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Newborn morbidities and care procedures at the special newborn care units of Gandaki Province, Nepal: a retrospective study

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Abstract

Background Despite recent improvements in the overall health status of Nepal's population, newborn morbidities and mortalities have remained a challenge. This study explores the situation and care strategies for newborn health problems in the Gandaki Province of Nepal.

Methods This is a retrospective hospital records analysis. A structured questionnaire was employed to collect data on socio-demographic, clinical, and outcome variables in 1,355 newborns admitted to the Special Newborn Care Unit (SNCU) between May 1, 2021, and April 30, 2022, in five hospitals within the Gandaki Province.

Results Among all newborns, 60% were male, and 40% belonged to Janajati indigenous families. The mean age of mothers at the time of delivery was 24.4 years; the average birth weight of babies was 2.8 kg; and the gestational week was 38 weeks. Around 96% of births occurred in healthcare facilities. The average inpatient hospital stay was 4.7 days. The reasons for SNCU admission were newborn sepsis (51%), neonatal hyperbilirubinemia (23%), respiratory distress syndrome (18%), and low birth weight (11%). Approximately 7% of the newborns were found to have died due to various causes, including sepsis, asphyxia, and indirect medical reasons. Female newborns had a 0.45-times (CI: 0.23–0.84) lower risk of mortality compared to male newborns. Underweight newborns had 8.8 times (CI: 4.5–17.2) higher risk of death than newborns with a normal birth weight, even after adjusting for other factors like sex, delivery site, mode of delivery, mother's age, respiratory distress syndrome, neonatal hyperbilirubinemia, neonatal sepsis, and age at admission to SNCU. The most common treatments included injectable antibiotics (73%), intravenous fluids (53%), oxygen delivery (39%), and phototherapy (36%), while 3% received "Kangaroo Mother Care (KMC)".

Conclusions The study showed that newborns suffered from multiple health complications such as sepsis, hyperbilirubinemia, or asphyxia, and many newborns received essential medical services from hospitals. Birth weight, sex of the newborn, and respiratory distress syndrome were significantly associated with neonatal mortality. Hospitals should focus on reinforcing KMC, neonatal resuscitation, and early infection control measures.

Keywords Morbidity, Mortality, Newborn, Newborn intensive care, SNCU

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Introduction

Nepal has made remarkable strides in child health over the past two decades, witnessing a significant reduction in child mortality rates. However, despite these advancements, newborn mortality remains alarmingly high, showing slight improvement in recent years [1]. In fact, newborn mortality accounts for a substantial portion, 57%, of under-five child deaths in Nepal, translating to approximately 13,000 newborn deaths annually [2].

The latest Demographic and Health Survey of Nepal revealed that the Newborn Mortality Rate in Gandaki Province stands at eight deaths per 1,000 live births, which is lower than the national average of sixteen deaths per 1,000 live births [1]. Nonetheless, studies conducted in Gandaki Province have highlighted perinatal death [3, 4] and respiratory illnesses as major concerns, leading to frequent hospital admissions [5].

Efforts to address these challenges are ongoing, with Nepal's public health system expanding newborn care initiatives such as Kangaroo Mother Care (KMC), skilled birth attendance, and early breastfeeding initiation, alongside improvements in Special Newborn Care Unit (SNCU) in district hospitals and Newborn Intensive Care Units within tertiary hospitals are being made [6, 7]. The Safe Motherhood Program aims to enhance maternal and newborn health through initiatives like free-of-cost ill newborn care packages and standardized procedures across health facilities [4, 6].

Despite these efforts, gaps persist in ensuring quality maternal and newborn services, particularly in primary healthcare settings in the province [8]. Developing a continuum of care strategy that utilizes up-to-date health service professional learning resources can enhance the scope and capacity of healthcare workers [9].

The province has set ambitious targets to reduce newborn deaths to 12 per 1,000 live births by 2030 [10]. Essential infant care services, such as those offered by SNCUs in district, provincial, and federal hospitals have given priority to accomplish this goal [11]. Key focus areas include maternal and newborn health, mental health, and nutrition for mothers and newborns, alongside evidence-based interventions to address perinatal death and respiratory illnesses [12].

Despite significant national initiatives, there remains a lack of comprehensive data at the provincial level. Therefore, this research aims to assess the status of newborn health and evaluate care procedures for infants admitted to SNCUs in hospitals across Gandaki Province. By examining the effectiveness of existing interventions and identifying areas for improvement, the study seeks to contribute to the ongoing efforts to reduce newborn mortality and improve the quality of newborn care in the province.

Methods

This is a retrospective study using data from hospital records in five of the twelve government hospitals with SNCUs in the province of Gandaki.

Population and sample

All newborns admitted to the SNCUs of five government hospitals in the Gandaki Province between May 1, 2021, and April 30, 2022, constitute the study population.

Study setting and context

Gandaki Province, one of Nepal's seven provinces, has a population of more than 2.4 million. Situated amidst diverse landscapes, the province encompasses a wide range of altitudes, spanning from lowland plains to the towering peaks of the Annapurna, Manaslu, and Dhaulagiri Mountain ranges.

The province has eleven districts, eighty-five municipalities (including one metropolitan city and twenty-six municipalities), and fifty-eight rural municipalities. Its health system comprises 480 health posts, 104 urban health centers, 167 community health units, 208 basic health centers, twenty public hospitals, thirty-eight basic hospitals, twenty primary health care centers, and 104 non-public health facilities (see Fig. 1).

Gandaki Province is home to many ethnic communities, including Gurung, Magar, Brahmin, Chhetri, Thakali, Tamang, and others, each with its unique language, history, and traditions. Most of the population comprises Brahmin, Chettri, and Janajati (Magar and Gurung) caste groups. According to the Economic Survey 2020/21 conducted by the Ministry of Finance of Nepal, the per capita income in Gandaki Province stood at USD 1,492, ranking it as the second highest among Nepal's seven provinces. However, poverty persists particularly in rural areas [13].

