

APPLICATION OF BIRTH INTERVAL AND BIRTH ORDER STATISTICS TO THE ANALYSIS OF FERTILITY IN INDIA

T. S. Sanal

Department of Statistics
Manipal University, Manipal
Karnataka.

P. Mohana Chandran Nair

Department of Demography, University of Kerala
Kariavattom, Trivandrum
Kerala.

e-mail: *sts.nlm.manipal@gmail.com*, *pmohanachandran@yahoo.com*

Abstract. In recent years the study of birth intervals has acquired added importance because of its relationships to fertility. The mean duration of successive birth intervals is obviously related to fertility rate. So the main objectives of this paper are to estimate the distribution of open birth interval and to study the linkage between total fertility rate (TFR) with birth order and birth interval Statistics. In order to estimate the distribution of open birth interval the concept of life tables were used and to ascertain the joint predictability of birth order and birth interval statistics on the TFR, it was regressed jointly with birth interval and birth order variables. The results of analysis reflects the levels and trends of fertility in India and its major states by an investigation through birth interval and birth order statistics on the basis of national family health survey-II (NFHS-II) conducted in 1998–99. Thus birth order and birth interval statistics are logically, theoretically and empirically suitable for measuring small and rapid changes in fertility.

Mathematics Subject Classification. 91D10, 91D20.

Keywords. Birth intervals, Birth order, Parity, Multiple regression.

1 Introduction

Fertility is one of the components of population change. Fertility analysis is important in understanding past, current and future trends of population size, Composition and growth. Information on fertility levels, patterns and trends experienced by a country is important for socio-economic planning, monitoring and evaluating programs.

The basic approach underlying the analysis of birth interval is to view the process of family building as consisting of series of stages where women move successively from marriage to first to second birth and so on, until they reach the completed family size. There are two aspects to the family building process. The first is the parity progression ratio, which is related to the quantum of fertility and the second is the time it takes to make the transition from one parity to the next for those who continue reproduction, or the distribution of birth intervals, which is related to the timing or tempo of fertility. The study of birth intervals both closed and open has gained considerable importance as they are used as sensitive indices of fertility and for detecting current changes in the natality pattern of women who are still in reproductive stages. Difference in a country's fertility level can be attributed to the difference in the length of the reproductive life of women and difference in the length of time between births when women are exposed to risk of conception. Analysis of those factors influencing the span and those affecting the spacing of fertility has proven useful, since in many cases they appear to vary quite substantially across populations.

Research problem

The problem of analyzing fertility rates from developing countries is the accuracy of reporting. Different errors may affect the data and lead to false conclusions. The direction and magnitude of the error are influenced by the number of births displaced by women from one period to another. The magnitude of the deficiency increases as the respondent report further into the past. In addition to this, data relating to fertility may contain errors and biases in the timing and location of births. To overcome these problems, it would be rewarding if one could assess the level of fertility and changes. In recent years policy makers and planners have focused a great deal of attention on the birth interval data.

Relevance of the study

An increasing body of data on birth intervals is available from various retrospective surveys on maternity histories of currently married women. Large scale surveys have also been carried out recently in India in a number of states, which provide a rich volume of data on birth intervals in measuring and explaining levels, and changes in fertility in a population are being increasingly recognized by demographers on the basis of several studies. Hence it is very relevant to the study the relationship between birth order and birth interval data with conventional fertility measures.

Objectives

The main objectives of this study are :

- To estimate probability that a women will have parity ‘ i ’.
- The distribution of open birth interval.
- To study the linkage between TFR with birth order and birth interval Statistics.

Hypothesis

- An increase in the length of the open birth interval is in direct proportion to the decline in the fertility.
- There exist empirical relationship between birth interval, birth order and conventional measures of fertility.

2 Data and Methodology

Data source

The data used for the study were taken from national family health survey conducted during 1998–1999 (NFHS-II) for India and various states.

Methodology

1. Calculation of parity

In order to estimate the probability that a women will have parity ‘ i ’, say P_i , then

$$P_i = \frac{[\text{TFR}]^i}{i!} e^{-\text{TFR}}$$

where

$$\text{TFR} = \int_{\alpha}^{\beta} m(x) dx.$$

α and β are the beginning and end of the reproductive span and $m(x)$ be the fertility rates corresponding to the women’s age x .

2. Distribution of open birth interval $g(u)$

If $u(x)$ is the length of the open birth interval to a women aged x , which implies that the women had a birth ‘ u ’ years ago from the date of survey. The distribution of $u(x)$ can be then obtained analogous to the concept of life tables as follows :

$$f(u/x) = m(x - u) e^{-\int_{x-u}^x m(a) da}$$

where $f(u/x)$ denotes probability density function of u for given x .
 $m(x-u)$ is the probability that there was a birth at time $(x-u)$ then second term probability of no birth in an interval $(x-u, x)$.

