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ESTIMATION OF PARITY PROGRESSION RATIO BY BIRTH ORDER STATISTICS USING VARIOUS SAMPLING FRAME

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Abstract

Fertility analysis plays a crucial role in understanding the past, current and future trends of population size, composition and growth. The spacing between two consecutive births and progression from a birth to next higher order birth are two important dimensions of fertility behavior of a woman. The specific index which measures fertility in the second dimension is the parity progressive ratios (PPR) which gives the probability that a woman of a given birth order ever proceeds to the next child, has acquired dominant place in the study of fertility. The objective of this paper is to obtain an alternative procedure for estimating PPR after using some approximations in procedure given by Blacker et al. (1989). In the proposed procedure there is no need of gross reproduction rate and life table survivorship at age one rather we need the growth rate which is easily computed. The proposed procedure has been applied on the various data obtained through different sampling scheme to explore the suitability of the procedure.

Key Words: Parity, Parity Progression Ratio, Birth Order, Birth Interval.

1. Introduction

Fertility, mortality and migration are the three important components of population change. Fertility analysis plays a crucial role in understanding the past, current and future trends of population size, composition and growth. It is also important to know the level of fertility, trends and patterns of a country for socio-economic planning, monitoring and development of the country. The spacing between two consecutive births and progression from a birth to next higher order birth are two important dimensions of fertility behavior of a women. The first aspect is the inter-live birth interval, which is a good index of measuring the level and pattern of fertility (Henry, 1953; Rodriguez et al. 1980; Pandey et al. 1989 and Srinivasan 1967a). The specific index which measures fertility in the second dimension is the parity progressive ratios (PPR) which gives the probability that a woman of a given birth order ever proceeds to the next child, has acquired dominant place in the study of fertility. It came into importance as a useful measure of fertility specially to compare the reproductive outcome of two or more populations having similar child spacing pattern but different desired family sizes. Parity progression analysis of fertility therefore plays a critical role in the process of assessment of the impact of contraceptive practices in the population. Research suggests that two populations having same child spacing pattern, may have different limiting pattern and thereby may have different parity progression ratios (Yadava et al. 1985). The PPR is partly affected by incidence of secondary infertility which changes over age. Gandotra et al. (1998) have studied fertility differential at national as well as state level and indicated that rural women were more prone to have greater PPRs than urban women. Alagarajan and Kulkarni in 1998 used parity progression ratios to examine the fertility differentials by religion in Kerala. Mutharayappa et al. (1997) and Chaudhuri (2012) studied the effect of desire of son on parity progression ratio.

Total fertility rate gives an idea about the average completed family size (number of children ever born) of a female during her entire reproductive span ignoring her mortality up to that period. However, it does not reveal anything about the proportion of females in the population who after having a specified number of children proceed to the next birth. This proportion of females plays an important role in explaining overall fertility performance of any population because of the fact that, it not only reflects the extent of family limitation practices that are being followed in the population but also determines the estimate of total fertility of that population after some modification. Hence, the knowledge of this proportion of females who proceeds for next birth is of particular importance in context of India and its most populous state i.e. Uttar Pradesh in order to assess the impact of various family planning programs on human fertility. PPR, the proportion of women with an $(i)^{th}$ births who continue to an $(i+1)^{th}$ birth during their lifetime is a sensitive indicator of changes in family building process which follow the adoption of contraception. They are much less affected than the traditional aggregate measures of total fertility by changes in proximate determinants, such as age at marriage, birth intervals or sterility. Hence, the estimation of trends of PPR obtained in birth history surveys has recently become more important.

PPR, like other fertility measures, may be calculated either on a cohort or on a period basis. Cohort calculations typically use census or survey data on number of children ever born, classified by age or by duration of marriage. Period calculations are made by using birth probabilities specific for parity and for one other characteristic or more. The liabilities of period measures for the analysis of fertility trends were recognized clearly by Hajnal (1947) and were modeled formally by Ryder (1951). Whereas the liability of cohort measures is that they may be computed only after the experience of the cohort in objective is completed. Because this experience typically spans one decade or more, cohort statistics are incapable of describing the recent past.

