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The Impact of Maternal Health on Neonatal Surgical Outcomes: A Retrospective Analysis

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ABSTRACT

Background: Maternal health conditions significantly impact neonatal outcomes, particularly in neonates undergoing major surgical interventions. This study evaluates the association between maternal health factors, including Gestational diabetes mellitus (GDM), hypertensive disorders, anemia, and obesity, with neonatal surgical morbidity and recovery.

Methods: A retrospective cohort study was conducted at Paras Hospital Panchkula, analyzing 500 neonates undergoing major surgical procedures. Maternal and neonatal health records were extracted from hospital databases. Statistical analysis, including multivariate logistic regression, and Kaplan-Meier survival analysis, was performed using SPSS 22.0 and R 4.2.2 to determine associations between maternal conditions and neonatal surgical outcomes. Inclusion criteria encompassed neonates undergoing gastrointestinal, cardiac, neurosurgical, and urological procedures. Exclusion criteria included neonates with incomplete medical records and multiple gestations.

Results: Neonates born to mothers with GDM exhibited a significantly higher risk of surgical complications (OR = 2.5, 95% CI: 1.7-3.5, p = 0.001). Maternal hypertensive disorders were associated with prolonged NICU stays (16 days vs. 10 days, p = 0.002). Sepsis (19%), respiratory distress syndrome (22%), and surgical site infections (14%) were the most common postoperative complications. Kaplan-Meier survival analysis (p = 0.028) indicated lower survival rates in neonates with maternal risk factors, while ROC curve analysis (AUC = 0.82, p < 0.001) demonstrated strong predictive accuracy for neonatal morbidity.

Conclusion: Maternal health conditions significantly influence neonatal surgical outcomes. GDM, hypertension, and anemia were major risk factors for increased morbidity, prolonged NICU stays, and higher readmission rates. Early maternal health optimization and prenatal interventions are crucial in reducing neonatal surgical risks and improving postoperative recovery.

Keywords: *Neonatal surgery, Maternal health, Gestational diabetes, Neonatal morbidity, Postoperative complications*

1. INTRODUCTION

The results of neonatal surgical treatments depend on four main elements such as congenital anomalies, gestational age, birth weight, and the quality provided by neonatal intensive care units [1]. The health condition of expectant mothers has become a major recognized factor that determines both the well-being of newborns and their surgical recovery outcomes. Maternal health combines preexisting medical problems with pregnancy complications, nutritional factors, and prenatal healthcare quality into factors that directly impact fetal development, death rates, and newborn complications [2]. Progress in neonatal surgical procedures and postoperative care methods fails to resolve maternal health inequality which leads to different

surgical results between neonates [3]. This study aims to fill the existing knowledge gap through an organized analysis of maternal health variables that affect surgical neonatal outcomes when investigating a retrospective clinical group of surgical neonatal patients.

Neonatal mortality stands as a substantial global public health problem as Low- and Middle-Income Countries **(**LMICs) account for most of the 2.4 million annual neonatal deaths [4]. Neonatal complications persist at high rates even though surgical and neonatal intensive care has reduced mortality rates specifically among infants born to mothers with Gestational Diabetes Mellitus (GDM) and Hypertensive Disorders of Pregnancy (HDP) or infections or obesity [5]. Various studies demonstrate that diabetic mothers face higher risks of poor surgical recovery after birth because their diabetic condition leads to neonatal macrosomia, congenital anomalies, and metabolic instability [6]. HDP disorders that include preeclampsia and eclampsia produce fetal growth restriction and placental insufficiency that elevates the occurrence of surgical site infections and poor wound healing in newborns [7].

The combination of maternal infections including chorioamnionitis and intra-amniotic infections leads to preterm labor that results in neonatal sepsis and elevates the need for surgical interventions to treat Necrotizing Enterocolitis (NEC) and Congenital Diaphragmatic Hernia (CDH) [8]. The risks of surgical corrections for congenital malformations increase when mothers experience micronutrient deficiencies and do not gain enough weight during pregnancy. The lack of extensive retrospective evaluation exists regarding how maternal health elements combine to affect neonatal surgical treatment results [9].