For the proper distribution at $u(x)$ divide the above expression by the probability of a woman ever becoming a mother before age x . Hence, the distribution of $u(x)$ say $g(u)$ is obtained as :

$$g(u) = f(u)/s_i$$

where

$$S_i = 1 - e^{-\int_a^x m(a)da}$$

3. Linkages between TFR, birth order and birth interval statistics

TFR has been widely used to assess the levels and changes in period fertility. TFR requires information regarding the age of the women at different times during their childbearing years. As is well known, age statistics are subject to reporting errors and other inherent biases which makes the computation of rates highly biased one. To overcome such problems, it would be rewarding if one could assess the level of fertility and changes their in from a knowledge of numerator data only.

Birth order and birth interval statistics are logically, theoretically and empirically suitable for measuring small and rapid changes in fertility. Correlation and regression coefficients were computed between TFR with the proportion of birth order $\{i = 1, 2, 3, 4, 5, \text{ and above } \}$ proportion of women having the last closed and open birth interval of various duration as follows :

$$\text{TFR} = a + b[\text{ordb} > i] \quad \{i = 2, 3, 4, 5, \text{ and above}\}$$

$$\text{TFR} = a + b[\text{lbi} > i] \quad \{i = 12, 24, 36, 42, 48, 54, 60\}$$

$$\text{TFR} = a + b[\text{obi} > i] \quad \{i = 12, 24, 36, 42, 48, 54, 60\}$$

In order to ascertain the joint predictability of birth order and birth interval Statistics on the Total Fertility Rate, it was regressed jointly with birth order and birth interval variables having the highest zero order correlation with the formula $\text{TFR} = a + b[\text{obi} > i] + c[\text{lbi} > i] + d[\text{ordb} > i]$ where

$\text{ordb} > i$ = Proportion of birth order more than i $\{i = 2, 3, 4, 5 \text{ and above } \}$

$\text{lbi} > i$ = Having open birth interval greater than or equal to i months

$\text{obi} > i$ = Proportion of women having last closed birth interval greater than or equal to i months.

SPSS Package is used for the analysis.

Table 1: ASFR and TFR for india and major states–NFHS–II.

| State | ASFR | | | | | | | TFR |
|------------------|-----------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|------|
| | 15–19 | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 | 45–49 | |
| India | 0.107 (18.8) | 0.210 (36.8) | 0.143 (25.1) | 0.069 (12.1) | 0.028 (4.9) | 0.008 (1.4) | 0.003 (0.5) | 2.85 |
| Kerala | 0.039 (9.95) | 0.166 (42.3) | 0.128 (32.7) | 0.040 (10.2) | 0.016 (4.1) | 0.003 (0.77) | 0.000 (0.00) | 1.96 |
| Tamilnadu | 0.083 (18.9) | 0.189 (41.3) | 0.121 (27.6) | 0.032 (7.4) | 0.010 (2.3) | 0.003 (0.68) | 0.000 (0.00) | 2.19 |
| Rajasthan | 0.126 (16.7) | 0.264 (34.9) | 0.181 (23.9) | 0.103 (13.6) | 0.048 (6.3) | 0.023 (3.0) | 0.009 (0.90) | 3.78 |
| West Bengal | 0.107 (23.4) | 0.173 (37.8) | 0.110 (24.0) | 0.047 (10.3) | 0.015 (3.3) | 0.003 (0.7) | 0.004 (0.9) | 2.29 |
| Punjab | 0.040 (9.0) | 0.178 (40.3) | 0.158 (35.7) | 0.051 (11.5) | 0.012 (2.7) | 0.003 (0.7) | 0.000 (0.00) | 2.21 |
| Maharashtra | 0.129 (25.6) | 0.223 (44.2) | 0.106 (21.0) | 0.034 (6.7) | 0.012 (2.4) | 0.000 (0.00) | 0.000 (0.00) | 2.52 |
| Madhya Pradesh | 0.142 (21.5) | 0.228 (34.4) | 0.159 (24.0) | 0.081 (12.2) | 0.033 (5.0) | 0.012 (1.8) | 0.006 (0.9) | 3.31 |
| Himachal Pradesh | 0.029 (6.7) | 0.203 (47.4) | 0.130 (30.4) | 0.045 (10.5) | 0.015 (3.5) | 0.006 (1.4) | 0.000 (0.00) | 2.14 |
| Haryana | 0.092 (15.9) | 0.240 (41.7) | 0.150 (26.0) | 0.062 (10.8) | 0.018 (3.1) | 0.013 (2.3) | 0.008 (1.4) | 2.88 |
| Gujarat | 0.087 (16.0) | 0.230 (42.3) | 0.148 (27.2) | 0.052 (9.6) | 0.018 (3.3) | 0.005 (0.9) | 0.003 (0.6) | 2.72 |
| Assam | 0.089 (19.0) | 0.149 (32.3) | 0.116 (25.1) | 0.070 (15.2) | 0.031 (6.7) | 0.007 (1.5) | 0.000 (0.00) | 2.31 |
| Andhra Pradesh | 0.132 (29.3) | 0.186 (41.3) | 0.087 (9.3) | 0.029 (6.4) | 0.012 (2.7) | 0.003 (0.7) | 0.000 (0.00) | 2.25 |
| Karnataka | 0.112 (26.3) | 0.172 (40.4) | 0.090 (21.1) | 0.037 (8.7) | 0.009 (2.1) | 0.003 (0.7) | 0.001 (0.2) | 2.13 |
| Uttar Pradesh | 0.120 (15.0) | 0.256 (32.1) | 0.208 (26.1) | 0.127 (15.9) | 0.064 (8.0) | 0.018 (2.1) | 0.006 (0.7) | 3.99 |
| Orissa | 0.079 (16.1) | 0.174 (35.3) | 0.138 (28.0) | 0.071 (14.4) | 0.023 (4.7) | 0.006 (1.20) | 0.001 (0.2) | 2.46 |
| Bihar | 0.113 (16.2) | 0.223 (31.9) | 0.180 (25.8) | 0.112 (16.0) | 0.050 (7.2) | 0.018 (2.6) | 0.002 (0.3) | 3.49 |

