SPECIAL ARTICLE

EXPECTATION OF LIFE IN SINGAPORE 1956 — 1971

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INTRODUCTION

One of the most sophisticated techniques of measuring the mortality level of a population is by means of the period life table which shows, among other things, the expectation of life at different ages(1). A period life table is constructed on the assumption that the population is a closed one not affected by migration and that the death rates for a chosen period of usually three years will prevail indefinitely. We normally commence with a radix of 10,000 at birth and trace this cohort over the age range as it is depleted by deaths in accordance with the selected schedule of mortality rates. The life table may take the form of a complete table with values for single years of age or an abridged table with figures for five-year age groups. In this paper we will discuss the methodology used in constructing abridged life tables for the period 1969-1971 as well as analyse the trends and differentials in the expectation of life in Singapore during the years 1956 to 1971.

A set of eight abridged life tables for the male and female segments of the three races and all races combined for the period 1956-1958 centered around the census year 1957 have been prepared already by the writer in an earlier publication(2). The degree of detail given in these abridged life tables is for single years of age from age 0 to 4 and for quinary age groups from 5-9 to 85 and over. The 1970 Census Report has included a set of abridged life tables for the period 1969-1971 but these tables are not quite suitable for our purpose(3). Apart from the slightly different and less effective method of calculating these tables, the age grouping adopted is somewhat abbreviated with single years for age 0 only, four-year age group for ages 1 to 4, and quinary age groups for age 5 upwards but terminating as early as 75 and over. Life tables based on such broad age classification produce less accurate results because they do not take into consideration the sensitive mortality at single years of age below age 5 and the extremely heavy mortality at quinary age groups from 75-79 to 85 and over. To obtain more accurate results which are also more comparable with those of the 1956-1958 tables already prepared, we will construct a similar set of eight abridged life tables for the period 1969-1971 built around the census year 1970(4).

Table 1

Age-Specific Death Rates ($_n m_x$) by Race and Sex, 1969-71

Age Group	Males				Females			
	All Races	Chinese	Malays	Indians	All Races	Chinese	Malays	Indians
1	2.37	2.05	3.21	3.10	2.22	1.78	3.87	2.08
2	1.51	1.13	3.34	0.84	1.18	1.00	1.87	1.10
3	0.99	0.92	1.35	0.98	0.94	0.88	1.66	1.37
4	0.73	0.64	1.06	0.71	0.76	0.60	1.22	1.09
5 - 9	0.47	0.42	0.57	0.57	0.50	0.44	0.76	0.45
10 - 14	0.53	0.53	0.63	0.64	0.31	0.29	0.37	0.44
15 - 19	1.12	1.13	1.01	1.06	0.52	0.52	0.59	0.33
20 - 24	1.40	1.39	1.25	1.52	0.66	0.64	0.91	0.53
25 - 29	1.55	1.58	1.17	1.62	0.95	0.88	1.14	1.66
30 - 34	1.41	1.39	1.06	1.98	1.19	1.09	1.51	1.54
35 - 39	2.72	2.70	2.55	3.08	1.71	1.58	2.36	2.07
40 - 44	4.35	4.11	3.51	5.86	2.81	2.52	4.26	3.25
45 - 49	7.23	6.83	6.37	8.81	4.18	3.58	7.14	5.89
50 - 54	13.01	12.74	11.91	15.66	6.68	6.14	10.01	10.52
55 - 59	19.90	19.76	19.04	20.20	10.99	10.05	18.35	17.96
60 - 64	34.50	34.22	32.65	37.78	18.14	16.09	33.74	32.54
65 - 69	53.63	53.96	51.52	52.15	27.90	25.95	50.81	46.24
70 - 74	83.16	81.97	99.91	71.99	46.07	42.98	78.80	87.82
75 - 79	111.11	110.88	112.92	93.63	69.24	67.22	99.55	92.59
80 - 84	157.81	160.48	139.58	164.02	128.27	116.49	142.38	115.38
85 & Over	204.80	204.13	195.12	233.33	176.66	178.54	163.17	176.47

CONSTRUCTION OF 1969 — 1971 LIFE TABLES

The statistical data employed to construct the period abridged life tables are the deaths for the years 1969 to 1971 obtained from the vital registration system (5) and the population enumerated in the June 1970 Census (6). The statistics for deaths classified by age contained some deaths where ages have not been stated, and instead of ignoring these unspecified figures it was decided to pro-rate them to the various age groups from 0 to 85 and over so as to obtain a truer picture of overally mortality level (7). Similar adjustment for the census population figures tabulated by age was not necessary since they do not contain persons with unspecified ages.

The adjusted death statistics for 1969-1971 and the population figures for June 1970 were used to compute the age-specific or central death rates for single years 1 to 4 and for quinary age groups from 5-9 to 85 and over. These central death rates shown in Table 1 are known as the $_nm_x$ values and constitue the starting point for deriving the first function of the life table known as the life-table death rates, $_nq_x$. The central death rate for age 0 is not calculated because the $_nq_x$ value for this age has been derived separately from infant deaths and births.

