Estimation of the Distribution of Duration of Breastfeeding from Cross-Sectional Data: Some Methodological Issue

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Background: Duration of breastfeeding is an important health indicator of mother and child. There are various indirect epidemiological methods available to estimate the duration of breastfeeding from cross sectional data.

Objective: To estimate the distribution of duration of breastfeeding at national level cross sectional data and compare various available technique. The impact of the sampling frame (ascertain of the individual understudy) is also evaluated.

Method: National Family Health Survey (NFHS-IV) data is used. Duration of breastfeeding of only those children who were born before 60 months from survey date were included in the study. The technique of Current Status Data, Life Table Analysis, and Kaplan Meier (KM) estimator is applied to assess the distribution of duration of breastfeeding.

Result: The mean estimate is 32.84, 33.14 and 33.64 months by Kaplan Maier Estimator, Current Status Data and Life Table Analysis respectively. The Current Status and Life Table method are better than Kaplan Meier Estimator as it is doesn’t based on recall data and heaping present in the data.

Conclusion: One must be very cautious while estimating the various epidemiological parameters from cross section data set. The assumptions of the methodology as per data available should be evaluate. If such data is not available, the available methodology may be modified. Regression analysis based on Current Status data technique may be used to assess the impact of various clinical and epidemiological factors (such as nutrition of mother, health status of mother etc.) on duration of breastfeeding.
Introduction

Distribution of duration of breastfeeding is an important indicator of health of mother and child. Breastfeeding is one of the most effective ways to ensure child health and survival(1,2) in first year breastfeeding, and up to one-third of the second year of life of the child. Breastfed children have better intelligence tests, are less overweight or obesity and less prone to diabetes later in life. The mother who breastfeed also have a reduced risk of breast and ovarian cancers. Mothers worldwide are recommended to exclusively breastfeed infants for the child's first six months to achieve optimal growth, development, and health of child.

Generally, for estimating the distribution of duration of breastfeeding, a cohort of birth say of size N is followed, till all have completed breastfeeding. The data thus obtain may provide us the distribution of duration of breastfeeding of the cohort. Practically such data is unavailable and also difficult to obtain. On the other hand, cross-sectional data on the duration of breastfeeding is available in different national level health survey. Various literature explained different techniques for estimation of duration of breastfeeding(3–5).

Generally, Life Table, Kaplan Meier, and Current Status Estimator are very commonly used methods. In cross-section data, the duration of breastfeeding is not appropriately reported due to recall lapse of women. Hence confirmed age heaping at 6,12,36 months etc are common(6–10) . Generally studies rely on reported duration/recollection of duration, in first approach, duration of breastfeeding is considered to refer to the age of the children at the time of complete termination, regardless of the time when consumption of other foods began(6; 7). Other approach sees the use of current status or interval-censored data, whereby just the current breastfeeding status along with the age of the child at the time of survey interview is considered in building a picture of termination age (8; 9).

The major advantages of retrospectively reported breastfeeding data are the ease of data collection, researchers often opting for cross-sectional approaches in order to save time and cost, as well as the ability to capture relatively larger sample sizes (14). Drawback of recalled data is associated with age heaping, with participants tending to round up or down (15) the exact age of the child when the breastfeeding termination took place. This limits the ability to draw valid inferences (16). With current status data, the likelihood of age heaping is comparatively lower, except for the case of heaping in the reported age of children. This remains a problem due to misreporting of age. In general, more errors occur the greater the time-lag between an event and its recall. Some previous studies, concerning the distribution of breastfeeding termination times, have observed that the current-status measures lead to unbiased estimates of the survival function for a sample of births that occur during a fixed period (14). While, the present approach promises more reliable measures, several studies on breastfeeding have been conducted using this approach(13,16–18) due to computational complexity (8).

Apart from the types of estimation techniques, one another important factor affecting the distribution of duration of breastfeeding is the sampling frame. Sampling frame is defined as the method by which an individual is ascertained or identified as a member sample population and the time’s reference for the duration variable to be measured(14, 15). The distribution of duration of breastfeeding also depends much upon the sampling frame as shown in table 6. As the sampling frame changes the distribution also change. For estimating the duration of breastfeeding there are two sampling frames and consequently, the distribution will also change (21). For example, the duration of breastfeeding would be different if considering child as unit or mother as a unit. On the basis of these two sampling frame the distribution will be change.
Further, the sampling frame is also decided on the feasibility and considering the non-sampling error. In all these cases, the distribution is likely will vary in such a situation. Hence, certainly, a careful evaluation of the sampling frame is needed for analyzing the observed data and drawing inferences about population characteristics.

The three techniques (Current Status, Kaplan Meier and Life Table Techniques) for estimating the distribution of duration of breastfeeding from cross-sectional data is compared. The effect of the sampling frame is also evaluated. Consequently, the appropriate technique and feasible sampling frame in cross-sectional data is examined.

