

What we know about...

WEIGHT GAIN DURING PREGNANCY

in low- and middle-income countries

THE EFFECTS OF TOO MUCH
OR TOO LITTLE WEIGHT GAIN ON
INFANTS AND MOTHERS, AND HOW
WE CAN BOLSTER MONITORING AND
SUPPORT TO IMPROVE OUTCOMES

INTRODUCTION

The science of maternal nutrition and its application programmatically continues to evolve as societies change and demographics shift.¹ Yet, across the globe, in many diverse settings, questions remain about maternal weight gain and diet. *How much weight should a woman gain during pregnancy? How does ideal weight gain vary according to pre-pregnancy weight and other lifestyle factors? How do we effectively monitor weight gain and design and implement interventions to ensure appropriate gain?*

These are important questions since insufficient or excessive weight gain during pregnancy can have consequences for both the infant and mother. For women with a low pre-pregnancy body mass index (BMI), inadequate weight gain has been linked to low birthweight (LBW), preterm birth, and small for gestational age (SGA) infants. Infants with low birthweight are known to have an increased risk of infant morbidity and mortality.² Conversely, excessive weight gain during pregnancy has been linked to large for gestational age (LGA) infants, delivery-related complications, challenges with breastfeeding, and long-term battles with weight retention and obesity for the mother.^{3, 4, 5}

Weight gain and nutrient intake are among the modifiable elements of a pregnancy. Weight gain measurement, monitoring, and counseling are part of standard antenatal care (ANC) practice in most high-income countries (HICs) and some low- and middle-income countries (LMICs). The updated WHO 2016 Guidelines on ANC include recommendations to improve diets and nutrient intake during pregnancy, along with health assessments, disease prevention, and health system strengthening to improve the utilization and quality of ANC.⁶ For nutrition specifically, they recommend that all women receive counseling on healthy diets and keep physically active to prevent excessive weight gain.

While care providers in HICs are primarily focused on addressing too much weight gain, available data show that the greater issue in LMICs is inadequate weight gain.⁷ In undernourished populations, the WHO guidelines further recommend that women receive nutrition education to increase daily energy and protein intake, and in food insecure areas women receive balanced energy and protein dietary supplements.⁶

Maternal nutrition services are meant to help women adopt nutrition practices that ensure healthy pregnancies and better birth outcomes. In LMICs, it has become increasingly evident that appropriate standards, processes, and tools for monitoring pregnancy weight gain and providing effective counseling are lacking. The aim of this technical brief is to draw attention to this issue and to provide suggestions for steps to take to address it.

OVERVIEW OF THIS BRIEF

This brief by Gilberto Kac, Thais Carrilho, Kathleen Rasmussen, and Joy Del Rosso summarizes our understanding of weight gain during pregnancy and the consequences of gaining too little or too much. It shares the available data and information on the prevalence of inadequate and excessive weight gain in LMICs and highlights the need to prioritize the issue of inadequate weight gain. This brief presents what little we know about weight gain monitoring and counseling interventions for appropriate weight gain, as well as the impact of maternal balanced energy and protein (BEP) supplementation on weight gain. It also offers recommendations for ways we might begin to strengthen pregnancy weight gain interventions in LMICs and suggestions for filling in research gaps.



Pregnancy weight includes...

- fetus
- placenta
- amniotic fluid
- maternal tissues (growing uterus and breast)
- expansion in blood volume and extracellular fluid
- maternal adipose tissue

THE SCIENCE BEHIND HEALTHY WEIGHT GAIN DURING PREGNANCY

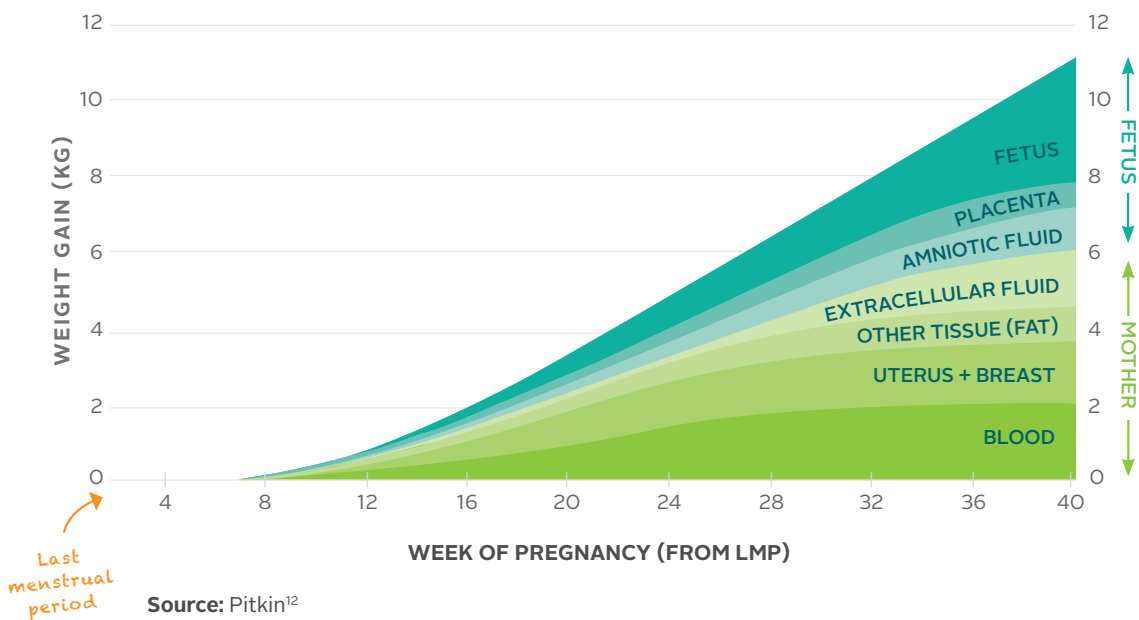
Composition and pattern of weight gain during pregnancy

Weight gain during pregnancy, referred to as gestational weight gain (GWG), is normal and necessary for a woman's body to support adequate growth and development of the fetus and subsequent lactation (breastfeeding upon birth). It is caused by changes in maternal physiology and metabolism, which include the increase in blood and plasma volume, increase in total body water, and changes in appetite that can alter dietary intake.^{8,9} GWG is also influenced by the placenta that can mediate the alterations in maternal metabolism.⁸ Figure 1 shows when a woman typically gains these different components of weight after her

last menstrual period (LMP) and how much of each type of weight is typically gained.