3 Results

Fertility rates

In India about 19 percent of births occurred in the age group 15–19, 62 percent in 20–29 age group, 17 percent in 30–39 age group and only 2 percent of births above the age 40. Among the major states, Kerala have about 10 percent of births occurring in the age group 15–19, 75 percent in 20–29 age group, 14 percent in 30–39 age group and only 1 percent of births above the age 40. In Tamil Nadu about 19 percent of births occurred in the age group 15–19, 70 percent in 20–29 age group, 10 percent in 30–39 age group and only 1 percent of births above age 40. In Gujarat about 16 percent of births occurred in the age group 15–19, 70 percent in 20–29 age group, 13 percent in 30–39 age group and only 2 percent of births above the age 40. Details of age specific fertility rates (ASFR) is given in Table 1.

Table 2: Percentage distribution of women by duration of open birth intervals in months

| State | Months | | | | | | |
|------------------|----------|----------|----------|----------|----------|----------|----------|
| | Obi > 12 | Obi > 24 | Obi > 36 | Obi > 42 | Obi > 48 | Obi > 54 | Obi > 60 |
| India | 55.8 | 32.3 | 18.9 | 14.8 | 11.9 | 9.5 | 7.6 |
| Kerala | 47.3 | 19.1 | 9.6 | 7.3 | 5.3 | 4.3 | 3.5 |
| Tamilnadu | 49.9 | 24.7 | 13.5 | 10.0 | 8.3 | 6.7 | 5.7 |
| Rajasthan | 65.5 | 44.5 | 28.2 | 22.8 | 14.1 | 14.1 | 11 |
| West Bengal | 55.6 | 32.1 | 18.1 | 14.3 | 11.6 | 9.2 | 7.2 |
| Punjab | 44.8 | 20.0 | 9.0 | 6.7 | 5.1 | 4.0 | 3.2 |
| Maharashtra | 57.3 | 30.7 | 15.6 | 11.6 | 8.7 | 7.1 | 5.8 |
| Madhya Pradesh | 61.6 | 40.1 | 24.9 | 19.5 | 15.5 | 12.3 | 9.2 |
| Himachal Pradesh | 52.6 | 25.4 | 12.5 | 9.0 | 6.9 | 5.4 | 4.3 |
| Haryana | 60.1 | 34.2 | 18.0 | 13.7 | 10.4 | 7.5 | 5.5 |
| Gujarat | 58.7 | 34.2 | 20.0 | 15.9 | 12.7 | 10.4 | 8.6 |
| Assam | 48.1 | 21.6 | 10.6 | 8.2 | 6.8 | 5.6 | 4.4 |
| Andhra Pradesh | 61.0 | 38.3 | 24.0 | 19.5 | 16.3 | 3.5 | 10.8 |
| Karnataka | 52.8 | 27.8 | 14.8 | 11.2 | 9.0 | 7.1 | 5.7 |
| Uttar Pradesh | 63.0 | 44.1 | 29.8 | 24.1 | 19.7 | 16.2 | 18.5 |
| Orissa | 52.0 | 29.2 | 16.2 | 12.5 | 10.6 | 8.4 | 6.7 |
| Bihar | 64.7 | 42.9 | 27.5 | 21.4 | 16.2 | 13 | 14.3 |

Distribution of women by duration of open birth intervals

Open birth interval is a sensitive measure of the parity progression ratio. The extent of spacing between births is analyzed through closed birth interval, especially the last closed birth interval, the extent of limitation in terms of the parity progression ratios estimated from data on open birth intervals. The sample women in the NFHS-II survey grouped according to the duration of the open birth interval in mothers. The intervals are classified as greater than 12, 24, 36, 42, 48, and 54 and 60 and above months. The details are given in Table 2.

