

Research Article

Assessment of Maternal Health Determinants and Their Impact on Neonatal Outcomes in Tertiary Care Hospital

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Abstract: Maternal health and nutritional status during pregnancy are critical determinants of neonatal survival and early-life outcomes. This study aimed to assess maternal health determinants and evaluate their impact on neonatal outcomes in a tertiary care setting. **Methods:** A hospital-based analytical cross-sectional study was conducted in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital in Lahore over a six-month period (June 2025 – December 2025). A total of 300 mother–neonate pairs were selected using consecutive non-probability sampling. Structured questionnaires and medical record reviews were used to gather data on maternal health determinants and neonatal outcomes. Descriptive statistics, Chi-square tests, and multivariable logistic regression analyses were performed using SPSS version 25.0. **Results:** The mean maternal age was 28.6 ± 5.4 years. Among the participants, 38.7% had maternal anemia, 14.3% had hypertensive disorders, and 68.0% had adequate antenatal care (≥ 4 visits). Neonatal outcomes revealed low birth weight (18.3%), preterm birth (15.7%), NICU admission (13.0%), and Apgar score < 7 at 5 minutes (10.7%). Multivariable logistic regression revealed that hypertensive disorders (AOR = 3.21, 95% CI: 1.71–6.04), maternal anemia (AOR = 2.84, 95% CI: 1.62–4.97), and inadequate antenatal care visits (AOR = 2.39, 95% CI: 1.34–4.28) were strong independent predictors of adverse neonatal outcomes. **Conclusion:** Maternal anemia, hypertensive disorders, and inadequate antenatal care significantly increase the risk of adverse neonatal outcomes. Early screening and targeted interventions during antenatal visits are critical to improving neonatal survival.

Keywords: Maternal health, neonatal outcomes, antenatal care, low birth weight, tertiary care hospitals, maternal determinants, neonatal complications

INTRODUCTION

Maternal health remains a critical determinant of neonatal survival and early-life outcomes worldwide. The health and nutritional status of a mother during pregnancy significantly influence fetal growth, development, and neonatal adaptation after birth. Adverse maternal conditions such as anemia, hypertensive disorders, gestational diabetes mellitus, poor nutritional status, and inadequate antenatal care are associated with increased risks of low birth weight, preterm birth, neonatal intensive care unit (NICU) admission, birth asphyxia, and early neonatal morbidity and mortality (World Health Organization, 2023) [1].

Despite substantial improvements in maternal and child healthcare services, neonatal mortality continues to be a major public health concern, particularly in low- and middle-income countries. Globally, approximately 2.3 million neonatal deaths occur annually, with a significant proportion attributed to preventable maternal and perinatal factors [2]. South Asian countries, including Pakistan, continue to report high rates of neonatal complications due to limited access to quality antenatal care, delayed identification of maternal risk factors, and inadequate healthcare infrastructure [3].

Antenatal care serves as a cornerstone for identifying and managing maternal health risks during pregnancy. Adequate antenatal visits facilitate early diagnosis of complications such as pregnancy-induced hypertension, gestational diabetes, maternal infections, and nutritional deficiencies, thereby reducing adverse neonatal outcomes [4]. However, disparities in maternal education, socioeconomic status, and healthcare accessibility frequently hinder optimal utilization of antenatal services in tertiary care settings [5].

Maternal age and parity are also important determinants of neonatal outcomes. Extremes of maternal age, particularly adolescent and advanced maternal age pregnancies, are associated with increased risks of fetal growth restriction, preterm delivery, and neonatal complications [6]. Similarly, maternal nutritional deficiencies, especially iron-deficiency anemia, contribute significantly to intrauterine growth restriction and low birth weight [7].

Tertiary care hospitals provide an ideal setting for evaluating the relationship between maternal health determinants and neonatal outcomes, as they frequently manage high-risk pregnancies and complicated deliveries. Understanding these associations is essential for strengthening maternal healthcare policies and designing targeted interventions to improve neonatal survival. Therefore, this study aimed to assess maternal

health determinants and their impact on neonatal outcomes in tertiary care hospitals.

MATERIALS AND METHODS

2.1 Study Design and Setting

A hospital-based analytical cross-sectional study was conducted in the Department of Obstetrics and Gynecology of a tertiary care teaching hospital in Lahore over a period of six months from June 2025 to December 2025.

2.2 Study Population

The study population comprised mothers who delivered live neonates at the tertiary care hospital during the study period.

2.3 Inclusion Criteria

- Mothers aged 18–45 years
- Singleton pregnancies
- Mothers delivering live-born neonates at the study site
- Participants who provided informed written consent

2.4 Exclusion Criteria

- Multiple pregnancies
- Stillbirths
- Mothers with incomplete medical records
- Neonates with major congenital anomalies

2.5 Sample Size and Sampling Technique

A sample size of 300 mother–neonate pairs was calculated using the WHO sample size calculator, considering a 95% confidence level, 5% margin of error, and anticipated prevalence based on previous regional studies [8]. Participants were selected using consecutive non-probability sampling until the required sample size was achieved.

