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The Impact of Maternal Obesity on the Development and Outcomes of Congenital Masses: A Review

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ABSTRACT

Background: The global prevalence of obesity has risen sharply, including among pregnant women, contributing to a significant increase in obstetric complications and adverse birth outcomes. One such concern is the development of congenital anomalies, which include cystic, solid, or vascular malformations. These anomalies are influenced by maternal factors such as pre-pregnancy malnutrition, inadequate folic acid intake, iodine deficiency, consanguineous marriages, insufficient immunization, and exposure to teratogens like alcohol. Addressing the high morbidity associated with these abnormalities requires a deep understanding of their anatomical and etiological factors.

Purpose: This review aims to examine the impact of maternal obesity on the development and outcomes of congenital masses. It seeks to identify mechanisms underlying these malformations, assess their prevalence, and explore strategies for prevention and management.

Method: A comprehensive literature review was conducted, focusing on studies that link maternal obesity with congenital anomalies. Relevant articles were identified from databases such as PubMed, Scopus, and Web of Science using keywords like "maternal obesity," "congenital masses," "foetal malformations," and "pregnancy outcomes."

Results: Maternal obesity was associated with an increased risk of congenital anomalies due to factors such as altered metabolic states, inflammation, and suboptimal nutrient levels. Early diagnosis and intervention were identified as critical for improving outcomes.

Conclusion: Maternal obesity significantly impacts the development and outcomes of congenital masses. Effective prevention strategies, such as nutritional counselling, obesity management, and early screening programs, are essential to mitigate these risks and improve maternal and neonatal health outcomes.

1. Introduction

According to the World Health Organization (WHO), over 303,000 infants per year die from congenital abnormalities within four weeks after birth worldwide. Preconception healthcare programs have recently become concerned about the rising obesity rate because being overweight before becoming pregnant is linked to a higher risk of negative reproductive health outcomes such as infertility (Stothard *et al.*, 2009).Congenital malformations are a major public health concern because of the long-term implications they have on the well-being of affected children, adults, and families. Years of life lost and family satisfaction are two indicators of the impact on infant and maternal mortality. The emotional toll of routine prenatal screening on expectant mothers and the public. medical, social, and educational services offered to impacted persons and their families; their availability; the quality of those services; and the financial cost of providing those services (Waller, 2007). In this article, we will refer to these conditions as congenital abnormalities.

Congenital anomalies include many kinds of birth deformities, both single (i.e., isolated) and numerous (i.e.,

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clustered) malformations (i.e., multiple defects) (Langley-Evans *et al.*, 2022). The severity of congenital abnormalities varies widely. Deaths attributed to congenital abnormalities worldwide have reduced from 750.6 thousand in 1990 to 632.1 thousand in 2013, with mortality rates of 11.0 and 8.7 per 100,000 people, respectively, when adjusted for age. Estimated global mortality rates from certain forms of fatal congenital malformations in 2013. The likelihood of survival in cases with other congenital abnormalities is uncertain (Sun *et al.*, 2020). Major anomalies are those that significantly impact the infant's health, quality of life, or ability to function physically or socially. In contrast, "small" abnormalities do not significantly affect health or the body's short- or long-term operation. Rapid progress has been made in prenatal screening and diagnosis. In the not-too-distant future, we will have less invasive technologies with higher sensitivity and specificity for diagnosing chromosomal abnormalities. For reducing the number of abortions women are pressured to consider, improving the health and well-being of affected children and their families is a critical priority. Primarily, this can be accomplished by reducing exposure to harmful conditions in the first place (McDowell *et al.*, 2019).

1.1. What is Obesity?

The Body Mass Index (BMI), calculated by dividing a person's weight in kilograms by the square of their height in meters, is widely accepted as a measure of obesity. Those who have a body mass index (BMI) of 30 or above are classified as obese, while those with a BMI of 40 or more are considered severely obese (Lawrence & Kopelman, 2004). Despite these caveats, BMI is still used today since it is simple to compute and serves as the most effective instrument from a public health policy standpoint (Reichetzeder, 2021).

1.2. Causes of Birth Defects

Causes of most congenital malformations can be traced to genetic or environmental influences, or both (multifactorial birth defects). However, the root of the problem usually needs to be identified (Dow & Szymanski, 2020).

