DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

# CONSTRUCTION OF MORTALITY TABLE FOR PENSION SYSTEM AND TURKEY

by
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August, 2012
İZMİR

# CONSTRUCTION OF MORTALITY TABLE FOR PENSION SYSTEM AND TURKEY

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**by**
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We have read the thesis entitled **"CONSTRUCTION OF MORTALITY TABLE FOR PENSION SYSTEM AND TURKEY"** completed by **HANİFE TAYLAN** under supervision of **ASSOC. PROF. DR. GÜÇKAN YAPAR** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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# CONSTRUCTION OF MORTALITY TABLE FOR PENSION SYSTEM AND TURKEY

## ABSTRACT


In actuarial science and demography, a life table is a table which shows, for each age, what the probability is that a person of that age will die before his or her next birthday. Developments countries use a life table which reflects demographic structure of their countries. The purpose of this thesis is constructed a life table which is demonstrated demographic features of Turkey with changing database.

In application of this thesis, Turkey Abridged Period Life Tables are constructed by using population, deaths and births data which are published by TUİK. The tables are obtained for general, female and male population in section 5.4. The forecasting of older ages pattern of mortality have been necessaried because of increasing older population. Thus, number of person lived have been estimated for older ages in section 5.4.1. In section 5.4.2, Abridged Period Life Tables have been finally formed for regions that are determined in level IBBS-1 by TUİK. In section 5.3, The Exponential Smoothing Method is used for modeling death rates of urban and general population. The death rates of urban population are forecasted by using smoothed constant are compared the real deaths rates of general population. As a result of this analysis showed us, trend of urban and general death rates are different to each other.

In this thesis, Turkey Life Tables are constructed by using survival analysis. And the methodology of survival analysis is explained in section 2. Moreover, demographic approach is used for period life table analysis which is explained in section 3.



**Keywords:** Survival analysis, life/mortality table, period life table, exponential smoothing.

# TÜRKİYE VE SOSYAL GÜVENLİK SİSTEMİ İÇİN YAŞAM TABLOSUNUN OLUŞTURULMASI

## ÖZ

Yaşam tablosu aktüerya bilimi ve demografi alanında bir toplumda yaşayan insanların her bir yaş için ölüm ve yaşama olasılıklarının gösterildiği tablolardır Gelişmiş ülkeler kendi demografik yapılarını yansıtan yaşam tablolarını kullanırlar. Bu çalışmanın amacı değişen veri kayıt sistemi ile birlikte ülkemizin demografik yapısını yansıtan yaşam tablolarının oluşturulmasıdır.

Bu tezin uygulamasında, Türkiye İstatistik Kurumundan (TUİK) elde edilen ölüm, nüfus ve doğum verileri kullanılarak Türkiye Özetlenmiş Dönem Yaşam Tabloları elde edilmiştir. Tablolar uygulama bölümü 5.4'te Türkiye geneli, kadın ve erkek nüfus için oluşturulmuştur. Ülkemizde giderek artan yaşlı nüfusu, oluşturulan yaşam tablolarının ileriki yaşlar için tahminini gerekli kılmıştır. Bu yüzden 5.4.1'de yaşayan kişi sayısı yaşlı nüfus için tahmin edilmiştir. Son olarak bölüm 5.4.2'de TUİK tarafından İBBS-1 düzeyinde tanımlanan bölgeler için Özetlenmiş Dönem Yaşam Tabloları oluşturulmuştur. Bölüm 5.3'te il-ilçe ve genel nüfusun ölüm oranlarının modellenmesi için üstel düzleştirme yöntemi kullanılmıştır. İl-ilçe nüfusunun ölüm oranları, düzleştirme sabitleri kullanılarak tahmin edilmiştir. Elde edilen tahmin değerleri genel nüfusun gerçek ölüm oranlarıyla karşılaştırılmıştır ve il-ilçe ve genel nüfusun ölüm oranlarının trendlerinin farklı olduğu görülmüştür.

Yaşam tablosu oluşturmak için yaşam sürelerinin modellenmesini sağlayan sağkalım analizi kullanılmıştır ve metodolojisi bölüm 2'de anlatılmıştır. Ayrıca bu çalışmada dönem yaşam tablosu analizi için geliştirilen demografik yaklaşımlar kullanılmış ve bölüm 3'te metodolojisi anlatılmıştır.

**Anahtar Kelimeler:** Sağkalım analizi, yaşam tablosu, dönem yaşam tablosu, üstel düzleştirme yöntemi.

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# CHAPTER ONE
# INTRODUCTION

Improvement for life conditions, developments in medical and technological conditions yields change of demographic structure in our country. These developments caused longevity and increase the rate of older population. Increase in older population creates many risk factors such that decrease in working population, longer pensions, rise in health expense, charge on younger population and rising in social problems. Besides these risk factors, lengthen life expectancy which is an important indicator of development and health shows that the prosperity of a country rises (Çiftçi, 2008).According to the study which is completed by the researchers at the department of gerontology of Mediterranean University in 2012 states that population is getting older in Turkey. Modeling pattern of mortality and forecasting future demographic structure have an important role in the management of social security, employment and renovation of health system for our country.

Analyzing some indicators related with life such as probability of deaths, number of survivors, number of deaths and survivals, life expectancy and so on can be obtained by constructing life table which demonstrates country's demographic structure. Unfortunately, studies in our country have not been progressed because of lack of reliable database. Since reliable and official data which is necessary for demographic researches was declared in 2009.

First attempt for construction of Turkey Life and Life Annuity tables using Preston Bennett method tended together with some academicians by Republic of Turkey, Prime Ministry, Under Secretariat of Treasury (Haymer, 2010). The last study in Turkey is constructed the complete period life table of 2009, and in this study, Heligman and Pollard method which is approach interpreted with different eight parameters is used by Smoothing method (Şirin, 2011).

Life tables are widely used in many areas. In particular, these tables are crucial in actuary and demography. The tables is used some areas such as product creation and premium assurance calculation in insurance, calculation of health expenditure and social security obligations in pension system. In demography, life tables can be used to distinguish different risk factors for life expectancy, such as smoking statues occupation, socio-economic class and others. Moreover, as clinical and epidemiologic researches become more common, the life table analysis has been applied to patients with a given disease who have been followed for a period of time (Lee & Wang, 2003).

Survival analysis is the phrase used to describe the analysis of data in the form of times from a well-defined time origin until the occurrence of some particular event or end point. Life table is obtained by analyzing occurrence time until people die in a population. The survival analysis is used not only in examination of mortality but also in examination of measure process. Mentioned process is determined time from the beginning of any event to ending and it can be applied for living and nonliving units. The process is used in many areas such as; i) analyzing treatment time of a disaster and analyzing survival time of patient with cancer in medical area (Ferlay et al, 2006), ii) measure of unemployment times in economic area, iii) analyzing breakdown times for any tool in industry area, iv) analyzing marriage time for married couple in demography area (Preston et al, 2001), v) analyzing retirement times in pension system.

Modeling age pattern of mortality is a specific field in life table analysis. The search for a mathematical model of age variation in mortality risk is called mortality law. The development of a ‘law of mortality’, a mathematical expression for the graduation of the age pattern of mortality, has been of interest since the development of the first life tables by John Graunt (1662) and Edmund Halley (1693). Although Abraham De Moivre proposed a very simple law as early as 1725 the best known early contribution is probably that of Benjamin Gompertz (1825). The shape of mortality curve includes many parameters. “Law of geometric progression pervades” was first noticed by Gompertz (1825) and was also suggested representing the mortality risk for a certain age. Makeham (1860) considered to act of age and suggested adding a constant to Gompertz’s model. For older ages the laws are commonly used smooth data (Horiuchi and Coale, 1982). Suggestions' belonging to Gompertz and Makeham applied to younger ages tends to over predict mortality (Horiuchi and Coale, 1990).