2.6 Data Collection Procedure

Data were collected through structured interviewer-administered questionnaires and a review of hospital medical records.

- **Maternal variables included:** Maternal age, educational status, socioeconomic status, parity, number of antenatal care visits, body mass index (BMI), presence of maternal anemia, hypertensive disorders of pregnancy, gestational diabetes mellitus, and pregnancy-related complications.
- **Neonatal outcome variables included:** Birth weight, gestational age at delivery, Apgar score at 5 minutes, NICU admission, and presence of neonatal complications.

2.7 Operational Definitions

- **Low birth weight:** Birth weight less than 2500 grams.
- **Preterm birth:** Delivery before 37 completed weeks of gestation.
- **Adequate antenatal care:** At least four antenatal visits during pregnancy as recommended by WHO guidelines [1].

2.8 Data Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive statistics were computed for all variables. Continuous variables were presented as mean $\pm$ standard deviation, while categorical variables were expressed as frequencies

and percentages. Associations between maternal health determinants and neonatal outcomes were assessed using the Chi-square test. Multivariable logistic regression analysis was performed to identify independent predictors of adverse neonatal outcomes. A p-value < 0.05 was considered statistically significant.

2.9 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board/Ethics Committee of the institute. Written informed consent was obtained from all participants before enrolment. Confidentiality and anonymity of participant information were strictly maintained throughout the study.

RESULTS

A total of 300 mother–neonate pairs were included in the study. The mean maternal age was 28.6 ± 5.4 years. Most participants (46.7%) were aged between 26–35 years, while 21.0% were older than 35 years. A majority of mothers (61.3%) had completed secondary or higher education. Maternal anemia was observed in 38.7% of participants, hypertensive disorders in 14.3%, and gestational diabetes mellitus in 11.0%. Regarding antenatal care utilization, 68.0% of mothers attended four or more antenatal visits, while 32.0% had inadequate antenatal care attendance (**Table 1**).

Among neonatal outcomes, 18.3% of neonates had low birth weight, 15.7% were preterm, 13.0% required NICU admission, and 10.7% had an Apgar score <7 at 5 minutes (**Table 2**).

Maternal anemia, hypertensive disorders, and inadequate antenatal care were significantly associated with adverse neonatal outcomes, including low birth weight (**Table 3**) and NICU admission (**Table 4**) ($p < 0.05$).

Table 1. Socio-demographic and Clinical Characteristics of Mothers (n = 300)

Variable	Frequency (n)	Percentage (%)
Maternal Age (years)		
18–25	97	32.3
26–35	140	46.7
>35	63	21.0
Educational Status		
No formal education	42	14.0
Primary	74	24.7
Secondary/Higher	184	61.3
Socioeconomic Status		
Low	128	42.7
Middle	117	39.0
High	55	18.3
Clinical Determinants		
Maternal Anemia	116	38.7
Hypertensive Disorders	43	14.3
Gestational Diabetes Mellitus	33	11.0
Antenatal Visits		
4 Antenatal Visits	204	68.0
< 4 Antenatal Visits	96	32.0

Table 2. Neonatal Outcomes (n = 300)

Neonatal Outcome	Frequency (n)	Percentage (%)
Low Birth Weight (<2500 g)	55	18.3
Preterm Birth (<37 weeks)	47	15.7
Apgar Score <7 at 5 min	32	10.7

NICU Admission	39	13.0
Neonatal Complications	41	13.7
Normal Neonatal Outcome	186	62.0

Table 3. Association Between Maternal Health Determinants and Low Birth Weight

Maternal Determinant	Low Birth Weight n (%)	Normal Birth Weight n (%)	p-value
Maternal Anemia			
Present	37 (31.9)	79 (68.1)	0.001
Absent	18 (9.8)	166 (90.2)	
Antenatal Care Visits			
Inadequate	29 (30.2)	67 (69.8)	0.003
Adequate	26 (12.7)	178 (87.3)	
Hypertensive Disorders			
Present	16 (37.2)	27 (62.8)	0.002
Absent	39 (15.2)	218 (84.8)	

Table 4. Association Between Maternal Health Determinants and NICU Admission

Maternal Determinant	NICU Admission n (%)	No NICU Admission n (%)	p-value
Maternal Anemia			
Present	24 (20.7)	92 (79.3)	0.004
Absent	15 (8.2)	169 (91.8)	
Hypertensive Disorders			
Present	14 (32.6)	29 (67.4)	0.001
Absent	25 (9.7)	232 (90.3)	
Antenatal Care Visits			
Inadequate	19 (19.8)	77 (80.2)	0.016
Adequate	20 (9.8)	184 (90.2)	

Key Findings

Multivariable logistic regression demonstrated that maternal anemia, hypertensive disorders, and inadequate antenatal care utilization were independent predictors of adverse neonatal outcomes (Table 5). Hypertensive disorders exhibited the strongest association (AOR = 3.21), followed by maternal anemia (AOR = 2.84).

