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Estimation of the Level of Mortality in Nepal

'THERE has been a growing concensus among the researchers, planners and policy makers, on the need for reliable estimates of level of mortality in Nepal. Estimates of level of mortality prior to 1950 are virtually impossible due to nonavailability of data. Until recently, Nepal had no vital registration system. It was only in 1977, that vital registration system was started in some parts of the country and aims at covering the entire country within ten years.

There were no national sample surveys conducted until the early sixties of this century. In 1966 a National Health Survey was conducted in Nepal (Worth and Shah, 1969). Due to weaknesses in sample design and methodology, the survey is generally considered "inaccurate in its reporting on population matters" (Blumberg, 1970). Therefore, the mortality estimates provided by this survey wer not accepted. Very recently, two national sample surveys were conducted namely: (1) the Demographic Sample Survey, 1974/75, 1976 and 1977; and (2) the Nepal Fertility Survey, 1976. These surveys provide the estimation of level of mortality in Nepal.

Although there are historical evidences of partial population counts in Nepal dating back to the nineteenth century (CBS, 1958), the first census-like enumeration for which the data exist took place in 1911. Since 1911, there have been censuses taken roughly every decade. But these censuses appear to have been just a little more than population counts. It was only in 1952/54 that the first modern and complete census of Nepal was taken using internationally acceptable concepts (CBS, 1958). Yet this census also did not strictly meet the definition of the census, as the whole country was enumerated at two points of time. The eastern part was enumerated on May 28, 1952 and the western part on May 28, 1954. Subsequently, the second and the third censuses were taken on June 22, 1961 and June 22, 1971. Unfortunately none of these censuses were

followed by post-enumeration surveys, so it is not possible to assess quantitatively the completeness of the census enumeration.

As with censuses in most of the developing countries, the censuses of Nepal are also characterised by the substantial underenumeration of deaths and misreporting of age and sex data. The application of the Brass technique on estimating completeness of reported deaths in 1961 census indicated that the reported deaths would have to be increased by more than 100 percent (Kramer, 1979). The distribution of reported deaths in 1971 census was not available in the report so it was not possible to estimate the completeness of reported deaths. However, there was no indication that the quality of data in 1971 census was any better than 1961 census. But on the U.N. Age-Sex Accuracy Index of 52 for the 1952/54 census, 56 for the 1961 census and 59 for the 1971 census, the quality of the census, age and sex distributions would be described as quite unreliable (Kramer, 1979).

The Myers Index for 1961 and 1971 censuses also revealed that there were heavy preferences for ages ending in digits 0 and 5 and in even digits in preference to odd digits (Rajbanshi *et al*, 1976). Hence, this would suggest that the estimation of level of mortality in Nepal from the direct evidence of reported deaths is far from reality. However, the development of indirect techniques has become extremely helpful in estimating the level of mortality of the countries with incomplete and deficient data.

Various authors have adopted the indirect technique to estimate the level of mortality of Nepal in 1952/54, 1961 and 1971 (Thakur, 1960; U.N., 1965; Ramachandran, 1969; Krotki and Thakur, 1971; Vaidyanathan and Gaige, 1973; Gubhaju, 1974; Gubhaju, 1975; CBS, 1974). The results of which are summarized in the tables below:

TABLE 1—ESTIMATED CRUDE DEATH RATE IN NEPAL

Source	*Period of estimation*	*Crude death rate per WOO population*
U. N., 1965; Thakur, 1960; Vaidyanathan and Gaige, 1973	1952/1954	3C-37
Gubhaju, 1975; Krotki and Thakur, 197J; Ramachandran, 1969	1961	22-27
CBS, 1974	1971	22

The objective of the present paper is to estimate the level of mortality in Nepal in 1971 with the application of some of the notable indirect techniques. The sensitivity of the techniques with differentials in the completeness of enumeration in the censuses will also be examined.

