



(REVIEW ARTICLE)



Association between body mass index and adverse pregnancy outcomes

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GSC Advanced Research and Reviews, 2024, 20(03), 102–108

Publication history: Received on 01 August 2024; revised on 13 September 2024; accepted on 16 September 2024

Article DOI: <https://doi.org/10.30574/gscarr.2024.20.3.0340>

Abstract

The prevalence of elevated body mass index (BMI), including overweight and obesity, has been increasing globally, posing significant challenges to maternal and fetal health. This review examines the association between elevated BMI and adverse pregnancy outcomes, emphasizing maternal, fetal, and long-term complications. Elevated BMI in pregnancy is associated with an increased risk of gestational diabetes mellitus, hypertensive disorders, cesarean delivery, and postpartum complications. For the fetus, elevated maternal BMI is linked to an increased risk of macrosomia, preterm birth, congenital anomalies, and stillbirth. Furthermore, these adverse outcomes extend into long-term risks, including a higher likelihood of childhood obesity and metabolic disorders in offspring, as well as persistent obesity and related health issues in mothers. Pathophysiological mechanisms underlying these associations include chronic inflammation, oxidative stress, and hormonal dysregulation. Effective management strategies include preconception counselling, nutritional and exercise interventions, and regular monitoring throughout pregnancy to mitigate these risks. This review underscores the importance of addressing elevated BMI in reproductive-aged women as a critical component of prenatal care to improve pregnancy outcomes and long-term health for both mother and child.

Keywords: Body Mass Index (BMI); Pregnancy Outcomes; Adverse Pregnancy Outcome; Obesity Maternal Health

1. Introduction

Pregnancy is the period in which a fetus grows and develops inside a woman's uterus, usually lasting about 40 weeks from the last menstrual period (LMP) to childbirth. This process is divided into three trimesters, each roughly three months long, and is characterized by significant physiological and hormonal changes in the mother's body. These changes are essential for supporting the developing fetus and preparing the body for childbirth. In the first trimester, the embryo forms and begins developing vital organs. During the second trimester, the fetus experiences rapid growth, and the mother's body adjusts visibly to accommodate this development. The third trimester involves the fetus reaching full maturity and preparing for birth. Throughout pregnancy, the mother's body adapts in various ways, including increased blood flow, hormonal adjustments, and changes in metabolism, all to ensure a healthy pregnancy and delivery. [1].

2. Trimesters of Pregnancy

During pregnancy, the pregnant mother undergoes significant anatomical and physiological changes to nurture and accommodate the developing foetus. These changes begin after conception and affect every organ system in the body. In a pregnancy, there can be multiple gestations, as in the case of twins or triplets. Childbirth usually occurs about 38 weeks after conception; in women who have a menstrual cycle length of four weeks, this is approximately 40 weeks from the last normal menstrual period [1,2]

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2.1. First Trimester (Weeks 1-12)

- **Conception and Implantation:** Fertilization of the egg by the sperm, followed by implantation in the uterine lining.
- **Early Development:** Formation of the placenta, amniotic sac, and major organs begins. Common symptoms include nausea (often referred to as morning sickness), fatigue, and breast tenderness.

2.2. Second Trimester (Weeks 13-26):

- **Fetal Growth:** The fetus continues to grow, with more defined facial features, and the development of organs and systems. The mother may begin to feel fetal movements, often called "quickening."
- **Maternal Changes:** Many women experience relief from early pregnancy symptoms and start to "show" as the uterus expands.

2.3. Third Trimester (Weeks 27-40):

- **Final Development:** The fetus gains weight, and its organs mature in preparation for birth. The fetus often turns head-down in the uterus.
- **Preparation for Birth:** The mother may experience increased discomfort, Braxton Hicks contractions, and preparation for labor.

