Fertility And Mortality In Nepal

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INTRODUCTION

The need for reliable estimates of birth rate and death rate of Nepal has been felt by the planners, administrators, policy makers and research workers. These informations are required to assess the problems and to formulate plans for health, education, employment, social services and many other functions of government and private organizations.

The vital registration system which is the most reliable source of estimating the vital rates does not exist in Nepal. Vital registration system on an experimental basis was introduced in 1964 in one city and two villages, but it proved unsuccessful. Because of the failure of this experiment the idea of continuous registration has received a set-back. Very few numbers of sample surveys were being conducted for the purpose of collecting statistics on health, mortality and morbidity, but the results obtained from them were not very reliable.

Now the third source is the periodic censuses. Although there is evidence that partial counts were made during the nineteenth century, the first census of the population of Nepal for which data exist was taken in 1911 A.D. Since 1911 there have been censuses taken roughly every decade. But these censuses appear to have been little more than just population counts. The first systematic and scientific census using internationally acceptable concepts and comparable to censuses of other countries, was taken in 1952 (28th May 1952 for East Nepal) and 1954 (28th May 1954 for West Nepal). The second systematic census was taken on June 22, 1961 covering the entire kingdom. The latest census has been taken in 1971 (22nd June 1971).

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So under these conditions, the estimation of birth rate and death rate is very difficult, that is why the experts are not yet able to pinpoint the actual level of birth rate and death rate of Nepal.

Estimates of birth and death rates based on 1952-54, and 1961 censuses have been obtained by several authors. Thakur(1) estimated the fertility, mortality conditions of Nepal based on 1952-54 census. Ramachandran(2) used the 1961 data adjusted for plausible errors. C.B.S.(3) also utilized the censuses to estimate the vital rates in Nepal. Recently Krotki and Thakur(4) estimated vital rates in Nepal using the census data. The U.N. Population Division(5) also estimated vital rates for Nepal for recent periods based on 1961 census results.

Whereas the U.N., Thakur, Ramachandran, and Krotki and Thakur estimated the CBR as around 45-50, C.B.S. estimated it as around 40. There was thus a 5-10 point difference in estimation of vital rates.

This study aims to probe into the levels of fertility and mortality in Nepal and tries to arrive at a consistent and convergent set of vital rates.

Objective

In the absence of the vital registration system, it is necessary to depend upon alternative methods to estimate the birth rate and death rate in Nepal. The main objective of this study is two-fold.

1. By directly applying the various methods to the raw data on age distribution, to see the applicability of the methods and to see the range of variations in the estimates.

2. After getting the information from various methods, to evaluate and adjust the age distribution for obtaining a consistent convergent set of birth and death rates.

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- (1) Thakur, H. N., Population Projection for Nepal 1955-75, D.T.R.C., Bombay, 1960-61.
 - (2) Ramachandran, K. V., An Evaluation and Adjustment of the Basic Demographic Statistics of Burma, Ceylon, Nepal and India. D.T.R.C., Bombay, 1969 pp. 45-62
 - (3) Central Bureau of Statistics, Population Projection for Nepal 1961-81 Kathmandu, Nepal 1968.
 - (4) K.J. Krotki and H.N. Thakur, Estimation of Population Size and Growth from the 1952-54 and 1961 Censuses of the Kingdom of Nepal, Population Studies, vol. 25, No. 1 March 1971 p. 89.
 - (5) U.N. Population Bulletin of the United Nations No. 7, New York, 1965.

Methodology

Various methods have been utilized for this purpose and some of them are based on the stable population model. In Nepal fertility can be assumed to be fairly constant over the past several decades and mortality has been declining, so the population can be regarded as quasi stable. Thus the stable or quasi stable population model is applicable. In most of the methods vital rates have been computed for females only. These vital rates for females are then converted to the total population by the relationship:

$$\text{Total birth rate} = \text{Female birth rate} \times (1 + \text{sex ratio at birth}) \\ \times \frac{\text{Female population}}{\text{Total population}}$$

The sex ratio at birth is assumed to be 1.05.

