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Maternal and Neonatal Outcomes in Gestational Diabetes Mellitus: Review Article

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ABSTRACT

Background: Diabetes is described as a grouping of chronic metabolic abnormalities resulting in hyperglycemia, marked by either absolute or relative insulin insufficiency. Gestational diabetes mellitus (GDM) is a kind of diabetes described by impaired glucose metabolism that is initially identified throughout pregnancy. Gestational diabetes mellitus is identified in 5.8–12.9% of females with gestation. Pre-gestational diabetes mellitus (PGDM) affects 0.4–1.1% of females with gestation. Gestational diabetes mellitus is described by glucose intolerance of varying severity that arises or is initially identified throughout pregnancy.

Objective: This article aimed to highlight the maternal and neonatal outcomes in gestational diabetes mellitus.

Material and methods: We searched Google Scholar, Science Direct, PubMed and other online databases for Maternal outcomes, Neonatal outcomes, and Gestational diabetes mellitus. The authors also reviewed references from pertinent literature, however only the most recent or comprehensive studies from 1997 to 2024 were included. Documents in languages other than English were disqualified due to lack of translation-related sources. Papers such as unpublished manuscripts, oral presentations, conference abstracts, and dissertations that were not part of larger scientific studies were excluded.

Conclusion: Gestational diabetes mellitus has been related to negative outcomes during pregnancy such as preterm birth, primary Cesarean section, & preeclampsia. Prenatal exposure to maternal hyperglycemia results in fetal hyperinsulinemia, thus elevating the possibility of neonatal hypoglycemia, macrosomia, hyperbilirubinemia, and other complications. Neonatal problems may encompass birth trauma, involving shoulder dystocia & brachial plexus injury, along with possible hypoglycemia, hypoxia, jaundice & kernicterus. Bacterial infections & newborn respiratory distress syndrome (NRDS) may also be included

Keywords: Maternal outcomes, Neonatal outcomes, Gestational diabetes mellitus.

INTRODUCTION

The Polish Diabetes Association (PDA) currently recommends diagnosing gestational diabetes between twenty-four and twenty-eight weeks of gestation. The PDA guidelines specify groups of females for which diabetes screening must occur at the time of pregnancy diagnosis**.** Hyperglycemia in pregnancy adversely impacts both the progressing baby & the pregnant females. Chronic hyperglycemia exposure in utero results in various metabolic disorders, potentially leading to macrosomia & associated perinatal complications, intrauterine fatalities, respiratory issues, hypoglycemia, polycythemia, hypomagnesemia, as well as postnatal hypocalcemia in the baby. There is growing discussion regarding the long-term repercussions for kids of diabetic moms, including overweight, obesity, heightened incidence of glucose metabolism problems, and psychomotor & intellectual impairments [1].

Pregnant females with GDM have an improved likelihood of having pre-eclampsia or gestational hypertension compared to the general population as well as are also at a heightened risk of subsequently acquiring type 2 diabetes. Hyperglycemia is a significant risk factor for neoplastic change as it impacts several processes, resulting in deoxyribonucleic acid (DNA) damage. Cellular changes due to hyperglycemia induce modifications that may promote neoplastic transformation. Postprandial hyperglycemia entails a slight dysfunction in secretion of insulin, irregular pulsatile insulin patterns, heightened immature insulin release, as well as a result, compromised first-phase secretion, all of which influence the onset of initial postprandial hyperglycemia seen in the early stages as well as milder forms of gestational diabetes mellitus. These pathways elucidate why fasting hyperglycemia poses greater risks to the developing baby [2].

Gestational diabetes mellitus

Pregnancy imposes a metabolic problem on females, characterized by weight increase & insulin resistance. Concurrent with the worldwide epidemic of obesity & its associated metabolic problems, GDM represents the most prevalent complication throughout pregnancy [3].

