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Factors associated with adverse neonatal outcome in a tertiary hospital of Nepal: Case Study

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ABSTRACT

Introduction: Neonatal outcomes are crucial indicators of maternal and child health, reflecting the quality of healthcare services. Adverse outcomes, like preterm birth, low birth weight, neonatal sepsis, and neonatal mortality, remain significant global challenges, especially in low- and middle-income countries (LMICs) like Nepal. Despite progress, Nepal's neonatal mortality rate remains high at 21 per 1,000 live births, highlighting gaps in healthcare access and quality.

Objective: The objective of this study was to investigate factors associated with adverse neonatal outcomes in a tertiary hospital setting.

Methodology: A hospital-based case-control study was conducted in a tertiary hospital in Nepal from November 01, 2023 to April 30, 2024. Data were collected on sociodemographic and healthcare-related factors, maternal health pregnancy and obstetric related factors and analysed through IBM SPSS version 23. Chi square test and Odds ratios (ORs) was calculated. P Value <0.05 was considered statistically significant.

Results: Low birth weight (OR = 13.205, CI: 5.587–31.212), preterm delivery (OR = 13.17, CI: 5.808–29.880), twin pregnancies, missed antenatal care, lack of supplementation, deworming, maternal infections, per vaginal leaking, abnormal amniotic fluid, labor complications and referral cases showed significant associations ($p < 0.05$).

Conclusion: The study identifies key risk factors for adverse neonatal outcomes, including low birth weight, preterm delivery, twin pregnancies, inadequate antenatal care, lack of supplementation, maternal infections, and labor complications. Addressing these factors through targeted healthcare interventions could significantly improve neonatal health outcomes in resource-limited settings

INTRODUCTION

Neonatal outcomes are critical indicators of maternal and child health and serve as essential metrics for evaluating the quality of healthcare services. Globally, adverse neonatal outcomes including preterm birth, low birth weight, neonatal sepsis, birth asphyxia, and neonatal mortality, remain significant public health challenges. These outcomes contribute substantially to the global burden of disease, with low- and middle-income countries (LMICs) disproportionately affected. According to the World Health Organization (WHO), approximately 47% of all under-5 deaths occurred in the newborn period, with the majority occurring in LMICs, including Nepal.[1]

Nepal has made considerable strides in improving maternal and neonatal health

through policy reforms and healthcare interventions. Despite these advancements, neonatal morbidity and mortality rates remain unacceptably high. The neonatal mortality rate in Nepal is estimated at 21 deaths per 1,000 live births, reflecting persistent gaps in the accessibility, quality, and utilization of maternal and neonatal health services.[2] Identifying the factors associated with adverse neonatal outcomes is essential to designing effective interventions and policy measures tailored to the specific needs of the population.

Tertiary hospitals often serve as referral centers for high-risk pregnancies and neonatal care, making them critical settings for studying determinants of neonatal outcomes. Existing studies have primarily focused on individual determinants such as socioeconomic status, maternal health conditions, and obstetric complications, but there is a need for a holistic approach that considers a wide range of maternal, fetal, and healthcare-related factors.[3,4,5]

This case-control study aims to evaluate the factors associated with adverse neonatal outcomes in a tertiary hospital in Nepal. By identifying key risk factors, this study seeks to contribute to the evidence base for improving neonatal care and reducing neonatal morbidity and mortality in similar resource-limited settings.