Besides period and cohort measures of PPR there is one more term called Instantaneous Parity Progression Ratio (IPPR here after). Srinivasan (1967a, 1967b, 68) proposed a procedure to estimate IPPR of a population using the data on open and last closed birth interval obtained from married females in reproductive age group. Srinivasan (1967a) mentioned that IPPR is a period measure which is conceptually different from PPR. PPR denotes the probability that a woman after delivering her $(i)^{th}$ birth will ever proceed to next while IPPR is the probability that a woman of parity $(i)^{th}$ at the time of survey will ever proceed to the next child. Thus we see that both are probabilities of progression from $(i)^{th}$ to $(i+1)^{th}$ child, one at the time of birth of $(i)^{th}$ child and other at the time of survey. Later Yadava and Saxena (1989) have investigated the difference between the two in detail and have also provided a procedure to convert IPPR to PPR and vice versa. PPR, by definition, depends only upon the pattern of limiting of births while IPPR is dependent not only on the pattern of limiting births but also on the spacing pattern behaviour between births. Thus, two populations having identical values of PPR may have different values of IPPR simply because of the differences in the spacing patterns between births.

2. Literature Review

In the study of human fertility birth intervals are very important because of availability of birth interval data in developed as well as developing countries from various retrospective surveys on maternity history, fertility surveys and demographic health surveys (DHS). Also it offers a lot of opportunities for measuring and explaining the levels and changes in fertility by analytical model building based on the theories of stochastic process and renewal theory.

The first attempt of estimation of PPR was done by Norman B. Ryder and Louis Henry in early 1950s. Henry (1953) estimated PPR using life table technique for all women who have completed their reproductive period. After that various attempts have been done by many researchers to estimate PPR with more ease and relaxing the data requirement and for the same purpose some researchers used complete birth history while some used the data of last closed birth interval and open birth interval only and showed the desired result using limited data (Srinivasan, 1968; Brass, 1975; Feeney, 1983; Feeney and Ross, 1984; Bhrolchain, 1987; Feeney and Yu, 1987; Feeney, 1988). Yadava and Bhattacharya (1985) have proposed an alternative procedure for estimating PPRs from the data on open and last closed birth intervals for the females who are in the reproductive period. This is actually a modification of Srinivasan's (1968) procedure which provides estimates of PPRs rather than IPPRs and it also does not require data on the age at last birth for females who have completed their reproductive period. Later Yadava et al. (1992, 1993, 2006, 2013) have given many modifications to estimate PPR by considering open, last closed and most recent closed birth intervals. Simultaneously some researchers used birth order statistic to estimate PPR and such a first attempt was done by Brass in 1975. Also Pandey and Suchindran (1997) and Pandey et. al. (1997) estimated PPR using respectively vital statistics and birth order statistics.

In developing countries like India, Nepal, Pakistan, Bangladesh and a few others in Asia and Latin America, the conventional measures of fertility like crude birth rate, age specific and total fertility rates, and other measures of reproduction cannot be computed for each year because it requires a high degree of accuracy in data. In India registration of births and deaths is still very poor both in coverage and accuracy. Therefore, numerator data is inherent with gross deficiencies in the registration of births and the required denominator data on population size and its characteristics necessary for computing these rates are just not available on a yearly basis. The desired denominator data on population size and its characteristics such as age, sex, and marital status, with high degree of accuracy can be obtained by census only which is conducted once in ten years. Under these conditions there is need to develop a method of estimating fertility based on numerator data only like number and characteristics of birth that occur in a specified area or population. Such analysis is called as numerator analysis.

The distributions of births by order are not solely determined by the level of fertility, they are influenced by the age distribution of the childbearing women. Hence, we need to standardize age of mother so that distribution of births by order can be used as an index of fertility. Normally this standardization is done by dividing the number of births in each age-group-birth-order cell by the total number of women in each age group. But the numbers of women in different age groups which form the denominators of age-order-specific rates are unknown. One of the possible reasons is ill-registration of birth statistics and hence we need to use numerator analysis.

Considering all these facts Blacker et al. (1989) has given a formula to compute weighted number of $(i)^{th}$ order births using birth order statistic and maternal age at different order births. This procedure needs, besides other information, the estimate of mean reproduction rate, which is approximated by the product of gross reproduction rate (GRR) and infant mortality rate. The formula given by Blacker et al. (1989) to compute weighted number of $(i)^{th}$ order births is given below:

$$F_i = B_i (G.l_1)^{k_i}$$

where F_i is weighted number of births at $(i)^{th}$ order, B_i is reported number of births at $(i)^{th}$ order, G is the gross reproduction rate and l_1 is survivors at age one such that $(1- l_1)$ is the infant mortality. k_i is the relative difference in age of mothers at different order so that

$$k_i = \frac{(M_i - M_1)}{M} \quad , \qquad i = 1, 2, 3 \ldots\ldots\ldots$$

Here M is the mean age of mothers at all births and M_1 is the mean age of mothers at first order birth. M_i is the mean age of mothers at $(i)^{th}$ order births. According to the Blacker et al. $(G.l_1)^{k_i}$ is the correction factor and he obtained PPR as follows:

$$PPR_i = \frac{F_{i+1}}{F_i}$$

Later Yadava & Srivastava (1993) suggested an alternative methodology to that of Blacker et al. (1989) to obtain PPR which does not need estimate of gross reproduction rate as well as the infant mortality rate but it requires knowledge of the growth rate of the population. The procedure suggested by Yadava and Srivastava (1993) to obtain the adjusted number $(i+1)^{th}$ order birth is as follows:

$$B`_{i+1} = B_{i+1} + B_i (M_{i+1} - M_i)\, r$$

where M_i and M_{i+1} are the average ages of mothers at $(i)^{th}$ and $(i+1)^{th}$ births and 'r' is the growth rate of population. $B`_{i+1}$ is the adjusted figure for $B_{i+1}$ accounting for the variation in the number of females. They proposed that $B`_{i+1}/ B_i$ gives an estimate of PPR for parity i. The authors have also seen the applicability of the technique on the data given in Blacker et al. (1989).

The suggested adjustment is based on some heuristic reasoning and lack sound proof for the same. In fact, the adjustment factor itself needs some logical change. Later

Yadava et al. (2006) has explained the shortcomings and gave a simple procedure which requires growth rate and i^{th} order closed birth interval. For application purpose they have taken the value of closed birth interval as 3 years for all the parities. Yadava et al. (2006) have modified $B`_{i+1}$ as

$$B^*_{i+1} = B_{i+1} / (1-rC_i) \approx B_{i+1} (1+rC_i)$$

where r is the growth rate of population and C_i is $(i)^{th}$ order closed birth interval and it was suggested that it is equal to 3 years for all the parities for application purpose. The obtained estimate of PPR for parity i as B^*_{i+1}/ B_i. It is important to mention that although Pandey et al. (1997) have suggested a procedure to estimate the values of M_i and M_{i+1} based on CFR (completed fertility rate) but they have not discussed anything regarding adjustment in the value of B_{i+1}. Besides this, Srinivasan et al. (1994) showed the relationship between TFR with birth order and birth interval statistics. They showed that an increase in the length of open birth interval is directly proportion to the decline in the fertility. They also gave a formula of estimating probability that a woman will have parity i. The objective of this paper is to obtain an alternative procedure for estimating PPR after using some approximations in procedure given by Blacker et al. (1989). In the proposed procedure there is no need of gross reproduction rate and life table survivorship at age one rather we need the growth rate which is easily computed.

3. Proposed Procedure

For simplification purpose if we assume that l_1 is same for all reproductive intervals then the correction factor given by Blacker et al. will become

$$(G.l_1)^{k_i} = (NRR)^{k_i}$$

Further we know that $NRR = e^{rM}$ for the stable population. Here r is the growth rate and M is the mean age of mothers at all births so that

$$(NRR)^{k_i} = \{e^{rM}\}^{(\frac{M_i - M_1}{M})} \Rightarrow (NRR)^{k_i} = e^{r.(M_i - M_1)}$$

Hence the weighted number of $(i)^{th}$ order births will become

$$F_i = B_i.e^{r.(M_i - M_1)}$$

in this proposed procedure we need only growth rate instead of G the gross reproduction rate and l_1 the survivors at age one or infant mortality required in the procedure given by Blacker et al. (1989). Finally, we calculate the PPR by the following formula

$$PPR = \frac{F_{i+1}}{F_i} = \frac{B_{i+1}}{B_i}\left[\frac{e^{r(M_{i+1}-M_1)}}{e^{r(M_i - M_1)}}\right] = \frac{B_{i+1}}{B_i}\left[e^{r(M_{i+1}-M_i)}\right]$$

$(M_{i+1} - M_i)$ can be approximated as C_i the closed birth interval between $(i)^{th}$ and $(i+1)^{th}$ order births. To check the suitability of the proposed procedure we have used the data of Indian census 1981 published in Pandey et al. (1997) and found a very good approximation of the procedure given by Blacker et al. Further the proposed procedure has been applied to the real data for India and most populated state of India i.e. Uttar Pradesh, taken from all the three set of NFHS data to know the trend and pattern of change of fertility.