Table 5. Multivariable Logistic Regression Analysis for Adverse Neonatal Outcomes

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Maternal Anemia	2.84	1.62–4.97	<0.001
Hypertensive Disorders	3.21	1.71–6.04	<0.001
Inadequate ANC Visits	2.39	1.34–4.28	0.003
Low Socioeconomic Status	1.76	1.01–3.08	0.045
Maternal Age >35 years	1.52	0.81–2.84	0.182

DISCUSSION

The present study demonstrated that maternal health determinants significantly influence neonatal outcomes in tertiary care settings. Maternal anemia, hypertensive disorders of pregnancy, and inadequate antenatal care utilization emerged as significant predictors of adverse neonatal outcomes, including low birth weight, preterm birth, low Apgar scores, and increased neonatal intensive care unit (NICU) admissions. These findings underscore the critical role of comprehensive maternal healthcare in improving neonatal survival and reducing neonatal morbidity.

Maternal anemia was identified as one of the strongest independent predictors of adverse neonatal outcomes in the present study. Mothers with anemia were significantly more likely to deliver low birth weight neonates and had higher rates of NICU admissions. This finding is consistent with previous studies demonstrating that maternal anemia compromises placental oxygen delivery and fetal growth, thereby increasing the risk of intrauterine growth restriction and prematurity. Rahman et al. reported that maternal iron deficiency was significantly associated with low birth weight and neonatal complications in low-resource settings [1]. Similarly, a meta-analysis by Figueiredo et al. concluded that maternal anemia substantially increases the risk of preterm birth and

neonatal morbidity [2]. The high prevalence of maternal anemia observed in this study reflects persistent nutritional deficiencies and inadequate prenatal supplementation, which remain major public health challenges in developing countries.

Hypertensive disorders during pregnancy also showed a strong association with adverse neonatal outcomes. Mothers diagnosed with gestational hypertension or preeclampsia were significantly more likely to have neonates requiring NICU admission and experiencing low Apgar scores. These findings align with previous evidence indicating that maternal hypertension contributes to placental insufficiency, fetal hypoxia, and restricted intrauterine growth [3]. World Health Organization has emphasized hypertensive disorders as a leading cause of maternal and perinatal morbidity globally [4]. Similar findings were reported by Magee et al., who observed significantly increased neonatal complications among pregnancies complicated by hypertensive disorders [5].

The present study further identified inadequate antenatal care utilization as an independent determinant of poor neonatal outcomes. Mothers with fewer than four antenatal visits demonstrated significantly higher risks of delivering preterm and low birth weight neonates. This finding supports prior research highlighting the protective role of regular antenatal care in identifying and managing maternal complications at earlier stages. Adequate antenatal care facilitates screening for anemia, gestational diabetes, infections, and hypertensive disorders, thereby reducing preventable neonatal complications [6]. Carroli et al. reported that structured antenatal care programs significantly reduce adverse perinatal outcomes through timely interventions [7].

Low socioeconomic status was also significantly associated with unfavorable neonatal outcomes. This association may reflect reduced access to quality healthcare, poor maternal nutrition, delayed health-seeking behavior, and limited awareness regarding pregnancy-related complications. Similar associations have been reported by studies conducted in South Asia, where socioeconomic disparities substantially affect maternal and neonatal health indicators [8]. In resource-constrained settings, social determinants continue to exert a profound influence on healthcare access and utilization.

Although maternal age above 35 years showed an increased odds ratio for adverse neonatal outcomes, the association did not reach statistical significance in multivariable analysis. This contrasts with previous studies reporting advanced maternal age as a significant risk factor for adverse obstetric and neonatal outcomes

[9]. The discrepancy may be attributable to the relatively smaller proportion of older mothers in the present study.

The findings of this study have important clinical and public health implications. Strengthening maternal nutrition programs, ensuring routine antenatal screening, and improving accessibility to quality prenatal services are essential strategies for reducing neonatal morbidity and mortality. Tertiary care hospitals should prioritize early risk stratification and multidisciplinary management of high-risk pregnancies to optimize neonatal outcomes.

Strengths and Limitations

A major strength of this study lies in its comprehensive evaluation of multiple maternal determinants within a tertiary care setting managing diverse obstetric cases. However, the cross-sectional design limits causal inference. Additionally, the study was conducted at a single tertiary care center, which may affect the generalizability of findings to primary and secondary healthcare settings.

CONCLUSION

Maternal anemia, hypertensive disorders, and inadequate antenatal care are significant predictors of adverse neonatal outcomes in tertiary care hospitals. Early identification and targeted management of these modifiable maternal risk factors are essential to improving neonatal health outcomes and reducing neonatal morbidity.

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