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THE ESTIMATION OF FERTILITY FROM INCOMPLETE BIRTH REGISTRATION DATA FOR INDIAN TOWNS AND CITIES

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FOREWORD

As the author of this paper notes, "the estimation of fertility measures from incomplete birth registration data has been a comparatively neglected area by the demographers". However, fertility measures for cities and towns and other civil subdivisions are frequently needed for the planning and evaluation of family planning and other public health programs. The method of estimation presented in this paper appears to give reasonable estimates for Indian towns and cities which are consistent with and supplement the estimates for the nation and states provided by the Sample Registration System. Until such time as birth and death registration are complete in India, this method may well serve the continuing needs for frequent estimates of fertility for cities and towns.

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The Estimation of Fertility from Incomplete Birth Registration Data for Indian Towns and Cities**

EVEN today, registration of births and deaths is incomplete in majority of countries of the world. The estimation of fertility measures from incomplete birth registration data has been a comparatively neglected area by the demographers. Some demographers have made attempts in the past to utilise the incomplete birth registration data to measure fertility, but the reliability was not free from doubts. To analyse or obtain any sensible result from the incomplete birth registration data has been a considerable problem due to various reasons such as lack of knowledge about the number of women in the reproductive ages; lack of suitable techniques; lack of socio-economic characteristics of the parents of the registered births; registration of births by place of occurrence or place of residence and the delay in the reporting of births especially those births who have taken place outside hospitals.

The main objective of this paper is to make an attempt to derive fertility measures as well as trends from incomplete birth registration data especially for the period 1961-1970 for which we have very little knowledge about the Indian towns and cities and the period 1970-1981 for which estimates are available from Sample Registration system. Since 1959, birth registration data on live births by age of mother and birth order are regularly being published for Indian towns and cities, but so far these data have not been fully utilised by the demographers.

This paper is divided broadly into three sections. The first section of the paper provides a methodology for estimation of fertility, data requirements and illustration of the application of the method. The second section deals with the derivation of fertility measures for the period 1961-1981 as well as trends in towns and cities. The final section gives discussion on the results obtained by the method and concluding remarks.

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Methodology for Estimation of Fertility

The fertility estimates are obtained from the incomplete birth registration data for towns and cities of India from the Birth Order Ratio Method[1]:

$$\ln (F_i) = \ln (B_i) + K_i \ln [G\, l\,(1)]$$

(ln = Natural Logarithm)

where

F_i = Total fertility for births of order i;
B_i = Number of birth in i-th birth order;
K_i = $(M_i - M_1)/M$ where M_1 is the mean age of mothers by first birth order in a year; M_i is the mean age of mothers by i-th birth order and M is the mean age of mothers for all births distribution in a year (these are calculated from the actual number of births registered by order and age of mothers).
G = Gross reproduction rate; and
$l(1)$ = Life table survivorship at age One.

The F_i values by birth orders are obtained from the number of births registered in a year from the above method. Initially, the F_i values can be estimated with a little knowledge from any source about the level of gross reproduction rate and life table survivorship of children at age One. The effect of the G and $l(1)$ factor will be comparatively very small on the result because they appear only as complimentary in the formulae. Subsequently the G value may be obtained from the mean completed fertility of mothers F_m value by iteration procedure.

The F_m is found by summing the estimated F_i values by birth order and sum can be denoted by F. The sum F is divided by the F_i first birth order value ($F_m = F/F_1$). If the registration of the first and all births is in the same proportion, then estimated F_m value from the method will be reasonable and there is no need to make any adjustment in the derived value. If it is not so, then registration of births by birth order in a year can be checked by plotting the ln F_i values against a standard distribution of births by birth order. If any deviation is observed in the reporting of births by order, especially the first births, then it requires some adjustment and the same can be adjusted by fitting a straight line with a group average procedure.

Total fertility rate can also be obtained by multiplying the estimated F_m value from the proportion of women who becames mothers at the end of their reproductive life span.

Data Requirements

The data needed for application of the method are: (i) the distribution of the births in a year by order and age of mother; (ii) a rough approximation of the gross reproduction rate; (iii) life table survivorship at age One, and (iv) a standard fertility distribution by birth order.

