Preceding Child Survival Status and Its Effect on Infant and Child mortality in India: An Evidence from National Family Health Survey 2015-16

Background

As per 2017 statistics 4.1 million infant deaths occurred which constituted about 75% of all under-five deaths. Globally, the infant mortality rate has decreased from an estimated rate of 65 deaths per 1000 live births in 1990 to 29 deaths per 1000 live births in 2017. Annual infant deaths have declined from 8.8 million in 1990 to 4.1 million in 2017 ("WHO | Infant mortality," 2018). On the other hand 5.4 million under five child deaths occur in the same year which actually translates into 15000 under five deaths per day (WHO, 2018). The risk of a child dying before completing five years of age is still highest in the WHO African Region (74 per 1000 live births), around 8 times higher than that in the WHO European Region (9 per 1000 live births) (WHO, 2018). Top six preventable cause of under five deaths are premature birth, Pneumonia, Birth defects, Newborns infections, malaria, sepsis and missiles, Birth complications and diarrhea (Bryce et al., 2005; Huber, 2016; Mathers, 2014).

India had achieved impressive gains in child survival over the last two decades, however was not successful to achieve MDG 2015 goals. For example, U5MR reduced from 114 per 1000 live births in 1990 to 39 in 2016 at an annual rate of 3%. Similarly, IMR reduced from 81 to 34 per 1000 live births between 1990 and 2016 (Bhatia, Dwivedi, Ranjan, Dixit, & Putcha, 2019; UNICEF, 2012). Children born to mothers with at least 8 years of schooling have more chances to survive, Children born to adolescent mothers are at higher risk of death, children born less than two years after the first delivery are less likely to survive, mortality among children born to malnourished, anaemic as well as obese mothers is higher (UNICEF, 2012). Exclusive breast-feeding, serving good quality complementary food, proper feeding of micro-nutrients such as vitamin A and Iron, proper hand wash, full immunization were found to be some of the preventive measures for child health (SMillion & Study, 2010; WHO, 2002).

Previous study found that effect of short preceding intervals on children under age five years were mainly concentrated in the neo-natal period (Gonçalves & Moultrie, 2012; Hobcraft, McDonald, & Rustein, 2016). Moreover, earlier studies presented the fact that prenatal factors are more important than postnatal factors in the causal pathway between rapid childbearing and heightened risk of early childhood mortality. If the birth interval was shorter than 24 months, the joint effects of pregnancy and lactation on a mother's physiology and nutritional status may be a mechanism through which short preceding intervals affect child-health status. This may result in low birth- weight children, prematurity, or impaired lactational abilities. Also short birth intervals are associated with a somewhat higher risk of not attending prenatal care at all, which is one of the factor that effect child health. Moreover, children born after short birth intervals also had somewhat higher chances of not being breastfed, even after controlling for neonatal mortality, which may in part indicate that women who do not breastfeed have shorter birth intervals (Boerma, Bicego, Boerma, & Bicego, 2019). Long preceding birth intervals have lower odds of under-five child mortality. Interestingly, when the associations were stratified by maternal completed fertility, the association between short birth intervals and child mortality largely disappeared for mothers with low completed fertility. Both shorter intervals and higher risk of repeat infant mortality occur in families that have experienced one early infant death, the death of a second child after a short interval may not be due to the interval but to some other factor that also caused the first death and the shortened interval (Winikoff, 1983).

Low fertility mothers may have better nutritional status and access to care, hence short birth intervals may not deplete the mother's nutritional resources to a level that results in increased risk of mortality for the child. For high fertility mothers, the women may be starting out with worse nutritional status and access to care (Kozuki & Walker, 2013; Molitoris, 2017). Many studies confirms the fact that multiple births have higher likelihood of death. Moreover, Household wealth is also one of the strong predictor of infant mortality, whereas mother's education and mother's age at first birth was not found to be significantly associated with risk of death (Fotso, Cleland, Mberu, Mutua, & Elungata, 2013).

Previous literature confirms that if first-born children of adolescent mothers are the most vulnerable to infant mortality and poor child health outcomes(Finlay, Özaltin, & Canning, 2011). This issue can be confirmed by the fact that low maternal age is highly associated with stunting of child (Finlay et al., 2011). Offspring mortality had a U-shaped association with maternal age, as compared to reference group of 20-24 years, younger (≤19 years) and older (≥35 years) maternal ages were associated with a higher risk of offspring mortality (Sinha et al., 2016). However, advanced age of the mother, more than male gender of the baby, contributes an increased risk of preterm delivery, which poses high risk of infant mortality (Astolfi & Zonta, 1999). Birth order and mortality risk among infant and child are having significant relationship has been proved in various previous studies. It has been argued that birth-order effect is much stronger in the post-neonatal period. As the birth order goes up the risk of dying also shoots up and this relation is further differentiated between male and female children. Moreover, mother's age, mother's education, child's sex and child's birth weight – are highly significant in confounding, explaining or modifying the relationship between birth order and infant mortality (Mishra, Ram, Singh, & Yadav, 2018). Mother's age at birth has a U–shaped relationship with early neonatal, neonatal, post–neonatal, and infant mortality. This relationship persists even after adjusting for the preceding birth–to–conception interval, the child's birth order, and other potential confounders (Rutstein, Winter, & International, 2014).

