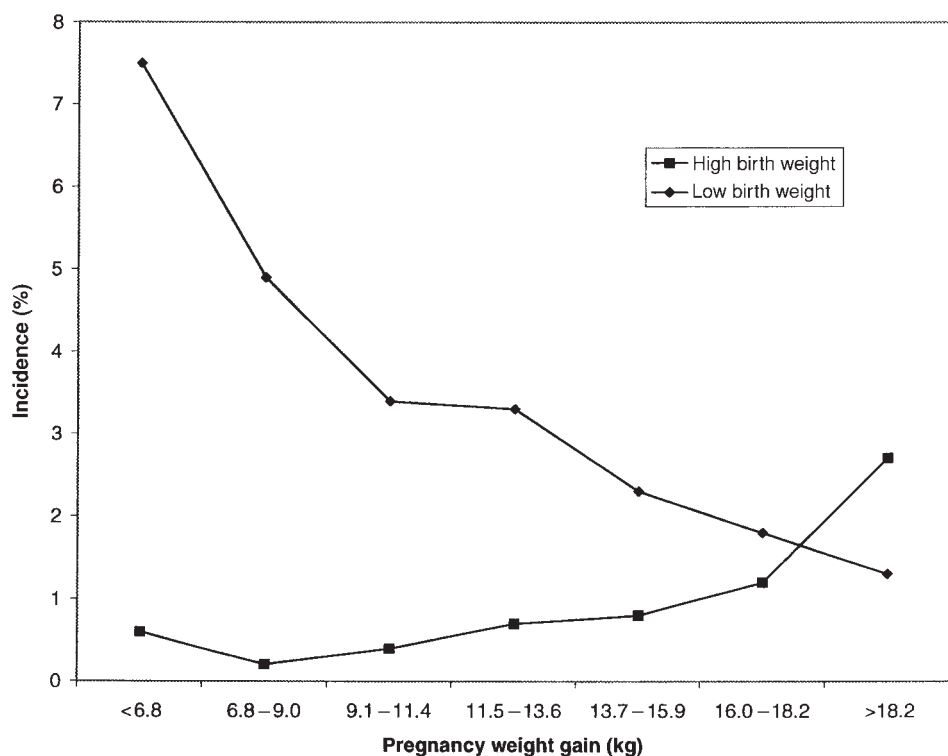


FIGURE 2. Incidence of low and high birth weight by pregnancy weight gain in 33 809 normal-weight women, 1990–1991. Adapted from reference 21.

persisted after birth weight was controlled for in a multivariate analysis. Again, in that population, the best balance of outcomes was seen in women who had weight gains within the IOM's recommended ranges when compared with women with weight gains either above or below the recommended ranges.

#### Risk of cesarean delivery

Results of several newer multivariate studies have confirmed that the risk of cesarean delivery increases with increasing weight gain, even after adjustment for birth weight. In a study of >4000 women giving birth to infants at Johns Hopkins University, the odds of cesarean delivery increased  $\approx 4\%$  per kilogram of pregnancy weight gain (24). Another study of  $\approx 3000$  women throughout the United States reported that the risk of cesarean delivery increased with both higher maternal prepregnancy weight and BMI measured at 27–31 wk gestation (data on gestational weight gain were not available) (25). In each of these studies, the relation between maternal weight gain and cesarean delivery was continuous and the authors could identify no threshold above which the risk of cesarean delivery increased more rapidly. These data suggest that there may be a modest but consistent dose-response relation between pregnancy weight gain and cesarean delivery but, because there is no obvious threshold, it is difficult to determine what cutoff for gestational gain would be desirable to reduce cesarean delivery.

