Use of Maternal and Neonatal Health Services Associated with Neonatal Death in Myanmar

Further Analysis of the Myanmar Demographic and Health Survey 2015-16

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ABSTRACT

Neonatal death is a main contributor to the death of children under age 5. Research has identified factors that influence neonatal death such as the use of health services and other behavioral and biological factors. Of these factors, access to and use of maternal and neonatal health services is one of the most manageable with health interventions. This study aims to assess the association between the use of maternal and neonatal health services and neonatal death, and to provide information that will help direct priority public health interventions to reduce neonatal deaths.

We conducted secondary analysis of the 2015-16 Myanmar Demographic and Health Survey data. We analyzed data from 3,583 last children born to women age 15 to 49 and calculated the probability of neonatal death. With bivariate analysis and multiple logistic regression, we analyzed the association of neonatal death with the use of maternal and neonatal services and other important factors (household, maternal, and neonatal characteristics).

Compared to neonates who received postnatal care from skilled providers, the risk of neonatal death among neonates who received postnatal care from unskilled providers was more than 4 times higher and neonates without any postnatal care had a 9-fold increase in risk of neonatal death. More than 60% of neonates in the study did not receive any postnatal care. When compared with neonates with average birth size, neonates with small birth size had a 4-fold increase in risk of neonatal death, while neonates with a very small birth size had a 9-fold increase in the risk of neonatal death. The odds of receiving postnatal care from a skilled provider were nearly double among mothers who had four or more antenatal visits compared to those who received fewer than four visits or no antenatal care.

The results of this study suggest that a major focus of public health interventions should be improving the use of postnatal care. This should also be linked with the promotion of proper antenatal care and institutional delivery because these services are closely linked and integrated.

KEY WORDS: neonatal death, antenatal care, Myanmar, DHS, postnatal care

ACRONYMS AND ABBREVIATIONS

ANC	antenatal care
CI	confidence interval
DHS	Demographic and Health Survey
MDHS	Myanmar Demographic and Health Survey
MPHC 2014	Myanmar Population and Housing Census 2014
OR	odds ratio
PNC	postnatal care
PSU	primary sampling unit

1 INTRODUCTION

1.1 Background

Globally, 2.6 million children died within their first 28 days of life, the neonatal period, in 2016 with neonatal deaths accounting for nearly half (46%) of all under-5 deaths (Hug et al. 2017). The first few days of newborn life are critical because more than one-third of all neonatal deaths occur within the first 24 hours of life (Hug et al. 2017). Although there has been substantial progress in reducing the child mortality rate worldwide, the progress with neonatal mortality is slower. The mortality of children age 1-59 months declined by 62% from 1990 to 2016, while neonatal mortality declined only by 49% (Hug et al. 2017).

Worldwide, almost all neonatal deaths occurred in low and middle-income countries including Myanmar (Lawn et al. 2005). In Myanmar, according to the Demographic Health Survey (DHS), the neonatal mortality rate was 25 per 1,000 live births in the 5 years before the survey (MOHS and ICF 2017). Newborn death was major contributor to under-5 deaths, with the proportion of neonatal deaths in under-5 deaths increasing from 24% in 2003 to 48% in 2013 (MOH 2014). The most common causes of neonatal deaths in Myanmar were prematurity-related conditions or low birth weights (36%), birth asphyxia (26%), neonatal jaundice (15%), and neonatal sepsis (12%) (MOH 2014).

Health outcomes of newborns are influenced by maternal, socioeconomic, children's, pregnancy, and childbirth characteristics, as well as health care services for the mother and newborn (Fort et al. 2008; Lawn et al. 2005). Maternal characteristics such as young maternal age, low education, short birth interval, birth order (first birth is associated with a higher mortality rate compared to second and third births), and poor maternal nutritional status increases the risk of neonatal death (MOHS and ICF 2017; Fort et al. 2008). Poverty, which is associated with poor sanitation, housing conditions, and nutrition, is an underlying cause of neonatal mortality, which can increase risk of infection and the inability to access health services (Lawn et al. 2005). Characteristics that determine newborn survival include low birth weight, the main cause of neonatal deaths (60-80%), which can be associated with pre-term birth or intrauterine growth retardation (Lawn et al. 2005).

Characteristics of pregnancy and childbirth are also important determinants of neonatal health. Maternal health conditions during pregnancy such as ante-partum hemorrhage and pregnancy-induced hypertension can affect newborn survival. Complications of childbirth such as mal-presentation of the fetus and obstructed labor can cause birth asphyxia in neonates, one of the most common causes of newborn deaths.

Health interventions that improve newborn health include proper antenatal care (ANC), delivery care, and postnatal care (PNC). Limited access to and poor use of these health services are associated with increased newborn deaths. Research has shown that effective interventions in quality ANC such as the use of insecticides-treated bed nets in pregnancy; antenatal syphilis screening combined with penicillin treatment; detection and proper treatment of pregnancy complications such as pre-eclampsia, eclampsia, and gestational diabetes; iron and nutrient supplementation for maternal under-nutrition; and antenatal steroids can reduce newborn deaths (Bhutta et al. 2014). The day of childbirth is one of the crucial times for both the mother's and newborn's survival. Research has found that availability of basic and comprehensive emergency obstetric and newborn care at the time of childbirth can reduce newborn deaths by 40% (Bhutta

et al. 2014). Immediate newborn care with clean cord care, early initiation of breastfeeding, and Kangaroo mother care are effective postnatal interventions that reduce neonatal deaths. With small and ill newborns, the availability of immediate care by skilled health personnel is also essential for improving newborn survival (Bhutta et al. 2014). Thus, skilled attendance and institutional delivery are important factors for preventing newborn deaths.

To reduce neonatal deaths, coverage of effective health interventions must be increased to reach the poorest and most underserved populations. Increasing coverage of essential maternal, newborn, and child health interventions is a priority in the Myanmar National Health Plan 2017-2021 (MOHS 2016). According to the Myanmar DHS (MDHS) 2015-16, 81% of women of reproductive age received ANC from skilled providers, while only 59% completed four antenatal visits. Only 37% of births took place at health facilities; 60% were delivered by skilled providers; and only 36% of newborns received the recommended postnatal check-up within the first 2 days after birth (MOHS and ICF 2017).