This paper mainly concerns itself with the data on age distribution available from the census of Nepal in 1952-54 and 1961. The 1952-54 population has been projected back to 1951 by the application of geometric rate of growth formula using the intercensal rate of growth.

This various methods which have been utilized here are described below in brief. The results are shown in Table 1 and 2.

1. SCALE AND DEMENY METHOD

This method is based on stable population theory, but there is provided a correction mechanism for quasi stability resulting from known mortality declines. In this method the cumulative proportion upto age x is compared with the corresponding proportion in stable age distribution with observed value of r and various levels of mortality. The level of mortality is determined by comparing between the cumulative proportion in actual population and stable population, which is done by interpolation. Then the level of birth rate is estimated from the corresponding stable population. The same procedure is repeated for other values of x i.e. 5, 10, 15 etc. And therefrom the sequence of birth rates are estimated. For female age distribution the birth rate estimated from the cumulative proportion upto the age 35 is expected to be at about the right level.(6)

Adjustment for distabilisation can be done based on correction factors given in Manual IV.

(6) U. N. Manual IV, Method of Estimating Basic Demographic Measures from Incomplete Data. New York 1967, p. 23.

2. BOURGEOIS-PICHAT METHOD

This method is based on stable population theory. The birth rate (b) and the death rate (d) are estimated by the following relationships.

$$b \approx (3.76 p - 44.68 - r) / 1.076(7) \text{ and}$$

$$d \approx b - r.$$

$$\text{where } P = \frac{P}{5+} \times 100$$

r = annual rate of natural increase expressed per 1000 population.

3. USE OF THOMPSON'S INDICES

Thompson's indices, which are based on stable population theory are used to estimate vital rates. It is also known as replacement index and is the ratio of the children aged 0-4 to women aged 15-44 in an actual population divided by the similar ratio in the life table stationary population. The Thompson's index is given by

$$Th = \frac{\frac{P}{50}}{\frac{L}{3015}} \bigg/ \frac{\frac{L}{50}}{\frac{L}{3015}}$$

which under the assumption of stable population becomes

$$Th = \frac{\int_0^5 e^{-ra} p(a) da}{\int_{15}^{44} e^{-ra} p(a) da} \bigg/ \frac{\int_0^5 p(a) da}{\int_{15}^{44} p(a) da}$$

where p [a] is the probability at birth of surviving upto age a. On simplification it becomes

$$Th \approx e^{r(A-a)} \left\{ \frac{1 + \frac{rS}{2}}{1 + \frac{rS}{2}} \right\}$$

(7) Jean Bourgeois Pichat, "Utilization de la notion de population stable pour mesurer la mortalité et la fécondité des populations des pays sous développés", Bulletin de l'Institut International de Statistique, Tome 36, 2e Livraison, Stockholm, 1957, pp. 94-121.

where a and A are the average ages of the stationary population below age 5 and between ages 15 to 44 respectively.

s^2 and S^2 are the variance in the stationary population below age 5 and between ages 15 to 44 respectively.

The above relation can be written as

$$r = \frac{1}{(A-a)} (\log_e Th + \log_e \frac{1 + r^2 S^2/2}{1 + r^2 s^2/2})$$

$$\frac{\log_e Th}{(A-a)} \left\{ 1 + \frac{\log_e Th}{(A-a)^2} \frac{(S^2 - s^2)}{2} \right\} \quad (8)$$

The values of r were computed for different levels of mortality and that the particular level of mortality which gave the observed value of r was selected. From the corresponding level of mortality the death rate and then the birth rate were calculated.

For this purpose two Thompson's indices have been taken :

children aged 0-4 divided by women aged 15-44 and children aged 5-9 divided by women aged 20-49.

4. RELE METHOD

This method is also based on stable population theory and is used to estimate Gross Reproduction rate and birth rate by using the two characteristics of the population—the child women ratio and e_0^c .