Distribution of women by duration of last birth intervals

In India, about 76 percent of the women have last birth interval more than 12 months and the percentage decreases with increasing of duration. About 65 percentages had more than 24 month of last birth interval and 46 percentages have last birth interval of more than 60 months. Among the states, Kerala and Himachal Pradesh (81 percent) have the highest proportion of women with last birth interval greater than 12 months. In Uttar Pradesh it is the lowest (71 Percent). The details are given in Table 3.

Distribution of women by birth order

Birth order helps to understand the fertility trends and patterns in the context of low shifting fertility. In India, about 54 percent of women have birth order greater than 2 and only 12 percent of the women have birth order greater than 5. Among the states, as expected Kerala have the lowest proportions of

Table 3: Percentage distribution of women by duration of last birth intervals in months

| State | Months | | | | | | |
|------------------|----------|----------|----------|----------|----------|----------|----------|
| | Lbi > 12 | Lbi > 24 | Lbi > 36 | Lbi > 42 | Lbi > 48 | Lbi > 54 | Lbi > 60 |
| India | 76.3 | 65.3 | 57.0 | 53.8 | 51.1 | 48.1 | 45.7 |
| Kerala | 81.3 | 73.3 | 67.1 | 64.9 | 62.7 | 59.8 | 57.4 |
| Tamilnadu | 79.2 | 70.5 | 63.8 | 60.8 | 58.0 | 55.6 | 53.4 |
| Rajasthan | 72.3 | 59.6 | 59.1 | 45.5 | 42.8 | 39.8 | 37.9 |
| West Bengal | 79.2 | 70.3 | 63.1 | 60.1 | 57.6 | 54.8 | 52.8 |
| Punjab | 80.9 | 72.2 | 64.7 | 61.3 | 58.9 | 56.1 | 54.0 |
| Maharashtra | 77.4 | 67.9 | 60.8 | 58.3 | 55.9 | 53.5 | 51.1 |
| Madhya Pradesh | 72.7 | 60.3 | 51.3 | 47.8 | 45.1 | 42.3 | 39.9 |
| Himachal Pradesh | 81.3 | 72.5 | 67.1 | 64.8 | 62.1 | 59.3 | 56.3 |
| Haryana | 79.3 | 68.3 | 66.6 | 57.0 | 55.1 | 51.5 | 49.2 |
| Gujarat | 76.7 | 67.5 | 60.1 | 57.1 | 54.9 | 53.1 | 51.6 |
| Assam | 77.6 | 67.6 | 60.2 | 56.9 | 53.4 | 48.6 | 45.6 |
| Andhra Pradesh | 77.7 | 68.8 | 63.4 | 61.4 | 59.3 | 56.4 | 53.7 |
| Karnataka | 78.9 | 69.4 | 63.2 | 60.9 | 57.7 | 55.1 | 53.1 |
| Uttar Pradesh | 71.0 | 57.1 | 46.8 | 43.1 | 40.6 | 37.2 | 34.8 |
| Orissa | 77.2 | 66.3 | 57.8 | 55.1 | 52 | 49.3 | 46.6 |
| Bihar | 72.4 | 57.6 | 55 | 47.1 | 41.9 | 37.3 | 33.5 |

women (35.3 %) having birth order greater than 2, then it is highest in Uttar Pradesh (62 %). Madhya Pradesh, Rajasthan, Bihar and Haryana also have higher proportion of women with birth order greater than 2. Again it can be seen that in Kerala only 3.2 percent have birth order greater than 5 while for Uttar Pradesh it is nearly 22 percent. Details are given in Table 4.

Estimation of parity

The probability that a women will have parity ' i ', is estimated for India and its major states and the results are given in Table 5. From the table it can be seen that nearly 6 percentage of the Indian women are in zero parity, about 40 percent in first or second parity and more than 50 percentage are having three or more births.

