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Maternal and Neonatal Factors Associated with Neonatal Mortality: a Prospective Follow-up Study in Selected Hospitals of Nepal

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ABSTRACT

Background: Neonatal mortality, a sensitive indicator which indicates the availability, utilization, and effectiveness of maternal and child health services in the community, are major global public health challenges. The objective of the study was to find out the maternal and neonatal factors associated with neonatal mortality in selected hospitals of Nepal.

Methods: This was a hospital based prospective follow up study conducted among babies nested for case control study design. Among 1104 babies, 368 babies with LBW and 736 babies with normal birth weight were followed up after 28 days of birth and mortality was assessed.

Results: Neonatal mortality was about 10/1000 live birth. In multivariable logistic regression analysis, father with no formal education [AOR:12.54, 95% CI:(2.61-60.13), p=0.002], multi parity [AOR:11.26, 95% CI:(1.25-100.89), p=0.030] and depressed (<7) APGAR score at 5 minutes of birth[AOR:7.44, 95% CI:(1.18-46.80), p=0.032] were significantly associated with neonatal mortality.

Conclusions: The study identified 'father with no formal education, multi parity and low APGAR score at 5 minutes of birth' as the major contributors to neonatal mortality. Improving parental education, and access to child health care will help to improve neonatal outcome.

Keywords: Maternal factors; neonatal factors; neonatal mortality; Nepal.

INTRODUCTION

Neonatal mortality is a major global public health challenge with approximately 2.6 million babies worldwide dying each year in the neonatal period of life in 2016. Although neonatal mortality rate has reduced by 49% during 1990 to 2016, the proportion of death is highest in the neonatal period (19 deaths/1000 live-births). As overall infant and child mortality declined, the proportion of neonatal mortality among children under-five raised from 40% in 1990 to 46% in 2016.[1] However, neonatal mortality during the first 28 days of life is 14 times higher in the under-developed countries.[2] Although neonatal mortality declined from 50 to 21 deaths per 1000 live births, it has been stagnant between 2006 and 2011 as 33/1000 live birth, and between 2016 and 2022 as 21/1000 live birth.[3] According the WHO, the leading causes of neonatal deaths worldwide are premature birth and LBW, infections, asphyxia and birth trauma. [4] According to NDHS 2016, neonatal deaths are more in male (59%), rural-areas(58%), and illiterate mothers (36 deaths/1,000 live-births). The objective of the study was to find out the maternal and neonatal factors associated with neonatal mortality.

METHODS

This was a hospital based prospective follow up study conducted in two tertiary level hospital of Nepal (Koshi Zonal Hospital, Biratnagar from state 1 and Narayani

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Regional Hospital, Birgunj from state 2)during 1st April 2017 to 31st March 2018.

Mothers with term single live LBW babies were nested as case and mothers with term single live normal birth weight babies were nested as control for case control studies. The sample size for case control study design was determined using the proportion difference approach with the assumption of 95 % confidence level ($Z_{\alpha/2}$ = 1.96), 80 % power (Z_{β} = 0.84), control to case ratio 1:2 (r = 2), the odds ratio to be detected 0.18 and the25 % control group will be exposed. The final sample size was 1104 (368 cases and 736 controls).Cases were selected sequentially till the required number of cases completed. Mothers not willing to participate in the study, having preterm birth and having multiple births were excluded from the study. The weight of the newborn babies was measured within 30 min after birth using a baby weighing machine (pan type scale of Crown Company) after correcting the zero error. For one case, two controls were selected. While selecting control, sex of the babies and place of delivery were matched. Babies with LBW of case group and babies with normal birth weight of control group were followed up after 28 days to find out the pattern of mortality among LBW and NBW neonates.

The data were collected by researcher himself and health workers previously trained on interviewing using a pretested schedule. The information was collected by face-to-face interviews and by mobile phone for those unable to visit for follow up. (**Figure 1**)

Ethical approval was obtained from Institutional Ethical Committee (SHUATS), Allahabad, India on 21st March 2017 (Reg. No.: IEC/SHUATS/2017/B/53) and Nepal Health Research Council approved by '232 Ethical Review Board' on 28th December 2017 (Ref. No.: 1306, Reg. No.: 541/2017.Written Permission was taken from concerned authority of the Koshi Zonal Hospital and Narayani Regional Hospital. Written as well as verbal consent was taken from the mothers of neonates after giving information about the nature and objective of the study before taking interview.

