# Effect of Maternal Mortality on Survival of Under-five Children: Evidence from Matlab, Bangladesh

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## Abstract

**Background:** Globally, about half a million women die each year due to maternal causes but most of these deaths are preventable. However, more than 99% of these deaths occur in less developed countries. In fact, maternal death can affect health and well-being of the children in various ways: children of dead mothers usually suffer due to lack of day-to-day care, isolation, lack of motivation for better life as well as sufferings due to economic costs associated with mother's death. All these factors directly or indirectly affect children's health and well-being. The objective of the study is to assess the effect of maternal deaths on mortality of under-five children.

**Data and Methods:** The study uses data from Matlab Health and Demographic Surveillance System (HDSS) of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b). Using the HDSS database, the study initially identified mothers who died due to a maternal cause during the period 1974-2005. For those who gave a second- or higher-order livebirth, two children of the same mother were identified for comparison of their survival: one born at or shortly before the mother's death (index child) and another born just before the last child (penultimate child). Our sample comprised 209 index children (without first birth and twin) and 209 penultimate children (without twin). We also identified index first births (72 children) and index twin (26 children). If the index children were adopted by other households after mother's death, survival was compared with those who stayed in their own households; the study also conducted in-depth interviews with 14 of these households. For index children who stayed in their own households after mother's death, survival was also compared between two situations: (a) where a grandmother was present or (b) another female member was present.

We also examined survival probability for the same period (1974-2005) of the most recent children born to women who died during pregnancy (158 children) and the most recent

children born to mothers who died due to non-maternal causes (1,048 children) as well as the most recent children born to surviving mothers (2,170 children). Life-table analyses were performed to examine the survival of under-five children of all categories.

**Results:** Of the children born shortly before the mother's death, 61% died in the first 60 months compared to 19% of those born just before the last child of the same mother. Such difference is mainly due to high mortality in the first six months, however, mortality from 6 to 60 months was almost similar for the two groups of children. Over the period (1974-2005), survival improved for children born just before the last child but not for those born shortly before the mother's death; this is mainly due to change in child adoption pattern. Of those born shortly before the mother's death, 22% died by age 60 months if adopted at the age of 7 days compared to 53% if the children stayed in their own households. However, those adopted at the age of 1 month or later, mortality by age 60 months was similar for the two groups of children. Of the children born shortly before the mother's death, mortality by age 60 months was significantly lower if they stayed in their own households where a grandmother was present compared to where a female member was present (70% vs 82%).

Compared to children born before the last child of the mother who died due to maternal causes, mortality by age 60 months was significantly lower for the most recent child whose mother died due to non-maternal causes (19% vs 11%), and also significantly lower for the most recent child whose mother survived (19% vs 8%).

**Conclusion:** To improve survival of children whose mother died due to maternal cause, adequate day-to-day care should be ensured. The following points may serve as guidelines for this purpose: (a) survival is higher among those children adopted by other households after mother's death than those staying in their own households; (b) child adoption should take place no later than 7 days of life as delay in adoption would increase the probability of death; (c) among those who stay in their own households after the mother's death, better survival is observed if a grandmother present than presence of other female member.

## Background

In developing countries, complication relating to pregnancy and childbirth is the leading cause of mortality and morbidity among women of reproductive age (World Bank 1993). In 2000, there were 529,000 maternal deaths worldwide, of which more than 99% occurred in less developed countries (WHO 2004). The maternal death can affect health and well-being of the

children in various ways: motherless children usually suffer due to lack of day-to-day care, isolation, lack of motivation as well as economic costs associated with mother's death.

The potential social and economic consequences of maternal mortality seem obvious but estimates of the extent of the problem are generally not available mainly due to lack of appropriate and reliable data (Chen *et al.* 1983). This is because identification of maternal death is difficult to get in a community setting. Moreover, mother might die from economically and socially-disadvantaged section as well as mother and the baby might have inherent health problems.

Studies of historical populations (Pavard 2005; Andersson 1996; Brittain 1992) as well as contemporary populations in the developing countries (Anderson *et al.* 2007; Greenwood *et al.* 1987; Koenig *et al*. 1988) have reported a higher level of mortality of infants and children whose mothers died due to maternal causes compared to children of surviving mothers. However, levels of child mortality of those mothers who died due to maternal causes vary widely within (data issue) and across countries (cultural issue).

