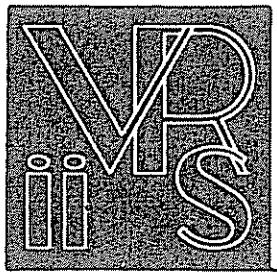

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THE EVALUATION OF THE COMPLETENESS OF DEATH REGISTRATION IN THE PRESENCE OF HIGH NET OUT-MIGRATION THE CASE EXAMPLE OF MAURITIUS

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FOREWORD

As the developing countries continue in their efforts to improve their civil registration and vital statistics systems, it is important for them to be able to evaluate their progress. For estimating the completeness of death reporting, a number of indirect estimation techniques have been developed. These techniques assume a closed population, and so their usefulness for countries which have high rates of net in or out migration is a matter of concern. The author of this paper applies the techniques to the case of Mauritius, an island nation with high net out migration, to study the impact of this demographic condition on the estimates of completeness of death reporting.

The views expressed in this report are those of the author's and do not necessarily reflect those of the IIVRS.

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THE EVALUATION OF THE COMPLETENESS OF DEATH REGISTRATION IN THE PRESENCE OF HIGH NET OUT-MIGRATION: THE CASE EXAMPLE OF MAURITIUS

By

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Introduction

Mauritius is a very small island of approximately 720 square miles. It is situated in the Indian Ocean, 500 miles east of Madagascar and over 1,000 miles from the southeast coast of Africa. In 1987, the population was about one million and is made up of three broad population groups: the Indo-Mauritians, the Sino-Mauritians and the 'general population'. The Indo-Mauritians comprising of immigrants from India and their descendants make up about two-thirds of the population, while the Sino-Mauritians comprising of immigrants from China and their descendants make up about 3 percent. The rest of the population is known as the 'general population' and is made up of persons from European or African or mixed decent.

In Mauritius, data on death and other vital statistics is collected by the Registrar General's Department, which by 1982, maintained 48 Civil Status Offices located throughout the country. Mauritius is known to have a tradition of very good birth and death registration statistics as well as censuses. According to the UN (1982,2):

> "Research and evaluation by national and international organizations have shown that recent censuses in Mauritius have been quite accurate....Civil registration of vital events is compulsory and in the last few decades, with the exception of marriages, has been nearly complete."

The ascertainment of the completeness of death registration is important not only for its role in the estimation of intercensal populations but also in the construction of life tables which is used in many other demographic estimation procedures.

During the 1980s, several techniques were developed for the evaluation of census data and the evaluation of vital statistics data for the intercensal period. Some of these techniques were based on stable population theory or the more recent generalized stable population theory which relaxes the assumption of stability but retains the assumption of closure to migration. This paper is an excercise on the application of such techniques; namely, the estimation of the completeness of death registration. In Mauritius, vital registration is quite good but because of high population density, emigration is encouraged; as a result, net out-migration figures are high. The paper aims to investigate the behaviour of these techniques when applied to Mauritian data.

In indirect estimation, many of the techniques used are robust with respect to the violation of the assumptions of the technique. Since these relatively new techniques which make use of two censuses have potential to be used in many developing countries, it is worthwhile to investigate the degree of their robustness. In this case, Mauritian data is used as an example of data with high accuracy but one in which emigration rates are known to be high.

Literature review of relevant techniques

For the total population, the only source of error that one is concerned with is net under-enumeration error. Net misreporting error is no longer considered since all the misreported cases are included in the population total. Closely associated with this net under-enumeration error is the completeness of the death registration. The ascertainment of this completeness is important not only for its role in the estimation of intercensal populations and in the construction of life tables but also because recorded number of deaths are used as inputs in estimating the relative completeness of one census to another.

Various methods have been developed for estimating the completeness of death registration. Each of them assumes that the population is closed to migration and that ages at death were correctly reported. In addition to these, the following assume stability of the population:

(1) Brass's sectional growth balance method (Brass, 1975)
(2) Preston and Coale method (Preston, Coale et al, 1980)
(3) Bourgeois-Pichat method (Preston, 1984)

The other methods which relax the assumption of stability are given below:

(4) Forward projection method
(5) The modified growth balance method (Martin, 1980)
(6) Preston and Hill method (Preston and Hill, 1980)
(7) Bennett and Horiuchi method (Bennett and Horiuchi, 1981)
(8) United Nation method (United Nations, 1979).