The 1,000 $_nq_x$ column of the life table refers to the probability of dying per 1,000 alive at the beginning of the age interval. Except for age below one year, these life table death rates are derived from the central death rates by means of the formula $_nq_x = \frac{2n.nm_x}{2 + n.nm_x}$ The heavy mortality in the first year of life necessitates the calculation of q_o directly from infant death and birth records in four separate computations according to the following formulae, where for instance β^{68}, β^{68}_4 and β^{68}_D denote births in the year 1968, births in the fourth quarter of 1968, and births in December of 1968 respectively.

Table 1

Age-Specific Death Rates ($_nm_x$) by Race and Sex, 1969-71

$$q_o^{(0\text{-}1\ mth.)} = \frac{\text{Deaths in 1969-1971 aged 0-1 mth.}}{\frac{1}{2}\beta_D^{68}+\beta^{69}+\beta^{70}+\beta^{71}-\frac{1}{2}\beta_D^{71}}$$

$$q_o^{(1\text{-}3\ mth.)} = \frac{\text{Deaths in 1969-1971 aged 1-3 mth.}}{\frac{1}{2}(\beta_o^{68}+\beta_N^{68})+\beta_D^{68}+\beta^{69}+\beta^{70}+\beta^{71}-\frac{1}{2}(\beta_o^{71}+\beta_N^{71})-\beta_D^{71}}$$

$$q_o^{(3\text{-}6\ mth.)} = \frac{\text{Deaths in 1969-1971 aged 3-6 mth.}}{\frac{1}{2}\beta_3^{68}+\beta_4^{68}+\beta^{69}+\beta^{70}+\beta^{71}-\frac{1}{2}\beta_3^{71}-\beta_4^{71}}$$

$$q_o^{(6\text{-}12\ mth.)} = \frac{\text{Deaths in 1969-1971 aged 6-12 mth.}}{\frac{1}{2}(\beta_1^{68}+\beta_2^{68})+\beta_3^{68}+\beta_4^{68}+\beta^{69}+\beta^{70}+\beta^{71}-\frac{1}{2}(\beta_1^{71}+\beta_2^{71})-\beta_3^{71}-\beta_4^{71}}$$

The sum of the above four probabilities of death will give the required mortality rate for q_o for age under one year.

The $_nl_x$ column refers to the number of survivors at the beginning of age interval, and is obtained by a direct mathematical procedure on the bases of the life-table death rates according to the formula $_nl_x = {}_nl_{x-n} - ({}_nl_{x-n} \times {}_nq_{x-n})$.

The $_nd_x$ column refers to the number of deaths occurring within an age interval and can be easily obtained by a subtraction of successive values of $_nl_x$. Thus, $_nd_x = {}_nl_x - {}_nl_{x-n}$.

The $_nL_x$ column represents the number of years that will be lived collectively within any one age interval by a cohort numbering 10,000 at birth and subject to the given mortality conditions. Owing to the very uneven distribution of deaths in the first year of life, it is necessary to derive L_o in four separate stages by summing the results of the following four calculations.

$$L_{(0\text{-}1\ mth.)} = \tfrac{1}{2}({}_0l_{0\ mth.} + {}_1l_{1\ mth.}) \times 1/12$$
$$L_{(1\text{-}3\ mth.)} = \tfrac{1}{2}({}_1l_{1\ mth.} + {}_3l_{3\ mth.}) \times 2/12$$
$$L_{(3\text{-}6\ mth.)} = \tfrac{1}{2}({}_3l_{3\ mth.} + {}_6l_{6\ mth.}) \times 3/12$$
$$L_{(6\text{-}12\ mth.)} = \tfrac{1}{2}({}_6l_{6\ mth.} + {}_{12}l_{12\ mth.}) \times 6/12$$

It is known that the distribution of deaths in the second year of life is still uneven, and it has been ascertained that by equating L_1 to $0.45l_1 + 0.55l_2$ fairly satisfactory results can be attained (8). For ages two to four, L_x is taken as the average of l_x and l_{x+1}, and for quinary age groups $_5L_x$ is equated to $\frac{5(l_x + l_{x+5})}{2}$.

The T_x column indicates the number of years that will be lived collectively, from the given age upwards, by the survivors to that age from the original cohort of 10,000 births. The values of T_x may be obtained by cumulative additions of the $_nL_x$ column from the bottom upwards, with first of all T_{85} (or L_{85}) taken as $\frac{l_{85}}{m_{85}}$

The last column $\mathring{e}_x$ represents the individual expectation of life at the beginning of the age interval, and is derived by dividing T_x by the corresponding l_x. Thus $\mathring{e}_x = T_x$.

CHANGES IN LIFE EXPECTANCY

By means of the technique outlined above, the eight abridged life tables for the period 1969-1971 for each sex separately for the three principal races and for all races combined are computed and shown in full in Tables 2 to 9 (10). From the viewpoint of methodology and age grouping, these life tables are now comparable with our earlier set of eight life tables already prepared for the first period 1956-1958. With these two sets of similar life tables in hand, we can proceed to study the changes in the expectation of life that have taken place in Singapore during the years 1956 to 1971. Before doing this, let us look at the general characteristics of the expectation of life.