Studies using data from the Matlab area documented that the effect of maternal death on child survival varied considerably. Chen *et al*. (1974) reported that 88% children died within two months of the maternal death during 1968-1970, and only 4% survived up to one year while Koenig *et al*. (1988) found that 35% children died within two months of a maternal death during 1983-1987, and only 26% survived up to one year. In another study, Strong (1998) reported that after mother's death (1983-87), 70% of children below one month of age and half of the children aged one to eleven months were likely to die. For children aged 1-5 year(s), the probability of death was lower (4.4% for sons and 7.8% for daughters). In another study, Ronsman *et al*. (2010) reported that the cumulative probability of survival up to the age of 10 years was 24% among children whose mothers died before their tenth birthday compared to 89% of children whose mothers survived; the greatest effect was noted in children aged 2-5 months whose mothers had died (rate ratio 25.05, 95% CI 18.57-33.81). However, all these studies were based on small number of death cases and did not control for confounding factors.

In a study in Nepal reported by Katz *et al*. (2003), among 47 livebirths (1994-97), maternal death increased the odds of death by 6.4 for infants in their first week of life, by 11.7 in the 2nd to 4$^{th}$ week of life, and by 51.7 in the post-neonatal period. In a study in the Gambia,

among 9 livebirths preceding maternal deaths (1982-1983), not a single child survived up to his or her first birthday (Greenwood *et al*. 1987). In Guinea-Bissau, Masmas *et al*. (2004) reported that, after controlling for significant background factors, motherless children had a markedly higher mortality than that of controls in both urban and rural areas. From a study in Haiti, Anderson *et al*. (2007) reported that when a family experienced a maternal death due to childbirth complications, the family had a 55% increased odds of experiencing the loss of a child whereas when a mother died from non-maternal causes, the odds of child death did not increase. However, the author noted that children of the control group might have longer survival than the cases.

Although the above studies have examined the consequences of maternal mortality on infant and child survival, most of these studies suffered from the lack of adequate sample-size, inadequate control for confounding factors and lack of appropriate methodology to deal with the selectivity issue. The Matlab study area, where icddr,b has been maintaining the Health and Demographic Surveillance System (HDSS) over the last 40 years, offers an excellent opportunity to study the effect of maternal mortality on infant and child survival. This is because identification of maternal death is unique (misclassification corrected by special studies), recording of event-date is accurate (collected through regular household visits by trained and trusted female Community Heath Research Workers), and the sample-size is large.

The objective of the study is to examine the effects of maternal death on survival of under-five children. To minimize selectivity, we compared mortality for two children of the same mother: one born at or shortly before the mother's death (index child) and the one born just before the last child (penultimate child) of the same mother. The mortality of index children who stayed in their own households after mothers' death was compared with that of children who were adopted by other households. For index children who stayed in their own households, mortality was compared between two situations: grandmother's presence and the presence of another female member.

**Conceptual framework**

The consequences of maternal mortality, defined here as a death during pregnancy or shortly after giving birth, have the potential to affect children in various ways (Reed *et al*. 1988). Children of a dead mother (maternal cause) might suffer from demographic events (for example, death, out-migration, early marriage), inadequate day-to-day care (poor diet,

hygiene, and healthcare) as well as lack of motivation for better life. Moreover, household economic costs associated with mother's death (medical and funeral) affect children more than all other family members.

The following hypotheses will be tested:

*(a) Survival probability will be higher for penultimate than the index children.* The index child grows in absence of mother's care**:** breastfeeding stops, becomes vulnerable to poor hygiene and improper feeding. Moreover, mother's health problem might affect the fetus or vice-versa. These can affect the survival of the index child.

*(b) Survival probability of the index child will be lower for those who stayed in the household than those adopted by others.* For those children who stay in the household after mother's death, the day-to-day care is usually shared by household members but if the child is adopted by others, responsibility goes to the person who adopts the child. This leads to better care and better survival than those who stays in the own household.

*(c) Survival probability of the index child will be higher if a grandmother is present in the household compared to the presence of another female member.* For those children who stay in the household after mothers' death, care might be better if a grandmother is present. It might be that the grandmother had direct blood connection with the child, and the grandmother usually is the most respected person in the household, who can ensure proper care of the child.

*(d) Sex differentials in survival probability will be more prominent for the index than the penultimate child*. Preference for son to daughter exists among Bangladeshi couple: the index child can suffer in day-to-day care in absence of the mother, and the suffering is expected to be more for girls than boys; this might increase gender difference in mortality.