Excellent summary of these techniques has been given by Preston (1984). The methods that do not assume stability are a generalisation of the methods assuming stability. One of these non-stable methods, the United Nations method, has not been much used and has shown to give erratic results (Preston, 1984).

In the modified growth balance method, Martin (1980) sought to adjust the Brass estimate of completeness, for mortality decline. The procedure requires the knowledge of the rate and duration of mortality decline. Estimation of these factors involves some circularity because the estimate of the mortality condition is the aim of the exercise in the first place.

The Preston and Hill method and the forward projection methods are related to the size of cohorts in two censuses. They become awkward to use for irregular intercensal periods as in Mauritius with an intercensal period of 11 years, 1972-1983. For such a purpose, one is left with the Bennett-Horiuchi method.

Method and material

The Bennett-Horiuchi method builds on the Preston and Coale (1980) method that assumes stability. Beside the advantage of relaxing the assumption of stability, the Bennett-Horiuchi technique can also be used for irregular intercensal periods. Instead, it makes the less restrictive assumption that the observed number of persons in each five-year interval is approximately equal to the corresponding number in a stable population inferred from the numbers at ages a and a+5 and the observed age-specific growth rates. This relationship is given by:

$$N(a) = \int_a^{\infty} D^*(x) \exp\left[\int_a^x r(u)\,du\right] dx \qquad (1)$$

Where N(a) is the number of persons aged a, r(u) is the growth rate of the population aged u and D*(x) is the true number of deaths experienced by persons aged x. D*(x) is defined as:

$$D^*(x) = k(x)D(x) \qquad (2)$$

Where D(x) is the number of registered deaths to persons aged x and k(x) is the inverse of the completeness of death registration, c(x).

Using the concept of differential growth rates within a population, values of ${}_5N_a'$, the estimated number of persons in the age group a to a+5 are computed. Estimates of completeness are derived from the median of a series of age specific completeness of death(${}_5c_a$)which are ratios of estimated to observed populations (${}_5N_a'/{}_5N_a$) This median is then used to calculate an adjusted set of age-specific death rates and life expectancies for ages 5 and above (Bennett and Horiuchi, 1981).

Results

Using this Bennett and Horiuchi technique on Mauritian data, the results obtained are summarised in Tables 1 and 2 for males and females respectively.

In Table 1, eight of the age-specific estimates of completeness, ${}^5c_a$, are above unity. According to Preston (1984), one reason for the upward bias of ${}_5c_a$ is age over statement of deaths at higher ages.

Table 1

ESTIMATED COMPLETENESS OF DEATH REGISTRATION AND ADJUSTED LIFE EXPECTANCY (APPLICATION OF BENNETT-HORIUCHI TECHNIQUE)
Mauritius males, 1972-1983

AGE	POPULATION		GROWTH	INTERCENSAL DEATHS		COMPLETENESS (1) OF DEATH	ADJUSTED LIFE TABLE (2)	
	JUN 1972	JUL 1983	RATE	NUMBER	RATE	REGISTRATION	DEATH RATES	APPROX E(X)
0- 5	51312	56219	.00824	7132	.01198	.	.01199	. . .
5-10	60031	52533	- .01204	402	.00065	.835	.00065	60 6
10-15	56205	48172	- .01392	389	.00067	.862	.00067	55 8
15-20	50276	57480	.01208	648	.00109	.909	.00109	51 0
20-25	40190	53122	.02517	742	.00145	.916	.00145	46 3
25-30	26230	44746	.04819	756	.00199	.991	.00199	41 6
30-35	21189	39263	.05565	816	.00255	1 011	.00255	37 0
35-40	20772	26978	.02359	985	.00375	.947	.00376	32 4
40-45	18328	19969	.00774	1479	.00698	.981	.00698	28 0
45-50	20159	19301	- .00392	2185	.00999	.996	.01000	23 9
50-55	14549	16173	.00955	3095	.01820	1 034	.01821	20 0
55-60	12629	17296	.02837	3844	.02347	1 057	.02348	16 7
60-65	9222	11888	.02291	4538	.03910	1 003	.03912	13 4
65-70	6073	8665	.03207	4578	.05694	1 042	.05697	10 8
70-75	3677	5237	.03191	4145	.08522	1 048	.08526	8 5
75-80	1686	2720	.04315	2940	.12387	1 072	.12393	6 7
80-85	767	1159	.03725	1712	.16383	1 094	.16391	5 3
85+	285	447	.04061	1018	.25734	. . .	.25746	3 9
TOTAL	413580	481368	.01369	41404				