An important line of enquiry is that how the survival status of preceding child actually affects the survival status of the next born child. Also, the effect of confounding variables like preceding birth interval, gender of child, birth order, maternal age at birth of first child, multiple births and other background factor of mother are need to be evaluated.

Methods

This is a retrospective analysis of data from the National Family Household Survey 2015-16. The 2015-16 National Family Health Survey (NFHS-4), the fourth in the NFHS series, provides information on population, health, and nutrition for India and each state and union territory. All four NFHS surveys have been conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. MoHFW designated the International Institute for Population Sciences (IIPS), Mumbai, as the nodal agency for all of the surveys. The NDHS is a cross-sectional household survey conducted on representative samples selected across the 36 states in India (Balram Paswan, S.K. Singh, Hemkhothang Lhungdim, Chander Shekhar, Sunita Kishor, Manoj Alagarajan, & Laxmi Kant Dwivedi, 2017).

This study focused on survival of preceding child; therefore, analysis was restricted to women with second or higher order births because women with first order births do not have preceding child. As few children in the analysis had been exposed to the risk of mortality after the age of 2 years, the outcomes of interest in this paper are infant mortality and under-five child mortality. The key predictor is survival status of any preceding child (alive, dead), sex of the child (male, female), maternal age at child birth (<18, 18-34, 35+), child birth order (2, 3, 4+), preceding birth interval (PBI), defined as the difference in months between the date of birth of the index child and the date of birth of the preceding child. It is coded as a four-category variable (<19 months, 18–23 months, 24–35 months, 36 months) and multiple birth status was coded as (single, multiple). Other maternal socio-economic factors were taken in consideration which includes: education (illiterate, primary, secondary and higher), religion (Hindu, Muslims and others), caste (deprived: Sc/St and not-deprived: other than Sc/St), wealth index (poorest, poorer, middle, richer and richest), type of residence (urban and rural), regions of India (north, central, east, north-east, west and south).

Statistical analysis

Proportional hazards regression, also called Cox regression, models the incidence or hazard rate, the number of new cases of disease per population at-risk per unit time. If the outcome is death, this is the mortality rate. The hazard function is the probability that if a person survives to t, they will experience the event in the next instant.

The proportional hazards model is as follows:

Let $\lambda(t|X_{1i},X_{2i},\cdots,X_{Ki})$ denote the hazard function for the i*th* person at time t, i=1,2,⋯,n, where the K repressors are denoted as $X_{1i},X_{2i},\cdots,X_{Ki}$. The baseline hazard function at time *t*, i.e., when X1i=0, X_{2i}=0... X_{Ki} = 0, is denoted as $\lambda_0(t)$. The baseline hazard function is analogous to the intercept term in a multiple regression or logistic regression model. Notice the baseline hazard function is not specified, but must be positive.

The hazard ratio, $\lambda_1(t)/\lambda_0(t)$ can be regarded as the relative risk of the event occurring at time *t*. The log of the hazard ratio, i.e. the hazard function divided by the baseline hazard function at time *t*, is a linear combination of parameters and repressors, i.e.,

$$\text{Log}\,(\lambda\,(t|X_{1i},\,X2i...\,XKi)\;\lambda_0\,(t)) = \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_K X_{Ki}$$

The ratio of hazard functions can be considered a ratio of risk functions, so the proportional hazards regression model can be considered as function of relative risk (while logistic regression models are a function of an odds ratio). Changes in a covariate have a multiplicative effect on the baseline risk. The model in terms of the hazard function at time *t* is:

$$\lambda\,(t|X_{1i},\,X_{2i},...,XKi) = \lambda_0(t)\exp(\beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_K X_{Ki})$$

Infant and Child deaths were used for the analysis. Kaplan–Meier (K–M) survival curves were also generated, with focus on the preceding birth intervals. Non-parametric K–M survival curves were used to explore the data and assess the fitness of the choice of Cox proportional hazard model for the multivariate analysis. The Cox models were fitted using the index child’s age as the timing variable and death of child as the censoring variable. The hazard of mortality at any point in time t is given as:

$$h(t|X) = h(t)exp\sum_{i=1}^{p} X_i\beta_i$$

Where h (t) is the baseline hazard, which represents the probability of the child dying before any exposure to X.