The best-fitting are the functions including the age pattern of mortality in childhood, young adulthood and senescence. The Heligman Pollard model (Heligman & Pollard, 1980) also has eight parameters; each term takes positive values only at relevant ages, the whole function being estimated in one step. The parameters have meaningful interpretations. Others encountered difficulties, particularly in determining the best base period for projecting the parameters (Keyfitz, 1991) and (Pollard, 1987). McNown and Rogers (1989) modeled the eight parameters as univariate ARIMA processes.

The Heligman Pollard model represents senescent mortality using the Gompertz function; three variants were also proposed. This method is still used in United States population by National Center for Health Statistics. (Arias, 2010). Kostaki (1992) introduced a ninth parameter to improve the fit at young adult ages.

The Brass Relational Logit Model (1971) are used for forecasting at an older ages mortality. The relational model of mortality (Brass, 1971) linearly relates the logit transformations of observed and standard mortality. Forecasts based on this model include those by Golulapati, De Ravin, and Trickett (1984) for Australian male cohorts and Keyfitz (1991) for Canadian data.

McNown and Rogers (1989) was suggested projection methods of forecasting the hazard or mortality and was also used the functional form of Heligman Pollard (1980) to explain age behavior with time series model. McNown and Rogers (1992) forecast total mortality and five cause-specific mortalities by fixing six parameters and modeling only the level parameters by univariate ARIMA models.

Method of exponential smoothing is another approach for smoothing and forecasting mortality rates. Modeling future age-specific breast cancer mortality using state-space exponential smoothing models as described by Hyndman et al (2002) and similarly by Erbas et al (2005). Exponential smoothing method is applied for forecasting age-related changes in breast cancer mortality among white and black US women (Yasmeen et al, 2010).

Life tables describe the mortality and survival experience of a population. These tables can be described different forms as period or cohort. Cohort life table explains the survival and mortality pattern for people who are all born in the same year or in the same period. Period life-tables are synthetic constructs that show what the mortality patterns of a hypothetical group of persons would be if they experienced the death rates observed in a population during a given period. In the United states, cohort and period life tables by age, sex and race are published from time to time by the National Center of Health Statistics (NCHS). Similar to Australian Life Tables (Cohort and Period life tables) are issued by Australian Bureau of Statistics (ABS). In United Kingdom period life tables are constructed by The Government Actuary, based on the mortality experience of general populations in England and Wales, known as English Life Tables, and in Scotland. At 2006, responsibility for the production of national life tables transferred to the Office for National Statistics (ONS). In New Zealand, similar period and cohort life tables are published by Statistics New Zealand (SNZ). These tables are constructed from registrations of births, deaths and population estimates.

Cohort life-tables have the advantage of conceptual simplicity, but the disadvantage of requiring data for, and referring to mortality risks over a very long time span. Since the upper limit of human life is about 100 years, a cohort life table can be constructed only for groups of persons born at least one hundred years ago. Even when such life-tables can be constructed and this is not possible for many countries of the world, including many developed countries they represent mortality experience over a very long period.

Period life tables are conceptually more complex, but have the advantage of providing mortality measures localized in time. It shows the change in expectation of life at birth from one year to the next. Most life-tables available for human populations are, in fact, period life-tables. It is also possible to distinguish between period and cohort statistics in a more general way because life-table measures can be constructed on the basis of cohort experience over just a portion of the human life span. Period mortality statistics are those calculated on the basis of deaths observed during a given period and cohort statistics are those calculated on the basis of all deaths occurring to a particular group of persons followed over time.

In this thesis, the period life tables will be constructed by interpreting mortality experience of Turkey. The study consists of five chapters. In the first chapter, the introduction containing the areas of usage life table and the development of the life table analysis concepts which are the modeling mortality experience and the demographic approach are introduced. In the second chapter, the notations of the survival theory is explained in detail. In the third chapter, the notations of the Period Life Table is introduced and explained in detail by using demographic approach. In the fourth chapter, the exponential smoothing method is explained in detail. In the fifth chapter, the data of deaths are analyzed according to one parameter double exponential smoothing method and the period life tables are constructed by gender and region for Turkey. In the last chapter, the deductions gathered from the application are interpreted.

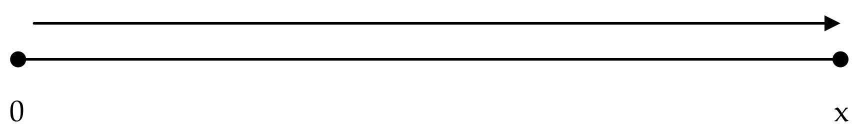
## CHAPTER TWO
## LIFE TABLE ANALYSIS

### 2.1 Survival Models

A survival model is a probabilistic model of a random variable that represents the time until the occurrence of an unpredictable event such as failure, deaths, response, relapse or divorce. For instance, we may wish to study the life expectancy of a newborn baby, the future working lifetime of a person until he/she retires or the lifetime of a machine until it fails. In both cases, we study how long the subject may be expected to survive. The focus of our study is the time until the specified event takes place which is known as waiting time or a random time until the specified event occur. Probabilities associated with these models play a central role in actuarial calculations such as life table. The life table method measures mortality and describes the survival patterns of a population. It has been used by actuaries, demographers, agencies and medical researchers in studies of survival, population growth, fertility, migration, length of married life and so on (Lee & Wang, 2003). In this part, we study the theory of survival models in mortality table functions.

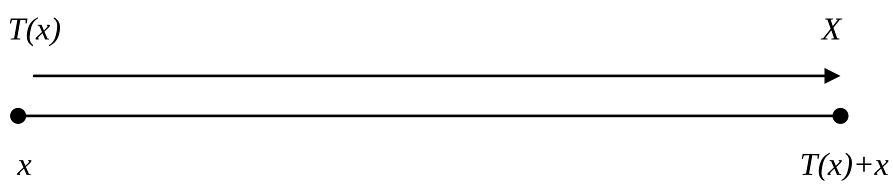
Random lifetime, complete future lifetime and curtate future lifetime are three basic variables, all of which are measured in years (Bowers et al, 1997):

- The random lifetime of a newborn life is denoted by *X*.




