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A Critical Review of South African Life Tables

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Abstract

The paper gives a critical review of South African life tables published since the 1920s. The published life tables were subjected to internal and external consistency checks to assess their plausibility. Life tables-based quantitative measures such as: under-five mortality, entropy, life expectancy at birth and Anson's *U* were computed for South Africa, and for the purpose of comparison, for Canada as well. In the case of Canada, the measures computed show normal and consistent trends while in the case of South Africa, there were marked inconsistencies in the trends. The paper argues that the South African life tables of the past, under-estimated mortality on the basis of the assumption that death registration was complete.

Résumé

L'article donne une revue critique des tableaux de vie Sud Africain publiés depuis les années 1920. Ces tableaux de vie ont été soumis aux vérifications interne et externe pour évaluer leurs vraisemblances. Les mesures quantitatives de ces tableaux de vie basés entre autre à la mortalité des moins de cinq ans, à l'entropie, à l'espérance de vie à la naissance et à l'indicateur *U* d'Anson ont été calculées pour l'Afrique de Sud ainsi que pour le Canada comme element de comparaison. Dans le cas du Canada, les measures calculées montrent des tendances normales et consistantes alors que pour le cas d'Afrique du Sud, il y a des tendances inconsistantes. L'article argumente que les anciens tableaux de vie sud-Africain ont sous-estimé la mortalité sous supposition que l'enregistrement des dècès étaient parfait.

Key Words: life table, entropy, Anson's *U*, life expectancy at birth

Introduction

In a cross-national study on levels and trends of mortality since 1950, United Nations (1982a) made a general observation regarding life expectancy and the amount by which it increases. It was observed that countries with the lowest values for life expectancy around 1950 had the greatest increases over the period considered, and, conversely, countries with the highest life expectancies at the start showed the smallest increases. Until recently, stagnating or decreasing life expectancies was not a common phenomenon. In the case of Africa, there have been claims of reduction in life expectancies since the 1980s. One study that shed more light on this emerging phenomenon was that of Hill (1987). In that study, Hill grouped several African countries such as Angola, Niger Nigeria, Mozambique, Ethiopia and Rwanda as belonging to those which experienced 'static or rising' mortality. Such experience of static or rising mortality has often been attributed to socio-political instability and interruptions in socio-economic development. On the other hand, claims for decline in life expectancies have been disputed on the basis of questionable quality of past estimates. If analytical techniques were poor in the past and life expectancies had been inflated, a misleading picture may emerge. Ayeni (1985) made similar arguments when discussing levels and trends in infant and child mortality in Africa.

When past official life tables are uncritically accepted to be true and accurate, two results emanate from this. In the first instance, they are used to judge the accuracy of current life tables. In the second instance, when past life tables are compared with current ones, statements are made about the health gains (or

losses) of the recent past. Under such circumstances, if the mortality levels were under-estimated in the past, the comparison would lead to the conclusion that health gains have been low. On the contrary, if mortality levels were overestimated in the past, the comparison would lead to the conclusion that health gains have been very high. Both conclusions would have undesirous effects for both research and health policy-making. One conclusion would lead researchers to frantically search for possible reasons for the apparent 'slowdown in mortality decline' while the other conclusion would lead to complacency. Since the demographic literature shows evidence of both rapid gains in mortality declines as well as slowdowns (and sometimes even reversals) in mortality decline, in theory then, any of the two conclusions arrived at has precedents and is demographically plausible.

Against this background the paper looks at South African life tables published since the 1920s. The life tables were published separately for whites, coloureds and Asians/Indians[1].The paper uses internal and external consistency checks to validate those life tables.

Methods and Materials

Some of the data sources used in the paper are the official complete life tables for South Africa dating back to 1921. Since the South African life tables were published in terms of population groups and gender, the analysis and presentation of results are also structured along those lines. In assessing the quality of South African life tables, the following methods were used: graphical assessment, comparison with model life tables and the use of quantitative measures of mortality at childhood, youth and adult ages and old ages.

Graphical assessment of survivorship curves.

Age patterns of mortality generally show similar patterns. Typically, 'mortality declines from a high level during the first days of life to a trough somewhere during the later childhood years and rises again monotonically thereafter (although some populations have a local maximum within the prime age-groups)' (United Nations, 1982b:2). The United Nations (1982b) used this general pattern as an indicator of internal consistency of life tables. All mortality curves that did not follow this basic pattern were excluded in the selection of life tables to be included in developing model life tables for developing countries. As life table parameters are all related, a similar reasoning applies with respect to the life table survivorship function, $l(x)$. When a series of survivorship functions are plotted, aberrant shape as well as abrupt changes could easily be identified.

Comparison with model life tables.

While there are many sets of model life tables, the two widely used ones are those of Coale and Demeny (1966) and those of United Nations (1982). Model life tables are developed after analysis of empirical life tables. The Coale and Demeny model life tables were derived from a set of 192 life tables from mostly developed countries while the United Nations life tables were derived from 72 life tables from developing countries. In most cases, the life table of a given country would fit closely within a family of one of the two sets of model life tables. Different measures of fit are available for use. In this case, the following approach is used: the South African published life table is compared with all the families of both the United Nations and the Coale and Demeny life tables (using the United Nations software, MORTPAK). From the outputs, the implied life expectancies at birth are then summarised and discussed (United Nations, 1988).

Quantitative measure of mortality during childhood.

While life expectancy at birth is a robust measure of mortality over all ages, there is need for a more specific measure to capture mortality during childhood. Three contending life table measures for this are: the probability of dying between birth and exact age 1, popularly known as infant mortality (written as ${}_1q_0$ or $q(1)$); the probability of dying between exact ages 1 and 5, popularly known as child mortality (written as ${}_4q_1$) and the probability of dying between birth and exact ages 5, popularly known as under-five mortality (written as ${}_5q_0$ or $q(5)$). Of these measure, under-five mortality is argued to be a more robust measure of mortality during childhood (United Nations, 1990).

Quantitative measure of mortality at youth and adult ages.

Not much work has been done on developing life table measures to capture mortality (or survivorship) during youth and adult ages. For this, it is possible to use the *U* measure proposed by Anson (1992).

Anson's *U* is defined as the ratio of the survivorship in middle-adulthood (35-59) to the square of the survivorship in young adulthood (15-35):

$$U = \frac{{}_{25}p_{35}}{{}_{20}p_{15}^{2}} = \frac{l(15)^2 * l(60)}{l(35)^3}$$

While this measure was originally proposed to be a measure of rectangularity, Keyfitz and Golini (1992) argue that it should rather be seen as a measure of the slope of survivorship from age 15 to age 60. Viewing *U* as such, it is expected

that as mortality reaches its minimum, *U* must approach unity. One ventures to add that, if *U* is to exhibit any trend, it would be a very gentle sloping line with positive slope.

Quantitative measure of mortality at old ages.

A specific measure that has been found to capture survivorship at older ages is that of entropy, *H*. Entropy refers to the information content or randomness of a distribution. It is used differently in different disciplines. Theil (1972) applied it to general probability density functions while Demetrius (1976) applied it in the context of population biology. In the study of mortality, the concept was first applied by Keyfitz and Golini (1975). In this latter context, *H* can be viewed as the average years of future lifetime that is lost by observed deaths.

The entropy parameter, *H*, is defined as the weighted average of the logarithm of the life table survivorship function (*l(x)*):

$$H = \frac{-\int_0^w l(x)[\ln l(x)]dx}{\int_0^w l(x)dx}$$

The usefulness of *H* lies in the fact that it gives the percentage change in life expectancy produced by a reduction of one per cent in the force of mortality at all ages. Keyfitz (1977) had shown that if mortality at all ages changes by 100δ the effect of this change on life expectancy would be:

$$\Delta e(0)/e(0) \approx -H\delta$$

As life expectancy increases, the survivorship function assumes a more rectangular form and the values of *H* decrease. Thus, entropy *H* is a measure of the degree of rectangularity of the *l(x)* curve. Empirically derived correlation between *e(0)* and *H* have been found to be quite high (Keyfitz 1977). For this paper, *H* was calculated using a numerical integration method due to Weddle.