**Methodology**

**Data**

Birth record data of National Family Health Survey (NFHS-IV), collected during year 2015-16 is used. It is cross-sectional data. From this dataset, variables such as child is alive, index of birth history, date of the interview, date of birth of the child, currently breastfeeding (‘yes’, ’no’), months of breastfeeding are used. Only those children included in study, whose age was in-between 0-60 months at the time of survey. Among this group of children or duration of breastfeeding many children have completed the breastfeeding and many are still continuing breastfeeding. A total 176335 number of children found whose age were less than 60 months. Figure 1 shows the extraction of dataset from Birth record data of National Family Health Survey (NFHS-IV) data.

Following three techniques explained below were used to estimate the duration of breastfeeding on available data (NFHS-IV).

1. Current status technique
2. Kaplan Meier Estimator
3. Life table technique

**Current status technique**

In observation, \((t)\) is the duration of breastfeeding which is restricted to knowledge of whether or not \((t)\) exceeds the date of survey. This structure is known as current status data and sometimes referred to as referred case I interval censored data. In cross sectional study, the age of the child along with his current status of breastfeeding is noted. For example, there will \(n_0\) of number of child of 0-1 month, \(n_1\) number of child of 1-2 month, \(n_i\)
is the number of child of age \((t,t+1)\) months \((t=1,2,\ldots,T)\) and among that \(n_t\), \(y_t\) number of children are still breastfeeding. So, \(S_t\) proportion of child still breastfeeding

\[
S_t = \frac{y_t}{n_t} = 1 - F(t) \tag{1}
\]
denote the proportion of children has breastfeeding more than \(t\). The value of \(S_t\) can be obtained for different \((t)\) from the data and the duration of breastfeeding can be obtained by spline smoothing, the plot between \(t\) and \(S_t\). \(S_t\) is obtained by the equation (1). \(S_t\) is smoothed by spline, and after smoothing the cumulative distribution and distribution is obtained (see table 2).

**Kaplan Meier estimator**

The retrospectively reported durations of breastfeeding for weaned children, along with censored durations of breastfeeding for children still being breast-fed at the time of the survey. Analysis of this type of data is done by Kaplan Maier estimator. Let \(t > 0\) be the duration of breastfeeding if a child stops breastfeeding then it is events of interest takes place. As indicated above, the goal is to estimate the survival function \(S_t\) underlying.

\[
S_t = \text{Prob} (t > T), \text{where } t = 0,1,\ldots \text{is the time } .(2)
\]
The estimator of the survival function \(S_t\) (the probability that life is longer than \(T\)) is given by:

\[
S_t = S_t = \prod_{i:t_i \leq T} \left(1 - \frac{d_i}{n_i}\right), \tag{3}
\]

With \(t_i\) a duration of breastfeeding when at least one event happened, \(d_i\) the number of events (e.g., number of the child who weaned) that happened at time \(t_i\) and \(n_i\) the individuals known to have survived (have not yet had an event or been censored) up to time \(t_i\) as shown in table 3.

For applying the Kaplan Meier estimator, in National Family Health Survey (NFHS-IV) the months of duration of breastfeeding is given and the event has been occurred or not is given by “whether baby is current breastfeeding or not” is given by these two variable the Kaplan Meier estimator is estimated.

**Life Table Technique**

The simplest analysis of the data of duration of breastfeeding irrespective of how they are ascertained in subject to serious limitation when the observation is truncated at some point before the age or due to survey date. To minimize the bias resulting in incomplete observation of duration of breastfeeding. A brief description of the method and notation are given in below table1:

| Notation | Description |
|----------|-------------|
| \(N_o\)  | The number of an eligible child in the study |
| \(t\)    | Completed number of months since birth. |
| \(N_t\)  | Number of child having breastfeeding more than \(t^{th}\) month: |
| \(B_t\)  | Number of child complete the breastfeeding between \(t & t + n\) months: |
| \(V_{t:t}\) | The time of breastfeeding of \(t^{th}\) child within the interval \((t & t + n)\). |
| \(W_t\)  | No. of child withdrawn breastfeeding within the interval between \(t & t + n\). |
| \(w_{t:j}\) | The time of withdrawn of \(j^{th}\) child with in the interval \((t; t + n)\). |
| \(q_t\)  | Conditional probability of breastfeeding between \(t & t + n\) months of breastfeeding. |
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| Notation | Description |
|----------|-------------|
| \( p_t \) | \( 1 - q_t \). |
| \( a_t \) | Average time of breastfeeding in the interval \((t; t + n)\). |
| \( M_t(dt) \) | Conditional probability of breastfeeding between \(t \& t + n\). |
| \( n_t \) | Length of interval |
| \( E_t \) | Expected duration of breastfeeding after \(t\) months |
| \( r_t \) | Number of child weaned at the \(t\) months |