By and large, we will discuss the $\mathring{e}_x$ values in the last column of the life tables which refer to the average number of years of life remaining to persons at the beginning of the age interval on the assumption that they will experience, during their life time, the mortality rates exhibited in the life table. Taking the 1969-1971 tables for the Chinese males as an illustration, it may be observed that according to this three-year mortality experience a Chinese man can expect to live 66.3 years at birth, 48.5 years at age 20, 29.9 years at age 40, 14.0 years at age 60, and 4.9 years at age 85. A close inspection of the $\mathring{e}_x$ values in the various life tables will in fact reveal the existence of a distinct pattern of variation with age irrespective of the overall level of mortality in the population. The expectation of life is seen to commence at birth at a high point and quickly reaches the peak at about age 1 or 2, after which it falls consistently with the advance of an old age until it touches the lowest level at age 85. The slightly lower life expectancy experienced by a newborn child than by a child at about 1 or 2 years of age may be attributed to the transition from extremely heavy mortality during the first year of life to much lower mortality in early childhood(11).

The trends in the expectation of life of the male and the female populations in Singapore are analysed in Table 10 showing the $\mathring{e}_x$ values for the two three-year periods. It may be observed that the expectation of life at birth or the mean length of life for the Singapore men increased from 60.5 years in 1956-1958 to 68.9 years in 1969-1971, a gain of some 5.4 years or 8.9 per cent during this sixteen-year period. The same period witnessed the Singapore women recording an improvement of 5.6 years or 8.4 per cent in their mean length of life which went up to 72.2 years from the original 66.6 years. If we equate the mean length of life for both sexes combined to the average of the two computed figures for the two sexes, the total population in Singapore would have extended their mean length of life from 63.6 years to 69.1 years, up by 5.5 years or 8.6 per cent.

The changes in the expectation of life at the other ages for the male and the female populations may also be observed in Table 10. There is no doubt that both the men and the women have enjoyed increasing life expectancy at all ages during the sixteen years 1956-1971. In absolute terms, the gain in the life expectancy for the Singapore men diminshed progressively from the maximum of 5.4 years at birth to the low of 1:1 years at 80. A smiliar pattern

Table 2

Abridged Life Table for All Races Males, 1979-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	22.68	10,000	227	9,806	659,114	65.9
1	2.37	9,773	23	9,760	649,308	66.4
2	1.51	9,750	15	9,743	639,548	65.6
3	0.99	9,735	10	9,730	629,805	64.7
4	0.73	9,725	7	9,722	620,075	63.8
5 - 9	2.35	9,718	23	48,533	610,353	62.8
10 - 14	2.65	9,695	26	48,410	561,820	57.9
15 - 19	5.58	9,669	54	48,210	513,410	53.1
20 - 24	6.98	9,615	67	47,908	465,200	48.4
25 - 29	7.72	9,548	74	47,555	417,292	43.7
30 - 34	7.03	9,474	67	47,203	369,737	39.0
35 - 39	13.51	9,407	127	46,718	322,534	34.3
40 - 44	21.52	9,280	200	45,900	275,816	29.7
45 - 49	35.51	9,080	322	44,595	229,916	25.3
50 - 54	63.00	8,758	552	42,410	185,321	21.2
55 - 59	94.78	8,206	778	39,085	142,911	17.4
60 - 64	158.80	7,428	1,180	34,190	103,826	14.0
65 - 69	236.45	6,248	1,477	27,548	69,636	11.1
70 - 74	344.23	4,771	1,642	19,750	42,088	8.8
75 - 79	434.78	3,129	1,360	12,245	22,338	7.1
80 - 84	565.82	1,769	1,001	6,343	10,093	5.7
85 & Over	1,000.00	768	768	3,750	3,750	4.9

Table 3

Abridged Life Table for All Races Female, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number alive during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	18.13	10,000	181	9,852	722,266	72.2
1	2.22	9,819	22	9,807	712,414	72.6
2	1.18	9,797	12	9,791	702,607	71.7
3	0.94	9,785	9	9,781	692,816	70.8
4	0.76	9,776	7	9,773	683,035	69.9
5 - 9	2.50	9,769	24	48,785	673,262	68.9
10 - 14	1.55	9,745	15	48,688	624,477	64.1
15 - 19	2.60	9,730	25	48,588	575,789	59.2
20 - 24	3.29	9,705	32	48,445	527,201	54.3
25 - 29	4.74	9,673	46	48,250	478,756	49.5
30 - 34	5.93	9,627	57	47,993	430,506	44.7
35 - 39	8.51	9,570	81	47,648	382,513	40.0
40 - 44	13.95	9,489	132	47,115	334,865	35.3
45 - 49	20.68	9,357	194	46,300	287,750	30.8
50 - 54	32.85	9,163	301	45,063	241,450	26.4
55 - 59	53.48	8,862	474	43,125	196,387	22.2
60 - 64	86.77	8,388	728	40,120	153,262	18.3
65 - 69	130.40	7,660	999	35,803	113,142	14.8
70 - 74	206.56	6,661	1,376	29,865	77,339	11.6
75 - 79	295.12	5,285	1,560	22,525	47,474	9.0
80 - 84	485.62	3,725	1,809	14,103	24,949	6.7
85 & Over	1,000.00	1,916	1,916	10,846	10,846	5.7