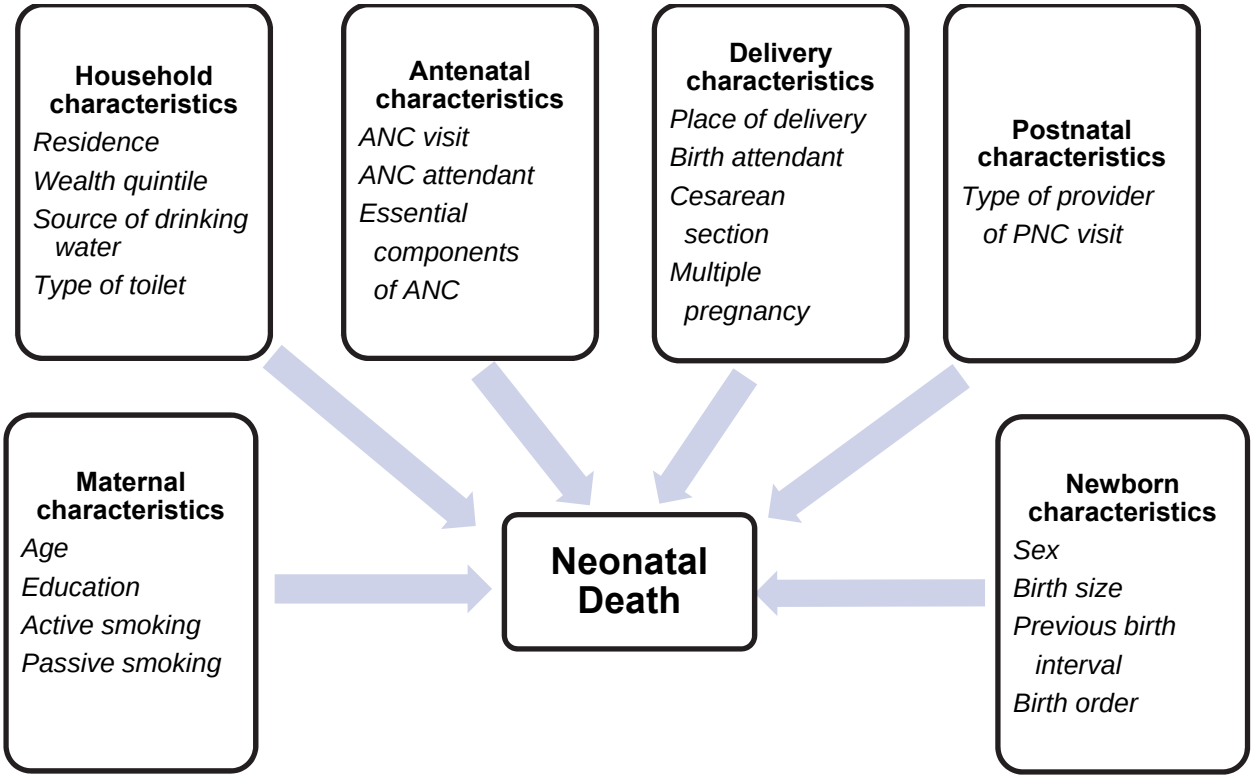
All factors associated with neonatal death must be identified in order to address the causes of preventable maternal and newborn deaths in Myanmar. Among them, maternal and neonatal health care are important determinants of neonatal survival that can improve access and use of health interventions. However, there are limited studies with national data on the determinants of neonatal deaths, and especially on the role of health services in neonatal survival in Myanmar.

The MDHS was conducted for the first time in Myanmar in 2015-16. The MDHS documented household characteristics, health conditions, and use of health services by women and men of reproductive age. Information about neonatal death and factors that influence neonatal death such as wealth quintile, maternal education, age, birth interval, and birth size were reported. Nevertheless, there are more data that affect neonatal health in this nationally representative survey such as water and sanitation conditions, maternal health conditions, and use of health services during pregnancy, delivery, and the postnatal period. This study aims to identify the maternal and neonatal health services factors associated with neonatal death in Myanmar using data from 2015-16 MDHS. The findings from this study will provide information that will help prioritize high-impact health interventions that can reduce neonatal deaths in Myanmar.

1.2 Conceptual Framework

The conceptual framework is based on a literature review of factors that influence neonatal death and data available from the MDHS. Factors were divided into four categories, namely household; maternal; neonatal; and health service factors such as ANC, delivery care, and PNC. A total of 20 possible variables include four variables related to household characteristics (urban-rural residence, wealth quintile, source of drinking water, and toilet type); four variables for maternal characteristics (age, education, smoking status, and smoker in home); five variables for neonatal characteristics (sex of the child, birth weight, previous birth interval, birth order, and type of birth—either single or multiple); three variables for maternal health services (antenatal visit, ANC attendant, and receipt of essential ANC components); three variables for delivery service (birth place, birth attendants, delivery by cesarean section); and one for the provider of PNC (if PNC was provided, and if so, by either a skilled or unskilled provider).

Figure 1 Conceptual framework for factors associated with neonatal death



1.3 Research Objectives

The main objective of this study is to assess the association between the use of maternal and neonatal health care and neonatal death. Specifically, this study aims to identify the association of household, maternal, and neonatal characteristics, use of maternal neonatal health services, and neonatal death.

2. DATA AND METHODS

2.1 Data

This study was a secondary data analysis of the 2015-16 MDHS, the first DHS conducted in Myanmar. The survey used nationally representative samples to estimate the core demographic and health indicators of the entire country. The indicators were disaggregated by seven states, eight regions, and urban versus rural areas. The total sample included 13,260 households. From these households, 16,800 women age 15-49 were interviewed for the women's survey and 7,500 men age 15-49 for the men's survey.

The 2015-16 MDHS used the sampling frame of the Myanmar Population and Housing Census 2014 (MPHC 2014), which included 76,990 primary sampling units (PSUs) for the entire country. Fifteen states/regions were stratified into urban and rural areas. Thirty sampling strata were created with samples selected independently from each sampling stratum. Two-stage stratified cluster sampling was used to select 442 clusters—123 from urban and 319 from rural areas. A fixed number of 30 households per cluster was selected to achieve 13,260 households. The survey did not allow replacement for any non-responsive households. The household response rate was 98% (12,500/13,238). The women's individual response rate was 96% (12,885/13,454).

All MDHS data are publicly available free of charge in the form of standard recode data files from The DHS Program at https://www.dhsprogram.com/Data/. Since this secondary analysis aimed to identify the factors associated with neonatal death, including the use of maternal and neonatal services, we used the children's recode data file (KR file) in the MDHS datasets because data on the use of maternal and neonatal services were available only in this data set. The children's data file (KR file) includes data on 4,815 children under age 5 (unweighted number) of interviewed women who were age 15-49 at the time of survey. Because data on use of maternal and neonatal services were only collected for the last children born to the interviewed women, our analysis used data only on the last children, which included 3,867 in unweighted numbers and 3,583 in weighted numbers.

2.2 Key Variables and Measurements

The dependent variable is neonatal death, which is defined as death of a newborn within 28 days after birth. Because we confined our analysis to the last children born to the interviewed women under age 5, neonatal death in our study is neonatal death among the last children. The 20 independent variables in our study included household, maternal, neonatal, and service use characteristics.

2.2.1 Household characteristics

Residence is categorized as either urban or rural based on the a priori definition of the PSU in the sample frame. **Household wealth quintile** is based on an index of the number and types of assets and housing characteristics of the household, and then divided into quintiles of the de jure population. **Source of drinking water** for the household is a dichotomous variable categorized as improved or non-improved. Improved sources include piped water, public taps, standpipes, tube wells, boreholes, protected dug wells and springs, rainwater, and bottled water. Non-improved sources are all other sources, including unprotected dug well, unprotected spring, tank truck, and surface water. **Type of toilet** is a categorical

variable with shared, unimproved, and improved (not shared) options. Improved toilets include flush to piped sewer system, septic tank, or latrine; ventilated improved pit latrine; pit latrine with slab; or composting toilet. All other types are considered unimproved.

2.2.2 Maternal characteristics

Maternal age is based on the mother's age at the time of birth and categorized as < age 20, and ages 20-29, 30-39, and 40-49. **Mother's education** is grouped in no education, primary education, secondary education, and higher education. **Smoking status of mother** and **smoker in home** are dichotomous variables based on the presence or absence of smoking.