Table 2 Distribution function of Current status data for duration of breastfeeding of \(\leq 60\) months

| Time   | No. of child whose breastfeeding duration is greater than that interval. | Total | \( S_t \) | \( F(t) \) after smoothing | \( f(t) \) after smoothing |
|--------|--------------------------------------------------------------------------|-------|------------|-----------------------------|-----------------------------|
|        |                                                                          |       | Unsmoothed | Spline smoothed             |                             |
| 0-1    | 1674                                                                     | 1702  | 0.984      | 0.987                       | 0.013                       | 0.004                      |
| 1-2    | 3642                                                                     | 3688  | 0.988      | 0.983                       | 0.017                       | 0.002                      |
| 2-3    | 3867                                                                     | 3944  | 0.980      | 0.981                       | 0.019                       | 0.004                      |
| 3-4    | 4064                                                                     | 4141  | 0.981      | 0.977                       | 0.023                       | 0.005                      |
| 4-5    | 4159                                                                     | 4270  | 0.974      | 0.972                       | 0.028                       | 0.002                      |
| 5-6    | 4226                                                                     | 4348  | 0.972      | 0.970                       | 0.030                       | 0.006                      |
| 6-7    | 4088                                                                     | 4221  | 0.968      | 0.965                       | 0.035                       | 0.004                      |
| 7-8    | 4104                                                                     | 4265  | 0.962      | 0.960                       | 0.040                       | 0.009                      |
| 8-9    | 4128                                                                     | 4308  | 0.958      | 0.951                       | 0.049                       | 0.005                      |
| 9-10   | 3956                                                                     | 4181  | 0.946      | 0.946                       | 0.054                       | 0.002                      |
| 10-11  | 3725                                                                     | 3931  | 0.948      | 0.944                       | 0.056                       | 0.017                      |
| 11-12  | 3496                                                                     | 3724  | 0.939      | 0.928                       | 0.072                       | 0.015                      |
| 12-13  | 3630                                                                     | 3951  | 0.919      | 0.913                       | 0.087                       | 0.019                      |
| 13-14  | 3720                                                                     | 4100  | 0.907      | 0.895                       | 0.105                       | 0.016                      |
| 14-15  | 3412                                                                     | 3865  | 0.883      | 0.878                       | 0.122                       | 0.007                      |
| 15-16  | 3365                                                                     | 3841  | 0.876      | 0.871                       | 0.129                       | 0.013                      |
| 16-17  | 3391                                                                     | 3923  | 0.864      | 0.858                       | 0.142                       | 0.019                      |
| 17-18  | 3258                                                                     | 3836  | 0.849      | 0.839                       | 0.161                       | 0.014                      |
| 18-19  | 3320                                                                     | 4005  | 0.829      | 0.825                       | 0.175                       | 0.023                      |
| 19-20  | 3065                                                                     | 3746  | 0.818      | 0.802                       | 0.198                       | 0.019                      |
| 20-21  | 2958                                                                     | 3770  | 0.785      | 0.783                       | 0.217                       | 0.010                      |
| 21-22  | 2784                                                                     | 3556  | 0.783      | 0.773                       | 0.227                       | 0.024                      |
| 22-23  | 2520                                                                     | 3328  | 0.757      | 0.749                       | 0.251                       | 0.029                      |
| 23-24  | 2238                                                                     | 3040  | 0.736      | 0.720                       | 0.280                       | 0.055                      |
| 24-25  | 2212                                                                     | 3212  | 0.688      | 0.665                       | 0.335                       | 0.028                      |
| 25-26  | 2056                                                                     | 3230  | 0.637      | 0.636                       | 0.364                       | 0.011                      |
| 26-27  | 2003                                                                     | 3143  | 0.637      | 0.626                       | 0.374                       | 0.036                      |
| 27-28  | 1877                                                                     | 3129  | 0.600      | 0.590                       | 0.410                       | 0.009                      |
| 28-29  | 1732                                                                     | 2988  | 0.580      | 0.581                       | 0.419                       | 0.007                      |
| 29-30  | 1677                                                                     | 2881  | 0.582      | 0.574                       | 0.426                       | 0.039                      |
| 30-31  | 1634                                                                     | 2912  | 0.561      | 0.534                       | 0.466                       | 0.025                      |
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| Time  | No. of child whose breastfeeding duration is greater than that interval. | Total | \( S_t \) | \( F(t) \) after smoothing | \( f(t) \) after smoothing |
|-------|------------------------------------------------------------------------|-------|-----------|-----------------------------|-----------------------------|
|       |                                                                       |       | Unsmoothed | Spline smoothed             |                             |
| 31-32 | 1479                                                                   | 2841  | 0.521     | 0.509                       | 0.491                       | 0.006                       |
| 32-33 | 1347                                                                   | 2660  | 0.506     | 0.504                       | 0.496                       | 0.010                       |
| 33-34 | 1324                                                                   | 2642  | 0.501     | 0.494                       | 0.506                       | 0.001                       |
| 34-35 | 1228                                                                   | 2499  | 0.491     | 0.495                       | 0.507                       | 0.039                       |
| 35-36 | 1220                                                                   | 2482  | 0.492     | 0.454                       | 0.546                       | 0.063                       |
| 36-37 | 1085                                                                   | 2559  | 0.424     | 0.392                       | 0.608                       | 0.024                       |
| 37-38 | 923                                                                    | 2453  | 0.376     | 0.368                       | 0.632                       | 0.028                       |
| 38-39 | 916                                                                    | 2544  | 0.360     | 0.339                       | 0.661                       | 0.013                       |
| 39-40 | 780                                                                    | 2397  | 0.325     | 0.327                       | 0.673                       | 0.003                       |
| 40-41 | 771                                                                    | 2335  | 0.330     | 0.324                       | 0.676                       | 0.011                       |
| 41-42 | 744                                                                    | 2355  | 0.316     | 0.313                       | 0.687                       | 0.011                       |
| 42-43 | 709                                                                    | 2289  | 0.310     | 0.301                       | 0.699                       | 0.008                       |
| 43-44 | 660                                                                    | 2244  | 0.294     | 0.293                       | 0.707                       | 0.011                       |
| 44-45 | 650                                                                    | 2224  | 0.292     | 0.282                       | 0.718                       | 0.027                       |
| 45-46 | 573                                                                    | 2141  | 0.268     | 0.255                       | 0.745                       | 0.005                       |
| 46-47 | 522                                                                    | 2093  | 0.249     | 0.258                       | 0.750                       | 0.006                       |
| 47-48 | 531                                                                    | 2016  | 0.263     | 0.244                       | 0.756                       | 0.043                       |
| 48-49 | 435                                                                    | 2012  | 0.216     | 0.201                       | 0.799                       | 0.018                       |
| 49-50 | 364                                                                    | 1925  | 0.189     | 0.183                       | 0.817                       | 0.006                       |
| 50-51 | 324                                                                    | 1815  | 0.179     | 0.178                       | 0.822                       | 0.013                       |
| 51-52 | 340                                                                    | 1952  | 0.174     | 0.165                       | 0.835                       | 0.006                       |
| 52-53 | 289                                                                    | 1868  | 0.155     | 0.159                       | 0.841                       | 0.006                       |
| 53-54 | 298                                                                    | 1820  | 0.164     | 0.153                       | 0.847                       | 0.003                       |
| 54-55 | 255                                                                    | 1892  | 0.135     | 0.132                       | 0.850                       | 0.017                       |
| 55-56 | 256                                                                    | 1928  | 0.133     | 0.133                       | 0.867                       | 0.001                       |
| 56-57 | 253                                                                    | 1902  | 0.133     | 0.135                       | 0.868                       | 0.001                       |
| 57-58 | 244                                                                    | 1786  | 0.137     | 0.131                       | 0.869                       | 0.003                       |
| 58-59 | 210                                                                    | 1772  | 0.119     | 0.118                       | 0.872                       | 0.004                       |
| 59-60 | 211                                                                    | 1708  | 0.124     | 0.124                       | 0.876                       | 0.124                       |
| >60   | 0                                                                      | 0     | 0          | 1                           | 0                           |

