

# Maternal pre-pregnancy body mass index and pregnancy outcome

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## ABSTRACT

The mother's nutritional status both before and during pregnancy is an important factor that influences the evolution of pregnancy and the condition of the fetus and the newborn. Maternal weight, either through excess or deficit, is associated with a number of adverse pregnancy outcomes that can affect both mother and fetus. Knowing the maternal body mass index (BMI) and how it can influence the outcome of pregnancy is an important step in preconception care, and prompt nutritional intervention can prevent possible complications.

**Keywords:** pre-pregnancy body mass index, obesity, underweight, pregnancy outcome, perinatal outcome

## INTRODUCTION

Keeping a normal body mass index is desirable at any stage of life and has the most long-term benefits. Preconceptually, a woman's weight plays an important role in addition to her age, both in the success of obtaining a pregnancy and in the results on the pregnancy and the newborn. During preconception care, an important stage is assessing maternal body mass index (BMI) and its information on the potential complications of high or low weight on the evolution of pregnancy.

A method of quantifying the nutritional status is the BMI, also known as Quetelet index, calculated by dividing the weight in kilograms by the square of the height in meters. According to WHO, a body mass index between 18.5 and 24.9 kg/m<sup>2</sup> is considered a normal or healthy weight. The decrease below 18.5 kg/m<sup>2</sup> is classified as underweight, and the increase between 25.0 and 29.9 kg/m<sup>2</sup>, as overweight or pre-obesity. A BMI over 30 kg/m<sup>2</sup> is defined as obesity and includes three categories: obesity class I (BMI between 30.0 and 34.9 kg/m<sup>2</sup>), obesity class II (BMI between 35.0 and 39.9 kg/m<sup>2</sup>),

and obesity class III (BMI over 40 kg/m<sup>2</sup>) [1].

Obesity is known to be one of the major health challenges for today's global community. Obese patients are at increased risk of developing a wide range of comorbid conditions, such as cardiovascular disease, type II diabetes, joint or muscle disorders, and psychological problems, significantly affecting their quality of life [2]. According to WHO, obesity worldwide is nearly three times more frequent than in 1975. In 2016, 39% of adults above the age of 18 were overweight, and 13% were obese [3].

The onset of pregnancy in a woman's life is an important event often seen as a medical one rather than normal. Among pregnant women, obesity is also a worrying issue. The prevalence of overweight and obese pregnant women varies between different regions of the world, being influenced by many factors such as environmental changes, income, cultural habits [4]. In the US, pre-pregnancy obesity has also increased, from a 26.1% in 2016 to 29.0% in 2019 [5]. In an analysis on a large cohort of Australian pregnant women, Cheney et al reported an increase in the prevalence of overweight, from 12.7%

(1990-1994) to 16.4% (2010-2014), and an increase in the prevalence of obesity in the same time span, from 4.8% to 7.3% [6]. In Romania, according to data provided by the National Institute of Statistics in 2014, 46.4% of the resident population aged 18 and over is overweight, and 9.3% are obese, compared to the European Union average obesity of 15.9% [7]. In recent years in contrast to the increasing incidence of obesity, the prevalence of underweight women has decreased from 11.6% in 2000 to 9.7% in 2016, being the most common in Asia and Africa [8].

Maternal obesity can cause various complications for the mother and the newborn, including gestational diabetes, gestational hypertension, or even pre-eclampsia. Infants of overweight or obese mothers have a higher risk of large gestational weight at birth, neonatal intensive care unit (NICU) admission, and lower Apgar score at 5 minutes than infants born to mothers with healthy weight [9]. As for underweight women, they associate an increased risk of miscarriage, premature birth, and low birth weight [10,11].

This article aimed to highlight the importance of a normal preconceptional BMI and the effects of extreme maternal weight on pregnancy outcomes.

## MATERNAL OVERWEIGHT AND OBESITY

Overweight and obesity in pregnancy can affect the health of both mother and child in the short-term and long-term, resulting in adverse outcomes such as gestational diabetes, gestational hypertension, and preeclampsia [12].