Estimation of GRR

GRR is estimated from the linear relationship of $y = a + bx$ where $y = \text{GRR}$ and $x = \text{child woman ratio, CWR}$ and a, b are the regression coefficients(9).

Estimation of Birth Rate

Intrinsic birth rate is estimated from the relationship of $y = a + bx + cx^2$.

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- (8) Nathan Keyfits, Dhruva Nagnur, and Divakar Sharma "On the Interpretation of Age Distribution", Journal of American Statistical Association, Vol. 62 1967, pp. 870-71.
- (9) J.R. Rele, Fertility Analysis Through Extension of Stable Population Concepts, University of California, Berkeley.

Where y is the intrinsic birth rate, and x is the CWR. a , b and c are the regression coefficients(10).

The crude birth rate (b_e) is estimated from intrinsic birth rate (b_i) by the formula

$$b_e = b_i \frac{(\text{Weighted sum} \div \text{total population}) \text{ for the given population}}{(\text{weighted sum} \div \text{total population}) \text{ for the corresponding stable population(11)}}$$

(the weighted sum of women aged 15-44 is obtained by weighting the female population in each quinary age by 1, 7, 7, 6, 4, 1 respectively.

5. ARRIAGE METHOD

The method is based on stable population theory. In stable population.

$$c(x, x+n) = b e^{-r(x+n/2)} \frac{L}{n x}$$

where $c(x, x+n)$ is the proportion of the population between ages x to $x+n$, b is the intrinsic birth rate, r is rate of growth and $n x$ is the life table stationary population between ages x to $x+n$ and e is the base of the Neperian logarithms.

Using the logarithms the above equation can be written as

$$\log_e \frac{c(x, x+n)}{\frac{L}{n x}} = \log_e b - r(x + n/2)$$

This is a straight line whose slope is the growth rate of the population, the birth rate and the growth rate are estimated for various levels of mortality. That level of mortality. That level of mortality is selected when the estimated value of r is nearest to the observed value of r for males and females separately(12). In this way the birth rate is estimated for both males and females.

6. REVERSE SURVIVAL RATIO METHOD

This method is based on the idea that the children enumerated in the age group 0-4 and 5-9 are the survivors of the children born upto 5 or between 5 to 10 years

(10) Ibid.

(11) Ibid.

(12) Eduardo E. Arriaga, New abridge life table for Peru: 1940, 1950-51 and 1961. Demography 1966, Vol. 3, No. 1, pp. 218-237.

before the census. The survival ratio for the assumed level of mortality is applied to the age group 0-4 and 5-9 of the population to obtain the total number of births during 1951-56 and 1956-61. Then the birth rate is calculated by dividing the average annual number of births in the intercensal period with the estimated population in the middle of the period and multiplying by 1000.

7. DIFFERENCING METHOD

If two age distributions are available at an interval of 10 years, the deaths among those already alive as of the base t is

$$D_{0+} = P_{0+}^t - P_{10+}^{t+10}$$

To get the total deaths we require the deaths among the births during the decade and it is obtained by the formula; Deaths among the birth occurring during the decade

$$D_B = R D_{0+}$$

$$\text{where } R = \frac{D_{0-4}}{D_{5+}}$$

Because of the non-existence of vital registration in Nepal the value of R has been taken from Uttar Pradesh(13).

$$\text{Therefore the total deaths, T. D.} = D_{0+} + D_B$$

$$= D_{0+} (1 + R).$$

which is then used to get the death rate.

8. OVERALL SURVIVAL RATIO METHOD

This method is closely related to the 'Differencing Method' and is also based on available age distribution at two points of time. In this method we calculate the overall survival ratio of those age 10+ at the later period to all those alive at the earlier period i.e.

$$O.S.R. = \frac{P_{10+}^{t+10}}{P_{0+}^t}$$

(13) India, The Registrar General, Vital Statistics of India, for 1965 p. 63.