METHODOLOGY

This was a hospital-based case-control study conducted to identify the factors associated with adverse neonatal outcomes in a tertiary hospital in Nepal. The study was carried out in the neonatal and maternity wards of Birat Medical College Teaching Hospital , a tertiary care center in Nepal, over a period of 6 months from to 1st November 2023 to April 30 2024. Ethical approval was obtained from the Institutional Review Committee (IRC-PA-343/2023) of the same institution. Voluntary informed consent was obtained from the mothers prior to data collection. Confidentiality of the data was maintained throughout the study, and all procedures adhered to the ethical standards of the Declaration of Helsinki. The study included neonates delivered in the hospital during the study period. The cases and controls were selected as follows:

- Cases: Neonates with adverse outcomes, defined as any of the following conditions: low Apgar score (<7 at 5 minutes), admission to the neonatal intensive care unit (NICU), or severe neonatal morbidity (e.g., birth asphyxia, sepsis, respiratory distress meconium aspiration syndrome), low birth weight, prematurity requiring intensive care unit and observation along with their index mothers.[6]
- Controls: Healthy neonates, low birth weight newborns without any other complications and with their indexed mothers without adverse outcomes, matched by delivery date to the cases. The case is to control ratio was 1:2

Sample size was calculated taking the reference of similar study entitled “Adverse neonatal outcome and associated risk factors: A case control study.[5]

The formula for unmatched case control study was applied using open EPI version 3.5.1 sample size calculator for unmatched case control study design with two sided confidence level (1-alpha) = 95[7]
Power of the test (% chance of detecting) = 80
Ratio of control to cases = 2
From multivariate analysis, taking APH as a risk factor;
Proportion of controls with exposure (APH) = 3.9%
Proportion of cases with exposure (APH) = 19.2%
Least extreme Odds Ratio to be detected (observed from the study): 5.87
Using Fleiss with continuity correction method, the estimated sample in cases and control is 56:112 each.

A structured data collection form was used to gather information from medical records, maternal interview, and neonatal records. Data were collected on the variables, sociodemographic and Healthcare-Related Factor: gender, birth weight, husband’s support, socioeconomic status (as measured by modified Kupuswamy scale), family size, past neonatal history and referral cases. Maternal Health and Pregnancy-Related Factors : maternal age (high risk < 18 and above/= 35 years, low risk 18-34 years), parity, history of twin pregnancy, past pregnancy complications, current pregnancy complications (obstetric and medical conditions like antepartum hemorrhage, oligohydramnios(Amniotic fluid index<8cm, preeclampsia, chronic and gestational hypertension, chronic and gestational diabetes, cardiovascular problems, thyroid problems etc reported by patients), period of gestation (term, preterm, postterm and postdated), regularity of antenatal visit, supplementation (iron/ calcium, folic acid) and deworming. Obstetric Complications: per vaginal bleeding, maternal infection, Amniotic fluid Index(,8cm in USG), characteristics, Fetal heart sound, non stress test (NST), labor complications, mode of delivery (spontaneous vaginal delivery (SVD), vacuum delivery, C-section), induction and augmentation of labor.

Data was entered in Microsoft Excel sheet and analyzed using IBM SPSS version 23. Pearson’s Chi square test, Fishers’ exact test and likelihood ratio was used to find the association of risk factors with adverse neonatal outcome among cases and control P Value <0.05 was considered statistically significant. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs), and a p-value.

RESULTS

Table 1: Sociodemographic and Healthcare-Related Factors Associated with Adverse Neonatal Outcomes (n=150)

Variables		Cases n(%)	Controls n(%)	P value	Odds ratio	CI
Gender	Males	28(33.3)	56(66.7)	1	1	.526-1.89
	Females	28(33.3)	56(66.7)			
Birth weight	Low birth weight	30(76.9)	9(23.1)	.000	13.205	5.587-31.212
	Normal	26(20.2)	103(79.8)			
Husband support	No	11(28.2)	28(71.8)	0.438	1.364	0.621-2.992
	Yes	45(34.9)	84(65.1)			
Socio economic status(SES)	Upper Middle class	15(34.9)	28(65.1)	0.859**	NA	
	Upper lower	16(35.6)	29(64.4)			
	Lower middle	25(31.3)	55(68.8)			
Family size	Joint	38(31.4)	83(68.6)	0.395	1.356	0.672-2.736
	Nuclear	18(38.3)	29(61.7)			
Referral cases	Yes	9(69.2)	4(30.8)	0.011*	5.170	1.516-17.63
	No	47(30.3)	108(69.7)			
Past neonatal history	Eventful	2(50)	2(50)	.582	2.353	.303-17.676
	Uneventful	19(30.2)	44(69.8)			