Data was entered in Epidata version 3.1 and exported to IBM statistical package for social science (SPSS) version 16 for analysis. Bivariate analysis was done between the dependent and independent variables to determine the associations using the Pearson's chi-square test and Fisher Exact Test where expected cell was less than 5.Statistical significance was assumed at a P value of <0.05. To find out the strength of association, odds ratios was calculated using logistic regression Forward Wald model with confidence intervals at 95% level of significance.

RESULTS

Among 1104 babies (736 NBW babies and 368 LBW babies), 364 babies (227 NBW babies and 137 LBW babies) lost to follow up and 740 babies (509 NBW babies and 231 LBW babies) were followed up after 28 days. Mean weight of LBW babies was 2161.32 grams NBW babies was 2910.34 grams. Among 740 followed up babies, 7 babies died and 733 babies survived 28 days after birth.

Higher rate of neonatal death was observed among neonates belongs to madhesi ethnic group (16/1000) whereas only 3/1000 neonatal death was observed among neonates belongs to other than madhesi ethnic group.. Higher rate of neonatal death was observed among neonates belongs to rural area (12/1000) whereas only 4/1000 neonatal death was observed among neonates belongs to urban area. Higher rate of neonatal death was observed among neonates whose mother had no formal education (25/1000) whereas only 2/1000 neonatal death was observed among neonates whose mother had formal education. Higher rate of neonatal death was observed among neonates whose father had no formal education (63/1000) whereas only 4/1000 neonatal death was observed among neonates whose father had formal education. Higher rate of neonatal death was observed among neonates whose mother were working in house and outside (11/1000) whereas only 9/1000 neonatal death was observed among neonates whose mother were working in house only. Higher rate of neonatal death was observed among neonates whose father were involved in sedentary work (11/1000) whereas only 9/1000 neonatal death was observed among neonates whose father were involved in hard work. Higher rate of neonatal death was observed among neonates whose monthly household income was less than NRs 10,000 (42/1000) whereas only 8/1000 neonatal death was observed among neonates whose monthly household income was NRs 10,000 or above. Higher rate of neonatal death was observed among neonates who belong to nuclear family (12/1000) whereas only 9/1000 neonatal death was observed among neonates who belong to joint family. The difference in distribution of survival and death in relation to education of mother, education of father was found to be statistically significant (p<0.05).

Table 1. Association between neonatal mortality and demographical factors mothers and neonates.				
Characteristics	**Survive 733**	**Death 7**	**NMR**	**Test of significance Fisher Exact Chi square**
Ethinic group				
Madhesi	366 (98.4%)	6 (1.6%)	16/1000	x^2=3.551, df=1
Other than Madhesi	367 (99.7%)	1 (0.3%)	3/1000	p=0.123
Residence place				
Rural	500 (98.8%)	6 (1.2%)	12/1000	x^2=0.982, df= 1
Urban	233 (99.6%)	1 (0.4%)	4/1000	p=0.442
Education of mother				
No Formal Education	235 (97.5%)	6 (2.5%)	25/1000	**x^2=9.089, df= 1**
Formal Education	498 (99.8%)	1 (0.2%)	2/1000	**p=0.006**
Education of father				
No Formal Education	59 (93.7%)	4 (6.3%)	63/1000	**x^2=21.456, df= 1**
Formal Education	674 (99.6%)	3 (0.4%)	4/1000	**p=0.001**
Type of work of mother				
House only	461 (99.1%)	4 (0.9%)	9/1000	x^2=0.098, df= 1
House and outside	272 (98.9%)	3 (1.1%)	11/1000	p=0.715
Occupation of father				
Sedentary work	282 (98.9%)	3 (1.1%)	11/1000	x^2=0.056, df= 1
Hard work	451 (99.1%)	4 (0.9%)	9/1000	p=1.000
Monthly household income				
Less than NRs10000	23 (95.8%)	1 (4.2%)	42/1000	x^2=2.746, df= 1
NRs10000 and above	710 (99.2%)	6 (0.8%)	8/1000	p=0.207
Family type				
Nuclear	160 (98.8%)	2 (1.2%)	12/1000	x^2=0.184, df= 1
Joint	573 (99.1%)	5 (0.9%)	9/1000	p=0.651

