

# Maternal weight gain during pregnancy and neonatal birth weight: a review of the literature

**Santo Monte<sup>1</sup>,**  
**Oriana Valenti<sup>1</sup>,**  
**Elsa Giorgio<sup>2</sup>,**  
**Eliana Renda<sup>3</sup>,**  
**Entela Hyseni<sup>4</sup>,**  
**Marianna Faraci<sup>2</sup>,**  
**Roberta De Domenico<sup>2</sup>,**  
**Fosca A. F. Di Prima<sup>5</sup>**

<sup>1</sup> S. Bambino Hospital, Department of Obstetrics and Gynecology and Microbiological Sciences, University of Catania, Italy

<sup>2</sup> Policlinico Universitario "G. Martino", Department of Obstetrics and Gynecology, University of Messina, Italy

<sup>3</sup> Policlinico Universitario "P. Giaccone", Department of Obstetrics and Gynecology, University of Palermo, Italy

<sup>4</sup> Campus Biomedico, Operative Unit of Gynecology, University of Rome, Italy

<sup>5</sup> Policlinico Hospital, Department of Obstetrics and Gynecology, University of Catania, Italy

## Corresponding author:

Santo Monte  
 S. Bambino Hospital, Department of Obstetrics and Gynecology and Microbiological Sciences, University of Catania, Italy.  
 Corso Raffaello, 6 – 95030 Mascalucia (CT)  
 mons77@inwind.it  
 Phone: +393289547513

## Summary

**Obesity has become a serious global public health issue and has consequences for nearly all areas of medicine. Within obstetrics, obesity not only has direct implications for the health of a pregnancy but also impacts on the weight of the child in infancy and beyond. As such, maternal weight may influence the prevalence and severity of obesity in future generations. Pregnancy has been identified as a key time to target a weight control or weight loss strategy to help curb the rapidly growing obesity epidemic.**

This study reviews the current evidence for interventions to promote weight control or weight loss in women around the time of pregnancy. Studies have shown positive correlations between both maternal pre-pregnancy weight and gestational weight gain with the birth weight of the infant and associat-

ed health risks, so interventions have been put to clinical trials at both time points.

Many women are concerned about the health of their babies during pregnancy and are in frequent contact with their healthcare providers, pregnancy may be an especially powerful "teachable moment" for the promotion of healthy eating and physical activity behaviors among women.

*Key Words: Weight gain; Birth weight; Obesity; Pregnancy.*

## Introduction

Obesity has become a serious global public health issue and has consequences for nearly all areas of medicine. Within obstetrics, obesity not only has direct implications for the health of a pregnancy but also impacts on the weight of the child in infancy and beyond. As such, maternal weight may influence the prevalence and severity of obesity in future generations. Pregnancy has been identified as a key time to target a weight control or weight loss strategy to help curb the rapidly growing obesity epidemic. In addition, if delivered sensitively, pregnancy may be a good time to target health behavior changes by using the extra motivation women tend to have at this time to maximize the health of their child.

Globally, a 50% increase was reported from 1995 to the year 2000 and current estimates from the International Obesity Task Force (1) suggest that today, over 300 million adults are obese and a further 1 billion are overweight.

## Definitions

Obesity is defined as 'an accumulation of excess body fat, to an extent that may impair health'. The most basic indicator, mean body mass index (BMI, kg/m<sup>2</sup>), is the accepted measure of the WHO and the Institute of Medicine (IOM) (Tab. 1).

Table 1

BMI < 18.5 Kg/m <sup>2</sup>	Underweight
BMI 18.5 – 24.9 Kg/m <sup>2</sup>	Normal
BMI 25 – 29.9 Kg/m <sup>2</sup>	Overweight
BMI ≥ 30 Kg/m <sup>2</sup>	Obese

This categorises weight profiles into the following: Central obesity, which is defined as waist circumference ≥ 94 cm for European men and ≥ 80 cm for European women, with ethnicity-specific values for other groups (according to new IDF definition) (2) as opposed to peripheral distribution of fat is associated with worse outcomes.

## Pregnancy

Pregnancy is a crucial life event when interventions to challenge the growing trend of obesity may be most effective. The mother may be more than usually accepting of change that would benefit the health of her unborn child. The benefits of weight management in pregnancy are numerous. Normal pregnancy has been implicated in the development of obesity in women having healthy weight previously (3).