An increase in maternal fat during pregnancy seems to act as a reserve to protect the fetus against nutritional deprivation and support lactation after childbirth. Fat buildup is correlated with size of the fetus, but excessive weight gain does not necessarily enhance fetal growth or ensure a pregnancy continues to term. Instead, excessive weight gain contributes to postpartum adipose tissue retention,¹⁰ an important predictor of the later development of obesity.¹¹

FIGURE 1. Timing and components of gestational weight gain

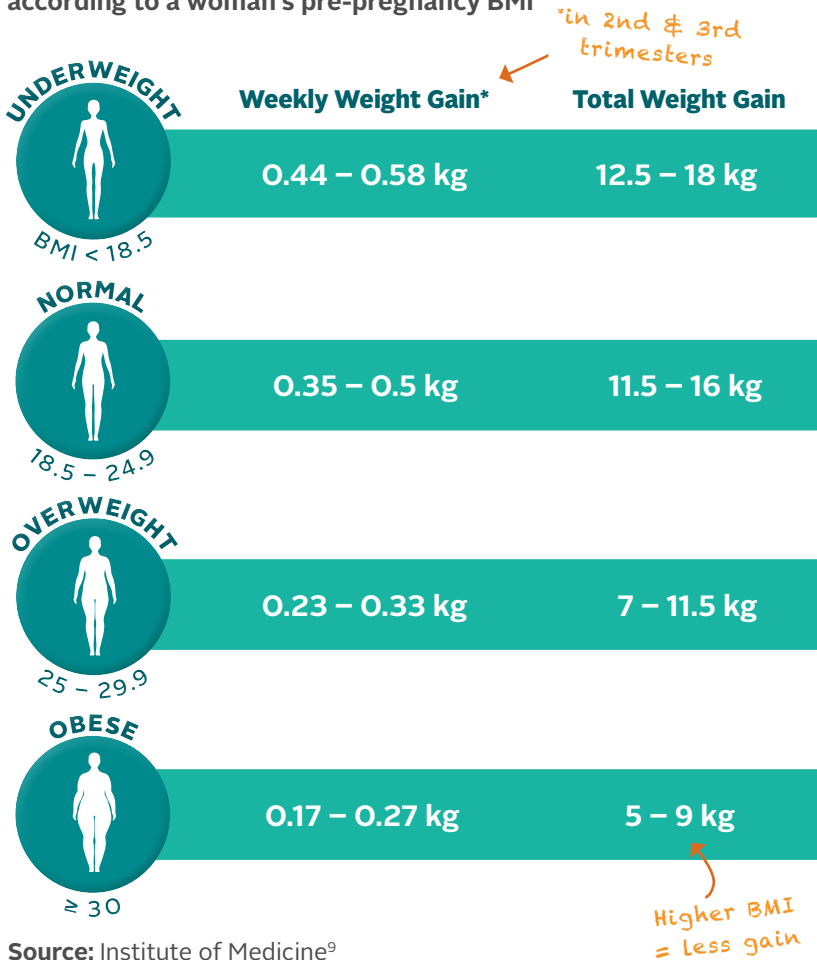


Recommended weight gain during pregnancy

Pregnancy is usually divided into three trimesters: the first trimester is less than 14 complete weeks of gestation; the second trimester is from week 14 to 27; and the third trimester is from week 28 until delivery. Normally, weight gain during the first trimester is relatively low. Then the rate of gain grows reaching its peak in the second trimester.¹³ During the third trimester, the rate of gain slows down slightly, and then remains constant at this lower rate until the date of delivery.^{9,14}

The WHO ANC Guidelines reference the GWG recommendations developed by the Institute of Medicine (IOM) in 2009 for North American populations, the most recognized GWG recommendations.⁹ In the absence of other recommendations, these guidelines (Figure 2) are often used in non-North American countries and as a reference for research.¹⁵

FIGURE 2. IOM gestational weight gain recommendations according to a woman's pre-pregnancy BMI



Source: Institute of Medicine⁹

Note: For the first trimester, the recommendations assume a 0.5-2 kg weight gain.

The IOM expressed caution when using these recommendations globally, stating that recommended gains for underweight women may be too high for some women living in situations where access to affordable obstetric care is unavailable to address the extra risk of having a large fetus (for example, cephalopelvic disproportion requiring a cesarean delivery).

ABOUT THE IOM GUIDELINES

The guidelines show a range of weight gains according to pre-pregnancy BMI, reflecting that available data show that good outcomes are achieved within a range of weight gains.⁹ Overall, they indicate that underweight women need to gain more weight than normal-weight women, and overweight and obese women should (and usually do) gain less than normal-weight women. They provide recommendations for total weight gain during a pregnancy as well as a weekly rate of weight gain for the second and third trimesters given that most women do not know exactly when conception occurred—the start of the first trimester.

THE EFFECT OF WEIGHT GAIN ON MATERNAL AND BIRTH OUTCOMES

The amount of weight gained over the course of a pregnancy is an important determinant of birthweight.* Birthweight is used as a proxy for intrauterine growth. Studies have shown associations between total GWG and birth outcomes, including SGA, LGA, and preterm birth.**

Risks associated with too little weight gain

Using the most recent available data from LMICs and pooled data from high-income countries (Figures 3-6), we estimated risks associated with delivering a preterm birth, SGA, LBW or LGA infant. Estimates of GWG below and above the IOM recommendations took into consideration the pre-pregnancy BMI status and GWG range. We used the most representative and recent data for countries with multiple studies. Our estimates show that women with GWG below IOM recommendations have a higher risk of delivering a preterm birth, SGA, or LBW infant than women with adequate GWG. In India, women who gained less than the recommended weight were almost four times more likely to deliver a preterm newborn (Figure 3). In Vietnam, women were two and a half times more likely to have an SGA newborn when they gained below recommendations (Figure 4). In Iran, women had more than two times the risk of a LBW newborn when weight gain was inadequate (Figure 5). A recent systematic review and meta-analysis that included women of

* Along with several other factors (e.g., genetic potential for growth, maternal nutrition, socioeconomic status, maternal height, placental function, smoking and alcohol consumption during pregnancy, and maternal morbidities).