Chi square test was applied.** Likelihood Ratio and * Fisher's exact test was applied. P value <0.05 was considered. statistically significant. CI= Confidence Interval

A total of 56 cases and 112 controls were enrolled for the study. Gender has no significant association with adverse neonatal outcomes, as indicated by a P-value of 1 and an odds ratio of 1 (CI: 0.526 - 1.89), showing equal distribution of males and females among cases (33.3%) and controls (66.7%). Low birth weight is strongly associated with adverse neonatal outcomes (P = 0.000, CI: 5.587–31.212). The odds ratio (13.205) indicated that neonates with low birth weight are over 13 times more likely to experience adverse outcomes compared to those with normal birth weight. Referred cases were over 3 times more likely to experience adverse outcomes (P = 0.011, OR = 3.170, CI: 1.516–17.63). Other factors, including socioeconomic status, husband support, family size, and past neonatal history, showed no statistically significant relationship with adverse outcomes (P = 0.859, 0.438, 0.395 and 0.582respectively), Table 1.

Table 2: Maternal Health and Pregnancy-Related Factors Associated with Adverse Neonatal Outcomes Among cases and controls

		Cases n(%)	Controls n(%	P value	OR	CI
Maternal Age	High risk	8(53.3)	7(46.7)	0.085	0.400	0.137-1.167
	Normal range	48(31.4)	105(68.6)			
Parity	Multiparous	26(31.0)	58(69.0)	.513	0.807	0.424-1.535
	Primiparous	30(35.7)	54(64.3)			
Twin pregnancy	Yes	8(72.7)	3(27.3)	0.004	6.056	1.539-23.822
	No	48(30.6)	109(69.4)			
Past pregnancy history	Eventful	10(38.5)	16(61.5)	0.447	1.447	0.556-3.765
	Uneventful	19(30.2)	44(69.8)			
Current pregnancy complication	Eventful	22(22.7)	75(77.3)	0.001	0.319	0.164-0.621
	Uneventful	34(47.9)	37(52.1)			
Term pregnancy	No	37(54.4)	31(45.6)	0.000	5.088	2.55-10.15
	Yes	19(19)	81(81)			
Preterm pregnancy	Yes	33(75.0)	11(25.0)	0.000	13.17	5.808-29.880
	No	23(18.5)	101(81.5)			
Postterm/post dated	Yes	4(16.7)	20(83.3)	0.061	0.354	0.115-1.09
	No	52(36.1)	92(63.9)			
Antenatal checkup	Missed	11(68.8)	5(31.3)	0.002	5.231	1.719-15.92
	Regular	45(29.6)	107(70.4)			
Supplementation	Missed	7(77.8)	2(22.2)	0.007*	7.857	1.575-39.195
	Yes	49(30.8)	110(69.2)			
Deworming	No	16(51.6)	15(48.4)	0.017	2.587	1.17-5.73
	Yes	40(29.2)	97(70.8)			

Chi Square test was applied. * Fisher's exact test was applied. P Value <0.05 was considered statistically significant. CI= Confidence Interval.

Twin pregnancy (P = 0.004, OR = 6.056, 95% CI: 1.539–23.822), preterm pregnancy (P = 0.000, OR = 13.17, 95% CI: 5.808–29.880), missed antenatal checkups (P = 0.002, OR = 5.231, 95% CI: 1.719–15.92), missed supplementation (P = 0.007, OR = 7.857, 95% CI: 1.575–39.195), and lack of deworming (P = 0.017, OR = 2.587, 95% CI: 1.17–5.73) demonstrated statistically significant associations with the outcome. In contrast, maternal age, parity, past pregnancy history, post-term pregnancy, and supplementation did not show significant differences between cases and controls, Table 2.