4. Computation of Total Fertility Rate

The importance of TFR in fertility study is well known. It is very useful while comparing the fertility level between two or more regions, or the change in fertility of a place over a period of time. The importance of PPR over TFR has been discussed above in literature. Another importance of PPR is that the estimates of PPR's viz. P_0, P_1, P_2, ... are capable of providing the estimate of TFR of any population considering only the married females (where P_0 stands for the probability of progression from marriage to first birth). The biggest disadvantage of using birth order data is that P_0 cannot be estimated as these are only available for parity one and above. Hence PPRs obtained through birth order data provides estimate of TFR excluding primarily sterile females. If we somehow get the value of P_0 (from previous studies or other sources) then we can estimate TFR by the formula given below:

$$TFR= P_0 *(1+ P_1 + P_1 P_2 + P_1 P_2 P_3 + \cdots\cdots)$$

where P_1 stands for probability of progression from first birth to second birth and P_2 stands for probability of progression from second birth to third birth and similarly P_3 , P_4 etc can be defined. Sometimes P(1,2), P(2,3), P(3,4)… notations are used for P_1, P_2 and P_3. Thus we can say $P(i, j)$ represents the probability of transition from i^{th} birth to j^{th} order birth.

5. Data and Methodology

For the present study we have taken third round of National Family Health Survey (NFHS) data. The National Family Health Survey (NFHS) is a large-scale, multi-round survey conducted in a representative sample of households throughout India. Three rounds of the survey have been conducted since the first survey in 1992-93 followed by second survey in 1998-99 and third survey in 2005-06. The survey provides state and national information for India on fertility, infant and child mortality, the practice of family planning, maternal and child health, reproductive health, nutrition, anaemia, utilization and quality of health and family planning services.

For computation of parity progression ratio, we need birth history information of those women who have completed their reproductive span. But in most of the demographic health surveys (DHS) only women of reproductive ages i.e. 15-49 years are considered for study. Hence it becomes difficult to estimate parity progression ratio. It is not advised to study the birth history of 50+ women for the fertility estimation because of two reasons. The first one there may be serious errors in data because of recall lapse and secondly the information provided by them will give past fertility behaviour. Srinivasan (1967a; 1967b, 1968) and Yadava et.al. (1993, 2006, 2013) proposed various methods of computing PPR from reproductive age women. They added a condition by which they can filter out those women who have completed their fertility but are still in reproductive age. In earlier times there were no contraceptive methods so women remain exposed to the risk of conception till the end of reproductive span. Now a day several contraceptives are common and after getting desired family size couples are using permanent contraceptive measures to avoid unwanted pregnancy and excess fertility. This is the reason behind considering those women who have completed their reproductive span. Therefore, we have considered here three conditions under which it is assumed that women have completed their childbearing. These conditions are:

(i). Current age of respondent $\geq$ 45 years.

(ii). Open birth interval (OBI) ≥ 60 months, and
(iii). Open birth interval (OBI) ≥ 60 months and no current contraceptive use

The reasons behind considering these situations as conditions for completed fertility are as follows. In India fertility beyond age 45 years is negligible hence we can consider condition (i) i.e. as case of completed fertility. Studies have shown that mean duration between two successive births is three years (or 36 months). Thus, if open birth interval, (OBI) ≥ 60 months and absence of conception may be because of either of these conditions, either the women have reached menopause or women have undergone sterilization or some kind of sterility may be present which again implies the condition of completed fertility and hence condition (ii). If a couple wants to prolong the birth interval then couple will use some contraceptive. Therefore, in the condition (ii) the (OBI) ≥ 60 months may be because of contraceptive use. To overcome this ambiguity, we have added another condition of no current contraceptive use along with (OBI) ≥ 60 and hence condition (iii) again shows a condition of completed fertility.

Further we computed total fertility rate with the proposed estimates and compared it to those provided by NFHS-III report. Also, an attempt has been done to see the pattern of PPR under the son preference. Son preference is calculated by taking the difference between ideal number of sons and daughters. If ideal number of sons is greater than ideal number of daughters then it is considered as son preference.

6. Results

To check the suitability of the proposed model we have applied it to data of Indian census 1981 as given in Pandey et al. (1997). The proposed procedure requires information on mean ages of females at various orders of birth along with the value of growth rate *r*. The value of *r* may be taken as the rate of natural increase which is easily obtained by subtracting crude death rate from crude birth rate and ignoring migration. Table 1 and fig. 1 show that the proposed method is a good approximation of the method given by Blacker. It is clear from fig. 1 that PPR estimates differ very slightly for transition from P_1 to P_2 and P_2 to P_3 but after that both the curves coincide.