These are examples of conditions that can be traced back to their genetic or inherited roots:

- Anomalies in the number or structure of chromosomes, such as those responsible for Down syndrome, are known as chromosomal defects (Pi-Sunyer, 2009).
- Achondroplasia and Marfan syndrome are examples of single-gene abnormalities, in which a single faulty gene is passed down from a single parent (who may or may not have the condition) (Helle & Priest, 2020).
- Cystic fibrosis and GM2 gangliosides are examples of recessive disorders in which both healthy parents pass on the gene causing the disorder to their offspring (Tay-Sachs disease).
- A birth defect's likelihood can be increased by exposure to environmental factors such as drugs, alcohol, or the mother's illness. Teratogens are agents that can cause birth defects.
- Inherited genetic predispositions and environmental factors play a role in developing multifactorial congenital anomalies. That is to say, it is possible to inherit a gene that makes one more reactive to a given environmental factor (Ji *et al.*, 2021).

2. General Relationship: Maternal Obesity

The percentage & severity of maternal obesity have been rising at a concerning rate in current times, mirroring trends in the overall population. Negative pregnancy outcomes, newborn difficulties, and morbidity are all linked to maternal fat. Stillbirth, macrosomia, shoulder dystocia, premature delivery, & congenital deformities such as neural tube defects, omphalocele, and congenital heart problems are all examples of such complications (Hedermann *et al.*, 2021).

Maternal obesity is directly linked to an increased risk for bad newborn outcomes, and this risk appears to increase in proportion to the degree of maternal obesity (refer to Figure 1). However, there has been no consensus in research on the nature of the link between risk and particular CHD subtypes. In several of this research, body mass index (BMI) estimates relied on retrospective self-reported data related to recall bias (Cedergren & Källén, 2003).

However, many of the studies only report problems that were detected in the fetus or newborn (refer to Figure 1). These studies may be underestimating the prevalence of CHD because noncritical CHD, which might not produce symptoms at birth and is instead a delayed diagnosis in adulthood, is being overlooked (Kurita *et al.*, 2021).

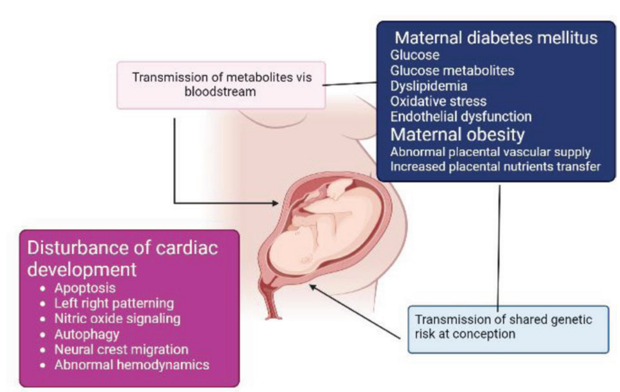

Figure 1: Risks Associated with Maternal Obesity

2.1. Foetal Alcohol Exposure and the Risk of Congenital Malformations

Prenatal alcohol usage is the single most important environmental risk factor for foetal malformations. An umbrella term encompassing the complete range of diseases induced by a mother's use of alcohol during pregnancy (Sarmah *et al.*, 2016). FASD accompanies two to five percent of U.S. births, and between two and seven out of every 1,000 births are accompanied by FAS (Dolk *et al.*, 2010).

2.2. Prevention

Preventive interventions may not be able to eliminate all instances of congenital malformations, but they can diminish their prevalence and impact. The initial steps in reducing the prevalence of birth abnormalities are found in raising public health awareness and promoting better health practices as shown in Figure 2 (Correa & Marcinkevage, 2013). The state of health, adopting good lifestyle habits, avoiding potentially harmful substances, and improving food by guaranteeing sufficient levels of vitamins and minerals, especially folic acid. (Carmichael *et al.*, 2010)

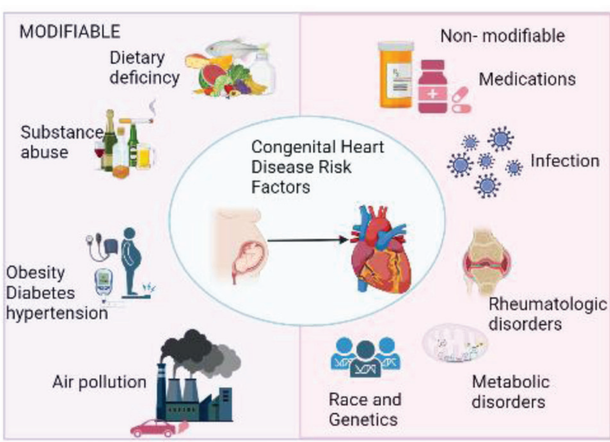

Figure 2: Measure which could be Opted for Preventing Congenital Heart Disease Risk Factors

In its broadest sense, the DOHaD idea holds that exposure to risk factors in the first few years of life significantly impacts whether an individual will develop a disease later in life. According to the DOHaD theory, there are critical periods of development in which tissues and organs are especially vulnerable to environmental exposures that shape or programme the body for disease susceptibility later in life (such as conception, pregnancy, and the first few years of life). Due to the complexity of the interconnected molecular pathways through which prenatal and early life exposures affect physiology and health, this area of study remains popular among scientists (Mills *et al.*, 2010).