Controlling weight at this time is not only important to prevent future complications of obesity for the woman herself, but also to improve the health of the pregnancy, and the neonate. Numerous adverse effects of obesity during pregnancy have been reported by many. Associations include an increased risk of miscarriage, congenital malformations, hypertension, gestational diabetes, pre-eclampsia, anesthetic complications, vaginal birth after cesarean (VBAC) failure, instrumental delivery, macrosomia and maternal death (4). Controlling weight in association with pregnancy will therefore impact many areas of adult, obstetric and neonatal healthcare.

It is generally accepted that women should not attempt to lose weight during pregnancy. Therefore, interventions during pregnancy aim to limit weight gain throughout gestation, a factor, which has strong correlations with long-term health risks associated with obesity for both the mother and the child. Pre-pregnancy BMI (kilogram/meter<sup>2</sup>) was calculated from pre-pregnancy weight, and height.

The Institute of Medicine (IOM) guidelines were developed in 1990 to provide recommended ranges of weight gain to optimize fetal growth and maternal/infant outcomes. Recently, the recommendations were revised to use the BMI cutpoints from the World Health Organization (eg, overweight = 25.0-29.9 km/m<sup>2</sup> instead of 26.0-29.9 km/m<sup>2</sup>) and provide a specific range of weight gain for obese women ( $\geq 30.0 \text{ km/m}^2$ ), previously lacking from the 1990 guidelines (5, 6) (Tab. 2).

## Material and Methods

A comprehensive investigation of medical databases including PubMed, Medline, Elsevier. The reference lists of relevant articles were searched and additional studies were included if relating pregnancy, obesity and health risks. The following search terms were used in different combinations: gestation, weight gain, obesity, pregnancy, birth weight.

As was aidin the introduction, high pregnancy weight gain increases the risk of excessive fetal growth, which results in infants who are born large for gestational age (LGA

$> 90\%$  of birth-weight for gestational age) and macrosomic ( $\geq 4500 \text{ g}$ ). A recent evidence-based review of all studies that have examined weight gain and LGA demonstrated an association between high pregnancy weight gain and LGA; others studies demonstrated an association between high pregnancy weight gain and macrosomia (7). An American National and Maternal Health Survey showed that women, who gain more weight during gestation than the amount recommended by the IOM, retain more than twice that of women who remain within the guidelines throughout their pregnancy (8).

This retrospective study was carried out on women who gave birth before the introduction of the IOM guidelines and also showed a difference in retention between white and black women. White women who gained above the IOM recommendations retained 2.2 kg at 10-18 months post-partum compared with 0.7 kg retained by those who stayed within the guidelines.

African American women who exceeded the IOM recommendations retained 5.8 kg compared with 3.3 kg in those who gained within limits. This may indicate a need for targeted interventions according to ethnicity as needs may vary, and will be discussed below in more detail.

Another study followed over 1000 normal weight women through two consecutive pregnancies and found that gaining over the recommended amount of weight during the first pregnancy resulted in a threefold increased risk of being overweight at the time of the second pregnancy (9). All of these outcomes increase the risk of encountering metabolic and physical problems associated with obesity in later life.

A Swedish study (10) compared the weight gain in pregnant women; keeping 7 kg as a benchmark. Women were randomly assigned to an index (155) and control (130) group respectively. An intervention programme with weekly motivational talks and aqua aerobic classes was offered to women in the index group. Weight gain in kilograms, delivery and neonatal outcome were studied. The index group had a significantly lower weight gain during pregnancy compared with the control group. They also weighed less at the postnatal checkup compared with the weight registered in early pregnancy. The percentage of women who gained more than 7 kg was greater in the control group. In addition, the women in the index group had a significantly lower BMI at the postnatal check-up, compared with the control group. Interestingly; there were no differences between the index group and the control group regarding birth weight, gestational age and mode of delivery. The intervention programme was effective in controlling weight gain during pregnancy and did not affect delivery or neonatal outcome.