For the purpose of comparison, these measures had to be calculated for another country whose life tables were of high quality. Canadian life tables were chosen for this task. However, since this writer only had available a series of abridged life tables, the eight parameter Heligman-Pollard model was used to interpolate

the abridged life tables to obtain complete life tables (Heligman and Pollard, 1980).

Results

Figures 1 and 2 (Appendix) show the trends over time in the life table survivorship function *l(x)*, for white males and females respectively. Similarly, Figures 3 and 4 (Appendix) show the trends for coloured males and females respectively while Figures 5 and 6 (Appendix) show the trends for Asian/Indian males and females respectively.

For each figure, the trends show some kind of peculiarity. For white males, the peculiarity occurs over the period 1946-1970. Survivorship up to age 40 is very high from 1946 onwards. Also, the *l(x)* values for 1946, 1951 and 1970 are very close to each other with mortality crossover occurring around age 55. After the crossover, mortality in 1970 became heavier than mortality in either 1941 or 1951. For white females, no crossovers occur in the *l(x)* curves but survivorship up to around age 40 is exceedingly high from 1970 onwards. For coloured males, one peculiar feature is the convergence of the *l(x)* for 1936, 1951 and 1970 in the old ages. Another peculiarity is the crossover of the 1936 and 1946 *l(x)* curves around age 55. For coloured females, there is convergence of the *l(x)* curves for 1936 and 1946. Also an excess gain in survivorship was experienced during the period 1951-1970, especially over the age range 30-55. For Asian/Indian males, the *l(x)* curves are very peculiar. The 1946 *l(x)* curve has an uneven distribution, there is convergence between the 1951 and the 1970 *l(x)* curves, especially in the oldest ages. The survivorship values for 1980 and 1985 are very high and very close for ages less than 40. For Asian/Indian females, the survivorship values for 1980 and 1985 are very high and very close for ages less than 40 while they diverge appreciably after age 40. For 1946, the *l(x)* curve for Asian/Indian females show an uneven distribution. Lastly, there is convergence between the 1946 and the 1951 *l(x)* curves, especially in the oldest ages.

Tables 1 and 2 show extract from the outputs of the COMPAR program in MORTPAK. The program uses reported life table values for ${}_nq_x$ or ${}_nm_x$ and compares them to the all families of model life tables from both the United Nations set as well as the Coale and Demeny set. Using these input values, the program calculates the implied life expectancy at birth for the different families in the model life tables. Since the highest recorded life expectancy at birth for the period 1990-1995 is less than 80 years

(Japan ,79.5; Iceland, 78.8 and Sweden, 78.1), it is taken that life expectancies at birth greater than 80 would refer to inaccuracies in the observed life table. Two summary measures are reported; the minimum life expectancy at birth that a model life table would imply given the different reported ${}_nq_x$ values ($e(0)_{min}$) and the number of life expectancies at birth greater than 80 years ($N_{e(0)>80}$). Tables 1 and 2 show that for all the population groups, in several cases, implied

Table 1. Comparison of South African Published Life Tables with Model Life Tables: Implied Life Expectancies at Birth for Males for Various Population Groups at Various Years

Population Group	Year	LATIN AMERICAN		CHILEAN		SOUTH ASIAN		FAR EASTERN		GENERAL		WEST		NORTH		EAST		SOUTH	
		e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80
White	**1921**	58.1	5	57.3	6	60.3	5	50.1	5	56.3	5	56.3	5	54.4	6	59.3	5	60.9	5
	1926	61.3	6	58.9	6	63.2	6	53.3	6	59.4	6	59.0	5	57.6	6	60.9	5	64.1	5
	1936	63.2	6	61.4	6	64.9	5	55.3	5	61.3	6	60.6	5	59.5	7	62.4	5	66.1	5
	1946	69.9	7	69.0	7	71.0	6	62.3	6	67.9	6	66.1	5	66.3	13	67.4	5	71.8	5
	1951	70.9	8	70.8	7	71.9	6	63.4	6	68.8	6	66.9	5	67.3	13	68.1	6	72.8	5
	1960	72.6	8	72.3	7	71.3	6	65.2	6	70.5	6	68.3	5	68.9	14	69.3	6	73.1	5
	1970	75.2	7	74.7	7	71.2	8	68.0	6	73.1	7	70.4	5	71.6	12	71.1	5	73.0	6
	1980	77.0	11	75.0	9	71.3	8	71.7	7	75.2	8	73.2	5	75.1	14	72.6	6	73.1	7
	1985	78.0	13	76.1	11	72.7	11	74.2	8	76.3	9	74.2	6	77.2	15	72.9	6	74.0	8
Coloureds	**1939**	38.6	4	40.7	5	42.1	4	31.9	4	37.7	4	40.5	4	36.8	4	45.8	4	39.6	3
	1946	45.5	4	43.6	4	48.7	4	38.1	4	44.3	4	46.0	3	42.7	3	48.8	4	47.1	2
	1951	47.3	4	43.0	4	50.3	4	39.7	4	45.9	4	47.4	4	44.2	4	48.3	4	49.0	3
	1960	47.9	5	46.0	5	50.9	5	40.4	5	46.6	5	48.0	4	44.8	5	51.0	5	49.7	3
	1970	49.2	4	50.2	4	52.1	4	41.6	4	47.8	4	49.0	3	45.9	5	53.2	4	51.1	2
	1980	62.7	4	59.7	4	64.4	4	54.7	4	60.7	4	60.2	4	59.0	4	61.4	4	65.5	2
	1985	67.2	5	63.9	5	66.2	4	59.4	4	65.1	4	64.0	4	63.5	6	63.7	4	68.8	3
Asians	**1946**	59.1	4	55.0	4	61.1	4	51.1	4	57.3	4	57.1	3	55.4	3	58.3	4	61.9	2
	1951	61.9	3	58.2	4	63.7	4	53.9	4	60.0	4	59.5	3	58.2	4	60.5	4	64.8	2
	1960	63.8	4	59.2	4	65.5	4	55.9	4	61.8	4	61.1	4	60.1	8	61.1	4	65.9	2
	1970	70.2	4	67.0	4	71.2	4	62.6	4	68.1	4	66.3	3	66.6	7	66.1	4	71.3	2
	1980	76.6	7	76.1	4	73.2	6	72.7	5	75.7	6	71.5	3	72.2	6	73.6	3	73.0	2
	1985	77.5	7	75.5	7	72.3	7	71.1	5	75.6	6	72.7	4	74.5	11	72.1	5	73.2	4

Table 2. Comparison of South African Published Life Tables with Model Life Tables: Implied Life Expectancies at Birth for Females for Various Population Groups at Various Years