- The complete future lifetime at age *x*, given that a newborn has survived to age *x*, is denoted by $T(x)$.

$$T(x) = (X - x \mid X > x)$$



- The curtate future lifetime at age *x*, given that a newborn has survived to age *x*, is the complete number of years of future lifetime at age *x* and is denoted by $K(x)$.

$$K(x) = \lfloor T(x) \rfloor$$

It should be pointed out that in order to understand three concepts: *X* and *T* are assumed to be continuous random variables while *K* is a discrete random variable. *K* is a function of *T* and *K* is the integer part of *T*. In the same way *T* is a function of X. So these random variables are associated with each other. Life tables are pivot tables constructed for actuarial calculations and life insurance and definitely example for discrete survival models. When to construct a life table, choosing an initial age is chosen firstly and enough number of persons is assumed lives at that age. Number of persons at initial age is called radix number and this number is generally an integer value multiples of ten like 100.000, 1.000.000 or 10.000.000. When life table is constructed, some variables are defined which are denoted by $l_x$, $d_x$, $q_x$ and $p_x$. The formula of the variables is given as follows (Cunningham et al, 2006). $l_x$ is defined as the number of lives expected to age *x* from a group of $l_0$ newborn lives. $d_x$ represents the number of lives among $l_0$ newborns die in the age range $x$ to $x+1$. It is formulated as:

$$d_x = l_x - l_{x+1}$$

In life table, $q_x$ is defined as a probability that a person currently at age *x* will die within a year and it is calculated as:

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

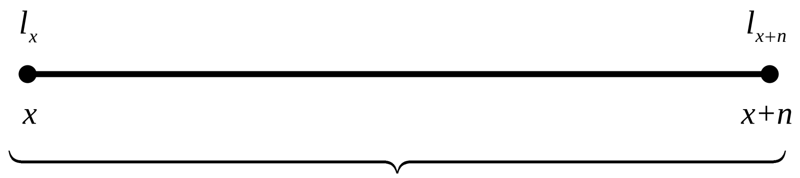
In a life table, $p_x$ is defined as a probability that a person currently at age *x* will survive the following age and it is calculated as:

$$p_x = \frac{l_{x+1}}{l_x}$$

Clearly not the case, there are two options that a person at age x, will survive or die within a year. There is no other option. According to the general concept of probability, life and death variables are complement of each other for any age. So the probability of death and life will be one for any age.

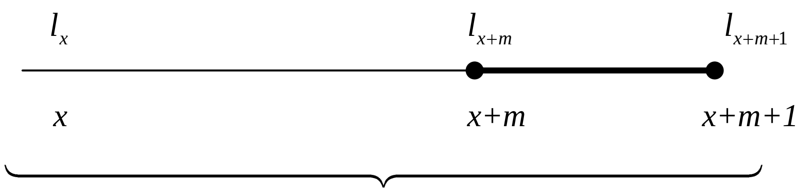
$$p_x + q_x = 1$$

Moreover, the probability of death and life can be calculated for each age interval (Gauger, 2006). The probability that a life currently at age *x*, will survive *n* years and it is denoted by ${}_n p_x$.



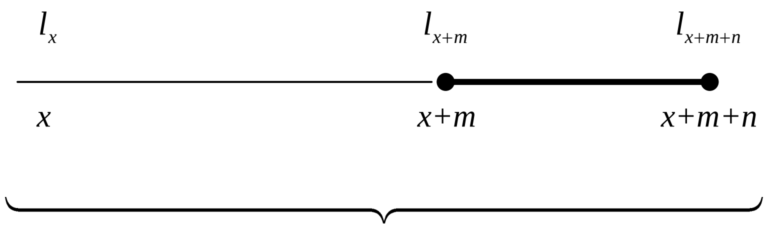

$${}_n p_x = \frac{l_{x+n}}{l_x}$$

Another formula states the probability that a life currently at age *x* will survive for *m* years and then die within one year is denoted by ${}_{m|}q_x$. $d_{x+m}$ people die at the age of $x+m$ from the $l_x$ people whom lives at the age of *x* then formula is attained as follows:




$${}_{m|}q_x = \frac{d_{x+m}}{l_x}$$

Lastly states the probability that a life currently at age *x* will survive for *m* years and then die within *n* years is denoted by ${}_{m|n}q_x$. This probability can be calculated as:




$$ {}_{m|n}q_X = \frac{d_{x+m} + d_{x+m+1} + \ldots + d_{x+m+n-1}}{l_x} = \frac{l_{x+m} - l_{x+m+n}}{l_x} $$

In actuary, at the expression ${}_{m|n}q_x$, sign *m* which is at the left side of the symbol $|$ shows waiting time and it is called deferred time, and which is at the right of the symbol $|$ shows desired time after waiting time.

Life tables can be defined as probabilistic. Let the random number of survivors at age *x* in life tables from the $l_0$ newborn babies. If the probability of any babies survival at the age of *x* states $p = \Pr\left(X > x\right) = s_X\left(x\right)$, the number of survivors at age *x* from the $l_0$ newborn babies can be distributed binomial (Slud, 2001). The parameters of binomial distribution are $n = l_0$ and $p = s_X\left(x\right) = {}_x p_0$. Because any individuals are bernoulli trials and the probability of success is survived at age *x* for any individuals. So the variance and the expected value of number of survivors at age *x* can be find by fallowing equations:

$$ E\left[L\left(x\right)\right] = l_x = np = l_0 s_X\left(x\right) $$

$$ Var\left[L\left(x\right)\right] = npq = l_0 s_X\left(x\right)\left(1 - s_X\left(x\right)\right). $$

Four mathematical functions will be defined at this part. Then these functions will be used to define new random variables and estimate future lifetime (Bowers et al).

### *2.1.1 Cumulative Distribution Function*

*X* is assumed to be a continuous random variable of a newborn that has a random lifetime (age of death). The probability that a newborn will die at or before *x* is defined by cumulative distribution function (cdf) and denoted with $F_X\left(x\right)$:

$$F_X(x) = \Pr(X \le x) = {}_x q_0.$$

It is possible to calculate cdf from probability density function (pdf). If the probability density function of random variable, *X*, is known, then the cumulative density function can be calculated by:

$$F_X(x) = \Pr(X \le x) = \int_0^x f_X(u)\,du.$$

$F_X(x)$ is non-decreasing and continuous with $F_X(0) = 0$ and $F_X(w) = 1$where *w* is the first age at which death is certain to have occurred for a newborn life.

### *2.1.2 Probability Density Function*

The probability density function is obtained by derivation of cumulative density function of a continuous random variable. Then, the probability density function of a random lifetime is:

$$f_X(x) = F_X'(x) = \frac{d}{dx} F_X(x).$$

Assuming that *X* is a continuous random variable, then the probability that a newborn life dies between ages *x* and *z*:

$$\Pr(x < X \le z) = \int_x^z f_X(u)\,du = F_X(z) - F_X(x).$$

It should be remarked that $F_X(x)$ is a probability of certain time interval as $f_X(x)$ is not a probability but also is a value. The probability that a newborn life dies in the interval $[x, x + \Delta x]$ can be estimated as:

$$\Pr(x \le X \le x + \Delta x) \approx f_X(x).\Delta x.$$

And the properties of probability density function of a newborn life at age *x* is:

- $f_X(x)$ is a continuous and nonnegative function in a range of $[0, w)$.
- $\int_0^w f_X(x)\,dx = 1$

### *2.1.3 Survival Function*

The survival function, $s_X(x)$, is defined as the probability of a newborn life survives to age *x* or is alive at age *x* and represented as follows:

$$s_X(x) = \Pr(X > x) = 1 - \Pr(X \le x) = 1 - F_X(x) = {}_x p_0.$$

Survival function is equal to one minus cumulative distribution function so this relation showed that survival function is a probability of a certain time interval. The listed properties of survival functions of a newborn life at age $x$ are given as follows:

- $s_X(x)$ is a continuous and decreasing function.
- $s_X(0) = 1 \quad and \quad s_X(w) = s_X(\infty) = 0$
- $s_X(x) = \dfrac{l_x}{l_0} = {}_x p_0$
- $s_X(x) = 1 - F_X(x)$
- $f_X(x) = -s'_X(x) = -\dfrac{d}{dx} s_X(x)$
- $\Pr(x < X \le z) = \int_x^z f_X(u)\,du = s_X(x) - s_X(z)$

