

## Differentials and determinants of neonatal mortality in Pakistan: A cross sectional analysis; Pakistan Demographic and Health Survey (2017-18)

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### Abstract

**Objective:** To investigate differentials and determinants of neonatal mortality in Pakistan.

**Method:** The cross-sectional data-based study was conducted at Lahore College for Women University, Lahore, Pakistan from February to July 2019, and comprised data obtained from the Pakistan Demographic and Health Survey 2017-18 which related to the period from November 22, 2017, to April 30, 2018. Neonatal mortality rates were computed to observe the differentials in relation to various categories of socio-demographic factors. Cox proportional hazard model was used to identify significant factors affecting neonatal mortality.

**Results:** Hazard of neonatal mortality significantly decreased as household size increased (hazard ratio: 0.41 and 0.36). Household with improved toilet facility had significantly lower chances (hazard ratio: 0.57) of neonatal death compared to that with unimproved toilet facility. Significantly elevated risk (hazard ratio: 5.56) of neonate death was observed in case of multiple births. Children had better chances (hazard ratio: 0.32 and 0.34) of surviving in neonatal period as duration of birth spacing increased (24-35 months; 36 or more months).

**Conclusion:** Household size, improved toilet facilities, multiple births and preceding birth intervals had significant effect on neonatal mortality.

**Keywords:** PDHS 2017-18, Neonatal mortality rate, Cox proportional hazard model. (JPMA 71: 900; 2021)

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### Introduction

In 2016, 46% of all under-5 deaths occurred in the neonatal period.<sup>1</sup> In past decades, there has been rapid development in reducing under-5 mortality, but reduction in neonatal mortality is still a major challenge for many developing countries<sup>2</sup> where the risk of death during neonatal period is six times higher than that in the developed countries.<sup>3</sup> More than one-third of neonatal deaths in the world occur in three South Asian countries; India, Pakistan and Bangladesh.<sup>3</sup>

Pakistan has the highest perinatal and neonatal mortality rates.<sup>4</sup> Every day almost 500 newborns die in Pakistan, while 216,000 die before completing the first month of life. Pakistan has the third-highest rate of neonatal deaths in the world. Global average annual rate of decline in neonatal mortality rate (NMR) was 2.6% from 1990 to 2018, whereas for Pakistan it was 0.5%<sup>5</sup> which is not enough for the country to achieve sustainable development goal (SDG) which is related to child mortality. Pakistan Demographic Health Survey (PDHS) 1990-91, 2006-07, 2012-13 and 2017-18 reported a neonatal rate of 49, 54, 55 and 42 per 1000 live births respectively.<sup>6</sup> It is evident from PDHS 2017-18 that progress on reducing neonatal mortality rate has started. But this rate is still highest in the region as NMR for

India, Bangladesh and Afghanistan was 22.7, 17.1 and 37.1 per 1000 live births respectively for 2018.<sup>5</sup> This fact is alarming. The current study was planned to investigate differentials and determinants of neonatal mortality in Pakistan.

### Material and Methods

The cross-sectional data-based study was conducted at Lahore College for Women University, Lahore, Pakistan from February to July 2019, and comprised data obtained from PDHS 2017-18 which related to the period from November 22, 2017, to April 30, 2018.

Cox proportional hazard model was used to investigate the association between the survival time and multiple predictor variables. The proposed model aims at examining how specific factors influence the rate of an event happening, like death of neonates, at a point in time. This rate is commonly referred to as the hazard rate.

The dependent variable in this study was the age of children who were born live five years preceding the survey, which is continuous in nature. Age at death (in days) during the first month of life (0-30 days) was treated as uncensored observation.

