

CONTRIBUTIONS OF VARIOUS MAJOR CAUSES OF DEATH TO LIFE EXPECTANCY IN SINGAPORE, 1980-1990

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ABSTRACT

This paper considers the contributions by age of the various major groups of deaths to the increase in life expectancy at birth between 1980 and 1990 for both sexes in Singapore. Sixteen cause groups were used in the study. The data were analysed using LIFETIME, a personal computer package with a wide variety of methods for mortality investigations. Respiratory diseases made the largest contribution to the increase in life expectancy for both sexes. In contrast, ischaemic heart disease made a negative contribution of 1% in the gain in female life expectancy but contributed 12% improvement for males. Life tables for Singaporean males and females in the year 2000 were projected by extrapolating the mortality trends observed in earlier periods. The calculations show that the life expectancy at birth in the year 2000 to be 74.72 years for males and 79.48 years for females.

Keywords: life tables, sex differential, mortality

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INTRODUCTION

The complete life expectancy at birth is a very commonly used summary measure of the mortality of a population. The main advantage lies in its ease of interpretation. Over the decade from 1980, the population in Singapore has experienced substantial improvements in life expectancy at birth. For females, the increase has been from 74.22 years in 1980 to 77.27 years in 1990. The corresponding figures for males are 69.02 in 1980 and 72.21 in 1990. The gap between male and female life expectancy is narrowing.

In this paper, the contributions by age of the various major groups of causes of death to the increase in the life expectancy at birth between 1980 and 1990 for both sexes are considered. The contributions of the same groups of causes to the 1990 sex differential are also presented. Extrapolating the mortality trends observed for the various cause-specific rates, projected life tables for Singaporean males and females in the year 2000 are obtained.

DATA

The data used in this study were kindly provided by the World Health Organisation, although the original source was of course the Department of Statistics, Singapore. All the data analyses were performed using the World Health Organisation personal computer mortality package LIFETIME. As five-year age groupings were used in the data provided, the life table functions produced by LIFETIME may differ slightly from those calculated using single-year age groups. The differences are of no consequence. In fact, LIFETIME has a slight graduation effect.

The cause of death codings used in the investigations have been the B codings under the Ninth Revision of the International Classification of Diseases. Sixteen cause groups are used in the present study. These cause groups are mutually exclusive and exhaustive and are listed in Table I.

Changes in life expectancy at birth

Life expectancy at birth for males increased by 3.20 years over the decade 1980 to 1990, compared with 3.05 years for females. Consequently, the sex differential in life expectancy at birth has narrowed from 5.21 to 5.05 years.

The contributions of the selected causes within selected age groups to these improvements in life expectancy are readily obtained using the decomposition method of Pollard⁽²⁾. In brief, the method recognises that the change in life expectancy at a particular age over a given period can be expressed as a weighted sum of the changes over the period of the all-cause mortality rates at all subsequent ages. Also, the instantaneous mortality rate (or the force of mortality) at any age can be written as the sum of the forces of mortality at that age for all the various causes. Hence, the contribution of the various causes of death and age groups to the overall change in life expectancy can be determined from the same weighted sum formula. The LIFETIME package allows such calculations to be performed. Tables II and III have been prepared on this basis.

In the case of males (Table II), improvement in respiratory diseases contributed almost 20% of the increase in life expectancy at birth (0.63 year out of 3.20), this contribution coming almost entirely from the mortality improvement in the age group 50

Table I – Causes of death grouping

| Group number | General description | ICD 9th revision - B coding |
|--------------|-------------------------|------------------------------------|
| 1 | Infections | 1-7 |
| 2 | Neoplasms - "smoking" | 8, 10 |
| 3 | Neoplasms - breast | 11.3 |
| 4 | Neoplasms - all other | 9, 11-17 excl. 11.3 |
| 5 | Ischaemic heart disease | 27 |
| 6 | Cerebrovascular | 29 |
| 7 | Circulatory | 25, 26, 28, 30 |
| 8 | Respiratory | 31, 32 |
| 9 | Cirrhosis | 34.7 |
| 10 | Childbirth and related | 38-41 |
| 11 | Congenital/perinatal | 44, 45 |
| 12 | Non-motor accidents | 47-53 excl. 47.1 |
| 13 | Motor accidents | 47.1 |
| 14 | Suicide | 54 |
| 15 | Other violence | 55, 56 |
| 16 | All other causes | 18-24, 33-37 excl. 34.7, 42-43, 46 |

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Table II – Contributions of the various causes of death by age to the change in Singapore male life expectancies at birth between 1980 and 1990. (The entries are hundredths of a year of life.)