**Data and Methods**

*Setting*

Data for this study came from Matlab *Upazila* (sub-district) where icddr,b has been maintaining the Health and Demographic Surveillance System (HDSS) covering 200,000 people since 1966. Matlab is a rural area located about 55 km southeast of Dhaka. The area is a low-lying deltaic plain intersected by the tidal river *Gumti* and its numerous canals. The major modes of transportation within the area are: walking, country boat and, in some cases,

small steamer or launch. However, in recent years, many villages are accessible by road. Farming is the dominant occupation, except in a few villages where fishing is the means of livelihood (Razzaque *et al*. 1998). Most of the farmers are in marginal situations with less than two acres of land, and 40% of them are landless. For many families, sharecropping and work on others' land on a daily-wage basis have become the main sources of livelihood. Some people also work in mills and factories in different towns and cities but their family members live in the study area. Rice constitutes the staple food and is harvested three times annually. Rates of literacy are high and increase with age. The Matlab HDSS area consists of two distinct areas: (a) icddr,b-served area, and (b) Government-served area. These two areas are almost similar in socioeconomic conditions but differ in MCH-FP program (van Ginneken *et al*. 1998).

*Data*

The study uses three sources of data from the Matlab study area: (a) HDSS data (birth, death, migration); (b) cross-sectional socioeconomic data; and (c) data from a special survey fielded for this project.

The HDSS collects information on births, deaths, migrations, marriages, divorces and household splits, and also periodically collects socioeconomic data. The HDSS data are of high quality, particularly on the timing of events because these have been collected during regular household visits (every two weeks until 1997, every month between 1998 and 2006, and every two months since then) by the Community Health Research Workers (CHRWs). The CHRWs live in the area where they work and have developed a close rapport with the people, which has enabled them to obtain accurate information.

If a person out-migrates from the HDSS area, his/her subsequent survival status is not known in the HDSS records, however, if a person internally moves within the HDSS area, his/her subsequent survival status is recorded. In fact, a large number of children moved from the own households after mother's death due to adoption by other households (within the HDSS area or outside the HDSS area). For our study, the original households of all out-migrated children were re-visited by the HDSS field workers during their routine field work in 2010 to find out survival status by interviewing their relatives. This gives us survival status of children who out-migrated and enabled us to study the survival of all children, including those who were adopted by others.

The special survey was conducted in 2010 by a qualified female interviewer to collect information on child-care through in-depth interviews. This was done by interviewing the person who was responsible for taking care of the child after the mother's death (responsible household member if the child stayed in the own household and the adopter of the child if adopted). Seven households of each category, where the index children stayed in their own households and where the index child was adopted by another household, were interviewed to find out the reason for the mortality difference between these two groups of children.

Using the HDSS database, the study initially identified all women who died from a maternal cause during the period 1974-2005. Assigning cause of death, particularly for the maternal causes, is challenging in a community-based study. Until 1986, the cause of death was assigned by the health assistant in the HDSS death form but, from 1987 onwards, all death forms were checked by medical assistant who assigned the cause of deaths. However, Koenig *et al*. (1988) reported that about 30% of maternal deaths were reported as non-maternal death by the HDSS (Koenig *et al*. 1988). Several special studies have been conducted to correct the numbers of pregnancy-related deaths in the HDSS (Koenig *et al*. 1988; Fauveau *et al*. 1988; Ronsmans *et al*. 1988). Our study uses the maternal death-codes[1] of those special studies. This makes the HDSS data an excellent source for studying the consequences of maternal mortality on children's health and well-being.

For women who died from a maternal cause, some of our analyses considered those who gave at least two livebirths: the one born at or shortly before the mother's death (index- 209 children) and the one born just before the index child (penultimate- 209 children). We did not consider cases with only one birth (72 first births) or where the index pregnancy resulted in the birth of twin (26 twins). Survival of index children adopted by others was compared with those who stayed in their own households after mother's death. Moreover, if the index child had stayed in the household, survival was compared between two situations: (a) where a grandmother was present, and (b) where a female member was present.

For mothers who died during pregnancy, the last child (158 children) was also selected. For comparison with a large sample (1974-2005), the last child of the mother who died due to non-

[1] A maternal death is defined as the death of a woman while pregnant or within 90 days of termination of pregnancy and includes direct cause (acute problem, such as obstetric complication) and indirect causes (problems that are not necessarily caused by the pregnancy but aggravated by the pregnant state).

maternal causes (1,048 children) and the last child of the surviving mother (2,170 children) were also selected from HDSS database.

All these children (index, penultimate, last child of the mother who died during pregnancy, last child of the mother who died due to non-maternal causes, and last child of the surviving mother) were subsequently followed for 60 months for death, out-migration or censor.

For mothers who died from maternal causes, independent variables included: (a) survival of index vs penultimate child (overall and by sex); (b) survival of the index child who were adopted by others vs index child who stayed in the own household; (c) survival of index child who stayed in their own household where a grandmother was present vs where a female member present. For mother who died due to non-maternal causes, independent variables included: survival of the last child vs survival of penultimate child (overall and by sex). For mothers who survived, independent variables included: survival of the last child vs survival of penultimate child (overall and by sex).