Outcome variable was examined against a set of independent variables to determine factors that affect neonatal mortality. Potential variables used were community-level factors, like place of residence

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(urban/rural), region, and community education, household characteristics, like household size, water source, toilet facility and wealth index, maternal characteristics, like maternal age, maternal education, maternal work status, maternal body mass index (BMI), and maternal short stature, father's characteristics, like father's education, child characteristics, like gender, multiple births, size of child at birth and preceding birth interval, and maternal and delivery care characteristics, like antenatal care (ANC) visits, antenatal care received by health professional, delivery in health facility, delivered by health professional and mother received tetanus injection. Some of the variables were re-coded while others were adopted as mentioned in PDHS.<sup>6</sup>

BMI and height of mothers were transformed into quartiles to study their effect on neonatal mortality. Mother's BMI was calculated by dividing its defined variable into quartiles, which was categorised into three levels i.e. low (1st quartile), normal (2nd and 3rd quartile) and high (4th quartile). Mother's stature was computed using the mother's height which was divided into two categories on the basis of quartiles. Height of mother was categorized as short stature (1st quartile) and not short stature (2nd, 3rd and 4th quartiles).

As the PDHS provides direct information only for place of residence and region, the other community-level variables were generated by transforming the individual characteristics of interest in a cluster. Community's mother education level was defined as the proportion of mothers within the cluster who had attained at least primary level education. Further, two categories were defined for this variable by comparing cluster proportion with national proportion value i.e. high if cluster proportion

was higher compared to the national proportion value, and low if the cluster proportion was less compared to the national value of proportion.

## Results

NMR was the highest for Punjab 47.3 per 1000 live births, followed by Baluchistan 42.8, Khyber Pakhtunkhwa (KPK) 39.6 and Sindh 36. Neonatal mortality seemed to follow a slight U-shaped pattern with increasing household size and preceding birth interval. NMR was lower for urban residence, communities with high level of education, educated parents and non-working mothers, while it was higher in case of multiple births, male child and for children born to short-stature mothers. Low NMR was also observed for mothers who availed improved toilet facilities, had at least 4 ANC visits, had received tetanus injection, and had

**Table-1A:** Differentials in NMR by selected background characteristics (PDHS 2017-18).

Community Level Characteristics	NMR	Household characteristics	NMR	Delivery Care Characteristics	NMR
Place of residence		Household size		ANC by health professional	
Urban	37.4	>5 members	74.1	No	28.6
Rural	44.8	5-7 members	36.9	Yes	31.2
Region		8 or more	40.0	No. of ANC visit	
Punjab	47.3	Improved water source		Less than or 3	38.5
Sindh	36.0	Unimproved	36.4	4 or more	23.8
KPK	39.6	Improved	42.5	Received tetanus injections	
Baluchistan	42.8	Improved toilet facilities		No	43.4
Community education		Unimproved	58.7	Yes	25.3
Low proportion	47.0	Improved	37.7	Delivery by health professional	
High proportion	34.2	Wealth index		No	47.1
		Poor	50.1	Yes	40.1
		Middle	40.6	Delivery in health facility	
		Rich	34.4	No	46.6
				Yes	39.6

NMR: Neonatal mortality rate; PDHS: Pakistan Demographic and Health Survey; ANC: Antenatal care; KPK: Khyber Pakhtunkhwa.

**Table-1B:** Differentials in NMR by selected background characteristics (PDHS 2017-18).

Maternal Characteristics	NMR	Paternal Characteristic	NMR	Child Characteristics	NMR
Age at 1st birth		Father's education		Child gender	
Under age 18	51.1	Educated	38.1	Male	51.7
18-34	40.9	Un-Educated	52.5	Female	33.0
35 or older	32.8			Multiple birth	
Education				Single	39.7
Uneducated	49.8			Multiple	152.1
Educated	35.2			Size at birth	
Working status				Small	58.9
No job	39.4			Middle	39.2
Have job	59.4			Large	31.5
Maternal BMI				Preceding birth interval	
Low (1 <sup>st</sup> quartile)	30.7			Less than 24 months	66.6
Normal (2 <sup>nd</sup> -3 <sup>rd</sup> quartile)	50.0			24-35 months	26.2
High (4 <sup>th</sup> quartile)	34.1			36 or more months	27.6
Short stature					
No (2 <sup>nd</sup> -4 <sup>th</sup> quartile)	32.8				
Yes (1 <sup>st</sup> quartile)	43.1				

NMR: Neonatal mortality rate; PDHS: Pakistan Demographic and Health Survey; BMI: Body mass index.

**Table-2:** Comparison of neonatal survival across various categories of socio-economic, demographic, community-level and delivery-care characteristics using Log Rank test.