Population Group	Year	LATIN AMERICAN		CHILEAN		SOUTH ASIAN		FAR EASTERN		GENERAL		WEST		NORTH		EAST		SOUTH	
		e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80	e(0)min	Ne(0)>80
White	**1921**	61.2	7	63.0	7	64.9	6	55.4	7	59.8	7	59.5	6	58.0	7	63.1	6	65.9	4
	1926	64.7	7	64.3	7	67.8	6	59.0	7	63.2	7	62.0	6	61.0	7	64.8	6	68.9	4
	1936	67.7	8	67.0	7	70.2	6	62.2	8	66.2	7	64.3	6	63.7	8	66.6	6	71.4	4
	1946	74.8	9	75.0	9	75.1	6	69.9	9	73.2	8	69.7	7	70.0	13	71.9	7	75.1	6
	1951	75.9	13	75.6	11	77.0	7	71.1	10	74.3	10	70.4	7	71.0	13	72.6	7	75.5	7
	1960	77.9	16	78.5	14	78.5	11	73.3	13	76.3	15	71.9	8	72.7	14	74.0	8	77.5	9
	1970	>80	17	80.0	16	78.3	13	76.2	14	78.9	16	73.8	9	75.1	14	75.7	10	78.7	13
	1980	>80	17	>80	17	78.6	14	79.4	14	>80	17	76.1	10	77.8	14	76.6	9	79.2	14
	1985	>80	17	>80	17	79.4	15	>80	17	>80	17	76.9	10	79.1	16	77.2	11	79.7	16
Coloureds	**1936**	36.1	4	45.5	4	43.5	4	31.1	5	35.4	4	42.3	4	38.9	4	47.6	3	42.0	3
	1946	44.6	4	48.8	4	51.1	4	38.9	5	43.6	4	47.9	4	44.9	4	52.0	3	50.2	3
	1951	46.6	5	48.0	5	52.7	4	40.8	5	45.5	5	49.2	4	46.3	4	51.3	4	52.0	3
	1960	47.4	6	52.0	6	53.4	5	41.5	7	46.3	6	49.7	5	46.9	6	54.5	4	52.8	3
	1970	49.8	6	55.9	6	55.5	5	43.9	6	48.7	5	51.4	5	48.7	6	56.0	4	55.2	3
	1980	65.7	7	65.5	6	68.6	5	60.1	7	64.2	6	62.8	5	61.9	9	65.6	4	69.8	3
	1985	70.4	9	69.4	7	72.5	5	65.1	7	68.9	7	66.4	5	66.1	10	67.9	5	73.7	3
Asians	**1946**	60.5	3	60.5	3	61.0	3	54.6	4	59.1	3	58.9	3	57.4	3	62.1	2	65.3	2
	1951	65.9	3	62.4	4	67.1	3	60.3	6	64.4	4	62.9	3	62.1	2	63.5	2	68.0	2
	1960	66.8	9	65.1	8	69.5	4	61.3	8	65.3	7	63.6	4	62.9	8	65.4	3	70.0	2
	1970	74.8	13	73.5	9	76.2	4	69.9	9	73.2	8	69.6	4	70.0	12	71.0	3	75.9	2
	1980	80.0	16	79.9	15	77.6	11	75.8	12	78.5	15	73.5	8	74.8	14	75.4	8	79.0	6
	1985	>80	17	79.7	16	78.3	13	78.6	13	>80	17	75.3	9	76.8	14	76.4	9	78.4	11

life expectancies at birth were greater than 80 years for all the years analysed. For whites, the earliest year analysed is 1921, for coloureds, 1939 and for Asians/Indians, 1946. For whites, values of $N_{e(0)>80}$ generally increase with time in almost all families of the model life tables. For coloureds, values of $N_{e(0)>80}$ are fairly constant over time while for Asians/Indians, values of the $N_{e(0)>80}$ generally start increasing from 1970 onwards. Table 2 shows that by 1985, in four out of nine families of model life tables, all the implied life expectancies at birth were greater than 80 years, when data for white females is used as input. With the same input data, the Table shows that in the rest of the families of model life tables, 10 or more of the implied life expectancies at birth were greater than 80 years. The same Table shows that for Asian/Indian females, in two out of nine families of model life tables, all the implied life expectancies at birth were greater than 80 years, using data for Asian/Indian females as input data. With the same input data, the Table shows that in the rest of the families, nine or more of the implied life expectancies at birth were greater than 80.

Table 3 shows the results of under-five mortality, *q(5)*, entropy values, *H*, Anson's *U* and life expectancy at birth, *e(0)* for South Africa while Table 4 shows the values of similar measures for Canada.

Figure 7 (Appendix) shows the trend in under-five mortality for South Africa. The Figure shows a pairing of the rates for males and females of each population group with males having higher values than females. The under-five mortality was highest for coloureds and least for whites. The differentials in under-five mortality between whites and coloureds remained fairly constant between 1936 and 1951. The differentials between the two population groups started narrowing after 1951 and accelerated between 1970 and 1980. The differential between whites and Asians/Indians was narrowing down since 1946. Between 1951 and 1970 the differential between the two population groups narrowed at a rapid pace and by 1985, there was close convergence between the under-five mortality of both population groups.

Figure 8 (Appendix) shows entropy values for South Africa. The expected decline of entropy with increase in life expectancy is manifested in the graphs. There is a pairing of the rates for males and females of each population group with males having higher values than females with the exception of Asians/Indians in 1946. Normally *H* changes very slowly with time. Sudden changes in *H* are not normal occurrences. In the South Africa, one observes sudden changes in *H* around 1946 for whites, around 1985 for coloureds and around 1970 for Asians/Indians. With the exceptions of these sudden changes, one observes smooth decline in *H* for white females and coloured males followed by white males and Asian/Indian males. One peculiarity to be noted in the Figure is the male-female crossover for Asians/Indians in 1951. Another peculiarity in the Figure is the Asian/Indian female-white male crossover in 1970.

Table 3.
Trends in Under-five Mortality (q(5)), Entropy, (H), Anson's U and Life Expectancy at Birth (e(0) by Gender for Canada, 1951-1981

Year	White Male				White Female			
	Q5	*H*	*U*	*e(0)*	*Q5*	*H*	*U*	*e(0)*
1921	0.124	0.322	0.860	55.60	0.110	0.281	0.928	59.20
1936	0.092	0.266	0.847	59.00	0.078	0.224	0.899	63.06
1946	0.053	0.197	0.838	63.78	0.044	0.159	0.892	68.31
1951	0.048	0.188	0.845	64.57	0.038	0.139	0.901	70.08
1970	0.030	0.174	0.832	64.73	0.023	0.112	0.900	71.67
1980	0.020	0.156	0.862	66.59	0.016	0.096	0.915	74.24
1985	0.015	0.138	0.884	68.37	0.010	0.083	0.924	75.84

Year	Coloured Male				Coloured Female			
	Q5	*H*	*U*	*e(0)*	*Q5*	*H*	*U*	*e(0)*
1921								
1936	0.278	0.604	0.867	40.18	0.262	0.599	0.991	40.86
1946	0.230	0.546	0.814	41.70	0.217	0.526	0.970	44.00
1951	0.220	0.497	0.816	44.82	0.203	0.469	0.952	47.77
1970	0.177	0.408	0.745	49.62	0.160	0.331	0.823	54.28
1980	0.094	0.308	0.756	54.34	0.083	0.230	0.831	62.55
1985	0.068	0.263	0.788	57.92	0.060	0.195	0.838	65.52

Year	Asian Male				Asian Female			
	Q5	*H*	*U*	*e(0)*	*Q5*	*H*	*U*	*e(0)*
1921								
1936								
1946	0.129	0.366	0.793	50.70	0.124	0.380	0.825	49.75
1951	0.111	0.299	0.768	55.77	0.099	0.301	0.823	54.75
1970	0.053	0.223	0.719	57.70	0.045	0.182	0.802	59.57
1980	0.032	0.193	0.742	62.26	0.025	0.136	0.849	68.39
1985	0.022	0.176	0.788	64.12	0.019	0.121	0.873	70.74

Table 4
Trends in Under-five Mortality(q(5)), Entropy, (H), Anson's U and Life Expectancy at Birth (e(0)) by Gender for Canada, 1951-1981

Year	Males				Females			
	Q5	H	U	e(0)	Q5	H	U	e(0)
1951	0.050	0.219	0.880	66.33	0.040	0.181	0.917	70.83
1956	0.040	0.199	0.891	67.61	0.032	0.161	0.922	72.92
1961	0.034	0.191	0.891	68.35	0.027	0.150	0.926	74.17
1966	0.029	0.187	0.894	68.75	0.023	0.144	0.929	75.18
1971	0.023	0.181	0.896	69.34	0.018	0.136	0.933	76.36
1976	0.017	0.173	0.902	70.19	0.015	0.123	0.941	77.48
1981	0.013	0.159	0.916	71.81	0.010	0.115	0.945	78.94

Figure 9 (Appendix) shows values for Anson's *U* for South Africa. White males and females show high but normal trend in Anson's *U*. However, there are several peculiarities in the trend in Anson's *U* for other population-gender groups. Firstly, the values of *U* among coloured females are very high, approaching unity as early as 1936. Secondly, there are very wide differences between values of Anson's *U* for coloured males and coloured females. Thirdly, there is a marked drop in values of Anson's *U* between 1951 and 1970 and as a result, the trend of the values for coloured females cuts across three other trends. Fourthly, there is convergence in values of Anson's *U* for coloured males and Asian/Indian males. Lastly, there is divergence in values of Anson's *U* between Asian/Indian males and Asian/Indian females.