Data collection tools and variables

Researchers used a structured closed-ended questionnaire developed in alignment with objectives and informed by literature review. SNCU registers track vital information on newborns needing specialized care, aiding in monitoring their progress and treatment outcomes. They record essential information such as sociodemographic details on newborns, clinical assessments, treatments administered, and discharge summaries. Records of SNCU admission were extracted from the SNCU registers of all five hospitals. The researchers, with the help of a research assistant, entered data in a data collection tool developed in excel sheets. The following variables were retrieved from these records:

- **Socio-demographic variables**: district of residence, maternal age, age at admission, sex, birth weight,

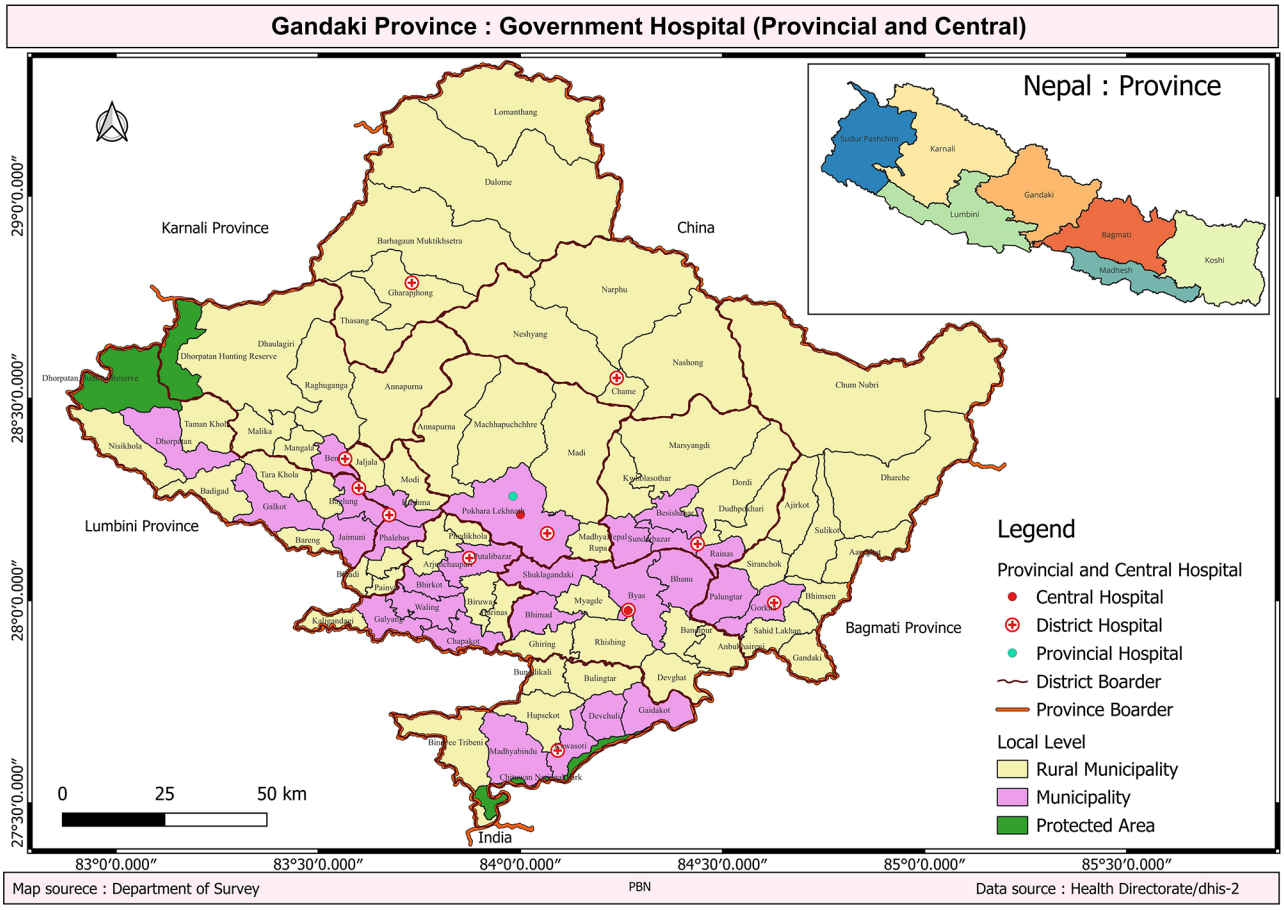

Fig. 1 Map of Gandaki province showing location of hospitals by district

ethnicity, gestational week, mode, place, and site of delivery.

- **Clinical management-related variables**: KMC, administration of oxygen, injectable antibiotics, management of shock, intravenous fluids, management of hypoglycemia, phototherapy use, seizure management, continuous positive airway pressure ventilation and blood transfusion variables were under this category.
- **Outcome variables**: newborn sepsis, newborn hyperbilirubinemia, respiratory distress syndrome, low birth weight, pre-term delivery, meconium aspiration with respiratory symptoms, transient tachypnea of newborn, newborn hypoglycemia, hypoxic-ischemic encephalopathy, dehydration of newborn, congenital pneumonia, premature rupture of membrane, newborn meningitis, rhesus factor incompatibility, intrauterine growth restriction, hypothermia of newborn, newborn seizure, newborn shock, pulmonary atresia.

The protocol for admission of the neonates into SNCUs states that newborns requiring medical management, ranging from observation to assisted ventilation, are admitted based on the clinical judgment of trained pediatricians. Operational definition of key terms used are given below:

- **Meconium aspiration syndrome (MAS)**: Breathing problems that a newborn baby may have when there are no other causes, and the baby has passed meconium (stool) into the amniotic fluid during labor or delivery.
- **Respiratory Distress Syndrome (RDS)**: Neonate with cyanosis, tachypnoea, (>60/min, shallow, rapid), grunting, retraction (Subcostal, sub-sternal, intercostal), flaring, reduced air entry.
- **Newborn Sepsis**: Sepsis cases were identified using clinical signs. Newborn sepsis is not confirmed by blood cultures but based on clinical signs such as feeding difficulties, temperature instability, tachycardia, irritability or lethargy, tachypnea, difficulty breathing, jaundice, pneumonia, meningitis or positive septic screening test.

