What impact does antenatal and postnatal care have on neonatal deaths in low and lower-middle income countries? Evidence from Bangladesh

Abstract

We investigated the contribution of antenatal and postnatal care in reducing the risk of neonatal deaths in Bangladesh. The effects of these services were examined using adjusted Cox regression models and secondary data with 7,314 live-born infants. We observed that neonatal mortality was significantly decreased for newborns whose mothers' attended antenatal care services but postnatal care did not show any effect. Health promotion programmes offering antenatal care in Bangladesh and other low and lower-middle income countries may build awareness about these practices. Further research is required to examine the reasons for the lack of impact of postnatal care on mortality.

Every year about three million newborns die in their first month of life (WHO & PMNCH, 2011). Low and lower-middle income countries (LMICs) experience most of these deaths due to their weak health systems where the usual practice for women is to give birth at home without any assistance from skilled birth attendants (WHO & PMNCH, 2011). Around two-thirds of these deaths can be prevented through promoting universal access to antenatal care, skilled birth attendance and early postnatal care services (Darmstadt et al., 2005).

Antenatal care, which mothers receive during pregnancy, plays an important role in reducing the risk of maternal and neonatal deaths (Carroli et al., 2001; Chen, Wen, Yang, & Walker, 2007; Raatikainen, Heiskanen, & Heinonen, 2007). These services include the routine identification and management of obstetric complications, the screening and treatment of conditions such as anaemia, syphilis and HIV, the provision of tetanus toxoid immunization as well as iron and folic acid supplements and health education and counselling on key intrapartum and postnatal issues (Ministry of Health and Family Welfare, 2009). Researchers examining different components of antenatal care have observed a significant reduction in neonatal mortality, including early neonatal mortality, with the rates varying from 39% - 69% and 23% - 53%, respectively (Dibley, Titaley, d'Este, & Agho, 2012; Nisar & Dibley, 2014b; Nisar, Dibley, Mebrahtu, Paudyal, & Devkota, 2015; Persson et al., 2012; Titaley, Dibley, Roberts, Hall, & Agho, 2010; Zeng et al., 2008).

Postnatal care practices, which include the initiation of early and exclusive breastfeeding, thermal care of the newborn and the provision of hygienic umbilical cord and skin care, have also been found to be effective in reducing neonatal mortality (WHO & PMNCH, 2011; WHO & UNICEF, 2009). Researchers indicated that home-based postnatal care interventions could prevent newborn deaths in South Asian countries by up to 61% (Bang, Bang, Baitule, Reddy, & Deshmukh, 1999; Baqui et al., 2008; Bhutta et al., 2011; Kumar et al., 2008; WHO

& UNICEF, 2009). Newborns in Bangladesh, who had had a postnatal visit on the day of their birth, experienced a two-third reduction in neonatal death compared to those who did not receive a postnatal visit (Baqui et al., 2009a). Against the same comparison group, the researchers also reported a reduced risk of neonatal mortality by more than half for those who received a postnatal visit on the second day after their birth (Baqui et al., 2009a).

From a statistical modelling point of view, controlling for both antenatal and postnatal care services in the model is required to identify the impact of postnatal care. This is important because the impact of antenatal care services may modify the impact of postnatal care (Titaley & Dibley, 2012). However, researchers examining the contribution of postnatal care rarely control for antenatal care in the statistical model. A recent investigation on Indonesia, which did control for antenatal care services in the model, found no protective effect of postnatal care on neonatal deaths (Titaley & Dibley, 2012). However, more empirical evidence is required to confirm such findings.

Against this background, we examine the impact of antenatal and postnatal care services on neonatal mortality in Bangladesh. Like other LMICs, neonatal mortality is high in Bangladesh (28 per 1000 live births) where approximately 62% of women give birth at home with the majority of them assisted by unskilled birth attendants (NIPORT, Mitra and Associates, & ICF International, 2016). Around 64% of women in Bangladesh receive antenatal care, while only 32% of children receive their first postnatal check-up from a trained provider within two days of delivery (NIPORT et al., 2016). By providing evidence of the effect of these services, this study may help to modify the focus of antenatal and postnatal care interventions policies and programmes which may improve newborn health outcomes in LMICs. Thus, this study aims to examine the contribution of antenatal care and postnatal care in reducing the risk of neonatal deaths in Bangladesh.