Among the major states of India, Kerala is having 14 percent of women in zero parity, 55 percent in 1st or 2nd parity and about 30 percent are in 3rd or higher parity. In Tamil Nadu 11 percent are in zero parity, 53 percent are in 1st or 2nd parity and about 37 percent are in 3rd or higher parity. In West Bengal 10 percent are in zero parity, 51 percent are in 1st or 2nd parity and about 39 percent are in 3rd or higher parity. Punjab has 11 percent in zero parity, 52 percent in 1st or 2nd parity and about 37 percent are in 3rd or higher parity. In Maharashtra 8 percent are in zero parity, 46 percent are in 1st or 2nd parity and about 46 percent are in 3rd or higher parity. Himachal Pradesh has 12 percent in zero parity, 53 percent in 1st or 2nd parity and about 35 percent in 3rd or higher parity. In Haryana 6 percent are in zero parity, 40 percent are in 1st or 2nd parity and about 55 percent are in 3rd or higher parity. Details are in Table 5.

Table 4: Percentage distribution of women by order of birth

| State | Months | | | |
|------------------|----------|----------|----------|----------|
| | Ordb > 2 | Ordb > 3 | Ordb > 4 | Ordb > 5 |
| India | 53.6 | 34.2 | 20.5 | 12.0 |
| Kerala | 35.3 | 14.3 | 6.4 | 3.2 |
| Tamilnadu | 40.4 | 20.0 | 9.6 | 4.4 |
| Rajasthan | 59.9 | 42.5 | 28.0 | 17.8 |
| West Bengal | 42.8 | 25.7 | 14.5 | 8.3 |
| Punjab | 52.8 | 28.2 | 12.5 | 6.0 |
| Maharashtra | 50.8 | 26.9 | 12.8 | 5.8 |
| Madhya Pradesh | 60.8 | 43.3 | 28.0 | 17.3 |
| Himachal Pradesh | 50.1 | 25.1 | 12.0 | 4.6 |
| Haryana | 56.5 | 34.0 | 19.4 | 10.6 |
| Gujarat | 53.7 | 31.9 | 17.3 | 8.9 |
| Assam | 51.4 | 34.0 | 19.6 | 11.1 |
| Andhra Pradesh | 49.1 | 27.9 | 15.4 | 8.1 |
| Karnataka | 50.0 | 28.9 | 15.8 | 9.1 |
| Uttar Pradesh | 61.6 | 45.9 | 32.4 | 21.8 |
| Orissa | 52.5 | 32.9 | 17.9 | 9.0 |
| Bihar | 60.0 | 44.2 | 31.2 | 18.5 |

Distribution of open birth interval $g(u)$ for India 1998–99

Table 6 presents the distribution of open birth interval corresponding to women aged 20, 25, 30, 35, 40 and 45 years by using age specific fertility rates for the Indian population from NFHS-II data for the years 1998–99. The distribution in the table can be used to obtain the mean and variance of open birth intervals referring to the period for which input data are available. It is observed that the values of the distribution decreases with years since last birth at each age.

Comparison of mean, S.D. and variance of $g(u)$ in some states of India

At the age 20 highest value of $g(u)$ occurred in Himachal Pradesh (0.92620) followed by Punjab (0.125) then in Kerala (0.1222) and the lowest is in Orissa (0.00025). By observing values of S.D. at the age 20, highest mean value in Himachalpradesh (0.82270) followed by Punjab (0.126500) and the lowest is in Uttar Pradesh (0.00277). From age 25 mean value of $g(u)$ is highest in Punjab (0.41620) followed by Kerala (0.00611). Details are given in Table 7.

Observed and estimated TFR

Birth intervals have vital role to decide average number of children a women would have under the existing fertility schedule. Increment in difference of fertility indicates the impact of birth interval on fertility. More details are given in Table 8.