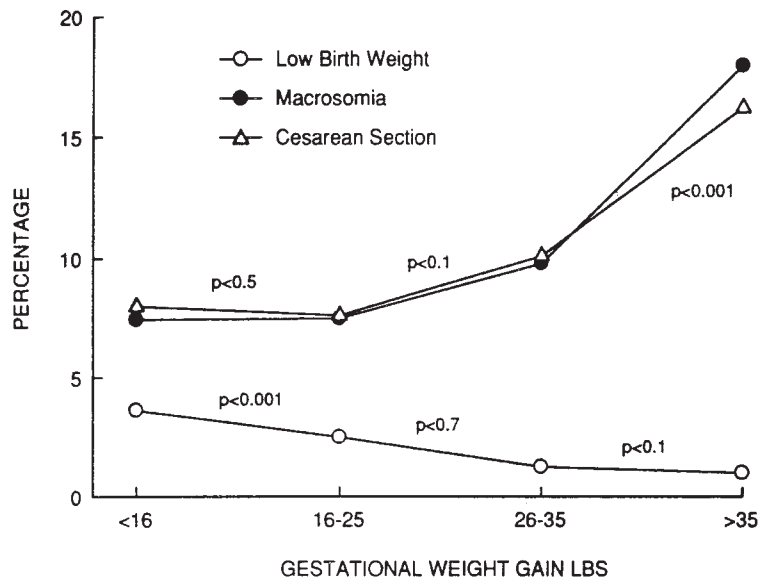
#### PREGNANCY WEIGHT GAIN AND MATERNAL OUTCOMES

Overall, the data on fetal outcomes and labor complications seem to suggest that optimal outcomes were found in mothers

with weight gains within the IOM's recommended ranges. However, fetal outcome and route of delivery are not the only indicators of a healthy pregnancy. For generations, obstetricians have worried that pregnancy increases the risk of obesity in women. With increasing rates of obesity in the United States, postpartum weight retention is an important factor to consider when assessing maternal health and pregnancy outcome. Studies reviewed by the IOM's Committee on Maternal Nutrition in 1990 suggested an average weight retention of 1 kg per birth, although it should be remembered that the mean pregnancy weight gain in these studies was lower than is currently seen in the United States (4).

#### Postpartum weight retention

An analysis of the 1988 National Maternal and Infant Health Survey examined the association between pregnancy weight gain and weight 10–18 mo postpartum in women who gave birth to live singleton infants at term (>37 wk gestation) (26). The sample of women with a normal prepregnancy BMI was divided into 3 groups according to pregnancy weight gain below, within, and above the IOM's recommended ranges. As shown in **Figure 5**, white women who gained within or below the IOM's recommended ranges had similar weight-retention distributions, but women who gained >16 kg were much more likely to retain >6 kg postpartum. Black women show a greater increase in postpartum weight retention with increasing pregnancy weight gain and in all categories of weight gain are more likely to retain  $\geq 6$  kg than are white women. Among women with weight gains within the IOM's recommended ranges, the median retained weight was 1 kg for white women and 3 kg for black women. Although weight retention was more likely in women with weight gains above the IOM's recommended ranges, even in this group, 45% of white women and 25% of black