A New Life(Style) Study (11) has been completed in the

Table 2 - The 2009 Institute of Medicine recommendations for total weight gain range for pregnant women

Recommended total gestational weight gain		
Body mass index category (Kg/m <sup>2</sup> )	Kg	lb
< 18,5	12,5 - 18	28 - 40
18,5 - 24,9	11,5 - 16	25 - 35
25 - 29,9	7 - 11,5	15 - 25
> 30	5 - 9	11 - 20

Adapted from the 2009 Institute of Medicine report

Netherlands. Their intervention aimed to keep gestational weight gain within the IOM limits for primi-gravida women through individual counseling sessions focussing on explanation of the IOM guidelines, nutrition and exercise, reviewing individual lifestyle and providing individual support. They aimed to enroll 275 women into the trial to be randomized between usual and interventional care groups. The intervention would be delivered at five counseling sessions, the last being at 6 weeks postpartum and the women followed up to 1 year postpartum. They planned to measure the outcomes of weight, BMI, skin-fold thickness, nutrition, exercise and blood levels of various hormones. The authors chose to include only primi-gravida women in this study to exclude previous experience and expectations of weight change during and after pregnancy. This is a factor, which is likely to influence the behavior of a woman during pregnancy and the adherence to advice or a prescription of diet and exercise patterns. Low-carbohydrate/high-protein diets such as Atkins have recently become popular for weight control. Such diets have been associated with an increased risk of kidney problems and metabolic ketoacidosis, another potential prenatal stressor. Beta-hydroxybutyrate which is one of the by-products of ketoacidosis has been linked to stunted behavioral and intellectual development in offspring (12).

Khoury et al. (13) conducted a study to assess effect of low carbohydrate diet on utero-placental circulation. Two hundred and ninety non-smoking white women, aged 21–38 years, without previous pregnancy complications and carrying a single foetus were assigned randomly to continue their usual diet (control subjects; n = 149) or to adopt a low-cholesterol low-saturated fat diet (intervention group; n = 141) from gestational week 17–20 to birth. Doppler velocimetry of the umbilical artery and both uterine arteries were assessed at gestational weeks 24, 30 and 36. Physiologic gestational decrease in umbilical artery pulsatility index (PI) from weeks 24 to 30 was more pronounced in the intervention group. The change in umbilical artery PI and mean PI value of the uterine arteries between weeks 24 and 36 were not significantly different between the two groups. It has been concluded that a cholesterol-lowering diet during pregnancy may modify foeto-placental circulation in mid-pregnancy.

Available data suggest that 37% of normal-weight women and 64% of overweight women gain more than IOM recommendations (14, 15).

Although there is a broad range of weight changes that are associated with healthy pregnancy outcomes, 15 weight gains that exceed the IOM recommended levels have been connected to gestational complications (hypertension, diabetes mellitus, and preeclampsia), complications in delivery (cesarean section deliveries), babies that are large for gestational age (macrosomia), (16-20) and obesity in offspring by age 3 years (21, 22).

## Results

Studies have shown positive correlations between both maternal pre-pregnancy weight and gestational weight gain with the birth weight of the infant and associated health risks, so interventions have been put to clinical trials at both time points. In addition, the postpartum period has been targeted to reduce the increased metabolic risks for the mother retaining weight gained during pregnancy and bet-

ter prepare the women physiologically for a subsequent pregnancy.

This study reviews the current evidence for interventions to promote weight control or weight loss in women around the time of pregnancy. The comprehensive review of medical research – PubMed, Medline and Elsevier – showed that despite numerous reports of the prevalence and complications of maternal obesity, few intervention strategies have been suggested.

Despite many articles and reviews reporting the prevalence and implications of maternal obesity on the health of mother and infant, surprisingly very few intervention options have been suggested, let alone undertaking clinical trials, in an attempt to combat this burgeoning problem.

## Discussion

Pregnancy could be a key time to target a weight control or weight loss intervention to help curb the rapidly increasing prevalence of obesity in the population. Pregnancy is traditionally a time when women feel they should be 'eating for two' and resting, but it is also a time when behaviours can be challenged with the aim of not only improving the woman's health, but more importantly from a motivational point of view, the health of her baby.

Effective interventions have been seen to promote smoking cessation in pregnancy, could the same be true of targeting diet and exercise behaviors if the correct support and guidance are available.