\[
P_t = \exp^{-\int_t^{t+n}m_t\,dt}
\]

\[
a_t = \left\{ \frac{1}{nm_t} - \frac{\exp^{-nm_t}}{1-\exp^{-nm_t}} \right\}
\]

\[
T=0,1,2, \quad n=0,1,2, \ldots
\]

\[
T=0,1,2, \ldots
\]

\[
n=0,1,2, \ldots
\]
The maximum likelihood estimation of \( m_t \) is obtained as, once the estimates of \( m_t \) are obtained, then for different values of \( t \), the estimated values of \( q_t \) and \( a_t \) can be obtained easily using equation respectively and consequently other columns of the life table can also be obtained. The other important column \( \text{exp}^t \) is computed using the procedure described in (22).

\[
m_t = \frac{B_t}{nN_t + a_tB_t + a_tW_t}
\]

\[
L_t = n_t(l_t - d_t) + a_t n_t d_t
\]

\[
r_t = l_t^t Q_t
\]

\[
E_t = l_t^t
\]

In fact, \( \text{exp}^t \) represents the expected duration of breastfeeding after \( t \) months. It is pertinent to mention that \( m_t \) is almost the same \( \lambda \) i.e. \( \lambda \) is assumed to be constant over time while \( m_t \) may vary for different values of \( t \) as shown in table 4.

For the life table analysis, the duration of breastfeeding and the specific question is asked whether a child was "still breastfeeding" at the