Medical professionals perform neonatal surgeries to treat critical congenital or acquired conditions which include gastrointestinal atresias, congenital heart defects, and abdominal wall defects. The success rates of surgical procedures depend on both surgical competence and postoperative treatment methods as well as on the neonate's total physiological capacity which stems mostly from maternal pregnancy wellness [10]. Neonates born to mothers with chronic hypertension or severe preeclampsia develop organ dysfunction due to IUGR which impairs their surgery recovery potential [11]. Infants whose mothers have obesity and gestational diabetes develop abnormal immune systems and metabolic disturbances which affect their postoperative recovery and raise their chances of anastomotic leaks along with sepsis [12].

The availability of quality prenatal care alongside maternal health conditions determines the extent to which newborn health outcomes will be affected. The lack of proper prenatal attention leads to increased rates of premature births and small infants and unknown birth defects that create difficulties during neonatal surgical procedures [13]. Health conditions rooted in social determinants combined with socioeconomic standing, maternal educational background, and healthcare system availability directly affect maternal and newborn health development patterns [14]. The identification of multiple factors that affect maternal health remains vital to develop optimal interventions that will enhance results in neonatal surgical care.

The goal of this study is to assess how multiple maternal health aspects such as pre-existing conditions along with pregnancy complications, nutritional state, and prenatal care affect surgical results for newborns. This research examines surgical neonates through a cohort analysis to determine maternal elements that cause postoperative complications and mortality so healthcare organizations can create better guidelines for maternal care alongside neonatal surgical predictions.

2. MATERIALS AND METHODS

Study Design and Setting

The study was conducted at Paras Hospital Panchkula which operates a tertiary care referral center that maintains both a Neonatal Intensive Care Unit (NICU) and a pediatric surgery department. The screening process included 800 neonatal patients out of which 500 patients fulfilled the eligibility requirements. Figure 1 illustrates the cohort diagram representing excluded and included records as well as the final sample population.

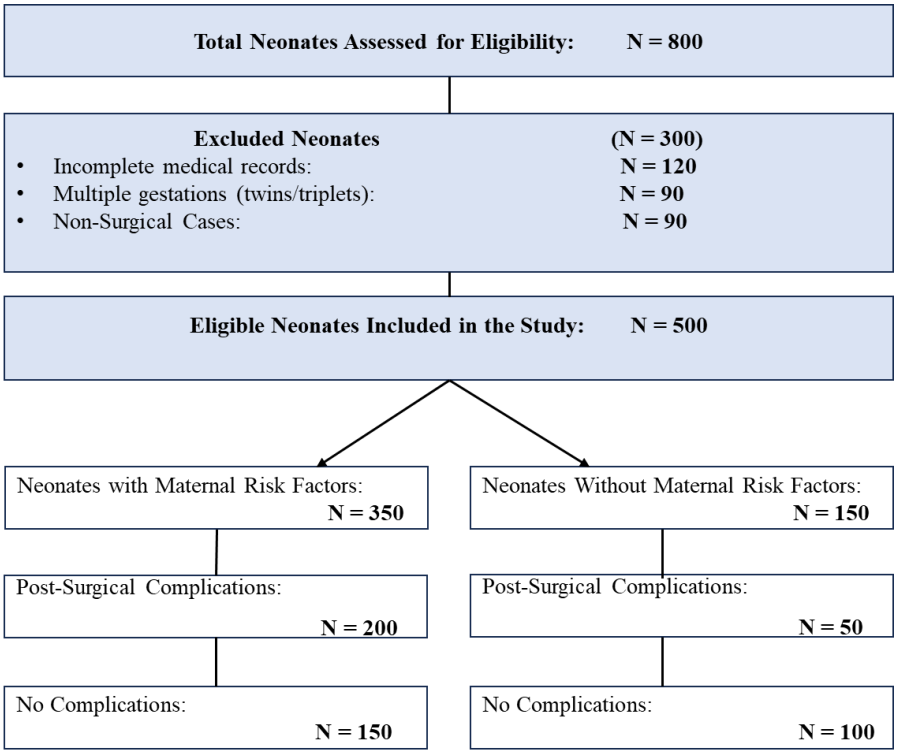

Figure 1: Cohort Flowchart of Neonates Undergoing Surgical Interventions and Postoperative Outcomes