3. Pregnancy Complications That Result from Maternal Obesity

Do not discount the dangers that mothers face when they are pregnant. foetal growth restriction, hypertensive disorders, gestational diabetes mellitus (GDM), stillbirth, and macrosomia are just a few of the pregnancy issues more common in obese gravidas (Plows *et al.*, 2018). The likelihood that an obese woman will have to have a caesarean section after a failed labour attempt is significantly higher among obese women (Marshall & Spong, 2012). Shoulder dystocia can cause permanent nerve damage known as Erb palsy. Obese moms raise their babies' chance of this problem, unrelated to GDM. Poor picture quality and the inability to finish the anatomy screen are potential issues with foetal anomaly screening ultrasound (Howell & Powell, 2017). Complications from anaesthesia are also more common in overweight women. Pregnant and postpartum obese women have an increased risk of thrombosis and infection. In addition, numerous pregnancy issues lead to iatrogenic preterm delivery, putting the neonate at risk for the difficulties of premature birth (Kelly *et al.*, 2020).

3.1. Congenital Heart Defects

Around a third of all severe congenital anomalies are heart problems, making them the most frequent abnormality. Although the severity of the mortality and disability risks associated with congenital cardiac abnormalities varies, they are almost always substantial (Murthi & Rajaraman, 2020). We still do not know much about the genetic and environmental factors that play into the pathophysiology of congenital heart abnormalities. Obese mothers are the result of a perfect storm of social and biological factors for having a child born with a heart abnormality. Understanding potentially modifiable risk factors for congenital cardiac abnormalities is essential for their prevention (refer Figure 3).

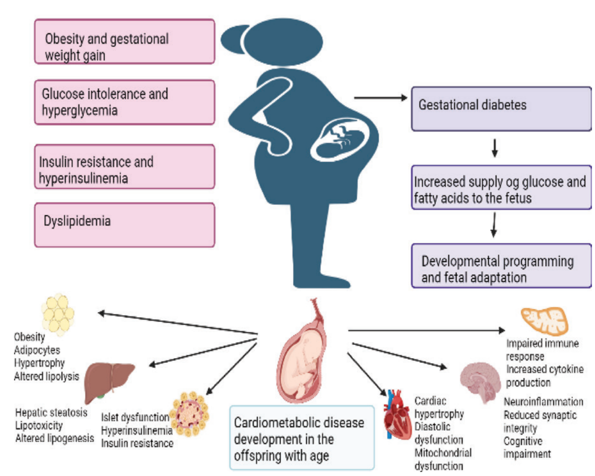

Figure 3: Identifying Modifiable Risk Factors: A Key Step in Preventing Congenital Cardiac Abnormalities

3.2. Risk Factors

3.2.1. Illicit Drug Use

Pregnancy-related substance addiction is complex, with many negative effects on both the mother and the baby. Prenatal exposure to illegal narcotics is rising worldwide, despite growing evidence of the harm it causes. Opiates, benzodiazepines, stimulants, and cannabis all have different effects and are often abused (Stupin & Arabin, 2014).

3.2.2. Obesity

Pregnancy in an obese patient can bring about a variety of perinatal risks and/or difficulties. It is becoming increasingly difficult for healthcare providers working with women to reduce these risks and manage problems.

3.2.3. Alcohol

There is still a no greater avoidable cause of birth abnormalities than alcohol usage during pregnancy. Foetal alcohol syndrome (FAS) causes problems like malformations and delayed development in new-borns. The effects of alcohol on the frontal lobe and facial architecture occur at around the same time throughout development (Loeken, 2006) and nervous system cells are especially vulnerable to alcohol's toxic effects, prenatal exposure can lead to serious attention, behavioural, and intellectual deficits. The long-term effects of neurocognitive disorders are frequently the worst-case scenario. Babies are more vulnerable to alcohol's effects during the second half of the first trimester while they are still forming their organs. Smooth philtrum, thin vermillion, microcephaly, and weight and height inadequacies are some of the face abnormalities linked to heavy alcohol usage during this time (Atreya *et al.*, 2004).