** The accuracy of the designation of a birth outcome as SGA, LGA and/or preterm birth depends on the quality of the estimate of GA. Inaccuracies in GA may under or overestimate the prevalence of SGA and LGA.

FIGURE 3. Likelihood of delivering a preterm infant
WHEN MOTHER'S WEIGHT GAIN IS BELOW IOM RECOMMENDATIONS

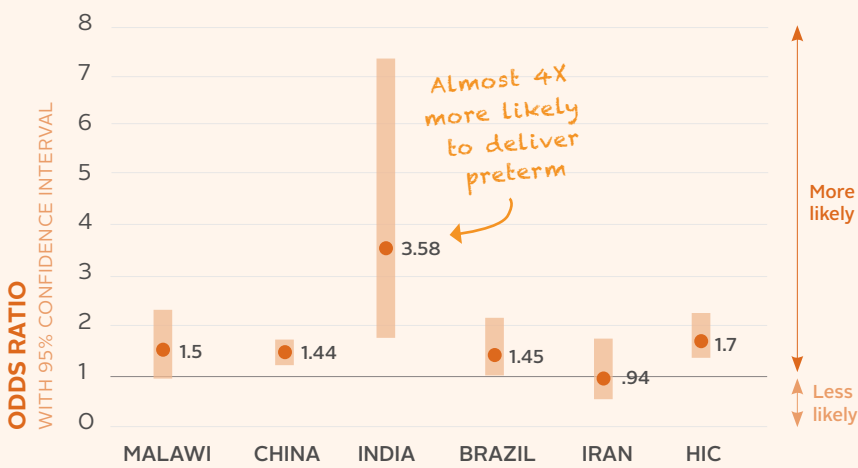


FIGURE 4. Likelihood of delivering an infant that is SGA
WHEN MOTHER'S WEIGHT GAIN IS BELOW IOM RECOMMENDATIONS

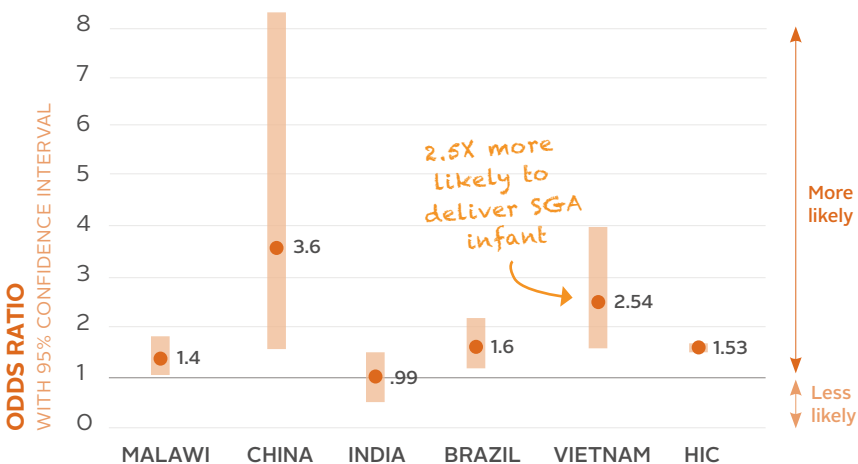
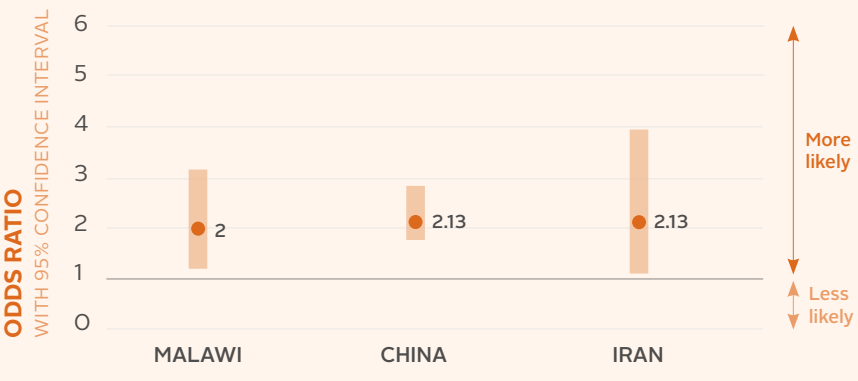


FIGURE 5. Likelihood of delivering an infant with LBW
WHEN MOTHER'S WEIGHT GAIN IS BELOW IOM RECOMMENDATIONS



different ethnicities showed a similar pattern of risk for SGA and preterm birth with GWG below the IOM recommendations across Western Europe, Asia, and the USA.¹⁶

Pre-pregnancy BMI and the rate of weight gain are other important considerations for achieving recommended weight gain and having a positive birth outcome. A large data set from Peru found that preterm birth was related to inadequate weight gain and that pre-pregnancy BMI was a contributing factor.¹⁷ In Malawi, weekly GWG was associated with pregnancy duration, birthweight, and the z-score of length at birth.¹⁸ Moreover, women with low weekly GWG were at higher risk of having LBW or SGA infants compared to women with adequate weekly GWG. Among pregnant women in rural Bangladesh, an adequate rate of GWG reduced the risk of delivering a LBW infant by 32%, a stunted infant by 36%, and a SGA infant by 20% compared to those who did not gain adequately.¹⁹

Risks associated with too much weight gain

While a much smaller percentage of women in LMICs are overweight and at risk for excessive weight gain, it is an emerging issue. Too much weight gain during pregnancy can lead to a LGA infant and result in delivery-related complications and challenges with breastfeeding.^{3,4} Excessive weight gain during pregnancy can also contribute to overweight and obesity in women, with consequences for their future health.¹¹

Rapid GWG in early pregnancy can result in an early increase in insulin resistance and lead to the development of gestational diabetes.²⁰ Preeclampsia—high blood pressure during pregnancy—has been associated with weight gain, particularly abrupt gains in weight.^{21,13} Both conditions are commonly monitored in HICs although infrequently in LMICs.