– **Neonatal hyperbilirubinemia**: TSB level ≥ 17 mg/dL at any time during the first to second week of life (for term infants) or

TSB level ≥ 12 mg/dL at any time during the first to second week of life (for preterm infants) or
TSB > 5 mg/dL within the first 24 h of life.

Data collection and analysis

The tools were field tested, and data were collected by trained persons from all hospitals. To ensure accuracy and completeness, daily oversight of the record review procedure done by research assistant was carried out by authors. The study includes the records of all newborns admitted to the SNCUs in selected hospitals.

Data was entered using Microsoft Excel 365 from August to October 2022 and analyzed using R version 4.3.1 and Stata 18 software. Bivariate and multivariate logistic regression models were created to assess the relationships, whereas means and proportions were used for descriptive analysis.

Ethical approval

The Nepal Health Research Council granted ethical permission (253–2022), the study also received approval from LMU ethics committee (23–0488), and Institutional Review Committee of Pokhara Academy of Health Science (118/079) and all hospitals provided written authorization for data retrieval.

Results

Background characteristics

Out of all the infants, 61% were males, 40% came from Indigenous Janajati ethnic groups, 31% were from Brahmin/Chhetri caste groups, and 26% were from Dalit caste groups. The mean age of mothers was 24.4 years (±5 SD), the mean gestational age was 38 weeks (±3 SD), and the mean birth weight was 2.8 kg (±0.8 SD).

Out of 1,355 cases admitted in SNCU, 999 cases (73.7%) were from western regional hospital, followed by Matri Sishu Miteri Hospital with 188 cases (13.9%). However, there were no cases from the Manang district, while forty-seven cases (3.5%) were from other districts outside of Gandaki Province.

The most common (45%) age group for mothers giving birth was 20–25 years. Around 15% were minors (below 20 years) as per Nepali legislation. Male babies accounted for 810 (60.7%). The majority, 991 (73.1%), had birth weights of more than 2,500 g, and 364 (26.9%) had birth weights below 2,500 g. Among the cases admitted to SNCU, the majority 1,297 (97.2%) newborns were born in health institutions, while 32 (2.4%) were born at home and 5 (0.4%) were born on route to the hospital, either on the road or in a vehicle (see Table 1).

The trend of cases by months

The figure shows a monthly trend of newborn admissions at SNCUs over a period of one year (1 May 2021 to 30 April 2022). The overall trend indicates a consistent number of cases over one year, with a slight drop in the month of November and slightly higher case numbers in July (see Fig. 2).

Reasons for admission to SNCU

Conditions related to newborn infections (51%), newborn jaundice (23%), RDS (18%), and low birth weight (11%) were the major reasons for SNCU admission (see Table 2).

Clinical management upon admission

The most common therapies were injectable antibiotics (73%) followed by intravenous fluids (53%) giving oxygen (39%), and phototherapy (36%). Only 3% of patients got KMC (see Table 3).

Inpatient profile

The average hospital stay was 4.7 (±5.1 SD) days. Regarding the length of stay, 459 (33.8%) of the newborns stayed for four to six days, followed by 377 (27.8%) staying for 2–3 days, 234 (17.2%) for 7 or more days, and the remaining 285 (21.1%) stayed for less than 24 h. Out of total, 1190 (87.6%) newborns discharged after improvement, 16 (1.2%) left against medical advice, 39 (2.9%) babies referred to specialized hospitals, and there were 95 (7%) deaths.

The risk factors for newborn death

The odd of a newborn dying was lower in females than in males. Compared to babies born with normal birth weight, babies born low birth weight had a higher risk of dying. Similarly, newborns referred from the maternity ward had a lower odd of newborn death. The risk of dying was also higher in infants with RDS. Additionally, newborns admitted between 25 and 72 h after birth had higher odds of dying compared to those admitted within 24 h, but it is statistically insignificant (see Table 4).

The risk factors for newborn morbidities

Newborns who were born after cesarian section had higher odds of NH. The newborns referred from emergency wards had higher odds of NH compared to referral from maternity or operation theater. The newborns that were born with low birth weight had lower odds of NH compared to normal weight newborns. The newborns admitted to SNCUs after 24 h of birth had higher odds of suffering from sepsis, and NH compared to those

Table 1 Background characteristics of cases

Characteristics	Frequency	Percentage
Institutions (*n* = 1,355)		
Western Regional Hospital	999	73.7
Dhaulagiri Hospital	145	10.7
Jomsom District Hospital	5	0.4
Damauli District Hospital	18	1.3
Matri Sishu Miteri Hospital	188	13.9
Districts of Residence (*n* = 1,355)		
Gorkha	20	1.5
Manang	0	0
Mustang	6	0.5
Myagdi	39	2.9
Kaski	597	44.1
Lamjung	52	3.8
Tanahu	228	16.8
Nawalparasi East	8	0.6
Syangja	113	8.3
Parbat	80	5.9
Baglung	165	12.2
Other districts	47	3.5
Maternal Age (*n* = 1,078[€])	Mean (SD): 24.4 (± 5)	
15–19	158	14.8
20–25	484	44.9
26–35	425	39.4
36–45	10	0.9
Sex (*n* = 1,334[€])		
Male	810	60.7
Female	524	39.3
Birth Weight (*n* = 1,310[€])	Mean (SD): 2.8 (± 0.8)	
Equal or above 2,500 g	959	73.2
Below 2,500 g	351	26.8
Caste (*n* = 998[€])		
Brahmin/Chhetri	310	31.1
Dalit	259	26.0
Janajati	405	40.6
Madhesi	9	0.9
Muslim	15	1.5
Gestational Weeks (*n* = 550[€])	Mean (SD): 38 (± 3)	
>=37	401	72.9
34–37	103	18.7
< 34	46	8.4
Place of delivery (*n* = 1334[€])		
Home	32	2.4
Institution	1,297	97.2
On the way	5	0.4
Site of delivery (*n* = 1334[€])		
Born in same SNCU facility	1,164	87.3
Born in other facility	170	12.7

[€] Responses are different because of missing data in the SNCU registers

admitted within 24 h. Similarly, the newborns referred from emergency department had higher odds of having sepsis compared to those referred from outpatient department. The newborns born with low birth weight had higher odds of experiencing RDS compared to those with normal birth weight newborns. The newborns admitted between 1 and 3 days had lower odds of experiencing RDS compared to those admitted within 24 h (see Table 5).