Etiology of gestational diabetes

The pathogenesis of GDM is evidently associated with 1) pancreatic beta-cell malfunction or the delayed response of beta cells to glycemic levels, & 2) significant insulin resistance developing from release of hormone by placenta. Human placental lactogen is the primary hormone associated with heightened insulin resistance in GDM. Other hormones associated with the progression of this condition include corticotropin-releasing hormone, prolactin, progesterone,

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& growth hormone. These hormones facilitate the induction of insulin resistance & hyperglycemia during gestation**.** GDM progression is influenced by several clinical risk factors, including reduced physical activity, elevated body weight, previous GDM or macrosomia, first-degree relative diabetes, high triglycerides, low high-density lipoprotein, high hemoglobin A1c, polycystic ovary syndrome, insulin resistance, abnormal oral glucose tolerance assessment, and a history of cardiovascular disorders. These factors can lead to complications and increased risk of complications in the future [4].

Pathophysiology of GDM

GDM is the emergence of spontaneous hyperglycemia during gestation in absence of a prior diagnosis of a disorder characterized primarily by insulin resistance (IR). This definition aligns with studies indicating that the pathophysiology of GDM varies from that of pregnancies in females with a history of diabetes in several aspects. Throughout a healthy pregnancy, peripheral insulin sensitivity varies. During early pregnancy, there is a rise in processes that enhance glycogen & adipose storage, which subsequently diminishes, leading to elevated maternal systemic & placental glycemia. The decline in insulin sensitivity, known as insulin resistance, arises from the hormonal fluctuations associated with pregnancy, including systemic & placental hormones such as cortisol, leptin, estrogen, & progesterone [5] and is accompanied by a twofold rise in insulin production from pancreatic β-cells.

Late prenatal hyperglycemia enhances glucose delivery to the fetus. Nevertheless, it diminishes glycogen reserves & promotes the utilization of fatty acids as an energy source. In gestational diabetes mellitus, maternal insulin sensitivity is nearly reduced by fifty percent, resulting in two implications: Diminished glycogen storage in both muscle & liver throughout early pregnancy & accelerated utilization of these stores in late pregnancy. Moreover, upon depletion of glycogen reserves, the utilization of fatty acids for energy becomes more pronounced than during healthy pregnancy, resulting in hypertriglyceridemia (HTG) (Figure 1) [6].

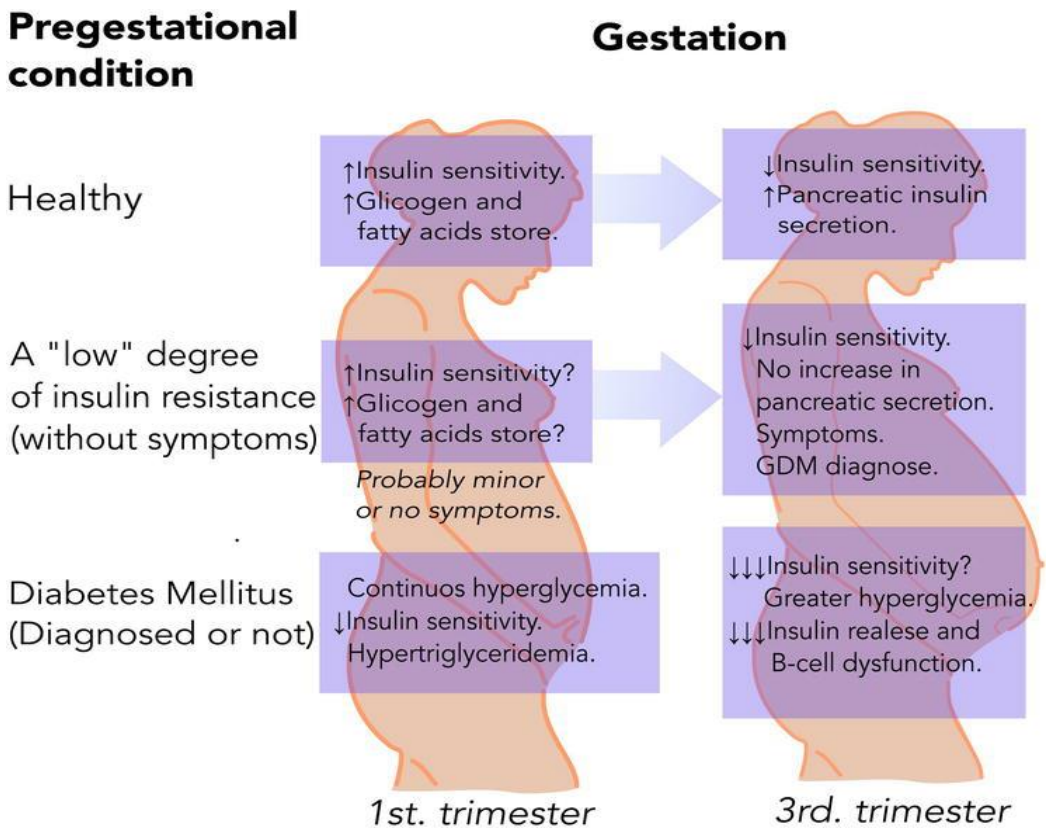

Figure (1): Metabolic variations among the 1st and 3rd trimesters in healthy pregnancies.