## References

1. Institute of Medicine (US). Nutritional status and weight gain. In: Subcommittee on nutritional status and weight gain during pregnancy, food and nutrition board, ed. Nutrition During Pregnancy. Washington, DC: National Academy Press, 1990. p27. International Obesity Task Force.
2. The International Diabetes Federation (IDF), IDF consensus worldwide definition of the metabolic syndrome, [www.idf.org](http://www.idf.org)
3. Rossner S, Ohlin A. Pregnancy as a risk factor for obesity. Lessons from the Stockholm Pregnancy and Weight Development Study. *Obes Res* 1995; 3 (Suppl. 2): 267s-75s (Review).
4. Catalano PM, Ehrenberg HM. The short- and long-term implications of maternal obesity on the mother and her offspring. *Br J Obstet Gynaecol* 2006; 113: 1126.
5. Institute of Medicine (US): Subcommittee on Nutritional Status and Weight Gain during Pregnancy; Institute of Medicine (US); Subcommittee on Dietary Intake and Nutrient Supplements during Pregnancy. Nutrition during pregnancy: part I, weight gain: part II, nutrient supplements. Washington, DC: National Academy Press; 1990.
6. Committee to Reexamine IOM Pregnancy Weight Guidelines, Food and Nutrition Board, and Board on Children, Youth, and Families. Weight gain during pregnancy: reexamining the guidelines. Washington, DC: Institute of Medicine; 2009.
7. Viswanathan M, Siega-Riz AM, Moos M-K, et al. Outcomes of maternal weight gain, evidence report/technology assessment no. 168. (Prepared by RTI Inter-

- national-University of North Carolina Evidence-based Practice Center under Contract no. 290-02-0016. AHRQ Publication no. 08-E-09.) Rockville, MD: Agency for Healthcare Research and Quality; 2008.
8. Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: implications of the 1990 Institute of Medicine guidelines. *Am J Public Health* 1993; 83: 1100.
  9. Gunderson EP, Abrams B, Selvin S. The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy. *Int J Obes* 2000; 24: 1660.
  10. Claesson IM. Weight gain restriction for obese pregnant women: a case-control intervention study. *BJOG* 2008; 115: 44-50.
  11. Althuizen E, van Poppel MNM, Seidell JC, van der Wijden C, van Mechelen W. Design of the New Life(style) Study: a randomised controlled trial to optimise maternal weight development during pregnancy. *BMC Public Health* 2006; 6: 168.
  12. Mead NM. Diet and Nutrition: You Are What Your Mother Ate. *Environ Health Perspect*. 2007; 115: A492-3. PMCID: PMC2022676.
  13. Khoury J, Haugen G, Tonstad S, Frøslie KF, Henriksen T. Effect of a cholesterol-lowering diet during pregnancy on maternal and fetal Doppler velocimetry: the CARRDIP study. *Am J ObstetGynecol* 2007; 196: 497-8.
  14. Keppel K, Taffel S. Pregnancy-related weight gain and retention: implications of the 1990 Institute of Medicine guidelines. *Am J Public Health* 1993;83:1100-3.
  15. Olson CM, Strawderman MS, Hinton PS, Pearson TA. Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. *Int J Obes* 2003;27:117-27.
  16. Carmichael SL, Abrams B, Selvin S. The pattern of maternal weight gain in women with good pregnancy outcomes. *Am J Public Health* 1997;87:1984-8.
  17. Hellerstedt W, Himes J, Story M, Alton IR, Edwards L. The effects of cigarette smoking and gestational weight change on birth outcomes in obese and normal-weight women. *Am J Public Health* 1997;87:591-6.
  18. Abrams B, Altman SL, Pickett KE. Pregnancy weight gain: still controversial. *Am J ClinNutr* 2000;71(suppl):1233s-41s.
  19. Shepard MJ, Saftlas AF, Leo-Summers L, Bracken MB. Maternal anthropometric factors and risk of primary cesarean delivery. *Am J Pub Health* 1998;88:1334-538.
  20. Cogswell ME, Serdula MK, Hungerford DW, Yip R. Gestational weight gain among averageweight and overweight women-what is excessive? *Am J Obstet Gynecol* 1995;172:705-12.
  21. Witter F, Caufield L, Stolzfus R. Influence of maternal anthropometric status and birth weight on the risk of cesarean delivery. *ObstetGynecol* 1995;85:947-51.
  22. Oken E, Taveras EM, Kleinman KP, Rich- Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. *Am J Obstet Gynecol* 2007;196:322.e321-8.