All Cox models were tested for proportionality assumptions. This test was performed using the Schoenfeld test of proportionality, a re-estimation procedure using residuals of the Cox proportional hazard model. The multivariate analyses were carried out through four models. Model 1 includes the key predictor (survival status of any preceding child) coded as a binary variable (alive or dead). Model 2 adds to Model 1 and other five bio-demographic factors: sex of the child, maternal at child birth, PBI (preceding birth interval), and single/multiple births. Model 3 adds to Model 1 the remaining background covariates of mother which included: education, religion, caste, wealth index, type of residence and regions. Model 4 adds all the other covariates from all three models.

Results

Table 1 shows the bivariate association of background and bio-demographic factors with infant and under five mortality rates. Births succeeded by a dead child have the highest infant (15.21) and under five deaths (17.64). Infant deaths constitute more deaths of male children (4.98) while under five mortalities are more among the females (6.27). Higher infant (5.61) and under five deaths (7.15) are noticed for maternal age below 18 years. Noticeably, birth order 4+ is associated with higher infant (6.43) and under five mortality rates (8.23). Births with preceding birth intervals shorter than 19 months have the highest infant mortality rate (10.22) and under five mortality rate (12.34). A considerably higher infant (26.61) and under-five deaths (27.95) were recorded in case of multiple births. Among maternal socioeconomic factors, education of mother and household wealth index showed a negative association with infant and under five mortality rates. A significantly higher infant and under-five deaths were found amongst children belonging to Hindu religion (5.04 & 5.31) and deprived section of the society (6.36 & 6.90). Higher infant deaths (5.29) as well as under-five deaths (6.73) were found in the rural areas when to the urban counterparts. Region wise, highest infant deaths were found in the Central region (6.79) while a major preponderance of under-five deaths were found in the central region of India (8.70).

The results of the hazard models on the determinants of infant mortality are shown in **Table 2.** In model 1, the partial effect of survival status of preceding child is strong as the infants with preceding child as dead are more likely to experience infant mortality (3.43*) than the alive ones. Model 2 includes bio-demographic factors along with the survival status of preceding child. After the inclusion of other factors, the effect of survival status on infant death reduces to certain extent (2.63*). Female children were more likely to experience infant mortality than their male counterparts (1.16*). Higher maternal age at childbirth (18-34) depicted lower likelihood of infant deaths (0.85*) than the below 18 age group. Children born after birth interval of 36+ months were least likely to experience infant mortality (0.61*) compared to birth interval less than 19 months. Lastly, multiple births showed more likelihood of infant mortality (4.56*) than single births. Model 3 includes survival status of the preceding child along with the maternal socioeconomic factors. In model 3, the effect of survival status of preceding child on infant mortality remains strong and significant (3.08*); implying that infant mortality was more likely to occur among the births with a preceding dead child. Among these factors, place of residence came up as insignificant while education of mother showed a negative relationship with infant mortality. It was seen that infants of educated mothers experienced least mortality (0.46*) when compared to the illiterate ones. Infants belonging to other religion were more likely to experience mortality (1.13*) compared to the Hindu counterparts. Infant deaths are less likely to occur among the not-deprived caste category (0.96*) than the deprived ones. Household wealth index shows a negative association with infant mortality wherein the children from the children wealth quintile are least likely to experience infant mortality than the poorest ones. Lastly, infants from the Central region of India were more likely to experience mortality (1.34*) whereas the least likelihood was found in western region (0.67*) compared to the northern region. Model 4 includes all the factors into consideration, i.e., bio demographic and maternal socioeconomic factors. With the inclusion of all the factors, the effect of survival status of preceding child decreases but remains significant (2.42*). Factors like caste and place of residence became insignificant in this full effect model. Like model 2, female infants were more likely to experience mortality (1.15*) when compared to the male infants. Infants born to mothers of age 18-34 showed less likelihood of mortality (0.86*) when compared to less than 18 years of mothers. Similar to Model 2, infants of birth order 4+ were less likely to die (0.29*) when compared to birth order 2. Likelihood of infant deaths among multiple birth increased from model 2 to model 4 (4.77*). Education of mother and household wealth index showed a negative relationship with infant deaths. Infant deaths were less likely among the children belonging to educated mothers and having sound wealth background. Infants from Other religion were more likely to experience mortality (1.09*) than the Hindu ones. Similar pattern has been observed for regions; in which the infants from the

Central region of India were more likely to experience mortality (1.33*) whereas the least likelihood was found in western region (0.67*) compared to the northern region.