Table 4

Abridged Life Table for Chinese Males, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number alive during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	20.57	10,000	206	9,821	662,640	66.3
1	2.05	9,794	20	9,783	652,819	66.7
2	1.13	9,774	11	9,769	643,036	65.8
3	0.92	9,763	9	9,759	633,267	64.9
4	0.64	9,754	6	9,751	623,508	63.9
5 - 9	2.10	9,748	20	48,690	613,757	63.0
10 - 14	2.50	9,728	24	48,580	565,067	58.1
15 - 19	5.63	9,704	55	48,383	516,487	53.2
20 - 24	6.93	9,649	67	48,078	468,104	48.5
25 - 29	7.87	9,582	75	47,723	420,026	43.8
30 - 34	6.93	9,507	66	47,370	372,303	39.2
35 - 39	13.41	9,441	127	46,888	324,933	34.4
40 - 44	20.34	9,314	189	46,098	278,045	29.9
45 - 49	33.58	9,125	306	44,860	231.947	25.4
50 - 54	61.73	8,819	544	42,735	187,087	21.2
55 - 59	94.15	8,275	779	39,428	144,352	17.4
60 - 64	157.62	7,496	1,182	34,525	104,924	14.0
65 - 69	237.73	6,314	1,501	27,818	70,399	11.1
70 - 74	340.15	4,813	1,637	19,973	42,581	8.8
75 - 79	434.07	3,176	1,379	12,433	22,608	7.1
80 - 84	572.65	1,797	1,029	6,413	10,175	5.7
85 & Over	1,000.00	768	768	3,762	3,762	4.9

Table 5

Abridged Life Table for Chinese Females, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number alive during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	16.55	10,000	166	9,862	732,068	73.2
1	1.78	9,834	18	9,824	722,206	73.4
2	1.00	9,816	10	9,811	712,382	72.6
3	0.88	9,806	9	9,802	702,571	71.6
4	0.60	9,797	6	9,794	692,769	70.7
5 - 9	2.20	9,791	22	48,900	682,975	69.8
10 - 14	1.45	9,769	14	48,810	634,075	64.9
15 - 19	2.60	9,755	25	48,713	585,265	60.0
20 - 24	3.19	9,730	31	48,573	536,552	55.1
25 - 29	4.39	9,699	43	48,388	487,979	50.3
30 - 34	5.44	9,656	53	48,148	439,591	45.5
35 - 39	7.87	9,603	76	47,825	391,433	40.8
40 - 44	12.52	9,527	119	47,388	343,618	36.1
45 - 49	17.74	9,408	167	46,623	296,280	31.5
50 - 54	30.24	9,241	279	45,508	249,657	27.0
55 - 59	49.02	8,962	439	43,713	207,149	23.1
60 - 64	77.34	8,523	659	40,968	160,436	18.8
65 - 69	121.85	7,864	958	36,925	119,468	15.2
70 - 74	194.05	6,906	1,340	31,180	82,543	12.0
75 - 79	287.74	5,566	1,602	23,825	51,363	9.2
80 - 84	451.08	3,964	1,788	15,350	27,538	6.9
85 & Over	1,000.00	2,176	2,176	12,188	12,188	5.6

Table 6

Abridged Life Table for Malay Males, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number alive during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000_nq_x$	ℓ_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
0	33.22	10,000	332	9,733	654,492	65.4
1	3.20	9,668	31	9,651	644,759	66.7
2	3.33	9,637	32	9,621	635,108	65.9
3	1.35	9,605	13	9,599	625,487	65.1
4	1.06	9,592	10	9,587	615,888	64.2
5 - 9	2.85	9,582	27	47,843	606,301	63.3
10 - 14	3.15	9,555	30	47,700	558,458	58.4
15 - 19	5.04	9,525	48	47,505	510,758	53.6
20 - 24	6.23	9,477	59	47,238	463,253	48.9
25 - 29	5.83	9,418	55	46,953	416,015	44.2
30 - 34	5.29	9,363	50	46,690	369.062	39.4
35 - 39	12.67	9,313	118	46,270	322,372	34.6
40 - 44	17.40	9,195	160	45,575	276,102	30.0
45 - 49	31.35	9,035	283	44,468	230,527	25.5
50 - 54	57.83	8,752	506	42,495	186,059	21.3
55 - 59	90.87	8,246	749	39,358	143,564	17.4
60 - 64	150.93	7,497	1,132	34,655	104,206	13.9
65 - 69	228.21	6,365	1,453	28,193	69,551	10.9
70 - 74	399.71	4,912	1,963	19,653	41,358	8.4
75 - 79	440.30	2,949	1,298	11,500	21,705	7.4
80 - 84	517.37	1,651	854	6,120	10,205	6.2
85 & Over	1,000.00	797	797	4,085	4,085	5.1