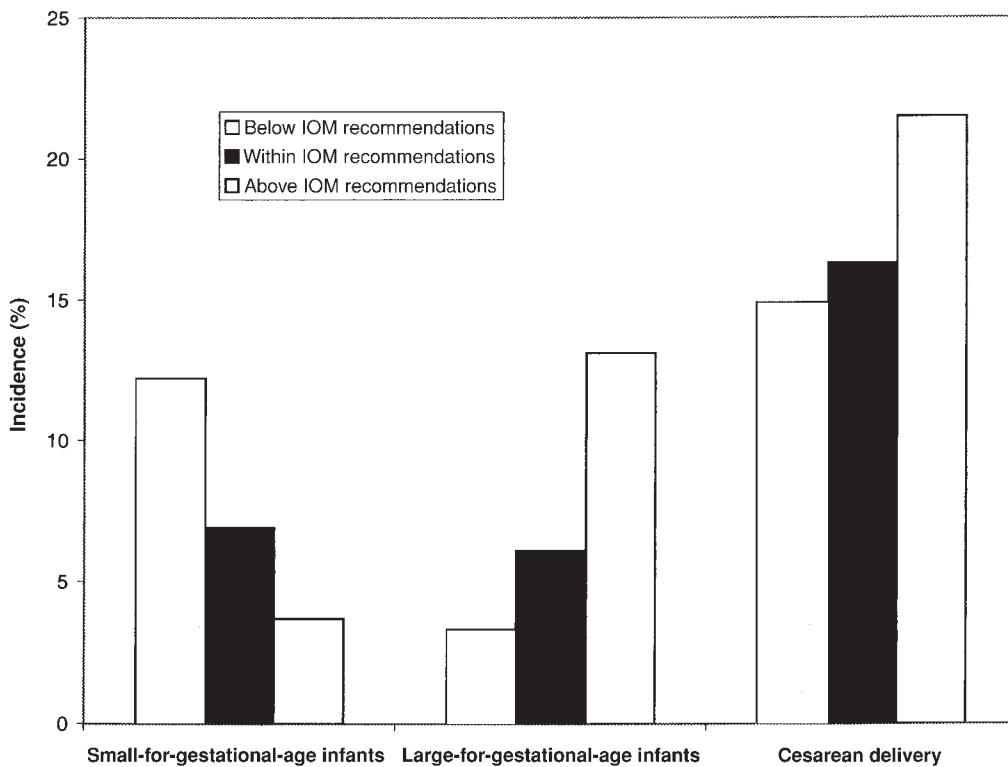


**FIGURE 3.** Relations between pregnancy weight gain (1 lb = 2.2 kg) and 3 pregnancy outcomes, unadjusted for other factors. Reprinted with permission from reference 22. *P* values represent differences in the proportion of low birth weight, macrosomia, and cesarean delivery between successive categories of maternal weight gain.

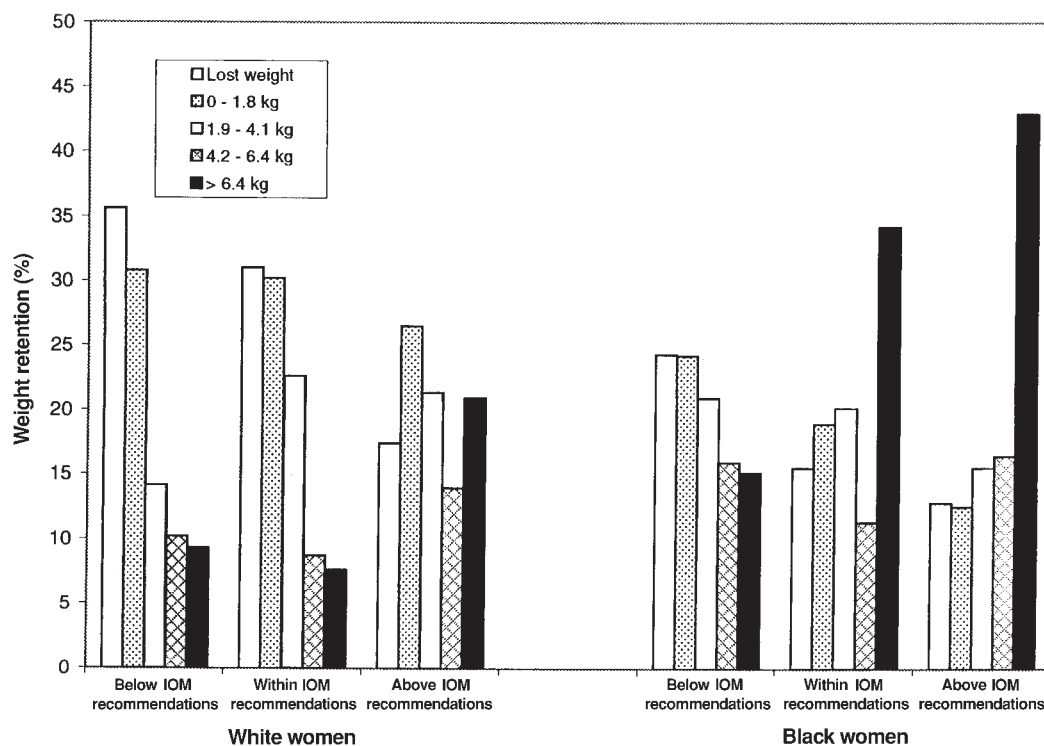
women had either lost weight or retained <1.5 kg at 10–18 mo postpartum. These data suggest that weight retention is more of a problem for women who gain excessive amounts of weight. Furthermore, although black women are known to be at greater risk of