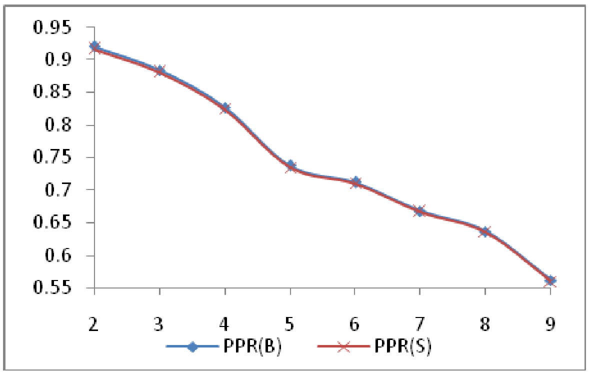

Fig 1: Comparison of PPR by Blacker and proposed procedure

Order	B_i	$Ln(B_i)$	M_i	k_i	$k_i*ln(G*l_1)$	$Ln(F_i)$	F_i
1	4285507	15.27075	19.9			15.27075	4285507
2	3581936	15.09141	24.0	0.140893	0.09641456	15.18783	3944483
3	2923695	14.88836	27.4	0.257732	0.1763681	15.06473	3487609
4	2258591	14.63025	30.3	0.357388	0.24456377	14.87482	2884365
5	1566024	14.26405	32.9	0.446735	0.30570471	14.56976	2126005
6	1065970	13.8794	34.8	0.512027	0.35038463	14.22978	1513265
7	685334	13.43766	36.4	0.56701	0.38800982	13.82567	1010213
8	423207	12.95562	37.7	0.611684	0.41858029	13.3742	643191
9	228158	12.33779	39.4	0.670103	0.45855706	12.79635	360898
10+	227552	12.33513					
	17245974		29.1				
GRR=	2.24	l_1=	0.885	r =	0.0224		

Order	PPR(B)	M_i-M_1	(M_i-M_1)*r	exp(M_i-M_1)*r	F_i(S)	PPR(S)
1				1	4285507	
2	0.920424	4.1	0.09184	1.096189418	3926480	0.916223
3	0.884174	7.5	0.16812	1.182936611	3458546	0.880826
4	0.827032	10.4	0.23296	1.262330985	2851089	0.824361
5	0.737079	13.0	0.29121	1.338032164	2095390	0.734944
6	0.711788	14.9	0.33376	1.396208013	1488316	0.710281
7	0.667571	16.5	0.36962	1.447155637	991785	0.666381
8	0.636689	17.8	0.39872	1.489916384	630543	0.635766
9	0.561106	19.5	0.43683	1.547746497	353130.7	0.560042
10+						
GRR=						

Table 1: The PPR obtained by proposed procedure and Blacker et. al. (1989) for the data of Census 1981

* PPR(B)- PPR by Blacker method, PPR(S)-PPR by proposed method, M_i- Mean age of Mothers at $(i)^{th}$ order birth, M-Mean age of mothers.
G-Gross Reproduction Rate (GRR), l_1- life table survivorship at age one, r- Growth rate = (CBR-CDR); CBR- crude birth rate, CDR-crude death rate.

Further, the proposed procedure is applied to the data on birth order obtained in the third round of NFHS data (i.e. NFHS-III) for India and its most populous state Uttar Pradesh. Table 2(a) presents the PPR estimates for India under the three different conditions discussed above and with the help of these PPR estimates TFR is also calculated and compared with the TFR reported in NFHS-III report. The growth rate, *r*, is taken from NFHS report. After comparison we find, TFR under case (iii) is 2.46 which is closest to the reported TFR of Uttar Pradesh as 2.68. The estimated value of TFR under case (i) and (ii) are 3.11 and 2.36, which show overestimation. The probability of transition from parity 1 to parity 2 is obtained as 0.9542, 0.9202 and 0.8135 respectively under three cases. Thus, we find much fluctuation among the transition probabilities from parity one to two from 95% to 81% under three different conditions. Here we also find that transition probabilities under case (i) and case (ii) both start by close points (0.9542 and 0.9202 respectively) but thereafter a constant difference of 8-10 percent has been observed throughout. Also we found that there is much difference in transition probabilities from parity one to two under case (ii) and case (iii) but at the end point both are quite close. The PPR estimates under case (iii) has least transition probability from parity one to two but it shows an almost constant transition probability from parity two to three, three to four and four to five and then declining trend is observed. From fig. 2 we can see that PPR estimates under case (iii) starts at lower point and then goes above the other two during parity three to parity six. We have considered P_0=0.97 (because almost 3% childlessness is observed among 45+ women) and calculated compounded PPR and the corresponding results are shown in table 2b. PPR tells us the progression from $(i)^{th}$ parity to $(i+1)^{th}$ parity while compounded PPR tells the what proportion is progressing among the total population. Here we see that the TFR calculated by with and without P_0 is approximately same and the reason is that value of P_0 is close to unity. If the value of P_0 is far from unity then there will be more discrepancy between TFR with and without P_0. Though we find remarkable differences in level as well as in magnitude in transition probabilities from P(1,2) to P(2,3) under all the three conditions but one thing is clear that maximum drop of probability is observed at P(1,2) to P(2,3). Thus, we can say that point of depression is observed at progression from parity 2 to 3. Then next maximum drop is observed at P(2,3) to P(4,5). Thereafter very slight change is observed in transition probabilities.