| Cause group | Age group | | | | | | | All ages |
|---------------------------|-----------|-----|------|-------|-------|-------|-----|----------|
| | 0 | 1-4 | 5-14 | 15-29 | 30-49 | 50-69 | 70+ | |
| 1 Infections | 2 | 2 | 0 | -0 | 5 | 10 | 7 | 26 |
| 2 "Smoking" neoplasm | 0 | 0 | -0 | 1 | 2 | 10 | 1 | 14 |
| 3 Breast cancer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 All other neoplasms | -0 | -1 | -2 | 0 | 7 | 14 | 3 | 22 |
| 5 Ischaemic heart disease | 0 | 0 | 0 | 1 | 13 | 27 | -1 | 39 |
| 6 Cerebrovascular | 1 | 0 | -0 | 1 | 1 | 17 | 5 | 26 |
| 7 Circulatory | 0 | 0 | 0 | 1 | 2 | 12 | 7 | 22 |
| 8 Respiratory | 7 | 2 | 0 | -2 | -1 | 28 | 28 | 63 |
| 9 Cirrhosis | 0 | 0 | -0 | -0 | 1 | 2 | -0 | 3 |
| 10 Obstetrics | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 Congenital/perinatal | 18 | -1 | 0 | 1 | 0 | 0 | -0 | 19 |
| 12 Non-motor accidents | 1 | 1 | 1 | 0 | -5 | -1 | -1 | -4 |
| 13 Motor accidents | 0 | 1 | -1 | 1 | 1 | 2 | 1 | 5 |
| 14 Suicide | 0 | 0 | 0 | -2 | -2 | 0 | 1 | -2 |
| 15 Other violence | 0 | 1 | 0 | 5 | 2 | 4 | 1 | 14 |
| 16 All other causes | 4 | 5 | 0 | 6 | 11 | 20 | 28 | 75 |
| All causes | 33 | 9 | 0 | 14 | 38 | 146 | 80 | 320 |

Table III – Contributions of the various causes of death by age to the change in Singapore female life expectancies at birth between 1980 and 1990. (The entries are hundredths of a year of life.)

| Cause group | Age group | | | | | | | All ages |
|---------------------------|-----------|-----|------|-------|-------|-------|-----|----------|
| | 0 | 1-4 | 5-14 | 15-29 | 30-49 | 50-69 | 70+ | |
| 1 Infections | 4 | 2 | 1 | 0 | 3 | 2 | 4 | 16 |
| 2 "Smoking" neoplasm | 0 | 0 | 0 | 2 | 4 | 6 | -1 | 11 |
| 3 Breast cancer | 0 | 0 | 0 | -1 | -2 | -0 | 1 | -2 |
| 4 All other neoplasms | 0 | -0 | -1 | -0 | -3 | 16 | 2 | 14 |
| 5 Ischaemic heart disease | 0 | 0 | 0 | -0 | 5 | -3 | -4 | -3 |
| 6 Cerebrovascular | 1 | 0 | 0 | 1 | 3 | 18 | 23 | 46 |
| 7 Circulatory | 1 | 0 | 0 | 1 | 1 | 20 | 20 | 42 |
| 8 Respiratory | 7 | 3 | 2 | 2 | -1 | 20 | 29 | 63 |
| 9 Cirrhosis | -0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| 10 Obstetrics | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 Congenital/perinatal | 29 | 3 | 1 | 1 | 1 | 1 | 0 | 36 |
| 12 Non-motor accidents | -1 | 1 | 0 | -1 | -1 | -0 | -1 | -3 |
| 13 Motor accidents | 0 | 1 | 2 | -1 | 0 | -1 | 2 | 3 |
| 14 Suicide | 0 | 0 | -0 | 1 | -2 | 1 | 0 | -0 |
| 15 Other violence | 0 | -0 | 1 | 0 | 1 | 2 | -0 | 3 |
| 16 All other causes | 1 | 3 | 3 | 5 | 9 | 16 | 38 | 74 |
| All causes | 41 | 12 | 10 | 10 | 19 | 99 | 114 | 305 |

years and above. The same gain of 0.63 year is shown by the females (Table III). Respiratory diseases remains a major killer for both sexes though its relative importance is diminishing.

Reduced mortality of ischaemic heart disease (IHD) had the effect of increasing male life expectancy by 0.39 year. Of course, it cannot be deduced from the data whether this is a result of education, a healthier lifestyle or improved medical technology. For females, increased IHD mortality reduced life expectancy by 0.03 year, mainly due to deaths from age 50 onwards. Whilst IHD remains the dominant killer for the males, it has now become the dominant killer for the females. Its relative importance has increased rapidly especially for the females.