Table 7

Abridged Life Table for Malay Females, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000_nq_x$	ℓ_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
0	24.01	10,000	240	9,817	667,838	66.8
1	3.86	9,760	38	9,739	658,021	67.4
2	1.89	9,722	18	9,713	648,282	66.7
3	1.66	9,704	16	9,696	638,569	65.8
4	1.22	9,688	12	9,682	628,873	64.9
5 - 9	3.79	9,676	37	48,288	619.191	64.0
10 - 14	1.85	9,639	18	48,150	570,903	59.2
15 - 19	2.95	9,621	28	48,035	522,753	54.3
20 - 24	4.54	9,593	44	47,855	474,718	49.5
25 - 29	5.68	9,549	54	47,610	426,863	44.7
30 - 34	7.52	9,495	71	47,298	379,253	39.9
35 - 39	11.73	9,424	111	46,843	331,955	35.2
40 - 44	21.08	9,313	196	46,075	285,112	30.6
45 - 49	35.07	9,117	320	44,785	239,037	26.2
50 - 54	48.83	8,797	430	42,910	194,252	22.1
55 - 59	87.73	8,367	734	40,000	151,342	18.1
60 - 64	155.58	7,633	1,188	35,195	111,342	14.6
65 - 69	225.42	6,445	1,453	28,593	76,147	11.8
70 - 74	329.16	4,992	1,643	20,853	47,554	9.5
75 - 79	398.56	3,349	1,335	13,408	26,701	8.0
80 - 84	525.02	2,014	1,057	7,428	13,293	6.6
85 & Over	1,000.00	957	957	5,865	5,865	6.1

Table 8

Abridged Life Table for Indian Males, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	23.91	10,000	239	9,796	651,655	65.2
1	3.10	9,761	30	9,745	641,859	65.8
2	0.84	9,731	8	9,727	632,114	65.0
3	0.98	9,723	10	9,718	622,387	64.0
4	0.71	9,713	7	9,710	612,669	63.1
5 - 9	2.85	9,706	28	48,460	602,959	62.1
10 - 14	3.19	9,678	31	48,313	554,499	57.3
15 - 19	5.29	9,647	51	48,108	506,186	52.5
20 - 24	7.57	9,596	73	47,798	458,078	47.7
25 - 29	8.07	9,523	77	47,423	410,280	43.1
30 - 34	9.85	9,446	93	46,998	362.857	38.4
35 - 39	15.28	9,353	143	46,408	315,859	33.8
40 - 44	28.88	9,210	266	45,385	269,451	29.3
45 - 49	43.10	8,944	385	43,758	224,066	25.1
50 - 54	75.35	8,559	645	41,183	180,308	21.1
55 - 59	96.14	7,914	761	37,668	139,125	17.6
60 - 64	172.60	7,153	1,235	32,678	101,457	14.2
65 - 69	230.68	5,918	1,365	26,178	68,779	11.6
70 - 74	305.05	4,553	1,389	19,293	42,601	9.4
75 - 79	379.35	3,164	1,200	12,820	23,308	7.4
80 - 84	581.61	1,964	1,142	6,965	10,488	5.3
85 & Over	1,000.00	822	822	3,523	3,523	4.3

Table 9

Abridged Life Table for Indian Females, 1969-71

Year of age	Mortality Rate	of 10,000 born alive		Stationary population		Average remaining life time
	Number dying per 1,000 alive at beginning of age interval	Number alive at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	Average number of years of life remaining at beginning of age interval
x to x + 4	$1{,}000\,{}_nq_x$	ℓ_x	${}_nd_x$	${}_nL_x$	T_x	$\mathring{e}_x$
0	21.25	10,000	213	9,832	677,662	67.8
1	2.08	9,787	20	9,776	667,830	68.2
2	1.10	9,767	11	9,762	658,054	67.4
3	1.37	9,756	13	9,750	648.292	66.5
4	1.09	9,743	11	9,738	638,542	65.5
5 - 9	2.25	9,732	22	48,605	628,804	64.6
10 - 14	2.20	9,710	21	48,498	580,199	59.8
15 - 19	1.65	9,689	16	48,405	531,701	54.9
20 - 24	2.65	9,673	26	48,300	483,296	50.0
25 - 29	8.27	9,647	80	48,035	434,996	45.1
30 - 34	7.67	9,567	73	47,653	386,961	40.4
35 - 39	10.30	9,494	98	47,225	339,308	35.7
40 - 44	16.12	9,396	151	46,603	292,083	31.1
45 - 49	29.02	9,245	268	45,555	245,480	26.6
50 - 54	51.25	8,977	460	43,735	199,925	22.3
55 - 59	85.94	8,517	732	40,755	156,190	18.3
60 - 64	150.46	7,785	1,171	35,998	115,435	14.8
65 - 69	207.24	6,614	1,371	29,643	79,437	12.0
70 - 74	360.05	5,243	1,888	21,495	49,794	9.5
75 - 79	375.93	3,355	1,261	13,623	28,299	8.4
80 - 84	447.75	2,094	938	8,125	14,676	7.0
85 & Over	1,000.00	1,156	1,156	6,551	6,551	5.7