1. For details about method, see Somawat (1990).

Application of the Method

The required data for application of the method is available for towns and cities with a total population of 100,000 and above. The application of the method is shown in columns 1 - 7 of Table 1 for Indian towns and cities for the year 1972. The first column is the natural logarithm of the births $\ln B_i$ by order, taken up to order eleven and above. The scale of the B_i is arbitrary and numbers in hundreds have been taken for convenience. The second column of the table gives the mean age of mothers of the i-th birth order M_i. A small number of births occurred to women in the under 15 age group; for the calculation of mean age of mothers the mid-point of the age group was taken as 14 years. For the rest of the age groups the mid-point was used in the calculation. The third column gives K_i from the formula $K_i = (M_i - M_1)/M$. The calculated K_2 for Indian towns and cities is 0.090, K_3 is 0.174 and so on. The corresponding values of column 4 of Table 1 are for a standard fertility distribution by birth order. They are derived after some adjustment from the previous work of Brass (1969) on the Soloman Islands. Column 5 is calculated by multiplying the K_i values of column 3 by the estimated factor of 0.865 from ln (Gl (1)).

TABLE 1: THE APPLICATION OF THE BIRTH ORDER RATIO METHOD TO TOWNS AND CITIES TO ESTIMATE THE MEAN COMPLETED FERTILITY OF MOTHERS (F_m) FOR THE YEAR 1972*

Birth Order	ln B_i	M_i	$K_i = (M_i - M_1)/M$	Q_i	$K_i =$ ln[Gl(1)]	ln F_i	F_i
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	8.166	22.438	0	0	0	8.166	3519
2	8.018	24.853	0.090	–0.049	0.078	8.096	3280
3	7.819	27.129	0.174	–0.113	0.151	7.970	2892
4	7.492	29.087	0.247	–0.201	0.213	7.705	2220
5	7.098	30.826	0.311	–0.300	0.269	7.367	1583
6	6.625	32.581	0.376	–0.437	0.326	6.951	1044
7	6.192	34.188	0.436	–0.635	0.377	6.569	713
8	5.595	35.157	0.472	–0.882	0.408	6.003	405
9	5.081	35.874	0.499	–1.194	0.431	5.512	248
10	4.522	36.622	0.526	–1.595	0.455	4.977	145
11+	4.263					4.718	112+
							16161

$F_m = F/F_1 = 16161/3519 = 4.592$.

* Excluding Rajasthan towns.

\+ Obtained by raising the ln B_{11} in the same proportion as the ln B_{10}.

Q_i Values derived from Brass (1969).

M = 26.947 Mean age of mothers of all birth distribution in the year 1972.

To obtain the weighting factor of 0.865 for Indian towns and cities an iteration procedure has been followed. In the first stage, the 1970 Sample Registration System (SRS) data of all urban areas was used to obtain the provisional G and l (1) (actual values obtained were G=2.05 and $l(1)$ = 0.900). These give ln[Gl (1)] as 0.612. However, many studies have recently concluded (see Dyson and Somawat 1983; Jain and Adlakha 1982; Panel on India 1984 and Somawat 1984) that, in fact, fertility had declined by the early seventies particularly in the urban areas. The age distribution may have moved from stability for the large towns and cities a good deal earlier. The first F_m was estimated for towns and cities by using the factor 0.612 for the

year 1970. Subsequently, G was estimated from the 1970 derived F_m to obtain a new weighting factor 0.70. This was further used to weight the K_i values for the data of the year 1963. The estimated mean completed fertility of mothers for the year 1963 with this 0.70 factor was 5.726.

Finally, the estimated F_m value of 5.726 for 1963 gave a figure of 0.865 (5.726 x 0.95 x 0.48 x 0.910 = 0.865) to weight the K_i values for the year 1972. The calculations are shown in the 5th column of Table 1. It may be argued that 5.726 is still too low for fertility 20 to 30 years earlier but the infant mortality level is also too low and $l(1)$ too high. The net outcome seems a reasonable enough estimate. Column 6 is calculated by adding columns 1 and 5 for the i-th birth order and column 7 is the antilogarithm of column 6. The value for the 11+ birth order F_{11+} has been obtained by raising $\ln B_{11}$ in the same proportion as the tenth birth order. This means adding 0.455 to the $\ln B_{11}$ (4.263) which becomes 4.718 and its antilogarithm is 112.