The results of the hazard models on the determinants of child mortality are shown in **Table 3.** In Model 1, the risk of dying in early childhood is about 3.08 times higher among children with a preceding dead child. This result changes marginally in Model 2 where risk of dying in early childhood is about 2.43 times higher among children with a preceding dead child. There is significant difference between male and female child mortality, the latter is associated with statistically significant excess early childhood mortality (1.25*), compared with male children. Children born to mothers of age 18-34 have a mortality rate that is nearly 17 percent lower (0.83*) than their counterparts. Children born at birth order 4+ experience higher mortality than their respective counterparts (1.56*). Children born with birth interval more than 36+ months were 69 percent less likely to experience child mortality (0.31*). Multiple births continue to experience a mortality rate that is 3.2 times higher than single births. In model 3, the effect of survival status of preceding child was significantly associated with child mortality (2.68*). Mother's education is significantly related to the risk of death among children as children of educated mothers were 62 % less likely to experience child mortality than the uneducated ones. Children from other religion showed 15 % more likelihood to experience mortality than their Hindu counterparts. Lower likelihood of child mortality was observed among children belonging to non-deprived section of the society (0.93*). Household wealth was negatively associated with child deaths as the richest children were 45% less likely to experience child mortality than the poorest lot. Region wise association shows that children belonging to Central region were 43% more likely to experience child mortality compared to the North. Model 4 is the full effect model including all the factors, shows that the effect of survival status of preceding child on child mortality has decreased but is still significant (2.17*). The pattern of difference between male and female child mortality remains same as model 2 where females are associated with statistically significant excess early childhood mortality (1.24*). Mother's age at birth emerges to be significantly related to the risk of death in childhood depicting thereby lower risk of child mortality (0.77*) when the mother's age is above 35 years. Alike model 2, children born at birth order 4+ experience higher mortality than their respective counterparts (1.24*). Children born with birth interval more than 36+ months were 69 percent less likely to experience child mortality (0.31*). Multiple births continue to experience a mortality rate that is 3.3 times higher than single births. Household wealth and education of mother prove to be strong predictors of child mortality. Children from richest households and born to educated mothers have child mortality rate that is about 43% and 55% lower than the rate of their counterparts from the upper economic class and illiterate mothers. Infants belonging to other religion were more likely to experience mortality (1.11*) compared to the Hindu counterparts. Infant deaths are less likely to occur among the not-deprived caste category (0.94*) than the deprived ones. Region emerges to be a strong predictor of infant mortality, with births from Central region recording child mortality about 42% higher than those from North region. Infant mortality and childhood mortality trajectories by preceding child interval are depicted in Figure 1 and Figure 2.

Discussion and conclusion

This study shows that how the survival status of preceding child effects the survival status of succeeding child. Other maternal bio-demographic and demographic factors are taken into consideration to carry out the analysis.

Socio-economic status of mother plays a vital role in determining the survival status of the child. As found in the present study and also evident from the other literatures too that Infant and child survival is low among those whose mothers are illiterate as well as belong to poorest wealth quintile (Yaya et al., 2017). In the present study it was found that survival status of preceding child plays a vital role in survival status of the succeeding child. The similar results are depicted in other studies too (broeck, eeckels, & massa, 1996; Singhi et al., 1989). Mosley & Chen's analytical framework for studying the determinants of child survival also found age, parity, and birth interval as determining factors for child survival (Hill, 2003). It has been found that effect of short preceding birth interval on child mortality is strong when preceding sibling dies (Conde-Agudelo, Rosas-Bermudez, Castaño, & Norton, 2012). This statement signifies that if the preceding birth interval is short than chances of infant or child death is high and moreover if the child dies than this forms a chain of death clustering among siblings having short PBI and dead siblings. First, women with short birth intervals have shorter recuperative intervals between the end of lactation and the start of a new pregnancy than do women with longer intervals. The over-lap of gestation and lactation is particularly stressful to the mother and the child. Therefore, the joint effects of pregnancy and lactation on a mother's physiology and nutritional status may be a mechanism through which short preceding intervals affect child-health status. This may result in low birth- weight children, prematurity, or impaired lactational abilities. Second, short birth intervals are associated with a somewhat higher risk of not attending prenatal care at all. This higher risk may be due to the lack of opportunities to attend prenatal clinics, since there is a young child to care for, although con- trolling for the survival status of the previous child did not have an effect. There may also be sociocultural or personal reasons for not attending prenatal care, since a rapid return to pregnancy is often considered undesirable and perhaps embarrassing. Another explanation is that a higher proportion of premature deliveries among women having short birth intervals contributes to the lower proportion attending prenatal care among such women, particularly if women tend to make the first visit to prenatal clinics late in pregnancy. Women with long birth intervals (of three years or more) have moderately higher levels of attendance at prenatal care and are slightly more likely to deliver in institutions than women with shorter intervals. Both more opportunities and better motivation to have another child may contribute to these differences (Boerma et al., 2019).

Children born with multiple births were more prone to die in infancy than who are born children born single. Other studies too confirms the same fact that multiple births such as twins or triplets are at high risk pregnancy and birth (Uthman, Uthman, & Yahaya, 2008).