Table 10

Life Expectancy by Age and Sex, 1956-58 and 1969-71

Age	Males				Females			
	1956-58	1969-71	Change		1956-58	1969-71	Change	
			Years	%			Years	%
0	60.5	65.9	5.4	8.9	66.6	72.2	5.6	8.4
1	62.5	66.4	3.9	6.2	68.2	72.6	4.4	6.5
2	62.0	65.6	3.6	5.8	67.8	71.7	3.9	5.8
3	61.3	64.7	3.4	5.5	67.1	70.8	3.7	5.5
4	60.5	63.8	3.3	5.5	66.3	69.9	3.6	5.4
5	59.6	62.8	3.2	5.4	65.4	68.9	3.5	5.4
10	54.9	57.8	2.9	5.3	60.8	64.1	3.3	5.4
15	50.2	53.1	2.8	5.6	56.0	59.2	3.2	5.7
20	45.5	48.4	2.9	6.4	51.2	54.3	3.1	6.1
25	40.8	43.7	2.9	7.1	46.6	49.5	2.9	6.2
30	36.2	39.0	2.8	7.7	41.9	44.7	2.8	6.7
35	31.6	34.3	2.7	8.5	37.3	40.0	2.7	7.2
40	27.2	29.7	2.5	9.2	32.9	35.3	2.4	7.3
45	23.0	25.3	2.3	10.0	28.6	30.8	2.2	7.6
50	19.1	21.2	2.1	11.1	24.5	26.4	1.9	7.8
55	15.4	17.4	2.0	13.0	20.6	22.2	1.6	7.8
60	12.4	14.0	1.6	12.9	16.9	18.3	1.4	8.3
65	9.7	11.1	1.4	14.4	13.6	14.8	1.2	8.8
70	7.7	8.8	1.1	14.3	10.7	11.6	0.9	8.4
75	6.0	7.1	1.1	18.3	8.2	9.0	0.8	9.8
80	4.6	5.7	1.1	23.9	6.0	6.7	0.7	11.7
85	3.5	4.9	1.4	40.0	4.2	5.7	1.5	35.7

Source: 1956-58 figures are from Saw Swee-Hock, Singapore Population in Transition

Table 11

Life Expectancy at Birth by Sex and Race, 1956-58 and 1969-71

Races	1956-58	1969-71	Change	
			Years	%
	Males			
Chinese	60.9	66.3	5.4	8.9
Malays	56.9	65.4	8.5	14.9
Indians	62.7	65.2	2.5	4.0
	Females			
Chinese	67.9	73.2	5.3	7.8
Malays	58.7	66.8	8.1	13.8
Indians	61.4	67.8	6.4	10.4

Source: 1956-58 figures are from same source as Table 10.

Table 12

Differential Life Expectancy at Birth by Races, 1956-58 and 1969-71

Race	1956–58			1969–71		
	Males	Females	Both Sexes	Males	Females	Both Sexes
Chinese	60.9	67.9	64.4	66.3	73.2	69.8
Malays	56.9	58.7	57.4	65.4	66.8	66.1
Indians	62.7	61.4	62.1	65.2	67.8	66.5
	Chinese = 100					
Malays	93.4	86.5	89.1	98.6	91.3	94.7
Indians	103.0	90.4	96.4	98.3	92.3	95.3

Source: 1956-58 figures are from same source as Table 10.

Table 13

Differential Life Expectancy at Birth by Sex, 1956-58 and 1969-71

Race	Males	Females	Difference (F-M)	
			Years	% of Males
	1969–71			
All Races	65.9	72.2	6.3	9.6
Chinese	66.3	73.2	6.9	10.4
Malays	65.4	66.8	1.4	2.1
Indians	65.2	67.8	2.6	4.0
	1956–58			
All Races	60.5	66.6	6.1	10.1
Chinese	60.9	67.9	7.0	11.5
Malays	56.9	58.7	1.8	3.2
Indians	62.7	61.4	-1.3	-2.1

Source: 1956-58 figures are from same source as Table 10

was also exhibited by the Singapore women who saw their gain falling from 5.6 years at birth to 0.7 years at age 80. In percentage terms, however, the greatest rise was recorded at the oldest age group by both the men and the women. From the largest percentage increase in the last age group 85 and over, the percentage increase for each quinary age group was consistently reduced with the lowering of age until it reached the smallest percentage gain at around the ages of 4 to 10. The percentage increase varied from 40.0 per cent to 5.3 per cent for the men and from 35.7 per cent to 5.4 per cent for the women, with the men recording greater improvements at ages 20 and above.

The changes that have occurred among the three main races will be studied in terms of the values for the mean length of life shown in Table 11, bearing in mind that these figures are often utilized as an index to summarise the overall mortality condition of a population. Looking first at the male figures, we see that the greatest improvement of 8.5 years or 14.9 per cent was experienced by the Malay men and the unimpressive gain of only 2.5 years or 4.0 per cent was recorded by the Indian men. The Chinese men occupied an intermediate position with a rise of 5.4 years or 8.9 per cent. These diverse changes seemed to have revealed a common characteristic in that the shorter the mean length of life at the base period, the greater was the improvement in these years.