The relationship between GWG and postpartum weight retention is well established.²² Women retain on average 3 kg after a regular pregnancy and this retention is almost entirely body fat.²³ Postpartum weight retention is a significant issue in HICs, but is also a problem in LMICs.²² Excessive postpartum weight retention can lead to overweight or obesity in women, putting them at risk for a poor birth outcome in a subsequent pregnancy and increasing their risk for diseases associated with overweight and obesity.

Limited data from a few LMICs and pooled data from HICs indicate similar levels of risk for delivering LGA infants when women gained more than the recommended weight. In China, women who gained more than the recommended weight were almost four times more likely to deliver LGA newborns (Figure 6). More recent data support the conclusion that GWG above the guidelines is associated with a greater risk for LGA, macrosomia, and cesarean delivery across all regions.¹⁶

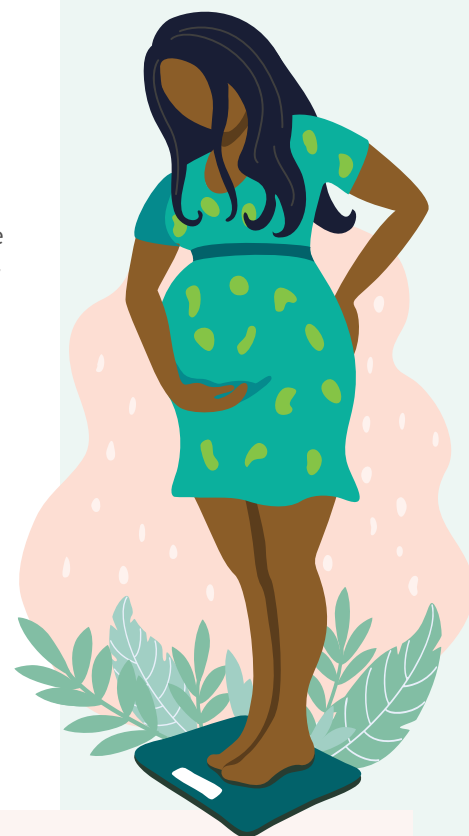
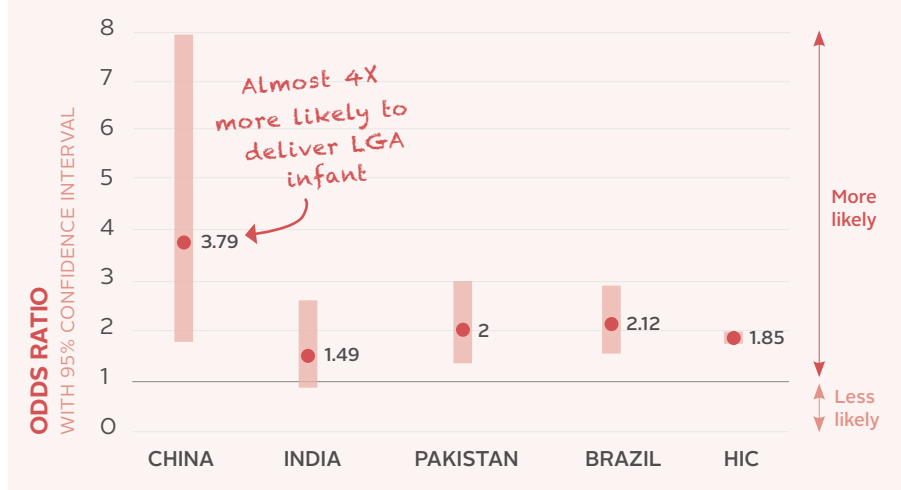


FIGURE 6. Likelihood of delivering an infant that is LGA
WHEN MOTHER'S WEIGHT GAIN IS ABOVE IOM RECOMMENDATIONS



Notes for Figures 3-6: Estimates of GWG below and above the IOM recommendations took into consideration the pre-pregnancy BMI status and GWG range (IOM, 2009, p. 2). HIC data are pooled data from Goldstein et al. Whenever there were more studies available for a specific country, the most representative and recent one was used.

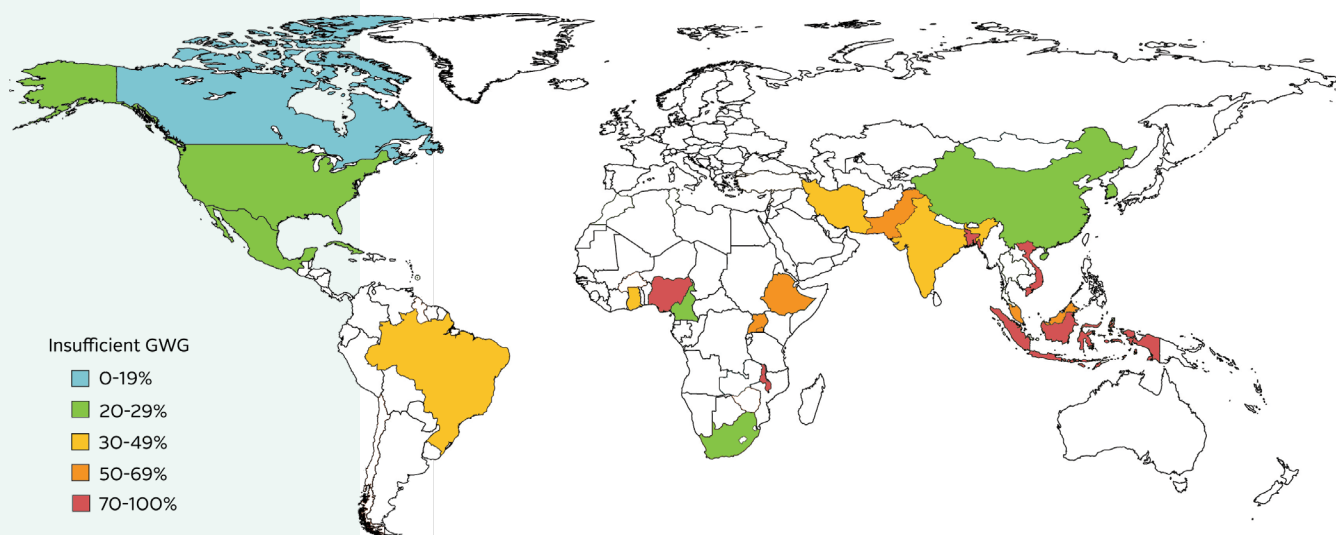
References used to construct the figures: 16, 18, 25, 26, 27, 28, 29, 30, 31