### *2.1.4 Force of Mortality*

In actuarial science, force of mortality represents the instantaneous rate of mortality at a certain age measured on an annualized basis. It is identical to failure rate in concept, also called hazard function in reliability theory. In a life table, we consider the probability of a person dying from age *x* to *x* + 1, called $q_x$. In the continuous case, we could also consider the conditional probability of a person who has attained age (*x*) dying between ages *x* and *x* + *Δx*, which is

$$\Pr(\Delta x) = \Pr(x < X \le x + \Delta x \mid X > x) = \frac{F_X(x + \Delta x) - F_X(x)}{1 - F_X(x)}$$

$$\cong \frac{f_X(x)\Delta x}{1 - F_X(x)} = \frac{f_X(x)}{1 - F_X(x)}$$

where $F_X(x)$ is the distribution function of the continuous age-at-death random variable, *X*. As *Δx* tends to zero, so does this probability in the continuous case. The approximate force of mortality is this probability divided by *Δx*. If we let *Δx* tend to zero, we get the function for **force of mortality**, denoted by $\mu(x)$:

$$\mu_X(x) = \frac{F_X'(x)}{1 - F_X(x)}$$

Since $f_X(x) = F_X'(x)$ is the probability density function of *X*, and $s_X(x) = 1 - F_X(x)$ is the survival function, the force of mortality can also be expressed variously as:

$$\mu_X(x) = \frac{f_X(x)}{1 - F_X(x)} = \frac{f_X(x)}{s_X(x)} = \frac{-\frac{d}{dx}s_X(x)}{s_X(x)} = -\frac{d}{dx}\ln s_X(x)$$

So the force of mortality is given, the survival function can be obtained by using integrated formula as:

$$\mu_X(x) = -\frac{d}{dx}\ln s_X(x) \;\Rightarrow\; \int_0^x \mu_X(t)\,dt = -\ln s_X(x)$$

To understand conceptually how the force of mortality operates within a population, consider that the ages, *x*, where the probability density function $f_X(x)$ is zero, there is no chance of dying. Thus the force of mortality at these ages is zero.

The force of mortality $\mu(x)$ can be interpreted as the conditional density of failure at age *x*, while $\mathrm{f_X(x)}$ is the unconditional density of failure at age *x*. The unconditional density of failure at age *x* is the product of the probability of survival to age *x*, and the conditional density of failure at age *x*, given survival to age *x*.
This is expressed in properties of force mortality as

- $\mu(x)$ is a piece wise continuous and nonnegative where defined
- $\int_0^\infty \mu(y)\,dy = \infty$ in order that $s_X(\omega) = 0$
- $\mu_X(x) = \frac{f_X(x)}{s_X(x)} = -\frac{s_X'(x)}{s_X(x)} = -\left(\ln\left(s_X(x)\right)\right)' = -\frac{l_x'}{l_x}$

- $s_X(x) = \exp\left(-\int_0^{\infty} \mu(y)\,dy\right)$
- $\mu_X(x).\Delta x \approx \Pr\left(X \le x + \Delta x \middle| X \ge x\right)$

Note that standard probabilities in a continuous survival model which is connected with life table functions defined that:

Conditional on survival to age *x*, the probability of living to reach age $x+t$ is:

$$ {}_t p_x = \frac{l_{x+t}}{l_x} = \frac{s_X(x+t)}{s_X(x)} = \frac{\Pr(X > x+t)}{\Pr(X > x)} = \Pr\left(X > x+t \middle| X > x\right)$$

Conditional on survival to age *x*, the probability of dying within *n* years is:

$$ {}_t q_x = \frac{l_x - l_{x+t}}{l_x} = \frac{\Pr(X > x) - \Pr(X > x+t)}{\Pr(X > x)} = \Pr\left(X \le x+t \middle| X > x\right)$$

Conditional on survival to age *x*, the probability of living within s years but dying in the fallowing *t* years is:

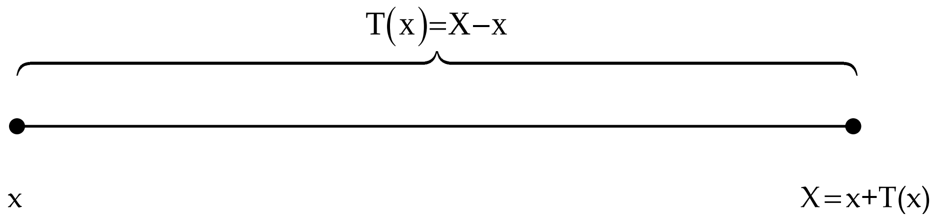
$$ {}_{s|t} q_x = \frac{l_{x+s} - l_{x+s+t}}{l_x} = \Pr\left(x+s < X \le x+s+t \middle| X > x\right)$$

### *2.1.5 Complete Future Lifetime*

According to that *X* is a continuous random lifetime of a newborn that is given survival age *x,* the future lifetime after age *x* will be $X - x$. This random variable is called complete future lifetime and denoted by $T(x)$ . The conditional distribution of the time lived after age *x*, given survival to age *X*, is:

$$T(x) = \left(X - x \middle| X > x\right)$$

*X* and $T(x)$ are to be the same value for a newborn$(age\ x = 0)$. But it should be known that a random variable *X* is defined by $X = x + T(x)$ in here.




Using the relationship between the random variable $X$ and random variable $T\left(x\right)$ and using the properties of conditional distribution, survival function of a complete future lifetime after age x is obtained as follows:

$$s_{T(x)}\left(t\right)={}_{t}p_{x}=\Pr\left(T\left(x\right)>t\right)=\Pr\left(X>x+t\,\middle|\,X>x\right)$$

$$=\frac{\Pr\left(X>x+t\cap X>x\right)}{\Pr\left(X>x\right)}=\frac{\Pr\left(X>x+t\right)}{\Pr\left(X>x\right)}=\frac{s_X\left(x+t\right)}{s_X\left(x\right)}.$$

The distribution function of $T\left(x\right)$ is meant that conditional on survival age x, the probability of dying within $t$ years and is obtained as follows:

$$F_{T(x)}\left(t\right)={}_{t}q_{x}=\Pr\left(T\left(x\right)<t\right)=\Pr\left(X\le x+t\,\middle|\,X>x\right).$$

The probability density function of $T\left(x\right)$ is calculated to use the derivative of distribution and survival functions of complete future lifetime.

$$f_{T(x)}\left(t\right)=\frac{d}{dt}F_{T(x)}\left(t\right)=-\frac{d}{dt}\frac{s_X\left(x+t\right)}{s_X\left(x\right)}=\frac{f_X\left(x+t\right)}{s_X\left(x\right)}\qquad 0\le t\le w-x$$

Using the equation of $\mu_X\left(x\right)=\dfrac{f_X\left(x\right)}{s_X\left(x\right)}$, the force of mortality of $T\left(x\right)$ is computed as fallow:

$$f_{T(x)}\left(t\right)=\frac{f_X\left(x+t\right)}{s_X\left(x\right)}=\frac{s_X\left(x+t\right)\mu_X\left(x+t\right)}{s_X\left(x\right)}\Rightarrow\mu_X\left(x+t\right)=\frac{f_X\left(x+t\right)}{s_X\left(x+t\right)}.$$

There are expressed to properties of complete future lifetime as:

- $s_{T(x)}\left(t\right)=\Pr\left(T\left(x\right)>t\right)={}_{t}p_{x}=\dfrac{s_X\left(x+t\right)}{s_X\left(x\right)}=\dfrac{l_{x+t}}{l_x}$