We can also calculate the overall survival ratios for persons aged 0+, 5+, 10+ of the earlier period to the corresponding persons aged 10+, 15+, 20+ at the period ten years later. The base population as of 1951 by age and sex is obtained by projecting the 1952-54 population by a rate of growth for 2 years backwards and applying the same age sex distribution as in 1952-54. For the observed value of r and O.S.R., we estimate the level of e_0^o from Table I to V(14), and the median value is taken as the estimate. The estimation is carried over for both the sexes.

Table I

Estimates of Birth rate and Death Rate in Nepal, for Femals Population and Total Population, based on raw data.

Method of Estimation	Female Population		Total Population	
	Birth rate	Death rate	Birth rate	Death rate
1. Coale and Deminy's Method	39.14	19.14	40.72	20.72
2. Bourgeois Pichat's Method	39.66	19.66	41.26	21.26
3. Use of Thompson's Indices				
(1) Th 1	29.93	9.93	31.14	11.14
(2) Th 2	38.16	18.16	39.70	19.70
4. Rele's Method			40.45	20.25
5. Arriaga's Method	37.94	17.94	39.47	19.47
$e_0 = 47.5$				
6. OSR Method	40.45	25.45	42.08	27.08
$e_0^o = 47.5$				
7. Differencing Method	38.48	20.98	40.03	22.53
8. Reverse Survival ratio				
Method $e_0^o = 40.0$	42.27	22.27	43.98	23.98

(14) P.S.G. Nair, The overall survival ratio method for evaluation defective and incomplete data and estimating mortality, D.T.R.C., 1967-68.

Table 2

Estimates of birth rate and death rate in Nepal, for female population and total population, based on smoothed data.

Method of Estimation	Female Population		Total Population	
	Birth rate	Death rate	Birth rate	Death rate
1. Coale and Deminy's Method	39.89	19.89	41.48	21.48
2. Bourgeois Pichat's Method	39.86	19.86	41.44	21.44
3. Use of Thompson's Indices				
(1) Th 1	37.21	17.21	38.69	18.69
(2) Th 2	34.59	14.59	35.97	15.97
4. Rel's Method			44.08	24.08
5. Arriaga's Method	38.41	18.41	39.93	19.93
$e_0^o = 50$				
6. OSR Method	47.32	32.32	49.20	34.20
$e_0^o = 32.5$				
7. Differencing Method	40.29	22.79	41.89	24.39
8. Reverse Survival ratio				
Method $e_0^o = 40$	44.05	26.55	45.80	28.30

Findings based on raw data

Even though the vital rates are more or less within a tolerable range of variation, still there are fluctuations in the values which could not be explained away by the methods or techniques. These could have been brought about by either divergencies of the age sex data from the models assumed or other age sex errors coming through enumeration and reporting.

In the case of Nepal, quasi-stability of the female population can easily be assumed because of the sustained high fertility, falling mortality and negligible migration rates. Among males, migration may have been not negligible even though the effect of migration

on age sex structure could have been only marginal due to the small size of the migrant population.

The largest component responsible for the divergencies in the rates could thus be only errors and deficiencies in data which in a census are usual. For example, the 1952-54 census of Nepal was the first of its kind in the country and faced problems like the terrain being unpassable, communication and transportation facilities being undeveloped and the enumeration and respondents being unprepared for an operation of this kind. The wide-spread illiteracy, ignorance and superstitions could have affected the data especially in regard to its coverage and completeness. Some areas were physically cut off and the taking of the census at two points of time could not eliminate the problem of internal migration. Even in 1961, many of the problems arising out of the terrain and physical conditions and illiteracy and ignorance of the population remained. The age reporting as evinced in 1952-54 and 1961 showed that there were heavy preferences for ages ending in digits 0 and 5 and in even digits in preference to odd digits. Over-reporting of age by older persons, under-reporting of ages by young adults, omission of young children from enumeration were some of the abnormalities and deficiencies noted in the data.

Such being the types of error in age sex data, adjustments to the enumerated data become important before one can use them to arrive at measures.