11/1000 neonatal death was observed among neonates whose mother were of ≥20 years whereas no death was observed among neonates whose mother were of <20 years. Higher rate of neonatal death was observed among neonates whose birth-order was multi-parity (22/1000) whereas only 2/1000 neonatal death was observed among neonates whose birth-order was primi-parity. Higher rate of neonatal death was observed among neonates whose birth interval was between 1-2 years (44/1000) whereas only 11/1000 neonatal death was observed among neonates whose birth-interval was >2 years. Higher rate of neonatal death was observed among neonates whose mother had history of poor pregnancy outcome (32/1000) whereas only 8/1000 neonatal death was observed among neonates whose mother had no history of poor pregnancy outcome. Higher rate of neonatal death was observed among neonates whose mother had consumed IFA for 90 days or less (21/1000) whereas only 5/1000 neonatal death was observed among neonates whose mother had consumed IFA for >90 days. The difference in distribution of survival and death in relation to parity was found to be statistically significant (p<0.05).

Table 2. Association between neonatal mortality and maternal factors of neonates.				
Characteristics	**Survive 733**	**Death 7**	**NMR**	**Test of significance Fisher Exact Chi square**
Age of mother				
Less than 20 years	123 (100.0%)	0 (0.0%)	0/1000	x^2=1.409, df= 1
20 years and above	610 (98.9%)	7 (1.1%)	11/1000	p=0.607
Parity				
Primi parity	468 (99.8%)	1 (0.2%)	2/1000	**x^2=7.338, df= 1**
Multi parity	265 (97.8%)	6 (2.2%)	22/1000	**p=0.007**
Birth interval between last two children	**N= (271)**			
1-2 Years	86 (95.6%)	4 (4.4%)	44/1000	x^2=3.096, df= 1
More than 2 years	179 (98.9%)	2 (1.1%)	11/1000	p=0.096
History of poor pregnancy outcome				
Yes	30 (96.8%)	1 (3.2%)	32/1000	x^2=1.795, df= 1
No	703 (99.2%)	6 (0.8%)	8/1000	p=0.260
IFA consumed during pregnancy				
90 days or below	190 (97.9%)	4 (2.1%)	21/1000	x^2=3.494, df= 1
More than 90 days	543 (99.5%)	3 (0.5%)	5/1000	p=0.081
Fulel used for cooking				
Low polluting fuel only	129 (100.0%)	0 (0.0%)	0/1000	x^2=1.492, df= 1
Highly polluting fuel	604 (98.9%)	7 (1.1%)	11/1000	p=0.303
Type of house				
Kachcha	102 (97.1%)	3 (2.9%)	29/1000	x^2=4.770, df= 1
Pucca/Semi pucca	631 (99.4%)	4 (0.6%)	6/1000	p=0.063
Status of ventilation				
Well ventilated	672 (99.0%)	7 (1.0%)	10/1000	x^2=0.635, df= 1
Poor ventilated	61 (100.0%)	0 (0.0%)	0/1000	p=0. 1.000

Higher rate of neonatal death was observed among neonates whose birth weight was <2.5 kg (22/1000) whereas only 4/1000 neonatal death was observed among neonates whose birth weight was ≥2.5 kg. Higher rate of neonatal death was observed among neonates who were born in dry season (11/1000) whereas only 5/1000 neonatal death was observed among neonates who were born in wet season. Higher rate of neonatal death was observed among female neonates (11/1000) whereas only 8/1000 neonatal death was observed among male neonates. Higher rate of neonatal death was observed among neonates whose APGAR score at 5 minute of birth was depressed (52/1000) whereas only 7/1000 neonatal death was observed among neonates whose APGAR score at 5 minute of birth was normal. The difference in distribution of survival and death in relation to birth weight and APGAR score at 5 minute of birth was found to be statistically significant (p<0.05).