Decreased mortality from cerebrovascular disease added 0.26 year and 0.46 year of life for males and females respectively, particularly for those aged 50 and above. Females also show a larger gain in life expectancy at birth than males from

improvements in circulatory disease mortality (0.42 year compared to 0.22), again particularly for those over 50 years of age. However, this pattern is reversed for infectious diseases mortality, male life expectancy having increased by 0.26 year and female expectancy by 0.16 year.

Both sexes show an improvement in life expectancy from reduced smoking cancer mortality. This is also the case with mortality from all other cancers. The combined contribution from these two causes is 0.36 and 0.25 year for males and females respectively.

Over the decade, females have not enjoyed improvement in breast cancer mortality. The effect is a reduction in life expectancy by 0.02 year, chiefly in the age range 15-49 years.

Improvements in congenital/perinatal mortality have led to an increase in life expectancy of 0.19 year for males and 0.36 year for females. Note that the improvements occur mainly at

Table IV – Contributions of mortality differentials by age and cause to the sex differential in life expectancy at birth in Singapore in 1990. (The entries are hundredths of a year of life.)

| Cause group | Age group | | | | | | | All ages |
|---------------------------|-----------|-----|------|-------|-------|-------|-----|----------|
| | 0 | 1-4 | 5-14 | 15-29 | 30-49 | 50-69 | 70+ | |
| 1 Infections | 1 | 0 | 0 | 1 | 2 | 6 | 7 | 18 |
| 2 "Smoking" neoplasm | 0 | 0 | 0 | 1 | 10 | 51 | 29 | 91 |
| 3 Breast cancer | 0 | 0 | 0 | -1 | -10 | -17 | -4 | -32 |
| 4 All other neoplasms | 0 | 2 | 1 | 3 | -3 | 34 | 25 | 62 |
| 5 Ischaemic heart disease | 0 | 0 | 0 | 0 | 20 | 71 | 31 | 123 |
| 6 Cerebrovascular | 0 | 0 | 0 | 0 | 5 | 15 | 5 | 25 |
| 7 Circulatory | -0 | 1 | 1 | 3 | 5 | 10 | 2 | 21 |
| 8 Respiratory | 2 | 1 | -1 | 4 | 8 | 27 | 57 | 98 |
| 9 Cirrhosis | -0 | 0 | 0 | 0 | 4 | 7 | 2 | 13 |
| 10 Obstetrics | 0 | 0 | 0 | 0 | -0 | 0 | 0 | -0 |
| 11 Congenital/perinatal | 8 | 2 | 1 | -0 | -0 | -0 | 0 | 9 |
| 12 Non-motor accidents | -1 | 1 | 2 | 6 | 8 | 6 | 1 | 24 |
| 13 Motor accidents | 0 | -0 | 2 | 14 | 7 | 4 | 2 | 28 |
| 14 Suicide | 0 | 0 | 0 | 3 | 3 | 4 | 1 | 11 |
| 15 Other violence | -1 | -0 | 1 | 6 | 7 | 2 | 2 | 17 |
| 16 All other causes | -2 | -0 | 0 | 1 | 0 | 0 | -1 | -2 |
| All causes | 7 | 6 | 6 | 41 | 66 | 219 | 160 | 505 |

birth. It should also be noted that mortality from pregnancy and childbirth has remained almost non-existent (crude mortality rate of 0.2 and 0.1 per 100,000 in 1980 and 1990 respectively).

The net contribution from non-motor and motor accidents mortality is almost nil for both sexes. The two separate contributions are also quite small. Suicide levels were largely unchanged. Reduced mortality from other violence increased life expectancy by 0.14 year for males and a much lower figure of 0.03 year for females.

For males, the age range which made the largest contribution to the improvement in life expectancy at birth was 50-69 years (1.46 years or 46% of the total improvement). For females, the major part of the improvement in life expectancy was due to decreases in mortality beyond the age of 70 years (1.14 years or 37% of the total improvement).

Sex differentials in life expectancy at birth

The sex differential in the life expectancy at birth was 5.21 years in 1980. It fell to 5.05 years in 1990. From Table IV, almost a quarter of the 1990 differential (or 1.23 years) can be attributed to excess IHD mortality in males. In fact, slightly more than 20% of the differential (1.02 years) is caused by higher mortality from IHD in males beyond the age of 50 years. The 1980 differential from IHD mortality was 1.44 years.

The other major causes producing the sex differential in life expectancy at birth were, in descending order of magnitude: respiratory diseases (0.98 year), smoking cancers (0.91 year), all other cancers excluding breast cancer (0.62 year), and motor vehicle accidents (0.28 year).

It is of some concern to note that the contribution from smoking cancers increased to 0.91 year from 0.79 year in 1980, indicating that male deaths from this cause is getting heavier than the females. Further, more than 50% of this differential of 0.91 year comes from the age range 50-69. The contributions from the other three major cause groups are essentially the same as in 1980.