- $F_{T(x)}(t)=\Pr\left(T(x)\le t\right)={}_t q_x=\dfrac{F_X(x+t)-F_X(x)}{s_X(x)}=\dfrac{l_x-l_{x+t}}{l_x}$
- $f_{T(x)}(t)=\dfrac{f_X(x+t)}{s_X(x)}={}_t p_x.\mu_X(x+t).$

### *2.1.6 Curtate Future Lifetime*

Recall that *X* is a continuous random variable of a newborn life and $T(x)$ is a complete future lifetime currently at age *x* and $K(x)$ is a curtate future lifetime currently at age *x*, is an integer value of complete future lifetime. *X* and $T(x)$ are continuous random variables while $K(x)$ will be a discrete random variable. Under the survival models it is defined as $K(x)=\lfloor T(x)\rfloor$. The possible values of $K(x)$ are the numbers $(0,1,2,3,\dots,w-x-1)$. The key observation is that $K(x)=k$, then we must have:

$$k\le T(x)<k+1$$

It is simple to calculate the probability function of curtate future lifetime after age *x* from what it is known about $T(x)$:

$$\begin{aligned} {}_{k|}q_x &= \Pr\left(K(x)=k\right)=\Pr\left(k\le T(x)<k+1\right) \\ &= \Pr\left(x+k\le X<x+k+1 \mid X>x\right) \\ &= \frac{d_{x+k}}{l_x}=\frac{l_{x+k}-l_{x+k+1}}{l_x} \qquad ; \qquad k=0,1,2,\dots,w-x-1 \end{aligned}$$

and the distribution function of $K(x)$ is calculated as:

$$\begin{aligned} F_{K(x)}(k) &= \Pr\left(K(x)\le k\right)==\Pr\left(K(x)=0\right)+\dots+\Pr\left(K(x)=k\right) \\ &= \sum_{h=0}^{k} {}_{h|}q_x = {}_{k+1}q_x \end{aligned}$$

and finally survival function of $K(x)$ is calculated from distribution function as:

$$s_{K(x)}(k)=\Pr\left(K(x)>k\right)=1-F_{K(x)}(k)=1-{}_{k+1}q_x={}_{k+1}p_x.$$

### *2.1.7 The Functions of Life Table*

Recall that relationship of the $s_X(x)$ and $l_x$ is given as $l_x = l_0.s_X(x)$. In there, a new two mortality table function derived from $l_x$ and these functions are useful devices in the calculation of life expectancy. First one is the number of person years lived by the survivors to age x during the next year and denoted by $L_x$.

$$L_x = \int_x^{x+1} l_y dy$$

The other function is aggregate person years lived from age x to last age $\omega - 1$ and denoted by $T_x$. Consider a brief time interval $[y, y + \Delta y]$ that is a part of the interval $[x, \omega]$. At the start of this brief period there are $l_y$ survivors. It can be estimated that the total people years lived by the survivors during this brief period by $l_y \Delta y$. This approximation ignores the possibility that anyone dies in the short time available. These people years lived over a set of disjoint sub intervals of length $\Delta y$ comprising the age interval $[x, \omega]$ are summed, then a Riemann sum for the integral $\int_x^w l_y dy$ is obtained. This Riemann sum can be interpreted as an approximation to the total number of people years lived after age *x* by the survivor to age *x*. Taking a limit as $\Delta y$ goes to zero, then it has been the integral:

$$T_x = \int_x^w l_y dy = L_x + L_{x+1} + ... + L_{w-1}$$

The function of $L_x$ includes one year period as The function of $T_x$ includes a time period from age *x* to last age $\omega - 1$.

## 2.2 Expected Survival Periods

In this part, we will deal with the expected future lifetime values of random survival future lifetime, *X*, random complete future lifetime, $T(x)$, and curtate future lifetime, $K(x)$. We will be making assumptions on future lifetimes by making modifications on these random variables.

### *2.2.1 Curtate Life Expectancy*

We can obtain moments of random variables for the lifetime of a newborn until death; in other words, survival period. Most important of these moments is the expected lifetime or survival period of a newborn. The continuous random variable that defined as $X$ was a survival period of a newborn baby. If we can find the expected value of this variable; then we can find the curtate life expectancy of a newborn and symbolize this expected value with $\overset{0}{e}_0$. In this section, we have attended to the calculations of this expected value. As we have mentioned in the earlier sections, $X$ is a continuous random variable. The expected value of $X$ is defined as follows;

$$\overset{0}{e}_0 = E[X] = \int_0^\infty x\, f_X(x)\,dx$$

Since curtate life expectancy of a newborn can be calculated using survival function, the integral above can be solved with partial integration. It's form is given by

$$\int u\,dv = uv - \int v\,du$$

where $u = x \Rightarrow du = dx$ and $f_X(x)\,dx = dv \Rightarrow -s_X(x) = v$

The curtate life expectancy of a newborn is again obtained by partial integration and the use of survival function

$$\overset{0}{e}_0 = E[X] = \int_0^\infty x\, f_X(x)\,dx = \underbrace{\left(-x\, s_X(x)\Big|_0^\infty\right)}_{0} + \int_0^\infty s_X(x)\,dx = \int_0^\infty s_X(x)\,dx$$

### *2.2.2 Remaining Life Expectancy*

Under this heading, we will deal with the moments of $T(x)$ random variable defined for survival period. By calculation of the expected value of the random variable $T(x)$, expected value of remaining life of a person aged *x* can be calculated. The value is shown with $\overset{0}{e}_x$ and formulated as follows

$$\overset{0}{e}_x = E\left[T(x)\right] = \int_0^{\infty} t\, f_{T(x)}(t)\,dt = \int_0^{\infty} t \frac{f_X(x+t)}{s_X(x)}\,dt = \frac{1}{s_X(x)}\int_0^{\infty} t\, f_X(x+t)\,dt$$

Integral in the equation can be solved using partial integration as done in the previous section and

$$\overset{0}{e}_x = \frac{1}{s_X(x)}\int_0^{\infty} s_X(x+t)\,dt = \int_0^{\infty} \frac{s_X(x+t)}{s_X(x)}\,dt = \int_0^{\infty} {}_t p_x\,dt$$

is obtained. Expected value formula we have found can be denoted with $L_x$ and $T_x$ as following;

$$\overset{0}{e}_x = E\left[T(x)\right] = \int_0^{w-x} t\, f_{T(x)}(t)\,dt = \int_0^{w-x} s_{T(x)}(t)\,dt = \int_0^{w-x} \frac{l_{x+t}}{l_x}\,dt = \frac{\int_0^{w-x} l_{x+t}\,dt}{l_x}$$

if alteration of variable $y = x+t$ is made in the equation, we get the result as;

$$\overset{0}{e}_x = \frac{\int_0^{w-x} l_{x+t}\,dt}{l_x} = \frac{\int_x^{w} l_y\,dy}{l_x} = \frac{T_x}{l_x}$$

Another expected value is **expected survival of a person aged *x* in a given or limited period**. We shall define a new random variable and obtain a function of survival of an individual aged *x* in the following *n* year period before we find the expected value of such a variable.

$$T(x)\wedge n = \begin{cases} T(X) & ; \quad T(x) \le n \\ n & ; \quad T(x) > n \end{cases}$$

Expected value of this newly defined variable gives us the life expectancy of an individual aged *x* in the following *n* years period. Calculated with the formula

$$\overset{0}{e}_{x:\overline{n}|} = E\left[T(x)\wedge n\right] = \int_0^{n} s_{T(x)}(t)\,dt$$

and shown as $\overset{0}{e}_{x:\overline{n}|}$.