PREVALENCE OF INSUFFICIENT AND EXCESSIVE GESTATIONAL WEIGHT GAIN IN LMICs

Insufficient weight gain

Data on weight gain during pregnancy in LMICs are available from a variety of studies and sources. All point to inadequate weight gain as a serious problem in LMICs. Data from 23 studies found that in six countries more than 50% of women gained less weight than the recommended amount (see figure below). Countries with studies reporting more than 70% of women had inadequate weight gain include Nigeria (96%), Malawi (72%), and Vietnam (73%). This contrasts with data from HICs where only about 20% of women gained less than the recommended weight during pregnancy, for example, the Republic of Korea (21%), United States (21%) and Canada (17%) (Figure 7).

FIGURE 7. Prevalence of GWG below the IOM recommendations worldwide



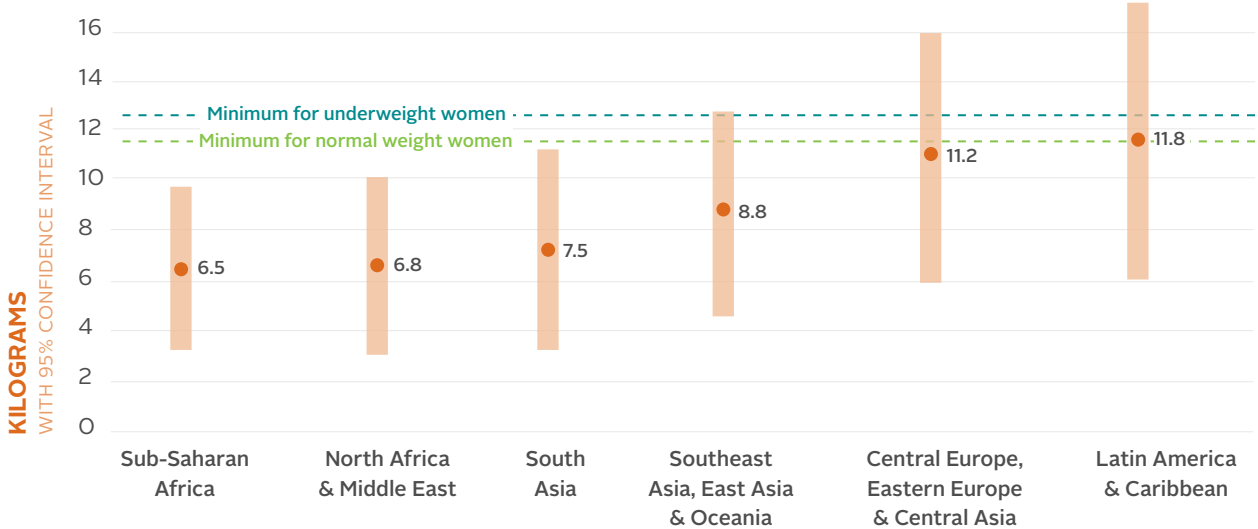
Note: Estimates of GWG below the IOM recommendations took into consideration the pre-pregnancy BMI status and GWG range.¹ Whenever there were multiple studies available for a specific country, the most representative and recent one was used.

References used to construct the figure: 18, 19, 26-30, 32-46

A recent review of 21 studies from sub-Saharan Africa shows a connection between income and weight gain. More than 58% of pregnant women, particularly underweight women in low-income sub-Saharan countries experienced inadequate GWG. Middle-income countries documented lower rates of inadequate weight gain—28% and 36.9% in Cameroon and 15.7% and 24% in South Africa depending on the study.⁴⁷

An analysis of GWG based on Demographic and Health Survey (DHS) data from 67 countries provides estimates by region. All regions except Latin America and the Caribbean documented inadequate weight gain during pregnancy. Africa and South Asia fared the worst (Figure 8).⁷

FIGURE 8. Estimated gestational weight gain by region



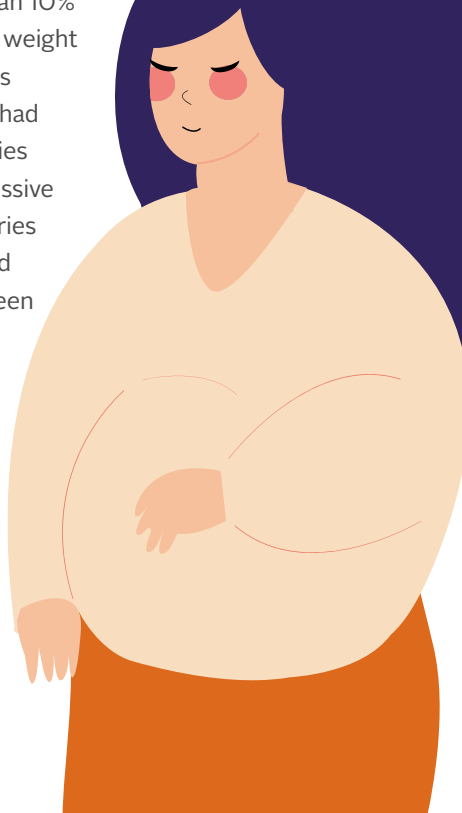
Source: Wang D, et al.⁷

Excessive weight gain

While the primary issue in LMICs is inadequate weight gain during pregnancy, the problem of excessive weight gain should not be overlooked. In LMICs, overweight and obesity, including among women of reproductive age, is increasing, especially among higher income quartiles. A recent meta-analysis of 63 studies found that the global prevalence of GWG above and below the 2009 IOM guidelines was 27.8% and 39.4% respectively.⁴⁸ The highest pooled prevalence of excessive GWG was found in North America (50.6%) and the lowest in Asia (20.2%).

