Gestational Diabetes Mellitus And Birth Weight With Respiratory Distress Syndrome

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Abstract. Gestational Diabetes Mellitus (GDM) is a major risk factor for neonatal complications, particularly Respiratory Distress Syndrome (RDS). Birth weight, especially in preterm infants, also plays a key role in the occurrence of RDS. The interplay between GDM, birth weight, and RDS, however, remains complex and warrants further investigation. This study aims to examine the relationship between GDM and birth weight with the incidence of RDS in newborns. A quantitative observational study with a cross-sectional design was conducted involving 124 participants, with a sample of 95 selected using proportional random sampling via the Slovin formula. Data were collected using observation checklists and medical record reviews. Statistical analysis applied Fisher's Exact Test for 2×2 tables and the Kolmogorov–Smirnov test for 3×2 tables. Results from Fisher's Exact Test showed a significant association between GDM and RDS incidence ($p = 0.014$, <0.05), while the Kolmogorov–Smirnov test also revealed a significant link between birth weight and RDS occurrence ($p = 0.019$, <0.05). The findings suggest that both GDM and birth weight significantly influence the risk of RDS in neonates. These results underscore the importance of close monitoring and management of GDM during pregnancy to potentially lower RDS rates and improve neonatal outcomes.

Keywords: gestational diabetes, birth weight, respiratory distress syndrome.

1 Introduction

Family-centered interventions have been shown to improve health outcomes in children and adolescents with type 1 diabetes mellitus (T1DM). Future approaches should integrate these interventions with other theories and models to achieve optimal results [1]. Globally, the leading causes of neonatal death include respiratory disorders (35.9%), prematurity (32.4%), sepsis (12%), hypothermia (6.3%), blood-related abnormalities/jaundice (5.6%), post-maturity (2.8%), and congenital defects (1.4%). In 2012, respiratory emergencies were a major factor in neonatal mortality: asphyxia accounted for 68.24% (159 cases), Meconium Aspiration Syndrome for 11.2% (26 cases), and Respiratory Distress Syndrome for 24.03% (56 cases). Additionally, 62.7% of cases

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involved low birth weight (LBW) and preterm neonates, 43.8% had sepsis, 6.9% pneumonia, and 2.2% apnea due to prematurity [2], [3].

Prematurity, respiratory issues, sepsis, and congenital anomalies are among the primary contributors to perinatal mortality. For newborns aged 0–7 days, respiratory disorders lead at 35.9%, followed by prematurity at 32.3%. Among those aged 7–28 days, sepsis ranks highest at 20.5%, followed by congenital anomalies at 18.1%[4]. Respiratory Distress Syndrome (RDS) is marked by hypoxemia, reduced lung compliance, dyspnea, and bilateral pulmonary edema without cardiac failure, as well as diffuse infiltrates. Clinically, RDS presents with rapid breathing, cyanosis, expiratory grunting, and retractions in the suprasternal, intercostal, and epigastric regions. The primary cause is a deficiency in surfactant—a substance that prevents alveolar collapse and maintains residual air at the end of expiration [5].

As reported by the World Health Organization (WHO), nearly 200 million people worldwide are affected by GDM, a number projected to reach 330 million by 2025. In Indonesia alone, there are over 13 million reported cases, with projections surpassing 20 million by 2030 [6][7]. Diabetes-related abnormalities in fetal development can lead to perinatal mortality in around 10% of cases involving type 1, type 2, or gestational diabetes. Babies born with excessive birth weight often experience delayed lung maturity, making them more vulnerable to respiratory complications and a greater risk of RDS [8].

Birth weight serves as a critical predictor of perinatal outcomes. Infants weighing under 2500 g face a 20-fold higher mortality risk, while those under 1500 g face a 90-fold increase [9][10]. RDS, or hyaline membrane disease (HMD), is caused by insufficient surfactant production—most common in preterm newborns [11]. This leads to alveolar collapse, edema, cell injury, and leakage of serum proteins, which further impair surfactant function. Surfactant production peaks around 35 weeks of gestation, and its deficiency destabilizes the lungs, requiring greater negative intrathoracic pressure for breathing. Clinical signs include tachypnea, perioral cyanosis, expiratory grunting, and chest retractions [11], [12].