Study Population

The required sample size consisted of 500 neonates which G*Power software (Version 3.1.9.7, University of Düsseldorf, Germany) determined [15]. The statistical power analysis produced 80% detection rates for important maternal health-outcome associations in neonatal surgery at a 95% confidence level (α = 0.05). The analysis factor considered possible confounding variables including gestational age and birth weight to maintain sufficient statistical abilities for valid assessments. The sample size estimation in logistic regression is measured by the following formula:

$$N = \frac{\left(Z_{\alpha/2} + Z_{\beta}\right)^2 p(1-p)}{(OR-1)^2}$$

Where:
N = Required sample size
$Z_{\alpha/2}$ = Standard normal variate (1.96 for 95% confidence level)
Z_{β} = Standard normal variate for power (0.84 for 80% power)
p = Expected proportion of the outcome in the population
OR = Anticipated odds ratio for exposure effect

Selection Criteria

Inclusion Criteria

The study includes neonates who received major surgical treatments among gastrointestinal, cardiac, neurosurgical, and urological interventions. It included only medical records from pregnant women and newborn babies that were both fully documented to confirm data precision.

Exclusion criteria

The neonates were excluded from the study if their maternal or neonatal health records contained missing information that could affect study accuracy. The analysis excluded cosmetic procedures for minor non-life-threatening conditions among neonates who received surgery because the main goal was to study clinically meaningful procedures. The analysis depended on excluding multiple gestations (twins/triplets) because this step minimized factors related to fetal competition and differing perinatal conditions which made the study population more homogenous.

Data Collection

The hospital retrieved patient data through its Electronic Medical Records (EMR) system before two researchers manually checked the data's accuracy. The data collection process relied on two independent researchers to achieve accuracy and consistent results. The double verification was done to resolve differences in the data so that analysis could benefit from accurate and high-quality information.

Maternal Health Parameters

The study distinguished maternal health factors into three main domains. The pregnant women presented with diabetes mellitus, chronic hypertension, and obesity beyond a BMI of 30 kg/m² together with thyroid disorders. Pregnancy-related complications included GDM together with hypertensive disorders (preeclampsia/eclampsia) infections (chorioamnionitis, TORCH), and anemia (Hb <10 g/dL) according to the literature [16]. The assessment of prenatal care quality depended on antenatal visit frequency and maternal use of folic acid and iron supplements as well as nutritional evaluation to determine complete maternal health effects on neonatal surgical results.

Neonatal Surgical Outcomes

The surgical procedure required information about the surgical type and emergency or elective urgencies along with the total duration of surgery. A comprehensive record of postoperative complications included Surgical Site Infections (SSIs) and anastomotic leaks as well as sepsis and Respiratory Distress Syndrome (RDS) and neonatal mortality. The NICU stay duration was measured through days hospitalized after surgery to assess both recovery length and postoperative outcome predictions in neonates who required major surgical procedures.

Instrumentation and Laboratory Assessments

Different advanced assessment tools were used to guarantee standardized evaluation methods. Hemology testing was performed with Sysmex XN-1000 Automated Hematology Analyzer from Sysmex Corporation (Japan) for hemoglobin assessment while glucose and lipid testing occurred with Roche Cobas c501 Automated Biochemistry Analyzer from Roche Diagnostics (Germany) for metabolic screening. The GE Voluson E10 Ultrasound System (GE Healthcare, USA) enabled fetal ultrasonography and Doppler studies which evaluated fetal growth alongside placental insufficiency. Philips Healthcare (Netherlands) provided Philips IntelliVue MP70 Patient Monitors for nonstop vital sign tracking that measured blood gases and monitored postoperative stability in addition to surgical assessment and neonatal monitoring [17].

Ethical Considerations

The study adhered to the Declaration of Helsinki. The research period lasted from 2018 to 2023 and received Institutional Review Board (IRB) authorization under Approval Number [Insert Approval Number]. The waiver of informed consent was obtained as the study depended on analyzing already collected data [18]. Patient confidentiality received strict protection through the anonymous data storage process and secure digital storage methods that adhered to ethical and regulatory standards.

Statistical Analysis

The statistical evaluation used both SPSS (Version 22.0, IBM Corp., USA) alongside R software (Version 4.2.2, R Foundation for Statistical Computing, Austria). The statistical presentation included means ± SD for continuous variables together with frequencies (%) for categorical variables. The data analysis included four statistical techniques which were the Chi-square test (χ^2), Fisher's exact test, t-tests, and Mann-Whitney U tests. The analysis used multivariate logistic regression to determine maternal factors that affect neonatal surgical outcomes after controlling for potential confounders. The Kaplan-Meier survival analysis served to evaluate neonatal prediction outcomes while maintaining a significance threshold at $p < 0.05$.