It is characterized by a low level of insulin resistance and a prior identification of DM. A prior low level of insulin resistance elevates the likelihood of advancing gestational diabetes mellitus in the 3rd trimester. Nevertheless, due to its asymptomatic nature, the consequences of earlier insulin resistance are often unexamined. PGDM modifies placental development during the first trimester, resulting in more severe difficulties for both mother & baby in the 3rd trimester [6].

Treatment / Management of gestational diabetes

Non-pharmacologic therapies: Management of gestational diabetes mellitus commences with nonpharmacological strategies, encompassing enhanced physical activity, dietary modifications, & glucose monitoring. Cases with gestational diabetes mellitus are advised to engage in thirty minutes of moderate-intensity aerobic activity a minimum of 5 days per week, totaling a minimum of 150 minutes weekly. Furthermore, postprandial exercise is frequently advised, as it has demonstrated efficacy in regulating the concentration of glucose for up to three hours following consumption [7].

Glucose monitoring

Monitoring glucose four times daily is typically recommended, while evidence for the optimal frequency is insufficient. The most prevalent monitoring plan involves measuring finger stick blood glucose levels once after fasting & again between one and two hours postprandial at each meal. Certain specialists advise monitoring four times daily for a duration of two weeks, depending on these results, treatment with insulin might be commenced for cases exhibiting heightened concentration of glucose, whereas those with normal reading may require less regular monitoring. The American Diabetes Association & ACOG recommend a fasting glucose target of < 95 mg/dl and a postprandial aim of 140 mg/dl or below at one hour, or 120 mg/dl at two hours. Clinicians must instruct cases to preserve reading logs of glucose for review during weekly prenatal visits or more commonly as necessary [8].

Pharmacologic therapies

If case's glycemic control is insufficient despite excellent compliance with food and exercise, pharmacological intervention is advised. Insulin treatment has historically been regarded as the regular cure for cases with gestational diabetes mellitus not managed by non-pharmacologic interventions. Oral agents are frequently utilized, but this constitutes an off-label application [9].

Insulin therapy: Insulin doesn't pass through the placental barrier & is endorsed by the American Diabetes Association as the primary therapy for GDM. Insulin regimens typically comprise basal & rapid-acting insulin compositions. Basal dosages address fasting hyperglycemia, whereas hyperglycemia postprandial is generally managed by modifying short-acting dosages of insulin. Insulin dosages should be tailored according to monitoring of glucose. Still, the estimated total insulin needed at the commencement of insulin treatment be able to calculate according to a case's weight & gestational age **(Table 1).**

Subsequently, insulin dosage may be modified based on glucose records [7].

Table (1): Determination of Initial Total Insulin Requirement Daily for diabetes pregnant women [10]

1–13 weeks	Patient weight in kg × 0.7
14–26 weeks	Patient weight in kg × 0.8
27–37 weeks	Patient weight in kg × 0.9
38 weeks to delivery	Patient weight in kg × 1.0

The case must split the total daily insulin dosage into 2 equal parts, administering one half as basal insulin at the evening & distributing other half among 3 meals, to be administered as or regular insulin rapid-acting before each meal [9].

Oral hypoglycemic agents

The predominant oral hypoglycemic medications are glyburide & metformin. Nevertheless, research on their efficacy has yielded inconclusive outcomes. Glyburide may be commenced at a daily dosage of 2.5 milligrams, with a maximum allowable dosage of twenty milligrams. Nonetheless, newer trials haven't demonstrated the same benefits to insulin therapy. Historically, glyburide has been believed to not traverse the placental barrier. However, new studies indicate this belief is erroneous. Moreover, glyburide has been related to a heightened risk of newborn intensive care unit hospitalization, hypoglycemia, respiratory distress syndrome, birth damage, and potential fetal insulin stimulation. Consequently, American College of Obstetricians & Gynecologists has advised that glyburide shouldn't be regarded as a first-line treatment [10].