inadequate pregnancy weight gain and low birth weight (4), in this study they tended to retain more postpartum weight.

Another study using the National Maternal and Infant Health Survey sample to investigate pregnancy weight gain and



**FIGURE 4.** Incidence of small-for-gestational-age infants, large-for-gestational-age infants, and cesarean delivery for women from San Francisco with normal prepregnancy weights and pregnancy weight gains below (<12.4 kg), within (12.5–16 kg), and above (>16 kg) the weight-gain recommendations of the Institute of Medicine (IOM) in 6690 pregnancies. Adapted from reference 17.



**FIGURE 5.** Weight retention 10–18 mo postpartum compared with prepregnancy weights of black ( $n = 133\,000$ ) and white ( $n = 859\,000$ ) women with normal prepregnancy weights and pregnancy weight gains below ( $< 12.4$  kg), within ( $12.5$ – $16$  kg), and above ( $> 16$  kg) the weight-gain recommendations of the Institute of Medicine (IOM). Adapted from reference 26.

postpartum weight retention limited its sample to black and white women who began their pregnancy with a normal BMI and gave birth to a live, singleton, non-low-birth-weight infant (27). After a variety of confounding variables were controlled for, women whose pregnancy weight gain exceeded the IOM's upper cutoff of 16 kg were twice as likely to retain  $> 9$  kg 10–24 mo postpartum than were women whose weight gains were within the IOM's recommended ranges (Figure 6). Black women were twice as likely to retain  $> 9$  kg than were white women, and many factors affecting postpartum weight retention were found to differ by maternal race. The authors of this study point out that the greater apparent weight retention in black women may have been due to either actual weight retention or weight gain in the postpartum period. Many investigators in the United States are now trying to understand these observed racial disparities in weight retention as well as the natural history of postpartum weight change in all women.

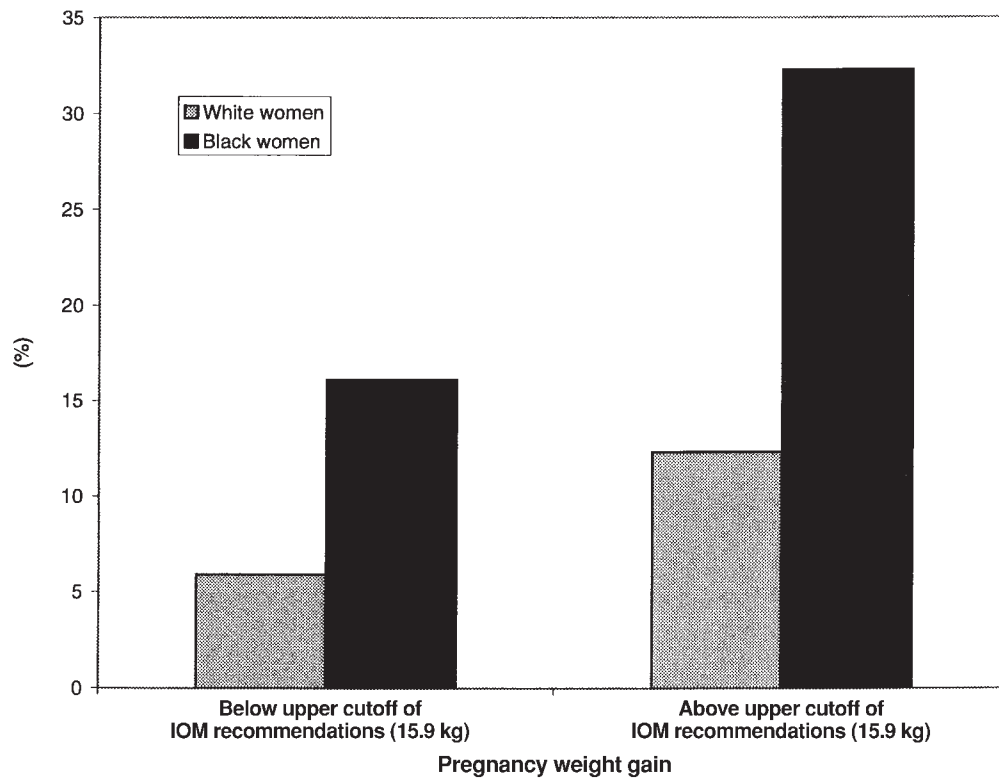
#### Studies of maternal and fetal outcomes