Methods

Data source

We analysed data from the 2011 Bangladesh Demographic and Health Survey (BDHS), a periodic cross-sectional survey (NIPORT, Mitra and Associates, & ICF International, 2013). The survey was based on a two-stage stratified sample design and the primary sampling unit was enumeration area (EA) with an average of 120 households. In the first stage, 600 EAs were sampled using probability proportional to the EA size followed by household listing. In the second stage, an average of 30 households were selected per EA using systematic sampling technique. The survey collected information from 17,141 households with an individual interview of 17,842 ever-married women aged 12-49 years. Male respondents from one-third of the surveyed households were interviewed comprising 3,997 observations. To collect information about causes of child death, the BDHS 2011 used separate questionnaires for mothers who reported the death of a under-five child in the five years preceding the survey. Details of the design and data collection procedures have been described elsewhere (NIPORT et al., 2013).

Ethics

The BDHS was approved by the Ethical Review Panel of the Ministry of Health and Family Welfare, Government of the Peoples' Republic of Bangladesh. All survey information was self-reported and no medical records were reviewed. Informed verbal consent was obtained from all survey participants.

Study participants

All live-born infants were considered for this analysis. Detailed information on perinatal healthcare services was only available for the most recent birth of women participants which was within five years of the survey. As a result, this study included 7,314 infants, of which

131 died during their neonatal period and of these, 102 were categorised as early neonatal deaths.

Outcome variable

The primary outcome of interest was neonatal mortality (deaths during first 28 days of life) and early neonatal mortality (deaths during first week of life) (WHO & PMNCH, 2011). Neonatal mortality was identified from the birth history of mothers, which involved the collection of information on their newborn's date of birth, survival status and age at death (if deceased).

Exposure variables

Antenatal care and postnatal care were the primary exposures in this study. These variables were categorized according to the recommendations of WHO, UNICEF and the National Neonatal Health Strategy and Guidelines for Bangladesh (Ministry of Health and Family Welfare, 2009; WHO & UNICEF, 2009). Antenatal care by a mother during pregnancy was categorized as 0 visit, 1-3 visits and 4 or more visits. We considered two definitions for the postnatal care variable. In the first definition, we considered whether a newborn received any postnatal care services from any type of provider within the first week of its birth. The other definition considered whether any such services had been received on day 1, within 2-7 days, or after 7 days of birth, which also included no services received.

Potential confounding variables

Based on previous literature and the availability of data, we considered two groups of variables that might potentially be associated with neonatal deaths (Titaley & Dibley, 2012). The first group was comprised of variables related to perinatal healthcare services, which included mode and place of delivery, as well as the types of delivery attendant. Our models

did not include any confounders related to delivery complications like preterm birth and preeclampsia due to the unavailability of such data. The second group of variables comprised demographic, socio-economic and birthing characteristics and included variables related to administrative divisions, usual place of residence (urban/rural), paternal years of schooling, maternal years of schooling, household wealth index, maternal age at birth, child sex, combined birth rank and interval, desire for pregnancy and birth size perceived by the mother. Following earlier research, the information about birth size perceived by mothers were used as a proxy for birth weight in our models, as the latter variable was unknown for babies born at home (Akter, Dawson, & Sibbritt, 2015, 2016; Nisar & Dibley, 2014a).

A wealth index for each participant was constructed using the household asset information and the principal components analysis (NIPORT et al., 2013; Rutstein, 1999). Parental years of schooling, household wealth index and maternal age at birth were considered as continuous variables. The variable related to infants birth rank and interval was created as first birth rank, second/third birth rank with previous birth interval of more than 2 years, second/third birth rank infants with previous birth interval of less than or equal to 2 years and fourth birth rank. The size of a baby at birth was categorized as average, larger than average and smaller than average. Assistance received during delivery was categorized as a binary variable indicating the presence or absence of skilled birth attendants. The variable related to the place of delivery was used to indicate whether the delivery took place at a health facility or not.