2.2.3 Neonatal characteristics

Neonatal characteristics include **sex of the child** (male or female). **Birth size** is based on the mother's report and is categorized as very large, larger than average, average, smaller than average, and very small. **Previous birth interval** is a categorical variable that measures the duration of the interval preceding the birth, and is grouped into less than 2 years, 2 years, 3 years, 4 or more years, and two additional categories. The "first child" category refers to first born children for whom there is no preceding birth interval and "don't remember" categorizes mothers who are uncertain of the duration of the preceding interval. **Birth order** is grouped into first order births, 2-3, 4-6, and 7 or greater.

2.2.4 Health service use characteristics

ANC visits is a dichotomous variable grouped into < 4 visits (including no ANC visits) and 4+ visits. **ANC attendants** are categorized as skilled (doctor, nurse, midwife, or lady health visitor) or not skilled (auxiliary midwife, community/village health worker, traditional birth attendant, or other). **Receipt of essential ANC components** is categorized as no ANC, ANC but not all three components, and ANC with all three components, which include measuring blood pressure, giving information about signs of pregnancy, and taking a urine or blood sample during an ANC visit. **Place of delivery** is grouped into either institutional (public, private, or NGO sector health facility) or non-institutional (home or other). **Birth attendants** were categorized as skilled or unskilled in the same manner as the ANC attendant. **Delivery by cesarean section** is a dichotomous variable, with **type of birth** grouped as either a single or multiple birth (twins or triplets). **Postnatal care** (PNC) is a categorical variable grouped into no PNC, PNC with a skilled provider, and PNC with an unskilled provider by using the same definition of skilled and unskilled.

2.3 Statistical Analysis

Background characteristics of the last children under age 5 born to the interviewed women were described. We describe the distribution of under-5 deaths by age to assess the contribution of neonatal deaths to all child mortality and to examine the timing of death among neonatal deaths. We conducted bivariate analysis to assess the relationship between the 20 independent variables and neonatal death. In all bivariate analyses, the independent variables were treated as categorical variables. The association between each independent variable and neonatal death was assessed by calculating the odds ratio (OR) and 95% confidence interval (CI). P values were also calculated by using Pearson χ^2 test to determine the statistical significance of each association. The significance level was set at 0.05.

We conducted multivariate logistic regression to assess the independent association of maternal and neonatal service utilization and neonatal death (binary outcome), controlling for other independent variables simultaneously. Three variables related to the use of maternal and neonatal services were included in this regression modelling as the main independent variables: frequency of ANC visit (less than four visits or four or more visits), type of delivery (institutional or non-institutional), and PNC (no PNC, PNC by non-skilled provider, or PNC by skilled provider). Other independent variables included in this regression modelling were urban-rural residence, wealth quintile, source of drinking water, type of toilet, maternal age, maternal education, maternal smoking status and smoker in home, sex of the last child, birth size of the last child, previous birth interval of the last child, and birth order of the last child.

Our analysis of neonatal death assumes that use of health services precede our outcome—neonatal death. However, with PNC, it is possible that this assumption is violated. It could be that the lack of PNC among some neonatal deaths is due to these deaths occurring immediately after birth and before there is an opportunity to provide PNC, rather than no PNC leading to neonatal death. This bias could contribute to an overestimate of the strength of any relationship detected between PNC and neonatal death. Therefore, we conducted a sensitivity analysis to check the robustness of our findings about PNC. We repeated the regression of neonatal death with a restricted sample that omitted deaths that occurred in the first 24 hours of life. We compared the OR and p-value for the PNC variables between the full sample model and the restricted sample model.

We further analyzed determinants of PNC with a skilled provider using a multivariate logistic regression model because of this factor's potential importance to reducing neonatal deaths. In this model, the outcome is expressed as PNC with a skilled provider versus PNC with an unskilled provider or no PNC (binary outcome). The service use, maternal, and neonatal variables specified in this model are similar to those for the model of neonatal deaths: frequency of ANC visit (less than four visits or four or more visits), type of delivery (institutional or non-institutional), urban-rural residence, wealth quintile, source of drinking water, type of toilet, maternal age, maternal education, maternal smoking status and smoker in home, sex of child, birth size, previous birth interval, and birth order.

All analyses were performed with Stata software Version 15 (Stata Corp. 2017). The complex survey design (stratification, clustering, and unequal sampling probabilities) was accounted for in every analysis by using 'svyset' and 'svy: tab' and 'svy:logit' Stata commands.

3. RESULTS

3.1 Distribution of Deaths by Age

Figure 2 shows the distribution of childhood death by age, categorized as neonatal deaths (0-28 days), post-neonatal deaths (1-11 months), and child deaths (1-5 years). The distribution indicates that neonatal deaths comprise the majority (55%) of deaths to children under age 5. This is followed by post-neonatal deaths, which are more than a third of all under age 5 deaths, and child deaths at 10%.

Figure 2 Distribution of under 5 deaths by age groups among children born to interviewed women in the previous 5 years (n=188)

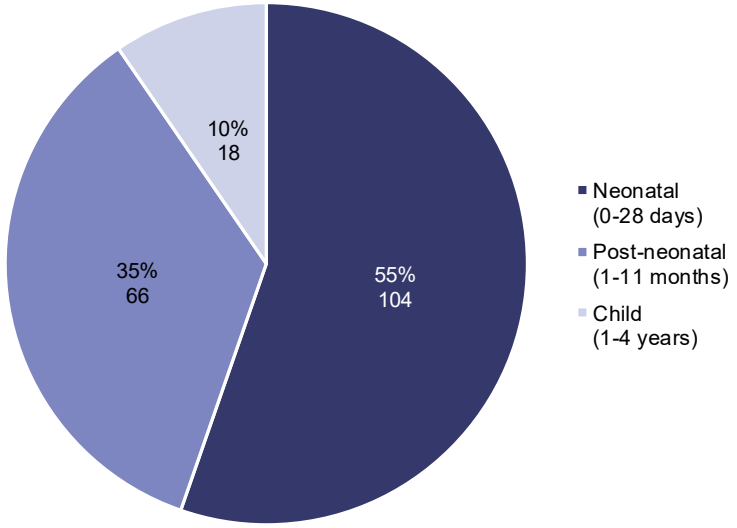
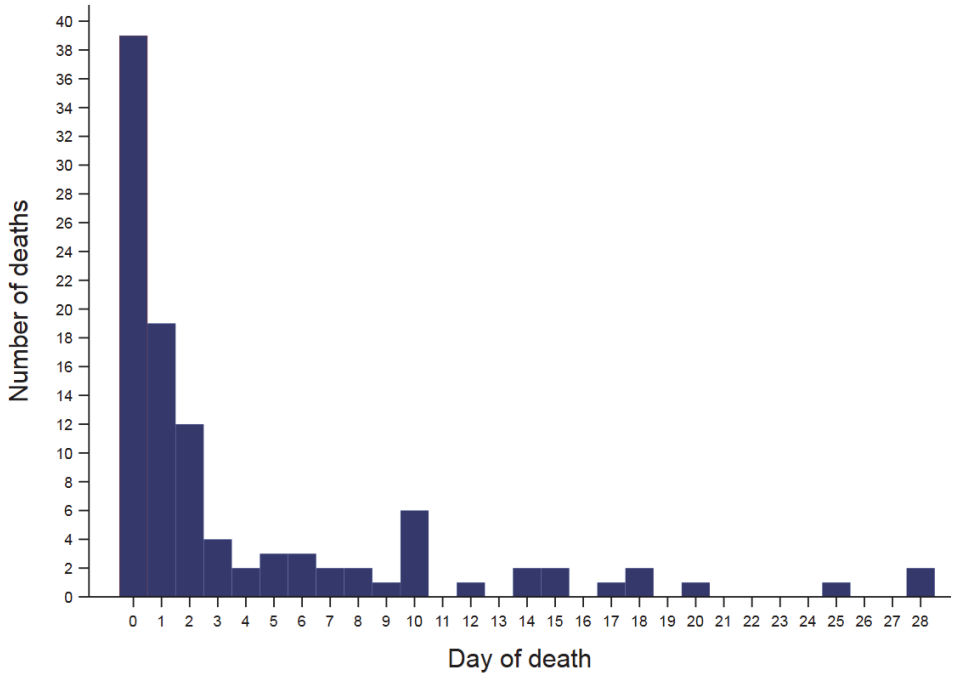