TABLE 2—ESTIMATED INFANT MORTALITY RATE AND EXPECTATION OF LIFE AT BIRTH IN NEPAL

Source	*Period of estimation*	*Infant mortality rate*		*Expectation of life at birth*	
		Male	*Female*	*Male*	*Female*
Vaidyanathan and Gaige, 1973	1952/54	260	250	27.1	28.5
Gubhaju, 1974	1961-71	200	186	42.9	38.9
CBS, 1974	1971	172			

Methods and Materials

The materials that are required for indirect estimation of the level of mortality are the age distribution of the population and intercensal rate of growth. These are readily available in the countries where more than one census have been conducted. Since most of the methods for estimating the level of mortality are based on stable population theory, certain conditions should bs fulfilled before applying them. For example, when a closed population is subject to a regime of constant fertility and mortality for a sufficiently longer period of time, then the population is known to be a stable and the age distribution thus generated is also stable. Since the age distribution of the population is the reflection of the regime of fertility and mortality schedules of the country, the level of fertility and mortality can also be determined from the age distribution, which is the main basis of indirect techniques. In Nepal, a total population of 9,412,996 enumerated in 1961 census rose to 11,555,983 in 1971 census, which gave an exponential intercensal growth rate of .0205 per annum. The male and female intercensal growth rate were .02270 and .01834 per annum. In Nepal fertility has remained high and fairly constant for the past several decades and mortality is declining and population particularly females, can be assumed to be closed to international migration. Hence, the indirect methods of estimating level of mortality can be fairly applicable. Various methods have been applied to female population to determine the level of mortality of females. The methods that have been utilized here are based on stable population model and are described below in brief.

Coale and Demeny Method

In this method, the cumulative proportion of population under age *x* i.e. 5, 10, etc. is compared with the corresponding proportion in model stable population at observed intercensal rate of growth (/•). The level of mortality is determined when the actual cumulative proportion of population under ageX match-

es with that of model stable population at observed *r*. With this procedure a series of mortality levels are determined for ages under 5, 10, etc., and for female age distributions level of mortality estimated from the cumulative proportion under age 35 is expected at about the right level (U.N. Manual IV, 1967).

2. *Use of One Census Method*

In stable population,

$$c(a) = be^{-ra}\, p(a),$$

where $c(a)$ = Proportion of population at exact age x

b = birth rate

r — rate of growth

$p(a)$ = Probability of surviving from birth to age a.

This can also be written as,

$$p(a) = \frac{c(a) \cdot e^{ra}}{b}.$$

Also,

$$e_x^0 = \frac{\int_{a=x}^{\infty} p(a)da}{p(x)} = \frac{\int_{a=x}^{\infty} c(a)\, e^{r(a-x)}da}{c(x)}$$

or,

$$\text{eg} = \frac{\sum_{a=x}^{\infty} {}_5C_a \cdot e^{r(a+2.5+x)}}{c(x)}$$

where e°_x life expectancy at age x;

${}_5Ca$ = proportion of population between age at a, $a + 5$; and

$c(x)$ = proportion of population at exact age x

$$= \frac{1}{10}({}_5C_{x-5} + {}_5C_x).$$

From this equation, it is evident that if we knew rate of growth of population, then the age distribution can easily be translated into life expectancy. From this method final estimate of $e0_{10}$ can be obtained as the average of estimates of eg, 4, and $e0_{15}$ (Preston, 1980).

3. *Bourgeois Pichat/Arriaga Method*

In stable population,

$$c(a) = be^{-ra}p(a)$$

$$\frac{c(a)}{p(a)} = be^{-ra}$$

$$\ln\left[\frac{c(a)}{p(a)}\right] = -ra + \ln b.$$

This equation can be rewritten as,

$$\ln\left[\frac{{}_5c_a}{\frac{{}_5L_a}{5 \cdot l_0}}\right] = \ln(5b) - r(a + 2.5),$$

where ${}_{\&}c_a$ = proportion of population aged a, $a + 5$;
${}_5$Lo = person years lived between ages a, $a + 5$ in model life table;
$/_0$ = radix of the table
b = birth rate; and
r = rate of growth.

This equation is a stright line whose slope is the negative rate of growth of population. By solving this equation, the level of mortality is determined when the slope of this equation is equal to the negative of the observed rate of growth of population.

4. *Use of Two Censuses*

If two censuses are available and are separated by 10 years then it is obviously possible to solve for the level of mortality in a system of model life tables that correctly survives the population forward from the earlier to the later census. In this method, the population aged x, $x + n$ in the earlier census is projected to aged $x + 10$, $x + n + 10$ in the later census by using 10 year survival ratios from model life tables. The level of mortality is determined when the expected population aged x and above ($x = 10$, 15, etc.) matches with that of actual population in the later census. With this procedure, a series of levels ofm ortality are determined for population aged 10 +, 15 -f, etc., and a median of the first nine levels is taken as representing the female mortality level (U.N. Manual IV, 1967).