PPR	Age ≥ 45+	OBI ≥ 60 months	OBI ≥ 60 months & No Contraceptive Use
1→2	0.9542	0.9202	0.8135

2→3	0.8124	0.6938	0.7165
3→4	0.7131	0.5954	0.7031
4→5	0.6590	0.5606	0.6901
5→6	0.6420	0.5449	0.6676
6→7	0.6119	0.5295	0.6142
7→8	0.6029	0.5157	0.6043
8→9	0.5646	0.4836	0.5494
9→10+	0.5180	0.4196	0.4535
TFR (observed)	2.68	2.68	2.68
TFR (estimated)	3.11	2.36	2.46
% change	16.03	11.89	8.07
r	0.016		

Table 2(a): PPR estimates for India based on distribution of births by birth order from NFHS-III data

PPR	Age ≥ 45+	OBI ≥ 60 months	OBI ≥ 60 months & No Contraceptive Use
1→2	0.9256	0.8926	0.7891
2→3	0.7519	0.6193	0.5654
3→4	0.5362	0.3687	0.3975
4→5	0.3534	0.2067	0.2743
5→6	0.2269	0.1126	0.1831
6→7	0.1388	0.0596	0.1125
7→8	0.0837	0.0308	0.0680
8→9	0.0473	0.0149	0.0373
9→10+	0.0245	0.0062	0.0169
TFR (observed)	2.68	2.68	2.68
TFR (estimated)	3.09	2.31	2.44
% change	16.03	11.89	8.07
r	0.016	P_0	0.97

Table 2b: Compounded PPR estimates for India based on distribution of births by birth order from NFHS-III data