Statistical analysis

The differences in the exposure and other variables associated with the survival status of the newborns were examined using chi-square and t-tests. We considered two independent Cox Proportional Hazards regression models to identify the potential confounder from the two

groups of variables. One model was related to perinatal healthcare services while the other model considered demographic, socio-economic and birthing characteristics. A backward stepwise elimination process was utilized to identify the potential confounder in these two groups (those with a p-value < 0.05). Then, after controlling for the identified confounding variables, adjusted Cox Proportional Hazards regression models were used to examine the effect of the exposures - antenatal and postnatal care service - on the neonatal mortality. A similar analysis was conducted for early neonatal deaths. All statistical analyses were performed using STATA version 11.2. The STATA survey commands were used to adjust the weights and sampling design.

Results

The selected sample was predominantly from rural areas (77%) with average mother's schooling of five years and maternal age at birth of 23 years. On the other hand, out of the total 131 neonatal deaths in our sample, 50 cases (38%) died on the 1st day of birth and 52 (40%) died on 2nd to 7th days of life. The overall distribution of demographic, socio-economic and birthing characteristics across neonatal death status are presented in Table 1. Statistically significant differences between alive and deceased neonates were observed among divisions and size of a baby at birth. Specifically, neonatal mortality was higher in the Dhaka, Barisal and Sylhet divisions ($p=0.018$) and for babies that were larger than average size at birth ($p<0.001$). Similarly, in the case of early neonatal deaths, statistically significant differences were observed for a child's sex, birth rank and interval and size at birth. The likelihood of early neonatal mortality was particularly higher for male newborns ($p=0.048$), infants with first birth rank and second/third rank with interval≤2 years ($p=0.041$) and infants who were larger than average at birth ($p<0.001$).

[Table 1]

Table 2 presents the distribution of perinatal healthcare service measures across neonatal death status. Statistically significant associations were observed for all probable confounders for both neonatal and early neonatal mortality (all $p<0.05$). Higher mortality was observed for those babies born by Caesarean section, attended by skilled birth attendants and delivered at a health facility.

[Table 2]

Results of the Cox regression models, presented in Table 3, show the association of antenatal and postnatal care services with neonatal deaths, both unadjusted and adjusted for potential confounders. Unadjusted analyses indicated an insignificant association of antenatal care with neonatal mortality (HR=0.91; 95% CI: 0.54, 1.52; p=0.712). On the other hand, when we did control for confounding variables, neonatal mortality was nearly half and significant for those whose mothers' attended four or more antenatal care visits during pregnancy compared to those without any visit (HR=0.52; 95% CI: 0.29, 0.96; p=0.036). Neonatal mortality was also less likely for those who made 1 to 3 antenatal care visits (HR=0.61; 95% CI: 0.38, 0.97; p=0.038).

In contrast, an unadjusted analyses with the postnatal care showed a significant and an increased risk of neonatal mortality both for the first week of life (HR=1.80; 95% CI: 1.21, 2.67; p=0.004) and for those who received care in the first day of life (HR=2.03; 95% CI: 1.36, 3.05; p=0.001). Even after controlling for confounding variables, receiving postnatal care showed an increased risk of neonatal mortality both in the first week of life (HR=1.51; 95% CI: 0.85, 2.69; p=0.157), and in the first day of life (HR=1.83; 95% CI: 0.98, 3.41; p=0.059), although these associations were not statistically significant.

[Table 3]

Table 4 presents results of the Cox regression model used to identify the contribution of antenatal and postnatal care for early neonatal deaths. Our findings in the unadjusted analysis of early neonatal deaths were largely similar to the findings in Table 3. On the other hand, in the adjusted analysis, a reduction in early neonatal mortality was observed for neonates whose mothers' received antenatal care during pregnancy (HR=0.61; 95% CI: 0.31, 1.21; p=0.160). In contrast, an increase in early neonatal mortality was observed in newborns who received postnatal care in the first week of life (HR=1.49; 95% CI: 0.77, 2.88; p=0.235). An increased HR was also observed for those who received such care in the first day of life (HR=1.83; 95% CI: 0.90, 3.75; p=0.097). However, none of these associations were statistically significant.