Results

The level of mortality of females in Nepal in 1971 has been estimated with the use of indirect techniques described above. As recommended (Coale and

Demeny, 1966) West Model Life Tables have been used for estimating the level of mortality in Nepal.

Table 3 presents the level of mortality of females based on cumulative proportions of population *C(x)* under age *x (x* = 5, 10, 15, etc.). The estimates of expectation of life at birth (eg)range from 35.9 based on C(10) to 46.0 based on C(5). The estimates based on C(10) and C(5) indicate the overenumeration under age 10 and underenumeration under age 5. However, the estimates of *el,* seem to have been clustered around a tolerable range af 40-44 based on C(15), C(20), C(25), C(30) and C(35). A slightly higher estimates of *e[]* based on C(20), C(25),andC(30) may be attributed to the characteristic tendency of overreporting of ages by women aged 15-19, 20-24 and 25-29 particularly after they are married and bear children. In the Nepalese context, this tendency seems to be plausible due to universal and early marriage practice. However, assuming that the estimate based on cumulative proportion of females under age 35 corresponds to about the right level, eg for females is estimated at 40.5.

TABLE 3-ESTIMATES OF LEVEL OF MORTALITY BASED ON COALE AND DEMENY METHOD

Age x	*Proportion of females upto age x, c(x)*	*Values of C(x) in female west stable population with r = .01834*				*Level of mortality*	*el*
		level 7	*level 9*	*level 11*	*level 13*		
5	.1470			.1483	.1416	11.4	46.0
10	.2964	.2988	.2854			7.4	35.9
15	.3999		.3999			9.0	40.0
20	.4870		.5010	.4849		10.7	44.4
25	.5748		.5897	.5726		10.7	44.4
30	.6574		.6668	.6495		10.1	42.7
35	.7316		.7334	.7167		9.2	40.5
40	.7941	.8075	.7907			8.6	39.0
45	.8477	.8546	.8396			7.9	37.3
50	.8853	.8940	.8810			8.3	38.3

The estimates of female life expectancies at ages 5, 10, and 15 based on one census method are 46.6, 44.2 and 48.3 respectively (Table 4). The mean of these gives the estimated $e?_0$ of 46.4 which corresponds to female e_0 of 40.0 in female west model life table. The estimated *el* of 40.0 based on one census

method is Surprisingly closer to estimated e^{n}_{0} of 40.5 based on Coale and Demeny method. The present estimates of eg, e^{0}_{5} and $e0_{15}$ are compared with the available life table for Nepal for the same period and are given in Table 4.

TABLE 4-ESTIMATED LIFE EXPECTANCIES AT AGES 5 10, AND 15 **FOR** MALES AND FEMALES, 1971

	Females		*Males*	
	Present estimate	*Life table**	*Present estimate*	*Life table**
e^{0}_{5}	46.6	48.6	54.7	55.1
$e0_{10}$	44.2	46.3	46.2	52.4
$e°i_{5}$	48.3	42.6	47.1	48.2
$Meane^{0}_{10}$	46.4	45.8	49.3	51.9
Corresponding $e°$	40.0	38.9	42.1	42.9

*Gubhaju, B. B., An Abridged Life Table Construction for Nepal for the Period 1961-70, F. P. & M. C. H. Project, Kathmandu, Nepal, December 1974.

The present estimates of e^{0}_{5}" and $e°_{10}$ for females do not show much variation with the available life table but estimate of $e°_{15}$ based on the present method is quite higher than the available life table. This may presumably be due to the underreporting of females aged 15-19. This abnormality has also been observed from Coale and Demeny method. However, it is encouraging to see that the corresponding $e^{\wedge}$ of 40.0 based on this method is quite closer to $e\$$ of 38.9 in the life table. Life expectancy at ages 5, 10 and 15 arc also estimated for males. Except for $e^{\wedge}_{5}$, the other estimates are found to be quite closer with the available life table.

The expectation of life at birth for female estimated by Bourgeois Pichat/ Arriaga method is 42.8. This method gave the estimate which is slightly higher than the estimates based on one census and Coale and Demeny Method. However, these differences can be accepted as tolerable.

The expectation of life at birth of 51.8 for males estimated by this method is significantly higher than the estimates given by any other method. It implies that this method can be applied only when the assumptions of stability are strictly met. In Nepal, male age distributions may not have remained stable because of heavy out-migration of Nepalese males in the past.