The final unadjusted F_m is found by summing the estimated F_i values of column 7 and dividing the sum by F_1. This gives a total F_m of 4.592 for towns and cities in the year 1972.

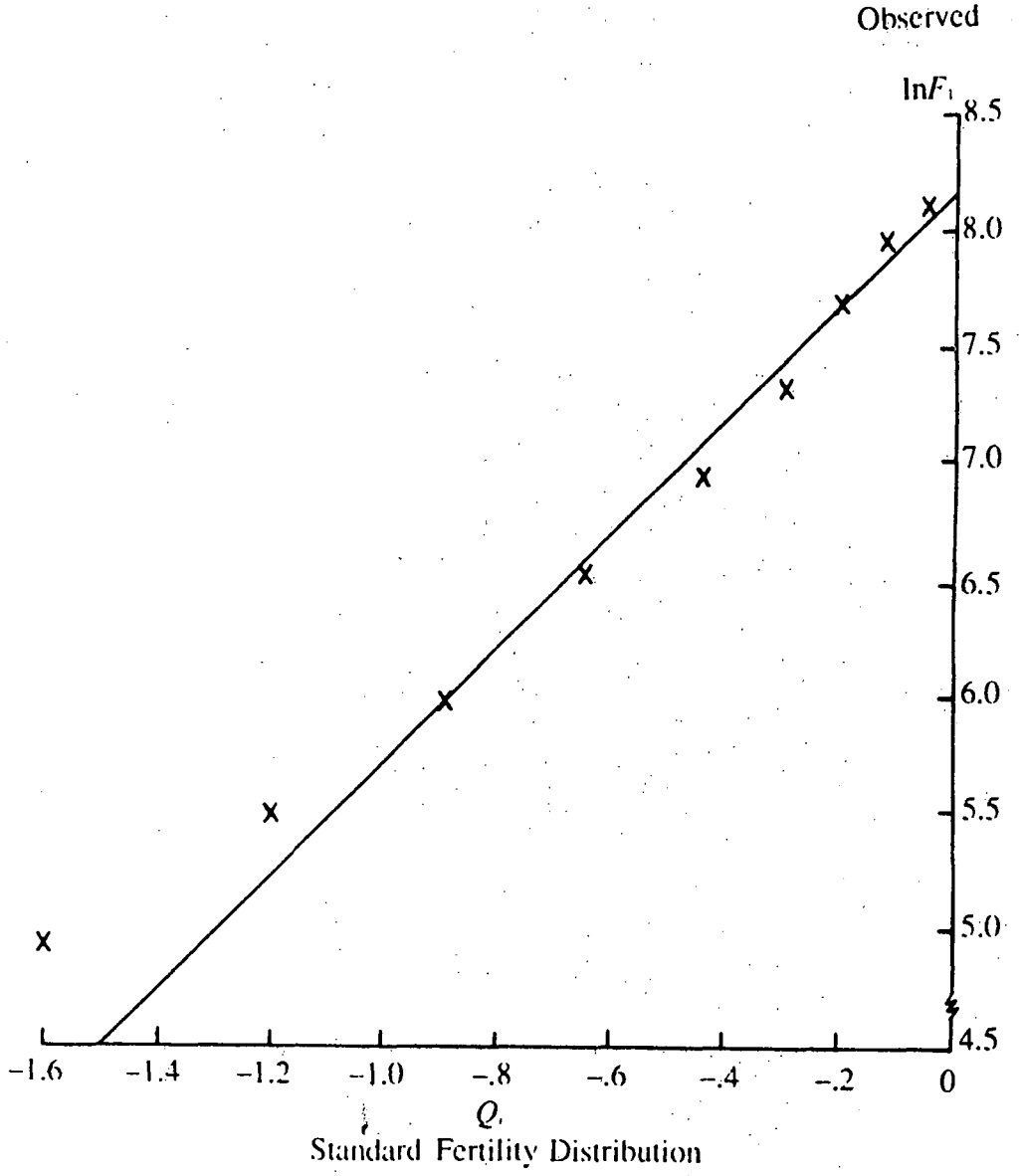

Fig.1. The observed ln F_i values plotted against the standard to adjust the ln F_1 for all Indian towns and cities 1972.