Table 3: Obstetric Complications and Their Association with Adverse Neonatal Outcomes among cases and controls

Variables		Cases n(%)	Controls n(%)	P value	Odds ratio	CI
Per vaginal leaking	Yes	23(69.7)	10(30.3)	0.000	7.109	3.070-16.464
	No	33(24.4)	102(75.6)			
Maternal infection during labor	Yes	9(81.8)	2(18.2)	0.001*	10.532	2.192-50.612
	No	47(29.9)	110(70.1)			
Amniotic Fluid Index(AFI)	Adequate	7(58.3)	5(41.7)	0.107*	3.057	0.924-10.114
	Inadequate	49(31.4)	107(68.6)			
Amniotic fluid characteristics	Abnormal	29(69.0)	13(31.0)	0.000	8.179	3.748-17.85
	Normal	27(21.4)	99(78.6)			
Fetal heart sound	Abnormal	18(100)	0(0)	0.000	NA	NA
	Normal	38(25.3)	112(74.7)			
Non Stress Test (NST)	Abnormal	18(66.7)	9(33.3)	0.000	5.421	2.243-13.101
	Normal	38(27)	103(73)			
Labor complications	Yes	31(54.4)	26(45.6)	0.000	4.102	2.066-8.141
	No	25(22.5)	86(77.5)			
Mode of Delivery	SVD	23(27.1)	62(72.9)	0.079**	NA	
	Vacuum	2(20)	8(80)			
	C-section	31(42.5)	42(57.5)			
Induction of labor	Yes	51(33.3)	102(66.7)	1.000	1.0	0.325-3.08
	No	5(33.3)	10(66.7)			
Augmentation of labor	Yes	9(20)	36(80)	0.027	0.404	0.179-0.914
	No	47(38.2)	76(61.8)			
APGAR Score (1 min)	Moderate	28(56)	22(44)	.000	4.091	2.029-8.248
	Excellent	28(23.7)	90(76.3)			
APGAR Score (5 min)	Moderate	18(100)	0(0)	.000	NA	
	Excellent	38(25.3)	112(74.7)			

* Fisher's exact test and **Likelihood ratio was applied. NA=Not applicable

Cases with per vaginal leaking are significantly higher 23 (69.7%) compared to controls 10 (30.3%) with an odds ratio (OR) of 7.109 ($p < 0.001$, 95% CI: 3.070-16.464). Maternal infection during labour was significantly higher among cases compared to controls with OR of 10.532 (95% CI: 2.192–50.612, $p < 0.001$) indicating a significant risk factor for adverse outcomes.

Abnormal characteristics of amniotic fluid was 8.139 times higher among cases than control and it was statistically significant

($p < 0.001$, 95% CI: 3.748-17.85). Significantly cases were 4 times (OR 4.102) likely to have labor complications (54.4% cases vs. 23.5% in controls)and there was a statistically significant association ($p < 0.001$, 95% CI: 2.066-- 8.141). The prevalence of C-section is significantly higher among cases than other modes of delivery. Augmentation is less common in cases (9.2%) compared to controls (36.0%), with a statistically significant association ($p = 0.027$). The odds ratio (OR: 0.404, CI: 0.179–0.914) suggests a reduced likelihood of augmentation among cases, potentially reflecting labor complications leading to other interventions, Table 3.

DISCUSSION

This study identified significant associations between adverse neonatal outcomes and various sociodemographic, healthcare-related, maternal health, and obstetric factors. Key predictors included low birth weight, preterm delivery, twin pregnancies, missed antenatal care, and insufficient maternal supplementation and deworming. These findings provide valuable insights into preventable risk factors and highlight opportunities for improving neonatal health outcomes.