Diagnosis often involves chest radiographs to determine the underlying cause of respiratory distress and assess lung status, along with blood tests for gas and electrolyte analysis. Management strategies include oxygen therapy, mechanical ventilation, surfactant replacement, inhaled nitric oxide (iNO), and nutritional support. Mechanical ventilation remains a key intervention for newborns with respiratory difficulties, especially preterm infants, and may be needed for short or extended durations [13]. Non-invasive approaches to enhance ventilation and oxygenation can complement invasive measures. GDM poses risks to maternal health, particularly in late pregnancy. If uncontrolled, elevated maternal glucose levels trigger excessive insulin production in the fetus, potentially causing RDS and other complications [14]. The etiology of diabetes mellitus includes non-modifiable factors (e.g., ethnicity, age, sex, family history) and modifiable ones (e.g., lifestyle, obesity, activity level) [15]. Diabetes results from impaired insulin action or secretion [16], and without proper treatment, can lead to complications, including insulin dependency. Diabetes mellitus disease if not treated properly will cause complications, one of which is dependence on insulin. Experimental studies have shown that combining ethanolic extracts of Andrographis paniculata and Morinda citrifolia produces hypoglycemic effects comparable to each extract alone, with added benefits such as improved pancreatic islet structure, increased β-cell count, and enhanced insulin expression in neonatal streptozotocin-induced type 2 diabetic rats. When administered together, the extracts yielded better pancreatic islet recovery, an increased β-cell population, and stronger insulin expression than when each extract was used individually in neonatal rats induced with type 2 diabetes via streptozotocin [17], [18].

2 Methods

This research employed a quantitative, observational-analytic design with a cross-sectional approach. The study population consisted of 124 participants, from which 95 were selected using proportional random sampling based on the Slovin formula. Data collection was conducted through observation checklists and medical record reviews. Statistical analysis involved the Fisher's Exact Test (2×2 table) to assess the association between gestational diabetes and the occurrence of Respiratory Distress Syndrome (RDS), and the Kolmogorov–Smirnov Test (3×2 table) to examine the relationship between birth weight and RDS incidence.

3 Results and Discussion

Table 1. Distribution Frequency Gestational Diabetes Relationship With Incidence of Respiratory Distress Syndrome (RDS)

Diabetes Gestational	**RDS**		**Total**	**P Value**	**Odds Ratio**
	Yes	No			
Diabetes	38 40,0%	1 1,1%	39 (41,1%)	0,014	9.289
Non Diabetes	45 47,4%	11 11,6%	56 (58,9%)		
Total	83 87,4%	12 12,6%	95 100%		

Fisher's Exact Test (2×2) the statistical test resulted in a p-value of 0.014 (<0.05), indicating a statistically significant relationship between gestational diabetes mellitus (GDM) and the incidence of Respiratory Distress Syndrome (RDS) in neonates. The odds ratio (OR) was 9.289 (95% CI), meaning that infants born to mothers with GDM have about 9.5 times greater risk of developing RDS compared to those born to non-GDM mothers. Since the OR is greater than one, GDM can be identified as a major risk factor for RDS, potentially due to its negative impact on fetal lung maturity through mechanisms such as fetal hyperinsulinemia and reduced surfactant production. These findings highlight the importance of early detection and proper management of GDM during pregnancy to minimize neonatal respiratory complications.

Table 2. Frequency Distribution of the Association Between Birth Weight and the Incidence of Respiratory Distress Syndrome (RDS)

	(RDS)			P
Wights			**Total**	**Valu e**
	Yes	*No*		
Low	52 54.7%	3 (3.2%)	55 (57.9%)	
Norma l	30 31.6%	8 (8.4%)	38 (40,0%)	0,0 19
Hight	1 1,1%	1 (1,1%)	2 ()	
Total	83 87,4%	12 (12,6%)	95 (100%)	

Using the Kolmogorov–Smirnov test with a 3×2 table, the analysis yielded a p-value of 0.019 (< 0.05), indicating a significant association between birth weight and the incidence of Respiratory Distress Syndrome (RDS).

3.1 Analysis of the Association Between Gestational Diabetes and Respiratory Distress Syndrome Incidence

The analysis revealed a significant correlation between gestational diabetes mellitus (GDM) and the occurrence of respiratory distress syndrome (RDS) in newborns. In the GDM group, 38 out of 39 mothers (97.4%) gave birth to infants with RDS, while only one infant remained unaffected—likely due to optimal prenatal care and timely consultations with specialists that ensured thorough fetal monitoring. Conversely, in the non-GDM group, 45 out of 56 mothers (80.4%) had infants who developed RDS, with several cases associated with delivery complications such as maternal seizures caused by uncontrolled hypertension, which negatively impacted fetal health. Through Fisher's Exact Test, the statistical examination obtained a p-value of 0.014 (<0.05), indicating a significant association. Furthermore, the odds ratio of 9.289 suggested that infants born to mothers with GDM were about 9.5 times as likely to experience RDS as those whose mothers did not have GDM, underscoring GDM as a major risk factor for neonatal respiratory problems.