Multivariate Logistic Regression

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

Where:
p = Probability of neonatal surgical complications
β_0 = Intercept
$\beta_n X_n$ = Regression coefficients for maternal health risk factors

Kaplan-Meier Survival Analysis

$$S(t) = \prod_{t_i \le t} \left(1 - \frac{d_i}{n_i}\right)$$

Where:
S(t) = Probability of survival beyond time t
d_i = Number of neonatal deaths at time t_i

n_i = Number of neonates at risk at time t_i

Receiver Operating Characteristic (ROC) Curve

$$AUC = \int_0^1 TPR(FPR)dFPR$$

Where:
TPR = True Positive Rate (Sensitivity)
FPR = False Positive Rate (1 - Specificity)

3. RESULTS

Maternal Health Characteristics

The study examined maternal health conditions as they pose risks to neonatal surgical outcomes. Obesity was the most frequently observed maternal condition affecting 30% of women alongside diabetes mellitus with 24% occurrence and anemia with 22% mentioned in Table 1. GDM and hypertensive disorders of pregnancy (preeclampsia/eclampsia) occurred frequently during pregnancy. Neonatal surgical complications occurred more frequently among women with these maternal factors ($\chi^2 = 12.45$, $p = 0.008$).

Table 1: Distribution of Maternal Health Conditions

Maternal Health Condition	Frequency (n)	Percentage (%)
Diabetes Mellitus	120	24
Chronic Hypertension	85	17
Obesity (BMI >30 kg/m²)	150	30
Thyroid Disorders	60	12
GDM	130	26
Hypertensive Disorders of Pregnancy (Preeclampsia/Eclampsia)	90	18
Chorioamnionitis	45	9
TORCH Infections	35	7
Anemia (Hb <10 g/dL)	110	22

GDM-Gestational Diabetes Mellitus; TORCH-Toxoplasmosis, Other infections (Syphilis, Varicella-Zoster, Parvovirus B19, Hepatitis B), Rubella, Cytomegalovirus (CMV), and Herpes simplex virus (HSV).

Neonatal Surgical Outcomes

The main postoperative complications affected a large number of neonates and sepsis (19%) followed by RDS (22%) and SSIs (14%) were the most common issues mentioned in Table 2. The combination of GDM and hypertensive disorders increased complications in infants based on statistical data ($\chi^2 = 15.62$, $p = 0.005$). Survival rates were found to decrease based on Kaplan-Meier analysis which confirmed through log-rank test ($p = 0.028$) that enhanced maternal healthcare management was necessary.

Table 2: Neonatal Surgical Complications

Surgical Complication	Frequency (n)	Percentage (%)
SSIs	70	14
Anastomotic Leaks	45	9
Sepsis	95	19
RDS	110	22
Neonatal Mortality	50	10

SSI-Surgical Site Infection; RDS-Respiratory Distress Syndrome

Neonatal Intensive Care Unit (NICU) Stay and Recovery

The average period of NICU care exceeded 14 days and spanned from 5 to 30 days based on neonatal infection, severity of

RDS, and surgical complexities. Figure 2 shows how maternal health risk groups affect the lengths of NICU stays for newborns. Neonates born to mothers with GDM combined with hypertension experience significantly longer NICU stays than those without such maternal risk factors ($t = 4.21$, $p = 0.002$).