[Table 4]

Discussion

Our study is the first to examine the impact of antenatal and postnatal care in reducing neonatal deaths in Bangladesh. The findings indicated a significant impact of antenatal care on neonatal deaths. In particular, we found that neonatal mortality was significantly decreased by 48% for those newborns whose mothers' attended at least four antenatal care visits. However, an insignificant effect was observed in the case of early neonatal deaths. Postnatal care did not exhibit a significant effect on the reduction of either neonatal or early neonatal deaths.

Earlier researchers reported a reduced risk of mortality for any form of antenatal care with a large effect observed for iron and folic acid supplementation (Dibley et al., 2012; Nisar &

Dibley, 2014b; Nisar et al., 2015; Pena-Rosas & Viteri, 2006; Titaley & Dibley, 2012; Titaley et al., 2010). Antenatal iron and folic acid supplements significantly reduced maternal anaemia which was associated with increased infant birth weight and reduced preterm delivery (Titaley et al., 2010; WHO & PMNCH, 2011; Zeng et al., 2008). Tetanus toxoid immunization, a component of antenatal care, also played a key role in reducing neonatal tetanus which was associated with the use of non-sterile instruments to cut the umbilical cord (Blencowe, Lawn, Vandelaer, Roper, & Cousens, 2010; NIPORT et al., 2013). This was particularly true for LMICs where many deliveries were conducted at home and in unhygienic conditions (Blencowe et al., 2010; NIPORT et al., 2013).

Unfortunately, it was not possible to directly compare the estimates of our study with previous research as the data were inadequate to investigate the impact of individual components of antenatal care. However, researchers reported that nine out of ten mothers were protected against neonatal tetanus through immunization and consequently, tetanus was not a major cause of neonatal mortality in Bangladesh (Fottrell et al., 2015; NIPORT et al., 2013). On the other hand, the 2007 BDHS indicated that around 60% of pregnant women in Bangladesh had received antenatal care (Fiedler, D'Agostino, & Sununtnasuk, 2014). Of these women, 74% took iron and folic acid supplements (Fiedler et al., 2014). Thus the effect of antenatal care might reveal the impact of iron and folic acid supplementation in our case.

The magnitude of the impact of antenatal care on neonatal mortality in our research was consistent with studies that focused on iron and folic acid supplementation (Dibley et al., 2012; Nisar et al., 2015; Titaley & Dibley, 2012; Zeng et al., 2008). For example, a reduction of 45% in early neonatal deaths and 42% in neonatal deaths were observed in Nepal, while a reduction of 53% in early neonatal deaths and 47% in neonatal deaths were observed in a cluster randomized trial in China as an impact of iron and folic acid supplementation (Nisar

et al., 2015; Zeng et al., 2008). A 51% reduction in neonatal mortality was also observed in case of Indonesia (Titaley & Dibley, 2012). Thus our study provides additional support for the hypothesis that iron and folic acid supplementation is crucial in reducing neonatal mortality.

In contrast with earlier studies, we did not find any significant impact of antenatal care on early neonatal deaths. Researchers observed regional differences in the causes of neonatal deaths in low-income countries (Fottrell et al., 2015). They also reported sepsis as the major cause of neonatal deaths in Bangladesh. Traditional practices in cord care, as well as in other essential newborn care might lead to newborn sepsis in Bangladesh (Darmstadt, Syed, Patel, & Kabir, 2006). Around 30% - 40% of reported infection developed during the first 72 hours after birth leading to neonatal deaths from sepsis in the country (Blencowe et al., 2011; Darmstadt et al., 2009). Such deaths were independent of iron and folic acid supplementation and might explain the difference of our finding with earlier studies.