Table 2. Association between neonatal mortality and neonatal factors of neonates.				
Characteristics	**Survive 733**	**Death 7**	**NMR**	**Test of significance Fisher Exact Chi square**
Birth weight				
NBW	507 (99.6%)	2 (0.4%)	4/1000	**x^2=5.322, df= 1**
LBW	226 (97.8%)	5 (2.2%)	22/1000	**p=0.034**
Season				
Wet Season	185 (99.5%)	1 (0.5%)	5/1000	x^2=0.442, df= 1
Dry Season	548 (98.9%)	6 (1.1%)	11/1000	p=0.686
Sex of newborn baby				
Male	385 (99.2%)	3 (0.8%)	8/1000	x^2=0.260, df= 1
Female	348 (98.9%)	4 (1.1%)	11/1000	p=0.714
Apgar score at 5 minute of birth				
Depressed condition	37 (94.9%)	2 (5.1%)	51/1000	**x^2=7.685, df= 1**
Normal condition	696 (99.3%)	5 (0.7%)	7/1000	**p=0.048**

Bivariate logistic regression analysis found that odds of neonatal mortality was 12.71 times higher [95% CI (1.52-106.21), p=0.019] among neonates whose mother had no formal education compared to neonates whose mother had formal education. Odds of neonatal mortality was 15.23 times higher [95% CI (3.33-69.67), p<0.001] among neonates whose father had no formal education compared to neonates whose father had formal education. Odds of neonatal mortality was 10.59 times higher [95% CI (1.26-88.48), p=0.029] among neonates whose birth-order was multi-parity compared to neonates whose birth-order was primi-parity. Odds of having neonatal mortality was4.16 times higher among neonates whose birth-interval was in between 1-2 years compared to neonates whose birth-interval was >2 years but the association was statistically insignificant. Odds of neonatal mortality was 3.81 times higher among neonates whose mother had consumed IFA during pregnancy for 90 days or less compared to neonates whose mother had consumed IFA during pregnancy for >90 days but the association was statistically insignificant. Odds of neonatal mortality was 5.60 times higher [95% CI (1.08-29.12), p=0.040] among neonates whose birth weight was <2.5 kg compared to neonates whose birth weights was ≥2.5 kg. Odds of having neonatal mortality was2.02 times higher among neonates who were born in dry season compared to neonates who were born in wet season but the association was statistically insignificant (p>0.05). Odds of neonatal mortality was 7.52 times higher [95% CI (1.41-40.08), p=0.018] among neonates whose APGAR score at 5 minutes of birth was depressed compared to neonates whose APGAR score at 5 minutes of birth was normal.

Table 4. Maternal and neonatal determinants for the occurrence of neonatal mortality						
Factors	SURVIVAL AND DEATH OF NEONATES					
	UOR	95% CI	p-value	AOR	95% CI	p-value
Education of mother						
No Formal Education	12.71	1.52-106.21	**0.019**	-	-	-
Formal Education	Ref			-	-	-
Education of father				-	-	-
No Formal Education	15.23	3.33-69.67	**<0.001**	12.54	2.61-60.13	**0.002**
Formal Education	Ref			Ref		
Parity						
Primi parity	Ref			Ref		
Multi parity	10.59	1.26-88.48	**0.029**	11.26	1.25-100.89	0.030
Birth interval between last two children (271)						
1-2 Years	4.16	0.74 - 23.17	0.103	-	-	-
More than 2 years	Ref			-	-	-
IFA consumed during pregnancy						
90 days or below	3.81	0.84-17.18	0.082	-	-	-
More than 90 days	Ref			-	-	-
Birth weight						
NBW	Ref			-	-	-
LBW	5.60	1.08 - 29.12	**0.040**	-	-	-
Season						
Wet Season	Ref			-	-	-
Dry Season	2.02	0.24-16.93	0.515	-	-	-
Apgar score at 5 minute of birth						
Depressed condition	7.52	1.41- 40.08	**0.018**	7.44	1.18-46.80	**0.032**
Normal condition	Ref			Ref		

Multivariable logistic regression analysis found that neonates whose father had no formal education were 12.54 times more at risk of neonatal mortality [95% CI:(2.61-60.13), p=0.002] compared to neonates whose father had formal education. Neonates whose birth order was multi parity were 11.26 times more at risk of neonatal mortality [95% CI:(1.25-100.89), p=0.030] compared to neonates whose birth-order was primi-parity. Neonates whose APGAR score at 5 minutes of birth was depressed were 7.44 times more at risk of neonatal mortality [95% CI:(1.18-46.80), p=0.032] compared to neonates whose APGAR score at 5 minutes of birth was normal.