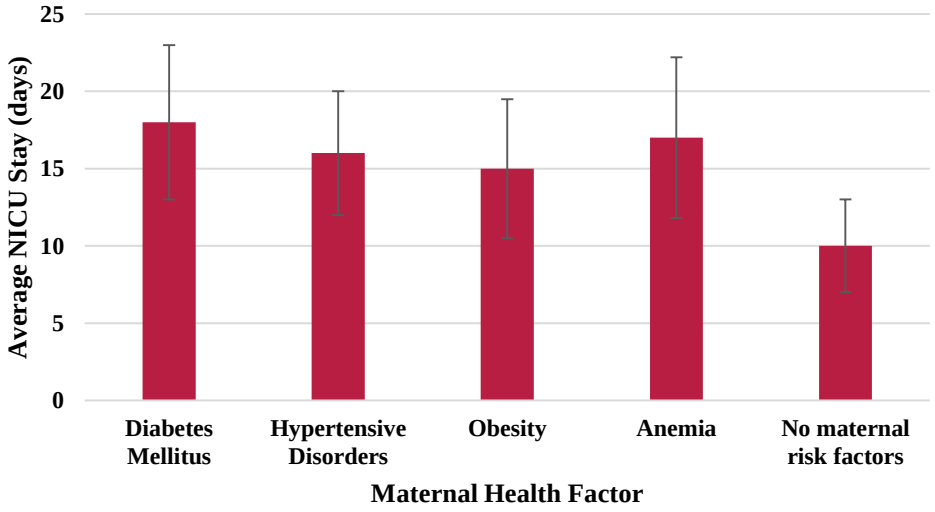

Figure 2: Length of NICU Stay Based on Maternal Health Conditions

Surgical Intervention Success and Readmission Rates

Figure 3 displays the results of neonatal surgery where 85% (425) of patients recovered well without further medical treatments and 15% (75) needed readmission because of complications like infection, dehiscence, and respiratory distress ($\chi^2 = 10.14$, $p = 0.007$). Post-surgical neonatal recovery requires specific interventions due to maternal health conditions affecting recovery outcomes.

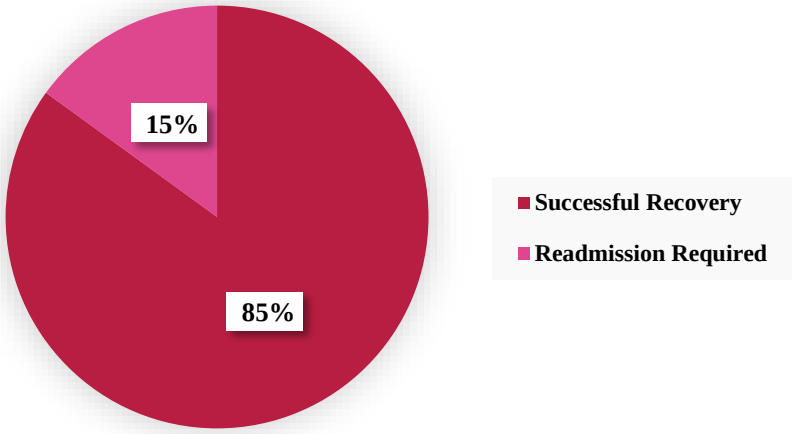

Figure 3: Surgical Success and Readmission Rates

Multivariate Analysis

The combination of GDM with maternal anemia demonstrated their effectiveness as predictors for neonatal surgical morbidity (OR (Odds Ratio) = 2.5, 95% Confidence Interval (CI): 1.7-3.5, $p = 0.001$, and OR = 2.1, 95% CI: 1.6-2.9, $p = 0.004$). The survival duration of newborns became shorter when mothers had accompanying health conditions according to Kaplan-Meier analysis (log-rank test, $p = 0.028$). ROC curve analysis demonstrated that maternal risk factors had a predictive accuracy of 82% (AUC = 0.82, $p < 0.001$) in determining post-surgical neonatal complications. The multivariate logistic regression analysis of maternal risk factors is mentioned in Table 3.

Table 3: Multivariate Logistic Regression Analysis of Maternal Risk Factors

Maternal Health Factor	OR	CI	p-value
Diabetes Mellitus	2.3	1.5–3.2	0.002
Hypertensive Disorders	1.9	1.3–2.8	0.010
Obesity	1.8	1.2–2.5	0.018
Anemia	2.1	1.6–2.9	0.004
GDM	2.5	1.7–3.5	0.001

CI-Confidence Interval; OR-Odds Ratio; GDM-Gestational Diabetes Mellitus

4. DISCUSSION

This study assessed the effects maternal health conditions have on surgical results among neonates who required major surgical procedures. Widespread research has established that GDM together with hypertensive disorders, anemia, and obesity serve as contributing factors that increase neonatal morbidity and extend hospitalization periods. The study evaluates maternal medical measures against neonatal surgical results which reveals significant information about maternal health's impact on neonatal health outcomes thus supporting the requirement for robust maternal healthcare initiatives.