These results indicates that gestational diabetes mellitus (GDM), as a multifactorial disorder, can result in coagulation abnormalities and impaired cardiac function, thereby reducing fetal oxygen supply and predisposing neonates to respiratory distress syndrome (RDS). From a theoretical perspective, poorly controlled GDM leads to elevated maternal blood glucose levels that cross the placenta, stimulating excessive insulin production in the fetus. This hyperinsulinemia may inhibit pulmonary surfactant synthesis, consequently increasing the risk of RDS. Regarding birth weight, the analysis showed that among neonates with low birth weight (LBW), 52 out of 55 (94.5%) developed RDS, while only 3 did not. In the appropriate birth weight group (BBLN), 30 out of 38 (78.9%) experienced RDS, whereas 8 did not. In the very high birth weight category (BBLL), the single case recorded (100%) was associated with RDS. These findings suggest that both LBW and macrosomia contribute to an elevated risk of RDS, with LBW demonstrating the highest proportion of cases in this study.

Respiratory Distress Syndrome (RDS) may occur due to complications during childbirth, such as maternal seizures caused by elevated blood pressure, which in turn can compromise fetal well-being. These study outcomes in line that gestational diabetes mellitus (GDM) is a multifactorial disorder in which diabetes during pregnancy can lead to blood coagulation abnormalities, impairing cardiac function and subsequently reducing or, in some cases, disrupting the adequate supply of oxygen to the fetus. This oxygen deficiency can result in respiratory complications in neonates, including RDS [16]. The researchers assume that gestational diabetes is one of the factors contributing to the occurrence of respiratory distress in neonates. When a mother experiences diabetes during pregnancy, it can result in either insufficient or excessive nutritional supply to the fetus. Additionally, increased blood viscosity may impair circulation, leading to disturbances in the delivery of essential nutrients and oxygen. Such disruptions in oxygen supply can ultimately result in respiratory complications in neonates, including respiratory distress syndrome.

In line with research conducted by [17], the proportional hazard ratio (pHR) for hypertension was 1.15 (95% CI: 1.00–1.32) and for diabetes mellitus was 1.21 (95% CI: 1.13–1.29), indicating that hypertension increased the risk of COVID-19 mortality by 1.15 times and diabetes mellitus by 1.21 times. Furthermore, findings from other studies demonstrated that enamel thickness in the diabetes mellitus (DM) group (333.02 ± 135.81 μm) was lower than in the control group (415.39 ± 146.17 μm). Results from the Mann–Whitney test revealed a statistically significant difference between the DM and control groups, leading to the conclusion that gestational diabetes mellitus may result in decreased enamel thickness in the offspring of affected rats [18]. Improper management of diabetes mellitus can lead to various complications, one of which is coronary heart disease (CHD). Previous studies corroborate this finding, revealing a significant association between diabetes mellitus and the recurrence of coronary artery disease (CAD). Individuals with diabetes mellitus have a greater likelihood of experiencing CAD relapse than those without the condition. Therefore, nurses should pay particular attention to monitoring and controlling modifiable risk factors for coronary artery disease to reduce the likelihood of recurrence and improve patient outcomes [19], [20].

To reduce RDS cases occurring in mothers with a diagnosis of gestational diabetes, one recommended intervention is the regulation of nutritional intake patterns for both the mother and the fetus. This aligns with previous research indicating significant associations between simple carbohydrate intake ($p = 0.002$), fiber consumption ($p = 0.000$), vitamin C intake ($p = 0.002$), physical activity ($p = 0.000$), and adherence to appropriate food types with blood glucose levels ($p = 0.026$). Conversely, no correlation was observed between overall dietary adherence ($p = 4.48$), adherence to meal schedules ($p = 1.000$), and dietary compliance with blood glucose levels. These findings suggest that hospitals should strengthen nutritional education, encourage the consumption of fiber-rich and vitamin C–containing foods as recommended, and motivate patients to adhere more consistently to dietary guidelines [21]. Similarly, other studies have reported that although the control and treatment groups showed no initial differences at the beginning of the survey, the Nutrition Care Process (NCP) significantly improved the attitudes and behaviors of diabetic patients, although it did not produce a significant change in knowledge between groups. Furthermore, fasting blood glucose levels improved significantly, whereas two-hour postprandial blood glucose levels showed no significant difference. These results indicate that the NCP should be implemented in Community Health Centers as a standard procedure for delivering high-quality nutritional care [10], [22]. Moreover, plant-based natural remedies have demonstrated potential in diabetes management. Previous studies have highlighted several herbal remedies such as *Zingiber officinale*, *Coriandrum sativum* L., *Silybum marianum*, *Allium sativum*, *Abelmoschus esculentus*, *Trigonella foenum-graecum*, *Citrullus colocynthis*, *Cinnamomum verum*, dan *Eryngium spp.* officinale as some of the most commonly utilized herbs in diabetes treatment.These plants are effective in lowering blood glucose due to their bioactive compounds and natural antioxidants, offering fewer side effects compared to synthetic drugs, although they typically require a longer treatment period [23].