The variables considered in the study are: (a) for child: age, sex, out-migration, survival status, residence status of index child (who stayed in the own household or adopted by another household); (b) for mother: age, survival status; (c) for father: re-marriage; and (d) family type (for index child): presence of a grandmother or presence of another female. All these data came from the HDSS database, except for survival status of out-migrated children, which were collected through interviewing relatives/neighbors by the CHRWs.

*Analyses*

Life-table analyses are performed to examine the survival of under-five children (birth up to 60 months) born to mothers who died due to maternal causes. The analyses included: (a) index children born to mothers with at least two livebirths- overall and by sex; (b) penultimate children born to mothers with at least two livebirths- overall and by sex; (c) index children born to mothers where the first birth and twin were included; (d) index children who stayed in the own household where a grandmother was present and where another female was present; (e) index children where the child stayed in their own household or where the index child was adopted by another household; and (f) the last child of the mother who died during delivery.

For comparison with a large sample, life-table analyses were also applied to examine the survival of under-five children (birth up to 60 months) for the mothers who died due to non-

maternal causes as well as those where mother survived: (a) the last child of mother's who died due to non-maternal causes- overall and by sex, (b) the last child of surviving mother- overall and by sex.

The log-rank test was used for assessing the difference in survival function between groups of children.

**Results**

Table 1 shows the descriptive statistics for 209 index and 209 penultimate children of the same mother. As expected, mean age of the mother and mean year of schooling were similar for the index and the penultimate child while proportion of boys was higher for the penultimate than index child (52.6% vs 46.4%). Mean number of previous pregnancy was higher for the index child than penultimate one (5.2 vs 4.0).

Figure 1 and Table 2 show the cumulative probabilities of survival up to 60 months for the index and the penultimate children. Figure 1 also shows cumulative probability of survival up to 60 months for the index child (including the first birth and twin), penultimate child, index first birth, index twin as well as the last child for those mothers who died during pregnancy. The survival probabilities differed significantly between the index and the penultimate children but survival difference reduced as the child attained a certain age (Table 2). The cumulative probability of survival up to 60 months was 0.39 for the index child compared to 0.81 for the penultimate child; this difference is statistically significant ($p<0.01$). For those who survived up to 3 months, the difference in cumulative probability of survival up to 60 months for the index and the penultimate child reduced substantially (0.70 and 0.89) but the difference is still significant ($p<0.05$). For those who survived up to 6 months, the difference in cumulative probability of survival up to 60 months did not differ significantly for these two groups of children (0.85 vs 0.89).

Cumulative probability of survival up to 60 months (0.36 vs 0.39) for the index child (including the first birth and twin) was slightly lower (ns) than the index child (excluding the first birth and twin) (Figure 1 and Table 3). For the last birth by mother who died during pregnancy, cumulative probability of survival up to 6 months was slightly higher (ns) than the penultimate child (0.85 vs 0.81).

For mothers who died due to non-maternal causes, cumulative probability of survival up to 60 months of their last child was significantly higher ($p<0.05$) than those of the penultimate child of the mothers who died due to maternal causes (0.89 vs 0.81) (Table 3). The cumulative probability of survival up to 60 months for the last child of surviving mother was significantly higher ($p<0.05$) than the last children of the mother who died due to non-maternal causes (0.92 vs 0.89).

For the penultimate children of mothers who died due to maternal causes, survival of boys was initially lower than that of girls but, by age 60 months, the survival of boys was higher than that of girls (Figure 3). For the index children, survival of girls was lower than that of boys until the age of 60 months. However, boy-girl mortality difference for both index and penultimate children is not statistically significant. For children of mothers who died due to non-maternal causes and for children of surviving mothers, the survival of girls was always lower than that of boys (Figure 4); the difference is significant for children of mothers who died due to non-maternal causes ($p<0.01$), but not for children of the surviving mothers.

The survival status improved for the penultimate children over time (1974-1982 and 1983-2005) but not for the index children (Table 4). During the period, the cumulative probability of survival up to 60 months improved significantly ($p<0.05$) from 0.74 to 0.85 for the penultimate child, but cumulative probability of survival up to 60 months declined slightly from 0.37 to 0.34 for the index child.

To find out the reason for not improving the survival status over time for the index child, we examined the residential status of these children. Between the two sub-periods, we examined the rate of child adoption. For the period 1974-1982, 45% of children whose mothers died were adopted by other households by the age of 12 months compared to 53.8% for the period 1983-2005 (Table 5). However, adoption varied in the two periods by age of the child; adoption was less likely for the later period until the age of 1 month. Of those who survived for 7 days, 17.4% were adopted by other households during the earlier period while it is 12.5% for the recent period; the pattern reversed since the age of 3 months, a higher percentage was adopted during the recent period than the earlier period (45.5% vs 41.3%). The lower rate of adoption of children at the early age has caused reduction in the survival rate over time for the index child.