If the completeness of registration of the first and all births is the same the estimated F_m from the method will be reasonable and there will be no need to make further adjustment. It is necessary to check whether the under registration of first and all births is in the same proportion. This can be done by plotting the ln F_i values of column 6 on the Y-axis against the set of standard values Q_i on the X-axis. The results are shown in Figure 1. It is clear from the graph that relationship between the estimated ln F_i values and standard is resonable linear except at very high birth orders where the relative number of births are small and the relation of the standard suspected. In case there is a deviation between the observed point of ln F_i as against the other higher order points, the first birth order point has to be adjusted by fitting a straight line to the estimated ln F_i values. To check this, a group average procedure has been used. The points grouped are the 2nd to 5th and the 6th to 9th. The line joins the mean 'Y' and 'X' values for the graphs. From the fitted straight line, the ln F_1 has to be calculated. It is observed from the fitted straight line that the registration incompleteness of first and all orders is in the same proportion. Therefore, there was no need for any adjustment in the ln F_1 and hence in the derived mean completed fertility of mothers (F_m).

If adjustment is required, the fitted straight line is used only to adjust the first point ln F_1 and the latter are taken to be correct apart from sampling. In case the points for the second and (possibly) third birth order had deviated notably from the straight line, they might also be adjusted However, since the correction appears only in the sum F, the effect on the estimated F_m is much smaller than alteration in F_1.

Discussion

The estimate of mean completed fertility of mothers F_m for Indian towns and cities from the method is 4.592 for the year 1972. For the same year F_m has been estimated from the Brass (1975) birth order techniques. The values are 4.685 and 4.393 from the first and second order birth procedure respectively. Brass (1975) assumes current stability on the age distribution. For the same year, the fertility estimate from the Sample Registration System (SRS) data for all urban areas was 4.344. It has been inflated by 0.95 (proportion of women who became mothers by the end of the reproductive life span in all urban areas from the 1972 Indian Fertility Survey data) to provide an F_m of 4.573. This compares very well with the 4.592 from the method.

The SRS figure of 4.573 is for all urban areas as against the 4.592 which is only for towns and cities. Recent studies have concluded (see Government of India 1980; Jain and Adlakha 1982; Panel on India Report 1984 and Dyson and Somawat 1983) that the completeness of birth registration was in the range of 90-92 per cent at all India level in the SRS. There is no doubt that the coverage is higher in urban areas as compared to rural areas, partly because the majority of the births are taking place in the hospitals and they are required to inform all the births taken place in the hospital to the Birth Registrar. Assuming an arbitrary figure of 5 per cent births incompleteness for the SRS in urban areas, the F_m increases from 4.573 to 4.801. The difference between the SRS urban area F_m and the measure found from the Birth Order Ratio Method is very little. Although, these estimates are not for exactly the same population, the true difference is likely to be very small. The higher SRS estimate for the year 1972 is also attributable to better coverage of births due to national fertility survey carried out in the sub-sample areas of the SRS in 1972.

The estimate derived from the Birth Order Ratio Method is quite reasonable and encouraging for the year 1972. The method is therefore, further applied to the data from towns and cities for the period 1961-1981. For the period 1970 to 1981 the estimates derived from the method are also compared with the SRS estimates. If the agreement is acceptable (bearing in mind the different population), it can be assumed that the method will also work well for the data prior to 1970. For this period, direct estimates are not available to compare with the derived measures.

Fertility Estimates for the Period 1961 to 1981

The derived F_m values for Indian towns and cities for each year from 1961 to 1981 are shown in columns 2 and 3 of Table 2. Columns 4 and 5 of the table are calculated from the Brass (1975) first and second birth order ratio techniques. Column 6 gives the total fertility rate in urban areas from the SRS reports. Column 7 is found from column 6 by inflating the total fertility rate for the proportion of women who became mothers (P_m) and incomplete registration in the urban areas. These adjustments are the same for all the years as used for 1972 year data.