Factors	Chi square	p-value	Factors	Chi square	p-value
<b>Community Level Factors</b>			<b>Child Characteristics</b>		
Place of Residence	1.84	0.1784	Child Gender	2.28	0.1306
Region	4.13	0.2479	Multiple Births	43.04	0.0000*
Community Maternal Education	8.34	0.0039*	Size at Birth	13.20	0.0014*
<b>Household Characteristics</b>			<b>Delivery Care Characteristics</b>		
Household members	18.52	0.0001*	Preceding Birth Interval	44.45	0.0000*
Improved Water Facilities	0.59	0.4443	No. of ANC Visit	3.36	0.0670
Improved Toilet Facilities	1.45	0.2290	ANC by health Professional	3.56	0.0590
Wealth Index	3.82	0.1481	Received Tetanus Injection	7.14	0.0075*
<b>Parental Characteristics</b>			<b>Delivery in Health facility</b>		
Mother's Age at 1st Birth	1.28	0.5265	Delivery by Health Professional	5.02	0.0250*
Mother's Education	8.30	0.0040*			
Mother's Working Status	8.10	0.0040*			
Mother's BMI	0.83	0.3623			
Mother's Stature	0.88	0.3471			
Father's Education	2.52	0.1122			

\*Significant at 5%; ANC: Antenatal care; BMI: Body mass index.

delivery in the presence of a health professional or at a health facility. Decline in NMR was obvious with increase in size of child at birth, in economic status of respondent and the age of mother at first birth. NMR was higher for households having improved water (Table 1A). Inverted U-shaped pattern was observed for various categories of BMI of women and NMR (Table 1B). Survival time of neonates differed significantly ( $p=0.0039$ ) between community with low proportion of maternal education and community with high proportion of

**Table-3:** Socio-economic, demographic and community-level factors associated with neonatal mortality: Unadjusted and adjusted hazard ratio (HR).

Characteristics	HR Unadjusted	HR Adjusted	Characteristics	HR Unadjusted	HR Adjusted
<b>Community Level Characteristics</b>			<b>Parental Characteristics</b>		
<b>Place of residence</b>			<b>Mother's age at 1st birth</b>		
Urban	Ref	-	Under age 18	ref	-
Rural	1.11 (0.76-1.63)	-	18-34	0.87 (0.54-1.39)	-
Region			35 or more	0.84 (0.12-5.79)	-
Punjab	Ref	ref	<b>Mother's education</b>		
Sindh	0.91 (0.59-1.40)	-	Uneducated	ref	-
KPK	0.81 (0.53-1.24)	-	Educated	0.65* (0.47-0.90)	-
Baluchistan	1.20 (0.67-2.15)	-	<b>Mother's work status</b>		
Community education			No job	ref	-
Low proportion	Ref	-	Have job	1.54* (1.06-2.23)	-
High proportion	0.7 (0.46-1.07)	-	<b>Father's education</b>		
-	Uneducated	ref	-	-	-
-	Educated	0.7 (0.48-1.00)	<b>Child Characteristics</b>		
<b>Household Characteristics</b>			<b>Child sex</b>		
<b>Household size</b>			Male	ref	-
<5 members	Ref	ref	Female	0.76 (0.54-1.07)	-
5-7 members	0.51* (0.31-0.83)	0.41*(0.23-0.74)	<b>Multiple birth</b>		
8 or more	0.53* (0.33-0.84)	0.36*(0.21-0.62)	Single	ref	Ref
<b>Improved water source</b>			Multiple	3.7* (2.10-6.52)	5.56*(3.10-9.94)
Unimproved	Ref	-	<b>Size at birth</b>		
Improved	1.01 (0.59-1.74)	-	-	-	-
<b>Improved toilet facility</b>			Middle	0.78 (0.55-1.12)	-
Unimproved	Small	ref	Large	0.45*(0.23-0.88)	-
Improved	Ref	ref	<b>Preceding birth interval</b>		
Wealth Index	0.6* (0.41-0.87)	0.57*(0.39-0.85)	<24 months	ref	ref
Poor	Ref	-	24-35 months	0.34*(0.22-0.52)	0.32*(0.21-0.51)
Middle	0.83 (0.54-1.27)	-	≥36 months	0.38*(0.24-0.60)	0.34*(0.22-0.52)
Rich	0.69 (0.46-1.04)	-			