(1) FOR CALCULATION PURPOSES, E(85) ASSUMED EQUAL TO 4 946
(2) BASED ON MEDIAN COMPLETENESS OF 1 000

Source: output from BENHR

Table 2

ESTIMATED COMPLETENESS OF DEATH REGISTRATION AND ADJUSTED LIFE EXPECTANCY (APPLICATION OF BENNETT-HORIUCHI TECHNIQUE)
Mauritius females, 1972-1983

AGE	POPULATION		GROWTH	INTERCENSAL DEATHS		COMPLETENESS (1) OF DEATH	ADJUSTED LIFE TABLE (2)	
	JUN 1972	JUL 1983	RATE	NUMBER	RATE	REGISTRATION	DEATH RATES	APPROX E(X)
0- 5	50253	55214	00849	5861	01004		01019	...
5-10	58681	51695	- 01144	357	00058	810	00059	67 5
10-15	55144	46701	- 01499	311	00055	840	00056	62 7
15-20	50484	56323	00987	586	00099	885	00101	57 9
20-25	39270	52250	02577	668	00133	896	00135	53 1
25-30	26999	44700	04549	604	00157	965	00159	48 5
30-35	21518	38698	05295	588	00184	982	00187	43 9
35-40	20492	27842	02766	611	00231	933	00234	39 2
40-45	17700	20523	01335	716	00339	963	00344	34 7
45-50	18461	19560	00522	905	00430	990	00436	30 2
50-55	13223	16047	01746	1302	00806	1 041	00818	25 8
55-60	12478	17526	03065	1822	01112	1 055	01128	21 8
60-65	9584	12712	02548	2297	01878	995	01905	17 9
65-70	6969	10006	03264	2676	02891	1 050	02934	14 5
70-75	5047	7048	03013	3195	04833	1 065	04904	11 4
75-80	3044	4581	03688	3123	07546	1 075	07656	8 8
80-85	1727	2512	03381	2632	11401	1 077	11569	6 8
85+	1095	1557	03176	2751	19009		19288	5 2
TOTAL	412169	485495	01477	31005				

(1) FOR CALCULATION PURPOSES, E(85) ASSUMED EQUAL TO 5 260
(2) BASED ON MEDIAN COMPLETENESS OF 986

Source: output from BENHR

As has been mentioned earlier, census age reporting was very good in Mauritius. It is not known whether this is the same for age reporting at death. Also, if the two population censuses are equally complete and if death registration is complete for all ages above 5, these series of ${}_5C_a$ values will be more or less constant. In Table 1, the values of ${}_5C_a$ range from 0.835 for age group 5-10 to 1.095 for age group 80-85. Indeed, from age group 65-70 onwards the values of ${}_5C_a$ continuously rise.

The series of expectation of life values estimated by this technique also over estimate male mortality in Mauritius. From the Mauritius official life tables, the expectation of life at age 5, e_5 is 61.17 and 61.49 in 1971 and 1982-84 respectively. It is expected that e_x values obtained from the Bennett-Horiuchi method should lie between those of the official life tables since the former refers to the intercensal period. Table 3 shows that this is the case for only three ages; 55, 60 and 65. For ages less than 55, the Bennett-Horiuchi method over estimates mortality while for ages greater than 65 it under estimates mortality.

Table 3

Comparison Between Expectation of Life Obtained From the Official Life tables and From the Bennet and Horiuchi Method. Mauritius Males, 1972-1983

Age	Official e_x 1971-73	Bennet-Horiuchi e_x 1972-1983	Official e_x 1982-1984
5	61.17	60.6	61.49
10	56.43	55.8	56.65
15	51.68	51.0	51.78
20	46.97	46.3	47.02
25	42.25	41.6	42.31
30	37.59	37.0	37.65
35	32.99	32.4	33.07
40	28.52	28.0	28.66
45	24.25	23.9	24.46
50	20.24	20.0	20.56
55	16.58	16.7	16.95
60	13.28	13.4	13.65
65	10.66	10.8	10.81
70	8.26	8.5	8.23
75	6.34	6.7	6.18
80	4.64	5.3	4.20

Source: Central Statistics Office (CSO), Table 1; Tables 5.13 and 5.14.