Discussion

This study examines newborn morbidities and care strategies at SNCU in Gandaki Province of Nepal. The study underscores newborn infections as the primary cause of admissions to the SNCU, followed by newborn hyperbilirubinemia, respiratory distress syndrome. Newborn mortality rates correlated with factors like sex and birth weight. Female newborns had lower mortality risk, while underweight newborns faced significantly higher mortality rates. Treatment comprised administration of antibiotics and oxygen, with limited use of KMC.

The findings on the average hospital stay, discharge rate, and primary reasons for admission provide valuable insights into the current state of newborn care in Gandaki province. Additionally, it underscores the significant burden of newborn infections, such as sepsis, as a leading cause of admissions to the SNCU in Gandaki province, Nepal, which resonates with similar studies conducted globally [14]. Improving antenatal care and promoting safe delivery practices are crucial interventions to prevent newborn infections and reduce morbidity and mortality rates [3, 15]. Additionally, promoting breastfeeding and hygiene practices, along with enhancing hospital resources, are essential measures to ensure the provision of quality care to newborns [3, 15, 16].

NH emerges as significant contributor to SNCU admissions, with factors such as blood group incompatibility, infection, liver problems, and premature birth as most important etiological factors [17], with cesarean section delivery and referral from emergency wards as potential risk factors. This highlights the need for heightened monitoring and early intervention strategies for these newborns. Remarkably, low birth weight newborns had lower odds of NH, a finding that warrants further investigation to understand probable protective factors. Reduced skin-to-skin contact increased cold exposure, and fetal issues requiring referrals may heighten the risk of NH in cesarean-born babies in Gandaki province [18]. Moreover, these newborns are at higher risk of developing conditions such as high bilirubin levels and RDS, further underscoring the importance of timely interventions and specialized care [5, 19, 20].

LBW emerges as another significant factor contributing to SNCU admissions in Gandaki province, mirroring global trends [21]. Multiple factors, including maternal malnutrition, infection, smoking, and premature birth, contributed to LBW [22]. Research indicated a high prevalence of LBW among newborns admitted to

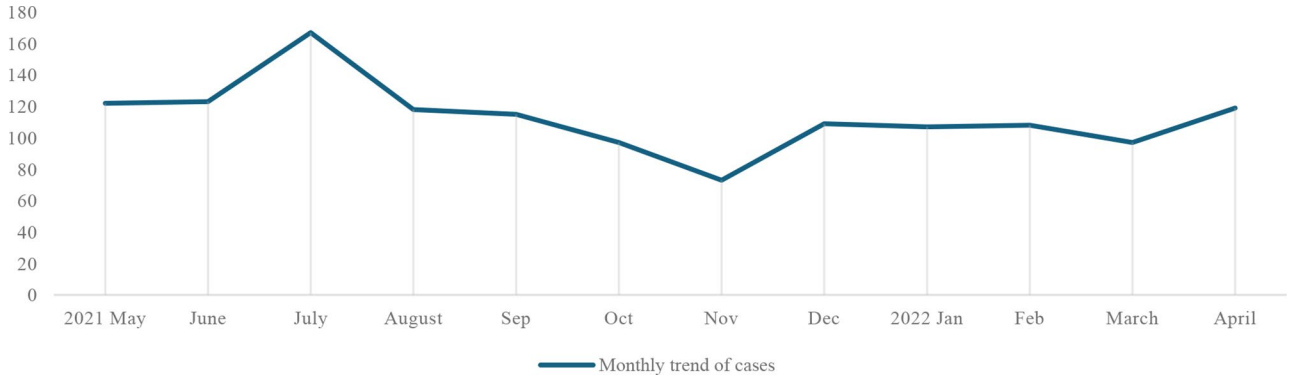

Fig. 2 Monthly trend of cases

Table 2 Reasons for admission ($n = 1,355$)

SN	Reasons of admission	Number (*n*)	Percentage[€]
1	Newborn Sepsis (NS) [P36]	687	50.7
2	Newborn Hyperbilirubinemia (NH) [P59.9]	305	22.5
3	Respiratory Distress Syndrome (RDS) [P 22.0]	246	18.2
4	Low Birth Weight (LBW) [P07.1]	143	10.6
5	Pre-Term (PT) [P07.2]	135	10.0
6	Meconium Aspiration with respiratory Symptoms (MAS) [P24.01]	99	7.3
7	Transient Tachypnea of Newborn (TTN) [P22.1]	30	2.2
8	Newborn Hypoglycemia [P70.4]	27	2.0
9	Hypoxic-Ischemic Encephalopathy (HIE) [P9160]	25	1.9
10	Dehydration of newborn [P74. 1]	25	1.9
11	Congenital pneumonia [P23]	23	1.7
12	Premature Rupture of Membranes (PROM) [01.1]	22	1.6
13	Newborn Meningitis [KA65. 4]	21	1.6
14	RH Incompatibility [Z31. 82]	20	1.5
15	Intrauterine Growth Restriction (IUGR) [P05.9]	17	1.3
16	Hypothermia of newborn [P80.9]	14	1.0
17	Newborn seizure [P90]	13	0.9
18	Newborn shock [P91.0]	12	0.8
19	Congenital heart disease [P09.5]	10	0.7
20	Other	179	13.2

[€]Multiple responses and codes inside [] are International Classification of Diseases (ICD) -10 codes