Before discussing these results, one needs to examine sets of yardsticks against which to compare. For this purpose, similar sets of Figures have been constructed for national Canadian life tables (without breakdown into population groups). For the purpose of brevity, the Figures have not been shown here. The reader is referred to the study by Nagnur (1986) for an in-depth review of Canadian life tables. Suffice to say that Canadian life tables show smooth progression in the *l(x)* curves over time. The rectangularity increases in a smooth manner. The trend in under-five mortality and the trend in entropy values both show smooth decline with time. Lastly, the trend in Anson's *U* show a very gradual increase tending towards unity.

Discussion

Given the wide range of countries and eras that the model life tables cover, it is rare to find a life table that does not fit within one or more families of either the United Nations or the Coale and Demeny model life tables. In the case of South Africa, the results show that for all the population groups and for all the periods covered, several of the reported probabilities of dying (from one age to another) did not fit within any of the families of model life tables from either the United Nations or the Coale and Demeny set. This is an oddity to say the least.

Using the Figures from the Canadian life tables as references, ideally, one would expect that *l(x)* curves to be smooth and the levels of the curves to increase with time. One would also expect that the *l(x)* for a later census year should be higher than an earlier census year. One would not expect to see convergence or crossover for *l(x)* curve for the same population-gender group. Correspondingly, the *q(5)* values would show smooth decline over time and slow convergence between male and female values. One would also expect the entropy values to decline slowly with time and the Anson's *U* values to increase slowly with time.

Upon judging the Figures obtained from South African life tables, the closest set of Figures that approach the Canadian reference set are those for white males and females. The *l(x)* curves show relatively smooth progression (more for females than males). For the other sets of Figures for coloureds and

Asians/Indians, there is marked deviation from the Canadian reference set. The convergence of *l(x)* values at old ages for coloured males suggests a lack of improvement in mortality in older ages. Gains in survivorship among children, youths and adults are not reflected in similar gains among the elderly. Alternatively, this could mean that old age mortality was overestimated in the more recent life tables compared to the earlier ones or that old age mortality was under-estimated in the earlier life tables compared to the latter ones. For coloured females, the excess gain in survivorship among adults suggests serious under-estimation of adult mortality. The trends in under-five mortality look realistic. The under-five mortality is higher for males than females for all the population groups. The decline in *q(5)* is fairly uniform for whites and coloureds. For Asians/Indians, the decline is rather rapid. One is not sure to what extent this rapid decline is real. For the entropy values, the sudden changes noted as well as the trends for Asian/Indian females and coloured females show marked deviations from the Canadian reference set. Values in Anson's *U* exhibit a near stationary trend among whites (more so for females than males). For coloureds, the trend in Anson's *U* show a peculiar trend. For Asians/Indians, there is divergence in the trends of Anson's *U* values for males and females rather than pairing up.

During the period of relatively rapid mortality decline, it has often been found that the health gains are greatest during childhood. As such, in a comparison of differential mortality between subgroups, one would expect childhood mortality to close up faster than old age mortality. Expressed in other words, if there was going to be a genuine cross-over in mortality, it would most probably occur first in the childhood ages before occurring in the middle and old ages. A recent review of the literature pertaining to the mortality cross-over phenomenon was provided by Nam (1995). He generalised the findings from published studies on mortality crossovers under nine points. In one of the points he observed that while mortality crossover could arise out of age misreporting in older ages, it could still arise in the absence of age misreporting. He observed further that mortality convergence and crossover was dynamic, that convergence and crossover would occur when two populations had dissimilar socio-economic characteristics. When, however, those two populations became more alike, convergence and crossover would decline and eventually disappear. In the case of South Africa, the measures derived from the life tables show absence of cross-over in the childhood ages but show evidence of the phenomenom in the middle and old ages. This goes against expectations. In addition, with the political policies of the past, it is hard to accept that the socio-economic characteristics of the different South African population groups were becoming more alike prior to the 1990s. This makes it highly questionable to accept the validity of the crossovers in the South African context.

From the above discussion, it is evident that South African life tables are faced with several problems. The fact that Anson's *U* have been close to unity even way back in the 1920's suggest that mortality in the youth and adult ages have been grossly under-estimated in the past. The sharp drop in both *U* and entropy values between 1950 and 1970 for coloureds suggest a forced correction in the trends life table values. In an unpublished report on the history of vital

statistics in South Africa, Bah and Kleinschmidt (1997) identified five phases in the development of vital statistics in South Africa, namely: pre-1910, 1910-1962, 1963-1975, 1976-1990 and post-1991 phases. Of interest in this paper are the second, third and fourth phases, from 1910 to 1990. In that paper, it was reported that uniformity in birth and death registration throughout the Union of South Africa was only achieved during the second phase, after the Act 17 of 1923. As such, the life table of 1921 could not have been representative of the whole union of South Africa. In the USA as well, vital registration data did not cover the entire United States until the Death Registration Area (DRA) was complete in 1933 (Haines and Preston, 1997). As such, mortality could have been grossly under-estimated then, as shown by the high *U* values, close to unity. During the third phase, a new act was passed concerning births and deaths registration, namely Act 81 of 1963. This Act required that a death in an urban area should be registered within 48 hours while a death in rural areas should be registered within 14 days. This in itself is an implicit admission of the urban-rural differential in completeness in death registration.

Conclusion

Even though the life table published in the 1920s and 1930s were meticulous and excellent pieces of work, they might have under-estimated mortality by assuming completeness in vital registration. In those decades, techniques had not yet been developed to take account of incompleteness in death registration. In the decades that followed, authors of life tables used the earlier published life tables as benchmarks and hence the under-estimation of mortality was handed down over the decades that followed. The life tables among whites showed the most plausible pattern in spite of their under-estimation of mortality. The life tables among coloureds showed the most irregular pattern.

Unless the historical set of life tables is reworked, they should not be used as benchmarks for judging contemporary life tables. Similarly, South African population projections based on life tables that under-estimate mortality would have an upward bias. Such projections should not be used to judge the completeness of the last 1996 population census of South Africa.

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Disclaimer:

The view expressed in this paper are mine and do not necessarily reflect the views of the Statistics South Africa.

Footnotes:

1. The terms 'white', 'coloured' and 'Asian/Indian' are aparthied classifiers. As the paper takes a historical perspective and the life tables were published under these population groupings, the terms have been retained.

