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Determinants of Neonatal Mortality in Nepal, 2011-2016: A Comparative Analysis

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ABSTRACT

Background: Neonatal mortality refers to the risk of death within the first month of life. This study investigates the key factors influencing neonatal mortality in Nepal between 2011 and 2016, focusing on changes over this period.

Methods: Data for this research were sourced from the Nepal Demographic and Health Survey (NDHS) for the years 2011 and 2016. Neonatal mortality was the primary outcome variable. Key determinants examined included community-level factors (residence), socio-economic factors (maternal and paternal education, wealth index), maternal characteristics (age, pregnancy duration, antenatal care visits), infant characteristics (sex, birth order, birth interval, birth weight), delivery factors (assistance and location of delivery), and post-delivery factors (breastfeeding status, postnatal check-ups).

Results: Statistical analysis utilized the Chi-squared test to identify significant relationships between determinants and outcomes, alongside a full logistic model based on treatment contrasts. Findings indicated that in 2011, the significant factors included pregnancy duration, postnatal checks, antenatal visits, and having twins. By 2016, important determinants shifted to the mother's age, breastfeeding status, pregnancy duration, postnatal checks, and antenatal visits.

Conclusions: The study highlights that pregnancy duration, postnatal check-ups, and antenatal visits consistently influenced neonatal mortality across both surveys. Given the rarity of studies addressing program impacts on neonatal mortality, this research suggests conducting panel studies to better understand the slow decline of neonatal mortality in Nepal.

Keywords: Community level factors; maternal factors; neonatal mortality.

INTRODUCTION

Neonatal mortality (NM) refers to the death of a newborn within the first 28 days of life, and it remains a critical focus of the Sustainable Development Goals (SDG) for 2030. In 2022, approximately 2.3 million newborns died globally, averaging over 6,500 infants deaths daily.[1] Neonatal mortality contributes significantly to under-five mortality rates, particularly in developing regions. Nepal's neonatal mortality rates have shown a decline from 50 deaths per 1,000 live births in 1996 to 21 in 2016, yet this reduction has not matched the pace of under-five mortality rate declines. In 2011, NM accounted for 61% of under-five deaths. Despite community-based health initiatives, NM rates stagnated from 2006 to 2011 before declining again in 2016, raising concerns about meeting SDG targets.[2] This study investigates the key factors influencing neonatal mortality in Nepal between 2011 and 2016, focusing on changes over this period.

METHODS

This secondary data analysis was done from the 2011 and 2016 Nepal Demographic and Health Surveys (NDHS). Conducted every five years, the NDHS provides reliable information on fertility, family planning, child mortality, child nutrition, maternal and child health services, domestic violence, and HIV/AIDS awareness. Detailed methodologies, including sampling instruments and data management, have been previously published. In brief, the NDHS employed a multistage cluster sampling design, collecting data from a representative sample of women aged 15-49 across Nepal. The analysis focused on women who reported one record for each

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child born in the five years prior to the surveys, with 12,674 women in 2011 and 12,802 in 2016 participating. The 2016 survey shifted its focus from eco-development regions to seven provinces.

This study examines neonatal mortality as the dependent variable, with independent variables including community-level, socioeconomic, and proximate factors. Data on singleton live births was extracted from the childbirth dataset Children's Recode (KR). Analysis was performed using R software (version 4.2.2) through both bivariate and multivariate techniques. Frequencies were assessed, followed by cross-tabulations, with chi-squared tests applied for categorical variables. Odds ratios with 95% confidence intervals were calculated for significant associations ($p<0.05$). Variables showing significance at the bivariate level were analyzed further using logistic regression to control for confounding effects. Multiple logistic regression was used due to the dichotomous outcome, where 1 indicated the presence and 0 the absence of the outcome. Initial models included all determinants, sequentially removing those with p-values greater than 0.05, using treatment contrasts to evaluate changes across categorical variables.

CONCEPTUAL FRAMEWORK

This study employs a modified version of Mosley and Chen's conceptual framework, tailored to the context of Nepal (see Figure 1).[3] It identifies three levels of factors associated with neonatal mortality: community, socioeconomic, and proximal factors, which encompass maternal, neonatal, delivery, and post-delivery elements. According to the framework, neonatal mortality directly affects the predictors related to socioeconomic and community factors, which in turn exert an indirect influence. These relationships have been analyzed through multivariate methods.