Table 3 Health care procedures administered ($n = 1,355$)

Procedures	Number	Percentage
Injectable antibiotics	985	72.9
Intravenous fluids	711	52.5
Administration of oxygen	525	38.8
Phototherapy use	488	36.2
Continuous positive airway pressure ventilation	200	14.8
Management of hypoglycemia	104	7.7
Seizure management	79	5.8
Management of shock	49	3.8
KMC	38	3
Blood transfusion	25	1.9

the newborn intensive care unit, with associated risks of mortality and morbidity [23]. Additionally, LBW emerges as a risk factor for RDS, emphasizing the vulnerability of these infants and the necessity for specialized care and preventive measures. Early admission to SNCUs within 1 to 3 days may mitigate the severity of RDS, highlighting the importance of early intervention. RDS in infants is strongly associated with LBW [24]. LBW newborns require specialist care and should be admitted to SNCUs within 1 to 3 days to effectively manage RDS [25]. RDS is a significant problem that occurs in babies born prematurely and is a major contributor to early death in newborns [26]. The correlation between LBW and RDS emphasizes the necessity for therapies aimed at enhancing fetal vitality and decreasing the occurrence and severity of RDS [25].

This study found that newborn mortality rates are higher among LBW babies and male newborns are at greater risk and evidence also support these facts [2, 27]. Studies have identified extremely low birth weight

Table 4 Association between risk factors and newborn death

Variables	Label	†AOR	95% CI
Sex	Male		
	Female	0.43*	0.22–0.83
Mode of delivery	Vaginal delivery		
	Cesarian section	0.42	0.16–1.10
Place of delivery	In other facilities		
	In same SNCU facilities	2.33	0.25–21.69
Birth weight	Normal		
	Low birth weight	6.50*	3.31–12.75
Age of mother	20 to 35 years		
	< 20 and > 35 years	1.20	0.63–2.29
Age of newborn at admission	Within 24 h		
	25 to 72 h	1.60	0.70–3.65
	4 to 30 days	0.62	0.20–1.94
Caste	Brahmin and Chettri		
	Dalits	1.07	0.47–2.42
	Janajati	1.27	0.61–2.62
Referred from	Emergency department		
	Maternity ward	0.27*	0.10–0.74
	Outpatient Department	0.29	0.05–1.56
	Operational Theatre	0.41	0.09–1.78
NS	No sepsis		
	Sepsis	0.62	0.33–1.18
RDS	No		
	Yes	4.25*	2.19–8.23
NH	No		
	Yes	0.34	0.09–1.32
Meconium Aspiration with respiratory Symptoms	No		
	Yes	0.93	0.29–3.02

†AOR = Adjusted Odds Ratio *: $p < 0.05$

and mechanical ventilation as significant predictors of death in newborn sepsis [28–31]. They are particularly vulnerable to infections, including late-onset sepsis, as evidenced by studies conducted in Germany and Brazil [32, 33]. Studies found that the survival rates of newborns admitted to the SNCU are influenced by several factors, including the quality of care provided, the availability of antibiotics, and the presence of co-existing conditions [28–31, 34–36]. While studies suggested disparities in survival rates between low-income and high-income countries [36, 37]. These findings emphasize the importance of strengthening healthcare systems and resources to improve newborn survival rates, especially in low-resource settings like Gandaki province, Nepal [38].

The wider use of injectable antibiotics, intravenous fluids, oxygen therapy, and phototherapy reflects current treatment strategies. High use of antibiotics might be because of prescription based on standing orders as prophylactic means to tackle conditions like unforeseen maternal genital tract infections, pre-labor rupture of membrane, eminent invasive procedures, community or hospital-acquired infections iatrogenic infections. A study by Karmila et al. have emphasized the necessity of administering prophylactic antibiotics to prioritize the well-being of mothers and infants, especially in low- and middle-income countries [39]. Preventive antibiotics play a crucial role in various medical procedures [40], as well as in surgical settings where adhering to established guidelines reduces the likelihood of infection [41, 42]. Nonetheless, it is crucial that antibiotics serve as a supplement to, rather than a substitute for, infection prevention and control methods [43].

While the low utilization of KMC suggests a need for increased awareness and adoption of this beneficial practice. Evidence found KMC as a powerful intervention for improving newborn health outcomes, particularly for preterm and LBW infants [44]. Despite its proven effectiveness, KMC remains underutilized in Gandaki province, with only a small percentage of newborns receiving it [45]. Scaling up KMC services is imperative and requires concerted efforts to raise awareness and address cultural and social barriers [46, 47].

The demographic data, indicating many male babies and a significant proportion from Indigenous Janajati ethnic groups, should guide targeted interventions and healthcare planning to address the specific needs of these populations. The study highlights the significant impact of contextual factors on newborn outcomes, including birth weight, maternal age, and delivery mode [48, 49], and the importance of specialized maternal care services [50]. Different outcomes by referral source shown by the data however, further research would explore variations in newborn outcomes by referral source and healthcare setting [51, 52] because of differing composition of patients.

Limitations

It is important to acknowledge the limitations of this study, which may impact the generalizability of the findings. The study focused solely on newborns admitted to government hospitals, excluding those treated in private health institutions. Additionally, because of the specialty center, newborns included in the study were high in number from the Pokhara Academy of Health Sciences, limiting the representation of other healthcare facilities in the province. In addition, we cannot fully highlight the potentially differing patient group compositions across the different referring departments. Additionally, this study is limited to the profile of newborns after admission to the SNCUs and could not capture profile of the health status of mother, which may have contributed to effects of confounding. Moreover, the value of microbial culture data was important in diagnosis, but the microbiology data was complex and will be part of a separate analysis and publication. Future research should aim to include a