The initial dosage of metformin is generally five hundred milligrams daily for one week, subsequently raised to one thousand milligrams daily, with a maximum dosage ranging from 2,500 - 3,000 milligrams. Metformin is recognized for its ability to traverse the placenta & induce negative outcomes, such as preterm labor, maternal stomach discomfort, & diarrhea. Moreover, when compared with insulin, the outcomes associated with metformin consume, including macrosomia, Cesarean delivery, and newborn hypoglycemia, were

similar. Notable treatment failure has been observed, with fifty percent of cases need insulin treatment. Metformin might serve as an alternative to insulin for cases who refuse or cannot afford insulin [7].

Obstetric considerations

Management of gestational diabetes mellitus differs based on several clinical parameters because of obstetrical concerns. Fetal growth is commonly evaluated using serial ultrasound to mitigate risks of shoulder dystocia & macrosomia. Gestational diabetes mellitus requires antepartum fetal monitoring because of the heightened risk of fetal mortality in diabetic cases. Furthermore, the timing and method of distribution may fluctuate based on clinical signs. In those who have diet-controlled gestational diabetes mellitus delivery is suggested by ACOG guidelines by 40 6/7 gestation weeks, while in those with medication-controlled gestational diabetes mellitus, delivery is suggested by 39 0/7 - 39 6/7 weeks' gestation. In cases with uncontrolled gestational diabetes mellitus, delivery between 37 0/7 weeks & 38 6/7 weeks of gestation is advisable. For those with uncontrolled DM & additional aberrant clinical characteristics (such as irregular prenatal fetal monitoring), early delivery may be warranted. Additionally, Cesarean birth might be considered for females with gestational diabetes mellitus & an anticipated fetal weight of 4500 grams or above [10].

Impact of diabetes on pregnancy

The problems of gestational diabetes are classified as fetus & mother. Fetal problems encompass macrosomia, newborn polycythemia, hypoglycemia, hyperbilirubinemia, shoulder dystocia, elevated perinatal mortality, neonatal respiratory distress syndrome, & hyp ocalcemia. Maternal problems encompass preeclampsia, hypertension, heightened susceptibility to diabetes mellitus, & an elevated likelihood of Cesarean delivery [11].

Effects on the mother

Gestational diabetes mellitus subsequently induces numerous short- & long-term consequences concerning maternal health. In addition to the usual problems of pregnancy, gestational diabetes mellitus can worsen prenatal depression. In numerous cases, the infant necessitates operative delivery owing to the heightened risk of complications in future pregnancies, including hypertension & pre-term birth. Women diagnosed with gestational diabetes mellitus are significantly more predisposed to developing DM in the future. Around ten percent of females with GDM are diagnosed with diabetes mellitus shortly after childbirth [12]. The possibility of postpartum diabetes mellitus is elevated by gestational diabetes mellitus, identical to prenatal complications. The risk of prenatal issues associated with gestational diabetes mellitus is significantly below probability of mother getting diabetes mellitus after a gestational diabetes diagnosis. Consequently, it is reasonable to infer that gestational diabetes mellitus is a kind of prediabetes akin to glucose intolerance in individuals haven't gestation [13]. Indicators of significant decompensation, including elevated blood sugar levels, pronounced insulin resistance, that diminished beta cell function, constitute risk factors for the rapid development of DM postpartum. Females showing these characteristics may exceed the glucose level threshold indicative of diabetes mellitus after a minor deterioration in their physical health [14]. Metabolic syndrome, encompassing obesity & related conditions, constitutes the basis for the development of T2DM. The likelihood of females with gestational diabetes mellitus exhibiting symptoms of metabolic syndrome is greater than that of females without gestational diabetes mellitus. A better prevalence of risk factors & events of cardiovascular is associated with prior occurrences of GDM. The majority of moms with gestational diabetes mellitus are obese, & a significant proportion of obese cases also have GDM [15].