The rather slow progress made by the Indian men as compared with their own female counterparts or indeed with any of the other four race-sex components needs some elucidation. One plausible explanation may be traced to the old custom of the Indian men to stay in Singapore as long as they are working and to return to their families in Indian on termination of employment, retirement or serious ill health (12). This implies that the Indian men in Singapore would by comparison tend to experience a longer mean length of life, and the steady weakening of this traditional practice over the years as the population becomes more settled has probably retarded the increase in their mean length of life during the period under review.

As regards the female mean length of life, the biggest gain of 8.1 years or 13.8 per cent was also registered by the Malay women but it was the Chinese women who experienced the smallest gain equivalent to 5.3 years or 7.8 per cent. Situated somewhere between these two positions were the Indian women whose mean length of life was lengthened by 6.4 years or 10.4 per cent. Even more important is that the women have also demonstrated the existence of the general principle of the shorter the mean length of life, the greater the possibility for future improvement. This consistency displayed by both the male and female populations is a reflection of the mean length of life having some kind of an upper limit beyond which further progress is almost impossible, and obviously as the mean length of life approaches nearer to this maximum, the extent of improvement that can be possibly attained in the future must necessarily be smaller.

DIFFERENTIALS IN LIFE EXPECTANCY

We will first examine the differentials in the mean length of life among the three main races at the earlier period 1956-1958, and then observe the subsequent shifts in these differentials that were engendered by the changes discussed in the preceeding section. The 1956-1958 data given in Table 12 reveal that the Indian men enjoyed the longest mean length of life equivalent to 62.7 years, the Chinese men the second longest length of life of 60.9 years, and the Malay men by far the shortest length of life of only 56.9 years. An alteration of this relative position seemed to take place as we move on to the female figures; here the longest mean length of life was enjoyed by the Chinese women and not by the Indian women, with the Malay women still experiencing the shortest length of life. Since the women exerted a greater influence, this kind of differentials continued to hold good in the case of the mean length of life for the two sexes combined. The Chinese had a length of life of 64.6 years, the Indians 62.1 years, and the Malays 57.4 years.

By far the most important consequence of the changes occurring during the sixteen years under survey was the unusually small gain made by the Indian men which led to the loss of their top position by the second period 1969-1971. In the second period the Chinese men came clearly on top, with a mean length of life equivalent to 66.3 years. Even the Malay men managed to record slightly longer length of life than the Indian men, 65.9 years as compared with 65.2 years. The women, on the other hand, maintained their relative position established in the first period. In the second period the Chinese women were still enjoying the longest length of life of 73.2 years and the Malay women the shortest length of 66.8 years. The figure for the Indian women was 67.8 years. This relative position also continued to persist in the case of both sexes combined, 69.8 years for the Chinese, 66.1 years for the Malays, and 66.5 years for the Indians.

An interesting aspect of the above figures is that the Chinese population as a whole was enjoying very much longer mean length of life than the other ethnic groups in the second period. Another general trend to note is that in the process of progressing towards higher levels, the three races have been narrowing their differences in the mean length of life as reflected by the percentage figures shown at the bottom of Table 12. In the first period the Malay men and women were experiencing a mean length of life 6.6 per cent and 13.5 per cent shorter than that of the Chinese men and women respectively, and by the second period these differentials were reduced to 1.4 per cent and 8.7 per cent respectively. Similarly, the percentage figures do indicate a diminution of the differences in the length of life between the Indians and the Chinese.

We will proceed to examine the sex differentials in the mean length of life experienced by the total population in Singapore and also by the three main races as presented in Table 13. The data exhibit a common feature in that the women experienced a longer mean length of life than the men, which is consistent with findings in other countries. The reverse situation noticeable in the Indian population in the first period 1956-1958 was an exception that can be partly explained in terms of the longer mean length of life of the Indian men being caused by their stronger tendency to return to India in the first period as mentioned earlier. The principal explanation, however, is that the higher life expectancy at birth of the Indian men seems to be a distinctive feature of the peoples from the Indian subcontinent as illustrated by the following figures for the Indian population in Peninsular Malaysia, Sri Lanka, Pakistan and India(13). But in all these cases the figures were below or in the early sixties, and the expereince of the Singapore Indians suggests that the universal phenomenon of higher female life expectancy at birth would emerge as mortality improves to a point equivalent to expectancy at birth around the mid-sixties or late sixties.

Country	Males	Females
India, 1951-1960	41.89	40.55
Pakistan, 1962	53.7	48.8
Sri Lanka, 1962	61.9	61.4
Peninsular Malaysia Indians, 1956-1958	58.3	57.7

Within the natural phenomenon of longer longevity for the women, there was still some variations in the sense that the actual gap between the two sexes was different among the three races. Judging by the 1969-1971 figures in Table 13, the Chinese women had experienced a mean length of life that was 6.9 years or 10.4 per cent longer than that of their male counterparts. In sharp contrast, there was a much smaller difference of 1.4 years or 2.1 per cent in the Malay population. Additionally, this sex differential was also by no means substantial among the Indian community, 2.6 years or 4.0 per cent. If we compare these figures with those in the first period, we will observe a general diminution of the sex differentials during the years under investigation.