The difference in cumulative probability of survival between those adopted by other households and those who stayed in the own households after mother's death diminished as the child became older (Table 6). Of those who survived at day 7, the cumulative probability of survival up to 60 months was 0.78 for those adopted by other households compared to 0.47 for those who stayed in the own home; the difference is statistically significant ($p<0.05$) (Table 6 and Figure 5). However, the difference in cumulative probability of survival up to 60 months is not statistically significant for those children who were adopted at 1 month of age or later.

During the in-depth interviews, it was found that day-to-day care of the children adopted by other households was performed by the person who adopted the child (acted as mother). For children who stayed in the own household after mother's death, it was reported that day-to-day care was usually shared among the female household members. So, there was a chance of inadequate care due to sharing responsibility as noted during the in-depth interviews.

According to the in-depth interviews, the day-to-day care for children who stayed in their own households (after mother's death) was usually performed by an adult female member. So, survival of the children was examined by type of household member present in the household (Figure 6). If the child stayed in their own household after mother's death, the cumulative probability of survival up to 60 months was much higher (0.30 vs 0.18) if a grandmother was present compared to if one was not; the difference in survival is statistically significant ($p<0.01$). Moreover, for those who stayed in their own household after the mother's death, most of the fathers re-married within 6 months of their wife's death (40% re-married within three months and 90% within 12 months). In case of father's re-marriage, child's day-to-day care usually gets worse as noted during the in-depth interviews.

**Discussion**

This study has several advantages over those conducted earlier. First, the study compared two children of the same mother to examine the effect of maternal death on child survival and, thus, minimized the selection bias. Second, survival status of out-migrated children was ascertained by re-visiting the original households/neighbors, and it was possible to compare survival of the index children who stayed in their own households after mother's death and those who were adopted by other households. Third, the study also examined child-care

arrangement for those who stayed in their own households after mother's death and those who were adopted by other households.

The cumulative probability of survival up to 60 months for the index child (one born at or shortly before mother's death) was 0.39 compared to 0.81 for the penultimate child (one born just before the last child). The results of our study are comparable with those of other studies in Bangladesh (Chen *et al*. 1974; Koenig *et al*. 1988; Ronsman *et al*. 2010) but mortality is higher than those found in African studies (Taha *et al*. 1996; Sear *et al*. 2002). In the earlier studies, high mortality during infancy after mother's death was attributed mainly to the cessation of breastfeeding (WHO 2000) as breastfeeding is almost universal as well as long-lasting in Bangladesh situation (Giashuddin & Kabir 2004). However, our study found that survival is better for the index child if adopted by another household compared to the child who stayed in the own household after mother's death. As both the children lost their mothers and their breastfeeding ceased, better survival for those adopted by others than those who stayed in the own households is mainly due to better day-to-day care opposed to breastfeeding alone (Ronsman *et al*. 2010). Based on the in-depth interviews, it was documented that if the child stayed in the own household, child-care is usually shared among some household members but if the child is adopted by another household, child-care is the responsibility of the adopter who usually acts as his/her mother.

For children who survived up to 6 months, the cumulative proportion of survival from 6 to 60 months is similar for the index child and the penultimate child. Similar survival after 6 months of age could be due to higher death of weaker child, leaving the healthy one that resulted in lower subsequent mortality for the index child. A similar finding for mortality difference after two years of life was also recorded in an earlier study in Matlab where famine and non-famine birth cohorts were compared for five years for survival (Razzaque *et al*. 1990).

It has also been found that if the index child stayed in the own household after mother's death, survival is better if a grandmother is present in the household. This again stresses the importance of proper day-to-day care in absence of the mother. An earlier study in Matlab documented that death of an adult member other than the mother in the household does not affect child survival (Strong 1998), suggesting that raising child is the sole responsibility of the mother opposed to African context (Sear *et al*. 2002). However, in absence of the mother, the grandmother probably ensures better day-to-day care than any other adult female member as the grandmother has a direct blood connection with the child.

The study documented higher mortality for boys than girls during infancy for the penultimate children but the opposite pattern holds true for the index child. Higher mortality of boys than girls during infancy for the penultimate child could be due to biological rather than behavioral factors; however, the opposite pattern for the index child could be due to discrimination against girls. In the past, higher mortality rate for girls than boys during childhood in rural Bangladesh is well-documented (D'Souza & Chen 1980), and it was documented that girls in Matlab were discriminated in terms of food, healthcare, and education (Chen *et al*. 1981). However, such differences in mortality have decreased substantially in recent years as mortality has declined (Rahman *et al*. 2011).