Figure 3 also shows the distribution of deaths by age, specifically within the neonatal period. The majority of neonatal deaths occur in the first several days of life. Deaths within the first 24 hours of life contribute disproportionately to all neonatal deaths, constituting 39 of 104 neonatal deaths. The number of deaths declines rapidly thereafter and levels off after the third day of life. Deaths in the 0-2 days after birth account for 70 of the 104 neonatal deaths.

Figure 3 Distribution of neonatal deaths by day of death among children born to interviewed women in the previous 5 years (n=104)



3.2 Neonatal Deaths among the Last Children Born in the Last 5 Years

Among the 3,583 last children born to the women age 15 to 49 in the 5 years before the survey, 52 children died in the 28 days after birth. The probability of neonatal death was 1.44% (95% CI=1.03 to 2.01).

3.3 Background Characteristics

The distribution of household characteristics, maternal characteristics of the last children under 5 years born to the interviewed women, characteristics of the last children under 5 years born to the interviewed women, and service utilization characteristics for the last children under 5 years born to the interviewed women was compared between the children alive and the children dead in the 28 days after birth, as shown in Tables 1 and 2.

The distribution of household characteristics, maternal characteristics of the last children under 5 years born to the interviewed women, characteristics of the last children under 5 years born to the interviewed women, and service utilization characteristics for the last children under 5 years born to the interviewed women is compared between the children alive and the children dead during 28 days after birth in Tables 1 to 4.

A greater proportion of children who died within 28 days after birth lived in a rural residence, were in poorest and poorer wealth quintiles, and lived in households with non-improved sources of drinking water as well as shared and unimproved toilets (Table 1).

A greater proportion of children who died within 28 days after birth had mothers with no education, although the distribution of the mother's age, mother's smoking status, and presence of smokers at home was similar between the children alive and the children dead during the 28 days after birth (Table 1). A

greater proportion of children who died during the 28 days after birth were female, with a birth size larger or smaller than normal, and a birth order higher than three (Table 1).

Table 1 Household, maternal, and neonatal characteristics of the last children under age 5 born to interviewed women

	Children alive during 28 days after birth		Children dead during 28 days after birth		Total	
Characteristic	%	n=3,531	%	n=52	%	n=3,583
Household characteristics						
Residence						
Urban	23.5	830	15.5	8	23.4	838
Rural	76.5	2,701	84.5	44	76.6	2,744
Wealth quintile						
Poorest	27.3	965	32.5	17	27.4	981
Poorer	21.8	770	33.8	17	22.0	787
Middle	17.5	618	12.5	6	17.4	624
Richer	17.9	631	13.2	7	17.8	638
Richest	15.5	548	7.9	4	15.4	552
Source of drinking water						
Non-improved	19.6	690	27.7	14	19.7	705
Improved	80.4	2,841	72.3	37	80.3	2,878
Type of toilet						
Shared	9.8	347	13.0	7	9.9	354
Unimproved	47.6	1,680	55.8	29	47.7	1,708
Improved	42.6	1,504	31.1	16	42.4	1,520
Maternal characteristics						
Mother's age						
<20 years	7.0	248	0.3	1	6.9	249
20-29 years	49.9	1,762	52.6	27	50.0	1,790
30-39 years	35.2	1,243	36.8	19	35.2	1,262
40+ years	7.8	277	10.2	5	7.9	282
Mother's education						
No education	16.2	570	31.3	16	16.4	587
Primary	45.6	1,611	34.5	18	45.5	1,629
Secondary	29.9	1,056	25.7	13	29.8	1,069
Higher	8.3	294	8.6	4	8.3	298
Smoking status of mother						
Not current smoker	95.8	3,384	93.5	48	95.8	3,432
Current smoker	4.2	147	6.5	3	4.2	150
Smoking in home						
Smoker	58.1	2,052	60.2	31	58.1	2,083
No smoker	41.9	1,479	39.8	21	41.9	1,499

Continued…

Table 1 Continued

Characteristic	Children alive during 28 days after birth		Children dead during 28 days after birth		Total	
	%	n=3,531	%	n=52	%	n=3,583
Neonatal characteristics						
Sex of child						
Male	51.5	1,818	46.2	24	51.4	1,842
Female	48.5	1,713	53.8	28	48.6	1,741
Birth size						
Very large	2.2	74	3.9	2	2.2	76
Larger than average	23.2	788	21.7	10	23.2	799
Average	61.8	2,099	37.4	18	61.5	2,118
Smaller than average	11.4	387	28.0	14	11.6	400
Very small	1.4	48	9.0	4	1.5	53
Previous birth interval						
<2 years	7.4	261	9.6	5	7.4	266
2 years	10.5	372	19.5	10	10.7	382
3 years	10.9	386	14.2	7	11.0	393
4+ years	36.5	1,287	36.7	19	36.5	1,306
First child	34.4	1,214	16.6	9	34.1	1,222
Don't remember	0.3	11	3.3	2	0.4	13
Birth order						
1	34.4	1,214	16.6	9	34.1	1,222
2-3	42.9	1,513	45.8	24	42.9	1,537
4-6	18.3	644	28.8	15	18.4	659
7+	4.5	160	8.7	4	4.6	165

Mothers of the children who died during the 28 days after birth were more likely to have no ANC, receive ANC with less than the three essential components of ANC, have the child delivered non-institutionally, have the child delivered by unskilled birth attendants, and received no PNC (Table 2).

