# A PROSPECTIVE COHORT STUDY ON THE SURVIVAL EXPERIENCE OF UNDER FIVE CHILDREN IN RURAL WESTERN INDIA

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***Objective:*** *To study the role of birth weight, nutrition, immunization and other medical as well as social factors in determining child survival.* ***Design:*** *A prospective cohort study. Setting: 45 villages in Shirur Development Block in Pune District in Maharashtra.* ***Methods:*** *A cohort of 4129 children were followed from birth till 5 years of age. Weight and length/height of the child was measured at birth and at 3 monthly home visits. Information was also obtained on common childhood morbidities, immunization status and other bio-medical factors. Cause of death was ascertained by verbal autopsy. Results: The neonatal, infant and underfive mortality rates were estimated to be 37, 60 and 79 per 1000 live births, respectively. Diarrhea and ARI contributed to the major mortality burden. The Kaplan Meier Survival curve showed a sharp fall in the neonatal period, a less rapid decline in the post-neonatal period followed by a marginal fall in the post-infancy period till 5 years age. Girls had a better survival in the early neonatal period but the trend reversed in the late neonatal period. Normal birth weight children had better survival curves compared to low birth weight children. Survival improved with increasing birth order. Multivariate analysis revealed that birth weight, immunization status, and mother's and child's nutritional status influenced infant and under five mortality.* ***Conclusion:*** *Birth weight continues to exert its influence not only on survival/mortality in early life but even as late as 5 years of age. Strategies to improve child survival should include immunization and breastfeeding.*

**Key words:** *Child survival, Survival analysis, Under-five mortality.*

THE Child Survival revolution, launched in 1983 in Manila at the Congress of the International Pediatric Association and followed by the World Summit for Children at New York in 1990, has come a long way. India too, has shown its political will by initiating the Child Survival Safe Motherhood program in 1991. The Child Survival strategies have been oriented towards reducing infant and under-five mortality. However, infant mortality in India continues to be unacceptably high at 79 per 1000 live births(l). In this paper, we describe the experience of a cohort of newborns from birth to 5 years age to study the relationship of child survival with birth weight, nutritional status, immunization and other social and environmental factors.

## Subjects and Methods

All live births occurring in 45 contiguous villages in Shirur Development Block in Pune District during December 1987 to November 1989, were followed up from birth to 5 years age as part of the 'Rural Cohort Study on Child Survival' funded by the World Health Organization, South East Asia Regional Office (SEARO). Birth weight and length were measured by trained field based medico-social workers within 24 hours of birth. Gestation duration was ascertained from the last menstrual period. The children were measured for weight, length/height and information was obtained on common childhood morbidities at regular 3 monthly intervals through home visits. In addition, information was collected on the immunization status, live birth order, type of family and other socio-economic variables. A pediatrician investigated all deaths and ascertained the cause of death based on reporting of symptoms and signs by the family members.

*Statistical Methods*

Survival analysis of the data including Kaplan Meier survival curves were constructed and log rank test and Mantel Haensel Test for comparison of survival curves were done using 'STATA' statistical software. Survival functions *(i.e.,* probability of surviving *at least* to time T) were estimated. The survival function reflects the cumulative past survival experience up to time T. It does not denote the probability of survival *at* any given time 't'. Multivariate logistic regression analysis for mortality was done using SPSS software.

## Results

A total of 4129 newborns were enrolled into the study, of which 351 (8.5%) were lost to follow up due to permanent migrations out of the study area. Information on all children (including the data available for those children till loss to follow up) has been included in the survival analysis.

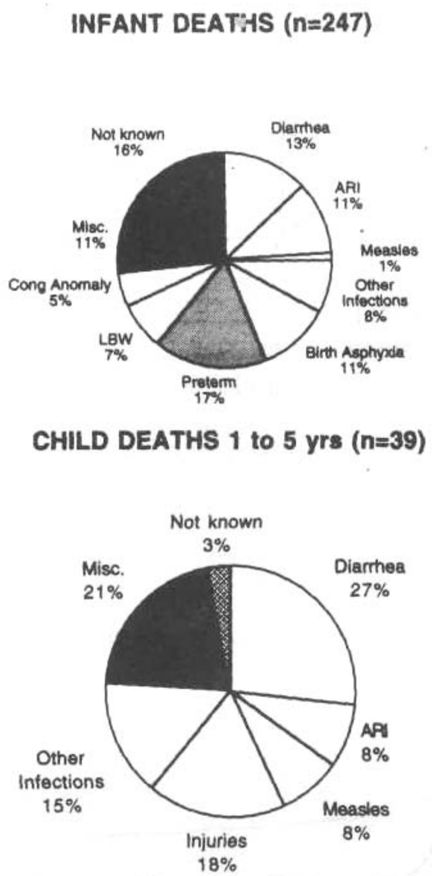
The sex composition of the cohort was 52% boys and 48% girls. Birth weight could be measured within 24 hours in 57% of all children. The incidence of low birth weight (<2500 g) was 28.2%. Of those children who were low birth weight (LBW), the majority (83.4%) were due to intra-uterine growth retardation (IUGR) while only 16.6% of LBW children were due to prematurity as ascertained from the 'LMP to birth' interval. The mean birth weight for boys was 2664 g which was slightly higher than the mean birth weight of 2601 g for girls. Girls had a 14.5% significantly higher risk of LBW (relative risk : 1.145). Only about 10% of children had more than 4 siblings. Only a third ( 34%) of the children in the cohort belonged to nuclear type of families.