| Time | Number of child who start breastfeeding during these interval | No. of child who stop breastfeeding | No. of child who are censored | \( S(t) \) | \( S_t \) after smoothing | \( F(t) \) after smoothing | \( f(t) \) after smoothing |
|------|---------------------------------------------------------------|-----------------------------------|-----------------------------|----------|--------------------------|--------------------------|--------------------------|
| 0-1  | 176335                                                        | 573                               | 1674                        | 0.997    | 0.991                    | 0.009                    | 0.021                    |
| 1-2  | 174008                                                        | 2363                              | 3642                        | 0.983    | 0.970                    | 0.030                    | 0.016                    |
| 2-3  | 168083                                                        | 3506                              | 3867                        | 0.963    | 0.954                    | 0.046                    | 0.008                    |
| 3-4  | 160710                                                        | 2073                              | 4064                        | 0.950    | 0.946                    | 0.054                    | 0.004                    |
| 4-5  | 154573                                                        | 869                               | 4159                        | 0.945    | 0.943                    | 0.057                    | 0.020                    |
| 5-6  | 149545                                                        | 981                               | 4226                        | 0.939    | 0.923                    | 0.077                    | 0.016                    |
| 6-7  | 144338                                                        | 4021                              | 4088                        | 0.913    | 0.907                    | 0.093                    | 0.007                    |
| 7-8  | 136229                                                        | 1023                              | 4104                        | 0.906    | 0.901                    | 0.099                    | 0.010                    |
| 8-9  | 131102                                                        | 1351                              | 4128                        | 0.896    | 0.891                    | 0.109                    | 0.009                    |
| 9-10 | 125623                                                        | 1347                              | 3956                        | 0.887    | 0.882                    | 0.118                    | 0.010                    |
| 10-11| 120320                                                        | 885                               | 3725                        | 0.880    | 0.882                    | 0.128                    | 0.030                    |
| 11-12| 115710                                                        | 504                               | 3496                        | 0.876    | 0.842                    | 0.158                    | 0.037                    |
| 12-13| 111710                                                        | 8213                              | 3630                        | 0.812    | 0.805                    | 0.195                    | 0.000                    |
| 13-14| 99867                                                         | 578                               | 3720                        | 0.807    | 0.805                    | 0.195                    | 0.014                    |
| 14-15| 95569                                                         | 895                               | 3412                        | 0.800    | 0.791                    | 0.209                    | 0.015                    |
| 15-16| 91262                                                         | 1994                              | 3365                        | 0.782    | 0.776                    | 0.224                    | 0.003                    |
| 16-17| 85903                                                         | 1122                              | 3391                        | 0.772    | 0.773                    | 0.227                    | 0.029                    |
| 17-18| 81390                                                         | 536                               | 3258                        | 0.767    | 0.744                    | 0.256                    | 0.030                    |
| 18-19| 77596                                                         | 4918                              | 3320                        | 0.718    | 0.714                    | 0.286                    | 0.002                    |
| 19-20| 69358                                                         | 369                               | 3065                        | 0.715    | 0.712                    | 0.288                    | 0.005                    |
| 20-21| 65924                                                         | 679                               | 2958                        | 0.707    | 0.706                    | 0.294                    | 0.006                    |
| 21-22| 62287                                                         | 194                               | 2784                        | 0.705    | 0.701                    | 0.299                    | 0.013                    |
| 22-23| 59309                                                         | 331                               | 2520                        | 0.701    | 0.709                    | 0.312                    | 0.054                    |
| 23-24| 56458                                                         | 378                               | 2238                        | 0.696    | 0.634                    | 0.366                    | 0.106                    |
| 24-25| 53842                                                         | 12027                             | 2212                        | 0.541    | 0.528                    | 0.472                    | 0.003                    |
| Time | Number of child who start breastfeeding during these interval | No. of child who stop breastfeeding | No. of child who are censored | $S_t$ | $S_t$ after smoothing | $F(t)$ after smoothing | $f(t)$ after smoothing |
|------|-----------------------------------------------------------|----------------------------------|-------------------------------|------|----------------------|------------------------|----------------------|
| 25-26 | 39603 | 569 | 2056 | 0.533 | 0.529 | 0.475 | 0.004 |
| 26-27 | 36978 | 644 | 2003 | 0.524 | 0.521 | 0.479 | 0.007 |
| 27-28 | 34331 | 328 | 1877 | 0.519 | 0.515 | 0.485 | 0.006 |
| 28-29 | 32126 | 643 | 1732 | 0.508 | 0.509 | 0.491 | 0.020 |
| 29-30 | 29751 | 181 | 1677 | 0.505 | 0.489 | 0.511 | 0.019 |
| 30-31 | 27893 | 1788 | 1634 | 0.473 | 0.471 | 0.529 | 0.000 |
| 31-32 | 24471 | 49 | 1479 | 0.472 | 0.470 | 0.530 | 0.002 |
| 32-33 | 22943 | 154 | 1347 | 0.469 | 0.468 | 0.532 | 0.004 |
| 33-34 | 21442 | 561 | 1324 | 0.468 | 0.464 | 0.536 | 0.014 |
| 34-35 | 20065 | 121 | 1228 | 0.456 | 0.470 | 0.550 | 0.052 |
| 35-36 | 18716 | 94 | 1220 | 0.462 | 0.398 | 0.602 | 0.051 |
| 36-37 | 17402 | 4019 | 1085 | 0.356 | 0.348 | 0.652 | 0.006 |
| 37-38 | 12298 | 52 | 923 | 0.354 | 0.354 | 0.658 | 0.008 |
| 38-39 | 11323 | 108 | 916 | 0.351 | 0.350 | 0.666 | 0.007 |
| 39-40 | 10299 | 34 | 780 | 0.350 | 0.327 | 0.673 | 0.001 |
| 40-41 | 9485 | 131 | 771 | 0.345 | 0.344 | 0.674 | 0.001 |
| 41-42 | 8583 | 17 | 744 | 0.344 | 0.341 | 0.675 | 0.001 |
| 42-43 | 7822 | 125 | 709 | 0.339 | 0.338 | 0.676 | 0.004 |
| 43-44 | 6988 | 11 | 660 | 0.338 | 0.338 | 0.680 | 0.002 |
| 44-45 | 6317 | 9 | 650 | 0.338 | 0.337 | 0.682 | 0.002 |
| 45-46 | 5658 | 40 | 573 | 0.335 | 0.334 | 0.684 | 0.002 |
| 46-47 | 5045 | 16 | 522 | 0.334 | 0.336 | 0.686 | 0.001 |
| 47-48 | 4507 | 6 | 531 | 0.334 | 0.318 | 0.687 | 0.001 |
| 48-49 | 3970 | 397 | 435 | 0.300 | 0.298 | 0.688 | 0.012 |
| 49-50 | 3138 | 5 | 364 | 0.300 | 0.300 | 0.700 | 0.002 |
| 50-51 | 2769 | 16 | 324 | 0.298 | 0.298 | 0.702 | 0.000 |
| 51-52 | 2429 | 3 | 340 | 0.298 | 0.297 | 0.703 | 0.001 |
| 52-53 | 2086 | 5 | 289 | 0.297 | 0.297 | 0.703 | 0.001 |
| 53-54 | 1792 | 1 | 298 | 0.297 | 0.296 | 0.704 | 0.001 |
| 54-55 | 1493 | 6 | 255 | 0.296 | 0.295 | 0.705 | 0.001 |
| 55-56 | 1232 | 3 | 256 | 0.295 | 0.294 | 0.706 | 0.001 |
| 56-57 | 973 | 5 | 253 | 0.293 | 0.293 | 0.707 | 0.001 |
| 57-58 | 715 | 0 | 244 | 0.293 | 0.292 | 0.708 | 0.002 |
| 58-59 | 471 | 1 | 210 | 0.291 | 0.291 | 0.709 | 0.000 |
| 59-60 | 260 | 0 | 211 | 0.290 | 0.290 | 0.710 | 0.290 |
| >60 | 49 | 49 | 0 | 0 | 0 | 1 | 0 |
## Table 4 Life table calculation for duration of breastfeeding for age at ≤ 60 months