Table 2 Service use characteristics for the last children under age 5 born to interviewed women

	Children alive during 28 days after birth		Children dead during 28 days after birth		Total	
Characteristic	%	n=3,531	%	n=52	%	n=3,583
Antenatal characteristics						
ANC visit						
<4 visit	40.7	1,438	45.0	23	40.8	1,462
4+ visit	58.6	2,070	55.0	28	58.6	2,099
Don't know	0.6	21	0.0	0	0.6	21
Missing	0.0	1	0.0	0	0.0	1
ANC attendants						
Not skilled	19.2	678	26.4	14	19.3	692
Skilled	80.8	2,853	73.6	38	80.7	2,891
Essential components of ANC						
No ANC	12.8	451	16.7	9	12.8	460
ANC but not all 3 components	42.4	1,497	47.7	25	42.5	1,521
ANC with all 3 components	44.8	1,583	35.6	18	44.7	1,601
Delivery Characteristics						
Place of delivery						
Institutional	40.8	1,439	28.0	14	40.6	1,453
Non-institutional	59.2	2,092	72.0	37	59.4	2,129
Birth attendant						
Not skilled	36.3	1,281	52.2	27	36.5	1,308
Skilled	63.7	2,250	47.8	25	63.5	2,275
Delivery by cesarean section						
No	80.5	2,831	91.4	47	80.6	2,878
Yes	19.5	687	8.6	4	19.4	692
Type of birth						
Single	99.1	3,499	92.7	48	99.0	3,547
Multiple (twins, triplets)	0.9	32	7.3	4	1.0	36
Postnatal characteristics						
Type of provider for first PNC visit						
No PNC	51.8	1,828	81.0	42	52.2	1,870
PNC with skilled provider	13.3	471	12.9	7	13.3	477
PNC with unskilled provider	34.9	1,232	6.1	3	54.5	1,235

3.4 Bivariate Associations with Neonatal Death

3.4.1 Household, maternal, and neonatal characteristics and neonatal death

Crude or unadjusted association of neonatal death with household characteristics, maternal characteristics of the last children under 5 years born to the interviewed women, characteristics of the last children under 5 years born to the interviewed women, and service utilization characteristics for the last children under 5 years born to the interviewed women are presented in Tables 3 to 5.

There were no significant associations between neonatal death and any of the household characteristics we measured in this study (Table 3). Children of the mothers with no education, and who were current smokers, female children, and children with birth size larger than average all appeared more likely to die during 28 days after birth, although these associations were not statistically significant at the 0.05 level (Table 3). However, statistical significance was found in associations with birth size that was smaller or very small, and with birth order of four or higher (Table 3).

Table 3 Bivariate analysis of household, maternal, and neonatal characteristics and neonatal death

Characteristics	Odds ratio	95% CI	P value
Household characteristics			
Residence			
Urban	1		
Rural	1.67	[0.72, 3.86]	0.227
Wealth quintile			
Poorest	2.34	[0.65,8.39]	0.191
Poorer	3.05	[0.88,10.52]	0.078
Middle	1.40	[0.37,5.37]	0.622
Richer	1.46	[0.36, 5.96]	0.600
Richest	1		
Source of drinking water			
Non-improved	1.57	[0.78,3.18]	0.206
Improved	1		
Type of toilet			
Shared	1.81	[0.60,5.47]	0.292
Unimproved	1.61	[0.78,3.31]	0.199
Improved	1		
Maternal characteristics			
Mother's age			
<20 years	0.04	[0.01,0.19]	<0.001
20-29 years	1		
30-39 years	0.99	[0.49,2.01]	0.981
40+ years	1.24	[0.45,3.39]	0.675
Mother's education			
No education	1.88	[0.54,6.55]	0.323
Primary	0.73	[0.21,2.52]	0.621
Secondary	0.83	[0.24,2.90]	0.773
Higher	1		

Continued…

Table 3 Continued

Characteristics	Odds ratio	95% CI	P value
Smoking status of mother			
Not current smoker	1		
Current smoker	1.59	[0.48,5.27]	0.446
Smoking in home			
No smoker	1		
Smoker	1.09	[0.59,2.01]	0.782
Neonatal characteristics			
Sex of child			
Male	1		
Female	1.24	[0.63,2.41]	0.535
Birth size			
Very large	2.97	[0.39,22.61]	0.292
Larger than average	1.54	[0.66,3.58]	0.312
Average	1		
Smaller than average	4	[1.62,10.16]	0.003
Very small	10.45	[2.42,45.09]	0.002
Previous birth interval[1]			
<2 years	1.29	[0.43,3.86]	0.648
2 years	2	[0.75,4.48]	0.180
3 years	1.29	[0.38,4.40]	0.685
4+ years	1		
First child	0.48	[0.19,1.24]	0.129
Birth order			
1	1		
2-3	2.21	[0.86,5.64]	0.097
4-6	3.26	[1.21,8.82]	0.020
7+	4	[1.05,15.02]	0.042

[1] "Don't remember" responses are excluded.

3.4.2 Health service use characteristics and neonatal death

Children of mothers with no ANC, mothers who received ANC with less than the three essential components, mothers who had the child delivered non-institutionally, mothers who had the child delivered by non-skilled birth attendants, mothers who received no PNC or PNC by unskilled providers, mothers who had the child delivered by cesarean section, and mothers who delivered multiple births were more likely to be dead during the 28 days after birth (Table 4). Statistical significance was found in associations with multiple births and with no PNC or PNC by unskilled providers (Table 4).

Table 4 Bivariate analysis of health service use and neonatal death

Characteristic	Odds ratio	95% CI	P value
ANC visit[1]			
<4 visit	1.18	[0.62.2.23]	0.615
4+ visit	1		
ANC attendants			
Not skilled	1.51	[0.74,3.07]	0.258
Skilled	1		
Receipt of essential component of ANC			
No ANC	1.64	[0.64,4.2]	0.299
ANC but not all 3 components	1.41	[0.68,2.94]	0.35
ANC with all 3 components	1		
Place of delivery			
Institutional	1		
Non-institutional	1.77	[0.88,3.56]	0.111
Birth attendant at delivery			
Not skilled	1.92	[1.00,3.69]	0.05
Skilled	1		
Delivery by cesarean section			
No	2.58	[0.83,8.01]	0.100
Yes	1		
Type of birth			
Single	1		
Multiple (twins, triplets)	8.64	[2.41,30.97]	0.001
Type of provider for first PNC visit			
No PNC	8.95	[2.52,31.84]	0.001
Unskilled	5.55	[1.12,27.60]	0.036
Skilled	1		

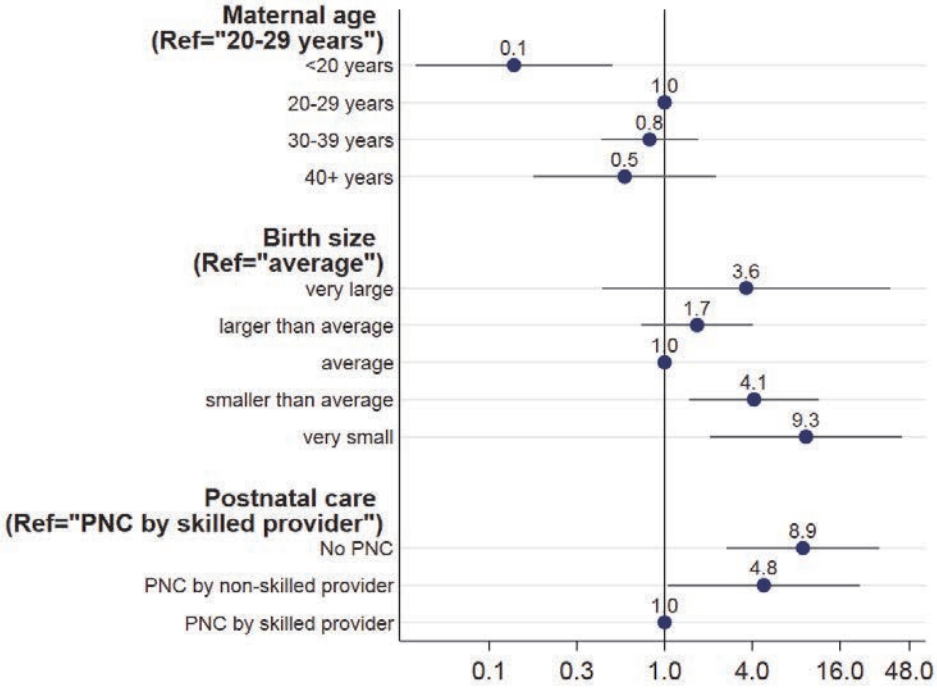
[1] "Don't know" and "Missing value" responses were excluded.