Being a public health issue and with an increasing incidence in recent years, several studies have highlighted the influence of increased maternal weight and obesity on pregnancy outcomes. In a prospective cohort study done on 19,052 pregnant women in Taiwan, Chen et al. found that overweight and obesity were significantly connected to maternal complications such as gestational diabetes, gestational hypertension, preeclampsia, and cesarean delivery [13].

A large retrospective cross-sectional study of more than 50,000 term deliveries with singleton pregnancies conducted in Brisbane, Australia, found that overweight and obese women were at a higher risk to be diagnosed with chronic hypertension, gestational hypertension, preeclampsia, or gestational diabetes. They were less likely to need an instrumental delivery, but the risk of postpartum hemorrhage increased proportionally with the BMI category [14].

A study performed among Turkish adolescent pregnant women concluded that overweight and obese adolescent pregnancies were associated with

higher risks of primary cesarean section, preeclampsia, and small for gestational age when compared to pregnant adolescents with normal BMI. The same study did not find any significant differences between neonatal outcomes [15].

A large population-based study on 27,807 deliveries in Italy offered a quantitative estimation of the impact of overweight and obesity on perinatal outcomes. The study showed that a 10% decrease in pre-gestational BMI was linked to a 15% reduction of gestational diabetes mellitus, preeclampsia, admission of the mother to the intensive care unit. The biggest impact was seen on gestational diabetes and preeclampsia, highlighting the negative impact that pre-pregnancy, overweight, and obesity have on pregnancy outcomes [16].

Super obesity or extreme obesity, defined as a BMI  $\geq 50$  kg/m<sup>2</sup>, during pregnancy increase the risk of serious maternal complications such as hypertension, diabetes, asthma, obstructive sleep apnea, gallbladder disease, or venous thromboembolism (VTE) [17]. Pregnant women with extreme obesity have a higher risk of emergency cesarean delivery, wound infection, and a nine-fold increase in the risk of developing thrombotic events compared with pregnant women with a BMI  $< 50$  [18].

Rates of maternal rectovaginal colonization with group B streptococci are higher among pregnant obese women [19]. Also, in women undergoing a cesarean section, the prevalence of various complications, including endometritis, post-cesarean wound complications, longer hospitalization or readmission, is higher among overweight and obese pregnant women [20,21].

Overweight and obesity are associated with an increased risk of adverse neonatal outcomes [22]. One of the major health concerns during pregnancy is preterm birth, leading to major short-term and long-term neonatal complications. Overweight and obesity lead to a higher risk of iatrogenic preterm birth, preterm premature rupture of membranes, but a lower risk of spontaneous preterm birth. On the other side, insufficient weight gain during pregnancy can lead to a higher risk of spontaneous preterm birth [23]. A cohort study of a population of over one million births in Sweden indicated that overweight and obese pregnant women have an increased risk of premature birth, with an inverse relationship between BMI and gestational age at birth. Thus, as the BMI increases, the risk of extremely premature birth increases [24]. Further studies are needed in other populations to support this evidence.

Obese women have an increased risk of needing labor induction compared to normal weight [19], one of the main reasons being fetal macrosomia. Maternal overweight and obesity are linked to a

higher risk of fetal macrosomia. It is known that fetal macrosomia is a risk factor for developing obesity later in childhood [25]. Concomitant gestational diabetes during pregnancy further increases the risk of giving birth to a macrosome fetus [26]. In a large cohort study on pregnant Australian nulliparous women, Cheney et al reported that 23.4% of macrosomia could be attributed to overweight and obesity. They also concluded that 15.9% of fetal macrosomia and 7.1% of LGA could have been avoided if overweight and obese pregnant women had dropped one BMI category [6]. Another retrospective cohort study of 731 pregnant women showed that the highest fetal acidosis and macrosomia rates were reported among obese pregnant women [27].

Overweight and obese women have higher rates of newborns requiring special care at birth. One study reported that newborns of overweight and obese pregnant women were more likely to need neonatal resuscitation or NICU admission. A higher maternal BMI was associated with an increased risk of an Apgar score < 7 at 5 minutes. Infants from the obese III category were three times more likely to receive an Apgar score < 7 at 5 minutes when compared with infants born to women with normal BMI [14].