Complications throughout pregnancy

Vaginal delivery will be more difficult if the infant is very big. Prolonged labor may result in the fetus becoming lodged in the birth canal, necessitating an instrumental delivery (utilizing vacuum or a forceps), or perhaps requiring an unplanned or emergency CS. Perineal rips (muscle ruptures among the vagina & anus), along with lacerations & tears of the vaginal tissue, are more probable after labor when the infant is of abnormal size. Furthermore, there exists a significant danger of uterine atony. Excessive hemorrhaging & hemorrhaging following delivery can result from the uterus's inability to contract effectively. Macrosomic newborns provide an approximately three- to fivefold elevated risk of bleeding after delivery & genital tract damage. Moreover, if the lady has previously had a Cesarean section, there is a heightened risk of uterine rupture along the operative scar from the earlier operation [13].

Diabetic retinopathy (DR), a common microvascular consequence of diabetes, is the primary cause of acquired blindness in young & middle-aged adults globally. Pregnancy, characterized by hemodynamic, metabolic, hormonal & immunologic alterations, is a risk factor for the advancement of DR. The cause of accelerated retinopathy throughout gestation remains unidentified. Suggested theories include rapid enhancement of glycemic control, modified hemodynamic characteristics, decreased retinal blood flow & immuno-inflammatory processes. [16].

Fetal complications and effects

Premature birth

Preterm birth may occur due to the induction of labor before to thirty-nine weeks and/or premature rupture of the membranes. Despite extensive attempts to initiate early labor, infants remain susceptible to complications associated with preterm, including respiratory and feeding difficulties, jaundice, infections, neonatal intensive care unit hospitalization, and perinatal mortality. Preterm birth occurs in around 10.6% of cases globally, particularly when associated with complications like hypertension & obesity throughout pregnancy [17].

Hypoglycemia at birth

Gestational diabetes mellitus adversely affects not only moms but also fetus. The developing fetus can generate only a limited quantity of glucose. Therefore, it derives most of its glucose from the maternal bloodstream. Maternal insulin doesn't traverse placenta, although glucose does of mother. The revised Pedersen's theory posits that, irrespective of glucose stimulation, increased fetal insulin creation is attributable to excess glucose transferred across the placenta under conditions of elevated & uncontrolled maternal blood sugar concentrations. The placental expression of glucose transport proteins is elevated in pregnancies affected by insulin-dependent DM [17].

Furthermore, insulin is recognized for its capacity to trigger the mechanistic target of rapamycin, a potent regulator of cell growth. The placenta's system A & L amino acids transporters enhance cell proliferation & provision of vital nutrients to the baby due to increased insulin of mother, which also triggers a rise in placental mechanistic target of rapamycin activity [18].

Maternal hyperglycemia and hyperinsulinemia might induce fetal changes analogous to those observed in gestational diabetes mellitus, potentially leading to newborn obesity. An elevation in neonatal birth size, referred to as macrosomia, is due to excessive nutrient accumulation. The predominant accumulation of fat is in the fetal belly & shoulders. Macrosomic infants occur in fifteen to forty-five percent of gestational diabetes mellitus pregnancies. Moreover, gestational diabetes mellitus was related to increased prevalence of respiratory distress in neonates [19].

Shoulder dystocia and Erb's palsy

Shoulder dystocia, especially associated with birth trauma, is one of the most severe outcomes of vaginal delivery, especially for macrosomic newborns. Babies weighing 4,500 grams or more are 6 times more susceptible to birth trauma, & if the birth weight exceeds 4,500 grams, the likelihood of brachial plexus injury increases about twenty-fold [13].

Congenital anomalies

The most common congenital anomalies encompass cardiac malformations and neural tube disorders, such as spina bifida. Congenital anomalies may arise from organ damage in the developing baby due to the high blood glucose concentrations in mothers with GDM. Moreover, the association between GDM & prenatal abnormalities remains uncertain. Congenital anomalies occur twice as frequently in females with pre-existing diabetes than non-diabetic persons, indicating a significant correlation among the two conditions. The data about GDM is nevertheless inconsistent [19].

Schaefer *et al.* [20] discovered a two-fold elevation in the incidence of congenital anomalies when fasting glucose concentrations exceed 120 mg/dl at the initial detection throughout pregnancy. The heightened possibility of congenital anomalies in mothers have diabetes appears to correlate with inadequate metabolic control throughout organogenesis in the 1st trimester of pregnancy, likely because of the adverse impacts of a hyperglycemic environment on the developing fetus [20].