Assuming, as in several other countries of the world, that the enumeration of children aged 5-9 is more or less complete excepting for some sex misreporting, the population aged 0-4 is adjusted such that the birth rate based on both will be the same. The sex ratio at birth is assumed at 105 males per 100 females. The errors in the ages 10-69 are usually those arising out of age shifting. A three point formula based on the idea that errors in adjacent age groups are similar in magnitude but opposite in sign has been used to smooth the age groups 10-69. This formula has an added advantage in that it does not remove any peculiarities arising out of migrations etc.

The age ratio score, sex ratio score and joint scores have been computed before and after adjustment, which shows that joint score of smooth data has come down to 17 as against 57 of the unsmooth data.

It has also been found out that the underlying errors are the same for both 1952-54 and 1961 enumerated population. So similar method has been utilized to adjust the 1952-54 population. Then 1952-54 population is projected back to 1951 by the application of geometric rate of growth formula using intercensal rate of growth.

Based on 1951 and 1961 adjusted age distribution, the various methods have been

applied further for estimating the consistent and convergent set of vital rates.

1961 Adjusted percentage age distribution

Age	Male	Female
0-4	16.8	16.1
5-9	14.0	13.5
10-14	11.6	10.5
15-19	9.1	8.7
20-24	8.0	8.5
25-29	7.7	8.4
30-34	7.1	7.4
35-39	6.0	6.1
40-44	4.9	5.0
45-49	4.1	4.2
50-54	3.4	3.4
55-59	2.6	2.7
60-64	1.9	2.2
65-69	1.4	1.6
70+	1.4	1.7
Total	100.0	100.0

Discussion of the final estimates

The estimates of birth rate and death rate based on adjusted age distribution has been obtained by the application of various indirect methods. Among the estimates the maximum birth rate is 49.20 which is given by overall survival ratio method. However this method is based on 1951 adjusted age distribution. Hence the birth rate of 49.20 and death rate of 34.20 given by this method is quite reasonable. The lower birth rate of 35.97 shown by Thompson's index 2 reveals that there is still some inconsistency and biases in adjusted age distribution or it may be that the method fails in such cases. However the adjustment also depends upon the assumption of sex ratio at birth and also on the assumption of expectation of life. It also depends upon limitations of the methods itself for example Thompson's method is applicable only when the population is stable. Reverse survival method has placed the birth rate at 45.00 which is maximum

as compared to other methods based on 1961 adjusted age distribution. This method also strictly depends on the assumption of expectation of life at birth and its implying survival ratios. The rest of the methods have estimated the birth rate in between 40 to 44.

In comparing the estimates of birth rates and death rates based on unadjusted and adjusted age distribution it shows that the estimates based on unadjusted age distribution are more or less closer than that based on adjusted age distribution. On an average the birth rate estimated by both age distribution lies within the range of 39 to 44 and death rate lies within the range of 19 to 24. So, the evaluation of the results shows that except two or three estimates there is a noticeable amount of consistency among the remaining. Hence from the evidences it can be concluded that the birth rate in Nepal during 1951-61 lies in a vicinity of 42 per 1000 population and death rate lies in a vicinity of 22 per 1000 population.

Birth and death rate for 1971

From 1971 Population Census of Nepal, also some estimates on birth and death rate are available. The Central Bureau of Statistics (CBS)(15) has recently applied a corrective technique to the raw data which gives the crude birth rate of 42.9 births per thousand population and 22.8 deaths per thousand population. Gubhaju(16) estimated the crude birth rate for Nepal at 42.4 using the 1961-70 smoothed age distribution and Stoeckel, Tuladhar, Gubhaju and Joshi(17) obtained a crude birth rate of 42.5 from the marital status data of 1971 Census. Thus, from the available evidences, it would appear to indicate that the crude birth rate for Nepal for 1971 is about 42 births per thousand population and crude death rate is about 22 deaths per thousand population.