To improve survival of the children whose mother died due to maternal cause, adequate day-to-day care should be ensured. The points that may serve as guidelines for the purpose: (a) survival is higher for those adopted by other households than those staying in their own households; (b) child adoption should be encouraged and adoption should take place no later than 7 days of life; (c) children staying in their own households, have better survival if a grandmother is present compared to presence of other female member.

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Table 1: Socio-demographic characteristics of the children[+], 1974-2005

| Characteristics | Index child (N=209) | Penultimate child (N=209) |
|---|---|---|
| Mother's age at death (mean) | 30.04 | 30.04 |
| Previous pregnancies (mean) | 5.19 | 4.05 |
| Child- boys (%) | 46.4 | 52.6 |
| Mother's education (mean) | 1.71 | 1.71 |
| Muslim (%) | 86.1 | 86.1 |

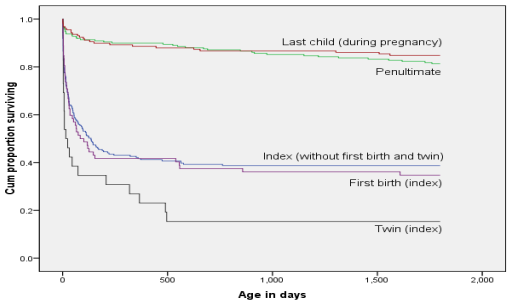
Note: + Index child (born at or just before mother's death) and penultimate child (born before last child)

Table 2: Cumulative proportion surviving (child) at different ages according to timing of observation and birth-order[+]

| | | Age of children | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Timing of observation/birth-order (N) | 3 days | 7 days | 1 month | 3 months | 6 months | 12 months | 24 months | 60 months | P values+ |
| 0 days of birth | | | | | | | | | |
| Index child (N=209) | 0.81 | 0.79 | 0.66 | 0.55 | 0.45 | 0.42 | 0.39 | 0.39 | P<0.01 |
| Penultimate child (N=209) | 0.97 | 0.96 | 0.94 | 0.91 | 0.91 | 0.90 | 0.87 | 0.81 | |
| 7 days of birth | | | | | | | | | |
| Index child (N=165) | | | 0.83 | 0.70 | 0.58 | 0.53 | 0.50 | 0.49 | P<0.01 |
| Penultimate child (N=201) | | | 0.98 | 0.95 | 0.95 | 0.94 | 0.91 | 0.85 | |
| 1 month of birth | | | | | | | | | |
| Index child (N=137) | | | | 0.84 | 0.69 | 0.64 | 0.60 | 0.59 | P<0.01 |
| Penultimate child (N=196) | | | | 0.98 | 0.97 | 0.96 | 0.93 | 0.87 | |
| 3 months of birth | | | | | | | | | |
| Index child (N=115) | | | | | 0.83 | 0.76 | 0.71 | 0.70 | P<0.01 |
| Penultimate child (N=191) | | | | | 1.00 | 0.99 | 0.96 | 0.89 | |
| 6 months of birth | | | | | | | | | |
| Index child (N=95) | | | | | | 0.92 | 0.86 | 0.85 | Ns |
| Penultimate child (N=190) | | | | | | 0.99 | 0.96 | 0.89 | |
| 12 months of birth | | | | | | | | | |
| Index child (N=87) | | | | | | | 0.94 | 0.93 | Ns |
| Penultimate child (N=188) | | | | | | | 0.97 | 0.90 | |

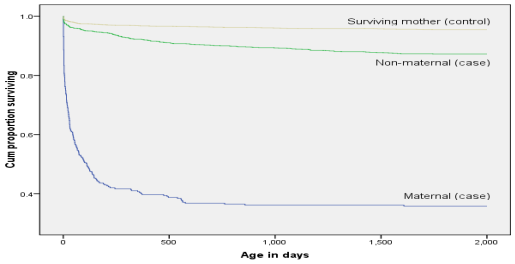
Note: + Index child (born at mother's death) and penultimate child (born before last child)

Fig 1: Cumulative proportion surviving at different ages for children[+] of mother died due to maternal cause




Note: + Index child (exclude first birth and twins), index-first birth, index-twins, penultimate child and last child of mother died during delivery

Fig 2: Cumulative proportion surviving at different ages of children[+] those mothers died due to non-maternal cause and those surviving mother




Note: +Last child of mother who died due to non-maternal cause (case) and last child of surviving mother (control)

Fig 3: Cumulative proportion surviving at different ages by sex for index and penultimate children