Maternal body mass index (BMI) is a vital predictor of various obstetric and delivery-related complications, influencing both maternal and neonatal outcomes. As the prevalence of obesity rises globally, understanding the impact of maternal BMI on pregnancy and delivery is crucial for developing effective management strategies and improving healthcare outcomes. This comprehensive review synthesizes the latest research on the subject, highlighting key complications associated with elevated maternal BMI, underlying mechanisms, and clinical implications [4]

3. Definition and Classification of BMI

BMI is a measure of body fat based on height and weight that applies to adult men and women. It is calculated as weight in kilograms divided by height in meters squared (kg/m^2). The World Health Organization (WHO) classifies BMI into several categories:

- Underweight: $<18.5 \text{ kg}/\text{m}^2$
- Normal weight: $18.5\text{--}24.9 \text{ kg}/\text{m}^2$
- Overweight: $25\text{--}29.9$

4. Comprehensive Review of Maternal Body Mass Index and Delivery Complications

Maternal body mass index (BMI) is a vital predictor of various obstetric and delivery-related complications, influencing both maternal and neonatal outcomes. As the prevalence of obesity rises globally, understanding the impact of maternal BMI on pregnancy and delivery is crucial for developing effective management strategies and improving healthcare outcomes. This comprehensive review synthesizes the latest research on the subject, highlighting key complications associated with elevated maternal BMI, underlying mechanisms, and clinical implications [5]

4.1. Definition and Classification of BMI

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- Overweight: $25\text{--}29.9 \text{ kg}/\text{m}^2$
- Obesity Class I: $30\text{--}34.9 \text{ kg}/\text{m}^2$
- Obesity Class II: $35\text{--}39.9 \text{ kg}/\text{m}^2$
- Obesity Class III: $\geq 40 \text{ kg}/\text{m}^2$

4.2. Epidemiology of Maternal Obesity

Obesity has become a global epidemic, with significant implications for reproductive health. The prevalence of obesity among women of childbearing age has increased markedly over the past few decades. According to the World Health Organization, approximately 15% of women worldwide are obese, with higher rates in high-income countries. In the United States, data from the Centers for Disease Control and Prevention (CDC) indicate that nearly 30% of women of reproductive age are classified as obese. This rising trend underscores the importance of addressing maternal obesity and its associated risks during pregnancy [6]

4.3. Complications Associated with Elevated Maternal BMI

- **Gestational Diabetes Mellitus (GDM)** Elevated BMI is a well-established risk factor for GDM. Women with obesity are at a higher risk of developing GDM compared to women with a normal BMI. Insulin resistance, exacerbated by increased adiposity, is a primary mechanism leading to GDM. A meta-analysis by Torloni et al. found that women with a BMI of 30 or higher have a significantly increased risk of developing GDM [7]
- **Hypertensive Disorders** Obesity during pregnancy is strongly associated with hypertensive disorders, including preeclampsia and gestational hypertension. These conditions pose significant risks to both mother and fetus. A study by Bodnar et al. reported that women with a BMI of 30 or higher had a fourfold increase in the risk of developing preeclampsia compared to women with a normal BMI. The pathophysiology involves increased inflammation, endothelial dysfunction, and altered placental development.
- **Labor Dystocia and Induction** Increased BMI is linked to a higher incidence of labor dystocia, often necessitating labor induction. Labor dystocia, characterized by slow and abnormal labor progression, is more common in obese women due to factors such as increased pelvic adiposity and decreased uterine contractility. Arrowsmith et al. found that obese women had higher rates of labor induction and prolonged labor compared to their normal-weight counterparts.
- **Cesarean Section (C-Section)** The likelihood of C-section delivery is notably higher in obese women. Several studies, including a systematic review by Chu et al., have highlighted that women with a BMI of 30 or higher are at a significantly increased risk for both elective and emergency C-sections. The technical difficulties associated with obesity, such as increased operative time, anesthesia risks, and postoperative complications, contribute to this increased risk.
- **Postpartum Hemorrhage (PPH)** Higher maternal BMI is associated with an increased risk of PPH, a serious complication characterized by excessive bleeding after delivery. Blomberg's study indicated that obese women had a significantly higher incidence of PPH due to uterine atony and the need for surgical interventions.
- **Neonatal Outcomes** Infants born to obese mothers are at greater risk for macrosomia (birth weight > 4000 g), which increases the likelihood of birth injuries and complications such as shoulder dystocia. Additionally, these infants have a higher risk of developing metabolic disorders later in life. Weiss et al. demonstrated that maternal obesity significantly increases the risk of macrosomia and associated neonatal complications.