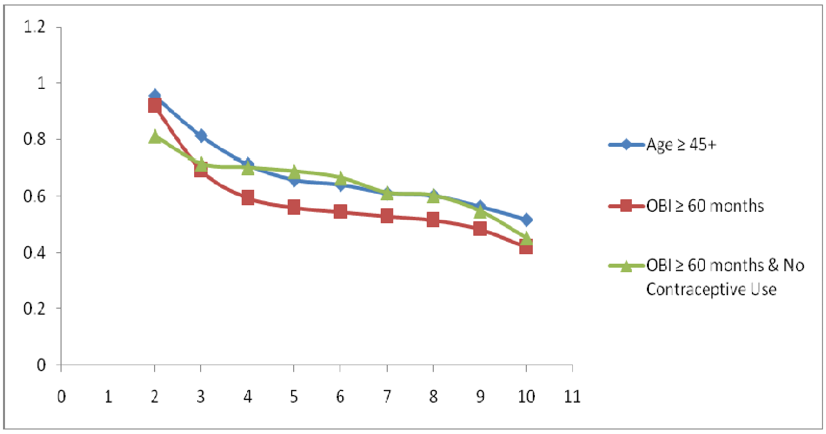

Fig 2: PPR estimates for India

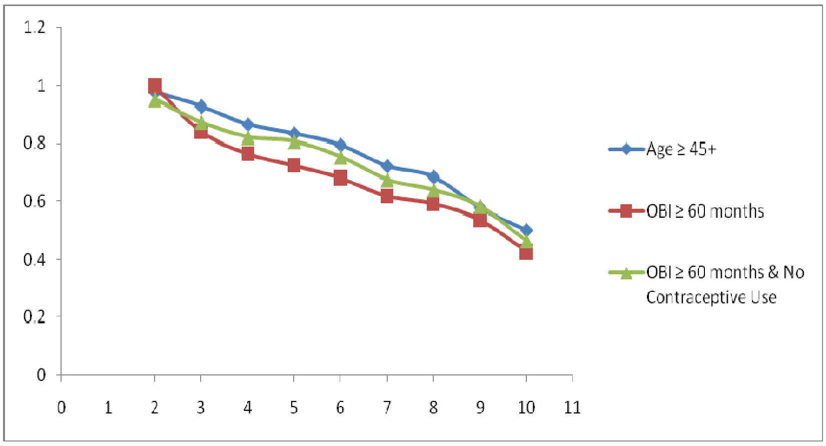

Fig 3: PPR estimates for Uttar Pradesh

Similarly, PPR estimates are calculated for Uttar Pradesh under these conditions and are presented in table 3 and corresponding PPR estimates are shown graphically in fig. 3. Here we find at least 95 percent couples proceed for second order birth and at maximum 99 percent for the same which implies that a two children norm is still present in Uttar Pradesh. Those couples who do not proceed, are consists of two types of couples one those who are voluntarily stopping and second those a few couples could not proceed because of secondary infertility. But with this method we cannot tell the magnitude of both factors separately.

PPR	**Age ≥ 45+**	**OBI ≥ 60 months**	**OBI ≥ 60 months & No Contraceptive Use**
1→2	0.9771	0.9984	0.9533

2→3	0.9283	0.8410	0.8738
3→4	0.8658	0.7643	0.8221
4→5	0.8333	0.7229	0.8073
5→6	0.7942	0.6798	0.7544
6→7	0.7212	0.6179	0.6756
7→8	0.6840	0.5909	0.6404
8→9	0.5764	0.5354	0.5827
9→10+	0.4991	0.4246	0.4626
TFR (observed)	3.82	3.82	3.82
TFR (estimated)	4.47	3.57	3.90
% change	17.15	6.57	2.17
r	0.019		

Table 3: PPR estimates for Uttar Pradesh based on distribution of births by birth order from NFHS-III data

Place of residence has a significant role in explaining the differentials of fertility therefore PPR estimates are also calculated for urban and rural Uttar Pradesh separately and presented in tables 4 and 5 respectively. From table 4 it is clear that in urban Uttar Pradesh transition probabilities are remarkably lower after parity 2 while in rural regions this change is observed after parity 3 and 4 (from table 5). Since in rural Uttar Pradesh contraceptive use is not very common hence TFR calculated under third condition may not be closest to observed TFR for rural region. Reported TFR of Uttar Pradesh is 3.82 while it is 2.95 for urban and 4.13 for rural region. From table 4 and 5 we can see the wide gap in TFR of rural and urban Uttar Pradesh which clearly shows urban fertility is progressing towards replacement level while in rural Uttar Pradesh fertility is still quite high and far from replacement level.

PPR	Age ≥ 45+	OBI ≥ 60 months	OBI ≥ 60 months & No Contraceptive Use
1→2	0.9866	0.9240	0.8193
2→3	0.8619	0.6958	0.7206
3→4	0.7671	0.5981	0.7060
4→5	0.7626	0.5637	0.6938
5→6	0.7444	0.5479	0.6707
6→7	0.6746	0.5320	0.6166
7→8	0.6127	0.5186	0.6071
8→9	0.5331	0.4849	0.5501
9→10+	0.5313	0.4208	0.4552
TFR (observed)	2.95	2.95	2.95
TFR (estimated)	3.76	2.38	2.50
% change	27.45	19.23	15.19
r	0.019		

Table 4: PPR estimates for urban Uttar Pradesh based on distribution of births by birth order from NFHS-III data

PPR	Age ≥ 45+	OBI ≥ 60 months	OBI ≥ 60 months & No Contraceptive Use
1→2	0.9651	0.9974	0.9767
2→3	0.9965	0.9223	0.9049
3→4	0.9269	0.8233	0.8413
4→5	0.8717	0.7516	0.8251
5→6	0.8177	0.7084	0.7623
6→7	0.7414	0.6229	0.6746
7→8	0.7156	0.6161	0.6722
8→9	0.5903	0.5354	0.5929
9→10+	0.4875	0.4214	0.4742
TFR (observed)	4.13	4.13	4.13
TFR (estimated)	5.04	4.09	4.21
% change	22.02	0.88	2.00
r	0.019		

Table 5: PPR estimates for rural Uttar Pradesh based on distribution of births by birth order from NFHS-III data

Son preference is an important factor for high fertility in Uttar Pradesh. Therefore, an attempt has been made to see the trend of PPR among son preference and where there is no son preference. Since calculated TFR under case (iii) is closest to the reported TFR we have considered case (iii) for calculation of PPR for tables 6. Here it is clearly observable that TFR among son preference is higher than their counter part. This difference implies excess and unwanted fertility due to son preference. Further we see that the difference of TFR between son preference and no son preference among actual and intension performance and found a wider gap in actual performance.