RESULTS

Table 1 shows the differences in characteristics of women who had neonatal mortality and those who had not between 2011 and 2016 survey. In 2011, among 5306 total women respondents, 164 (3.09%) had neonatal mortality whereas in 2016, among 5038 total women respondents, 107 (2.12%) had neonatal mortality.

Women those who were from rural place of residence had greater neonatal mortality than women living in urban place of residence in 2011 (3.3%) and 2016 (2.6%). Similarly, in both surveys, women whose wealth index was in poorest quintile had greater neonatal mortality.

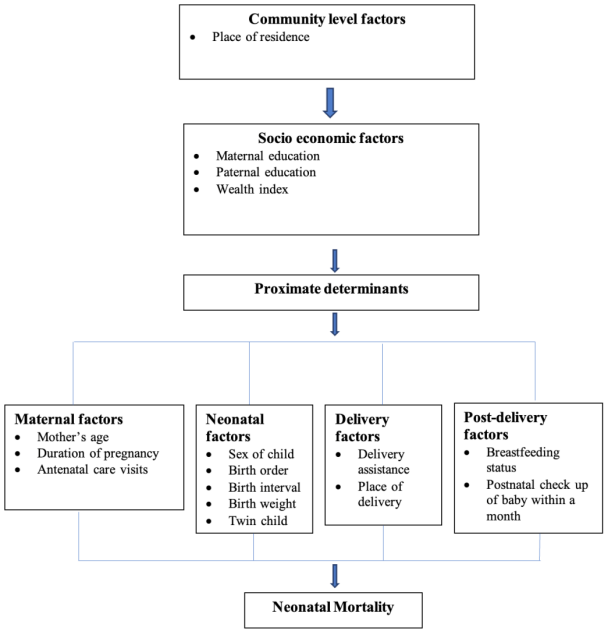

Figure 1. Conceptual framework for factors affecting neonatal mortality.

Regarding maternity characteristics, it was found that in 2011, higher proportion of women who belonged to 15-19 years had neonatal mortality 4.6%. Likewise in 2016, higher proportion of women had neonatal mortality who belonged to 15-19: 2.8%. Among women who had no antenatal visit had higher proportion on neonatal mortality 5.8% in 2011 and 5.4% in 2016.

Considering neonatal related characteristics, it was found that among women who gave birth to neonatal whose birth weight was less than two and half kilogram had higher proportion of neonatal mortality in 2011 was 5.8% and in 2016 those women with neonatal was not weighed was found to have higher neonatal mortality (3.7%).

Regarding delivery related characteristics, higher proportion of women had neonatal mortality who had home delivery, 3.2% in 2011 and 2.7% in 2016. However, in 2011 women whose delivery was without assistance of doctor had neonatal delivery (3.3%). However, in 2016, women whose delivery was assisted by doctor had higher proportion of neonatal mortality (2.7%).

Regarding post-delivery characteristics, women never breastfed neonatal had higher proportion of neonatal mortality 68.2 % in 2011 and 40.4 % in 2016. Furthermore,

women whose neonatal had no postnatal check within a month had higher proportion of neonatal mortality in 4.4 % in 2011 and 2.8 % in 2016.

Pearson's chi-squared test was used to assess the statistical significance of the association between the outcome and study determinants. It resulted that in 2011, mothers' age, duration of pregnancy, number of antenatal visits, birth weight, birth interval, twin child, place of delivery, assistance during delivery by doctor, breast feeding status and postnatal baby check were factors associated with neonatal mortality as the p-value <0.05.

The analysis revealed that in 2016, several factors were associated with neonatal mortality, including place of residence, wealth index, mother's age, duration of pregnancy, number of antenatal visits, birth weight, birth interval, having twins, place of delivery, assistance from a midwife or nurse during delivery, breastfeeding status, and postnatal check-ups within a month, all with a p-value < 0.05.

Table 1. Characteristics of women with neonatal mortality and comparison between 2011 and 2016 survey.