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Appendices:

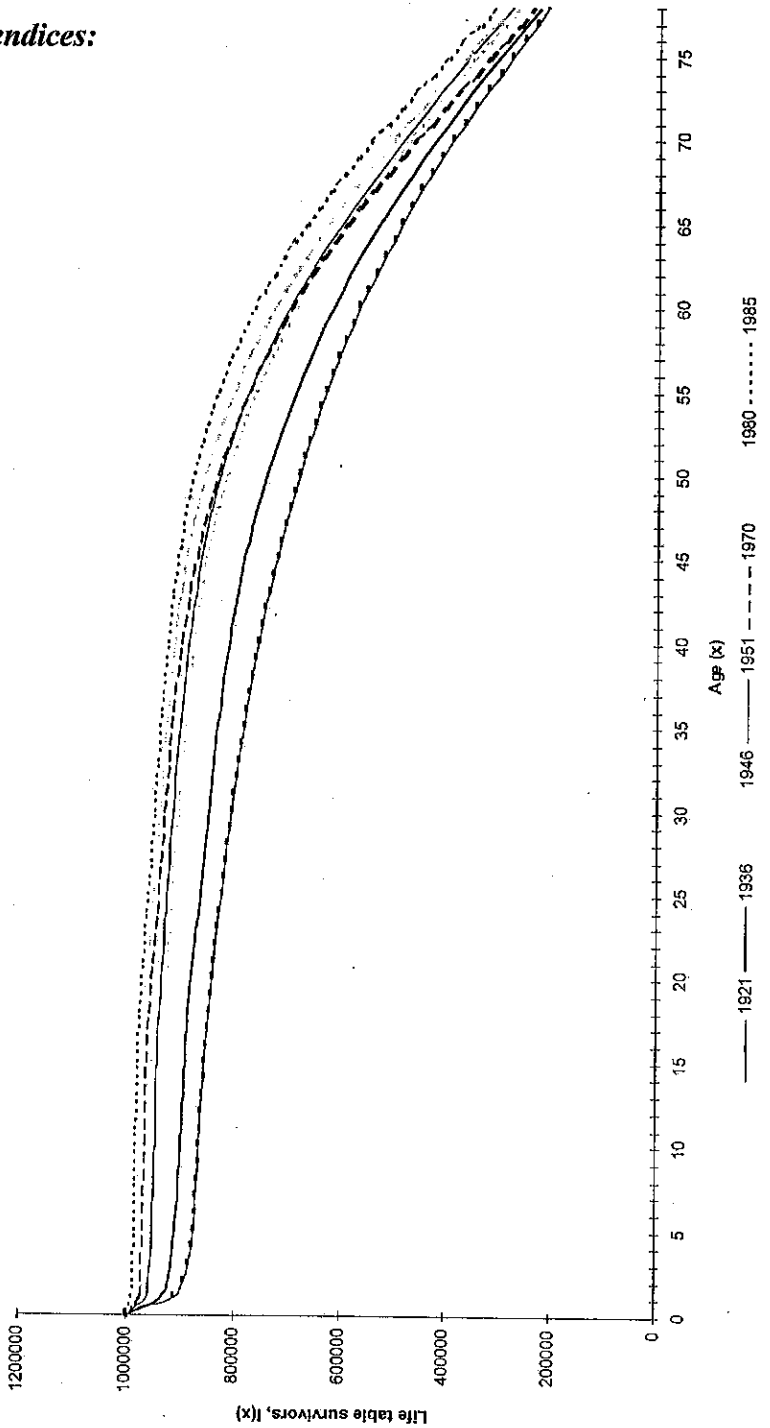


Fig 1: Life table l(x) values for white males, RSA, 1921-1985

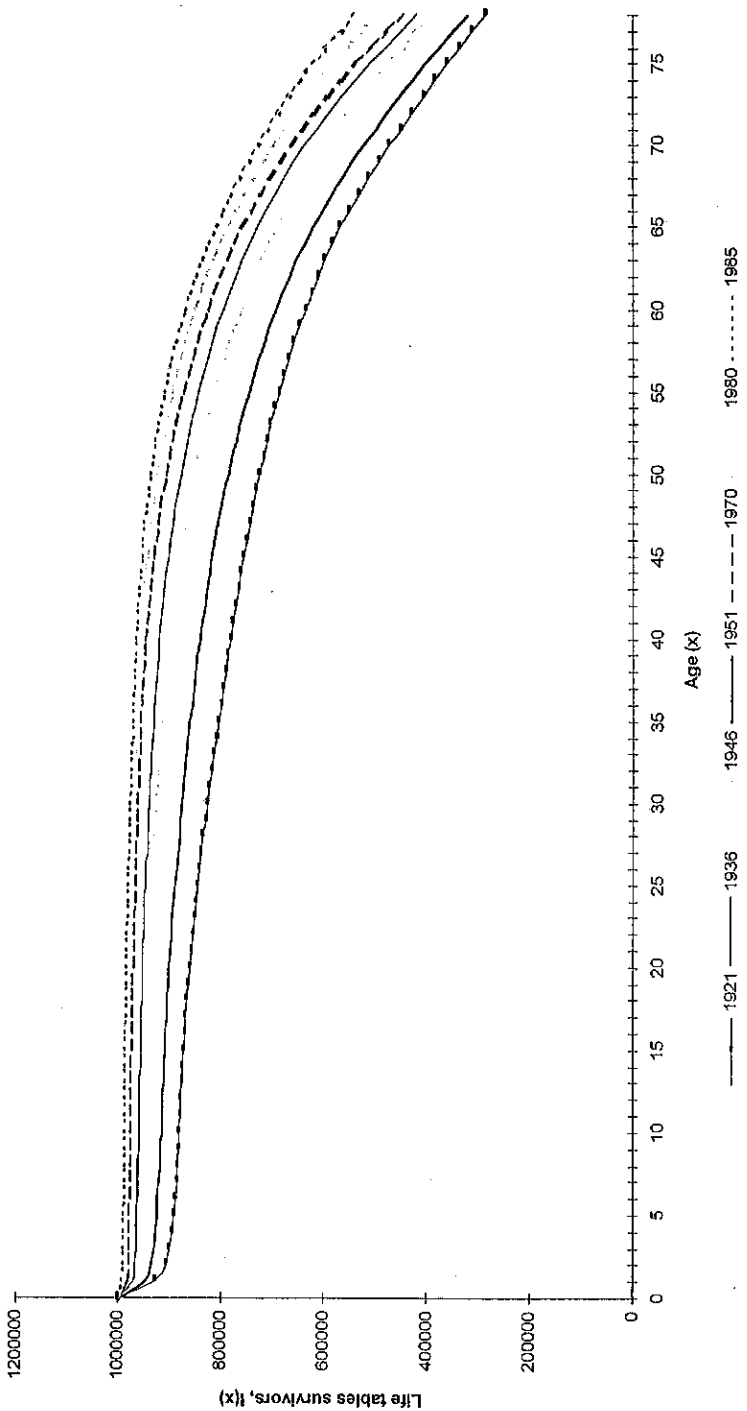


Fig 2: Life tables l(x) values for white females, RSA, 1921-1985