Breast cancer reduced the sex differential in life expectancy at birth by a quarter of a year in 1980 and a third in 1990.

Singapore life tables 2000

Over the decade 1980-1990, the changes in mortality that were observed have continued into the 1990s. It is natural to ask what

is the likely male and female life expectancies at the time of the 2000 census if the observed mortality trends continue. The estimation process is essentially one of extrapolation. Such an approach to mortality projection has proved as successful as any and better than most other methods⁽¹⁾.

Extrapolation to estimate the Singaporean life table in 2000 was performed assuming that the trends in cause of death observed over the decade to 1990 were to continue for another ten years. The ratio of the 1990 standardised mortality rate (SMR) to the 1980 SMR was calculated for each of the 16 causes of death. The standard population used was the Singaporean population 1990, males and females combined. Then the 1990 mortality rates by age and cause were adjusted with these ratios to project the 2000 mortality rates by age and cause. Life tables under the adjusted mortality scenario are readily computed using LIFETIME. The projected abridged life tables for 2000 are shown in Table V.

The projected life expectancies at birth in 2000 are 74.72 and 79.48 years for males and females respectively, resulting in a further narrowing of the sex differential to 4.76 years.

CONCLUSION

The cause of death which alone made the largest contribution to the increase in the life expectancy was respiratory disease, with 20% of the improvement in male life expectancy and 21% for the female improvement. In contrast, the other major killer, ischaemic heart disease, made a negative contribution of 1% in the gain in female life expectancy and contributed 12% improvement in the case of males.

The projected Singapore life table in 2000 was obtained by assuming that trends in the various causes of death observed over the period 1980-1990 will continue for another ten years. The calculations show that the expectations of life at birth in 2000 to be 74.72 and 79.48 years for males and females respectively.

These figures are similar to those achieved by Australian males (74.48 years) and females (80.47 years) in 1992. Preliminary analysis with the relevant Australian data shows that though the major causes of death over the decade from 1982 are the same as Singapore's, their contributions to changes in the life expectancies are not.

Table V – Projected abridged life tables for Singapore males and females in 2000.

| Age x | Males | | | Females | | |
|----------|--------|---------|-------|---------|---------|-------|
| | l(x) | q(x) | e(x) | l(x) | q(x) | e(x) |
| 0 | 100000 | 0.00516 | 74.72 | 100000 | 0.00401 | 79.48 |
| 1 | 99484 | 0.00046 | 74.10 | 99599 | 0.00024 | 78.80 |
| 2 | 99439 | 0.00039 | 73.14 | 99576 | 0.00021 | 77.81 |
| 3 | 99400 | 0.00034 | 72.16 | 99555 | 0.00019 | 76.83 |
| 4 | 99366 | 0.00029 | 71.19 | 99536 | 0.00017 | 75.84 |
| 5 | 99338 | 0.00025 | 70.21 | 99519 | 0.00015 | 74.86 |
| 10 | 99231 | 0.00023 | 65.28 | 99449 | 0.00015 | 69.91 |
| 15 | 99092 | 0.00040 | 60.37 | 99365 | 0.00019 | 64.97 |
| 20 | 98824 | 0.00083 | 55.52 | 99259 | 0.00034 | 60.03 |
| 25 | 98370 | 0.00097 | 50.77 | 99055 | 0.00048 | 55.15 |
| 30 | 97888 | 0.00100 | 46.01 | 98798 | 0.00059 | 50.29 |
| 35 | 97375 | 0.00119 | 41.24 | 98472 | 0.00082 | 45.45 |
| 40 | 96715 | 0.00174 | 36.50 | 98004 | 0.00115 | 40.65 |
| 45 | 95674 | 0.00302 | 31.87 | 97344 | 0.00177 | 35.91 |
| 50 | 93864 | 0.00504 | 27.43 | 96266 | 0.00309 | 31.28 |
| 55 | 91002 | 0.00839 | 23.21 | 94401 | 0.00528 | 26.84 |
| 60 | 86299 | 0.01435 | 19.33 | 91412 | 0.00819 | 22.63 |
| 65 | 79025 | 0.02214 | 15.86 | 86992 | 0.01322 | 18.65 |
| 70 | 69278 | 0.03268 | 12.73 | 80111 | 0.02145 | 15.02 |
| 75 | 57172 | 0.04451 | 9.88 | 70376 | 0.03216 | 11.74 |
| 80 | 43861 | 0.06814 | 7.10 | 57781 | 0.05200 | 8.73 |
| 85 | 27838 | 0.12312 | 4.71 | 41198 | 0.08916 | 6.20 |

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