3.5 Multivariate Determinants of Neonatal Death

3.5.1 Household, maternal, and neonatal determinants

The independent association of neonatal death with each of the household, maternal, children's, and service use characteristics for the children was obtained by multiple logistic regression. As shown in Figure 4, the results were statistically significant. Complete results from multiple logistic regression are shown in Appendix Table A1.

Figure 4 Odds ratio of neonatal death for significant household, maternal, and neonatal factors from multiple logistic regression[1] among the last children under age 5 born to interviewed women (n=3,426)



[1] Only significantly associated factors for neonatal death are shown. Full model is adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, and type of provider for the PNC visit.

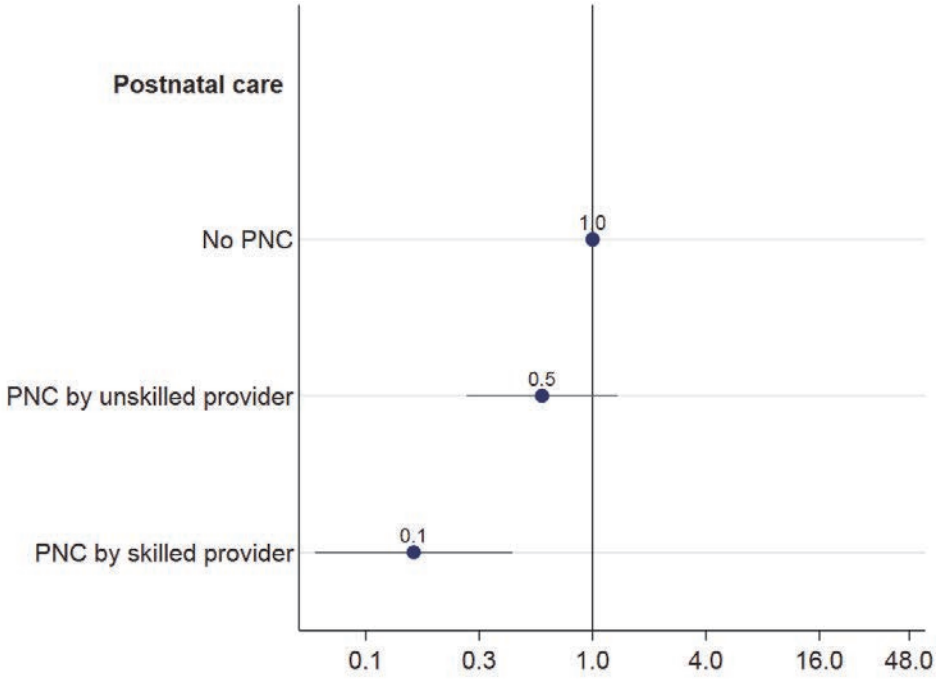
3.5.2 Health service use determinants

Compared to neonates who received PNC from skilled providers, neonates without PNC had a 9-fold increase in the risk of neonatal death, while neonates with PNC from unskilled providers had a nearly 5-fold increase in the risk of neonatal death (Figure 4).

Seventy-one percent of mothers and 36% of neonates received the recommended PNC check-up within the first 2 days after birth. This means that more than 60% of neonates in the study did not receive PNC within the first 2 days after birth (not shown in the table). Compared with neonates with average birth size, neonates with small birth size had a 4-fold increase in the risk of neonatal death and neonates with a very small birth size had a 9-fold increase in the risk of neonatal death (Figure 4).

To show the protective effect of PNC by an unskilled or skilled provider, the multiple logistic regression was re-run with no PNC as the reference group. The result is shown below in Figure 5.

Figure 5 Odds ratio of neonatal death for PNC use from multiple logistic regression[1] among the last children under age 5 born to interviewed women (n=3,426)

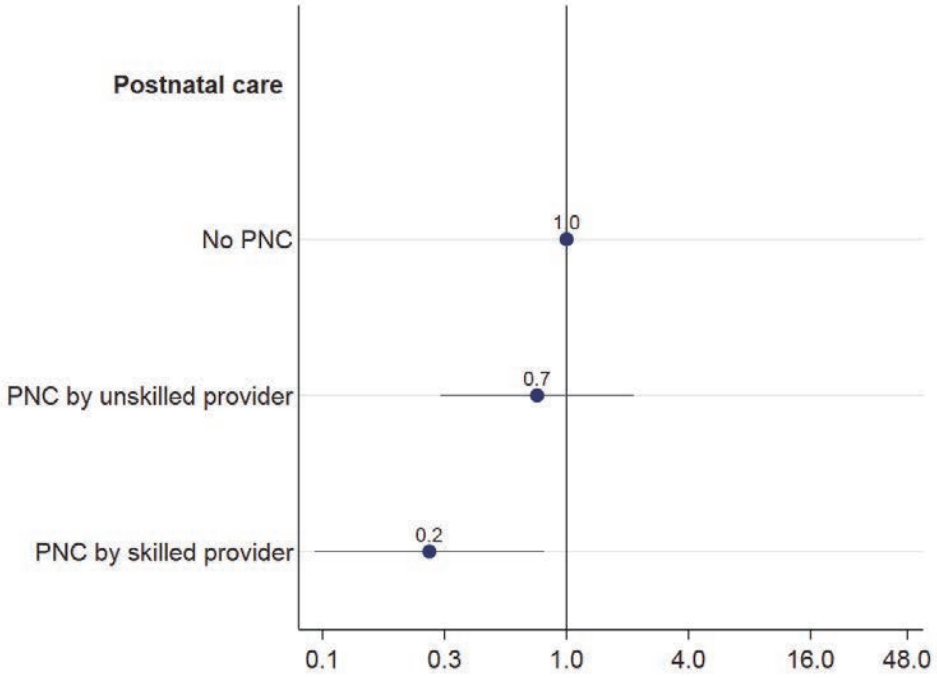


[1] Adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, the sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, and the type of provider for the PNC visit.

The results showed that PNC, whether provided by an unskilled or a skilled provider, is protective against neonatal death. The PNC by an unskilled provider was associated with a 50% decrease in odds of neonatal death (OR=0.54, 95% CI=0.21 to 1.35), while PNC by a skilled provider was associated with a 90% decrease in the odds of neonatal death (OR=0.11, 95% CI= 0.03 to 0.38) (Figure 5).

As a robustness check, we repeated this analysis excluding neonatal deaths in the first 24 hours of life. We assumed that PNC precedes the outcome, neonatal death versus survival, in our first analysis. However, for those deaths in the first 24 hours, it is possible that the reason for no PNC is that death occurred before the opportunity to provide PNC, and our assumed temporal order is reversed. Excluding these early neonatal deaths allows us to account for this possible confounding. Figure 6 shows that our results held, even when we excluded deaths in the first 24 hours. Compared to no PNC, the odds of neonatal death are 80% lower among infants who received PNC by a skilled provider. Further details are shown in Appendix Table A2.