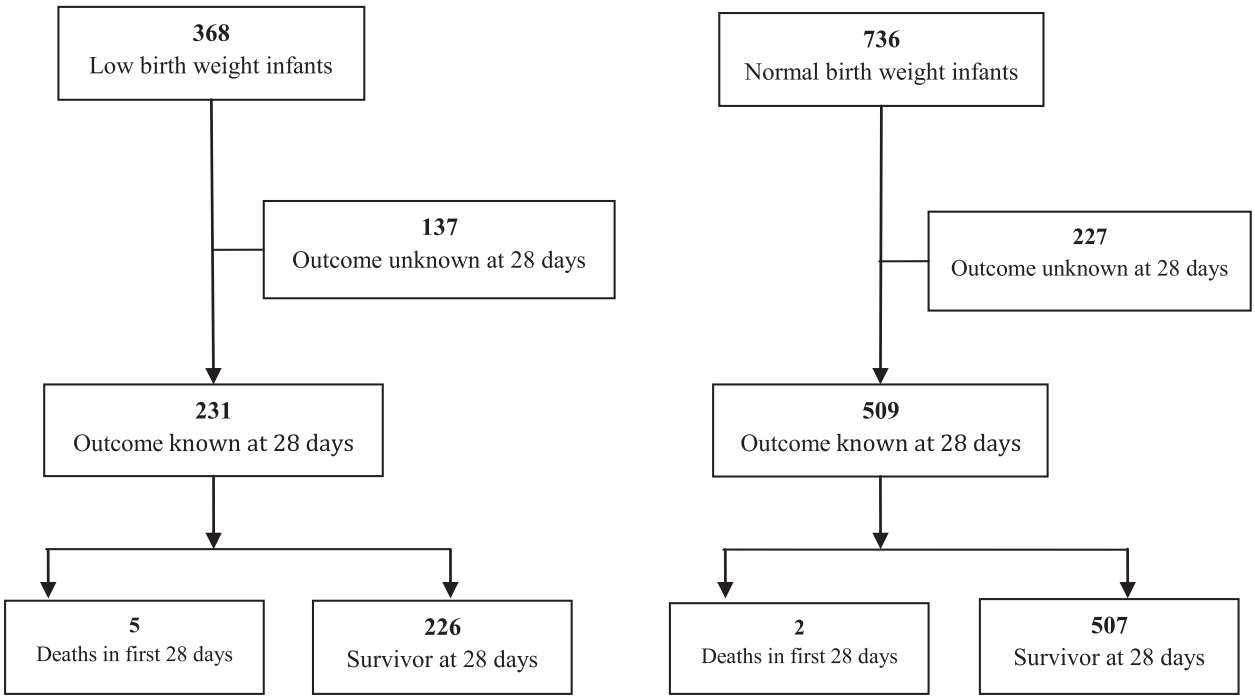

Figure 1: Progress through the study

DISCUSSION

Neonatal mortality is a sensitive indicator which indicates the availability, utilization, and effectiveness of maternal and child health services in the community. The incidence of neonatal mortality rate differs from place to place, from hospital to hospital and home born babies. According to NDHS 2016, the neonatal mortality of Nepal is 21 deaths/1,000 live-births. Childhood mortality rates have declined but the burden of neonatal deaths has increased.[5] Present study found that the neonatal mortality rate was about 10/1000 live-births. This finding is below the national level. This may be because the present study is hospital based and has excluded the babies with multiple-birth, preterm-birth and home delivery which are the strong predictor of neonatal survival.