The expected value formula can be again expressed in terms of the $L_x$ and the $T_x$ functions as;

$$\overset{0}{e}_{x:\overline{n}|} = E\left[T(x)\wedge n\right] = \int_0^n s_{T(x)}(t)\,dt = \int_0^n \frac{l_{x+t}}{l_x}\,dt = \frac{\int_0^n l_{x+t}\,dt}{l_x}$$

If variable alteration is made in the equation $y = x + t$, we then get

$$\overset{0}{e}_{x:\overline{n}|} = \frac{\int_0^n l_{x+t}\,dt}{l_x} = \frac{\int_x^{x+n} l_y\,dy}{l_x} = \frac{T_x - T_{x+n}}{l_x}.$$

### *2.2.3 Remaining Curtate Lifetime Expectancy*

Expected value of the discrete random variable $K(x)$ defined for survival period found and remaining **curtate life expectancy value** can then be calculated and shown with the symbol $e_x$ . Expected value of the $K(x)$ random variable can be calculated as;

$$\begin{aligned} e_x = E\left[K(x)\right] &= \sum_{k=0}^{w-x-1} k\,\Pr\left(K(x)=k\right) \\ &= \sum_{k=0}^{w-x-1} k\ {}_{k|}q_x = \sum_{k=0}^{w-x-1} k\,\frac{d_{x+k}}{l_x} \\ &= \frac{d_{x+1} + 2d_{x+2} + \ldots + (w-x-1)d_{w-1}}{l_x} \\ &= \frac{\mathrm{l}_{x+1} - \mathrm{l}_{x+2} + 2(\mathrm{l}_{x+2} - \mathrm{l}_{x+3}) + \ldots + (\mathrm{w}-\mathrm{x}-1)(\mathrm{l}_{w-1} - \mathrm{l}_{w})}{\mathrm{l}_x} \\ &= \frac{\mathrm{l}_{x+1} + \mathrm{l}_{x+2} + \mathrm{l}_{x+3} + \ldots + \mathrm{l}_{w-1}}{\mathrm{l}_x} \\ &= \mathrm{p}_x + {}_2\mathrm{p}_x + {}_3\mathrm{p}_x + \ldots + {}_{w-x-1}\mathrm{p}_x \end{aligned}$$

Now that let us find the curtate future lifetime expectancy formula of a person aged $x$ limited with $n$ years. Before finding the formula, a variable is defined and shown as $K(X)\wedge n$. The expected value we are looking for then be shown as $e_{x:\overline{n}|}$ and calculated as;

$$e_{x:\overline{n}|} = E\left[K(x)\wedge n\right] = p_x + {}_2p_x + ... + {}_np_x = \frac{l_{x+1} + l_{x+2} + ... + l_{x+n}}{l_x}$$

### *2.2.4 Central Death Rate*

Another conditional criterion is central death rate defined in the interval *x* and $x+n$. Central death rate is useful to find gross average death rate in an age interval or *n* years period, and is shown as ${}_nm_x$. General formula for computation of central death rate is as follows (Bowers et. al., 1997)

$${}_nm_x = \frac{\int_x^{x+n} s_X(y)\mu_X(y)dy}{\int_x^{x+n} s_X(y)dy}$$

Let us further extend and open the general definition above, by replacing the variable $y = x+t$

$${}_nm_x = \frac{\int_0^n s_X(x+t)\mu_X(x+t)dt}{\int_0^n s_X(x+t)dt} = \frac{\int_0^n {}_tp_x\mu_X(x+t)dt}{\int_0^n {}_tp_xdt} = \frac{{}_nq_x}{\overset{0}{e}_{x:\overline{n}|}}$$

Now that we can say central death rate is the ratio of the probability of a persons' death aged *x* before reaching age *x+n* to the life expectancy of a person aged *x* in following *n* years. Let us find our last expression in terms of $T_x$ .

$${}_nm_x = \frac{{}_nd_x/l_x}{T_x - T_{x+n}/l_x} = \frac{{}_nd_x}{T_x - T_{x+n}}$$

## 2.3 Parametric Survival Models

In this section, it is defined some parametric distributions and models related to survival times (Lee & Wang, 2003). These distributions are supposed to be defined in the positive domain and continuous. The aim of defining of the distributions is that they are simple and good in modeling the survival times.

### *2.3.1 Uniform Distribution*

As it is known, uniform distribution is a two-parameter continuous distribution defined in the $[a,b]$ interval. Although it is not very suitable for human lifetime and survival times; it can be used for short periods like 1 year (Gauger, 2006). Parameters of the distribution are defined as; $a=0$ for lower age limit and $b=w$ for upper last age. Some probabilities about the distribution are given in the table below.

<u>Probability Function:</u>

$$f_X(x)=\frac{1}{w} \qquad 0\le x<w$$

<u>Cumulative Distribution Function:</u>

$$F_X(x)=\int_0^x f_X(t)\,dt=\frac{x}{w} \qquad 0\le x\le w$$

<u>Survival Function:</u>

$$s_X(x)=1-F_X(x)=\frac{w-x}{w} \qquad 0\le x\le w$$

<u>Force of Mortality:</u>

$$\mu_X(x)=\frac{f_X(x)}{s_X(x)}=\frac{1}{w-x} \qquad 0\le x<w$$

<u>Remaining Life Probability Function:</u>

$$f_{T(x)}(t)=s_{T(x)}(t)\mu_X(x+t)=\frac{w-x-t}{w-x}\times\frac{1}{w-x-t}=\frac{1}{w-x} \qquad 0\le t<w-x$$

### *2.3.2 Exponential Distribution*

Exponential distribution is a single parameter non-negative continuous distribution. Most important feature of the distribution for survival models is the instant death rate is constant and equal to the value of the parameter. Although the distribution is not very suitable for human lifetimes, it is used in many different fields like in engineering, reliability analysis, service life of a machine or a lamp. Some probabilities related to the distribution are given in the table below.

Probability Function:

$$f_X(x) = \lambda e^{-\lambda x} \qquad x > 0$$

Cumulative Distribution Function:

$$F_X(x) = \int_0^x f_X(t)\,dt = 1 - e^{-\lambda x} \qquad x > 0$$

Survival Function:

$$s_X(x) = 1 - F_X(x) = e^{-\lambda x} \qquad x > 0$$

Force of Mortality:

$$\mu_X(x) = \frac{f_X(x)}{s_X(x)} = \lambda \qquad \text{for all } x$$

Remaining Life Probability Function:

$$f_{T(x)}(t) = s_{T(x)}(t)\,\mu_X(x+t) = \frac{e^{-\mu(x+t)}}{e^{-\mu x}} \times \mu = \mu e^{-\mu t} \qquad t > 0$$

### *2.3.4 Gompertz Distribution*

This distribution is a two-parameter continuous distribution proposed for lifetimes of people by Gompertz, who named the equation in 1825 (Bowers et al, 1997). Since it is not easy to calculate all the probabilities of the distribution, most important ones are given below.

Force of Mortality:

$$\mu_X(x) = Bc^x \qquad x > 0; B > 0; c > 1$$

Survival Function:

$$s_X(x) = \exp\left(-\int_0^x \mu_X(t)\,dt\right) = \exp\left(\frac{B}{\ln c}\left(1-c^x\right)\right)$$

### *2.3.5 Makeham Distribution*

This distribution is proposed for lifetimes of people by Makeham in 1860 with minor changes on the distribution proposed by Gompertz. This rearranged distribution is continuous and three-parameter (Bowers et al, 1997). Since it is not easy to calculate some of the probabilities of the distribution, most important ones are given below.