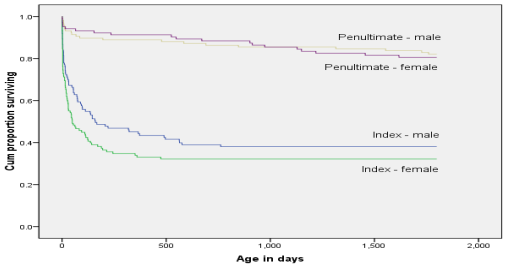


Fig 4: Cumulative proportion surviving at different ages by sex for children of mother who died due to non-maternal cause and those of surviving mother

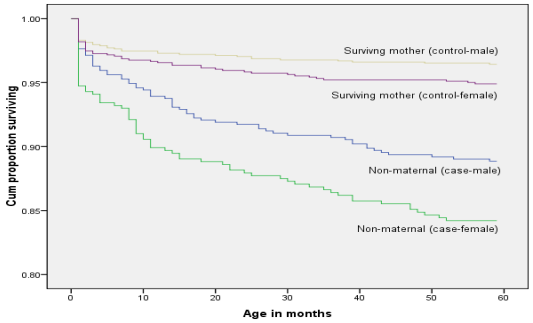


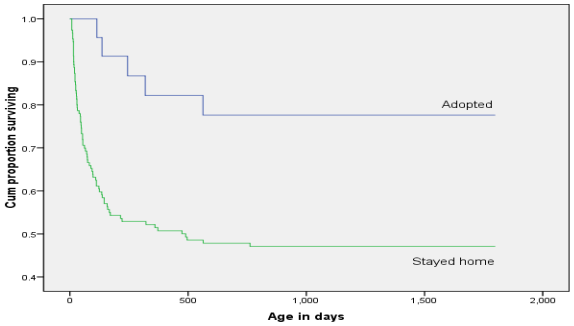

Table 3: Cumulative proportion surviving of children+ (under 12 and 60 months) according to birth-order and mother's survival status

| Serial No. | **Mother's survival status** | **Birth-order** | **N** | **Cumulative proportion surviving** | |
|---|---|---|---|---|---|
| | | | | **12 months** | **60 months**[++] |
| 1 | Died during pregnancy | Last birth-Include first birth and twin | 158 | 0.89 | 0.85 |
| 2 | Died after giving live-birth | Index child-First birth | 72 | 0.42 | 0.35 |
| 3 | Died after giving live-birth | Index child-Excluding first birth and twin | 209 | 0.42 | 0.39 |
| 4 | Died after giving live-birth | Index child-Include first birth and twin | 307 | 0.40 | 0.36 |
| 5 | Died after giving live-birth (exclude twin) | Penultimate child | 209 | 0.90 | 0.81 |
| 6 | Died after giving live-birth | Index child-Twin | 26 | 0.27 | 0.15 |
| 7 | Died of non-maternal cause | Last child-Include first birth and twin | 1261 | 0.92 | 0.87 |
| 8 | Surviving mother | Last child-Include first birth and twin | 2318 | 0.97 | 0.95 |
| 9 | Died of non-maternal cause | Last child- First birth | 213 | 0.92 | 0.89 |
| 10 | Surviving mother | Last child-First birth | 146 | 0.94 | 0.92 |

Note:
[+]Index child (exclude first birth and twin; first birth; twin; all birth), last child of mother died during pregnancy, last child of mother died due to non-maternal cause and last child of surviving mother

[++]Tests of significance: SL No. (3 vs 2-ns), (5 vs 7- p<0.05), (5 vs 8- p<0.01), (5 vs 1- ns), (3 vs 6-p<0.05), (6 vs 2-p<0.05), (7 vs 8-p<0.05), (9 vs 10 ??).

Fig 5: Cumulative proportion surviving at different ages of index children+




Note: +Those survived at age 7 days, stayed at household and those adopted by others

Table 4: Cumulative proportion of surviving at different ages by study period and birth-order[+]

| | Age of children | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Study period/birth-order (N) | 3 days | 7 days | 1 month | 3 months | 6 months | 12 months | 24 months | 60 months | P values[++] |
| Period (1974-1982) | | | | | | | | | |
| Index child (N=76) | 0.83 | 0.79 | 0.63 | 0.51 | 0.50 | 0.43 | 0.38 | 0.37 | 0.37 vs 0.34 (ns) |
| Penultimate child (N=69) | 0.97 | 0.94 | 0.90 | 0.84 | 0.84 | 0.84 | 0.83 | 0.74 | 0.74 vs 0.85 (p<0.05) |
| Period (1983-2005) | | | | | | | | | |
| Index child (N=155) | 0.77 | 0.75 | 0.63 | 0.52 | 0.40 | 0.37 | 0.34 | 0.34 | |
| Penultimate child (N=151) | 0.97 | 0.97 | 0.95 | 0.95 | 0.94 | 0.93 | 0.89 | 0.85 | |