Figure 6 **Odds ratio of neonatal death for PNC use from multiple logistic regression[1] among the last children under age 5 born to interviewed women (n=3,324), excluding neonatal deaths in the first 24 hours of life**



[1] Adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, the sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, and the type of provider for the PNC visit.

3.6 Multivariate Determinants of Postnatal Care

We further explored determinants of PNC with a skilled provider because this type of PNC emerged as an important protective factor against neonatal death in the previous analysis. Table 5 shows the odds ratios for household, maternal, neonatal, and other service use characteristics that are significantly associated with PNC with a skilled provider. Complete results from this multiple logistic regression are shown in Appendix Table A3.

Table 5 Odds ratios of PNC with a skilled provider from multiple logistic regression among the last children under age 5 born to interviewed women (n=3,444)

Characteristics	Odds ratio[1]	95% CI
Residence		
Urban	Ref.	
Rural	1.7***	[1.3, 2.3]
Mother's education		
No education	Ref.	
Primary	1.4*	[1.0,1.8]
Secondary	1.3	[1.0,1.8]
Higher	1.6*	[1.1,2.4]
Previous birth interval[2]		
<2 years	Ref.	
2 years	1.3	[0.9,1.9]
3 years	1.2	[0.8,1.7]
4+ years	1.2	[0.8,1.6]
The first child	1.4*	[1.0,2.0]
Number of ANC visits[3]		
<4 visits	Ref.	
4+ visits	1.7***	[1.4,2.4]

* p<0.05, ** p<0.01, *** p<0.001
[1] Only significantly associated factors for neonatal death are shown. Full model is adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, the sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, type of provider for PNC visit
[2] "Don't know" responses were excluded.
[3] "Don't know" and "Missing value" responses were excluded.

Among household characteristics, only residence shows an association with PNC. Births to women living in rural areas have a 70% greater odds of receiving PNC from a skilled provider. Births for mothers with primary or higher than secondary education have 40%-60% greater odds of PNC with a skilled provider than mothers with no education. Births with no previous birth interval because they were the first born also had 40% greater odds of PNC with a skilled provider than births with a preceding birth interval of less than 2 years. No other maternal or neonatal characteristics were associated with PNC.

With use of other services, mothers who received four or more ANC visits during their pregnancy had 70% higher odds of receiving PNC from a skilled provider. No such association was found between the place of delivery and PNC from a skilled provider.

4. DISCUSSION AND CONCLUSIONS

4.1 Discussion

Using the 2015-16 MDHS data, we analyzed data on the 3,583 last children born to women age 15 to 49. Among these children, 52 children died in the first 28 days of their life. The overall probability of neonatal death was 1.4% (95% CI=1.0 to 2.0). The age pattern of deaths in the neonatal period and the large contribution of neonatal deaths to all under-5 deaths in this study is similar to the age pattern found elsewhere (Hug et al. 2017).

We found a strong association between the use of PNC and neonatal survival. Compared to neonates who received PNC from skilled providers, neonates without PNC had a 9-fold increase in the risk of neonatal death. More than 60% of neonates in the study did not receive PNC within the first 2 days after birth. For neonates who received PNC by an unskilled provider, the risk of neonatal death was over 4-times higher than those who received PNC from skilled providers. Inversely, PNC by unskilled providers was associated with a 50% decrease in the odds of neonatal death, while PNC by a skilled provider was associated with a 90% decrease in the odds of neonatal death.

Our findings on the effect of PNC on neonatal death reflected the general pattern found in an analysis of data from DHS surveys in 10 African countries, which found that PNC by unskilled providers was associated with a 32% decrease in the probability of neonatal death and PNC by a skilled provider with a 60% decrease in the probability of neonatal death (Sing, Brodish, and Haney 2014). Analysis of data from a DHS survey in Nepal did not find a significant association between PNC and neonatal mortality. In this survey, the authors explained that the lack of association could be due to sample size and other limitations in the survey variables (Paudel et al. 2013).

Other research on the relationship between PNC and neonatal death has argued that the influence of PNC on neonatal death may be overstated if early neonatal deaths that occur in the first 24 hours after birth are not excluded (Mallick et al. 2018). Such deaths represented nearly half of all neonatal deaths in our analytic sample. Our sensitivity analysis showed our results to be robust to the inclusion or exclusion of deaths in the first 24 hours. When we exclude deaths in the first 24 hours, the odds of neonatal death decreases by 80% when PNC is provided by a skilled provider, as compared to 90% decreased odds when we do not exclude these deaths. We conclude that we did not overestimate the strength of the association between PNC and neonatal death.

While PNC was low (36% in the first 2 days) in this study, less than half of mothers in the world receive a PNC visit within 2 days of childbirth (Lawn et al. 2014). Lower levels of PNC than in our analysis were found in Sub-Saharan African countries. An analysis of DHS data from 23 Sub-Saharan African countries found that only 13% of women who delivered at home received PNC within 2 days of birth (Warren et al. 2006).

We find that ANC is a significant predictor of PNC by a skilled provider. We did not find such an association with place of delivery. Studies in a range of settings have shown that use of health services earlier in the continuum of care influence PNC use (Aryal et al. 2019; Mbugua and MacQuarrie 2018; Belachew et al. 2016; Owili et al. 2016; Obago 2013). However, these studies typically show that ANC loses its association

with PNC after the place of delivery is controlled. This demonstrates that ANC may act on PNC by influencing women to deliver in a health facility. Our study finds that ANC has a strong independent association with PNC regardless of the place of delivery. Our study concurs with a broad literature that indicates the importance of all stages in the continuum of maternal health care.

Our finding that PNC was associated with a low risk of neonatal death suggests that neonate health might have been improved by health services and health messages the caregivers received from providers about newborn care during the postnatal period. ANC, delivery by skilled birth attendants, and PNC are essential elements in an integrated care approach for mothers and neonates.

Providing PNC with a skilled provider is the ideal approach, although PNC with an unskilled provider such as an auxiliary midwife is a useful alternative in very remote areas where PNC by skilled providers is not feasible. Unskilled providers should be given proper, regular training on the key elements of newborn care in order to enhance the beneficial effect of PNC and to know when to refer to a skilled provider. Unskilled providers also need to work closely with the skilled providers. A strong referral system between community and facility care has been recommended as an integrated approach to newborn health (WHO and UNICEF 2009). Training for unskilled providers should emphasize when to refer to a skilled provider.

4.2 Limitations

Our study has some limitations. Since the study is a secondary data analysis, we relied on available variables which are not comprehensive for control of all confounding variables. Thus, some residual confounding may remain. Many women who deliver at home do not know their child's exact birth weight. We used a rough classification of birth size based on reported birth size as very large, larger than average, average, smaller than average, or very small. Questions on gestational age, another important confounder, are not included in the DHS. Finally, we can only estimate associations, but not causality because this is a cross-sectional survey.

This study also has some strengths. Based on a nationally representative sample, the MDHS is a methodologically rigorous survey, with high validity and reliability of the variables used in the analysis. Thus, we were able to provide evidence that supported efforts to promote PNC as a means of preventing neonatal deaths. This finding is important because countries like Myanmar are considering scaling-up PNC services in order to reach more newborns and save more lives.