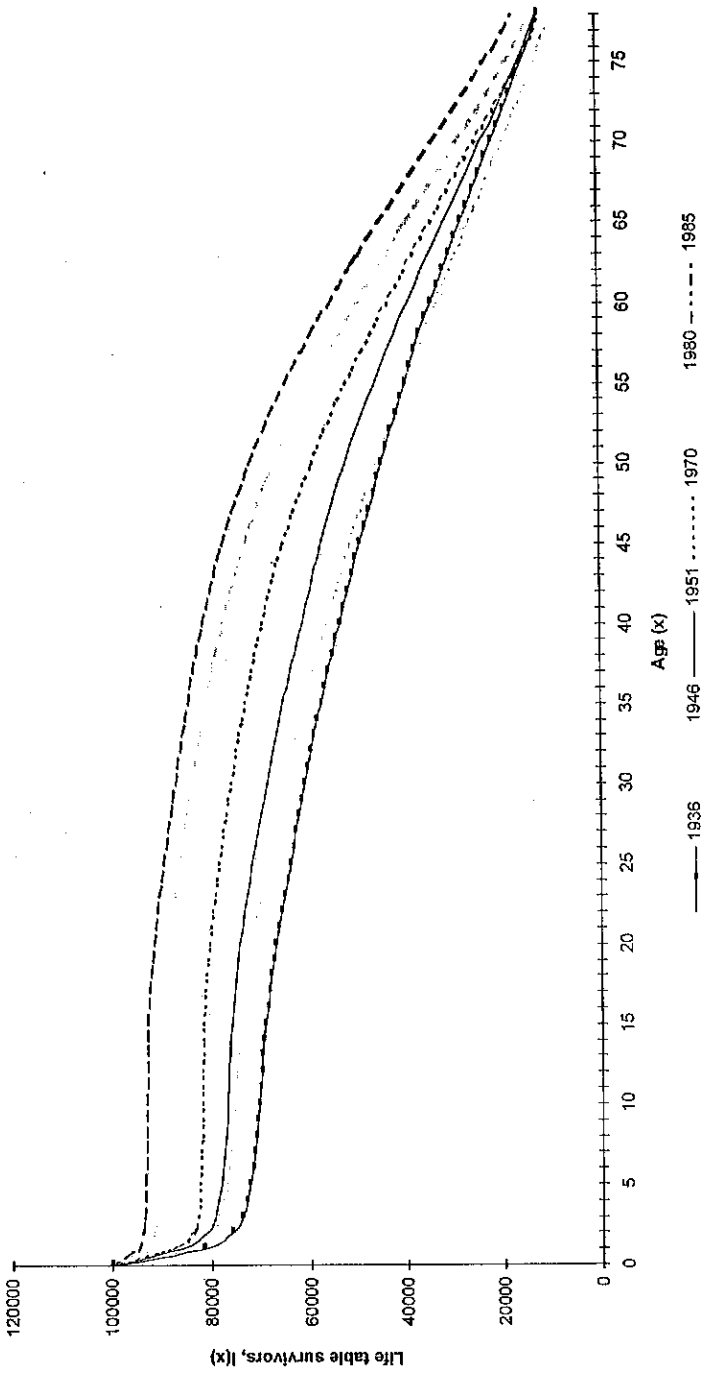


Fig 3: Life table l(x) values for coloured males, RSA, 1936-1985

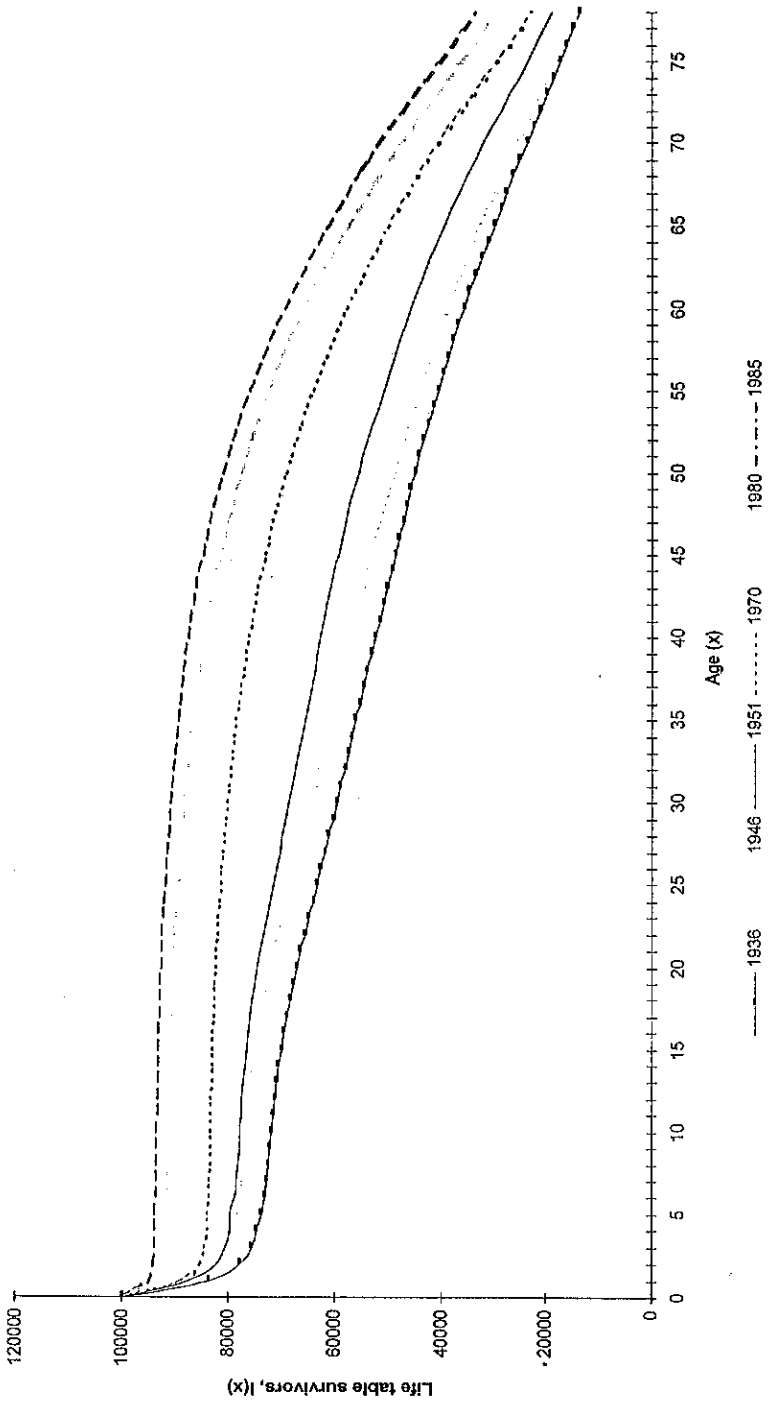


Fig 4: Life table l(x) values for coloured females, RSA, 1936-1985

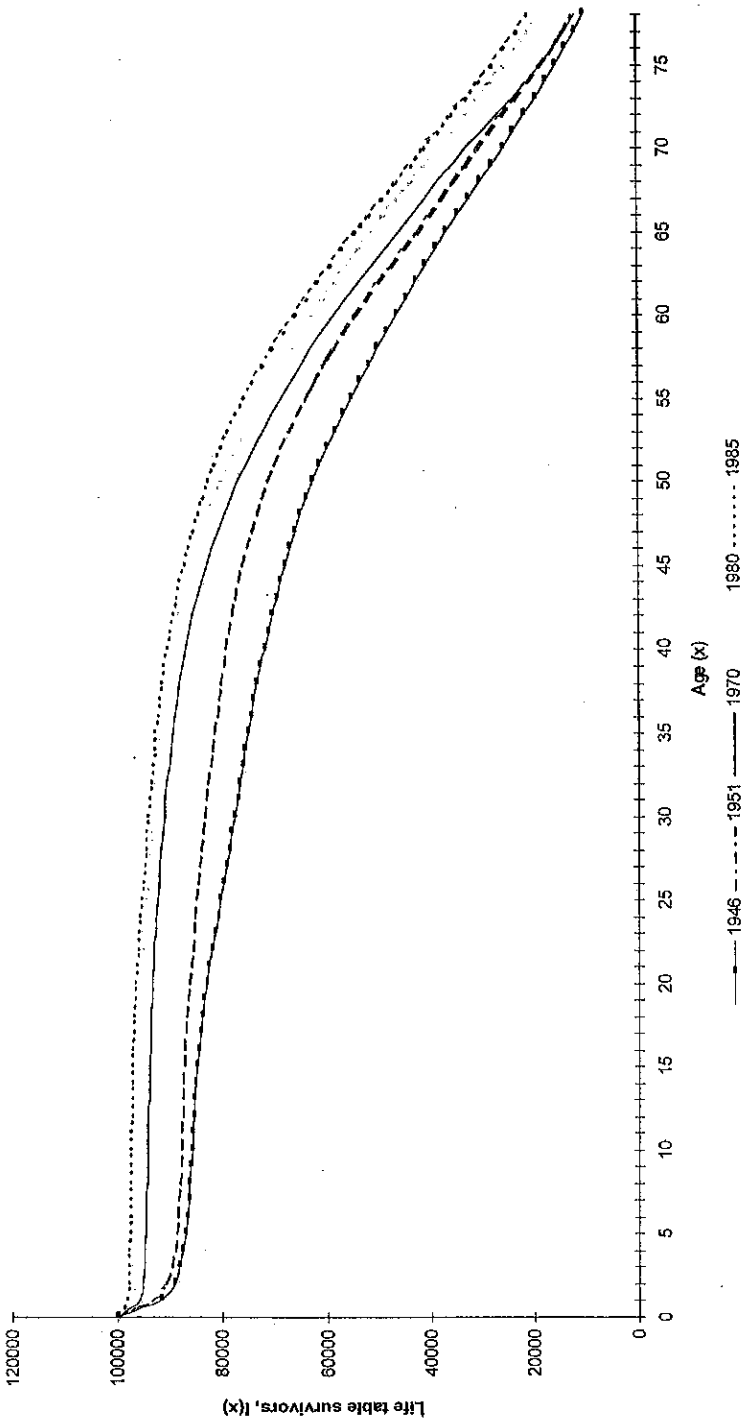


Fig 5: Life tables l(x) values for Asian males, RSA, 1946-1985