Similar to earlier studies it was found that central India exhibits highest IMR and child mortality, whereas south and western regions performs better in the respective scenario (Bhatia et al., 2019). It was further commented that IMR was higher in North India in comparison to South India. The results of bivariate and multivariate analyses show that illiteracy, working status of women and low age at birth were the main mother-related covariates for a high IMR (Kumar Patel & Gouda, 2017). Girls die more commonly than boys do due to existing underlying causes like inequality in health care for example fewer girls than boys are vaccinated in health facilities (Michael, 2010). RMNCH +A interventions were applied to achieve under five mortality to 33/1000 and IMR to 25/1000 by 2017, however the goals are not achieved yet. Current status of under-five and infant is 39 and 34 per 1000 respectively which is far behind the goals to be achieved (MoHFW, 2013). As stated younger maternal age is associated with lower birth weight, preterm birth and low nutritional status, which is the possible cause of infant and child mortality. The children of teenage mothers, aged ≤ 19 years, have higher chances of Preventable child death. Teenage pregnancy concentrates the worst damage to the health of the mother and perinatal complications, which can worsen in insecure socioeconomic and geographical situations, with difficulties in the access to health services and with the presence of patriarchal issues. Women of low socioeconomic level get pregnant early and have difficulties while taking care of newborns, since poverty and teen pregnancy are indicators of precarious life conditions and lack of prenatal care (Maria et al., 2018). Finding from other studies also adds up that risk of under-five death is high among women with age 16 years or less (Neal, Channon, & Chintsanya, 2018; Sachdev et al., 2015).

For this study, the nationally representative data from the 2015-16 Indian Demographic and Health Survey was used. The objective was to investigate the socio-economic, demographic, and geographic predictors of infant and under-five mortality in Ethiopia. The Cox regression analysis technique has been applied to identify the important socio-economic, demographic, and geographic predictors of infant and under-five mortality. A Cox regression model is used when the relative risk values for different levels of variables measured at different levels of socio-economic, demographic, and geographic variables. Even though infant and under five mortality rates have been decreasing in many parts of sub-Saharan Africa in recent decades, they remain among the highest in the world. In the literature, the decline in mortality is well documented, but it has been difficult to determine the various socio-economic, demographic, and geographic factors associated with this decline.

Infant and Child deaths are highly clustered among those mothers whose earlier child is dead. This signifies the result that some mothers are always at disadvantageous stage when it comes to infant and child mortality. Moreover, as maternal child bearing age is still low in India, poses a high risk of infant and child death among those. Mothers with higher birth order are having high risk to lose their child as it is difficult to take care of every child. However, in accordance with reason mothers who have short birth interval too had high risk of suffering from child mortality.

Limitation of the study

One of the main limitation of the study is that spacing between live births are taken into consideration i.e. the definition of interval ignores the abortion ((both induced and spontaneous) and still- births. It leads to the difficulty that both reproductive failure and intentional pregnancy spacing are associated with increased intervals between live births.

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Table 1: Bivariate analysis showing association between background and bio-demographic factors with Infant and Child death (n= 824,693)		
	Infant death	**U-5 child death**
Bio-Demographic Factors		
Survival status of any preceding child's		
Alive	3.83	4.98
Dead	15.21	17.64
Sex of the child		
Male	4.98	6.04
Female	4.73	6.27
Maternal age at childbirth		
<18	5.61	7.15
18-34	4.57	5.75
35+	4.68	5.55
Child's Birth order		
2	4.09	5.08
3	4.79	6.11
4+	6.43	8.23
Preceding birth interval		
<19 months	10.22	12.34
18-23 months	5.49	7.08
24-35 months	4.07	5.35
36+ months	2.47	3.17
Number of births		
Single	4.45	5.73
Multiple	26.61	27.95
Maternal socio-economic factors		
Education		
Illiterate	5.94	7.75
Primary	4.76	5.87
Secondary	3.36	3.91
Higher	2.08	2.30
Religion		
Hindu	5.04	6.36
Muslim	4.44	5.62
Others	3.49	4.50
Caste		
Deprived	5.31	6.90
Not-Deprived	4.74	5.94
Wealth Index		
Poorest	6.44	8.50
Poorer	5.40	6.86
Middle	4.61	5.61
Richer	3.75	4.57
Richest	2.86	3.36
Type of Residence		
Urban	3.76	4.65
Rural	5.29	6.73
Regions		
North	4.26	5.42
Central	6.79	8.70
East	4.85	6.17
North-East	4.35	5.54
West	3.13	3.84
South	3.45	4.10
Total	**4.86**	**6.15**