The pathophysiology of congenital abnormalities, which occur 4-10 times more frequently in pregnant females with diabetes, is highly complex & likely has a multiple origin. A definitive correlation among hyperglycemia & abnormalities was demonstrated, although the exact mechanism behind that association remains inadequately elucidated. Hyperglycemia is hypothesized to induce damage to the progressing yolk sac, elevate the creation & release of free oxygen radicals, & lead to deficiencies in myoinositol and arachidonic acid, as well as disrupt signal transduction. Increasing evidence indicates that embryopathies may be associated with disturbances in intracellular signaling mediated by inositol-derived effectors as well as prostaglandin precursors like arachidonic acid. Furthermore, the existence of these fuels may induce a genotoxic influence, potentially resulting in morphological harm to the fetus [21].

The impact of folic acid on human reproduction was carefully analyzed, and the correlation among folate and vitamin B12 regarding DNA synthesis and methylation was established. Randomized trials indicate that periconceptional folic acid supplementation can reduce the incidence of midline embryonic abnormalities, cardiac anomalies, orofacial clefts & miscarriages [22]**.** Folic acid requirements rise throughout pregnancy due to the proliferation of mother erythrocytes, placental development, uterine expansion & fetal growth. Folic acid deficiency throughout pregnancy is linked to compromised cellular growth & replication, potentially leading to spontaneous abortions, megaloblastic anemia, placental abruption, fetal abnormalities, low birth weight, and premature delivery. Numerous medical societies,

including the Canadian Obstetrical Societies & ACOG, advocate for high-dose supplementation of folic acid (four to five milligrams per day) in diabetic females prior to & throughout pregnancy to mitigate the risk of congenital defects in their offspring, this dosage is tenfold greater than that advised for female's non-diabetic [23].

The most common types of congenital malformations seen in the babies of diabetic females are those that affect the cardiovascular system (Which includes cardiac transposition of ventricular septal defect, great arteries, atrial septal defect, as well as coarctation of the aorta, in addition to asymmetric septal hypertrophy), the CNS (Which includes neural tube defects such as microcephaly, anencephaly, as well as isolated hydrocephalus), the gastrointestinal system (Which includes anorectal atresia, duodenal atresia, and hypoplastic left colon), the musculoskeletal system (Which includes talipes and arthrogryposis), the urinary tract (Which includes cystic kidney, uretal duplication, hydronephrosis, as well as renal dysgenesis), cleft lip, caudal regression syndrome & palate anomalies [24].

Fetal nutrition

Upon the emergence of gestational diabetes mellitus, alterations in the composition of breast milk are observed as well. Breast milk is a dynamic fluid with bioactive properties that significantly differ among individuals and across different stages. A variety of maternal factors, like term and preterm labor, maternal nutrition, metabolic disorders & illnesses, influence it. Diabetes mellitus is a chronic metabolic disorder that can impact pregnant women, either pre-existing or newly onset during gestation [25].

For mothers with gestational diabetes, citrate, lactose, and total nitrogen levels require an additional fifteen and twenty-four hours to reach concentrations like those of healthy females. The advantageous association among mammary gland development throughout pregnancy & circulating concentrations of human placental lactogen may result in a delay in the onset of breast milk for females with gestational diabetes. Pregnant females with gestational diabetes mellitus demonstrated increased concentrations of cytokines & chemokines in their colostrum. Concentrations of interleukin (IL)- 15, interleukin-6, & interferon-γ have been elevated, but levels of IL-1ra & GM-CSF refer to granulocyte-macrophage colony-stimulating factor have been diminished. This resulted in an altered immunological makeup of the colostrum [24].

Neonatal complications

Neonatal jaundice: Prematurity, insufficient nutrition, & heightened enterohepatic circulation of bilirubin resulting from diminished hepatic conjugation of bilirubin are parameters that could lead to jaundice. Newborns with macrosomia exhibit increased oxygen requirement, resulting in heightened erythropoiesis and, consequently, polycythemia. Consequently, as these cells deteriorate, bilirubin—a by-product of RBCs breakdown—increases, resulting in neonatal jaundice [26].