The Kolmogorov–Smirnov test produced a p-value of 0.019, signifying a significant relationship between birth weight and the occurrence of RDS. Among 55 neonates, three with low birth weight (LBW) did not develop RDS, possibly due to an uncomplicated birth process and the absence of fluid accumulation in the respiratory tract. In contrast, 30 out of 38 neonates with normal low birth weight (BBLN) experienced RDS, likely related to prolonged labor and premature rupture of membranes, which may cause asphyxia. For neonates with low low birth weight (BBLL), one out of two did not develop RDS, potentially due to the absence of birth complications or asphyxia. Neonates with LBW face a greater risk because of immature lung development and challenges in breathing. However, neonates with higher birth weights may also face RDS risk, often from lung stress caused by excess fluid or fat. This study highlights that LBW is a major risk factor for RDS, primarily due to immature lung development leading to poor oxygenation, while excessive lung stress can also pose risks in heavier neonates.

4 Conclusion

The demographic profiles of respondents in the Lily Room and NICU were evaluated according to maternal age, educational background, employment status, and the sex of the newborn. Most mothers were aged 20–35 years (n = 69, 72.6%). Most had completed high school (n = 42, 44.2%) and were housewives (n = 73, 76.8%). The neonatal sex distribution consisted of 49 males (51.6%) and 46 females (48.4%). A total of 39 mothers (41.1%) had gestational diabetes, while 56 (58.9%) did not. In terms of birth weight, 55 neonates (57.9%) were classified as low birth weight (LBW), 38 (40.0%) as normal birth weight, and 2 (2.1%) as very low birth weight (VLBW). Statistical analysis demonstrated a significant association between gestational diabetes and the incidence of Respiratory Distress Syndrome (RDS) ($p = 0.014$), as well as between high birth weight and RDS ($p = 0.019$). These findings indicate that both gestational diabetes and high birth weight are significantly correlated with the occurrence of RDS.

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References

[1] A. Ispriantari, R. Agustina, K. D. Konlan, and H. Lee, “Family-centered interventions for children and adolescents with type 1 diabetes mellitus: an integrative review,” *Child Heal. Nurs. Res.*, vol. 29, no. 1, pp. 7–23, 2023, doi: 10.4094/chnr.2023.29.1.7.

[2] D. Simmons *et al.*, “Effect of treatment for early gestational diabetes mellitus on neonatal respiratory distress: A secondary analysis of the TOBOGM study,” *BJOG An Int. J. Obstet. Gynaecol.*, no. August, pp. 1–9, 2024, doi: 10.1111/1471-0528.17938.

[3] R. Singh, L. P. Munian, and N. A. Memela, “Management of neonates with respiratory distress syndrome in resource-limited settings,” *South African Fam. Pract.*, vol. 66, no. 1, pp. 1–7, 2024, doi: 10.4102/SAFP.V66I1.5938.

[4] U. Galicia-garcia, A. Benito-vicente, S. Jebari, and A. Larrea-sebal, “Costus ignus: Insulin plant and it’s preparations as remedial approach for diabetes mellitus,” *Int. J. Mol. Sci.*, pp. 1–34, 2020.

[5] D. De Luca, “Respiratory distress syndrome in preterm neonates in the era of precision medicine: A modern critical care-based approach,” *Pediatr. Neonatol.*, vol. 62, pp. S3–S9, 2021, doi: 10.1016/j.pedneo.2020.11.005.

[6] A. Victor *et al.*, “The impact of gestational weight gain on fetal and neonatal outcomes : the Araraquara Cohort Study,” pp. 1–10, 2024.

[7] C. C. Ma and S. Ma, “The Role of Surfactant in Respiratory Distress Syndrome,” *Open Respir. Med. J.*, vol. 6, pp. 44–53, 2012.

[8] G. W. Jeon, “Surfactant preparations for preterm infants with respiratory distress syndrome: past, present, and future,” *Korean J. Pediatr.*, vol. 62, no. 5, pp. 155–161, 2019, doi: 10.3345/kjp.2018.07185.