Low birth weight (LBW) emerged as a significant determinant of adverse neonatal outcomes (OR = 13.205, CI: 5.587–31.212). This finding aligns with existing literature and global reports, such as those from the World Health Organization (WHO), which emphasize the critical role of LBW in neonatal morbidity

and mortality. LBW, often associated with preterm births, predisposes neonates to a range of complications, including respiratory distress, infections, neonatal death, and long-term developmental issues like cerebral palsy and retinopathy of prematurity.[8]

Referral cases were also significantly associated with adverse outcomes (OR = 3.170, CI: 1.516–17.63). This finding supports prior evidence indicating that delayed or inadequate care due to referrals exacerbates delivery risks, particularly for neonates requiring urgent resuscitation or specialized care. Timely referrals and strengthened healthcare systems are thus essential to reducing these risks..[9,109,11]

Interestingly, no statistically significant associations were observed between socioeconomic status, family size, or husband support and adverse neonatal outcomes in this study. These results are consistent with findings by Muktar Abadiga et al. (2020).[12]

The lack of association may be attributed to improved healthcare access and community support systems, which mitigate disparities in socioeconomic factors. Homogeneity in study variables or cultural factors, such as extended family support, may also contribute to these findings.

This study found several maternal health and pregnancy-related factors to be significant predictors of adverse neonatal outcomes. These included twin pregnancies, preterm delivery, missed antenatal checkups, lack of supplementation, and inadequate deworming.

Twin pregnancies increased the likelihood of adverse neonatal outcomes significantly (OR = 6.056, CI: 1.539–23.822). This finding is consistent with studies by Danielly S. Santana et al. (2018), which highlight that multiple gestations are inherently high-risk due to complications such as preterm labor, LBW, and increased neonatal intensive care unit (NICU) admissions.[13]

Preterm delivery was strongly associated with adverse outcomes (OR = 13.3, CI: 5.808–29.880), corroborating global evidence that preterm birth is a leading cause of neonatal mortality. [8,12]

For instance, Abhishek Gurung et al. (2020) reported a 10.6-fold increased risk of pre-discharge mortality in preterm neonates in Nepal. Immature organ systems and higher susceptibility to complications, such as respiratory distress and infections, make preterm neonates particularly vulnerable. [14]

Antenatal care was another significant factor, with missed antenatal checkups being associated with a fivefold increase in risk (OR = 5.231, CI: 1.719–15.92). This finding aligns with WHO recommendations and studies emphasizing the importance of regular antenatal care in detecting complications early and ensuring timely interventions to mitigate neonatal risks.[14,15,16]

Maternal supplementation with iron and calcium, as well as deworming, were protective factors in reducing adverse neonatal outcomes. Mothers who did not receive complete supplementation were nearly eight times more likely to experience adverse outcomes. Iron deficiency during pregnancy is well-documented to increase risks of LBW, preterm delivery, and neonatal morbidity. Deworming reduces maternal anemia and malnutrition, particularly in low-resource settings, further decreasing risks of preterm birth and LBW.[17,18] Calcium supplementation, particularly in populations with inadequate dietary intake, has been shown to reduce the risk of preeclampsia, which in turn improves neonatal outcomes.[19]

While current pregnancy complications were significantly associated with adverse neonatal outcomes, the odds ratio (OR = 0.319, CI: 0.164–0.621) suggested a protective relationship. This result may reflect effective management and timely interventions for these complications, such as early diagnosis, treatment, or medical surveillance. Early identification and management of complications are critical to improving outcomes.[5,12,22]

Multiparity showed a protective trend (OR = 0.807, CI: 0.424–1.535) for adverse neonatal outcomes, though not statistically significant. This finding contrasts with studies linking multiparity to complications like preterm birth and hypertensive disorders in subsequent pregnancies.[3,14,22] The protective trend in this study may reflect better awareness and management of risks among multiparous women or effective healthcare interventions

Maternal age, primiparity, and postterm pregnancy were not significantly associated with adverse neonatal outcomes. Contrary to our study findings, studies have shown that sociodemographic factors such as the age of the mother and educational level, showed strong association with adverse birth outcome.[5,14,20,21,23] While studies often link advanced maternal age and primiparity to increased risks, this study's results may be influenced by uniform characteristics in the population or effective healthcare access reducing these risks.