5. Mechanisms Underlying BMI-Related Complications

Several mechanisms contribute to the increased risk of complications associated with elevated maternal BMI [8]

- **Insulin Resistance and Hyperinsulinemia** Obesity is characterized by increased insulin resistance and hyperinsulinemia, which are key factors in the development of GDM. The altered metabolic environment affects glucose metabolism, leading to hyperglycemia and its associated complications.
- **Inflammation and Endothelial Dysfunction** Obesity is associated with a state of chronic low-grade inflammation and endothelial dysfunction. These changes contribute to the development of hypertensive disorders such as preeclampsia. Inflammatory cytokines and adipokines play a crucial role in altering vascular function and placental development.
- **Altered Uterine Contractility** Increased adiposity around the pelvis and altered uterine muscle function can lead to labor dystocia. Obesity affects the myometrial contractility, resulting in inefficient labor and increased rates of labor induction and C-sections.
- **Increased Surgical Risk** Obesity complicates surgical procedures due to technical difficulties, increased operative time, and higher rates of postoperative complications such as infections and wound dehiscence. These factors contribute to the higher rates of C-sections and related complications in obese women.

5.1. Clinical Implications and Management Strategies

Addressing maternal BMI through preconception counseling and appropriate weight management strategies during pregnancy is crucial. Healthcare providers should implement comprehensive weight management programs that

include dietary counseling, physical activity, and behavioral interventions to optimize maternal and neonatal outcomes [9]

- **Preconception Counseling** Women of reproductive age should receive counseling on the importance of achieving a healthy BMI before conception. This includes education on balanced nutrition, regular physical activity, and the risks associated with obesity during pregnancy.
- **Weight Management During Pregnancy** Weight gain recommendations during pregnancy should be individualized based on pre-pregnancy BMI. The Institute of Medicine (IOM) provides guidelines for appropriate weight gain during pregnancy to minimize risks. For example, women with a normal BMI are advised to gain 25-35 pounds, while those with a BMI of 30 or higher should aim for a weight gain of 11-20 pounds.
- **Monitoring and Screening** Regular monitoring of weight, blood pressure, and blood glucose levels is essential for obese pregnant women. Early screening for GDM and hypertensive disorders allows for timely intervention and management to reduce complications.
- **Interdisciplinary Care** A multidisciplinary approach involving obstetricians, nutritionists, endocrinologists, and physical therapists can provide comprehensive care for obese pregnant women. This team-based approach ensures that all aspects of maternal and fetal health are addressed.
- **Education and Support** Providing education and support to pregnant women regarding healthy lifestyle choices is crucial. This includes resources on healthy eating, safe exercise routines, and managing weight gain during pregnancy.

5.2. Maternal BMI and Recurrent Pregnancy Loss (RPL)

Recurrent Pregnancy Loss (RPL), defined as two or more consecutive pregnancy losses, affects about 1-2% of couples trying to conceive. Maternal BMI has emerged as a modifiable risk factor for RPL [10-13]

5.2.1. Obesity and RPL

Obesity is linked to an increased risk of RPL, possibly due to hormonal imbalances, insulin resistance, and chronic inflammation. A meta-analysis by Boots et al. (2016) found that obese women have a higher risk of experiencing RPL compared to women with normal BMI. The underlying mechanisms may involve impaired implantation and placental development due to altered inflammatory responses and vascular dysfunction [14]

5.2.2. Underweight and RPL

Underweight women also face an elevated risk of RPL, possibly due to nutritional deficiencies and hormonal imbalances. A study by Metwally et al. (2010) reported that underweight women had a significantly higher risk of RPL, particularly in the first trimester [15]

The relationship between maternal BMI and pregnancy outcomes, including delivery complications and RPL, underscores the importance of achieving and maintaining a healthy weight before conception. Both extremes of BMI—underweight and obesity—pose risks that can affect maternal and fetal health. While obesity is more commonly associated with adverse outcomes such as GDM, preeclampsia, and RPL, underweight status also carries risks, particularly for preterm birth, LBW, and RPL [16-18]

Healthcare providers should counsel women on the importance of maintaining a healthy BMI before and during pregnancy. Preconception care should include nutritional guidance, weight management strategies, and monitoring of maternal health to reduce the risk of adverse outcomes.