Table 5: Percentage distribution of women by state according to parity

| State | P_0 | P_1 | P_2 | P_3 | P_4 | P_{5+} |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| India | 0.058 (5.8) | 0.165 (16.5) | 0.235 (23.5) | 0.223 (22.3) | 0.159 (15.9) | 0.160 (16.0) |
| Kerala | 0.141 (14.1) | 0.276 (27.6) | 0.271 (27.1) | 0.177 (17.7) | 0.087 (8.7) | 0.048 (4.8) |
| Tamilnadu | 0.112 (11.2) | 0.245 (24.5) | 0.268 (26.8) | 0.196 (19.6) | 0.107 (10.7) | 0.072 (7.2) |
| Rajasthan | 0.023 (2.3) | 0.086 (8.6) | 0.163 (16.3) | 0.205 (20.5) | 0.194 (19.4) | 0.329 (32.9) |
| West Bengal | 0.101 (10.1) | 0.232 (23.2) | 0.266 (26.6) | 0.203 (20.3) | 0.116 (11.6) | 0.082 (8.2) |
| Punjab | 0.110 (11.0) | 0.242 (24.2) | 0.268 (26.8) | 0.197 (19.7) | 0.109 (10.9) | 0.074 (7.4) |
| Maharashtra | 0.080 (8.0) | 0.203 (20.3) | 0.255 (25.5) | 0.215 (21.5) | 0.135 (13.5) | 0.112 (11.2) |
| Madhya Pradesh | 0.037 (3.7) | 0.121 (12.1) | 0.200 (2.00) | 0.221 (2.21) | 0.183 (18.3) | 0.238 (2.38) |
| Himachalpradesh | 0.118 (11.8) | 0.252 (25.2) | 0.269 (26.9) | 0.192 (19.2) | 0.103 (10.3) | 0.066 (6.6) |
| Haryana | 0.056 (5.6) | 0.162 (16.2) | 0.233 (23.3) | 0.223 (22.3) | 0.161 (16.1) | 0.165 (16.5) |
| Gujarat | 0.067 (6.7) | 0.181 (18.1) | 0.490 (49.0) | 0.220 (22.0) | 0.149 (14.9) | 0.093 (9.3) |
| Assam | 0.099 (9.9) | 0.229 (22.9) | 0.265 (26.5) | 0.204 (20.4) | 0.118 (11.8) | 0.085 (8.5) |
| Andhra Pradesh | 0.105 (10.5) | 0.237 (23.7) | 0.267 (26.7) | 0.200 (2.00) | 0.113 (11.3) | 0.078 (7.8) |
| Karnataka | 0.119 (11.9) | 0.253 (25.3) | 0.270 (27.0) | 0.191 (19.1) | 0.104 (10.4) | 0.063 (6.3) |
| Uttar pradesh | 0.018 (1.8) | 0.074 (7.4) | 0.147 (14.7) | 0.196 (19.6) | 0.195 (19.5) | 0.526 (52.6) |
| Orissa | 0.085 (8.5) | 0.210 (21.0) | 0.259 (25.9) | 0.212 (21.2) | 0.130 (13.0) | 0.104 (10.4) |
| Bihar | 0.031 (3.10) | 0.106 (10.6) | 0.186 (18.6) | 0.216 (21.6) | 0.189 (18.9) | 0.272 (27.2) |

Table 6: Distribution of open birth interval $g(u)$ for India 1998–99

| Years since last month | Age | | | | | |
|---------------------------|----------|----------|----------|----------|----------|----------|
| | 20 | 25 | 30 | 35 | 40 | 45 |
| 1 | 0.131202 | 0.741243 | 0.083175 | 0.032209 | 0.358786 | 1.181109 |
| 2 | 0.085524 | 0.539060 | 0.059701 | 0.024368 | 0.277406 | 0.946179 |
| 3 | 0.039493 | 0.264382 | 0.034102 | 0.013801 | 0.172347 | 0.594138 |
| 4 | 0.015196 | 0.123112 | 0.016199 | 0.007247 | 0.094303 | 0.347384 |
| 5 | 0.005655 | 0.062199 | 0.009862 | 0.004412 | 0.062452 | 0.218815 |
| 6 | 0.001060 | 0.029169 | 0.004766 | 0.002488 | 0.035103 | 0.123196 |
| 7 | 0.000442 | 0.015443 | 0.002944 | 0.001645 | 0.021345 | 0.081652 |
| 8 | | 0.006434 | 0.001650 | 0.000995 | 0.016343 | 0.051212 |
| 9 | | 0.002717 | 0.001003 | 0.000625 | 0.009672 | 0.040828 |
| 10 | | 0.001001 | 0.000660 | 0.000413 | 0.008672 | 0.031514 |
| 11 | | | 0.000409 | 0.000285 | 0.005503 | 0.019698 |
| 12 | | | 0.000224 | 0.000225 | 0.003418 | 0.016473 |
| 13 | | | 0.000079 | 0.000140 | 0.002584 | 0.010742 |
| 14 | | | 0.000106 | 0.000430 | 0.002334 | 0.005015 |
| 15 | | | | 0.000055 | 0.001334 | 0.006089 |
| 16 | | | | 0.000024 | 0.000751 | 0.004299 |
| 17 | | | | 0.000020 | 0.000583 | 0.003941 |
| 18 | | | | 0 | 0.000417 | 0.001074 |
| 19 | | | | 0.000006 | 0.000083 | 0.000716 |
| 20 | | | | | 0 | 0.001432 |
| 21 | | | | | 0.000083 | 0.000716 |
| 22 | | | | | 0.000166 | 0.000358 |
| 23 | | | | | 0 | 0 |
| 24 | | | | | 0 | 0.000358 |
| 25 | | | | | 0 | |
| 26 | | | | | 0.000083 | |
| Mean | 0.00398 | 0.17850 | 0.00154 | 0.00047 | 0.00413 | 0.15360 |
| S.D | 0.00504 | 0.26070 | 0.00259 | 0.00908 | 0.00908 | 0.31440 |
| Variance | 0.00254 | 0.00680 | 0.00008 | 0.00001 | 0.00082 | 0.00988 |