The review and meta-analysis in sub-Saharan Africa (mentioned above) found less than 10% of women gained excessive gestational weight in 7 of 16 studies. Low-income countries including Ethiopia, Uganda, and Malawi had rates less than 6%. Seven of the countries with more than 10% prevalence of excessive weight gain were middle-income countries including Ghana, Nigeria, Cameroon, and South Africa, showing a clear link between income and overweight and obesity.⁷

In LMICs, the primary issue is inadequate weight gain. However, overweight and obesity among women of reproductive age is increasing, especially among higher income quartiles.



DRIVERS OF DIETARY PRACTICES THAT INFLUENCE GESTATIONAL WEIGHT GAIN IN LMICs

Cultural beliefs have been identified as a major barrier affecting diets of pregnant women and GWG, according to a widely cited major review of 24 qualitative studies covering 18 LMICs and 1 HIC (Japan).⁴⁹ These beliefs influenced the types of foods pregnant women ate, the quantity of food, the frequency of meals, as well as the practice of “eating down” during pregnancy to avoid delivering a large baby.

Drivers of food choice were influenced by food aversions, economic constraints, and household food availability. While studies showed that pregnant women value higher quality diets—including vegetables, fruits, meat, fish eggs and milk—and desire to eat more of the foods considered “good,” knowledge did not translate into practice. In some countries, women avoided foods of high nutrient value because of food taboos and misinformation. Personal preferences and cravings were also important factors.

Economic constraints and intra-household food distribution also impacted pregnant women’s diets. In some contexts, these constraints meant that women were unable to purchase nutrient-rich foods such as fish, chicken, eggs, red meat, and dairy products, despite their desire to consume these foods.

Cultural norms also affected diets during pregnancy. For example, husbands and children ate prior to women in some contexts and men were the primary decision makers for what foods to purchase at the market.

DRIVERS OF DIETARY PRACTICES INCLUDE...



Cultural beliefs

“Eating down” to avoid delivering a large baby



Food availability

Husbands deciding what foods to purchase for the household



Food avoidance

Avoiding certain foods because of preference, cravings, taboos, or misinformation



Cultural norms

Husband and children eating prior to pregnant woman



Economic constraints

Unable to purchase nutrient-rich foods, despite the desire to eat them



INTERVENTIONS FOR APPROPRIATE GESTATIONAL WEIGHT GAIN

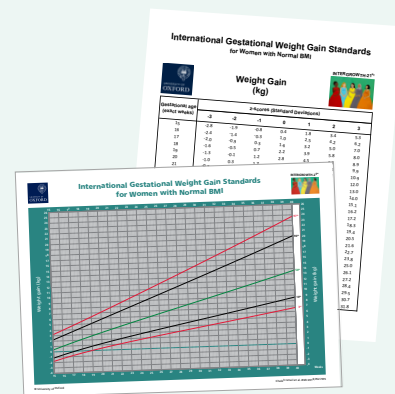
Social and behavior change interventions are needed to understand and address the drivers of diets and weight gain during pregnancy. This brief summarizes the scant literature on weight gain monitoring and counseling interventions to promote and support recommended weight gain. Some interventions aim to provide supplements to ensure that pregnant women have access to adequate energy and essential macro and micronutrients for a healthy pregnancy. The effects of maternal BEP supplements on maternal weight gain are briefly summarized, but a full review of those interventions is beyond the scope of this brief.

Weight gain monitoring interventions

Monitoring weight gain during ANC and providing counseling/advice is common practice in most HICs and some LMICs. However, the literature is scant on the frequency and effectiveness of weight measurement and monitoring and GWG counseling.

Tools for measurement and assessment of weight gain

Monitoring weight gain during ANC entails a routine assessment of body weight starting at the first visit and comparison with a reference or an international standard to determine if weight gain meets recommendations. An initial measurement of height, either before, or early in pregnancy, and pre-pregnancy weight estimate are also needed to determine the correct reference. Scales are used to measure weight during ANC visits. Charts are needed that allow the woman and/or her healthcare provider to plot either the weight or the weight gain against gestational age from conception to delivery. Ideally, GWG can be monitored according to the pre-pregnancy BMI.



WEIGHT GAIN CHARTS

The Intergrowth 21st Century project released a [chart](#) in 2016 that described patterns in maternal GWG in healthy, well-nourished women enrolled in the Fetal Growth Longitudinal Study, who had a BMI of 18.5–24.9 kg/m² in the first trimester (50). The study included eight geographically diverse urban regions in Brazil, China, India, Italy, Kenya, Oman, United Kingdom, and the United States. Data were used to determine fitted 3rd, 10th, 50th, 90th, and 97th, smoothed GWG centiles by exact week of gestation.

The Intergrowth tools only applied to women of normal weight calling for a reference for women who were under or overweight at pregnancy. A GWG [chart](#) was constructed for underweight, normal-weight, and overweight women as well as women with grade 1, 2, and 3 obesity in 2018. This chart was based on data from 33 cohorts of women from Europe, North America, and Oceania and, therefore mostly included HICs.⁵¹

Since these reference standards may not be applicable in a LMIC context, some countries have tried to develop their own standards and tools. Xu et al. have proposed a tool to monitor GWG for Malawi.⁵² They drew longitudinal data from an antenatal care intervention study, selecting participants if they had a healthy profile defined by BMI and infectious disease measures and delivered healthy singletons defined by birth weight, gestational age, and neonatal survival status. The results showed that GWG was substantially lower in this cohort than the IOM recommendation, but the specificity of this study precludes its use in other African countries.