Note: [+] Index child (born at or just before mother's death) and penultimate child (born before last child);
[++]Index child: (1974-82) vs (1983-2005) and penultimate child: (1974-82) vs (1983-2005)

Table 5: Residential status[+] of index child[++] at different ages (%) by study period

| Period/Residential status | 3 days | 7 days | 1 month | 3 months | 6 months | 12 months |
|---|---|---|---|---|---|---|
| 1974-82 | | | | | | |
| Stayed at home | 87.9 | 82.6 | 67.8 | 58.7 | 55.5 | 55.0 |
| Adopted by other | 12.1 | 17.4 | 32.2 | 41.3 | 45.5 | 45.0 |
| Total (N) | 83 | 75 | 59 | 46 | 45 | 40 |
| 1983-05 | | | | | | |
| Stayed at home | 92.3 | 87.5 | 78.0 | 54.5 | 47.0 | 46.2 |
| Adopted by other | 7.7 | 12.5 | 22.0 | 45.5 | 53.0 | 53.8 |
| Total (N) | 169 | 160 | 132 | 110 | 85 | 80 |

Note: +Stayed at home after mother's death or adopted by others

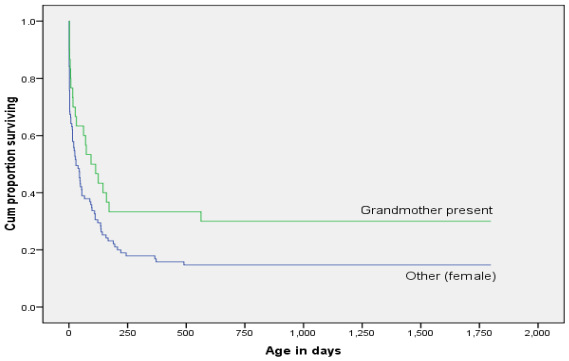
++ Index child (born at or just before mother's death)

Table 6: Cumulative proportion surviving of index child at different ages by residential status[+], 1982-2005

| Age at start/Residential status (N) | Age of children | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Observation begin | 7 days | 15 days | 1 month | 3 months | 6 months | 12 months | 24 months | 60 months | P values[++] |
| At 3 days birth | | | | | | | | | |
| Adopted by others (N=19) | 1.00 | 1.00 | 1.00 | 1.00 | 0.94 | 0.82 | 0.76 | 0.76 | P<0.05 |
| Stayed at home (N=169) | 0.93 | 0.86 | 0.76 | 0.62 | 0.52 | 0.49 | 0.46 | 0.45 | |
| At 7 days of birth | | | | | | | | | |
| Adopted by others (N=27) | | 1.00 | 1.00 | 1.00 | 0.91 | 0.82 | 0.78 | 0.78 | P<0.05 |
| Stayed at home (N=150) | | 0.91 | 0.80 | 0.65 | 0.54 | 0.51 | 0.48 | 0.47 | |
| At 15 days of birth | | | | | | | | | |
| Adopted by others (N=29) | | | 1.00 | 1.00 | 0.92 | 0.84 | 0.79 | 0.79 | P<0.05 |
| Stayed at home (N=134) | | | 0.87 | 0.71 | 0.59 | 0.56 | 0.51 | 0.51 | |
| At 1 month of birth | | | | | | | | | |
| Adopted by others (N=38) | | | | 1.00 | 0.91 | 0.85 | 0.82 | 0.82 | ns |
| Stayed at home (N=107) | | | | 0.79 | 0.65 | 0.61 | 0.57 | 0.56 | |
| At 3 months of birth | | | | | | | | | |
| Adopted by others (N=55) | | | | | 0.93 | 0.88 | 0.84 | 0.84 | ns |
| Stayed at home (N=65) | | | | | 0.78 | 0.72 | 0.66 | 0.65 | |
| At 6 months of birth | | | | | | | | | |
| Adopted by others (N=52) | | | | | | 0.96 | 0.92 | 0.92 | ns |
| Stayed at home (N=48) | | | | | | 0.92 | 0.83 | 0.81 | |
| At 12 months of birth | | | | | | | | | |
| Adopted by others (N=47) | | | | | | | 0.96 | 0.96 | ns |
| Stayed at home (N=43) | | | | | | | 0.91 | 0.88 | |

Note: + Stayed at home after mother's death or adopted by others

Fig 6: Cumulative proportion surviving at different ages of index child those stayed at household after mother's death by family type[+]



Note: +Presence of grandmother or other female member