Table 5 Association between risk factors and newborn morbidities

Variables	Labels	NH		Sepsis		RDS	
		†AOR	95% CI	†AOR	95% CI	†AOR	95% CI
Sex	Male						
	Female	1.10	0.66–1.81	0.80	0.57–1.12	0.84	0.55–1.27
Mode of delivery	Vaginal delivery						
	Caesarian section	2.13*	1.24–3.66	1.21	0.81–1.83	0.60	0.34–1.08
In born, out born	Other facilities						
	SNCU facilities	1.65	0.39–7.02	0.56	0.16–1.91	2.56	0.30–22.12
Birth weight	Normal						
	Underweight	0.44*	0.24–0.82	0.80	0.56–1.14	1.59*	1.05–2.42
Age of mother	< 20 and > 35 yrs.						
	20–35 yrs.	1.20	0.71–2.03	1.24	0.88–1.73	1.33	0.87–2.04
Age at admission	24 h						
	25 to 72 h	7.75*	3.64–16.52	1.67*	1.05–2.63	0.32*	0.17–0.59
	4 to 30 days	17.40*	7.96–38.01	0.76	0.46–1.24	0.15*	0.06–0.37
Caste	Brahmin & Chettri						
	Dalits	1.54	0.80–2.97	1.16	0.76–1.79	0.99	0.58–1.66
	Janajati	1.41	0.80–2.49	1.26	0.87–1.84	0.87	0.55–1.40
Referred from	Emergency department						
	Maternity ward	0.34*	0.16–0.72	0.68	0.40–1.18	1.93	0.91–4.09
	Outpatient department	1.90	0.94–3.81	0.27*	0.14–0.53	-	-
	Operation theater	0.21*	0.05–0.82	0.78	0.36–1.68	2.10	0.78–5.65
Observations		657		657		580	

†AOR: Adjusted Odds Ratio, *: p<0.05, -: missing value

more diverse sample of newborns from various healthcare settings to provide a comprehensive understanding of newborn health outcomes in Gandaki province.

Conclusions

The study concludes that newborn infections are the primary cause of SNCU admissions, with mortality rates linked to factors like sex and birth weight, while treatment involves antibiotics and oxygen; however, KMC as a low-resource intervention was less frequently observed, indicating a potential need for raising awareness among staff for KMC. To address these issues, stakeholders should use a comprehensive approach. This includes enhancing maternal and newborn healthcare services, promoting evidence-based practices such as strengthening of sanitation and hygiene practices and KMC. Collaboration among stakeholders is crucial to prioritize these interventions, leading to improved newborn health outcomes in the province.

Abbreviations

AOR Adjusted Odds Ratio
KMC Kangaroo Mother Care
LBW Low Birth Weight
NH Newborn Hyperbilirubinemia
NS Newborn Sepsis
RDS Respiratory Distress Syndrome
SNCU Special Newborn Care Unit

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Author contributions

K.B.K., N.K., O.I., R.C.B., D. S., and K. R. conceptualized and conducted the study, performed statistical analysis, and wrote the manuscript. V.G., R.P.A., B.B., D.P., and G.F. provided input during the study design and reviewed and edited the manuscript. All authors read and approved the final manuscript.

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Data availability

The corresponding author can provide the data confirming the findings of the research upon reasonable request, but they are not publicly available for sensitivity reasons. The Health Directorate, Gandaki Province of Nepal keeps the data in controlled access storage.