Early postnatal care practices such as thermal care, umbilical cord care, skin care and breastfeeding were likely to be associated with the reduction in the risk of birth asphyxia, preterm birth, low birth weight, sepsis, tetanus or pneumonia, which were the major causes of neonatal deaths in LMICs (Baqui et al., 2009a; Baqui et al., 2008; Blencowe et al., 2011; Darmstadt et al., 2005; Kumar et al., 2008). Researchers reported substantial improvements in neonatal survival as a result of postnatal care (Bang et al., 1999; Baqui et al., 2008; Bhutta et al., 2011; Kumar et al., 2008; WHO & UNICEF, 2009). For example, neonatal mortality in Bangladesh, Pakistan and India was reduced by 34%, 15% and 54%, respectively (Baqui et al., 2008; Bhutta et al., 2011; Kumar et al., 2008). While interventions in these research included both antenatal and postnatal visits to promote essential newborn care, they were not independent and the effect of antenatal care was not considered in those analyses.

The only study which included the effect of iron and folic acid supplementation in investigating the impact of postnatal care on neonatal deaths, like our findings, did not find any significant impact of postnatal care (Titaley & Dibley, 2012). Thus our findings could indicate that iron and folic acid supplementation was more important in reducing neonatal mortality rather than postnatal care, as found in Titaley & Dibley (2012). A higher neonatal mortality for those who had early postnatal check-ups, particularly on the first day of life, could be due to a higher probability of illness or morbidity. As reported by earlier researchers, families were more likely to visit medical professionals in case of severe complications (Akter et al., 2015; Baqui et al., 2009b; Titaley & Dibley, 2012). This might reflect issues related to the referral system, delays in seeking care and poor compliance with recommended treatments, along with lack of competent health professionals to manage obstetric and neonatal complications (Akter, Sibbritt, & Dawson, 2016; Baqui et al., 2009b; Titaley & Dibley, 2012; Titaley, Dibley, & Roberts, 2012). These findings could also be linked with the fact that the provision of postnatal care limited to extremely ill infants in LMICs.

Some points are worth mentioning to contextualize our results. First, our analysis showed a higher neonatal mortality for larger than average sized babies, contrasting with earlier research (Nisar & Dibley, 2014a; Titaley, Dibley, Agho, Roberts, & Hall, 2008). A further review of previous research indicated that this association might relate to gestational diabetes mellitus (GDM) (Mahtab & Bhowmik, 2016; Mannan, Rahman, Ara, & Afroz, 2012). Researchers reported that the prevalence of GDM in urban Bangladeshi population was about 7.5% in 2012, indicating that it might be responsible for our results (Mannan et al., 2012). Unfortunately, our data do not have information on GDM and therefore restrict any further investigation of the complications that could affect higher neonatal mortality for larger than

average sized babies. Second, we observed increased risk of neonatal deaths for those babies born by Caesarean section, attended by skilled birth attendants and delivered at a health facility. This might be due to the fact that mothers only came to the facility if they were medically in trouble (Titaley et al., 2012; Tura, Fantahun, & Worku, 2013). Finally, another point is the importance of controlling for confounding variables in the model. The effect of antenatal care was not significant in the unadjusted models. However, when we controlled for the potential confounders, the effect was large and statistically significant. An opposite scenario was observed in case of postnatal care. Thus our findings indicate that identification of impacts require a careful selection of confounders as some of them can be correlated with the exposure variables.

A major strength of this study is that data are obtained from a large and nationally-representative sample of newborns. However, this study is not free from potential limitations. Firstly, we cannot determine causal relationship, but rather only associations, because of the cross-sectional survey design. Secondly, the selected variables in our study relied on the availability of information in the survey. For example, due to the unavailability of information, some important variables such as delivery complications, gestational diabetes mellitus, timing of antenatal care and preterm birth were not considered in our study. Thirdly, recall bias was an important issue in this study as all information came from interviews with mother's who were required to remember details over the previous five years. Nevertheless, these limitations were unlikely to have had an important influence on the consistency of our findings.

Conclusion

We investigated the impact of antenatal and postnatal care on the mortality of neonates born in Bangladesh. We found that the neonatal mortality in Bangladesh can be reduced significantly through emphasising the antenatal care, probably through the intake of iron and folic acid during pregnancy. Health promotion programmes, including the community-based interventions, may build awareness about these practices. Our analysis may assist in designing policies and programmes related to antenatal and postnatal cares in LMICs. However, further research should examine the reasons for the lack of impact of postnatal care on neonatal mortality.