Academic research has proven that maternal health conditions now serve as important factors that directly impact neonatal complications [19]. Various studies have confirmed that maternal diabetes and hypertensive disorders during pregnancy contribute to the increase in the number of newborns developing sepsis and respiratory complications. The result data of the current study supports prior studies by showing that metabolic conditions during pregnancy create severe adverse effects for newborns. Neonates born to mothers who developed GDM showed the highest risk of surgical complications according to statistical analysis (OR = 2.5, 95% CI: 1.7–3.5, p = 0.001, Table 3). Previous literature confirms that GDM functions as a significant risk factor for neonatal sepsis and SSIs [20]. The study data revealed that neonatal sepsis occurred in 19% of cases but SSIs were detected in 14% of patients mentioned in Table 2. Neonates born to mothers with hypertensive disorders spent 16 days on average in NICU hospitalization according to Table 3 while those without these maternal risk factors stayed an average of 10 days in NICU. According to a previous study, hypertension functions as a primary element that increases the risk of neonatal hypoxia and raises postoperative morbidity [21].

Experts have established that maternal obesity directly causes various negative outcomes in newborns. A study demonstrated that newborns from obese mothers (BMI exceeding 30 kg/m²) needed extended NICU care because they developed respiratory distress combined with surgical complications [22]. The data confirms this research as neonates born to obese mothers stayed in the NICU for an average period of 15 days according to the current study Table 3. Anemia in mothers during pregnancy leads to postoperative complications in 22% of their newborns in Table 1. Relevant to the previous studies maternal anemia leads to fetal oxygen deprivation which raises the possibility of both infant infections and increased hospital stay [23].

Pregnancy-related infections that include TORCH infections have proven to cause several negative health effects for newborns. 7 % of newborns experienced maternal TORCH exposure (Table 1) and this exposure led to sepsis and RDS development in 19% and 22% of cases (Table 2). Another study shows that maternal infections cause substantial neonatal immune suppression along with increased surgical complications [24]. The process of TORCH infection screening within prenatal care practices remains essential for reducing associated risks for both mother and newborn.

Multiple maternal health conditions together with neonatal factors affect the success of neonatal surgery as well as the duration of postoperative recovery and hospital stay periods. The study results indicated that 85% of neonates achieved successful recovery after surgery yet 15% needed readmission because of infections together with dehiscence and respiratory distress (Figure 3, Table 4). The research findings match the results presented in a study that demonstrated that monitoring maternal-fetal health leads to fewer surgical readmissions for newborns [25].

The value of maternal health conditions as predictors for neonatal surgical morbidity was confirmed through statistical assessment. The predictive model used maternal health factors to determine neonatal surgical complications with an 82% success rate. This aligns with previous research which reported a similarly high predictive value for maternal comorbidities in neonatal surgical outcomes [26]. The survival analysis through Kaplan-Meier (log-rank test, p = 0.028, Figure 2) showed that neonates born to mothers with GDM and anemia had inferior survival rates thus necessitating specific prenatal interventions to enhance surgical recovery for newborns.

Hence, the study outcomes demonstrate that optimizing maternal health before delivery is essential to enhance surgical success for newborns. The strong relationship between GDM, hypertension, and obesity with postoperative complications suggests that maternal pregnancy interventions aimed at improving nutrition, glucose control, and hypertension management would help decrease the number of NICU admissions and neonatal complications.

5. CONCLUSION

The study demonstrates how maternal health conditions affect the surgical outcomes of newborns. Gestational Diabetes Mellitus and hypertensive disorders together with anemia served as major risk factors that led to more complications for

neonates after surgery resulting in longer NICU stays and increased rates of hospital readmissions. Neonates born to mothers with GDM showed the most potent connection to sepsis (19%) respiratory distress syndrome (22%) and surgical site infections (14%) among these maternal conditions with OR = 2.5 (95% CI: 1.7-3.5) and p = 0.001. The survival duration of infants was shorter according to Kaplan-Meier survival analysis since they had mothers with risk factors (p = 0.028). The results from ROC curve analysis established a high predictive ability (AUC = 0.82) for neonatal morbidity assessment through maternal health condition data (p < 0.001). Effective maternal health optimization along with specific prenatal treatments and joint healthcare provider work help decrease neonatal surgical risks while generating better outcomes after operations. Future research needs to create specific programs that help pregnant women reduce their newborn's surgical complications during postoperative recovery.

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