FactSheet

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Financial Demographics Pty Ltd

Life Expectancy

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What is Life Expectancy ?

No one can predict when they will die. The range of uncertainty is very wide. Gender, hereditary influences, state of health, lifestyle, accidents, disease, medical advances and wars all play a part in individual life spans.

However if we have a large group of people and we know their ages, predictions of the number of survivors each year can be made with a surprising degree of confidence.

The mathematics of mortality and life expectancy is known as "actuarial science" -- named after the profession of "actuaries" who developed the early "life tables". As well as calculating the expected number of deaths from life tables, it is also possible to calculate the average expected total years of life. This is known technically as the "expectation of life" or more commonly referred to as "life expectancy".

Early Life-Tables

Today's life tables are constructed from population census data and registrations of deaths. The early life tables came from research on epidemics and life insurance.

The landmark study, which started it all, was by a London merchant named John Graunt. In 1662 he published a book entitled "Natural and Political observations made upon the Bills of Mortality". The book was based on publications of the number of people dying each week in the big cities, classified by apparent cause of death. Graunt analysed 20 years of deaths according to cause and identified the likely age associated with cause. Although some of his methods were speculative because of absent data, his conclusions were close to the mark. Here is the life table derived from his work.

Graunt's 1662 Life-Table	
Age Group	Probability of Survival to next age group as %
0-5	64.0%
6-15	62.5%
16-25	62.5%
26-35	64.0%
36-45	62.5%
46-55	60.0%
56-65	50.0%

Life Annuities & Life-Tables

Further development of life tables occurred in Holland and England associated with governments and municipalities raising money by selling life annuities. A life annuity is a transaction where a person (the "annuitant") pays a large sum of money to someone who must then pay a smaller amount back to the annuitant each year (the "annuity payment") while ever the annuitant is still living.

The people developing these life tables were John De Witt, the Dutch prime minister in 1671, and John Hudde, a mathematician and mayor of Amsterdam in 1672.

In England Edmond Halley (of Halley's comet fame) produced the first widely circulated work on the calculation of life annuities in his paper published in 1693 in "Philosophical Transactions of the Royal Society". This was based on data collected for years 1687 to 1691 by Caspar Neumann, a pastor in the German city of Breslaw. Halley's life tables produced the following probabilities of survival:

Halley's 1693 Life-Table	
Age Group	Probability of Survival to next age group as %
0-5	71.0%
6-15	87.6%
16-25	90.0%
26-35	85.9%
36-45	80.5%
46-55	72.9%
56-65	64.5%
66-75	42.9%

Growth in commerce and trading caused the development of life tables to progress in line with the needs of the insurance market. Because the people with the need for and means to pay for insurance had different living standards to the general population, the life tables used for insurance did not represent population mortality.

Population Life-Tables

Population life tables originate from national census. Census of people date back to Eqypt in 2500 BC to assess the labour force for building pyramids. The first modern population census were in Prussia in 1719, USA in 1790, England and France in 1801, and Canada in 1851.

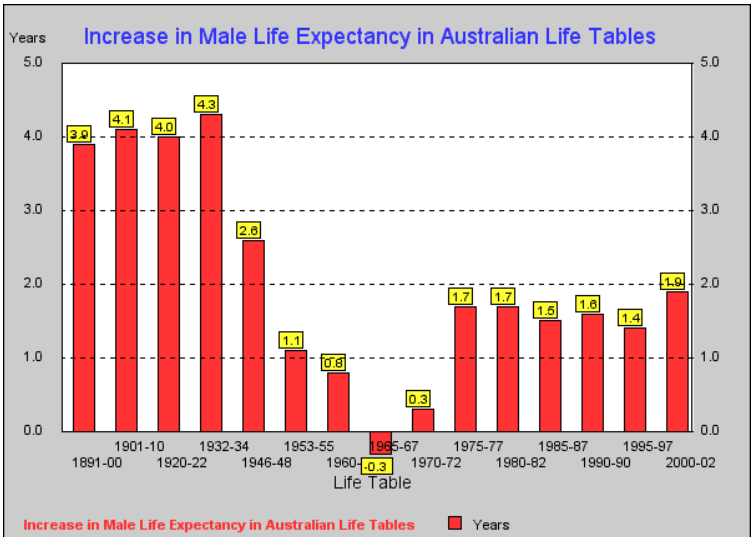
The first reliable population life table to be derived from census was for England and Wales in the English Life Tabled No. 1 in 1841.