\*Significant at 5% ; ()=95% Confidence Interval for HR.

maternal education. From household characteristics, survival time differed significantly ( $p=0.0001$ ) for the three categories. Survival time also differed significantly ( $p=0.0040$ ) for maternal education and mother's working status ( $p=0.0040$ ). Survival time varied significantly for all factors across the respective categories of different child characteristics except gender, and survival time of children born to women who received delivery-care characteristics was significantly different ( $p<0.05$ ) compared to mothers who had not utilised such facilities (Table 2).

Household size, improved toilet facilities, mother's education, mother's working status, multiple births, size at birth and preceding birth interval were significant in the unadjusted model at 5% level of significance (Table 3).

Risk of neonatal deaths was significantly lower for households comprising >5 members. Households having 5-7 members had 59% less chance of neonatal death compared to the lowest category of household size (<5 members) (hazard ratio [HR]=0.41). Chances decreased further (HR=0.36) to 64% for household comprising 8 or more members. A household with improved toilet facilities had a lower risk of neonatal death compared to those having unimproved toilet facilities ( $p<0.05$ ). Chances of neonatal deaths reduced (HR=0.57) by 43% in this case. Risk of neonatal death increased approximately 6 times (HR=5.56) for multiple births compared to singleton births. This risk was significantly less for children born after preceding birth interval >2 years compared to those who were born within less than two years of the preceding birth interval ( $p<0.05$ ). Chances of neonatal survival (HR=0.34) were 66% higher for long birth interval compared to the shortest preceding birth interval.

## Discussion

Differentials in NMRs were observed for various categories of socio economic, biological and demographic factors.

Positive strong effect of large household size was found for neonatal mortality in the final model (Table 2). Low risk of neonatal mortality in larger household sizes was also observed in Rwanda.<sup>7</sup> Less probability of neonates' deaths in larger household is attributed to the availability of experienced persons who take care of pregnant women and new born babies. Children born to mothers having improved toilet facilities have been reported to have low risk of neonatal deaths.<sup>7-9</sup> Non-shared toilets prevent diseases such as cholera and typhoid which are listed among the leading causes of child deaths. NMR for multiple births was higher as multiple pregnancies are related with increased risk of prematurity and growth restriction.<sup>10</sup> Another reason of higher risk of neonatal death in case of twins is low birth weight and preterm delivery. These

children also suffer from obstetric complications in mothers, like anaemia, post-partum haemorrhage (PPH), and hypertensive disorders.<sup>11</sup> Higher risk of neonatal mortality was also reported in other studies.<sup>7,12-16</sup> Majority of multiple births lead to prematurity and small gestational age that increase the risk of neonatal deaths.<sup>14,17</sup> In the current model, HR for this factor was the maximum, and the reason was lack of advanced healthcare service to handle complications of multiple births.

Longer birth interval decreased the chance of neonatal death significantly, and the finding is universal in this regard.<sup>12,18-20</sup> Long intervals between two births provide protection for later births.<sup>16</sup> Short birth-spacing has been found to be associated with increased preterm birth, and low birth weight.<sup>21</sup>

Long birth intervals, joint family system and use of improved toilet facilities should be promoted. Pregnant women and the community need to be educated about alarming signs of pregnancy, particularly in multiple births.

Overall, the results of the current study indicated a need to promote the coverage and quality of maternal and child healthcare to make their impact significant in reducing neonatal mortality. The finding related to the correlation between NMR and mother's BMI, however, were rather absurd as NMR was found to be the highest for mothers having normal weight. NMR for mother's BMI need to be probed further.

In terms of limitations, delivery-care characteristics, mother's BMI and mother's short stature were not included in the model because these variables had a high proportion of missing values. The same was the case with variables related to the utilisation of healthcare services.

## Conclusion

Utilisation of healthcare services has played a vital role in reducing NMR in Pakistan. Household size, improved toilet facilities, multiple births and preceding birth intervals were found to have significant effect on neonatal mortality. Significant protective factors of neonate deaths were large household size, improved toilet facilities, singleton births and long birth interval.

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