Chile, Uruguay, and Argentina have attempted to create GWG monitoring systems.^{53,54,55,56,57} These systems are outdated and have known limitations, namely that they were created based on small samples of women or based on old BMI cutoff values.^{53,55,57} A new study by Kac creates prescriptive GWG charts for each pre-pregnancy BMI category, according to WHO cutoffs. The charts describe patterns of GWG among Brazilian women with good pregnancy outcomes and provide an important tool for monitoring weight gain in pregnancy in clinical care, especially in Latin America and other LMICs.⁵⁸

Weight-gain based counseling interventions

Measuring and/or monitoring weight gain during pregnancy alone, without effective counseling, is insufficient to address the issue of inadequate (or excessive) weight gain. However, this counseling is uncommon in LMICs. Recent implementation research on maternal nutrition, conducted by Alive & Thrive in Burkina Faso, Ethiopia, and India, documented that although most women in the research areas were weighed, they were not weighed consistently given limited contacts, and very few were counseled on weight gain (Figure 9).

Similarly, few studies have documented the type and quality of counseling on diet and weight gain during pregnancy. Most behavioral intervention research has focused on interventions to avoid GWG above the guidelines among normal-weight or overweight and obese women before conception in HICs (see box). The literature specifically lacks studies that have tested ways of using non-food interventions (i.e., monitoring weight and providing counseling) to ensure that pregnant women gain adequate weight during pregnancy.

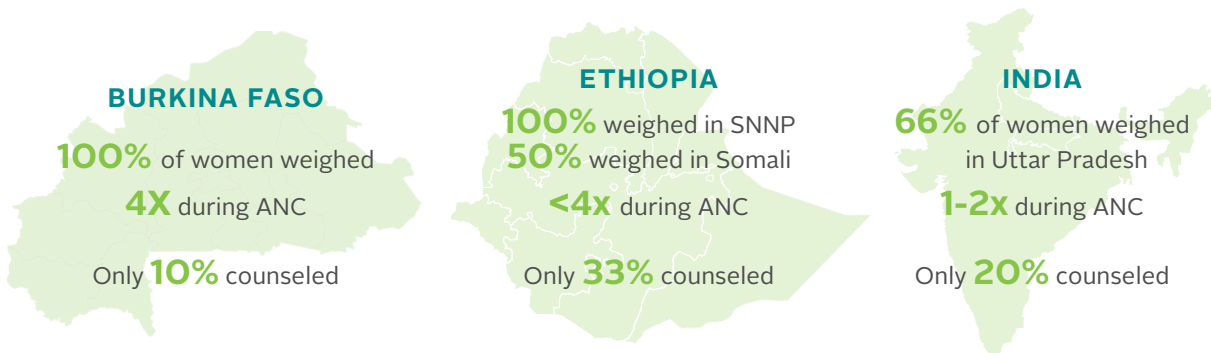
Addressing excessive weight gain

Globally, much research has taken place in HICs and focused on interventions aimed at avoiding GWG above the guidelines among women who are normal weight, overweight, or obese before conception. Currently, the types of interventions used to address excessive GWG vary widely. It has been observed that promotion of physical activity interventions during pregnancy contributed to reduced weight gain.⁵⁹ A recent meta-analysis of 33 randomized controlled trials conducted by the International Weight Management in Pregnancy Collaborative Network showed that diet and physical activity-based interventions reduced GWG by an average of 0.70 kg (95% CI 0.48 to 0.92) compared with the control group.⁶⁰ Similarly, a recent Cochrane review that included 24 randomized controlled trials, reported a risk reduction of excessive GWG with diet or exercise, or both interventions (average RR=0.80, 95% CI 0.73 to 0.87).⁶¹ Unfortunately, the estimated reduction in gain was perhaps half of what would be necessary for women to be able to gain within the guidelines.

The review cited above found that messages provided to pregnant women on weight gain tended to be general, such as, “eat well,” “eat a balanced diet,” or “eat more.”⁴⁹ Overall, the authors concluded that interpersonal communication/counseling on appropriate weight gain during pregnancy was being largely overlooked in national policy and protocols guiding service delivery.

Without effective, targeted weight gain counseling there is unlikely to be any change in a woman's GWG. Counseling may need to be paired with other interventions to address drivers of food choices and intake that are not within the control of individual women—for example, lack of access to enough and/or quality food—as well as health system strengthening to ensure that women have access to safe obstetric services.

FIGURE 9. Weight gain measurement and counseling of pregnant women during ANC



Source: Alive & Thrive

Note: Averages drawn from baseline and endline survey data in the three countries. **References used to construct the figure:** 69, 70, 71

Additionally, there is a need for health care worker skill-building to counsel and support women in gaining weight based on their weight status and individual circumstances. Where the issue of underweight and overweight coexist, it is essential that health care workers receive training and tools to deliver contextually-tailored counseling that can address both too little and too much weight gain during pregnancy.

BEP supplementation interventions

The impact of BEP and other food supplementation interventions specifically on weight gain as an indicator, in addition to birth outcomes, has infrequently been assessed. Results from studies that measured the impact of BEP and/or food supplementation on weight gain have been inconsistent. Ortolano et al. found that food supplementation increased the absolute GWG in underweight women from Bangladesh,⁶² while Nahar et al., also in Bangladesh, found no impact on GWG and that the average GWG remained low even in the supplemented group.⁶³ Tabrizi et al., in a clinical trial with 1,360 underweight women in Iran, reported that food supplementation (1,500 kcal/d) combined with nutritional education reduced the prevalence of poor maternal weight gain in the intervention group compared to nutritional education only in the control group ($p < 0.05$).⁶⁴ Also, in the intervention group there was a reduction in the prevalence of LBW and a significant decline in preterm births.