Quite unlike the estimated e_x values in Table 3 for males, those for females in Table 4 show remarkable consistency. Up to age 50, the estimated intercensal value obtained from the Bennett and Horiuchi method lie between those from the official life tables for the two successive censuses. However, after age 50, mortality seems to have been under estimated leading to higher values of life expectancy.

Table 4

Comparison Between Expectation of Life Obtained from the Official Life tables and from the Bennett and Horiuchi Method, Mauritius Females, 1972-1983

Age	Official e_x 1971-73	Bennet-Horiuchi e_x 1972-1983	Official e_x 1982-1984
5	65.93	67.5	68.18
10	61.27	62.7	63.32
15	56.45	57.1	58.46
20	51.76	53.1	53.72
25	47.21	48.5	48.99
30	42.66	43.9	44.24
35	38.24	39.2	39.51
40	33.75	34.7	34.84
45	29.38	30.2	30.31
50	25.06	25.8	25.88
55	21.00	21.8	21.61
60	17.18	17.9	17.66
65	13.77	14.5	14.03
70	10.51	11.4	10.68
75	7.95	8.8	7.89
80	5.62	6.8	5.23

Source: CSO, Table 2, Table 5.13 and 5.14.

Contrary to expectation, it is at those ages where mortality has been underestimated the most (above 65) that the completeness for under registration is consistently above unity.

Discussion

The over-estimation of mortality for ages under 55 could partly be due to genuine under reporting or due to the violation of the assumption of closure. One can be more certain of the later possibility as the population of Mauritius is not quite a closed one as can be seen from Table 5.

Table 5

Net Migration in Mauritius, 1973-1983

Year	Arrivals A	Departure D	Net migration A - D
1973	101184	104697	-3513
1974	109044	113362	-4318
1975	117548	120703	-3155
1976	139303	141148	-1845
1977	153208	155653	-2445
1978	161688	163733	-2045
1979	182771	186864	-4093
1980	163230	167269	-4039
1981	168973	174376	-5403
1982	166669	171991	-5322
1983	177665	182005	-4340

Source: CSO (1986) Extracted from Table 1.16

In the presence of net outward migration, emigrants appear as dead people under the assumption of a closed population. As a result, the estimate of completeness may be biased downward. This is summarised below:

From equation 2,

$$c(x) = \frac{1}{k(x)} = \frac{D(x)}{D^*(x)} \qquad (3)$$

This expression shows that c(x) would be low if D(x) is low either due to omission in reporting of dead or due to age misstatement. Low values of c(x) are, however, more plausible than values of c(x) exceeding unity as there is very low chance that reported deaths could exceed true deaths. The reason for the upward bias of c(x) could be because of large net out-migration and/or the use of higher age specific growth rate due to relative under-enumeration in the first census. These happen to be two of the limitations of this method which are also shared with other methods for estimating under-registration (Bennett and Horiuchi, 1981).

Summary and conclusion

The results of the application of the Bennett-Horiuchi technique showed a high degree of completeness of death registration in Mauritius. However, some results of the age specific completeness yielded improbable figures higher than unity. The problem could largely be due to out-migration. When out-migration is high and the population is assumed to be a closed one, the expected number of deaths may form a high proportion of reported deaths or may even exceed them. This may lead to an upward bias in the estimated values. However, the fact that the minimum and median values for completeness at specific ages (c(x)) are 0.835 and 1.000 respectively for males and 0.810 and 0.986 respectively for females confirms a very good registration system. According to Preston (1984), as a rough rule of thumb, a registration system that records 60 percent or more of deaths represents a very useful source of mortality information.

The presence of high out-migration in Mauritius makes the population an open one rather than being closed. This makes the application of methods for estimating completeness of death registration

slightly unsuited. One way to make the techniques more applicable is to adjust the data before applying them. It is suggested that if the extent of migration is significantly large compared to the number of deaths, prior adjustment of the data is necessary. Also, if the first census is relatively under-enumerated, the set of observed age specific growth rates may have to be deflated. This could be done by experimenting with different rates of growth to produce a sequence of completeness estimates that varies least with age. The former method is difficult in the absence of age specific migration rates while the latter may not be satisfactory (Preston, 1984). However, in many cases, data on age specific migration rates needed to do this are unavailable and the methods used for modifying the rates of growth are arbitrary. This makes adjustment of the data problematic.

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