Table 2. Results of Cox proportional hazards models (hazard ratio) on the determinants of infant mortality in India, NFHS 2015-16				
Bio-Demographic Factors	**MODEL 1**	**MODEL 2**	**MODEL 3**	**MODEL 4**
Survival status of any preceding child's	**Hazard Ratio**	**Hazard Ratio**	**Hazard Ratio**	**Hazard Ratio**
Alive®	Ref.	Ref.	Ref.	Ref.
Dead	3.43*(3.3,3.57)	2.63*(2.52,2.74)	3.08*(2.96,3.21)	2.42*(2.32,2.53)
Sex of the child				
Male®		Ref.		Ref.
Female		1.16*(1.12,1.2)		1.15*(1.11,1.19)
Maternal age at childbirth				
<18®		Ref.		Ref.
18-34		0.85*(0.82,0.88)		0.86*(0.83,0.89)
35+		0.8*(0.67,0.97)		0.83(0.69,1)
Child's Birth order				
2®		Ref.		Ref.
3		1.2*(1.15,1.25)		1.11*(1.06,1.16)
4+		1.53*(1.47,1.59)		1.29*(1.24,1.34)
Child's Birth interval				
<19 months		Ref.		Ref.
18-23 months		0.61*(0.58,0.65)		0.6*(0.57,0.64)
24-35 months		0.48*(0.46,0.5)		0.47*(0.45,0.5)
36+ months		0.29*(0.27,0.3)		0.29*(0.27,0.3)
Multiple births				
Single®		Ref.		Ref.
Multiple		4.56*(4.22,4.94)		4.77*(4.41,5.17)
Maternal socio-economic factors				
Education				
Illiterate®			Ref.	Ref.
Primary			0.88*(0.84,0.92)	0.89*(0.85,0.93)
Secondary			0.71*(0.68,0.75)	0.75*(0.72,0.79)
Higher			0.46*(0.39,0.54)	0.54*(0.46,0.63)
Religion				
Hindu®			Ref.	Ref.
Muslim			0.95(0.91,1)	0.89*(0.85,0.94)
Others			1.13*(1.06,1.21)	1.09*(1.01,1.17)
Caste				
Deprived®			Ref.	Ref.
Not-Deprived			0.96*(0.92,1)	0.98(0.94,1.02)
Wealth Index				
Poorest ®			Ref.	Ref.
Poorer			0.93*(0.89,0.97)	0.93*(0.88,0.97)
Middle			0.89*(0.85,0.94)	0.88*(0.84,0.93)
Richer			0.83*(0.77,0.88)	0.82*(0.77,0.88)
Richest			0.68*(0.62,0.74)	0.7*(0.65,0.76)
Type of Residence				
Urban®			Ref.	Ref.
Rural			1(0.95,1.05)	1.01(0.96,1.06)
Regions				
North ®			Ref.	Ref.
Central			1.34*(1.27,1.41)	1.33*(1.26,1.4)
East			0.9*(0.85,0.96)	0.93*(0.87,0.99)
North-East			1.02(0.95,1.1)	1.09*(1.01,1.17)
West			0.67*(0.61,0.74)	0.67*(0.61,0.74)
South			0.72*(0.66,0.78)	0.73*(0.67,0.8)
®/Ref: Reference group; *****if p<0.05				

Table 3. Results of Cox proportional hazards models (hazard ratio) on the determinants of child mortality in India, NFHS 2015-16				
Bio-Demographic Factors	**MODEL 1**	**MODEL 2**	**MODEL 3**	**MODEL 4**
Survival status of any preceding child's	**Hazard Ratio**	**Hazard Ratio**	**Hazard Ratio**	**Hazard Ratio**
Alive®	Ref.	Ref.	Ref.	Ref.
Dead	3.08*(2.99,3.18)	2.43*(2.36,2.51)	2.68*(2.6,2.76)	2.17*(2.1,2.24)
Sex of the child				
Male®		Ref.		Ref.
Female		1.25*(1.22,1.28)		1.24*(1.21,1.27)
Maternal age at childbirth				
<18®		Ref.		Ref.
18-34		0.83*(0.81,0.85)		0.85*(0.82,0.87)
35+		0.73*(0.64,0.84)		0.77*(0.66,0.88)
Child's Birth order				
2®		Ref.		Ref.
3		1.22*(1.19,1.26)		1.11*(1.07,1.14)
4+		1.56*(1.51,1.6)		1.24*(1.2,1.28)
Child's Birth interval				
<19 months		Ref.		Ref.
18-23 months		0.69*(0.66,0.71)		0.67*(0.65,0.7)
24-35 months		0.54*(0.52,0.56)		0.53*(0.51,0.54)
36+ months		0.31*(0.3,0.32)		0.31*(0.3,0.33)
Multiple births				
Single®		Ref.		Ref.
Multiple		3.2*(2.99,3.42)		3.39*(3.17,3.63)
Maternal socio-economic factors				
Education				
Illiterate®			Ref.	Ref.
Primary			0.8*(0.78,0.83)	0.81*(0.78,0.84)
Secondary			0.62*(0.6,0.64)	0.65*(0.63,0.68)
Higher			0.38*(0.34,0.44)	0.45*(0.4,0.52)
Religion				
Hindu®			Ref.	Ref.
Muslim			0.94*(0.91,0.98)	0.89*(0.85,0.92)
Others			1.15*(1.1,1.22)	1.11*(1.06,1.17)
Caste				
Deprived®			Ref.	Ref.
Not-Deprived			0.93*(0.9,0.96)	0.94*(0.91,0.97)
Wealth Index				
Poorest ®			Ref.	Ref.
Poorer			0.86*(0.83,0.89)	0.86*(0.83,0.88)
Middle			0.77*(0.74,0.8)	0.76*(0.73,0.79)
Richer			0.68*(0.65,0.72)	0.68*(0.65,0.72)
Richest			0.55*(0.52,0.59)	0.57*(0.53,0.61)
Type of Residence				
Urban®			Ref.	Ref.
Rural			0.98(0.95,1.02)	0.99(0.96,1.03)
Regions				
North ®			Ref.	Ref.
Central			1.43*(1.37,1.49)	1.42*(1.36,1.47)
East			0.97(0.92,1.01)	0.99(0.95,1.04)
North-East			1.04(0.98,1.1)	1.1*(1.04,1.17)
West			0.73*(0.68,0.78)	0.73*(0.68,0.78)
South			0.72*(0.67,0.77)	0.73*(0.68,0.78)
®/Ref: Reference group**;** ***if p<0.05				