Declarations

Ethics approval and consent to participate

The study obtained ethical approval from the Nepal Health Research Council in 2022 (253–2022) and by the Ludwig-Maximilians-Universität (LMU Munich) Ethics Commission, Munich, Germany in 2023 (23–0488). Informed written consent was received from each legal guardian prior to admission by the individual hospitals, but it was not relevant to this study because it assessed hospital data retrospectively.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Ministry of Health and Population [Nepal], New ERA. ICF: Nepal Demographic and Health Survey 2022. In. Kathmandu. Nepal: Ministry of Health and Population [Nepal]; 2023.
2. Central Bureau of Statistics: Nepal Multiple Indicator Cluster Survey 2019, Survey Findings Report. In, Kathmandu. Nepal; 2020.
3. Subedi N, Kandel D, Ghale T, Gurung B, Shrestha B, Paudel S, Subedi N, Kandel D, Ghale T, Gurung B et al. Causes of perinatal mortality and associated maternal factors in a tertiary referral hospital of Gandaki province of Nepal: a cross-sectional study from a hospital-based surveillance. BMC Pregnancy and Childbirth. 2022 Mar 24;22(1):1-8.
4. Family Welfare Division. Nepal Safe Motherhood and Newborn Health Road Map 2030. In. Kathmandu, Nepal: Ministry of Health and Population; 2019.
5. Bastola R, Shrestha Sk, Sigdel B, Poudel D, Ghimire S, Ghimire A, Khadka KB, Basnet A. Demographic Profile and Outcome of Pediatric Intensive Care Unit. J Nepal Health Res Council. 2023 Dec 13;21(02):201-6.
6. Family Welfare Division. National Medical Standard for Maternal and Newborn Care Volume III: Maternal and Newborn Care. Kathmandu, Nepal; 2022.
7. Jhpiego. Promoting Kangaroo Mother Care in Selected Hospitals of Nepal through the Training and Provision of a Baby Wrap. Baltimore, MD 21231-3492, USA; 2016.
8. Raman Singh D, Kumar Upadhyaya M, Sundar Budhathoki S, Gurung A, Målqvist M. Quality of Care for Maternal and Newborn Health in Health Facilities in Nepal. Matern Child Health J. 2020;24(1):24.
9. Marchant T, Tilley-Gyado RD, Tessema T, Singh K, Gautham M, Umar N, Berhanu D, Cousens S, Armstrong Schellenberg JRM. Adding Content to Contacts: Measurement of High Quality Contacts for Maternal and Newborn Health in Ethiopia, North East Nigeria, and Uttar Pradesh, India. PLoS One. 2015;10(5):e0126840.
10. Government of Nepal National Planning Commission. Nepal's Sustainable Development Goals Status and Roadmap: 2016-2030. Singha Durbar, Kathmandu, Nepal; December 2017;45
11. Pokhrel RP, Bhurtel R. Discharge Against Medical Advice from NICU in a Tertiary Hospital of Central Nepal: A Descriptive Cross-Sectional Study. Pediatr Health Med Ther. 2020;11:307-11.
12. Qiao J, Wang Y, Li X, Jiang F, Zhang Y, Ma J, Song Y, Ma J, Fu W, Pang R, et al. A Lancet Commission on 70 Years of Women's Reproductive, Maternal, Newborn, Child, and Adolescent Health in China. Lancet. 2021;397(10271):1715-47.
13. Ministry of Finance. Economic Survey 2020-21. Kathmandu, Nepal: Government of Nepal, Ministry of Finance; 2020/2021.
14. Zaidi AK, Huskins WC, Thaver D, Bhutta ZA, Abbas Z, Goldmann DA. Hospital-acquired neonatal infections in developing countries. Lancet. 2005 Mar 26;365(9465):1175-88.
15. Paudel PG, Sunny AK, Gurung R, Gurung A, Malla H, Budhathoki SS, Paudel P, KC N, KC A. Prevalence, risk factors and consequences of newborns born small for gestational age: a multisite study in Nepal. BMJ Paediatr Open. 2020 Mar 1;4(1):e000758.
16. Manandhar S, Amatya P, Ansari I, Joshi N, Maharjan N, Dongol S, Basnyat B, Dixit SM, Baker S, Karkey A. Risk factors for the development of neonatal sepsis in a neonatal intensive care unit of a tertiary care hospital of Nepal. BMC Infect Dis. 2021 Jul 30;21(1):546.
17. Annisa P, Astuti AW, Sharma S. Neonatal Jaundice Causal Factors: A Literature Review. Women Midwives Midwifery. 2023 Feb 27;3(1):1-10.
18. Tefera M, Assefa N, Roba KT, Gedefa L. Adverse Neonatal Outcome Are More Common Among Babies Born by Cesarean Section than Naturally Born Babies at Public Hospitals in Eastern Ethiopia: A Comparative Prospective Follow-Up Study at Eastern Ethiopia. Glob Pediatr Health. 2021;8:2333794X211018350.
19. Li Y, Zhu X, Shi Y. Non-invasive high-frequency oscillatory ventilation versus nasal continuous positive airway pressure in extremely preterm infants with respiratory distress syndrome: study protocol for a multicenter randomized controlled, superiority trial. BMJ Open. 2023 Mar 1;13(3):e068156.
20. Kr. Samanta D, Chandra S, Datta S, Datta S. Occurrence of Hyperbilirubinaemia in New-Born Babies and Its Relation to Maternal Factors. J Evol Med Dent Sci. 2017;5(98):7162-5.
21. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. Lancet Glob Health. 2019 Jul;7(7):e849-60.
22. Girma S, Fikadu T, Agdew E, Haftu D, Gedamu G, Dewana Z, Getachew B, Girma S, Fikadu T, Agdew E, et al. Factors associated with low birthweight among newborns delivered at public health facilities of Nekemte town, West Ethiopia: a case-control study. BMC Pregnancy Childbirth. 2019 Jul 2;19(1):1-7.
23. Mohamed HA, Shiferaw Z, Roble AK, Kure MA. Neonatal mortality and associated factors among neonates admitted to neonatal intensive care unit at public hospitals of Somali Regional State, Eastern Ethiopia: A multicenter retrospective analysis. PLoS One. 2022 May 10;17(5):e0268648.
24. Raha BK, Alam J, Bhuiyan AQ. Risk Factors and Clinical Profile of Respiratory Distress in Newborn: A Hospital Based Study in Bangladesh Army. Bangladesh Med J. 2021;48(3):21-7.
25. de A MB, Guinsburg R, Martinez FE, Procianoy RS, Leone CR, Marba STM, Suppo de Souza RL, Luz JH, de Andrade LM. Perinatal Factors Associated with Early Mortality in Premature Infants Born in Brazilian Neonatal Research Centers. J Pediatr. 2008;84(4):289-96.
26. Ke AB, Milad MA. Evaluation of Maternal Drug Exposure Following the Administration of Antenatal Corticosteroids During Late Pregnancy Using Physiologically-Based Pharmacokinetic Modeling. Clin Pharmacol Ther. 2019 Jul;106(1):164-73.
27. Jana A, Saha UR, Reshmi RS, Muhammad T. Relationship Between Low Birth Weight and Infant Mortality: Evidence from National Family Health Survey 2019-21, India. Arch Public Health. 2023 Feb 21;81(1):1-6.
28. Afeke I, Hirose M, Amegan-Aho KH, Haertel C, Becker M, Moustafa A, Schilf P, Badr MT, Mensah GL, Mbroh HK, et al. Neonatal and Young Infant Sepsis in a Regional Hospital in Ghana. Open J Pediatr. 2021 Apr 28;11(2):138-49.
29. Kayange N, Kamugisha E, Mwizamholya DL, Jeremiah S, Mshana SE. Predictors of Positive Blood Culture and Deaths Among Neonates with Suspected Neonatal Sepsis in a Tertiary Hospital, Mwanza, Tanzania. BMC Pediatr. 2010 Jun 4;10(1):1-6.
30. Geyt JL, Hauck S. G272 Epidemiological Trends of Neonatal Sepsis in a County Referral Hospital in Central Kenya. Arch Dis Child. 2016 Apr;101(Suppl 1):A107.
31. Nepal D, Agrawal S, Shrestha S, Rayamajhi A. Bacteriological Profile and Antibiotic Susceptibility Pattern of Neonatal Septicemia in Kanti Children Hospital, Nepal. J Gandaki Med Coll Nepal. 2020;13(2):1-5.
32. Troger B, Gopel W, Faust K, Muller T, Jorch G, Felderhoff-Muser U, Gortner L, Heitmann F, Hoehn T, Kribs A, et al. Risk for Late-Onset Blood-Culture Proven Sepsis in Very-Low-Birth Weight Infants Born Small for Gestational Age: A Large Multicenter Study from the German Neonatal Network. Pediatr Infect Dis J. 2014 Mar;33(3):238-43.
33. de Souza Rugolo LM, Bentlin MR, Mussi-Pinhata M, de Almeida MF, Lopes JM, Marba ST, Fiori HH, Procianoy RS, Leone CR. Late-Onset Sepsis in Very Low Birth Weight Infants: A Brazilian Neonatal Research Network Study. J Trop Pediatr. 2014 Dec;60(6):415-21.
34. Endazanaw A, Mulugeta T, Abebe F, Godie Y, Guadie Y, Birhanu D, Mihretu E. Treatment Outcome of Neonatal Sepsis and Associated Factors Among Neonates Admitted to Neonatal Intensive Care Unit in Public Hospitals, Addis Ababa, Ethiopia, 2021. PLoS One. 2023 May 30;18(5):e0278674.
35. Kermorvant-Duchemin E, Laborie S, Rabilloud M, Lapillonne A, Claris O. Outcome and Prognostic Factors in Neonates with Septic Shock. Pediatr Crit Care Med. 2008 Apr;9(2):186-91.
36. Oumer M, Abebaw D, Tazebew A. Time to Recovery of Neonatal Sepsis and Determinant Factors Among Neonates Admitted in Public Hospitals of Central Gondar Zone, Northwest Ethiopia, 2021. PLoS One. 2022 Jul 28;17(7):e0277198.
37. Fleischmann C, Reichert F, Cassini A, Horner R, Harder T, Markwart R, Tröndle M, Savova Y, Kissoon N, Schlattmann P, et al. Global Incidence and Mortality of

