Life Table

CHAPTER-8

Mortality table

1. The concept and basic principles of building a life table

2. System of interrelated indicators and calculations in the table of vitality

The subject

The subject of this chapter is the estimation of the average life expectancy of populations and expectation of life at different ages through the preparation of life tables.

1. The concept and basic principles of building a life table

In the statistics of the population, the table method has become very popular. Demographic tables are constructed on the basis of sex-age probabilities and the coefficients of demographic events for the so-called hypothetical (conditional) generation

One of the concerns of demographic analysis is the measurement of the longevity of populations.

A detailed description of one of the aspects of population reproduction is given by mortality tables, which in foreign statistics are also called life tables or tables of life (French-tableaux de mortalité, English-life tables)

Life table

According to Bogue, “The life table is a mathematical model that portrays mortality condition at a particular time among a population and provides a basis for measuring longevity. It is based on age specific mortality rates observed for a population for a particular year.”

The condition for carrying out the calculations in the mortality table is to maintain unchanged age-specific mortality rates. In other words, the table shows the order of extinction of the simultaneously born set of individuals in different age groups, provided that throughout the life of the studied generation the same mortality rates

The number of survivors is taken provisionally at the rate of 10 thousand or more per 100 thousand people; therefore all the indicators of the table are relative, not absolute values. Further we will proceed from the fact that our relative indicators are calculated for 100 thousand people.

LTs are compiled on the basis of the current statistical information on mortality. The death rate is calculated according to the year of the population census. The initial set of 100 thousand births is called the root of the LT

In the subject table are given single-year groups of the population, beginning with the zero (0) age and ending with the maximum age of N-1 years, that is, the year when the last representative of the studied generation dies

The predicate contains the following indicators.

1. Number of surviving to the age of x years l_X. The letter x denotes the age in years. For example, l_o is the initial number of births, equal to 100 thousand, and l_1 - the number of children surviving to the age of 1 year

Three major assumptions

Assumption 1: no migration

Assumption 2: annual age-specific death rates that do not change over time

Assumption 3: annual number of births that remains constant over time; the annual number of births chosen is usually 100,000 and accordingly the synthetic population has 100,000 deaths annually over time; thus, the synthetic population is stationary in that it never changes in size.

Data Requirements

- deaths by the age of the deceased over a period of time

- people classified by age who were alive in the middle of the same year.

Age Specific Death Rates

$$m_x = \frac{d_x}{P_x} \tag{1}$$

The probability of dying

$$q_x = \frac{d_x}{P_x + \frac{1}{2} d_x} \qquad (2)$$

probability of dying

$$q_x = \frac{\frac{d_x}{P_x}}{\frac{P_x}{P_x} + \frac{1}{2}\left(\frac{d_x}{P_x}\right)} \qquad (3)$$

The probability of dying

$$q_x = \frac{m_x}{1 + \frac{1}{2} m_x} \quad \text{simplified as :}$$

(4)

$$q_x = \frac{2m_x}{2 + m_x}$$

The probability of dying

$$q_0 = \frac{d_0}{B} \qquad (5)$$

The probability of dying

$$q_\omega = 1 \qquad (6)$$

Given that an x year old person will either die before reaching age $x + 1$, survive to the next age $x + 1$, it is certain that $(q_x + p_x) = 1$, and

$$p_x = 1 - q_x \qquad (7)$$

Number of deaths

$$d_x = q_x * l_x \qquad (8)$$

$$l_{x+1} = l_x - d_x \qquad (9)$$

And this equation can be re-written as:

$$d_x = l_x - l_{x+1} \qquad (10)$$

People alive at the beginning of that year

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

Substituting the value of (dx) from Eq. (10)

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

People alive at the beginning of that year

$$L_x = \frac{1}{2}\ (l_x + l_{x+1})$$ (11)

$$L_x = 0.5l_x + 0.5l_{x+1}$$ (12)

If the assumption in 2 holds then:

$$L_x = l_{x+0.5}$$ (13)

Because deaths are not uniformly distributed in early years of life (particularly the first year), (L0) may be calculated as follows:

$$L_0 = 0.3l_0 + 0.7l_1$$ (14)

$$L_{x+} = \frac{d_{x+}}{m_{x+}} \quad (15)$$

$$L_{x+} = l_x * log(l_x) \quad (16)$$

Total person-years lived beyond age x

$$T_x = L_x + L_{x+1} + L_{x+2} + \ldots + L_\omega \qquad \textbf{(17)}$$

Where ω is the highest attainable age. This can be done rather easily by cumulating (Lx) from age ω to age x.

life expectancy at age x

$$e_x = \frac{T_x}{l_x} \qquad \textbf{(18)}$$

Characteristics of Life Table Populations

- population will remain closed to migration
- every year it will be augmented by a constant number of births
- it will experience a constant schedule of mortality (q_x) every year
- deaths will generally occur uniformly within each year.

the characteristics of hypothetical population

- L_x is the number of persons at each age
- T_0 is the total size of the population
- l_0 is the number of births
- d_x is the number of deaths at each age
- the crude birth rate $= \frac{l_0}{T_0}$

$$\sum_{x=0}^{x=\omega} d_x = (l_0 - l_1) + (l_1 - l_2) + (l_2 - l_3) + \cdots = l_0$$

$$\sum_{x=0}^{x=\omega} d_x = d_0 + d_1 + d_2 + \cdots + d_{\omega-1}$$

$$\text{the crude death rate} = \frac{l_0}{T_0}$$

Thank you for attention!