Another study concluded that 7.1% of stillbirths and 6.5% of intensive care unit admissions could have been avoided if women in the overweight or obese groups had dropped one BMI category [6]. The risk of neonatal hypoglycemia is also higher among newborns of obese women [26]. In a large population-based study, the authors concluded that a 10% reduction in pre-pregnancy BMI was associated with a decrease of at least 15% of large for gestational age, an APGAR score below 6 at 5 minutes, and NICU admission risk [16].

The risks of the poor fetal outcome, including higher odds of death in the early neonatal period or stillbirth, are higher among infants born to extreme obese pregnant women (BMI  $\geq$  50 kg/m<sup>2</sup>) [18].

## MATERNAL UNDERWEIGHT

Although less studied than obesity, being underweight before pregnancy also involves some risks and may be associated with negative pregnancy outcomes. Underweight in a woman can reduce fertility through chronic energy deficiency with secondary hormonal imbalances, triggering anovulatory cycles and lowering the rate of spontaneous conception [28]. Assisted reproduction techniques (ART) among these women has become increasingly used, but not without negative effects. Tang et al. investigated the impact of the pre-gestational BMI and the outcome of pregnancies conceived by *in vitro* fertilization (IVF) and reported that underweight

women have lower implantation rates compared to those with normal weight. Also, women in the underweight group have low ongoing pregnancy rates, compared to women of normal weight [29]. In contrast, Romanski et al. demonstrated similar ongoing pregnancy and live birth rates among infertile women of normal weight and underweight who obtained a pregnancy through IVF [30].

Miscarriage in the first trimester of pregnancy is more common among women with high or low BMIs. A Danish cohort study of 23,821 women found that lower pre-pregnancy weight increased the risk of miscarriage compared to normal-weight women [11]. This statement was also demonstrated in the study of Metwally et al., who also showed that underweight and obese women have a significantly increased risk of recurrent miscarriage [31].

Many studies have shown that underweight women before pregnancy have an increased risk of preterm birth compared to women with normal prepregnancy weight [32,33]. There is a directly proportional relationship between the increase in the percentage of premature birth and the increase in underweight severity, even after removing behavioral risk factors or after the control of maternal pathologies associated with premature birth [34].

A higher risk of small for gestational age newborns among underweight women was also highlighted [32,33,35,36]. In addition, pregnant women with inadequate gestational weight gain have an increased risk of preterm and term LBW [23,37,38]. The weight of the fetus at birth is a marker of the intrauterine environment playing an essential role in cognitive development in the newborn and childhood [39]. Morbidity in adulthood is closely linked to body weight at the beginning of life, low birth weight increasing the risk of diseases such as diabetes, high blood pressure, and stroke [40,41].

There is also a link between maternal underweight and the mode of delivery. Pregnant women with a BMI  $\leq$  18.5 have lower rates of cesarean section [14,32,35] being more likely to achieve spontaneous vaginal birth when compared with women with normal BMI. Additionally, underweight pregnant women were less likely to need induction of labour or emergency cesarean section [14].

## CONCLUSIONS

Pre-pregnancy weight is an independent and potentially modifiable risk factor in the prognosis of pregnancy, being associated with increased maternal-fetal morbidity and mortality. The association with other lifestyle factors, such as the mother's weight gain during pregnancy, malnutrition, smoking, alcohol, or drug use, worsens pregnancy prognosis.

Studies in the literature indicate that overweight and obesity during pregnancy are associated with different maternal and neonatal complications, including gestational diabetes, gestational hypertension, preeclampsia, macrosomia, preterm or very preterm delivery, induction of labor, or cesarean section. There seems to be a direct relation between BMI category and risk of perinatal complication. On the other side, being underweight at the beginning of the pregnancy can also cause various complica-

tions during pregnancy or at birth, including a higher risk of preterm birth or small for gestational age newborns.

Pregnancy, especially in overweight or obese women, should be considered and managed as a high risk. Lifestyle interventions, such as diet quality and physical activity, are necessary in order to positively impact pregnancy outcomes among women with obesity.

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