Neonatal mortality						
	2011			2016		
	No N(%) 5142 (96.91)	Yes N(%) 164 (3.09)	p-value	No N (%) 4931(97.88)	Yes N (%) 107(2.12)	p-value
Community level factors						
Place of residence						
Urban	1066 (97.7)	25 (2.3)	0.087	2818 (98.3)	50 (1.7)	0.031
Rural	4076 (96.7)	139 (3.3)		2113 (97.4)	57 (2.6)	
Socio-economic factors						
Wealth index						
Poorest	1621 (96.8)	53 (3.2)	0.177	1309 (97.1)	39 (2.9)	0.013
Poorer	1048 (96.2)	41 (3.8)		1036 (97.3)	29 (2.7)	
Middle	900 (96.6)	32 (3.4)		1033 (98.5)	16 (1.5)	
Richer/est	1537 (97.6)	38 (2.4)		1553 (98.5)	23 (1.5)	
Highest education level						
No education	2390 (96.6)	84 (3.4)		1633 (97.4)	44 (2.6)	0.209
Primary	1029 (97.1)	31 (2.9)	0.475	981 (98.0)	20 (2.0)	
Secondary and above	1723 (97.2)	49 (2.8)		2317 (98.2)	43 (1.8)	
Respondent's occupation						
No work	1229 (97.2)	36 (2.8)		2141 (97.8)	49 (2.2)	0.367
Professional	487 (98.4)	8 (1.6)	0.088	166 (99.4)	1 (0.6)	
Agri-Skilled	3426 (96.6)	120 (3.4)		2624 (97.9)	57 (2.1)	
Husband's educational level						
No education	1053 (95.9)	45 (4.1)		723 (98.2)	13 (1.8)	0.282
Primary	1291 (97.1)	39 (2.9)	0.092	1101 (97.3)	31 (2.7)	
Secondary and above	2798 (97.2)	80 (2.8)		3107 (98.0)	63 (2.0)	
Proximate factors						

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Neonatal mortality						
	2011			2016		
	No N(%) 5142 (96.91)	Yes N(%) 164 (3.09)	p-value	No N (%) 4931(97.88)	Yes N (%) 107(2.12)	p-value
Maternity Characteristics						
Mother's age						
15-19	334 (95.4)	16 (4.6)		385 (97.2)	11 (2.8)	0.035
20-24	1677 (96.2)	66 (3.8)		1646 (97.2)	48 (2.8)	
25-29	1708 (97.6)	42 (2.4)	0.032	1708 (98.3)	30 (1.7)	
30 and above	1423 (97.3)	40 (2.7)		1192 (98.5)	18 (1.5)	
Duration of pregnancy						
< 9 months	44 (57.9)	32 (42.1)	0.000	290 (90.3)	31 (9.7)	0.000
9 months	5098 (97.5)	132 (2.5)		4641 (98.4)	76 (1.6)	
Number of antenatal visits						
No/don't know	1731 (94.2)	107 (5.8)	0.000	1215 (94.6)	69 (5.4)	0.000
1-3 visits	1291 (98.0)	26 (2.0)		937 (97.7)	22 (2.3)	
>=4 visits	2120 (98.6)	31 (1.4)		2779 (99.4)	16 (0.6)	
Neonatal related characteristics						
Birth weight						
<2.5 kg	244 (94.2)	15 (5.8)	0.000	381 (97.2)	11 (2.8)	0.000
2.5 kg and above	1673 (98.4)	27 (1.6)		2703 (99.0)	26 (1.0)	
not weighed and don't know	3225 (96.4)	122 (3.6)		1847 (96.3)	70 (3.7)	
Birth order						
1	1690 (96.3)	65 (3.7)	0.164	1933 (97.5)	49 (2.5)	0.332
2-3	2270 (97.1)	68 (2.9)		2170 (98.2)	40 (1.8)	
4 and above	1182 (97.4)	31 (2.6)		828 (97.9)	18 (2.1)	
Birth interval						
First baby	1695 (94.5)	65 (5.5)	0.000	1942 (97.4)	51 (2.6)	0.000
<2 years	674 (97.9)	39 (2.1)		610 (96.7)	21 (3.3)	
2-5 years	2773 (96.7)	60 (3.3)		1808 (98.3)	31 (1.7)	
> 5 years				571 (99.3)	4 (0.7)	
Sex of child						
Female	2473 (96.9)	78 (3.1)	0.893	2592 (97.7)	60 (2.3)	0.472
Male	2669 (96.9)	86 (3.1)		2339 (98.0)	47 (2.0)	
Child is twin						
Single birth	5090 (97.1)	150 (2.9)	0.000	4868 (98.0)	101 (2.0)	0.000
Multiple birth	52 (78.8)	14 (21.2)		63 (91.3)	6 (8.7)	

Table 1. Characteristics of women with neonatal mortality and comparison between 2011 and 2016 survey.