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Table 1: Frequency distribution of demographic, socio-economic and birthing characteristics for most recent deliveries in Bangladesh

Variable	Neonatal death			Early neonatal death		
	Alive n=7,183 (%)	Dead n=131 (%)	p-value	Alive n=7,212 (%)	Dead n=102 (%)	p-value
Division						
Dhaka	1,202 (31.4)	24 (37.6)		1,205 (31.3)	21 (40.8)	
Barisal	834 (5.8)	21 (9.6)		839 (5.8)	16 (8.9)	
Chittagong	1,377 (21.8)	15 (11.6)		1,377 (21.7)	15 (14.5)	
Khulna	863 (9.7)	13 (9.5)	0.018	865 (9.7)	11 (9.7)	0.148
Rajshahi	932 (13.6)	14 (11.6)		935 (13.6)	11 (11.6)	
Rangpur	946 (11.0)	14 (8.6)		950 (11.0)	10 (6.5)	
Sylhet	1,029 (6.8)	30 (11.6)		1,041 (6.9)	18 (8.0)	
Urban/Rural						
Urban	2,283 (23.3)	43 (25.4)	0.619	2,286 (23.3)	40 (30.8)	0.118
Rural	4,900 (76.7)	88 (74.6)		4,926 (76.7)	62 (69.2)	
Paternal years of schooling	5.08±0.06[a]	4.71±0.50[a]	0.465	5.07±0.06[a]	4.85±0.57[a]	0.693
Maternal years of schooling	5.35±0.05[a]	5.18±0.41[a]	0.672	5.35±0.05[a]	5.13±0.49[a]	0.643
Household wealth index	-0.10±0.01[a]	-0.15±0.09[a]	0.666	-0.11±0.01[a]	-0.07±0.11[a]	0.768
Mother's age at birth (years)	23.33±0.08[a]	23.26±0.62[a]	0.918	23.33±0.08[a]	23.05±0.71[a]	0.693
Sex of child						
Male	3,707 (51.5)	79 (60.3)	0.086	3,722 (51.5)	64 (62.9)	0.048
Female	3,476 (48.5)	52 (39.7)		3,490 (48.5)	38 (37.1)	
Birth rank and interval						
First rank	2,423 (33.5)	42 (34.1)		2,428 (33.5)	37 (37.5)	
Second/third rank, interval>2 years	2,965 (41.8)	49 (39.2)	0.117	2,977 (41.8)	37 (38.2)	0.041
Second/third rank, interval≤2 years	424 (5.8)	14 (11.5)		426 (5.8)	12 (12.6)	
≥4th rank	1,354 (18.9)	22 (15.2)		1,363 (18.9)	13 (11.7)	
Desire for pregnancy						
Wanted then	5,089 (70.6)	96 (77.1)		5,107 (70.6)	78 (78.2)	
Wanted later	1,118 (15.4)	22 (15.3)	0.134	1,123 (15.4)	17 (16.0)	0.096
Wanted no more	976 (14.0)	13 (7.7)		982 (14.0)	7 (5.9)	
Size of baby						
Average	4,884 (68.4)	61 (46.5)		4,900 (68.3)	45 (45.3)	
Larger than average	1,047 (14.2)	40 (33.9)	<0.001	1,052 (14.3)	35 (37.4)	<0.001
Smaller than average	1,249 (17.4)	30 (19.7)		1,257 (17.5)	22 (17.3)	

Note: Weighted analysis.
[a] = Mean±SE

Table 2: Frequency distribution of perinatal healthcare service characteristics for most recent deliveries in Bangladesh (confounding variables only)

Variable	Neonatal death			Early neonatal death		
	Alive n=7,183 (%)	Dead n=131 (%)	p-value	Alive n=7,212 (%)	Dead n=102 (%)	p-value
Mode of delivery						
Non-caesarean section	6,029 (85.1)	106 (76.3)	0.023	6,054 (85.1)	81 (72.8)	0.005
Caesarean section	1,143 (14.9)	25 (23.7)		1,147 (14.9)	21 (27.2)	
Delivery attendance						
Unskilled	4,871 (71.0)	79 (58.2)	0.007	4,890 (71.0)	60 (55.3)	0.003
Skilled	2,303 (29.0)	51 (41.8)		2,313 (29.1)	41 (44.7)	
Place of delivery						
Non-health facility	5,132 (73.9)	83 (59.8)	0.002	5,152 (73.9)	63 (56.6)	<0.001
Health facility	2,050 (26.1)	48 (40.3)		2,059 (26.1)	39 (43.4)	

Note: Weighted analysis.