3.2.4. Preeclampsia

In pregnant women, the Spiral arteries enlarge by as much as a factor of ten, becoming the enormous uteroplacental arteries that supply the growing foetus with its blood supply. Whereas in the condition, preeclampsia these arteries become fibrous in nature and gets narrower (Mitchell, 1997). Due to the reduction in the diameter of arteries, blood supply to the placenta gets reduced. A poorly perfused placenta may lead to intrauterine growth restriction and in the worst-case scenario foetal deaths.

3.2.5. Gestational Diabetes

Up to 89% of women with a healthy BMI before pregnancy become overweight or obese within 5 years of giving birth, according to studies (Prescott & Wilkie, 2007). Women who are overweight or obese at conception are more likely to retain more than 5 kilogrammes of that weight a year after giving birth. When this happens, a woman is more likely to be overweight or obese going into her following pregnancies, which raises her risk for GWG and GDM (Harris *et al.*, 2017).

3.2.6. Obstructive Sleep Apnoea

In addition to preeclampsia, a pregnant woman's cardiovascular health may be negatively impacted by Obstructive Sleep Apnoea (OSA), a common consequence of obesity. OSA is characterised by a significant reduction in airflow or its complete absence while a person is sleeping. Because of the intervals of decreased airflow, patients have frequent awakenings, repeated sympathetic activation, and hypertension. No thorough prospective investigation has been carried out too far to precisely identify the prevalence of OSA in expectant mothers (Khoury, 2000).

4. Prevalence

As many as 295 000 infants are born each year with congenital abnormalities and never make it past the fourth week of life. Around fifty percent of the instances of congenital abnormalities lack a clear explanation (Khokha *et al.*, 2017). Nevertheless, environmental teratogens, dietary inadequacies, and single-gene anomalies are some known causes, as are chromosomal abnormalities, multifactorial inheritance, and multifactorial inheritance. Both inherited genes and mutations contribute to genetic causes (Boyle *et al.*, 2018). When a kid's parents are related by blood, or consanguineous, the child has a significantly higher risk of being born with a birth defect and nearly doubles their risk of dying in infancy or early childhood and developing intellectual disabilities or other health problems. The likelihood of genetic abnormalities like the likelihood of having a child with Down syndrome increases as a mother ages. Certain infectious diseases are known to increase the risk of having a child born with a deformity, and they include Zika, syphilis, and rubella. Several racial and ethnic groupings have an increased prevalence of disorders such cystic fibrosis and haemophilia C (Paredes *et al.*, 2021).

The physical and mental impairments caused by congenital abnormalities often persist throughout a person's life. The economic toll of these illnesses is enormous, as is the toll taken by individuals, families, healthcare systems, and communities when long-term impairment strikes. These challenges are compounded in low- and middle-income nations due to a potential shortage of necessary support services for people with disabilities (Dolin & Kominiarek, 2018).

5. Important Nutrition - Regular and Irregular Diet

A large part of the recent interest in prenatal nutrition has been prompted by the alarming rise in both worldwide obesity rates and rates of overweight (Hieronimus & Ensenauer, 2021). Researchers in the field of Early Nutrition and related fields have found evidence for higher rates of obesity and cardiovascular risk in kids are linked to maternal obesity, excessive weight gain, and diet during pregnancy (TAVELLA *et al.*, 2020). For both mother and her children's well-being, careful consideration of mother's nutritional status throughout pregnancy due to the connections (Mariona, 2016)

During the first trimester of pregnancy, a woman's calorie needs are not much different from those she had before becoming pregnant (refer Figure 4). Instead of focusing on eating more, people should priorities consuming a diet rich in foods that provide essential nutrients. We need to put an end to the misconception that "eating for 2" is possible (Boyle *et al.*, 2018).