Australian Life-Tables

In Australia the first national census was in 1901 State census were held regularly prior to this and population was regularly counted from settlement in 1788.

The first Australian life tables were for the period 1880-90 and were based on two lots of state census data collected in 1881 and 1886. Since then 15 more life tables have been produced with the latest being for 2000-02 published in June 2004.

The increase in life expectancy (for males from birth) between each of the Australian life tables is shown in the graph to the left on this page. The pause in improvement in life



expectancy in the 1950's and 1960's is due to an upsurge in deaths from road accidents.

The male and female life expectancy from birth from the 16 Australian Life Tables is shown below:

ALT Life Expectancy from birth		
Aust. Life Tables	Men	Women
1881-90	47	51
1891-00	51	55
1901-10	55	59
1920-22	59	63
1932-34	63	67
1946-48	66	71
1953-55	67	73
1960-62	68	74
1965-67	68	74
1970-72	68	75
1975-77	70	77
1980-82	71	78
1985-87	73	79
1990-92	74	80
1995-97	76	81
2000-02	78	83

These tables show the dramatic improvement in life expectancy during this 120-year period with male life expectancy increasing 65% and females 63%.

How Life Expectancy is Calculated

The calculation of life expectancy requires firstly tables by each year of age from birth to the oldest age of reliable data (generally 110 nowadays). The data items required are Lx (the number of people living at age x) and Ux (the rate of change in mortality around age x). The formula for the "complete expectation of life" is then as follows:

$$\mathring{e}_x = \frac{1}{l_x}\sum_{t=1}^{120} l_{x+t} + \frac{1}{2} - \frac{1}{12}\mu_x$$

In this formula the Lx+t /Lx factor is the probability of living from age x to x+t. A simple example of how this works is as follows. Suppose people only died at ages 30, 60 and 80 and the probability of living to age 30 (from birth) was 10%, to age 60 from birth was 50%, and to age 80 from birth was 40%. A simple calculation of life expectancy is then the probability weighted total of the three ages – i.e. 10%x30 plus 50%x60 plus 40%x90. This calculation gives 65 years as the average life span.

The Range Of Life Expectancy

Whilst average life expectancy is a useful guide to individuals, there is a wide range around these averages. Financial Demographics has developed tools on the website www.findem.com.au to allow people to calculate ranges around the average. This is of most interest to people approaching the end of full-time work when planning how long their financial assets might need to last.

The range calculations as made by FinDem are the upper and lower "quartiles". These are statistical terms, which mean that 75% of all people can be expected to live past the lower quartile life expectancy and 25% of all people can be expected to live past the upper quartile life expectancy. We loosely label these ranges of life expectancy as relating to people experiencing "Poor" health and "Good" health.

A further variable in estimating future life expectancy is the degree to which the whole population will live longer due to improving medical technology and living standards. The Australian Government Actuary provides improvement factors which can allow estimation of this

The following table shows calculations made by FinDem from the latest Australian Life Tables (ALT) which show average and upper (Good Health) and lower (Poor Health) quartile life expectancy, based on the standard periodic table and also allowing for mortality improvement and a cohort mortality table. For age 30 and 65 the figures shown are the number of years expected to be lived after these ages.

Life Expectancy from ALT 2000-02				
Age Now and Future Health	Periodic Life Table		Cohort Life Table with future Improve-ment	
From Birth	M	F	M	F
Poor	71	78	88	93
Average	78	83	93	96
Good	87	91	103	104
From 30	M	F	M	F
Poor	43	47	55	57
Average	49	54	60	63
Good	57	57	69	71
From 65	M	F	M	F
Poor	12	16	13	19
Average	18	21	21	25
Good	23	28	29	31

For people planning retirement at age 65, the time they need to allow for their finances to last based on these calculations, varies from 12 years for a man who expects poor health to 40 years for a woman who expects good health and allowing for general population longevity improvement. Longevity therefore brings with it greater uncertainties for financial planning.

Sources:

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