Table 7: Mean, S.D. and variance of $g(u)$ in india and major states

| States | Items | Age | | | | | |
|------------------|----------|----------|----------|----------|----------|---------|---------|
| | | 20 | 25 | 30 | 35 | 40 | 45 |
| India | Mean | 0.12200 | 0.00611 | 0.00304 | 0.00478 | 0.12090 | 0.60940 |
| | S.D. | 0.00769 | 0.00707 | 0.00477 | 0.00814 | 0.20610 | 1.00550 |
| | Variance | 0.00059 | 0.00050 | 0.00023 | 0.00066 | 0.00467 | 1.01110 |
| Kerala | Mean | 0.12200 | 0.00611 | 0.00304 | 0.00478 | 0.12090 | 0.60940 |
| | S.D. | 0.00769 | 0.00707 | 0.00477 | 0.00814 | 0.20610 | 1.00550 |
| | Variance | 0.00059 | 0.00050 | 0.00023 | 0.00066 | 0.00467 | 1.01110 |
| Tamilnadu | Mean | 0.00844 | 0.00297 | 0.00177 | 0.00453 | 0.0375 | - |
| | S.D. | 0.10080 | 0.00413 | 0.00306 | 0.00763 | 0.20480 | - |
| | Variance | 0.00102 | 0.00017 | 0.00009 | 0.00058 | 0.00420 | - |
| Rajasthan | Mean | 0.00288 | 0.00120 | 0.00053 | 0.00036 | 0.00048 | 0.00076 |
| | S.D. | 0.00306 | 0.00139 | 0.00063 | 0.00056 | 0.00064 | 0.00117 |
| | Variance | 0.00938 | 0.00002 | .000004 | .000002 | .000004 | 0.00001 |
| West Bengal | Mean | 0.00491 | 0.00293 | 0.00166 | 0.00255 | 0.00434 | 0.20150 |
| | S.D. | 0.00485 | 0.00389 | 0.00271 | 0.00404 | 0.00870 | 0.32500 |
| | Variance | 0.00024 | 0.00015 | 0.00007 | 0.00016 | 0.00757 | 0.10560 |
| Punjab | Mean | 0.12500 | 0.41620 | 0.00295 | 0.00362 | 0.44220 | 0.37770 |
| | S.D. | 0.12650 | 0.56820 | 0.00447 | 0.00645 | 0.93440 | 0.78200 |
| | Variance | 0.00160 | 0.32280 | 0.00200 | 0.00042 | 0.87310 | 0.61150 |
| Maharashtra | Mean | 0.00484 | 0.00164 | 0.00121 | 0.00278 | 0.00765 | - |
| | S.D. | 0.00499 | 0.00245 | 0.00205 | 0.00473 | 0.12860 | - |
| | Variance | 0.00025 | 0.00006 | 0.00004 | 0.00022 | 0.00165 | - |
| Madhya Pradesh | Mean | 0.00393 | 0.00141 | 0.00061 | 0.00060 | 0.00105 | 0.00230 |
| | S.D. | 0.00402 | 0.00176 | 0.00088 | 0.00082 | 0.00140 | 0.00312 |
| | Variance | 0.00016 | 0.00003 | .000008 | .000007 | 0.00002 | 0.00010 |
| Himachal Pradesh | Mean | 0.92620 | 0.00521 | 0.00270 | 0.00372 | 0.00690 | 0.20980 |
| | S.D. | 0.82270 | 0.00586 | 0.00427 | 0.00631 | 0.13300 | 0.38010 |
| | Variance | 0.67680 | 0.00034 | 0.00018 | 0.00040 | 0.00177 | 0.14440 |
| Haryana | Mean | 0.00338 | 0.00197 | 0.00085 | 0.00070 | 0.00229 | 0.00330 |
| | S.D. | 0.00373 | 0.00242 | 0.00121 | 0.00143 | 0.00342 | 0.00496 |
| | Variance | 0.00014 | 0.00006 | 0.00001 | 0.00002 | 0.00017 | 0.00025 |
| Gujarat | Mean | 0.00626 | 0.00170 | 0.00095 | 0.00164 | 0.00352 | 0.01430 |
| | S.D. | 0.00585 | 0.00240 | 0.00147 | 0.00253 | 0.00564 | 0.17470 |
| | Variance | 0.00034 | 0.00006 | 0.00002 | 0.00006 | 0.00032 | 0.00305 |
| Assam | Mean | 0.00846 | 0.00352 | 0.00185 | 0.00201 | 0.00344 | 0.15890 |
| | S.D. | 0.00866 | 0.00512 | 0.00328 | 0.00364 | 0.00679 | 0.33100 |
| | Variance | 0.00075 | 0.00026 | 0.00012 | 0.00013 | 0.00046 | 0.10960 |
| Andhra Pradesh | Mean | 0.00466 | 0.00233 | 0.00176 | 0.00336 | 0.00668 | 0.32230 |
| | S.D. | 0.00437 | 0.00258 | 0.00273 | 0.00520 | 0.11190 | 0.50160 |
| | Variance | 0.00019 | 0.00007 | 0.00007 | 0.00027 | 0.00125 | 0.25160 |
| Karnataka | Mean | 0.00497 | 0.00304 | 0.00249 | 0.00552 | 0.12780 | 0.33530 |
| | S.D. | 0.00633 | 0.00444 | 0.00391 | 0.00878 | 0.20520 | 0.59330 |
| | Variance | 0.00040 | 0.00020 | 0.00015 | 0.00077 | 0.00421 | 0.35210 |
| Uttarpradesh | Mean | 0.00459 | 0.00138 | 0.00048 | 0.00038 | 0.00043 | 0.00125 |
| | S.D. | 0.00277 | 0.00145 | 0.00057 | 0.00033 | 0.00042 | 0.00111 |
| | Variance | 0.00008 | 0.000023 | 0.000003 | 0.000001 | 0.00002 | 0.00001 |
| Orissa | Mean | 0.00025 | 0.00034 | 0.00021 | 0.00034 | 0.00095 | 0.00379 |
| | S.D. | - | 0.00020 | 0.00021 | 0.00321 | 0.00107 | 0.00441 |
| | Variance | - - | .000004 | .000005 | .000001 | 0.00001 | 0.00019 |
| Bihar | Mean | 0.000052 | 0.00198 | 0.000189 | 0.00271 | 0.01198 | 0.21231 |
| | S.D. | 0.003280 | 0.000231 | 0.00219 | 0.00430 | 0.00275 | 0.23480 |
| | Variance | 0.000015 | 0.00008 | 0.00007 | 0.00026 | 0.00115 | 0.31510 |