*Mortality Analysis*

There were a total of 286 deaths in the cohort (birth to 5 years) with about 87% (247 deaths) occurring in the infancy period. Of the infant deaths, about 62% (153 deaths) occurring in the neonatal period. Of all neonatal deaths, about 69% (105 deaths) occurred within the first week of life. Thus 36.7% deaths occurred in the early neonatal period. The neonatal, infant and under fives mortality rates were estimated to be about 37, 60 and 69 per 1000 live births, respectively. These rates are lower than the ones reported for rural Maharashtra(2). Although boys formed 52% of the cohort population, only 45.8% of all under five deaths were boys. *Fig. 1* depicts the causes of death in infants and in children 1 to 5 years of age. About 13% of infant deaths were due to acute diarrheal diseases and 10.5% due to acute respiratory infections (ARI). Birth asphyxia accounted for about 11% of all infant deaths. Amongst child deaths (1 through 5 years), diarrhea accounted for the majority of deaths (28.2%) followed closely by deaths due to injuries (about 18%). Measles and ARI resulted in about 8% of deaths in this age group.

*Survival Analysis(3,4)*

A graph of loglog survival function [log(-log(S(t)))] vs log (time) where S(t) is




Causes of Death in children

the survivor function *(i.e.,* probability of surviving at least to time Y) as defined by the Kaplan Meier (KM) product limit estimate, supported the assumption that the survival data had a Weibull distribution. *Figs. 2, 3 & 4* show the KM product limit estimate of the survival curves, a descending step function where each of the descending legs indicates one or more deaths. The survival curves stratified by sex of the child *(Fig. 2)* for the different age periods show a sharp fall in survival function estimate in the first month of life after which the survival curve falls less rapidly up to 1 year of age.

The survival function estimate decreases marginally from then onwards to 5 years of age. Also, the survival function estimate is higher for girls as compared to boys in the early neonatal period but the trend reverses at about 10th to 12th day of life. The difference in survival curves between boys and girls increases with advancing age. Comparing the survival curves of boys and girls *(Table I)* for different age period, it is seen that girls have a better survival in the early neonatal period though this difference is not statistically significant. Boys have a better survival (actual number of deaths in boys less than predicted deaths) as compared to girls from the late-neonatal period onwards. This difference in survival is statistically significant from the post-neonatal period onwards.

*Figure 3* shows the increasing differences in the Kaplan Meier survival curves between LBW and normal birth weight children. Normal birth weight children, continue to have better survival curves even up to 5 years of age. As seen from *Table II* these differences remain significant even up to 5 years of age. This is true even after adjustment for the sex of the child. It is seen from *Fig. 4* that the 1st born child consistently has the poorest survival in all the age periods.

Log rank test showed that the type of family (nuclear or joint) and the socio-economic status of the household had no significant effect on the child's survival. Multivariate logistic regression analysis *(Table III)* revealed the risk of infant mortality to be 4.13 times higher for LBW (less than 2500 g) as compared to normal birth weight children. A non-immunized or incompletely immunized child has a more than 10 times higher risk of dying before 5 years age as compared to a child who has received his primary immunization. Mother's nutritional status (non-pregnant