| Interval | \( N_t \) | \( W_t \) | \( B_t \) | \( m_t \) | \( p_t \) | \( q_t \) | \( a_t \) |
|----------|-----------|-----------|-----------|----------|----------|----------|----------|
| 0-1      | 176335    | 1674      | 573       | 0.003    | 0.997    | 0.003    | 0.500    |
| 1-2      | 174088    | 3642      | 2363      | 0.013    | 0.984    | 0.016    | 0.499    |
| 2-3      | 168083    | 3867      | 3506      | 0.020    | 0.964    | 0.036    | 0.498    |
| 3-4      | 160710    | 4064      | 2073      | 0.013    | 0.952    | 0.048    | 0.499    |
| 4-5      | 154573    | 4159      | 869       | 0.006    | 0.946    | 0.054    | 0.500    |
| 5-6      | 149545    | 4226      | 981       | 0.006    | 0.940    | 0.060    | 0.499    |
| 6-7      | 144338    | 4088      | 4021      | 0.027    | 0.915    | 0.085    | 0.498    |
| 7-8      | 136229    | 4104      | 1023      | 0.007    | 0.908    | 0.092    | 0.499    |
| 8-9      | 131102    | 4128      | 1351      | 0.010    | 0.899    | 0.101    | 0.499    |
| 9-10     | 125623    | 3956      | 1347      | 0.011    | 0.890    | 0.110    | 0.499    |
| 10-11    | 120320    | 3725      | 885       | 0.007    | 0.883    | 0.117    | 0.499    |
| 11-12    | 115710    | 3496      | 504       | 0.004    | 0.880    | 0.120    | 0.500    |
| 12-13    | 111710    | 3630      | 8213      | 0.070    | 0.820    | 0.180    | 0.494    |
| 13-14    | 99867     | 3720      | 578       | 0.006    | 0.816    | 0.184    | 0.500    |
| 14-15    | 95569     | 3412      | 895       | 0.009    | 0.808    | 0.192    | 0.499    |
| 15-16    | 91262     | 3365      | 1994      | 0.021    | 0.791    | 0.209    | 0.498    |
| 16-17    | 85903     | 3391      | 1122      | 0.013    | 0.781    | 0.219    | 0.499    |
| 17-18    | 81390     | 3258      | 536       | 0.006    | 0.776    | 0.224    | 0.499    |
| 18-19    | 77596     | 3320      | 4918      | 0.060    | 0.731    | 0.269    | 0.495    |
| 19-20    | 69358     | 3065      | 369       | 0.005    | 0.727    | 0.273    | 0.500    |
| 20-21    | 65924     | 2958      | 679       | 0.010    | 0.720    | 0.280    | 0.499    |
| 21-22    | 62287     | 2784      | 194       | 0.003    | 0.718    | 0.282    | 0.500    |
| 22-23    | 59309     | 2520      | 331       | 0.005    | 0.714    | 0.286    | 0.500    |
| 23-24    | 56458     | 2238      | 378       | 0.007    | 0.709    | 0.291    | 0.499    |
| 24-25    | 53842     | 2212      | 12027     | 0.197    | 0.582    | 0.418    | 0.484    |
| 25-26    | 39603     | 2056      | 569       | 0.014    | 0.574    | 0.426    | 0.499    |
| 26-27    | 36978     | 2003      | 644       | 0.017    | 0.565    | 0.435    | 0.499    |
| 27-28    | 34331     | 1877      | 328       | 0.009    | 0.559    | 0.441    | 0.499    |
| 28-29    | 32126     | 1732      | 643       | 0.019    | 0.549    | 0.451    | 0.498    |
| 29-30    | 29751     | 1677      | 181       | 0.006    | 0.545    | 0.455    | 0.500    |
| 30-31    | 27893     | 1634      | 1788      | 0.060    | 0.513    | 0.487    | 0.495    |
| 31-32    | 24471     | 1479      | 49        | 0.002    | 0.512    | 0.488    | 0.500    |
| 32-33    | 22943     | 1347      | 154       | 0.006    | 0.509    | 0.491    | 0.499    |
| 33-34    | 21442     | 1324      | 53        | 0.002    | 0.508    | 0.492    | 0.500    |
| 34-35    | 20065     | 1228      | 121       | 0.006    | 0.505    | 0.495    | 0.500    |
| 35-36    | 18716     | 1220      | 94        | 0.005    | 0.503    | 0.497    | 0.500    |
| 36-37    | 17402     | 1085      | 4019      | 0.201    | 0.411    | 0.589    | 0.483    |
| 37-38    | 12298     | 923       | 52        | 0.004    | 0.409    | 0.591    | 0.500    |
| 38-39    | 11323     | 916       | 108       | 0.009    | 0.405    | 0.595    | 0.499    |
| 39-40    | 10299     | 780       | 34        | 0.003    | 0.404    | 0.596    | 0.500    |
time of the survey, is used for the interval of one month for the life table analysis and in the last, take interval of three months because in interval of one month the number of child who still breastfeeding is very small due to which estimated survival is not estimated. A spline \( S(x) \) is a smooth piecewise defined function whose “pieces” are low-degree polynomials defined on separate intervals of the range of \( x \). The pieces are joined together in a suitably smooth fashion at joint points called knots. It is represented by a limited number of parameters and are smoothen the function that are extremely flexible in shape. It bridges the gap between parametric and nonparametric methods in statistics. A large number literature presents an algorithm for calculating splines of various degrees. Cubic splines (splines of degree 3) are often used in practice, since they are reasonably flexible in shape and reliable algorithms are available for their calculation. A simple method for calculating cubic splines, which involves rescaling the time axis to the unit interval, is given by (18) and is used in this paper. “The \( S_t \) parameters, which represent the cumulative survival function up to various time points, were considered as a function of the age of the child at the time of the survey and were represented by a cubic spline”. Three knots at .25, .50, and .75 with 3 degrees were found to be sufficient for the model fitting.