4.3 Conclusion

This study is the first to evaluate associations between PNC by provider type and neonatal death in Myanmar. The results show clearly that Myanmar should continue to promote PNC as a means of preventing neonatal mortality and improving child survival. The provision of PNC at the national level is currently low. This study provides evidence for advocating scaling-up of PNC in the country.

As Myanmar works to increase the number of midwives as skilled providers of maternal care, provision of PNC by auxiliary midwives with proper training in newborn care may be used as an alternative strategy to improve neonatal death in remote areas where midwives and other skilled providers are not available. ANC and delivery care by skilled birth attendants should also be promoted, along with PNC, as an integrated care approach for both mothers and neonates. This study shows that the major direction for public health interventions to reduce neonatal death is improving the utilization of PNC, which should also be linked with promotion of proper ANC and institutional delivery.

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APPENDIX

Appendix Table A1 Odds ratio of neonatal death from multiple logistic regression among last children under age 5 born to interviewed women (n=3,426)

Characteristics	Odds ratio	95% CI
Residence		
Urban	Ref.	
Rural	1.2	[0.5,3.1]
Wealth index		
Poorest	2.1	[0.4,11.4]
Poorer	2.8	[0.6,14.2]
Middle	1.4	[0.2,8.2]
Richer	2	[0.5,8.5]
Richest	Ref.	
Source of water		
Non-improved	1.1	[0.5,2.4]
Improved	Ref.	
Type of toilet		
Shared	2.3	[0.7,7.7]
Unimproved	1.1	[0.5,2.4]
Improved	Ref.	
Mother's age at birth of the child		
<20 years	0.1**	[0.0,0.4]
20-29 years	Ref.	
30-39 years	0.8	[0.4,1.7]
40+ years	0.5	[0.1,2.3]
Mother's education		
No education	0.4	[0.1,2.2]
Primary	0.2	[0.0,1.1]
Secondary	0.3	[0.1,1.4]
Higher	Ref.	
Mother's smoking status		
No current smoking	Ref.	[1.0,1.0]
Current smoking	0.8	[0.2,3.3]
Smokers at home of the child		
Smokers at home	1	[0.5,2.0]
No smokers at home	Ref.	
Sex of the child		
Male	Ref.	
Female	1.5	[0.8,3.1]
Birth size		
Very large	3.6	[0.4,35.4]
Larger than average	1.7	[0.7,4.0]
Average	Ref.	
Smaller than average	4.1**	[1.5,11.5]
Very small	9.3**	[2.1,42.6]

Continued…

Appendix Table A1 Continued

Characteristics	Odds ratio	95% CI
Previous birth interval[1]		
<2 years	1.1	[0.3,3.7]
2 years	1.4	[0.5,3.8]
3 years	1.4	[0.4,5.4]
4+ years	Ref.	[1.0,1.0]
The first child	0.5	[0.1,1.5]
Birth order		
1	Ref.	
2-3	1	[1.0,1.0]
4-6	1.8	[0.7,4.3]
7+	2.2	[0.5,8.9]
Multiple birth		
Single birth	Ref.	
Multiple birth	4.6	[0.6,33.7]
Number of ANC visits[2]		
<4 visits	0.6	[0.2,1.3]
4+ visits	Ref.	[1.0,1.0]
Type of delivery		
Institutional	Ref.	
Non-institutional	1.2	[0.4,3.8]
Postnatal care (PNC)		
No PNC	8.9***	[2.7,29.8]
PNC by non-skilled providers	4.8*	[1.1,21.9]
PNC by skilled providers	Ref.	

* p<0.05, ** p<0.01, *** p<0.001
[1] "Don't know" responses were excluded.
[2] "Don't know" and "Missing value" responses were excluded.

Appendix Table A2 Odds ratio of neonatal death by type of PNC provider from bivariate logistic regression (n=3,561) and multiple logistic regression (n=3,324) among last children under age 5 born to interviewed women, excluding neonatal deaths in the first 24 hours of life

	Unadjusted odds ratio	95% CI	P value	Adjusted odds ratio[1]	95% CI	P value
Characteristics	Bivariate regression			Multivariate regression		
No PNC	4.7	[1.2,18.2]	0.027	4.8	[1.3,17.5]	0.019
PNC by non-skilled providers	4.4	[0.8,24.43]	0.093	3.4	[0.6,18.3]	0.153
PNC by skilled providers	Ref.			Ref.		

[1] Adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, the sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, and type of provider for PNC visit.

Appendix Table A3 Odds ratio of PNC from multiple logistic regression, among last children under age 5 born to interviewed women (n=3,444)

Characteristics	Odds ratio[1]	95% CI
Residence		
Urban	Ref.	
Rural	1.7***	[1.3, 2.3]
Wealth index		
Poorest	Ref.	
Poorer	1.1	[0.9,1.5]
Middle	1.3	[1.0,1.7]
Richer	1.2	[0.9,1.7]
Richest	1.5	[0.9,2.3]
Source of water		
Non-improved	Ref.	
Improved	0.9	[0.7,1.1]
Type of toilet		
Shared	1	[0.8,1.4]
Unimproved	Ref.	
Improved	0.8	[0.7,1.0]
Mother's age at birth of the child		
<20 years	Ref.	
20-29 years	1.1	[0.8,1.5]
30-39 years	1.2	[0.8,1.7]
40+ years	1.4	[0.9,2.2]
Mother's education		
No education	Ref.	
Primary	1.4*	[1.0,1.8]
Secondary	1.3	[1.0,1.8]
Higher	1.6*	[1.1,2.4]
Mother's smoking status		
Current smoking	Ref.	
No current smoking	1.3	[0.9,1.9]
Smokers at home of the child		
Smokers at home	Ref.	
No smokers at home	1.1	[0.9,1.3]
Sex of the child		
Male	Ref.	
Female	1.1	[0.9,1.2]
Birth size		
Very large	1.4	[0.8,2.4]
Larger than average	1.2	[1.0,4.1.5]
Average	Ref.	
Smaller than average	1	[0.8,1.2]
Very small	1	[0.5,1.8]

Continued…

Appendix Table A3 Continued

Characteristics	Odds ratio[1]	95% CI
Previous birth interval[2]		
<2 years	Ref.	
2 years	1.3	[0.9,1.9]
3 years	1.2	[0.8,1.7]
4+ years	1.2	[0.8,1.6]
The first child	1.4*	[1.0,2.0]
Birth order		
2-3	Ref.	
4-6	1.1	[0.8,1.3]
7+	0.9	[0.6,1.4]
Multiple birth		
Single birth	Ref.	
Multiple birth	2.1	[0.7,6.1]
Number of ANC visits[3]		
<4 visits	Ref.	
4+ visits	1.7***	[1.4,2.4]
Type of delivery		
Non-institutional	Ref.	
Institutional	0.7	[0.6,0.9]

* p<0.05, ** p<0.01, *** p<0.001

[1] Adjusted for place of residence, wealth index, source of water, type of toilet, mother's age at birth of the child, educational level, current smoking status of mother, smokers in the home, the sex of child, birth size, previous birth interval, birth order, multiple births, number of ANC visits, place of delivery, type of provider for PNC visit

[2] "Don't know" responses were excluded.

[3] "Don't know" and "Missing value" responses were excluded.