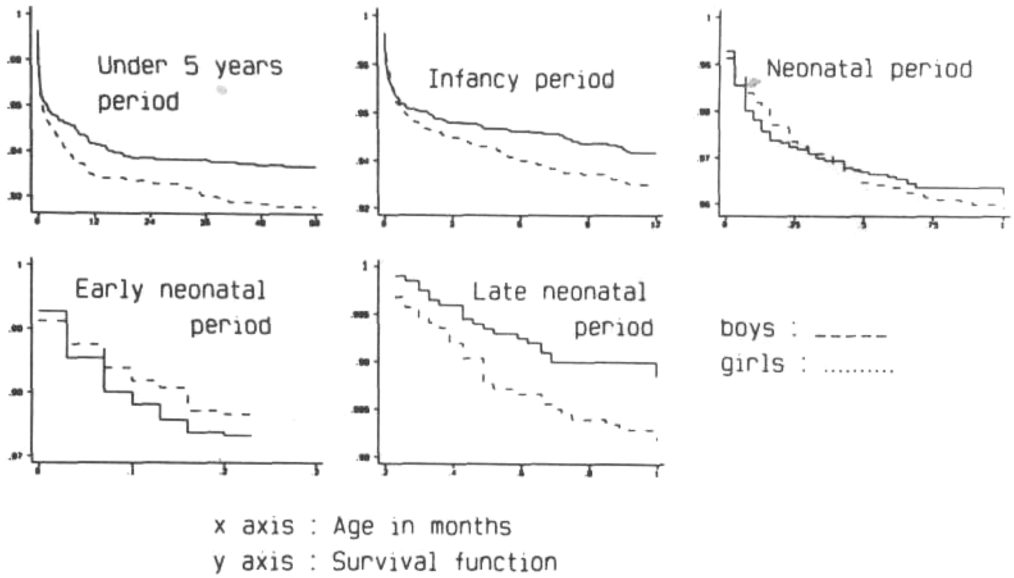



*Fig. 2. Kaplan Meier survival curves by gender for diff[illegible] age groups in children.*

*different age*

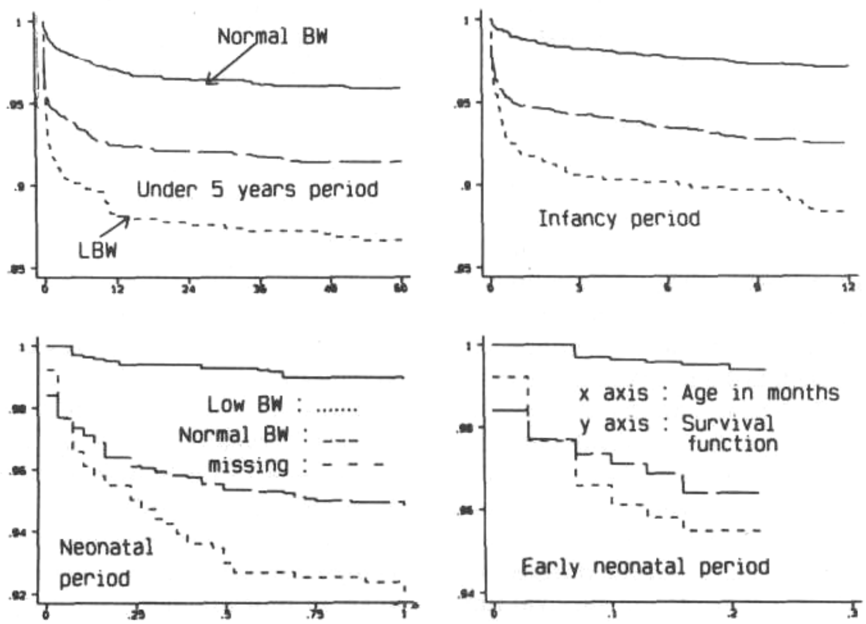



*Fig. 3. Kaplan Meier survival curves by birth weight for different age groups in children.*

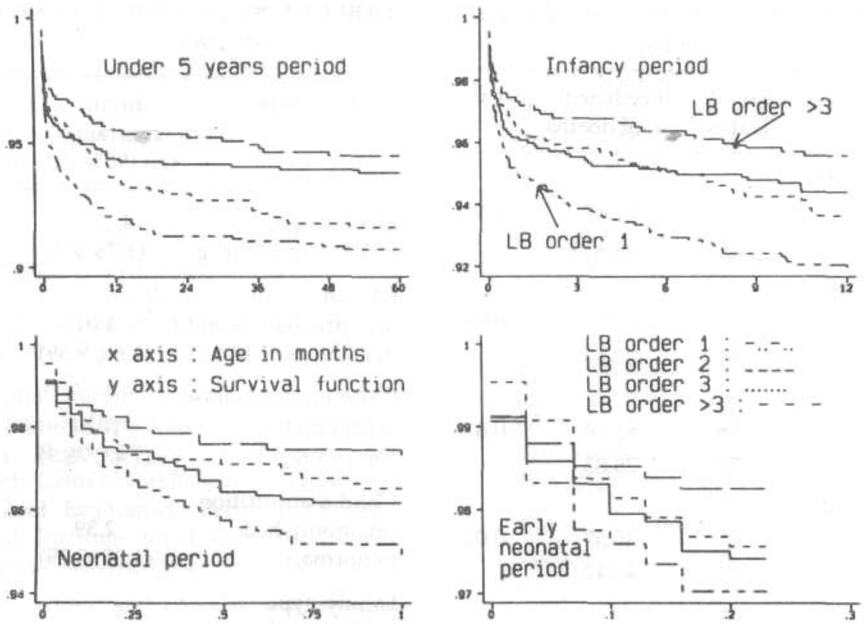



Fig. 4. *Kaplan Meier survival curves by live birth order for different age groups in children.*

weight less than 40 kg) also increased the risk of infant and under-five mortality by 3 to 4 fold. Breastfeeding had an important role in preventing infant mortality but lost its significance in preventing under-five mortality.