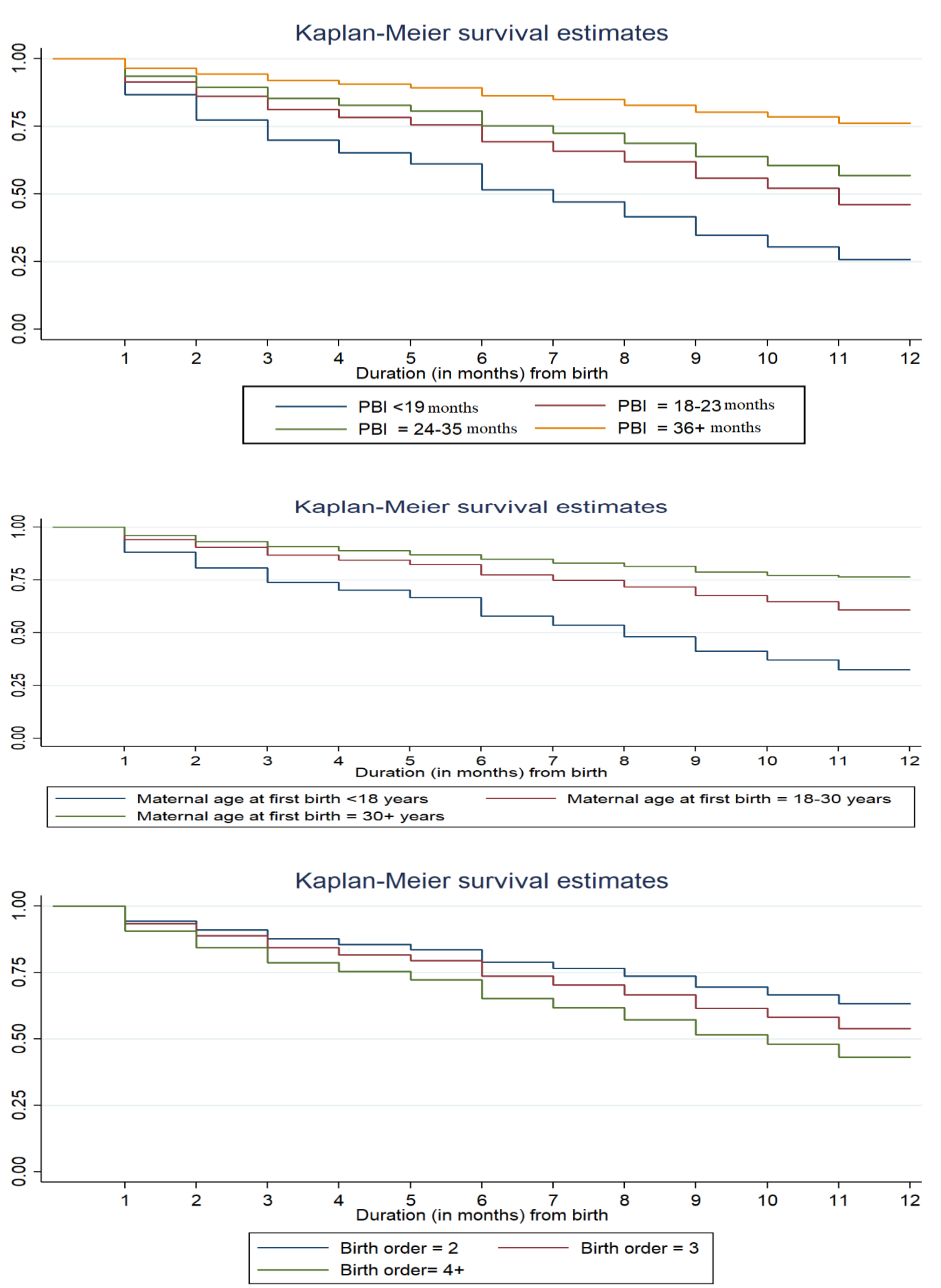

Figure 1 SURVIVAL CURVE FOR INFANT MORTALITY