Table 8: Difference between observed and estimated TFR

| State | Observed | TFR Estimated | TFR Difference |
|-----------------|----------|---------------|----------------|
| India | 2.85 | 2.47 | 0.38 |
| Kerala | 1.96 | 1.91 | 0.05 |
| Tamilnadu | 2.19 | 2.16 | 0.03 |
| Rajasthan | 3.78 | 2.98 | 0.80 |
| West Bengal | 2.29 | 2.17 | 0.12 |
| Punjab | 2.21 | 1.99 | 0.22 |
| Maharashtra | 2.52 | 2.36 | 0.16 |
| Madhya Pradesh | 3.31 | 2.86 | 0.45 |
| Himachalpradesh | 2.14 | 1.99 | 0.15 |
| Haryana | 2.88 | 2.44 | 0.44 |
| Gujarat | 2.72 | 2.54 | 0.18 |
| Assam | 2.31 | 2.14 | 0.17 |
| Andhra Pradesh | 2.25 | 1.18 | 1.07 |
| Karnataka | 2.13 | 1.98 | 0.15 |
| Uttar Pradesh | 3.99 | 3.76 | 0.23 |
| Orissa | 2.46 | 2.36 | 0.1 |
| Bihar | 3.49 | 3.25 | 0.24 |

4 Summary and Conclusions

The results presented in this study reflects the levels and trends of fertility in India and its major states by an investigation through birth interval and birth order statistics on the basis NFHS-II survey conducted in 1998–99.

Distribution of women by duration of open birth intervals for India shows that about 56 percent of the women have open birth interval more than 12 months and percentage decreases with marital duration. Except Punjab, Kerala, Tamil Nadu and Assam all other states have more than 50 percentages of women having birth interval above 12 months.

By estimating the probability that a women will have parity i , it is clear that nearly 6 percentage of the Indian women are in zero parity and about 40 percent women are in first or second parity. More than 50 percentages of the women are having three or more births. By state wise analysis it is again noted that the women in zero, first and second parities are highest in Kerala and lowest in Uttarpredesh. But fourth or higher order parities are higher in Uttar Pradesh lowest in Kerala.

Linkage between TFR with birth order and birth interval statistics shows that the degree of association is observed to be the highest between TFR and the proportion of birth order 5 and above. Again it is noted that the degree of inverse relationship increased with an increase in birth spacing and was maximum for the last closed birth interval of 42 months and above. Thus it is evident that the birth order and birth interval statistics are logically, theoretically and empirically suitable for measuring small and rapid changes in fertility.

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