## Discussion

Survival analysis has been commonly used in clinical drug trials and in medical research(5,6). It has been used recently in analyzing breastfeeding(7,8) and infant feeding practices(9) as also in evaluation of child survival and other health projects(10-12). We have applied this method of 'time to event' analysis to the longitudinal data from the Rural Cohort Study on Child Survival, to analyze the survival and mortality experience of children from birth till 5 years age. The mortality rates for the various age groups are relatively lower compared to that for rural Maharashtra. Also seen is a differential in mortality for boys and girls. Acute diarrheal dehydration and ARI (including measles) still contribute substantially to the mortality burden in both infants and children 1 to 5 years age. Interestingly, fatal injuries was the second most common cause of death in the age group 1 through 5 years.

Children born low birth weight have a poorer survival even up to 5 years of age though the influence of birth weight on survival is maximal in early life. The gender of the child adds yet another covert dimension to its survival. Girls have a better survival in the neonatal period compared to boys. This conforms with the biological hardiness of the girl child. However, this trend reverses in the post-neonatal period. The explanation of the reversal in mortality and/or survival trends in the post neonatal period (in favor of the boy) may probably be socio-cultural and not biological. Multi-variate analysis shows that child survival/mortality is significant-

**TABLE I-** *Log Rank Test for Comparison of Survival Curves for Boys and Girls*

| | No. of Deaths | Predicted no. of deaths | p-value |
|---|---|---|---|
| *Early Neonatal* | | | |
| Boys | 55 | 51.67 | 0.50 |
| Girls | 45 | 48.33 | |
| *Late Neonatal* | | | |
| Boys | 23 | 29.50 | 0.08 |
| Girls | 34 | 27.49 | |
| *Neonatal* | | | |
| Boys | 78 | 81.16 | 0.61 |
| Girls | 79 | 75.83 | |
| *Post Neonatal* | | | |
| Boys | 36 | 46.57 | 0.02 |
| Girls | 54 | 43.42 | |
| *Infancy* | | | |
| Boys | 114 | 127.73 | 0.08 |
| Girls | 133 | 119.26 | |
| *Under Fives* | | | |
| Boys | 131 | 147.93 | 0.04 |
| Girls | 155 | 138.06 | |

**TABLE II** - *Mantel Haensel Test for Comparison of Survival Curves of LBW with Normal Birth Weight Children*

| Period | No. of deaths | Predicted no. of deaths | p-value |
|---|---|---|---|
| *Early Neonatal* | | | |
| LBW | 29 | 10.80 | < 0.0001 |
| *Late Neonatal* | | | |
| LBW | 22 | 8.07 | < 0.0001 |
| *Neonatal* | | | |
| LBW | 51 | 18.88 | < 0.0001 |
| *Post Neonatal* | | | |
| LBW | 24 | 14.06 | 0.003 |
| *Infancy* | | | |
| LBW | 75 | 32.94 | < 0.0001 |
| *Under Fives* | | | |
| LBW | 83 | 39.44 | < 0.0001 |

**TABLE *III* -** *Adjusted Odds Ratio for Age Specific Mortality*

| Parameter | Infant mortality OR (95% CI) | Under 5 mortality OR (95% CI) |
|---|---|---|
| Birth weight <2500g»s>2500g | 4.13 (1.78, 7.3) | 3.55 (2.32,5.34) |
| Mother's non-pregnant weight (< 40 kg *vs* > 40 kg) | 4.01 (1.66, 9.59) | 3.15 (1.74, 5.63) |
| Child immunization (incomplete *vs* complete) | 10.64 (1.43,78.3) | 7.15 (2.15,23.5) |
| Child malnutrition (malnourished *vs* normal) | 2.39 (1.08,5.29) | 3.19 (1.76,5.74) |
| Family type Joint *vs* nuclear | 0.06 (0.01, 0.24) | - |
| Breastfed (within 3 days *vs* after 3 days) | 0.05 (0.006, 0.35) | |
| Mother's education (Literate *vs* illiterate) | — | 0.55 (0.37, 0.84) |
| Live birth order | | 0.39 (0.29, 0.51) |

ly influenced by both maternal and child factors. The role of child survival strategies like immunization, early initiation of breast feeding and oral rehydration therapy in improving survival cannot be challenged. Thus the study has been able to define and quantify the role of birth weight, the nutritional status of the mother and the child in determining child survival as also the importance of gender differentials in survival.

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