Neonatal mortality						
	2011			2016		
	No N(%) 5142 (96.91)	Yes N(%) 164 (3.09)	p-value	No N (%) 4931(97.88)	Yes N (%) 107(2.12)	p-value
Delivery characteristics						
Place of delivery						
Home	3203 (96.8)	105 (3.2)	0.000	2081 (97.3)	58 (2.7)	0.028
Government sector	1401 (96.9)	45 (3.1)		2221 (98.4)	35 (1.6)	
Private sector	538 (97.5)	14 (2.5)		629 (97.8)	14 (2.2)	
Assistance during delivery: doctor						
Yes	891 (98.0)	18 (2.0)	0.034	3477 (97.6)	84 (2.4)	0.072
No	4251 (96.7)	146 (3.3)		1454 (98.4)	23 (1.6)	
Assistance during delivery: midwife/nurse						
Yes	1825 (97.3)	50 (2.7)	0.187	2235 (97.3)	61 (2.7)	0.016
No	3317 (96.7)	114 (3.3)		2696 (98.3)	46 (1.7)	
Post-delivery characteristics						
Breastfeeding status						
Yes	5108 (98.2)	91 (1.8)		4844 (99.0)	48 (1.0)	0.000
Never breastfed	34 (31.8)	73 (68.2)	0.000	87 (59.6)	59 (40.4)	
Baby postnatal check within a month						
Yes	1976 (99.1)	17 (0.9)	0.000	1439 (99.7)	5 (0.3)	0.000
No	3166 (95.6)	147 (4.4)		3492 (97.2)	102 (2.8)	

Table 2 shows the result from logistic model based on treatment contrasts, 2011 survey. Each proportion is compared with the specified reference group. The model initially fitted contained additive effects for region, place of residence, sex of child, assistance of doctor, assistance of nurse during delivery, educational status, occupation, educational status of husband, place of delivery, birth weight, age, breast feeding status, duration of pregnancy, postnatal baby check, wealth, number of antenatal visits, twin baby and birth order.

Table 3 shows the result from logistic model based on treatment contrasts, 2016. Each proportion is compared with the specified reference group. The model initially fitted contained additive effects for province, place of residence, sex of child, assistance of doctor, assistance of nurse during delivery, educational status, occupation, educational status of husband, place of delivery, birth weight, age, breast feeding status, duration of pregnancy, postnatal baby check, wealth, number of antenatal visits, twin baby and birth order.

Table 2. Full logistic model based on treatment contrast, 2011 survey.

	Estimate	S.E.	z value	p-value	Adjusted Odds Ratio (95%CI)
(Intercept)	-3.074	0.971	-3.165	0.002	0.046 (0.007-0.310)
Region					
Hill	-0.106	0.269	-0.394	0.693	0.899 (0.530-1.525)

Table 2. Full logistic model based on treatment contrast, 2011 survey.