TABLE 2 : THE ESTIMATES OF THE MEAN COMPLETED FERTILITY OF MOTHERS FOR INDIAN TOWNS AND CITIES FOR THE PERIOD 1961-1981

Year	$F_m = F/F_1$	$Fm = F/F_1$ *(Adjusted)*	F_m	F_m	*TFR SRS Estimates*	$Fm = 1.05\ (TFR/P_m)$
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
1961*	6.028	5.722	6.240	6.094		
1962	5.631	5.516	5.799	5.706		
1963	4.986	5.620	5.073	5.707		
1964	4.855	5.443	4.961	5.791		
1965	5.442	5.377	5.691	5.708		
1966	5.599	5.281	5.815	5.791		
1967	4.381	5.118	4.469	5.280		
1968	4.799	5.001	4.939	5.049		
1969	4.743	4.595	4.911	4.812		
1970	4.804	4.414	4.984	4.480	4.151	4.588
1971	4.506	4.506	4.556	4.415	4.058	4.485
1972	4.592	4.592	4.685	4.393	4.344	4.801
1973	4.426	4.426	4.540	4.253	3.748	4.143
1974	4.168	4.168	4.241	3.900	3.673	4.060
1975	3.956	3.956	4.002	3.668	3.682	4.070
1976	3.662	3.662	3.736	3.271	3.603	3.982
1977	3.539	3.599	3.584	3.154	3.385	3.741
1978	3.424	3.424	3.428	3.011	3.377	3.732
1979	3.454	3.454	3.546	2.990	3.370	3.725
1980	3.476	3.476	3.606	3.075	3.372	3.732
1981	3.773	3.289	4.010	3.253	3.376	3.731

Notes 1. Column 2 is estimated by using the estimated F_m for the year 1963 to obtain the weighting factor for the K_i values.

2. Column 3 is derived by adjusted F_1 value by fitting a straight line on estimated F_i values in the graph for each year separately.

3. Columns 4 and 5 computed from the Brass (1975) first and second birth order techniques.

4. Column 6 is taken from the SRS reports and Column 7 is computed by inflating SRS estimates by 0.95 as a P_m value in urban areas, assuming also 5 per cent births registration incomplete in the SRS.

* Only for towns.

The checking of the birth registration has been applied by plotting the estimated ln F_i values on graph against the measures from the standard fertility distribution for each year separately. It was found that the relationship between the standard and estimated ln F_i values is reasonable consistent for each year and the case for an adjustment was not established especially for the years after 1971 and onward and prior to that small adjustments in the ln F_1 values were needed except for the year 1967. The deviation of the ln F_1 point from the fitted lines was always very small. This suggests that in recent years registration of births was in the same proportion by higher order births and the quality of the registration of births may have improved significantly.

The estimates from the method compare well with the values based on the Brass (1975) first and second birth order techniques. The SRS estimates, except for the years 1973 and