Force of Mortality:

$$\mu_X(x) = A + Bc^x \qquad x > 0; B > 0; c > 1; A > -B$$

Survival Function:

$$s_X(x) = \exp\left(-\int_0^x \mu_X(t)\,dt\right) = \exp\left(\frac{B}{\ln c}\left(1-c^x\right) - Ax\right)$$

### *2.3.6 Weibull Distribution*

In the analysis of lifetime and survival periods data, Weibull distribution is widely used because it is elastic and easily changeable. Weibull distribution is a two-parameter continuous distribution which can be reduced into the more popular normal and exponential statistical distributions by using different values for parameters. Probabilities of the distribution related to survival period are given in the table below.

Force of Mortality:

$$\mu_X(x) = \lambda x^n \qquad \lambda > 0; n > 0; x \geq 0$$

Survival Function:

$$s_X(x) = \exp\left(-\int_0^x \mu_X(t)\,dt\right) = \exp\left(\frac{-\lambda x^{n+1}}{n+1}\right)$$

# CHAPTER THREE
# PERIOD LIFE TABLE

## 3.1 Demographic Approach for Life Table

Demography is the statistical study of human populations and sub-populations. Public health and demography utilizes life tables for several uses of them. One of the basic statistical inferences can be made from life tables is the lifetime expected for a certain population. Life tables can be considered as an appropriate shortening index of death rate circumstances effective in a society (Brisbane, 2007).

It would provide a measure for the rate of death taking place at specified ages over particular periods of time by ideal depiction of human mortality. This condition is satisfied by analytical methods roughly over an extensive range of ages in the past, such as the Gompertz, Makeham, or logistics curves. Nevertheless, the uses of approximate analytical methods have become less required and suitable as the actual data have become more abundant and more dependable. In our present day, life tables, which give probabilities of death within one year at each exact integral age, are more commonly utilized to represent mortality. Such probabilities are usually founded on tabulations of deaths in a given populace and anticipation of the size of that population. In this study, life table functions can be produced from the $q_x$, which is the probability of deaths for a person aged $x$ within a year. Mathematical formulas can be used to compute mortality at non-integral ages or for non-integral intervals. Although, life tables do not give such information, appropriate methods for estimating such values are identified (Bell & Miller, 2005).

Two principal forms of life tables are the cohort and period life tables. The cohort life tables record the true mortality occurrence of a particular group of individuals from the birth of its first member to the death of its last member. Period of life tables are constructed from the circumstances of mortality actualized during a single year or a given period of years by means of the experience of an artificial cohort. These tables are practical in analyzing changes in the mortality experienced by a populace through time (Tucek, 2011).

Before the methodology of life period tables are clarified, some definitions in demography are given (Preston et al, 2001).

The term "population" is defined by demographers to denote the collection of persons alive at a specified point in time meeting certain criterion. We can count four ways of entering or leaving a population, changes in the size of population must be attributable to the extent of these flows. In particular,

$$N(T) = N(0) + B[0,T] - D[0,T] + I[0,T] - O[0,T]$$

where

$N(T)$: number of persons alive in the population at time *T*.

$B[0,T]$: number of births in the population between time 0 and *T*.

$D[0,T]$: number of deaths in the population between time 0 and *T*.

$I[0,T]$: number of in-migrations between time 0 and *T*.

$O[0,T]$: number of out-migrations from the population between time 0 and *T*.

We can come across with the term "rate" everywhere in demography, and it is frequently inappropriately used. Firmly speaking, a rate is a relation of a number of events (such as births, deaths, migrations) in its numerator, to a number of "person-years of exposure to risk" experienced by a populace during a certain time period in its denominator. Keeping the danger of over-simplifying in mind, we can articulate that a rate is a measure of the speed at which events take place.

$$Rate = \frac{\text{Number of Occurances}}{\text{Person-years of Exposure to the Risk of Occurance}}$$

A period rate for a population is constructed by limiting the count of occurrences and exposure times to those pertaining to members of the population during a specified period of time.

$$Rate\left[0,T\right]=\frac{\text{Number of Occurances between time 0 and }T}{\text{Person-years of Lived in the Population between time 0 and }T}$$

There are some principal period rates in demography:

*Crude birth rate:* Number of births over a given period divided by the person-years lived by the population over that period. It is expressed as number of births per 1,000 populations.

$$CBR\left[0,T\right]=\frac{\text{Number of births in the population between times 0 and }T}{\text{Number of person years lived in the population between times 0 and }T}\text{ x1.000}$$

*Crude death rate:* Number of deaths over a given period divided by the person-years lived by the population over that period. It is expressed as number of deaths per 1,000 populations.

$$CDR\left[0,T\right]=\frac{\text{Number of deaths in the population between times 0 and }T}{\text{Number of person years lived in the population between times 0 and }T}\text{ x1.000}$$

*Crude rate of in-migrations:* Number of in-migrations per 1.000 persons into the population over a given period of time.

$$CRIM\left[0,T\right]=\frac{\text{Number of in-migrations into the population between times 0 and }T}{\text{Number of person years lived in the population between times 0 and }T}\text{ x1.000}$$

*Crude rate of out-migrations:* Number of out-migrations per 1.000 persons from the population over a given period of time.

$$CROM\left[0,T\right]=\frac{\text{Number of out-migrations from the population between times 0 and }T}{\text{Number of person years lived in the population between times 0 and }T}\text{ x1.000}$$

*Crude growth rate:* Rate at which population grows (increase/decrease) during a given year, as the result of natural increase plus net migration; expressed as a percentage of the base population

$$CGR\left[0,T\right]=CBR\left[0,T\right]-CDR\left[0,T\right]+CRIM\left[0,T\right]-CROM\left[0,T\right]$$

where

$$CGR[0,T] = \frac{N(T) - N(0)}{PY[0,T]}$$

*Exponential population growth:* Under simplified conditions, such as a constant environment (and with no migration), it can be shown that change in population size $N(t)$ through time $(t)$ will depend on the difference between individual birth rate $b(t)$ and death rate $d(t)$, and given by:

$$\frac{dN(t)}{dt} = \frac{b(t) - d(t)}{N(0)}$$

$b(t)$ : Instantaneous birth rate, births per individual per time period $(t)$.

$d(t)$ : Instantaneous death rate, deaths per individual per time period.

$N(0)$: Current population size.

The difference between birth and death rates $(b(t) - d(t))$ is also called *r*, the intrinsic rate of natural increase, or the Malthusian parameter. It is the theoretical maximum number of individuals added to the population per individual per time. By solving the differential equation 1, we get a formula to estimate a population size at any time:

$$N(t) = N(0)e^{rt}$$

This equation shows us that if birth and death rates are constant, population size increases exponentially. If you transform the equation to natural logarithms (ln), the exponential curve becomes linear, and the slope of that line can be shown to be *r*:

$$\ln N(t) = \ln N(0) + \ln e^{rt}$$

$$r = \frac{\ln N(t) - \ln N(0)}{t} = \ln \frac{N(2010)}{N(2009)}$$

$$= \ln \frac{6.178.723}{6.155.321} = 0,003794$$

$$N_{2010} = \frac{N(t) - N(0)}{r} = \frac{6.178.723 - 6.155.321}{0,003794} = 6.167.015$$

$${}_4\mathrm{m}_1 = \frac{{}_4D_1}{{}_4N_1} = \frac{4.183}{4.911.332} = 0,00085$$

where $\ln(e) = 1$. The population growth rate, *r*, is a basic measure in population studies, and it can be used as a basis of comparison for different populations and species (Bennett & Horiouchi, 1984).