	Estimate	S.E.	z value	p-value	Adjusted Odds Ratio (95%CI)
Terai	-0.235	0.312	-0.752	0.452	0.791 (0.429-1.458)
Place of residence					
Rural	0.188	0.331	0.568	0.570	1.207 (0.631-2.306)
Sex of child					
Male	0.157	0.204	0.769	0.442	1.170 (0.785-1.744)
Assistance: Doctor					
No	-0.090	0.382	-0.236	0.814	0.914 (0.432-1.932)
Assistance: Nurse					
No	0.264	0.469	0.563	0.574	1.302 (0.519-3.264)
Educational status					
Primary	0.047	0.287	0.165	0.869	1.048 (0.598-1.839)
Secondary and above	-0.055	0.317	-0.172	0.863	0.947 (0.509-1.762)
Occupation					
Professional	-0.453	0.582	-0.780	0.436	0.636 (0.203-1.987)
Agri skilled	0.276	0.300	0.919	0.358	1.318 (0.732-2.375)
Educational status of husband					
Primary	-0.074	0.289	-0.256	0.798	0.929 (0.527-1.635)
Secondary and above	-0.175	0.297	-0.589	0.556	0.839 (0.469-1.503)
Place of delivery					
Government sector	1.276	0.514	2.484	0.013	3.581 (1.309-9.798)
Private sector	0.764	0.486	1.574	0.115	2.148 (0.829-5.564)
Birth weight					
2.5 and above	-0.179	0.459	-0.389	0.697	0.836 (0.340-2.057)
not weighed/don't know	0.720	0.568	1.266	0.205	2.054 (0.674-6.256)
Mother’s age					
20-24	-0.305	0.392	-0.780	0.435	0.737 (0.342-1.587)
25-29	-0.606	0.436	-1.390	0.165	0.546 (0.232-1.282)
30 and above	-0.935	0.496	-1.886	0.059	0.393 (0.149-1.037)
Breast feeding status					
Never breast	4.774	0.282	16.937	<0.001	118.446 (68.167-205.812)
Duration of pregnancy					
9 months	-3.177	0.388	-8.180	<0.001	0.042 (0.019-0.089)
Postnatal baby check					
No	1.266	0.347	3.646	0.000	3.547 (1.796-7.005)
Wealth					
Poorer	-0.075	0.285	-0.263	0.792	0.928 (0.530-1.623)
Middle	-0.125	0.358	-0.349	0.727	0.882 (0.437-1.781)
Richer and richest	0.256	0.397	0.645	0.519	1.291 (0.594-2.810)

Table 2. Full logistic model based on treatment contrast, 2011 survey.

	Estimate	S.E.	z value	p-value	Adjusted Odds Ratio (95%CI)
Number of antenatal visits					
>=4 visits	-0.091	0.350	-0.260	0.795	0.913 (0.460-1.812)
no/don't know	0.838	0.289	2.901	0.004	2.311 (1.312-4.069)
Twin baby					
Twins	2.174	0.459	4.737	<0.001	8.796 (3.578-21.628)
Birth order					
2-3 BO	0.034	0.264	0.129	0.897	1.035 (0.617-1.736)
4 and above	-0.224	0.403	-0.555	0.579	0.799 (0.363-1.762)

Table 3. Full logistic model based on treatment contrast, 2016 survey.

	Estimate	S.E.	z value	p-value	Adjusted Odds Ratio (95% CI)
(Intercept)	-4.358	1.172	-3.718	0.000	0.013 (0.001-0.127)
Province					
Province 2	-0.580	0.438	-1.323	0.186	0.560 (0.237-1.322)
Province 3	-0.309	0.547	-0.566	0.571	0.734 (0.251-2.143)
Province 4	-0.449	0.590	-0.762	0.446	0.638 (0.201-2.026)
Province 5	-0.290	0.466	-0.623	0.534	0.748 (0.300-1.864)
Province 6	0.289	0.443	0.653	0.514	1.336 (0.560-3.183)
Province 7	0.005	0.472	0.010	0.992	1.005 (0.398-2.537)
Place of residence					
Rural	0.256	0.258	0.990	0.322	1.292 (0.778-2.144)
Sex of child					
Male	0.346	0.248	1.392	0.164	1.413 (0.869-2.298)
Assistance: Doctor					
No	0.153	0.366	0.418	0.676	1.165 (0.568-2.389)
Assistance: Nurse					
No	-0.152	0.519	-0.293	0.770	0.859 (0.310-2.377)
Educational status					
Primary	-0.135	0.355	-0.381	0.703	0.873 (0.435-1.752)
Secondary and above	0.097	0.350	0.278	0.781	1.102 (0.555-2.190)
Occupation					
Professional	-0.445	1.057	-0.421	0.674	0.641 (0.081-5.086)
Agri skilled	-0.249	0.265	-0.941	0.347	0.779 (0.464-1.310)
Educational status of husband					
Primary	0.121	0.411	0.294	0.769	1.129 (0.504-2.527)
Secondary and above	0.155	0.404	0.384	0.701	1.168 (0.529-2.575)
Place of delivery					
Government sector	0.934	0.599	1.558	0.119	2.544 (0.786-8.239)

Table 3. Full logistic model based on treatment contrast, 2016 survey.