**Result and Discussion**

The figure (2) shows the overall pattern of duration of breastfeeding by the three methods. The survival curve represents the probability of mothers who continued to breastfeed at any given time. From figure (2) it is observed that the survival curve of Kaplan Meier Estimator is fluctuated with time and these are mainly occurring in multiple of six months although the survival curve by other two methods does not fluctuate timely.

| Interval | \( N_t \)  | \( W_t \)  | \( B_t \)  | \( m_t \)  | \( p_t \)  | \( q_t \)  | \( a_t \)  |
|----------|----------|----------|----------|----------|----------|----------|----------|
| 40-41    | 9485     | 771      | 131      | 0.013    | 0.399    | 0.601    | 0.499    |
| 41-45    | 8583     | 744      | 17       | 0.002    | 0.398    | 0.602    | 0.500    |
| 42-48    | 7822     | 2019     | 145      | 0.006    | 0.350    | 0.65     | 0.499    |
| 49-51    | 3970     | 1123     | 418      | 0.033    | 0.284    | 0.716    | 0.492    |
| 51-54    | 2429     | 927      | 9        | 0.001    | 0.254    | 0.746    | 0.500    |
| 54-57    | 1493     | 764      | 14       | 0.003    | 0.194    | 0.806    | 0.499    |
| 57-60    | 715      | 665      | 1        | 0.000    | 0.135    | 0.865    | 0.500    |
| >60      | 49       | 0        | 49       | 0.286    | 0        | 1        |          |
As $S_t$ is obtained by all the three methods as shown in table (2,3,4) after that it is smoothen by spline for 60 months of duration of breastfeeding. Then the cumulative distribution $F(t)$ and distribution function $f(t)$ is obtained for all the method. For 60 months of duration of breastfeeding mean estimate by Kaplan Maier Estimator is 32.84, by Current Status Data is 33.14 and by Life Table Analysis is 33.64 then for mean duration of breastfeeding for 60 months because after 60 months there are only 13.5(%) of proportion of child still doing breastfeeding, so we assume that, $S_t$ is zero after the 60 months of duration of breastfeeding. Quartiles are obtained by the graph. Similarly, for 36 months of duration of breastfeeding is obtained.