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- (15) H.M.G. National Planning Commission Secretariat, Central Bureau of Statistics, Population Projection For Nepal 1971-86, Kathmandu, Nepal, May 1974.
 - (16) Gubhaju, B. B., An Abridged Life Table Construction For Nepal For the Period 1961-70, Research, Planning and Evaluation Division NFP/MCH Project, Kathmandu, Nepal Dec. 1974.
 - (17) Stoeckel, J., Tuladhar, J., Gubhaju, B. B., and Joshi, F. L. Marital Structure and Birth Rate in Nepal, Research, Planning and Evaluation Division NFP/MCH Project, Kathmandu, Nepal, 1974.

Acknowledgement :

This is the revised version of the seminar paper presented by the author to the International Institute for Population Studies, Bombay as a part of the requirements for the certificate course. The author wishes to thank Dr. K. V. Ramchandram for his guidance while preparing this paper.

BIBLIOGRAPHY

1. U. N. Manual IV Methods of Estimating Basic Demographic Measures From Incomplete Data, New York 1967.
2. Jean Bourgeois Pichat, "Utilization de la notion de population stable pour mesurer la mortalite et la fecundite des populations des pays sous developpe's". *Bulletin de l'institute International de Statistique* Tome 36, 2^e Livraison, Stockholm, 1957.
3. Nathan Keyfitz, Dhruva Nagnur, and Divakar Sharma "On the interpretation of age distribution". *Journal of American Statistical Association*. 1967.
4. J. R. Rele, Fertility Analysis Through Extension of Stable Population Concepts, University of California, Berkeley.
5. Eduardo E. Arriaga, New Abridge Life Table for Peru: 1940, 1950-51 and 1961. *Demography* 1966 Vol. 3, Number 1.
6. India, The Registrar General, Vital Statistics of India for 1965.
7. P. S. G. Nair, The Overall Survival Ratio Method For Evaluating Defective And Incomplete Data and Estimating Mortality DTRC Bombay 1967-68.
8. H.M's Government of Nepal, Census of Nepal 1961 Vol. 3. Part II, Kathmandu, 1967.
9. H.M's Government of Nepal, Census of Nepal 1952-54 Kathmandu 1958.
10. K. J. Krotki and H. N. Thakur: Estimation of Population Size and Growth from the 1952-54 and 1961 Census of the Kingdom of Nepal, *Population Studies* Vol. 25, Number 1, March 1971.
11. Kulkarni, V. S. and Rao, G. R., An Evaluation and Adjustment of Nepal Data 1952-54 and 1961, DTRC Bombay 1968-69.
12. Ramchandran, K. V., An Evaluation and Adjustment of Basis Demographic Statistics of Burma, Ceylon, Nepal and India, DTRC Bombay 1969.
13. J. R. Rele and U. P. Sinha, Fertility and Mortality in India 1951-60, *Studies in Demography*, George Allen and Unwin, Ltd. London.

14. Thakur, H. N., Population Projection For Nepal 1955-1975, DTRC Bombay 1960-61.
15. U. N. Population Bulletin of the United Nations No. 7, New York, 1965.
16. Central Bureau of Statistics, Population Projection for Nepal 1961-81 Kathmandu, Nepal 1968.
17. Ansley J. Coale and Paul Deminy. Regional Model Life Tables and Stable Population, Princeton University Press, Princeton, New Jersey 1966.
18. K. V. Ramachandran and P. S. G. Nair. The Overall Survival Ratio Method for Evaluating Defective and Incomplete Data and Estimating Mortality, Studies in Demography, George Allen and Unwin Ltd. London.
19. HMG; National Planning Commission Secretariat, Central Bureau of Statistics, Population Projection For Nepal 1971-86, Kathmandu, Nepal, May 1974.
20. Gubhaju, B. B., An Abridged Life Table Construction For Nepal For the Period 1961-70, Research, Planning and Evaluation Division NFP/MCH Project, Kathmandu, Nepal, Dec. 1974.
21. Stoeckel, J., Tuladhar, J., Gubhaju, B. B., and Joshi, P. L. Marital Structure and Birth Rate in Nepal, Research Planning and Evaluation Division NFP/MCH Project, Kathmandu, Nepal, 1974.