[9] M. Mukosha *et al.*, “Determinants and outcomes of low birth weight among newborns at a tertiary hospital in Zambia: A retrospective cohort study,” *Ann. Afr. Med.*, vol. 22, no. 3, pp. 271–278, 2023, doi: 10.4103/aam.aam_22_22.

[10] C. K. Negara, T. Sukartini, D. Y. Setiya, and N. Nursalam, “Effectiveness of Diabetes Self-Management Education on Non-Ulcer Diabetic Foot Incidents,” *Heal. Educ. Heal. Promot.*, vol. 12, no. 1, pp. 53–58, 2024, doi: 10.58209/hehp.12.1.53.

[11] E. H. Ng and V. Shah, “Guidelines for surfactant replacement therapy in neonates,” *Paediatr. Child Heal.*, vol. 26, no. 1, pp. 35–41, 2021, doi: 10.1093/pch/pxaa116.

[12] C. Billionnet *et al.*, “Gestational diabetes and adverse perinatal outcomes from 716,152 births in France in 2012,” *Diabetologia*, vol. 60, no. 4, pp. 636–644, 2017, doi: 10.1007/s00125-017-4206-6.

[13] T. S. De Guia, “Acute respiratory distress syndrome: Diagnosis and management,” *Am. Fam. Phsician*, vol. 101, no. 12, pp. 730–738, 2020, doi: 10.1111/j.1440-1843.1996.tb00007.x.

[14] J. F. Lestari, R. Etika, and P. Lestari, “Maternal Risk Factors of Low Birth Weight (Lbw): Systematic Review,” *Indones. Midwifery Heal. Sci. J.*, vol. 4, no. 1, pp. 73–81, 2021, doi: 10.20473/imhsj.v4i1.2020.73-81.

[15] G. P. G. Fung, L. M. Chan, Y. C. Ho, W. K. To, H. B. Chan, and T. T. Lao, “Does gestational diabetes mellitus affect respiratory outcome in late-preterm infants?,” *Early Hum. Dev.*, vol. 90, no. 9, pp. 527–530, 2014, doi: 10.1016/j.earlhumdev.2014.04.006.

[16] X. Wang *et al.*, “Study on the Relationship Between Respiratory Distress Syndrome and SP-A1 (rs1059057) Gene Polymorphism in Mongolian Very Premature Infants,” *Front. Pediatr.*, vol. 8, no. March, pp. 1–5, 2020, doi: 10.3389/fped.2020.00081.

[17] R. Adhani *et al.*, “Risk Factors of Hipertension and Diabetes Mellitus on COVID-19 Mortality,” *Open Access Maced. J. Med. Sci.*, vol. 10, no. E, pp. 145–150, 2022, doi: 10.3889/oamjms.2022.6951.

[18] N. Dewi, A. Syaify, and I. A. Wahyudi, “The enamel thickness of gestational diabetes mellitus rat

offspring," *J. Dentomaxillofacial Sci.*, vol. 6, no. 3, pp. 193–196, 2021, doi: 10.15562/jdmfs.v6i3.1130.
[19] P. M. P. Winoto, Ahsan, and T. H. Nasution, "The relapse of coronary artery disease in patients with dia- betes mellitus at Dr. Ramelan Navy Hospital, Surabaya, Indonesia," *J. Public Health Africa*, vol. 10s1, no. 1193, pp. 84–85, 2019, doi: 10.4081/jphia.2019.
[20] M. Idris, E. R. Sukandar, A. S. Purnomo, F. Martak, and S. Fatmawati, "Antidiabetic, cytotoxic and antioxidant activities of Rhodomyrtus tomentosa leaf extracts," *RSC Adv.*, vol. 12, no. 39, pp. 25697–25710, 2022, doi: 10.1039/d2ra03944c.
[21] Bertalina and A. Hasan, "Analysis of factors associated with blood sugar levels in type 2 diabetes mellitus patients," *Indian J. Public Heal. Res. Dev.*, vol. 9, no. 12, 2018, doi: 10.5958/0976-5506.2018.01867.3.
[22] S. Prihatin, S. Noormintarsih, A. Y. Rahmawati, J. Supadi, A. T. Gunawan, and I. Rajiani, "The nutrition care process (NCP) impact to the dietary behavior of diabetes mellitus patients," *Indian J. Public Heal. Res. Dev.*, vol. 9, no. 7, pp. 38–42, 2018, doi: 10.5958/0976-5506.2018.00610.1.
[23] B. Gholamine *et al.*, "Herbal therapy in diabetes mellitus: A review," *Adv. Life Sci.*, vol. 11, no. 1, pp. 40–48, 2024, doi: 10.62940/als.v11i1.2254.