Table 3: Hazard ratios showing the relative contribution of antenatal and postnatal care in reducing neonatal deaths in Bangladesh

Variable	Unadjusted			Adjusted (Model 1)[a]			Adjusted (Model 2)[a]		
	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Use of antenatal service									
No ANC visit	1.00			1.00			1.00		
1-3 visit	0.77	0.49,1.22	0.271	0.61	0.38,0.97	0.038	0.62	0.39,0.98	0.043
4 or more visit	0.91	0.54,1.52	0.712	0.52	0.29,0.96	0.036	0.53	0.29,0.96	0.037
PNC on the first week of life									
No PNC or day 8+ PNC	1.00			1.00					
Days 1-7 PNC	1.80	1.21,2.67	0.004	1.51	0.85,2.69	0.157			
PNC on the first week of life by day									
No PNC or day 8+ PNC	1.00						1.00		
Day 1 PNC	2.03	1.36,3.05	0.001				1.83	0.98,3.41	0.059
Days 2-7 PNC	0.74	0.32,1.73	0.491				0.81	0.33,1.96	0.640

Note: Weighted analysis.

a= Data on 48 cases were missing and were excluded from the analyses.

ANC: Antenatal Care; PNC: Postnatal Care.

Model 1 examined the effects of ANC and days 1-7 PNC by any care provider and adjusted for division, desire for pregnancy, birth size perceived by mother and place of delivery.

Model 2 examined the effects of ANC and day 1 PNC by any care provider and adjusted for division, desire for pregnancy, birth size perceived by mother and place of delivery.

Potential confounders division, desire for pregnancy, birth size perceived by mother and place of delivery were identified from demographic, socio-economic and birthing characteristics, and perinatal healthcare service characteristics through backward stepwise elimination process.

Table 4: Hazard ratios showing the relative contribution of antenatal and postnatal care in reducing early neonatal deaths in Bangladesh

Variable	Unadjusted			Adjusted (Model 1)[a]			Adjusted (Model 2)[a]		
	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Use of antenatal service									
No ANC visit	1.00			1.00			1.00		
1-3 visit	0.91	0.54,1.54	0.737	0.70	0.41,1.19	0.186	0.71	0.41,1.21	0.203
4 or more visit	1.12	0.62,2.00	0.708	0.61	0.31,1.21	0.160	0.62	0.31,1.22	0.166
PNC on the first week of life									
No PNC or day 8+ PNC	1.00			1.00					
Days 1-7 PNC	1.97	1.26,3.09	0.003	1.49	0.77,2.88	0.235			
PNC on the first week of life by day									
No PNC or day 8+ PNC	1.00						1.00		
Day 1 PNC	2.27	1.43,3.59	<0.001				1.83	0.90,3.75	0.097
Days 2-7 PNC	0.67	0.24,1.83	0.431				0.70	0.24,2.01	0.506

Note: Weighted analysis.

a= Data on 48 cases were missing and were excluded from the analyses.

ANC: Antenatal Care; PNC: Postnatal Care.

Model 1 examined the effects of ANC and days 1-7 PNC by any care provider and adjusted for division, desire for pregnancy, birth size perceived by mother and place of delivery.

Model 2 examined the effects of ANC and day 1 PNC by any care provider and adjusted for division, desire for pregnancy, birth size perceived by mother and place of delivery.

Potential confounders division, desire for pregnancy, birth size perceived by mother and place of delivery were identified from demographic, socio-economic and birthing characteristics, and perinatal healthcare service characteristics through backward stepwise elimination process.