Guide to Calculating Interim Life Tables

Introduction

Interim life tables, which are produced annually for the United Kingdom and its constituent countries, provide period expectation of life. This is the average number of additional years a person can be expected to live for if he or she experiences the age-specific mortality rates of the given area and time period for the rest of his or her life.

Each life table is based on the population estimates and deaths by date of registration data for a period of three consecutive years. This helps to reduce the effect of annual fluctuations in the number of deaths caused by seasonal events such as winter 'flu. The interim life tables are based on the mid-year population estimates and corresponding data on births, infant deaths and deaths by individual age from those years (the calculation of infant mortality also requires monthly births data for the year before the three year period – Appendix A).

Summary Quality Reports for the data used in the calculation of interim life tables are available here: births and population estimates.

Life Tables

Life tables are usually constructed separately for males and females because of their very different mortality patterns. A life table describes the course of mortality throughout the life cycle. A life tables contains:

m_x

The central rate of mortality, defined as the average annual number of deaths at age x last birthday in the three year period to which the Interim Life Table relates divided by the average population at that age over the same period.

q_x

The mortality rate between age x and (x +1), that is the probability that a person aged x exactly will die before reaching age (x +1).

l_x

The number of survivors to exact age x of 100,000 live births of the same sex who are assumed to be subject throughout their lives to the mortality rates experienced in the three year period to which the Interim Life Table relates.

d_x

The number dying between exact age x and (x +1) described similarly to l_x, that is $d_x=l_x-l_x+1$.

e_x

The average period expectation of life at exactly age x, that is the average number of years that those aged x exactly will live thereafter based on the mortality rates experienced in the three year period to which the Interim Life Table relates.

Methodology

Starting with a radix of 100000 simultaneous births (l_0), the life table population is calculated by multiplying l_0 by q_0 to give d_0, the number of deaths aged 0. The resulting d_0 is then subtracted from the l_0 to give l_1. Similarly l_2 is l_1 less d_1 (where $d_1 = l_1 \times q_1$) and so on.

Generally:

$$d_x = q_x \cdot l_x \qquad\qquad l_{x+1} = l_x - d_x$$

The calculation of expectation of life at each age

In order to calculate the expectation of life at exact age x the number of 'years alive' at each individual age (L_x) needs to be calculated.
For ages above 1, where deaths can be assumed to occur linearly over a year of age, this can be taken as:

$$L_x = \frac{l_x + l_{x+1}}{2}$$

Below age 1, this assumption is unrealistic. L_0 is calculated using the following formula:

$L_0 = a_0 l_0 + (1 - a_0) l_1$ where a_0 is the average age of death of those dying within the first year of life (see Appendix A).

Summing the L_x column from age x to the oldest age gives the total number of years lived (T_x) from age x. The period expectation of life at exact age x is given by dividing the number of years lived by the number at that age i.e.

$$\frac{T_x}{l_x}$$

For more information on life tables and their calculation see:

Shyrock, H.S (1971) The Methods and Materials of Demography Volume 1. *US Bureau of the Census;* or

Hinde, A (1998) Demographic Methods. *Arnold*

Appendix A

Infant mortality (q_0)

For Interim Life Tables covering the period year T to year T+2 inclusive, infant deaths at <4weeks, 1-2 months, 3-5 months, 6-8 months and 9-11 months are summed separately for males and females over the three years T, T+1 and T+2. The 'at risk' population is then derived for each group from the monthly birth figures, separately for males and females, as follows (where B_{XxxT} = Births in Month Xxx of calendar year T):

<4 weeks:

$$\frac{B_{Dec(T-1)}}{2} + \sum_{i=JanT}^{i=Nov(T+2)} B_i + \frac{B_{Dec(T+2)}}{2}$$

1-2 months:

$$\frac{(B_{Oct(T-1)} + B_{Nov(T+2)})}{4} + \frac{3*(B_{Nov(T-1)} + B_{Oct(T+2)})}{4} + \sum_{i=Dec(T-1)}^{i=Sep(T+2)} B_i$$

3-5 months:

$$\frac{(B_{Jul(T-1)} + B_{Sep(T+2)})}{6} + \frac{(B_{Aug(T-1)} + B_{Aug(T+2)})}{2} + \frac{5*(B_{Sep(T-1)} + B_{Jul(T+2)})}{6} + \sum_{i=Oct(T-1)}^{i=Jun(T+2)} B_i$$

6-8 months:

$$\frac{(B_{Apr(T-1)} + B_{Jun(T+2)})}{6} + \frac{(B_{May(T-1)} + B_{May(T+2)})}{2} + \frac{5*(B_{Jun(T-1)} + B_{Apr(T+2)})}{6} + \sum_{i=Jul(T-1)}^{i=Mar(T+2)} B_i$$

9-11 months:

$$\frac{(B_{Jan(T-1)} + B_{Mar(T+2)})}{6} + \frac{(B_{Feb(T-1)} + B_{Feb(T+2)})}{2} + \frac{5*(B_{Mar(T-1)} + B_{Jan(T+2)})}{6} + \sum_{i=Apr(T-1)}^{i=Dec(T+1)} B_i$$

$$L_x = \frac{l_x + l_{x+1}}{2}$$

Each of the total groups of deaths is then divided by the appropriate at risk population calculated above and the results totalled to give q_0.

The m_0 shown in the life table is calculated from q_0 using the formula:

$$m_0 = \frac{2q_0}{2 - q_0}$$

By making assumptions for the average age of death for each of the periods used for the infant death calculation, a_0 can be calculated. The assumed average ages at death are as follows:

Age at death	Assumed average age at death (months)	Notes
<4 weeks	0.2	Based on analysis of England and Wales data for deaths under 1 month
1-2 months	1.5	
3-5 months	4	
6-8 months	7	
9-11 months	10	