	Estimate	S.E.	z value	p-value	Adjusted Odds Ratio (95% CI)
Private sector	1.247	0.658	1.895	0.058	3.478 (0.958-12.628)
Birth weight					
2.5 and above	-0.494	0.452	-1.093	0.274	0.610 (0.251-1.480)
not weighed/don't know	1.042	0.541	1.927	0.054	2.836 (0.982-8.186)
Mother's age					
20-24	-0.623	0.416	-1.497	0.134	0.536 (0.237-1.212)
25-29	-1.045	0.472	-2.213	0.027	0.352 (0.139-0.887)
30 and above	-1.365	0.592	-2.305	0.021	0.255 (0.080-0.815)
Breast feeding status					
Never breast	3.714	0.272	13.664	<0.001	41.002 (24.069-69.848)
Duration of pregnancy					
9 months	-1.232	0.325	-3.795	0.000	0.292 (0.154-0.551)
Postnatal baby check					
No	1.082	0.505	2.144	0.032	2.952 (1.097-7.942)
Wealth					
Poorer	-0.067	0.360	-0.185	0.853	0.935 (0.462-1.893)
Middle	-0.671	0.443	-1.515	0.130	0.511 (0.214-1.218)
Richer and richest	-0.086	0.427	-0.201	0.841	0.918 (0.398-2.118)
Number of antenatal visits					
>=4 visits	-0.921	0.386	-2.389	0.017	0.398 (0.187-0.848)
no/don't know	0.410	0.325	1.259	0.208	1.506 (0.796-2.849)
Twin baby					
Twins	0.635	0.661	0.960	0.337	1.887 (0.516-6.897)
Birth order					
2-3 BO	0.159	0.310	0.513	0.608	1.172 (0.639-2.152)
4 and above	0.152	0.516	0.295	0.768	1.164 (0.424-3.199)

The significant variables were included in reduced model based. The natural logarithm of odds ratio was estimated from coefficient and its 95 % confidence interval.

Table 4 shows the results of reduced model. In 2011, p-values shows that four factors: duration of pregnancy, postnatal baby check, number of antenatal visits and twin baby in the model are highly statistically significant and influence outcome. Hence, these factors are determinants for neonatal mortality. Likewise, in 2016, p-values shows that four factors: mother's age, breastfeeding status, duration of pregnancy, postnatal baby check and number of antenatal visits are highly statistically significant and influence the outcome. Hence, these factors are determinants for neonatal mortality.

Table 4. Reduced model, 2011 and 2016 survey.

2011			2016		
	p-value	Adjusted Odds Ratio (95% CI)		p-value	Adjusted Odds Ratio (95% CI)
(Intercept)	0.000	0.15 (0.07-0.33)	(Intercept)	0.000	0.03 (0.01-0.12)
Place of delivery			**Mother's age**		
Government sector	0.010	1.69 (1.13-2.54)	20-24	0.193	0.59 (0.27-1.30)
Private sector	0.682	0.87 (0.44-1.69)	25-29	0.018	0.37 (0.16-0.84)
Duration of pregnancy			30 and above	0.015	0.33 (0.13-0.80)
9 months	<0.001	0.02 (0.01-0.05)	**Breast feeding status**		
Postnatal baby check			Never breast fed	<0.001	38.09 (23.53-61.67)
No	0.000	4.31 (2.36-7.86)	**Duration of pregnancy**		
Number of antenatal visits			9 months	0.000	0.25 (0.14-0.44)
>=4 visits	0.902	0.96 (0.54-1.70)	Postnatal baby check		
no/don't know	0.000	2.52 (1.56-4.06)	No	0.018	3.22 (1.22-8.52)
Twin baby			**Number of antenatal visits**		
Twins	0.000	4.99 (2.41-10.36)	>=4 visits	0.003	0.33 (0.16-0.68)
			no/do not know	0.339	1.33 (0.73-2.42)

Table 4 shows that, in terms of place of delivery women delivered in private sectors are less likely to have neonatal mortality by 0.87 times. Women who had nine months duration of pregnancy are less likely to have neonatal mortality by 0.02 times. Women whose antenatal visits are equal to four or more visits are less likely to have neonatal mortality by 0.96 times. Whereas women who did not had their baby postnatal check-up are more likely to have neonatal mortality than women who had post-natal baby check. Also, multiple births or twins' baby are also more likely to have neonatal mortality than women who have single birth baby. In terms of age women aged 20-24, 25-29, 30 and above aged women were less likely to have neonatal mortality.