Recently, researchers have been conducting studies that look at both fetal and maternal outcomes to assess the overall effect of pregnancy weight gain. One study looked at 274 young, low-income, mostly minority women with normal prepregnancy BMI in Camden, NJ, to examine how pregnancy weight gain related to both birth outcome and postpartum weight retention (28). Using measured prenatal and 6-mo postpartum weights, the investigators reported that for women with weight gains below or within the IOM's recommended ranges, mean postpartum BMI was  $\approx 23.5$ , whereas those with weight gains above the IOM's

recommended ranges had an average postpartum BMI of 25.8, which was significantly higher (Table 2). At the same time, both birth weight and gestational age at birth were significantly lower in the group with weight gains less than the IOM's recommended ranges than in the group with weight gains within or above these ranges. However, despite the greater postpartum BMIs in the group with excessive weight gains, neither birth weight nor gestational age were significantly different from those with weight gains within the IOM's recommended ranges. The authors concluded that the best combination of birth outcome and postpartum body status was associated with maternal weight gains within the IOM's recommended ranges. Another study of postpartum weight retention measured shortly after delivery reported a similar finding (29).

#### DISCUSSION

We identified an impressive body of evidence indicating that weight gains within the IOM's recommended ranges are associated with better pregnancy outcomes than are weight gains outside these ranges. In contrast, we found no evidence that pregnancy weight gain within the IOM's ranges is a cause of substantive postpartum weight retention. Although the studies reviewed involved thousands of North American women, representing a variety of different subpopulations and in many cases using multivariate analysis to adjust for possibly confounding variables, they had some methodologic limitations. First, all of the studies were observational in design and thus could not prove causation. Second, none of the studies assessed the predictive value of pregnancy



**FIGURE 6.** Percentage of US women with normal prepregnancy weights who retained >9 kg 10–24 mo postpartum relative to prepregnancy weight, by maternal race and pregnancy weight gain above or below the recommended upper cutoff of the weight-gain recommendations of the Institute of Medicine (IOM). Adapted from reference 27.

weight gain as a screening tool. Third, only the ranges proposed by the IOM's Committee on Maternal Nutrition were validated, and although some studies did present their data over a variety of weight-gain ranges, it was not possible to determine from these studies whether different cutoff values might perform as well as, or better than, those recommended by the IOM. Future studies that report maternal and fetal health outcomes along the entire spectrum of weight change might help to clarify whether there are more optimal weight-gain ranges for women in both the general population and subpopulations. Finally, during the past decade, research has been published suggesting the importance of the pattern of pregnancy weight gain as well as the total amount gained and only a few studies examined the IOM's recommended ranges in terms of the pattern of weight gain.