As shown in table 5 for 60 months the mean duration of breastfeeding is approximately equal but the median and quartiles are different by all the methods. This may occurred due to possible reasons, Kaplan Maier Estimator the information about duration of breastfeeding is depend on recall bases, the survival time is estimated at the point at which event occur, and censored event are uniformly distributed over the time however in current status data the information about duration of breastfeeding is find out by subtracting 60 months from date of interview (in CMC) and the survival time is estimated at the point at which event occur, but the roll of censored event is in interval of duration of breastfeeding is not uniformly distributed over time although in life table the information about duration of breastfeeding is also taken on recall bases but the roll of censored event is in interval of duration of breastfeeding.

The way of taking sampling frame is also very important aspect of determining the distribution of estimation of duration of breastfeeding.
Table 5 Mean and Quartiles obtained for the duration of breastfeeding by all three methods

|                      | duration of breastfeeding for 36 months | duration of breastfeeding for 60 months |
|----------------------|----------------------------------------|----------------------------------------|
|                      | Current Status Data | Life Table Analysis | Kaplan Meier Estimator | Current Status Data | Life Table Analysis | Kaplan Meier Estimator |
| Mean                 | 27.08 | 28.56 | 28.33 | 33.14 | 33.64 | 32.84 |
| Q₁                   | 24.25 | 22.35 | 23.65 | 22.65 | 23.62 | 24.58 |
| Q₂/Median            | 30.98 | 32.53 | NA    | 31.64 | 34.26 | 30.00 |
| Q₃                   | NA    | NA    | NA    | 46.54 | 46.47 | 59.00 |

Table 6-Estimation on different sampling frame

|                      | Birth’s record file(Mother) | Kids record file(Child) |
|----------------------|-------------------------------|--------------------------|
|                      | duration of breastfeeding for ≤36 months | duration of breastfeeding for ≤60 months |
|                      | Current Status Data | Life Table Analysis | Kaplan Meier Estimator | Current Status Data | Life Table Analysis | Kaplan Meier Estimator |
| Mean                 | 27.08 | 28.56 | 28.33 | 33.14 | 33.64 | 32.84 |
| Q₁                   | 24.25 | 22.35 | 23.65 | 22.65 | 23.62 | 24.58 |
| Q₂/Median            | 30.98 | 32.53 | NA    | 31.64 | 34.26 | 30.00 |
| Q₃                   | NA    | NA    | NA    | 46.54 | 46.47 | 59.00 |

|                      | Current Status Data | Life Table Analysis | Kaplan Meier Estimator |
|                      | Current Status Data | Life Table Analysis | Kaplan Meier Estimator |
| Mean                 | 29.58 | 30.58 | NA    | 33.24 | 32.21 | 58 |
| Q₁                   | 23.56 | 29.56 | 36    | 33.58 | 33.56 | 60 |
| Q₂/Median            | 29.54 | 21.24 | 36    | 33.58 | 20.59 | 33.56 |
| Q₃                   | 27.51 | 18    | NA    | 34    | 18    | 30 |

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estimation of the duration of breastfeeding from cross-sectional data.

If we are taking child information data from National Family Health Survey (NFHS-IV) then we collect the information all the child which was taken birth in last the five years, then determining the estimation of distribution of duration of breastfeeding. But if we take mother information data from National Family Health Survey (NFHS-IV) then we collect the information of all the women who are currently breastfeeding in the last five years, then determining the estimation of the distribution of duration of breastfeeding. Because an inverse relationship exists between birth rates and the time between the ways you are taking the data its affects the distribution.

The distribution in the form of $1 - F(t)$ (Survival function) is obtained for the duration of breastfeeding by current status, life table, and Kaplan Meier techniques. Further, the value of mean and quartiles is also obtained. The distribution is quite close in each other in life table and current status data, whereas in Kaplan Meier estimator the distribution is different (obtain by Kolmogorov smirnov test). It was found that difference in current status and life table K-S test is 0.016, for current status and Kaplan Meier estimator K-S test is 0.027 and for life table method and Kaplan Meier estimator K-S test is 0.025. This may be because there is age heaping due to recall lapse. Life table techniques method adjusts the effect of recall bias up to some extent. But the distribution obtained based on current status review very less effort to collect the data. The chance of recall bias is almost zero. Hence the distribution obtained from this technique is most feasible and appropriate in the contrast of cross sectional data. One must take care of the sampling frame while estimating such distribution as shown in table 6. Ideally, it would be appropriate to involve only those children whose age is at least 60 months. But such data will suffer from recall bias. So current status data of children whose age is 0 to 60 months should be used to evaluate duration of breastfeeding.

**Conclusion**

All the above mentioned three techniques are of a non-parametric approach. Although a parametric approach may also be used to evaluate the distribution under some suitable assumptions.

The current status and life table method are better than Kaplan Meier estimator as it is doesn’t based on recall data and heaping present in the data. One must be very cautions while estimating the various epidemiological parameters from available data set. The assumptions of the methodology as per data available should be evaluate. If such data is not available, the available methodology may be modified. Regression analysis based on current status data technique should be used to assume the impact of various clinical and epidemiological factors (such as nutrition of mother, health status of mother etc.) on duration of breastfeeding.

**Conflict of Interest**

The author declares that there is not conflict of interest.
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