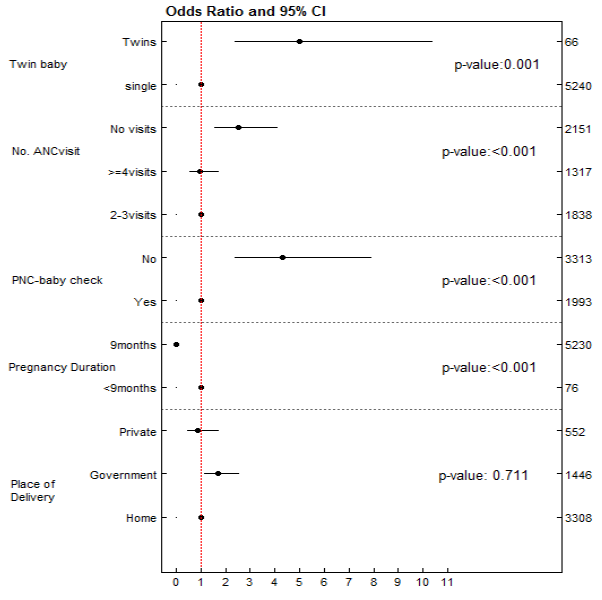

Figure 2. Odds Ratio and 95% confidence interval, 2011.

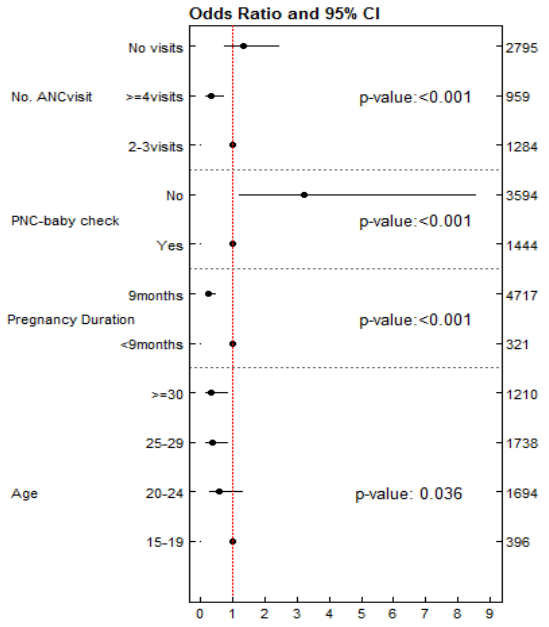

Figure 3. Odds Ratio and 95% confidence interval, 2016.

Figure 2 and 3 shows the odds ratio for each variable together with the corresponding 95% confidence intervals after adjusting for the other variables using logistic regression for 2011 and 2016 respectively. A positive estimated value indicates that odds are in favor of the event and the event is likely to occur, while a negative value indicates that the event is not likely to occur. The vertical red line represents the reference group, right side numbers indicate total number of women in each category of each variable.

Table 5. Results of reduced model, 2011 and 2016 survey.

2011				2016			
	Df	Residual deviance	p-value		Df	Residual deviance	p-value
Null		1463		Null		1036	
Place of delivery	2	1463	0.042	Mothers' age	3	1027	0.036
Duration of pregnancy	1	1332	<0.001	Breast feeding	1	728	<0.001
Postnatal baby check	1	1260	<0.001	Duration of pregnancy	1	706	<0.001
Number of antenatal visits	2	1230	<0.001	Postnatal baby check	1	686	<0.001
Twin baby	1	1215	0.000	Number of antenatal visits	2	664	<0.001

In 2011 reduced model, the residual deviance was 1215 on 5298 degrees of freedom with AIC 1231. In 2016 reduced model, the residual deviance was 664 on 5029 degrees of freedom with AIC 682. Table 5 shows the results of reduced model. The p-values shows that determinants in the model are highly statistically significant and are influence for the outcome.