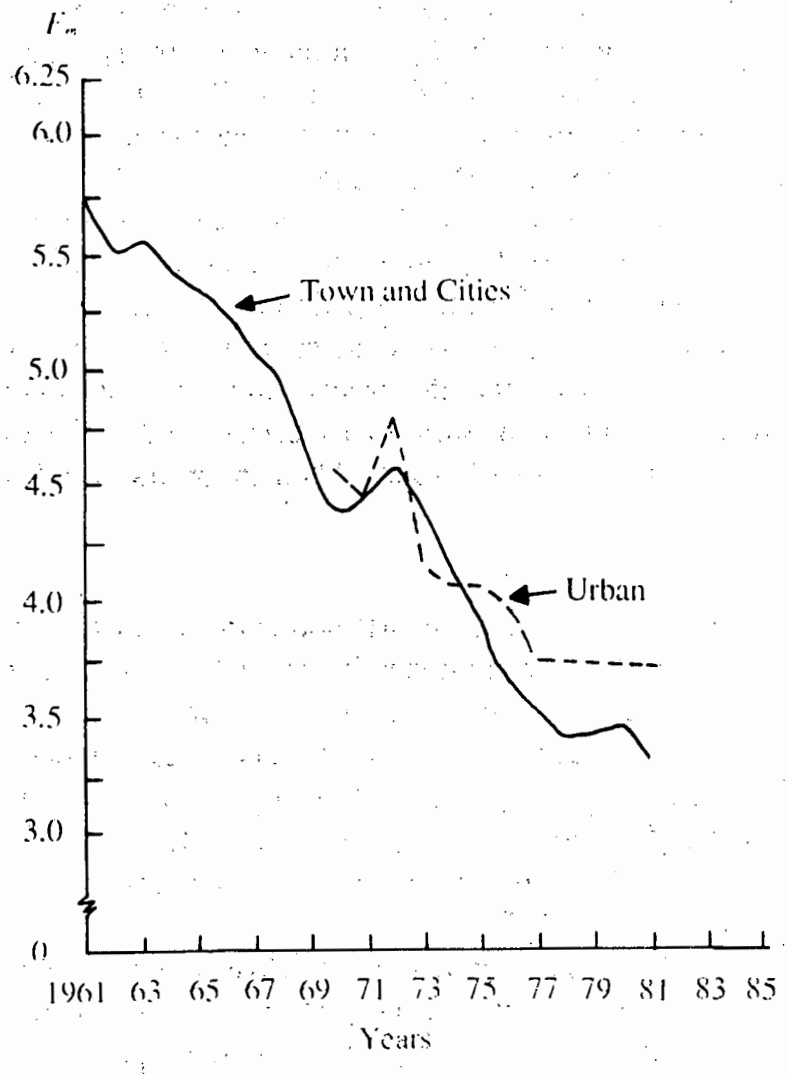

Fig. 2. The fertility trends in towns and cities and urban areas of India.

1974, tend to be a little lower than the method. The lower level from the SRS in the particular year is probably due to greater incompleteness of the birth records, resulting from the postponement of the half yearly survey for the period July-December 1973 and its combination with the half yearly survey for January-June 1974, as well as the suspension of supervision work (see *SRS Bulletin*, **15** (2), 2).

The F_m in the towns and cities should be slightly lower than for all urban areas is by no means unreasonable and the trend of the estimates from the birth order procedure is consistent and sensible. The analysis is carried out for all India to trace the fertility trends for the period 1961-81 and have been shown in Figure 2. The fertility curve F_m declines continuously during 1961-81 period except for marginal increase in the years 1963 and 1972. The initial decline in the year 1962 is attributable to the main factor that the 1961 value is for towns only (excluding cities) and 1963 and onwards are for the towns and cities together. The higher value for towns only compared to towns and cities may be a real difference.

The trends in the SRS fertility estimates (F_m) are also shown for the period 1970-1981 in Figure 2. The Trend in urban areas (SRS) is similar to the towns and cities at the all India level except for a small reduction during 1973 and 1974. The reduction in the SRS estimates for 1973 and 1974, described previously was probably due to the greater incompleteness of birth recording during the same period. Interestingly, the rise in the curves in the year 1972 clearly suggests the better enumeration of births at national level. It is the reference period for the 1972 National Survey carried out in the sub-sample areas of the SRS. Supervision as well as birth recording may have improved during the period due to special survey activities. Similar rise in the curve was not evident at the time of second national survey carried out in the 1979 year. This time the events netted by enumerators in the SRS but missed by computer supervisors in the survey have been excluded. The estimates for urban areas are higher except for the years 1973 and 1974 than for towns and cities of India.

Conclusions

The application of the Birth Order Ratio Method to Indian towns and cities data for the period 1961-81 has demonstrated overall that the derived estimates are reasonable. These estimates compare well with the values based on the Brass (1975) Birth Order Ratio procedure as well as with SRS estimates. In recent years, an adjustment in $\ln F_1$ values was not needed which suggests that completeness of birth registration was in the same proportion by birth order or reporting by birth order may have improved. The fertility trends in towns and cities and all urban areas is similar and curves decline continuously except for marginal increases in the years 1963 and 1972.

Recently, the method has been applied to the Pakistan Demographic Survey data by Blacker *et al.* (1989) and the derived estimate from the method was virtually identical to that obtained in the conventional way. The estimates derived for towns and cities clearly show that the method has yielded consistent results from incomplete birth registration data. The method can also be used with census or survey data obtained from questions on births during the last 12 months, which may have been biased by errors of non-response, reference

period and distribution of women exposed to risk by age group. However, one must be cautious about the estimation of fertility levels from the method because the birth statistics data suffer from several limitations (apart from incompleteness of birth registration) for example, migration or changes in the definitions of birth, area, registration period or place of birth or residence may affect the age distribution of women in ways which make the method estimates very crude.

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