CONCLUSION

In this paper we have observed the considerable progress made by the major race-sex segments of the population in lengthening their expectation of life during the years 1956 to 1971 covered by our study. It was also noted that there were some interesting race and sex variations in the expectation of life, but these differentials have been narrowed during these years as further inroads in the lengthening of life expectancy were made. By the second period

1969-1971 the longevity of the total population in Singapore had reached a reasonable level of 69.5 years. This compares more than favourably with the 67.4 years in Spain (1970), 67.7 years in Yugoslavia (1970-1971), 68.2 years in Portugal (1970), and 69.2 years in Hungary (1970). It was not so far behind the 71.3 years in Israel (1970), 71.6 years in New Zealand (1970-1972), 72.0 years in England and Wales (1970) and also in Japan (1970), and 73.4 years in Sweden (1969), the last figure being the highest in the world at that time (14). The levels registered in the second group of developed countries may serve to indicate the good possibility of enhancing the longevity of Singaporeans in the future to beyond the 69.5 years attained in 1969-1971.

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EXPLANATORY NOTES AND REFERENCES

1. A period life table is different from a cohort life table in that the latter records the mortality experience of a birth cohort throughout the history of a generation, while the former observes the state of mortality of a population in a period of say three years. Period life tables enables us to study mortality changes at different periods of times.
2. See Appendix 1: Abridged Life Tables in Saw Swee-Hock, **Singapore Population in Transition,** Philadelphia: University of Pennsylvania Press, 1970.
3. The tables are given in Appendix 1: Abridged Life Tables, 1970 in pp. 286-292 Arumainathan, **Report on the Census of Population 1970,** Singapore, Vol. I, Singapore: Department of Statistics, n.d. Strictly speaking, the tables are for 1969-1971 and not for 1970 because the deaths used in preparing these tables are for the years 1969 to 1971.
4. In Singapore it is particularly essential to prepare life tables for a period of three years so as to minimise the errors eminating from random deviations related to the use of small numbers in the death figures.
5. **Report on the Registration of Births and Deaths and Marriages** for the years 1969 to 1971.
6. Table 6 in P. Arumainathan, **Report on the Census of Population 1970, Singapore,** Vol. II, Singapore: Department of Statistics, n.d.
7. There is no explanation regarding the treatment of the deaths with unspecified ages in the construction of the life tables included in Vol. I of the 1970 Census Report. However, since the computed values for ${}_nq_x$ in our life tables are generally higher than those in the census report and since both sets use the same formula, we can infer that the unspecified deaths were excluded in the census report life tables. Direct comparison of ${}_nm_x$ values is not possible because such values are not given in the census report.
8. For a derivation of the formula, see Appendix: Ascertaining Value of B in Formula $L_1 = \beta l_1 + (1-\beta)\, l_2$ in Saw Swee-Hock, "Malaya: Tables of Male Working Life, 1957," **Journal of the Royal Statistical Society** Series A, (General), Vol. 128, Part 3, 1965.
9. There is no explanation regarding the derivation of the value for T_{75} or L_{75} in the construction of the census report life tables, but a few re-calculations of the figures show that in these tables L_{75} was obtained by multiplying l_{75} by its own logarithm as suggested in **Manual III: Methods for Population Projections by Sex and Age,** ST/SOA Series A, No. 25, New York: United Nations, 1956. This procedure is not quite tenable because there is no evidence of m_{75}, and in fact it implies equating l_{75} to log l_{75} but the former depends only on mortality **after** 85 and the latter only on mortality **before** 75.
10. A comparison of our abridged life tables with those included in Vol. I of the 1970 Census Report shows that the different and less effective method of calculation and the very abbreviated age grouping used in the census report life tables have under-estimated the life expectancy at birth of all the race-sex segments of the population in Singapore.
11. The rise in life expectancy at these young ages, or for that matter the changes at single years of age from 1 to 4 over time, cannot be studied in the life tables included in the census report because the figures are given for the four-year age group 1-4 combined.
12. For a fuller discussion of this Indian custom in Singapore, see K. S. Sandhu, **Indians in Malaya: Immigration and Settlement 1786-1957,** London: Cambridge University Press, 1969 and Saw Swee-Hock, "Indian Immigration in Malaya before the Second World War", **Journal of the Malaysian Historical Society,** Vol. 23, 1980.
13. The figures are obtained from **the Demographic Yearbook,** New York: United Nations and Saw Swee-Hock, **Construction of Abridged Life Tables for West Malaysia, 1956-1958,** Hong Kong: Department of Statistics, University of Hong Kong, 1971. See also M.A. El-Badry, "Higher Female Than Male Mortality in Some Countries of South Asia: A Digest", **Journal of the American Statistical Association,** Vol. 64, No. 328, December 1969.
14. The $\mathring{e}_o$ values for both sexes combined are obtained by taking the average of the two figures for the males and the females obtained from various issues of the **Demographic Yearbook,** New York: United Nations.