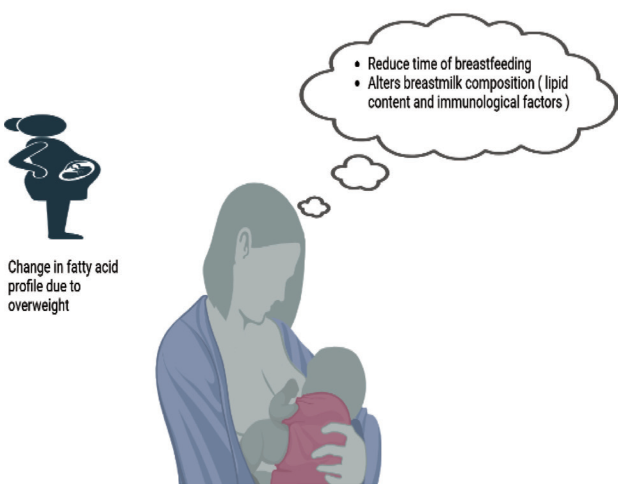

Figure 4: Impact of Maternal Overweight on Breastfeeding: Changes in Fatty Acid Profile, Reduced Duration, and Altered Breast Milk Composition

There's more to prenatal nutrition than counting calories and gaining weight. Most nutrients have higher dietary reference intakes (DRIs) during a singleton pregnancy. In general, pregnant women need an extra 2200 to 2900 kcals per day (on average), though this number varies by trimester. Yet, pregnant women's energy metabolism is highly individual (Paredes *et al.*, 2021).

Increase of 25 g/day in the minimum amount of protein that should be consumed. Low intakes are a concern for some women, but this is not the case for the majority. Zinc and iron DRI both go up. Fiber, vitamin A, vitamin C, vitamin B, a variety of minerals, and even iron all increase, albeit to a lesser level (Prescott & Wilkie, 2007). Pregnancy does not necessarily increase the need for certain nutrients. Vitamins D, E, and K remain the same, and neither does fluoride. Nonetheless, it is important for the mother to know that bottled water is not a dependable supply of fluoride. Many women enter pregnancy with calcium intakes below the recommended minimum (Murthi & Rajaraman, 2020).

While there is an increase in the requirement for calories, it is smaller than that for most other nutrients. Because of the limited amount of storage capacity that expectant mothers have, it is important that they focus on eating small, frequent meals that are high in nutrients.

Patients should opt for low-fat or skim milk or yogurt, leaner cuts of meat, especially red meat, less juice, whole grains, and water rather than sugary sports drinks (Carmichael *et al.*, 2010). High nutritional density with low calorie count can be achieved by consuming a lot of fresh or frozen produce and avoiding processed foods high in fat and sugar (Kurita *et al.*, 2021).

Women who are pregnant with multiples, those with HIV, and smokers, alcoholics, and drug addicts have greater nutritional requirements during pregnancy; hence, it is suggested that expecting mothers should take prenatal vitamins (multivitamins and multiminerals). Others use them as insurance rather than as a replacement for healthy eating habits (Dow & Szymanski, 2020).

6. Conclusion

Even though absolute increases are likely to be minimal, maternal obesity is linked to an increased risk of a variety of anatomical abnormalities. Most of the research regarding possible risks for congenital abnormalities following maternal vaccination is reassuring. The use of non-biologically possible exposure periods, varying definitions of outcomes, and insufficient sample sizes have all been limitations of research to date. It is believed that 3% of pregnancies have one or more congenital abnormalities. The interpretation of shifts in Global Burden of Disease estimates considering primary, secondary, and tertiary prevention requires awareness of these challenges.

Major public health consequences result from the worrisome rate of growth in maternal obesity and its associated comorbid illnesses (diabetes, cardiovascular disease). Obesity in mothers influences not only the mom's health but also the health of the infant with some adverse effect on the child's health, increasing childhood obesity and diabetes. There are still significant obstacles to providing these women with clinical care, despite advances in our understanding of this endocrinopathy. Obstetrician gynecologists are in a key position to prevent and treat this epidemic.

Abbreviations

WHO: World Health Organization; **BMI:** Body Mass Index; **CHD:** Congenital Heart Defects; **GDM:** Gestational Diabetes Mellitus; **DOHaD:** Developmental Origins of Health and Disease; **FASD:** Foetal Alcohol Spectrum Disorder; **FAS:** Foetal Alcohol Syndrome; **GWG:** Gestational Weight Gain; **OSA:** Obstructive Sleep Apnoea; **HIV:** Human Immunodeficiency Virus; **DRI:** Dietary Reference Intake; **KCALS:** Kilocalories; **DNA:** Deoxyribonucleic Acid; **RNA:** Ribonucleic Acid.

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Authorship Contribution

Designing of manuscript: Sarita Jangra and Tanya Sood; Analysis of the data: Amit Sharma and Sarita Jangra; Editing of the manuscript: Bhavesh Dharmani and Kritika Sharma; Critical review of the article: Thakur Gurjeet Singh, Amit Sharma, Bhupinder Bhyan, Yousef Saeed Alqarni, and Fahad Thabet Alsulami; Supervision: Thakur Gurjeet Singh.

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