For example, a study of trimester weight gain and birth weight was conducted in almost 3000 white San Franciscan women. Rate of weight gain was estimated for each trimester and birth weight was regressed on each of the trimester weight gains, along with several covariables (30). Each kilogram of pregnancy weight gain during the first, second, and third trimesters was associated with a statistically significant increase in birth weight of 18, 33, and 17 g, respectively. Thus, weight gain in the second trimester was more strongly associated with fetal growth than was weight gain in the first or third trimester. The importance of the weight-gain pattern for birth weight and preterm delivery was also shown in other populations (18, 19, 31, 32). These studies suggest that there may be crucial times in pregnancy when weight gain most influences birth weight and thus crucial times when weight restriction would be harmful.

**TABLE 2**

Prepregnancy BMI, pregnancy weight gain, birth weight, and postpartum BMI (in kg/m<sup>2</sup>) by Institute of Medicine weight-gain category in the Camden Study<sup>1</sup>

	Below (<2.4 kg) (n = 59)	Within (12.5–16 kg) (n = 138)	Above (>16 kg) (n = 77)
Prepregnancy BMI	22.2 ± 0.21	22.2 ± 0.14	22.2 ± 0.19
Total weight gain (kg)	10.2 ± 0.74	13.3 ± 0.47 <sup>2</sup>	20.0 ± 0.64 <sup>3</sup>
Birth weight (g)	3049 ± 56.94 <sup>4</sup>	3208 ± 36.33	3191 ± 49.46
Gestational age (wk)	38.5 ± 0.28 <sup>4</sup>	39.2 ± 0.17	39.4 ± 0.24
BMI 6 mo postpartum	23.4 ± 0.38	23.7 ± 0.25	25.8 ± 0.34 <sup>5</sup>

<sup>1</sup> Adapted from reference 28.

<sup>2</sup> Significantly different from below,  $P < 0.001$ .


<sup>3,5</sup> Significantly different from below and within: <sup>3</sup> $P < 0.001$ , <sup>5</sup> $P < 0.005$ .

<sup>4</sup> Significantly different from within and above,  $P < 0.05$ .

The pattern of weight gain in pregnancy also has implications for postpartum weight change. A small Canadian study found that women with high postpartum weight retention were more likely to have gained excessively during the first 20 wk of pregnancy than were those who retained less weight, irrespective of their BMI (33).

We need to continue to ask critical questions about weight gain and pregnancy to ensure that we are providing the best guidance and care to pregnant women. We need to address the criticisms that have been leveled at the clinical use of weight-gain recommendations, and weight monitoring during pregnancy. Given the sensitivity of Western women to weight and body-image issues, we need to discover and validate experimentally effective and thoughtful interventions to support women's nutritional and other needs during pregnancy.

In conclusion, we identified no published scientific evidence to support the concept that weight gain within the IOM's recommended ranges is harmful for either mothers or their infants. The studies reviewed here, although observational, consistently indicate a greater risk of low birth weight and preterm birth with pregnancy weight gains below the IOM's recommended ranges and a greater risk of macrosomia, cesarean delivery, and postpartum weight retention with weight gains in excess of the IOM's ranges. Overall, the data support the conclusion that, for women who begin pregnancy with a normal BMI, pregnancy weight gain within the IOM's recommended ranges is associated with the best outcome for both mother and infant. We also found no evidence supporting the concept that routine weighing of pregnant women should be discontinued or that restricting weight gain in normal pregnancy is either safe or beneficial.

Given the data reviewed here, it is distressing to note that most US women seem to not gain weight within the target ranges recommended by the IOM. Until rigorous evidence is available to allow a scientifically based consensus that current recommendations and clinical practices surrounding weight gain in pregnancy should be changed, we should determine the best interventions to help pregnant women achieve the currently recommended weight gain, with the objective of ensuring the best possible outcome for their infants and themselves. 

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