DISCUSSION

This explored significant factors associated with neonatal mortality between 2011 and 2016 in Nepal separately and examined predictors that have been changed over the same periods. This study found that, in 2011 survey maternal factors including duration of pregnancy, number of antenatal visits and neonatal factors including postnatal baby check, twins' baby were determinants of neonatal mortality. Whereas in 2016, maternal factors including mother's age, duration of pregnancy, number of antenatal visits, and post-delivery factors including breastfeeding status, postnatal baby check were determinants of neonatal mortality. Overall analysis shows that, in 2011 and 2016 surveys' maternal factors including duration of pregnancy and number of antenatal visits; post-delivery factors including postnatal baby check were common independent variables associated to influence the neonatal mortality in Nepal.

Women who delivered in private sectors decreases the odds of neonatal mortality compared to women delivered in government facilities. Women assisted by SBA were less likely to have neonatal mortality 2.26 (95 %: 1.19-4.26). The study conducted in India found that the likelihood of the delivery taking place in a private institution increased when the woman made the healthcare decisions.[4] Longitudinal study conducted in Nepal found that women using birth centers or public hospitals had lower mean scores for the overall quality of the health facility and its subscales than did those going to private hospitals. In terms of adequacy of medical equipment, health staff suited to women's health, adequacy of health staff, birth center was rated lowest by the participants.[5] Women who had less than nine months duration of pregnancy increases the odds of neonatal mortality compared to women who had nine months. Study conducted by Lindegren et al (2021) found that pregnancy duration, particularly among obese women, was linked to an increased risk of neonatal death before 45 post-menstrual weeks in primiparous women at 41+3 to 42+2 weeks of gestation.[6] This could be attributed by preterm birth, susceptible to infection and low immunity.

Women with no ANC visits increases the odds of neonatal mortality compared to mothers with >=4 ANC visits. A systematic review and meta-analysis conducted in Ethiopia found that neonatal mortality was more prevalent among mothers who had fewer than three prenatal visits throughout their pregnancy.[7]

Furthermore, study by Lamichhane et al., 2017, having prenatal care was found to be less likely to have neonatal mortality 1.75 (95 %: 1.1-2.6).[8]

Women who did not had postnatal baby check-up increases the odds of neonatal mortality compared to who had postnatal baby check-up. The study conducted in Indonesia also suggests that infants receiving any postnatal care were significantly protected from neonatal deaths.[9] However, study conducted in India found that no association between check-up of newborns within 24 hours of birth and neonatal mortality.[10] A observational cohort study conducted in Bangladesh found that neonatal mortality was 67% lower in infants who had a visit on their first day of life than in infants who did not. Having the first visit on the second day was linked to a 64% reduced neonatal mortality rate than not having a visit for infants who survived their first two days of life. No any association found the day after the second day of life for first visits with a lower mortality rate.[11]

In this study, twins' pregnancy was associated with higher odds of neonatal mortality compared with women with single birth baby. The likely explanation could be twin pregnancy, which frequently results in low birth weight, which makes children more susceptible to infection and lowers their immunity.

In terms of age women aged 20-24, 25-29, 30 and above aged women were less likely to have neonatal mortality. Similar findings were found in the study conducted in 2008 that neonatal mortality was more likely to affect babies born to mothers between the ages of 12 and 15 than to those between ages of 20 and 24.[12]

Breast feeding was associated with higher odds of neonatal mortality compared to who were never breast fed.[13] The findings were reported in different study conducted in many other countries as well.

CONCLUSIONS

In line to objectives, in 2011 survey, duration of pregnancy, postnatal baby check, number of antenatal visits and twins' baby were determinants of neonatal mortality. In 2016, age of mother, breast feeding status, duration of pregnancy, postnatal baby check and number of antenatal visits were determinants of neonatal mortality. Overall analysis shows that, in both surveys' duration of pregnancy, postnatal baby check and number of antenatal visits were common independent variables associated to influence the neonatal mortality in Nepal.

For future research, this study recommends for the panel study for the identifying reason behind the slow reduction of neonatal mortality in Nepal.

The NDHS data is cross sectional surveys, which gather data from respondents about past events and activities. Such self- reporting is subject to recall bias, but in the absence of a vital registry, is one of the best ways to obtain nationally representative estimates of neonatal mortality. Moreover, this study is based on only quantitative data. Moreover, only singleton live births that occurred five years before to the surveys were included in this study.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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