This study highlights modifiable risk factors like antenatal care, supplementation, deworming, and timely referrals as crucial intervention points. While findings align with existing literature, some variations underscore the role of context-specific factors such as healthcare systems and cultural practices.Women with an eventful pregnancy history showed a higher likelihood of adverse neonatal outcomes, though not statistically significant, likely due to a small sample size or effective healthcare interventions. Complications such as per vaginal leaking, maternal infections, inadequate amniotic fluid, and abnormal fetal heart sounds were more common in adverse cases, emphasizing the need for early diagnosis and effective management to prevent adverse outcomes. The findings from our study demonstrated that cases with adverse neonatal outcomes had a higher prevalence of complications such as per vaginal leaking, maternal infection during labor, inadequate amniotic fluid, abnormal fetal heart sounds, labor complications, and higher rates of cesarean section compared to controls. These findings are consistent with existing literature and provide insights into potential risk factors for adverse perinatal outcomes.[12,4,24]

The mode of delivery also showed significant variation, with cesarean sections being more common in adverse outcome cases (42.5% vs. 24.7%; OR = 2.067). This finding aligns with studies indicating that C-sections are often performed in high-risk pregnancies to prevent adverse outcomes.[5,12] Conversely, labor augmentation was less common in cases (9.2% vs. 36.0%; OR = 0.404), potentially reflecting complications leading to alternative interventions such as cesarean delivery.

Contrary to our study finding, induction of labor had significant association with adverse neonatal outcome in a study by Melaku Laikemariam(2023).[3]

APGAR scores at 1 and 5 minutes were significantly lower in neonates with adverse outcomes, with moderate scores (4–6) being more prevalent among cases. These results are consistent with existing literature demonstrating that low APGAR scores are predictive of neonatal morbidity and mortality.[25,26]

CONCLUSION

This study underscores the significant influence of various factors on adverse neonatal outcomes, highlighting low birth weight, preterm delivery, inadequate antenatal care, insufficient maternal supplementation, and deworming as key modifiable risks. Twin pregnancies and delayed referrals further compounded neonatal risks, emphasizing the need for targeted interventions and timely healthcare access. While protective trends were noted for multiparity, and maternal age showed no significant associations, these findings likely reflect effective healthcare and population-specific dynamics.

RECOMMENDATIONS

The findings of this study underscore the importance of addressing modifiable risk factors to reduce adverse neonatal outcomes. Key areas for intervention include promoting regular antenatal care, ensuring adequate maternal supplementation and deworming, and strengthening referral systems to provide timely and effective care. Future research with diverse populations is needed to validate these findings and inform strategies for reducing neonatal morbidity and mortality.

LIMITATIONS OF THE STUDY

This study has some limitations. Although the sample size for this case-control study was adequate to identify significant associations for many primary variables, it may have been insufficient for subgroup analyses and rare exposures. This is evident in the wide confidence intervals and the lack of statistical significance for certain predictors, such as past pregnancy complications and multiparity, despite supportive trends from previous studies. While the sample size met the study's main objectives, larger cohorts may be required to validate these findings and assess associations with less common factors. The study's homogeneity, including uniform healthcare access and cultural practices, could limit the applicability of results to more diverse populations. Recall bias may have occurred due to the reliance on participants' memory of pregnancy history, particularly for antenatal care and supplementation data. Furthermore, unmeasured confounders, such as genetic factors or environmental conditions, might have influenced neonatal outcomes but were not considered in the analysis.

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