Table 5 presents the estimates of the level of mortality based on two censuses. This method gives a series of mortality levels based on female population aged 10 4, 15 -r, etc. The median of the first nine levels of mortality selected as being the best single estimate of the level of mortality of females is 6.7, which

corresponds to the expectation of life at birth of 34.2. The estimate of the level of mortality given by this method is surprisingly lower than any other method, which in no way is likely to reflect the true level for Nepal. The expectations of life at birth based on population 10 + 15 + etc. also show a large range of variations from the lowest estimated e^{o}_{0} of 30.0 based on female population aged 35+ to eg of 45, based on female population aged 20+. The range of variations observed in this method obviously reflects the errors in the age reporting in the censuses. For instance the estimated $e0_0$ of 45 based on female population aged 20+ is higher compared to $e0_0$ based on other ages which obviously reflects the tendency of overreporting of the ages by females aged 15-19. Due to this reason, the estimate of level of mortality based on females 15+ is significantly lower than that based on females 20+.

TABLE 5—ESTIMATES OF THE LEVEL OF MORTALITY BASED ON TWO CENSUSES

Age x	*1971 female population* (in 1000) *age x and above*	*Projected female population aged x and above at various level*				*Level of mortality*	*el*
		Level 5	*Level 7*	*Level 9*	*Level 11*		
10	4038		4000	4105		*1.1*	36.7
15	3444		3418	3504		7.6	36.5
20	2943				2943	11.0	45.0
25	2440			2409	2472	10.0	42.5
30	1966	1505	1977			6.7*	34.2
35	1540	1539	1602			5.0	30.0
40	1182	1176	122			5.2	30.5
45	874	866	909			5.4	31.0
50	659	630	665			6.6	34.0
55	462		459	48'4		7.3	35.7
60	338			328		10.1	42.7
65	182		174	188		8.2	38.0

*Median of the First Nine Levels.

The estimates of the level of mortality of females are obtained with the use of indirect techniques. Three of the four techniques that have been utilized here use the age distribution from only one census while one method uses the age distribution from two censues. It is observed that the estimates of level of mortality are reasonably closer when the methods are based on only one census age distribution. The method based on two censuses age distribution gave the estimate which is significantly different from any other method.

The largest component responsible for this divergency could be the errors and deficiencies in the data which in a census is usual. Particularly the use of two censuses method seems to be problematic when there are differentials in omission and age.sex reporting errors in the censuses. For example, the 1961 and 1971 censuses of Nepal were the second and the third of its kind in the country and faced problems like the terrain being unpassable, communication and transportation facilities being undeveloped and the enumerators and respondents being inadequately prepared for an operation of this kind. The widespread illiteracy, ignorance and superstitions could have affected the data especially in regard to its coverage and completeness. Particularly when the types of errors in two censuses in terms of coverage and completeness are additive in nature then the method based on two censuses is likely to be seriously affected than the method based on only one census.

Finally an attempt has been made to estimate the effect of differentials in the completeness of enumeration on the estimates of level of mortality. Suppose the female intercensal rate of growth(r) is increased by 10% and 20% then the new *r* will be increased from .01834 to .02017 and to 02201 respectively. Now these new growth rates have been used to reestimate the level of mortality. Table 6 Presents the estimates of expectation of life at birth of females at different values of r.

TABLE 6—ESTIMATES **OF** EXPECTATION OF LIFE AT BIRTH OF FEMALES IN NEPAL—1971

Method	*Estimates based on*	*Estimates based on r' = r(1 + k)*	
	Intercensal r = .01834	*k=0.1 New r = .020/7*	*k = 0.2 New r = .02201*
	(1)	*(2)*	*(3)*
1. Based on two censuses	34.2	37.0	39.7
2. One census	40.0	44.2	48.9
3. Coale and Demeny	40.5	44.6	48.9
4. Arriaga	42.8	46.0	49.7

The result of this new estimate shows that with the increase in *r* the $e0_0$ has shown an almost the same increase by all the methods. It is interesting to note that when r is increased by 20%, the methods based on one census gave almost the same eg of 49 while the estimate based on two censuses remains at remarkably lower level. Hence increase in -intercensal rate of growth did not improve the situation, and the discrepancies remain almost the same. Therefore, these discrepancies observed may only be due to the differentials in omission and age-sex-reporting errors in the censuses. The age-sex data corrected for omission and

misreporting may be expected to give the consistent results. The indirect techniques have been widely used to estimate the level of mortality in the countries with incomplete and deficient data. The techniques are found to have been extremely useful not only in estimating the levels but they can also be used as tools for detecting the errors in the age-sex distribution of the population.

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