PPR	Total		Urban		Rural	
	Son preference	No son preference	Son preference	No son preference	Son preference	No son preference
1→2	0.9266	0.8857	0.9285	0.8967	0.9733	0.9799
2→3	0.9190	0.7949	0.8717	0.7779	0.9529	0.8720
3→4	0.8136	0.7899	0.7901	0.7834	0.8495	0.8389
4→5	0.7980	0.7523	0.7618	0.7031	0.8038	0.8488
5→6	0.7562	0.7049	0.7201	0.7366	0.7976	0.7451
6→7	0.6449	0.6540	0.5449	0.6586	0.7313	0.6451

7→8	0.6456	0.5714	0.4709	0.5856	0.7055	0.6704
8→9	0.5294	0.5833	0.4269	0.5254	0.5620	0.6872
9→10+	0.3704	0.4603	0.4127	0.4363	0.3819	0.6621
TFR (estimated)	4.04	3.28	3.55	3.19	4.66	4.33
r	0.019					

Table 6: PPR estimates for Uttar Pradesh according to the son preference

Son preference is common phenomenon in India and especially in traditional society of Uttar Pradesh. So, we tried to see the pattern of the PPR among those who have son preference and those who have not and corresponding results are presented in Table 6. Here we see that probabilities of progression to next higher parity are higher among those having son preference compared to corresponding probabilities with those having no son preference. Further we have calculated pattern of PPR in rural and urban regions under son preference and it is clear from the results that son preference is still present remarkably. From table 6 we can see that TFR is obtained as 4.04 and 3.28 under presence and absence of son preference respectively, contributing to additional one birth per woman. Also, it is clear that in urban Uttar Pradesh TFR under presence and absence of son preference i.e. 3.55 and 3.19 respectively. The difference in TFR under the presence and absence of son preference phenomenon is very minimal of 0.36 only. Thus, it clearly shows the ambiguity between stating the intensions of sex composition of children and actual performance.

7. Discussion

The birth order statistic and data on closed and open birth intervals are extremely useful in evaluation the impact of family planning programs both in terms of an increase in the extent of spacing as well as in the extent of limitation of family size. The birth order of a child indicates the cumulative fertility performance of a woman. The closed birth interval, i.e., the time interval between two successive births to a woman, averaged over all the mothers in a population indicates the extent of spacing between births.

NFHS data suffers misreporting of age, recall lapse of past events etc and hence Spoorenberg (2010) has suggested not using preceding three years data for analyzing fertility decline as it over estimates the change in fertility decline. Therefore, he took 25 years data during 1977 to 2004 to study the change in fertility by parity progression ratio approach. Thus, parity progression ratios calculated from NFHS based on birth interval as well as birth order data will be biased by these defects. Therefore, in the present paper we have considered birth history data for those women who have completed their childbearing. The advantage of birth order statistics over birth interval data is that it is free from recall lapse. Therefore, PPR estimates obtained by proposed method will be better than those by using birth interval statistics. One serious limitation of this method is that we cannot tell anything about progression of parity zero to parity one which is important to know the adolescent sterility present in the population. But

PPR estimates obtained by birth interval are capable of producing estimates of progression from marriage to first birth.

A lot of literature is available on son preference but there is no any clear-cut formula for measuring it (Arnold, 1997; Gandotra et. al. 1998; Kulkarni, 1999; Chaudhary, 2012). Different researchers have proposed different methods of measuring the phenomenon. One simple method of measuring son preference phenomenon with existing children can be by asking the preferred sex of the next child, among those who express a desire to have another child, and then those reporting a choice of male child can be thought of son preference. Such a question was asked in NFHS-II but absent in NFHS-III. Therefore, we tried to measure the phenomenon with the existing child and ideal number of children of either sex expressed by the respondents.

Table 2(a) and table 3 represent PPRs for India and Uttar Pradesh under different conditions and fig. 2 and fig. 3 shows corresponding PPRs graphically. Besides this we have calculated TFRs (Total fertility rates) corresponding to each PPR pattern and compared it with the value of TFR provided by NFHS-III report. The method which shows least deviation is supposed to be best method and hence third condition is used for further study. Further we calculated PPR separately for urban and rural regions of Uttar Pradesh and results are presented in tables 4 and 5. Therefore efforts are needed to educate and motivate the couples of Uttar Pradesh especially, rural couples, in favor of small family norm otherwise the fertility of this most populous state of the country will continue to remain higher. Since around the $1/6^{th}$ of the population of the India lives in Uttar Pradesh and hence its level of fertility would certainly play a major role in shaping the future fertility level of the country as a whole.

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