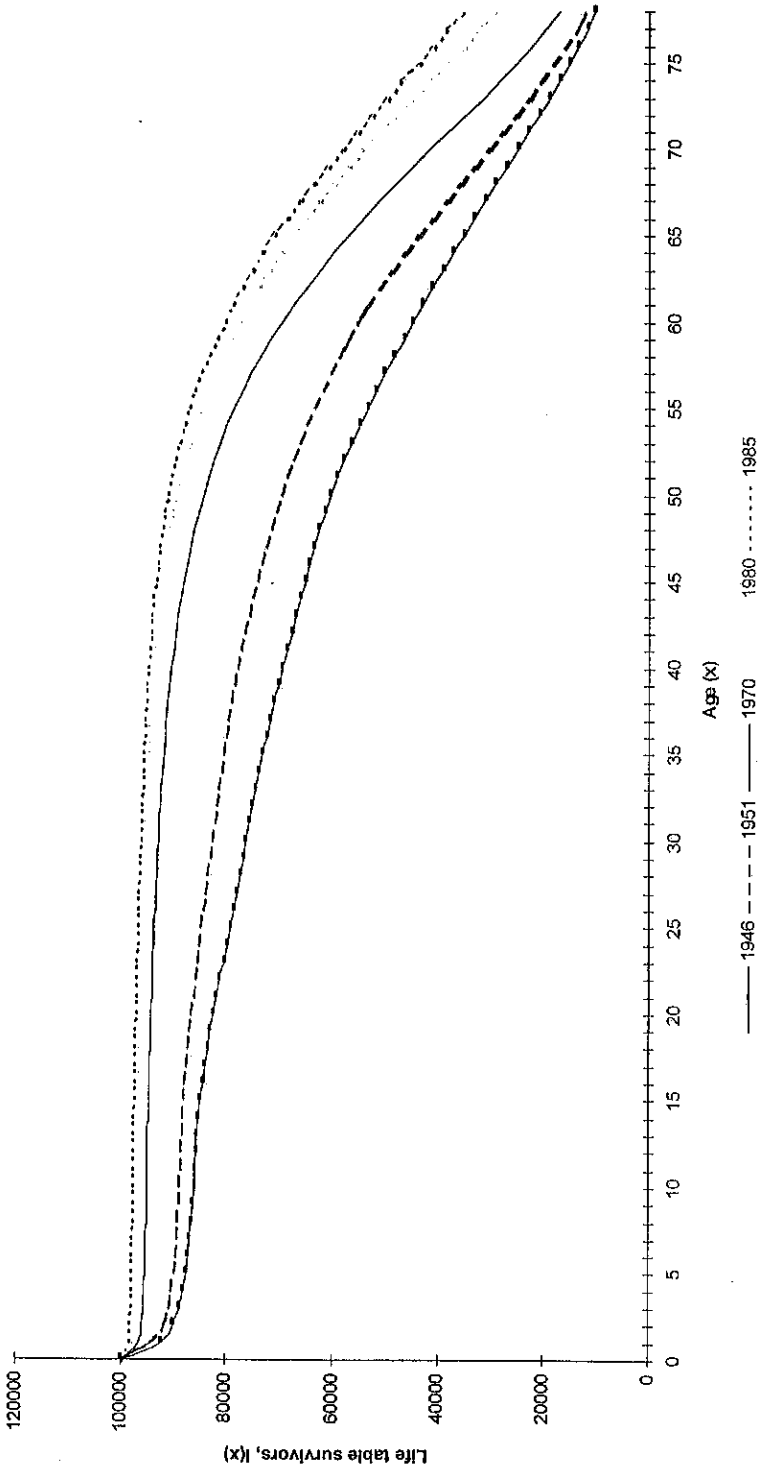


Fig 6: Life tables l(x) values for Asian females, RSA, 1946-1985

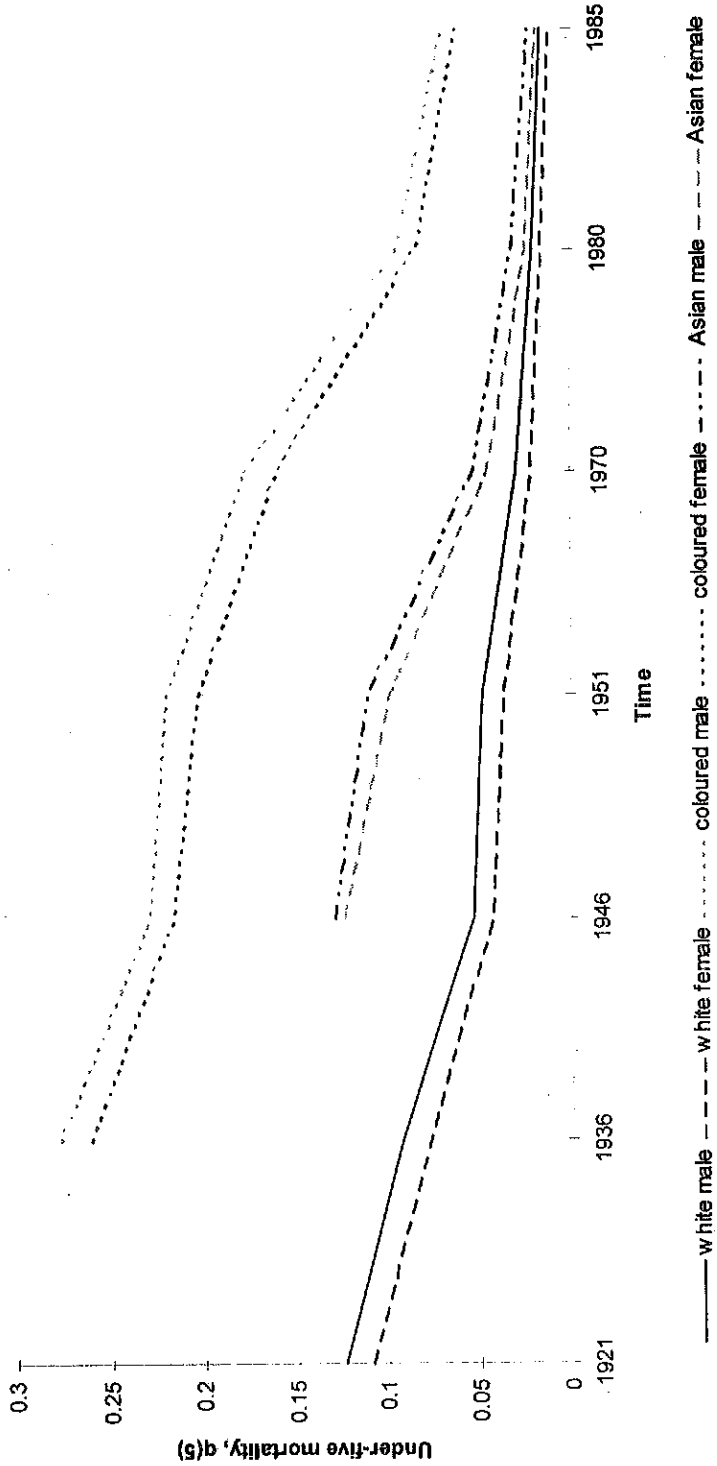
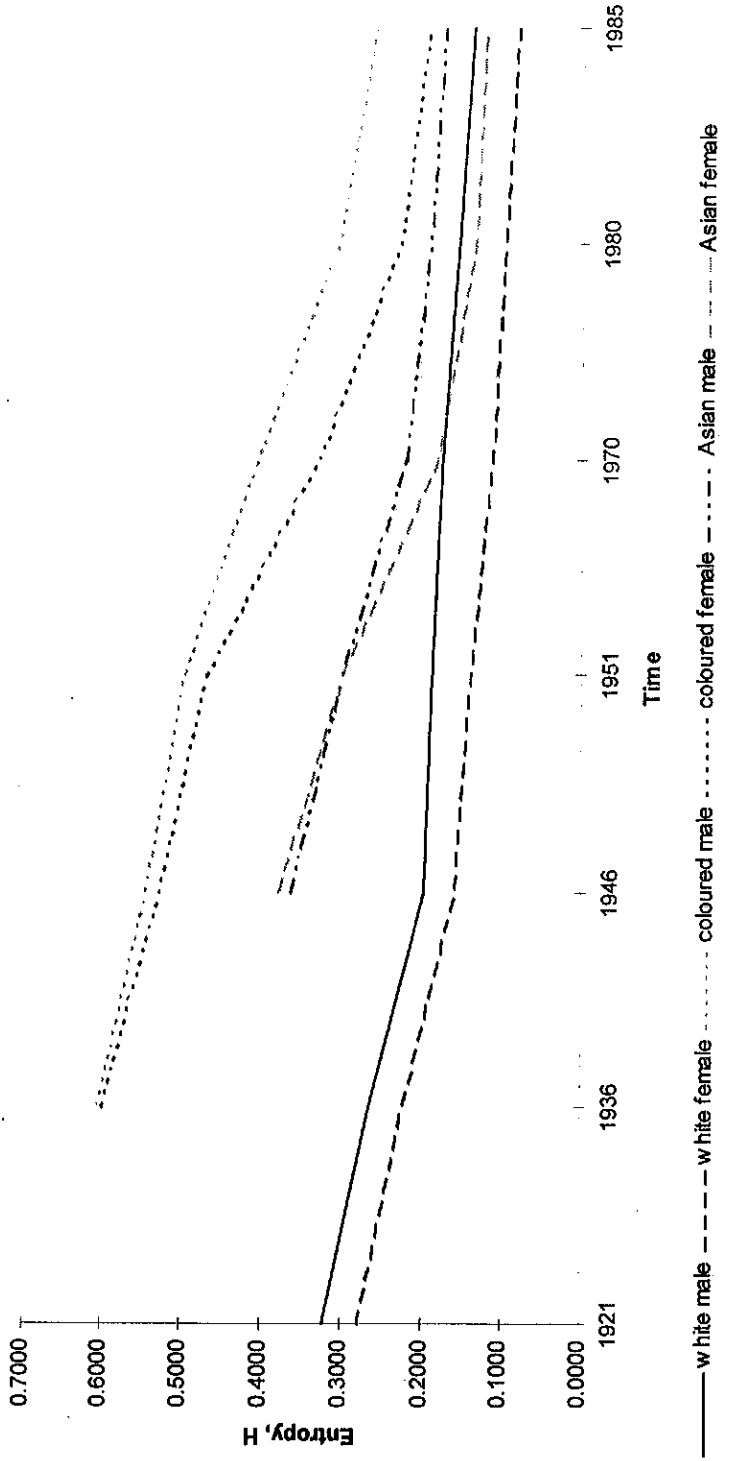


Fig 7: Trends in under-five mortality, q(5), RSA, 1921-1985