Neonatal Sepsis: A Systematic Review and Meta-Analysis. Arch Dis Child. 2021 Aug;106(8):e119.
38. KC A, Wrammert J, Clark RB, Ewald U, Vitrakoti R, Chaudhary P, Pun A, Raaijmakers H, Målqvist M. Reducing Perinatal Mortality in Nepal Using Helping Babies Breathe. Pediatrics. 2016 Jun;137(6):e20160141.
39. Karmila A, Zulkarnain M, Martadiansyah A, Mirani P, Bernolian N, Gardiner JC, Zhang L. The Prevalence and Factors Associated With Prophylactic Antibiotic Use During Delivery: A Hospital-Based Retrospective Study in Palembang, Indonesia. Antibiotics. 2021 Aug 10;10(8):1004.
40. Kumazawa T. Are Prophylactic Antibiotics Required for Combined Intracavitary and Interstitial Brachytherapy of Gynecologic Cancers? J Radiat Res. 2024;65(3):387-92.
41. Adzillina E. Evaluation of Administration Prophylactic Antibiotic Against Incidence of Surgical Site Infection in Post Appendectomy at Panembahan Senopati Hospital, Indonesia. J Medicoeticolegal Manag Rumah Sakit. 2024;13(1):1-15.
42. Johnson HC, Bailey AM, Baum RA, Justice SB, Weant KA. Compliance and Related Outcomes of Prophylactic Antibiotics in Traumatic Open Fractures. Hosp Pharm. 2019 Mar;55(3):193-98.
43. Bonet M, Ota E, Chibueze CE, Oladapo OT. Routine Antibiotic Prophylaxis After Normal Vaginal Birth for Reducing Maternal Infectious Morbidity. Cochrane Database Syst Rev. 2017 Nov 27;(11):CD012137.
44. Kangaroo Mother Care to Reduce Morbidity and Mortality in Low Birthweight Infants. Cochrane Database Syst Rev. 2016 Jan 12;(2):CD002771.
45. WHO. Kangaroo Mother Care: A Transformative Innovation in Health Care. Global Position Paper. Geneva: World Health Organization; 2023.
46. Foong WC, Foong SC, Ho JJ, Gautam D, Leong JJ, Tan PY, Baskaran M. Exploring Factors Influencing the Uptake of Kangaroo Mother Care: Key Informant Interviews with Parents. BMC Pregnancy Childbirth. 2023 Oct 3;23(1):1-9.
47. Bilal SM, Tadele H, Abebo TA, Tadesse BT, Muleta M, W/Gebriel F, Alemayehu A, Haji Y, Kassa DH, Astatkie A, et al. Barriers for Kangaroo Mother Care (KMC) Acceptance and Practices in Southern Ethiopia: A Model for Scaling Up Uptake and Adherence Using Qualitative Study. BMC Pregnancy Childbirth. 2021 Jan 7;21(1):1-9.
48. Lamichhane R, Zhao Y, Paudel S, Adewuyi EO. Factors Associated with Infant Mortality in Nepal: A Comparative Analysis of Nepal Demographic and Health Surveys (NDHS) 2006 and 2011. BMC Public Health. 2017 Jan 10;17(1):1-7.
49. Erchick DJ, Lackner JB, Mullany LC, Bhandari NN, Shedain PR, Khanal S, Dhakwa JR, Katz J. Causes and Age of Neonatal Death and Associations with Maternal and Newborn Care Characteristics in Nepal: A Verbal Autopsy Study. Arch Public Health. 2022;80(1):1-9.
50. Singh S, Doyle P, Campbell OMR, Murthy GVS. Management and Referral for High-Risk Conditions and Complications During the Antenatal Period: Knowledge, Practice, and Attitude Survey of Providers in Rural Public Healthcare in Two States of India. Reprod Health. 2019 Jul 10;16(1):1-8.
51. Biadgo A, Legesse A, Estifanos AS, Singh K, Mulissa Z, Kiflie A, Magge H, Bitewulign B, Abate M, Alemu H, et al. Quality of Maternal and Newborn Health Care in Ethiopia: A Cross-Sectional Study. BMC Health Serv Res. 2021 Jul 10;21(1):1-9.
52. Ajao AE, Adeoye IA. Prevalence, Risk Factors, and Outcome of Congenital Anomalies Among Neonatal Admissions in Ogbomosho, Nigeria. BMC Pediatr. 2019 Apr 3;19(1):1-7.

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