Childhood and adulthood complications: The heightened prevalence of obesity in infants born to women with gestational diabetes mellitus is correlated with an elevated risk of several disorders, involving cardiovascular problems & insulin resistance. Besides hyperglycemia & body mass index, kids born to moms with gestational diabetes mellitus exhibited significantly elevated cardiovascular risk & obesity. Children with gestational diabetes mellitus are at an elevated risk of cardiac arrhythmias & are more likely to necessitate hospitalization for cardiovascular diseases (CVDs) due to heightened cardiovascular risk. Furthermore, offspring of cases with GDM exhibit a twenty-nine percent increased likelihood to get early-onset cardiovascular illnesses including hypertension, heart failure, pulmonary embolism & deep vein thrombosis [27].

Fetal hyperinsulinemia & excessive fetal growth:

Hyperglycemia in the mid to late stages of gestation elevates amino acid & fatty acid levels in maternal blood, resulting in an overabundance of nutrients sent to the fetus via the placenta. An adequate food supply prompts embryonic pancreatic β-cells to enhance insulin production. Fetal hyperinsulinemia stimulates abnormal proliferation of insulin-responsive organs, including the adipose tissue, liver, & heart. Fetal abdominal enlargement can be identified with ultrasound as early as twenty-four to twenty-eight weeks of gestation. This finally elevates the risk of large for gestational age births in females with GDM [28].

The ACOG advises conducting ultrasonographic monitoring in mothers with pregnancies complicated by gestational diabetes mellitus due to the significance of assessing fetal growth. The diagnostic threshold & treatment objective might demand individualization based on fetal state (Such as females with tiny for gestational age fetuses resulting from placental insufficiency may require lenient glycemic management). Pregnancy loss is significantly greater in females with diabetes relative to the non-diabetic group. The principal congenital malformations in offspring of women with diabetes affect the following systems: Cardiovascular (Cardiac transposition of ventricular septal defect, coarctation of the aorta, great arteries, atrial septal defect, asymmetric septal hypertrophy), gastrointestinal (Anorectal atresia, duodenal atresia & hypoplastic left colon), CNS (Neural tube defects, such as

isolated hydrocephalus, microcephaly & anencephaly), musculoskeletal (Arthrogryposis & talipes), urinary tract (Ureteral cystic kidney, duplication, hydronephrosis & renal dysgenesis), caudal regression syndrome, as well as cleft lip & palate anomalies [21].

Significant congenital anomalies are a crucial cause contributing to the elevated mortality rates detected in babies born to moms with diabetes. Preterm delivery occurs from four to five times more frequently in moms with diabetes. The vast majority of macrosomias (Seventy percent) result from constitutional and genetic causes, extended gestation, or specific disorders. Macrosomia in offspring of diabetic mothers accounts for thirty percent of cases. These macrocosmic infants typically exhibit dysmorphic features, characterized by excessive development of the shoulders & abdomen relative to the head, thereby elevating the possibility of various obstetric complications, including increased rates of Cesarean delivery, chorioamnionitis, severe perineal lacerations, shoulder dystocia, as well as bleeding after delivery. The incidence of macrosomia is 3.5–4.5 times higher in children of females with pregestational diabetes compared to those delivered to non-diabetic moms [17].

The neonate's heart possesses a significant quantity of insulin receptors. In hyperinsulinism, like gestational diabetes, hypertrophic cardiomyopathy may develop. This condition is marked by enlargement of the ventricular & septum walls, which can, in certain instances, restrict flow of blood. It may be asymptomatic, occasionally lead to heart failure, or resolve during the initial months of life. It is considered a significant factor in intrauterine death & stillbirth [29].

Excess insulin in fetal circulation might impede lung maturation due to reduced surfactant production, resulting in respiratory distress syndrome hyaline membrane illness. This disease occurs approximately six times more commonly in babies of diabetic moms compared to those of non-diabetic women [30].

Ethical considerations: All the procedures of the research were permitted by The Ethics Committee of Faculty of Medicine, Obstetrics and Gynecology Department, Damanhur Teaching Hospital. Administrative consents required were taken. The goal of this investigation was to carry out research on humans in compliance with the Declaration of Helsinki, the code of ethics of the World Medical Association.

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