Fig 8: Trends in entropy values, RSA, 1921-1985



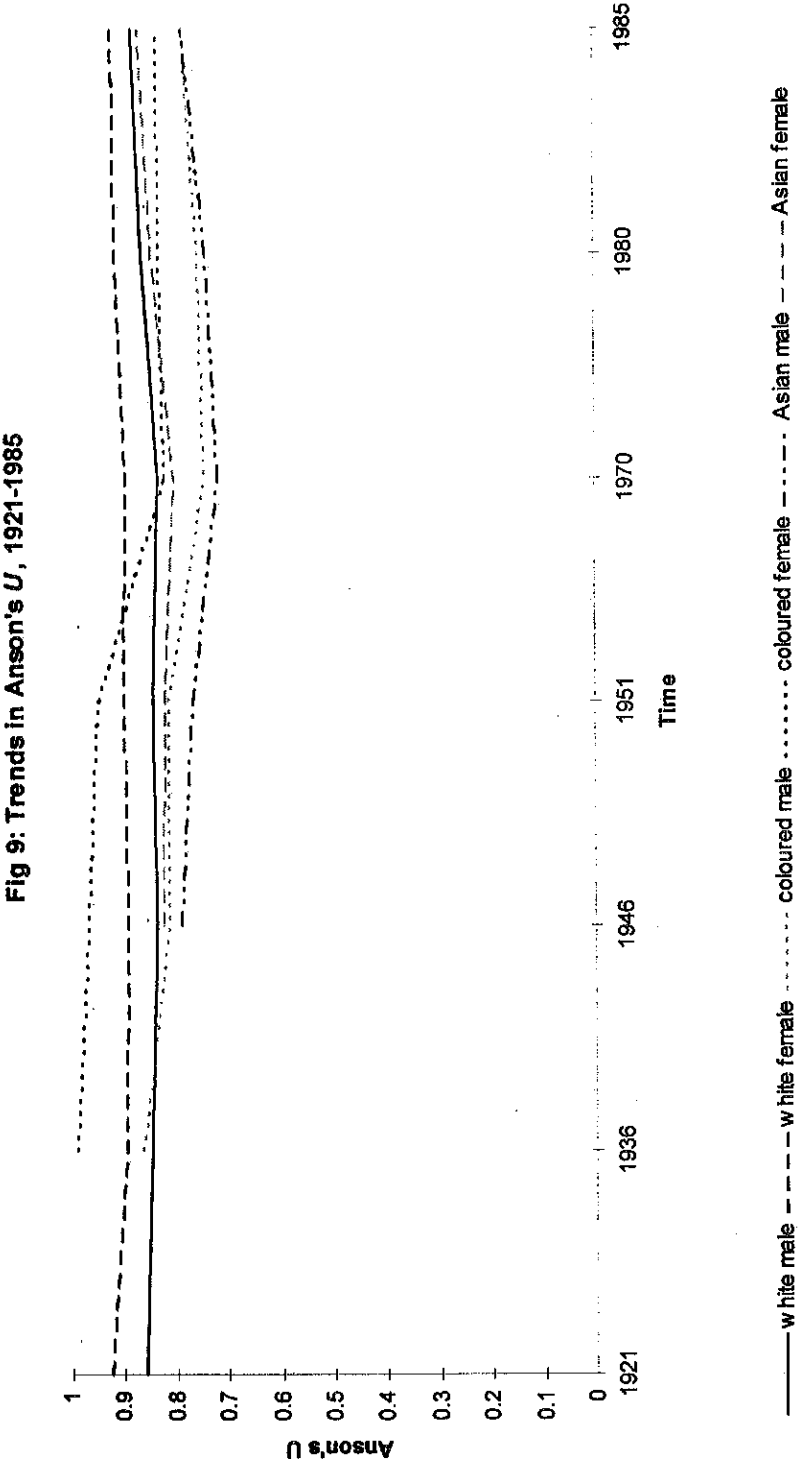


Fig 9: Trends in Anson's U, 1921-1985
Anson's U
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1921
1936
1946
1951
1970
1980
1985
Time
white male
white female
coloured male
coloured female
Asian male
Asian female