The present study on multivariable logistic regression analysis found that neonates whose mother had no formal education were 12.71 times more at risk of neonatal mortality [95% CI (1.52-106.21), p=0.019] compared to neonates whose mother had formal education in bivariate analysis; it was not statistically significant in the multivariable forward model. This finding may be because father is the deciding person in most of the family of Nepal.

Finding in the present study on multivariable logistic regression analysis implies that neonates whose father had no formal education were 12.54 times more at risk of neonatal mortality [95% CI:(2.61-60.13), p=0.002] compared to neonates whose father had formal education. This may be because of patriarchal society where father is the deciding person in the family. This finding is supported by a study conducted in India found that a progressive reduction in the odds occurred as the level of fathers' education increased.[6] Another study conducted in Bangladesh found that parental education level was associated with NMR in bivariate analyses, but it was statistically insignificant in the final multivariable model.[7]

Finding of the present study on multivariable logistic regression analysis revealed that neonates whose birth order was multi-parity were 11.26 times more at risk of neonatal mortality [95% CI:(1.25-100.89), p=0.030] compared to neonates whose birth order was primi-parity. This finding is supported by a study conducted in Bangladesh which found that the odds of neonatal mortality were significantly higher among first born child (AOR:2.9, 95% CI:1.6-5.3).[7] Similarly a study conducted in Rwanda found that first birth-rank (cOR=2.1, 95% CI:1.1-3.9) was associated with neonatal mortality in Gitwe District Hospital [8] Another study conducted in India found that children of higher birth-order were

less likely to die compared to first birth-order.[6] On the contrary a study conducted in rural Tanzania found that neonates in second birth-order were more likely to die than those in first birth-order (aOR=1.85: 95% CI=1.52-2.26).[9]

Finding of the present study on multivariable logistic regression analysis showed that neonates whose APGAR score at 5 minutes of birth was depressed (<7) were 7.44 times more at risk of neonatal mortality [95% CI:(1.18-46.80), p=0.032] compared to neonates whose APGAR score at 5 minutes of birth was normal (≥7). This finding is consistent with the studies conducted in city of Cuiaba, capital of Mato-Grosso State which revealed that neonatal mortality was associated with APGAR score < 7 at the 5th minute (AOR=5.72,CI:2.24-14.60)[10] and APGAR score <7 at 5 minutes remained associated (OR=7.70) with neonatal death in the adjusted logistic regression.[11]Similarly a study conducted in Chile found that the presence of APGAR score at 5 minute 4-7 (OR:4; 95% CI 1.8-10.5), was the most prevalent risk factors for neonatal mortality. [12]

LBW is a major factor contributing towards high infant morbidity and mortality in developing countries. [13-15] The present study found that neonatal mortality was about 5 times higher among LBW infants weighing <2.50 kg compared to NBW infants weighing 2.50 kg or more in bivariate analysis; it was not statistically significant in the multivariable forward model which may be because of high impact of APGAR score on neonatal mortality. Evidence from the past studies has indicated that neonatal mortality is significantly associated with the birth weight of neonates. Study conducted in Orisa, India found that proportion of neonatal mortality was higher (20.5%) among male LBW babies as opposed to only 9% among female LBW babies. [16] Another study conducted in rural Gambia found that LBW babies who weighed <2500 g were 8.6 times more likely to result in an early hospital neonatal death than those babies weighing ≥2500g.[17] Similarly study conducted in Bangladesh, Ghana and Brazil found that neonatal mortality was more in LBW babies.[18-20]

CONCLUSIONS

The study aimed to identify the maternal and neonatal factors associated with neonatal mortality in selected hospital of Nepal. In multivariable logistic regression analysis, father with no formal education [AOR:12.54, 95% CI:(2.61-60.13), p=0.002], multi parity [AOR:11.26, 95% CI:(1.25-100.89), p=0.030] and depressed(<7) APGAR score at 5 minutes of birth [AOR:7.44, 95% CI:(1.18-46.80), p=0.032] were identified as significant risk factors associated with neonatal mortality. Several of these risk factors could be addressed by improving parental education, antenatal care, maternal health and nutrition, access to child health care facility as well as by providing guidance and financial support to construct better house.

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