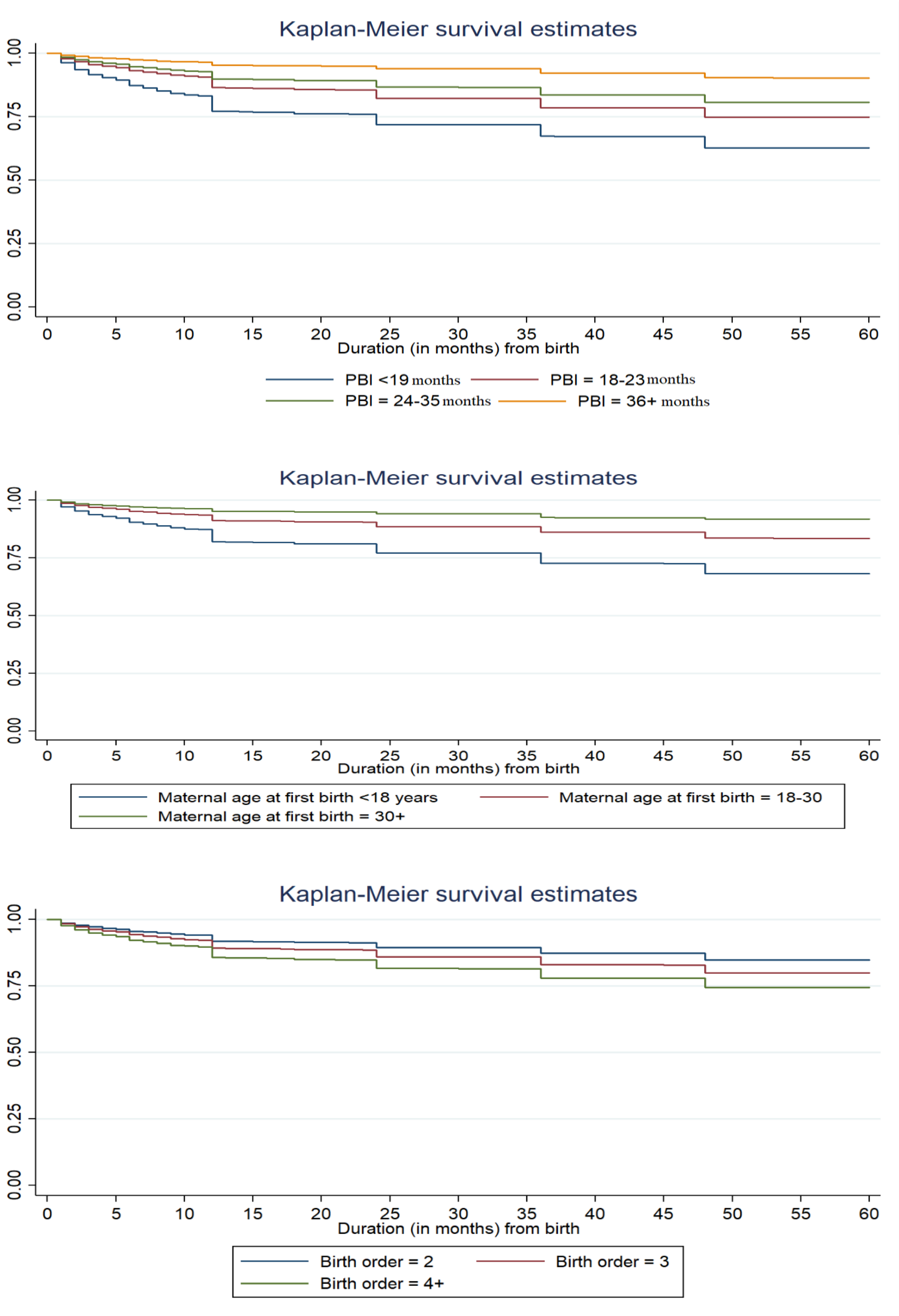

Figure. 2 SURVIVAL CURVE FOR CHILD MORTALITY