6. Clinical Implications and Management Strategies for RPL

This management plan emphasizes the importance of individualized care, addressing both BMI-related and other potential causes of RPL. Adherence to evidence-based guidelines can optimize outcomes for women with a history of recurrent pregnancy loss. Management of recurrent pregnancy loss (RPL) in the context of maternal BMI involves a comprehensive and individualized approach. This management strategy focuses on addressing BMI-related issues while also considering other potential causes of RPL [19-25]

Below is an outline of the key components of management:

6.1. Preconception Care and Counselling:

6.1.1. Nutritional Counselling:

For **obese** women: Emphasize a balanced diet rich in fruits, vegetables, whole grains, and lean proteins. Caloric intake may need to be reduced, and a dietitian can help create a sustainable weight-loss plan.

For **underweight** women: Nutritional guidance is aimed at gaining weight safely through an increased intake of nutrient-dense foods.

6.1.2. Exercise:

Regular physical activity is encouraged to achieve or maintain a healthy BMI. For obese women, moderate exercise can help with weight loss, while underweight women may benefit from strength training to build muscle mass.

6.2. Medical Management

6.2.1. Obesity

- **Metformin:** May be prescribed in cases of insulin resistance or polycystic ovary syndrome (PCOS) to improve ovulatory function and reduce the risk of miscarriage.
- **Bariatric Surgery:** For severely obese women who have not achieved significant weight loss through diet and exercise, bariatric surgery may be considered before conception, although this option requires careful consideration due to the associated risks and the need for a delay in pregnancy post-surgery.

6.2.2. Underweight

- **Nutritional Supplements:** Folic acid, iron, zinc, and other essential vitamins and minerals may be prescribed to address deficiencies and support fetal development.
- **Hormonal Therapy:** If low BMI is associated with hormonal imbalances, hormone therapy (e.g., progesterone supplementation) may be recommended to support early pregnancy.

6.3. Monitoring and Support During Pregnancy

- **Regular Monitoring:** Women with a history of RPL and abnormal BMI should be closely monitored during pregnancy. This includes frequent ultrasounds to assess fetal growth and development, as well as monitoring maternal health parameters like blood pressure, blood glucose, and lipid levels [25-35]
- **Psychological Support:** RPL can be emotionally challenging, and women may benefit from counseling or support groups to manage anxiety and stress during pregnancy.

6.4. Addressing Other Potential Causes of RPL

- **Comprehensive Evaluation:** In addition to addressing BMI, a thorough evaluation should be conducted to rule out other causes of RPL, including genetic, anatomical, hormonal, infectious, and autoimmune factors.
- **Personalized Treatment Plan:** Based on the findings of the evaluation, a personalized treatment plan may be developed. This could involve surgical correction of uterine abnormalities, anticoagulation therapy for thrombophilias, or immunotherapy in cases of autoimmune-related RPL.

6.5. Post-Pregnancy Care

- **Weight Management:** Postpartum care should include strategies for maintaining a healthy BMI, especially if significant weight was gained or lost during pregnancy.
- **Long-Term Monitoring:** Women who have experienced RPL should continue to be monitored for potential long-term health issues related to BMI, such as metabolic syndrome, cardiovascular disease, and future pregnancy risks.

7. Conclusion

Elevated BMI during pregnancy significantly increases the risk of adverse outcomes for both mother and baby, including gestational diabetes, hypertensive disorders, cesarean delivery, and fetal complications such as macrosomia and

congenital anomalies. Effective strategies, including preconception weight management, lifestyle interventions, and close monitoring, are essential to mitigate these risks. Addressing elevated BMI as part of routine prenatal care can enhance pregnancy outcomes and promote the long-term health of mothers and their children.

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