The Women's First random controlled trial found a positive impact from a BEP supplement provided prior to or early in pregnancy on infant length and weight outcomes. A recent secondary analysis of the data from this trial focused on the impact of the BEP intervention on pre-pregnancy BMI and weight gain during pregnancy and the relationship with fetal growth and growth outcomes. Across all sites—the DRC, Guatemala, India and Pakistan—newborn length and weight was positively associated with early weight gain, GWG velocity, and baseline BMI. For all maternal weight categories, adequate GWG was associated with an 8% reduction in LBW. The associations varied by baseline maternal BMI status. These findings reinforce the importance of tracking and supporting adequate GWG during pregnancy and the need to develop and implement interventions that can reach women and girls before they become pregnant.⁶⁵

For underweight women from low-income countries, it is important to assure their access to nutrient-dense food and adequate energy intake to help them to achieve adequate GWG. It is noteworthy that, when planning interventions in these situations, one should consider the occurrence of infectious diseases or inflammation and the impact of those on appetite.⁶⁶ Additionally, interventions with food supplementation per se may not be effective if they do not address intra-household food distribution and do not include nutrition education to raise the awareness of the family about the importance of having the pregnant woman consume an adequate amount and quality of food.⁶⁷



MOVING FORWARD: RECOMMENDATIONS AND ISSUES

Currently, although GWG is commonly measured as part of ANC,¹⁵ the WHO does not specify a process for monitoring and assessing weight gain in its antenatal care manual.⁶ In many LMIC contexts, appropriate guidance, and tools to monitor weight gain and to respond properly with counseling, support, and advice are lacking. Even when guidance and tools are available, however imperfect, they are not being used well or necessarily suitably. This gap and others need to be filled to help advance the maternal nutrition agenda specifically related to gestational weight gain.

FOCUS ON THE PROBLEM

- **Give more attention (in services, programs, and research) in LMICs to the issue of inadequate weight gain.** Inadequate weight gain (not excessive weight gain) is the primary issue facing low-income countries particularly in sub-Saharan Africa and South Asia. Too little weight gain is associated with SGA, LBW, and preterm infants.
- **Find strategies to identify women at risk for too little weight gain.** Pre-pregnancy BMI strongly predicts the tendency to gain inadequate weight in pregnancy. Adolescent and low-income populations are particularly vulnerable.
- **Continue to track excessive weight gain.** Too much weight gain is a growing issue in some contexts in LMICs putting women at risk for delivering an LGA infant and/or delivering by C-section. Postpartum weight retention, gestational diabetes, and preeclampsia are other risk factors for women who are overweight and gain excessive weight (outside of the guidelines) during a pregnancy.

IMPROVE MEASUREMENT AND MONITORING OF GWG

- **Work toward developing a well-accepted standard to monitor GWG in LMICs.** The lack of consensus on a global standard for GWG is a serious problem. In some cases, its absence means that pregnant women are either not assessed or are assessed according to the IOM guideline or a local and potentially inappropriate reference. When monitoring cannot occur, the risk of repercussions from inadequate or excessive weight gain and related poor outcomes increases since counseling and actions to modify dietary intake are unlikely to occur. Using an inappropriate reference is also problematic since it may lead to overestimating GWG insufficiency and/or underestimating excessive weight gain.
- **Use the IOM guidelines until a global standard is available.** While uncertainty exists about the applicability of the IOM guidelines, in the absence of other guidelines they can be used with some caution. Current recommendations suggest advising women of short stature and low BMI to gain at the low end of the range of recommended weight gain. Use this guidance to train health care workers and in tools to support counseling.
- **Encourage and support efforts to develop health worker-friendly tools to monitor and assess weight gain.** An appropriate GWG reference and charts/tools are needed to monitor the progress of weight gain in pregnancy, starting as early as possible. Research shows that optimal GWG varies according to pre-pregnancy BMI and that underweight women need to gain more (and benefit more from the additional weight gain), while those who are overweight need to gain less. Research also suggests that progress is needed to develop an applicable standard based on the country context.

STRENGTHEN GWG COUNSELING

- **Carry out situational analyses and formative research.** Effective counseling for GWG requires understanding the specific drivers of dietary practices during pregnancy and strategies to address those that inhibit achieving recommended weight gain. Where an insufficient understanding of the drivers is available, high quality formative research may be needed to provide the information base to develop effective strategies and materials.

- **Build and support effective counseling skills.** Counseling to address GWG should be country/region-specific and consider dietary practices and life-style factors. Where needed, interventions should be designed to address both issues—too little and too much weight gain. Health care workers will need skill building in counseling, supported by appropriate materials, to be able to support women in achieving recommended GWG.

FILL IN THE GAPS IN RESEARCH

- **Test interventions that provide tailored counseling to women with low weight gain.** Very little is known about interventions in LMICs that combine GWG monitoring, assessment, and tailored counseling, and their impact on weight gain. Some studies have looked at birth outcomes. More research is needed on which non-food supplement interventions (particularly nutrition education and GWG monitoring and counseling) are effective in helping address low GWG.
- **Look for cost-effective interventions.** For HICs, the literature contains many interventions focused on the prevention of excessive weight gain, which are designed to achieve adequate GWG and promote healthy birth outcomes. The efficacy of such interventions is still a matter of debate. More research is needed to identify cost-effective interventions.
- **Test interventions that target pregnant adolescents and younger mothers early in pregnancy.** Pre-pregnancy BMI strongly influences GWG and potentially fetal and maternal outcomes. More research is needed to understand how to reach younger pregnant women earlier so they are able to receive ANC sooner and those who are most at risk can be identified and provided appropriate care.
- **Study the impact of inaccuracies in self-reported BMI estimates.** GWG recommendations are a function of one's pre-pregnancy nutritional status measured according to BMI. However, a woman's pre-pregnancy weight is frequently unknown, creating inaccuracies in both pre-pregnancy BMI and GWG. There have been some attempts to cope with this difficulty, but researchers should evaluate the potential magnitude of bias introduced by measurement error in self-reported weight, ideally through quantitative bias analysis.
- **Don't overlook weight gain in the first trimester.** Estimates of GWG during the first trimester are also understudied. Women who over-gain in the first trimester are more likely to gain excessive weight over the course of the whole pregnancy. The literature is limited on this foundational period of pregnancy. The IOM recommendations for weight gain in the first trimester are based on decades old studies. More recent approaches to understanding weight gain examine the trajectory of GWG throughout pregnancy and associations with child outcomes (68). More research is needed to understand the impact of abrupt weight gain changes both on maternal and child adverse outcomes.



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