*Age-Specific rate:* Rate obtained for specific age groups (age-specific fertility rate, death rate, marriage rate, illiteracy rate, or school enrollment rate etc.).

*Mortality:* Deaths as a component of population change.

*Infant mortality rate:* The number of deaths of infants under age 1 per 1,000 live births in a given year.

### 3.2 Construction of Period Life Table

The life table is one of the oldest statistical methods for measuring mortality or for the study of any event which has an associated waiting time. The data source dichotomizes life tables into the actuarial/demographic type constructed from vital statistics data. In this type of life table the event of interest is death. Usually the life table is viewed as the experience of an actual or synthetic cohort.

The notation and definitions are those given by Shryock, Siegel, and Associates (1971). Numerous methods are available for constructing an actuarial/demographic life table. Some well known methods are those of Reed and Herrel (1939), Greville (1943), Chiang (1968, 1972), Fergany (1971), and Keyfitz and Frauenthal (1975). Construction of period life table steps is listed as follow:

Step 1: The ratio ${}_nM_x$ is often called the age specific death rate and it is obtained that number of deaths in the age range $x$ to $x+n$ between time 0 and *T* divided by number of person years lived in the age $x$ to $x+n$ between time 0 and *T*. We define as (NVSR, 2010):

$${}_nM_x = \frac{{}_nD_x}{{}_nN_x} \approx {}_nm_x$$

Step 2: the average person years lived in the interval by those dying in the interval is denoted by ${}_na_x$ and it is estimated in this step. Methods for estimating ${}_na_x$ are as follows (Preston et al 2001):

- Direct observations
- Graduation of the ${}_nm_x$ function
- Barrowing values
- Rules of thumb

Step 3: The likelihood of dying in age between $x$ and $x+n$ is calculated and it is denoted by ${}_nq_x$. To obtain ${}_nq_x$, the ${}_nm_x$ values needs to be adapted. Death rates of specific age are altered to probabilities of dying at a specific age. By this transformation, from the set of observed period age specific death rates are converted into a set of age specific probabilities of dying. Conversion of these death rates of specific age to the probabilities of dying at a specific age is usually accomplished by referring to the relation between them in an actual cohort. An equal expression of the related formula for the conversion can be derived by replacing the $l_x$ term in the formula for age specific probabilities of dying.

$${}_nL_x = n.l_{x+n} + {}_na_x \cdot {}_nd_x \rightarrow {}_nq_x = \frac{{}_nd_x}{l_x} = \frac{n.{}_nm_x}{1+\left(1-{}_na_x\right){}_nm_x}$$

${}_nL_x$ : Number of person years lived by the cohort between ages $x$ and $x+n$

$n.l_{x+n}$ : Number of person years lived in the interval by members of the cohort who survive the interval

${}_na_x$ : Mean number of person years lived in the interval by those dying in the interval

${}_nd_x$ : Number of members of the cohort dying in the interval

Then we can rewrite the formula as follows:

$${}_nL_x = n\left(l_x - {}_nd_x\right) + {}_na_x \cdot {}_nd_x$$

$$n.l_x = {}_nL_x + n.{}_nd_x - {}_na_x \cdot {}_nd_x$$

$$l_x = \frac{1}{n}\left[ {}_nL_x + \left(n - {}_na_x\right). {}_nd_x \right]$$

Thus, substituting $l_x$ into the formula for ${}_nq_x$ is obtained by given:

$${}_nq_x = \frac{{}_nd_x}{l_x} = \frac{n.{}_nd_x}{{}_nL_x + \left(n - {}_na_x\right). {}_nd_x}$$

Both numerator and denominator of above equation is divided by ${}_nL_x$ and is obtained as follows:

$${}_nq_x = \frac{n \cdot \frac{{}_nd_x}{{}_nL_x}}{\frac{{}_nL_x}{{}_nL_x} + \left(n - {}_na_x\right). \frac{{}_nd_x}{{}_nL_x}} = \frac{n \cdot {}_nm_x}{1 + \left(n - {}_na_x\right). {}_nd_x}$$

Then the probability can be written as follows:

$${}_nq_x = \frac{n.{}_nm_x}{1 + \left(1 - {}_na_x\right){}_nm_x} \quad \text{and} \quad q_\infty = 1$$

Above equation by Greville (1943) and Chiang (1968), shows us that for a cohort, the conversion from ${}_nm_x$ to ${}_nq_x$ depend on one parameter only, which is the average number of person years lived in the interval by those dying in the same interval.

Since ${}_nm_x$ and ${}_nq_x$ are both observable, the ${}_na_x$ function bares little importance in a cohort life table. It is important because it is utilized in making the ${}_nm_x \rightarrow {}_nq_x$ conversion useful in a period life table. Particularly, supposing the hypothetical cohort in a period life table is to experience an observed set of period age specific death rates then all that remains to complete the period life table is the implementation of a set of ${}_na_x$ values in order to convert the ${}_nm_x \rightarrow {}_nq_x$ .This conversion is very common and If we choose to make it, then we have supposed that the observed period age specific death rates $\left({}_nM_x\right)$ are to be reproduced in the hypothetical cohort passing through life in the period life table $\left({}_nm_x\right)$. The rest to be done is to convert the ${}_n m_x$'s to ${}_n q_x$'s. Whether the strategy is implied or clear, techniques for period life table construction that start out with a set of ${}_n m_x$'s are focused on the selection of a set of ${}_n a_x$ values (Preston et al, 2001).

Step 4: We calculate the probability of surviving an age interval $x$ to $x+n$ as the fallowing (Bell & Miller, 2005):

$${}_n p_x = 1 - {}_n q_x$$

$$p_{w+} = 0$$

Step 5: We choose radix which is denoted by $l_0$. Then we calculate the number of people alive at exact age $x$ as fallowing (Bell & Miller, 2005):

$$l_{x+n} = l_x \cdot {}_n p_x$$

Step 6: We calculate the number of deaths an age interval $x$ to $x+n$ as the fallowing (Bell & Miller, 2005):

$${}_n d_x = l_x - l_{x+n}$$

Step 7: We calculate the total number of person years lived between exact ages $x$ and $x+n$ as the fallowing formula (Preston et al, 2001):

$${}_n L_x = n\left(l_{x+n} + {}_n a_x \cdot {}_n d_x\right)$$

This formula does not apply for age 0 and for age interval 1 to 4. There are obtained using the following formula:

$$L_0 = l_1 + \left(a_0 . d_0\right)$$

$${}_4 L_1 = 4.l_5 + 4\left({}_4 a_1 . d_1\right)$$

The above mentioned open ended interval does not bare any defined length; therefore an assumption is necessary concerning how many more years individuals will live at the start of the life interval. a good approximation is provided by the following formula:

$$L_{w+} = \frac{d_{w+}}{m_{w+}} = \frac{l_{w+}}{m_{w+}}$$

Step 8: We calculate the total number of person years lived after age *x*. It is obtained by cumulating the ${}_nL_x$ function from the bottom (highest age interval) up. It refers to exact age *x*, not an age interval (Pfaff & Seltzer, 2012).

For any age $x$:

$$T_x = T_{x+n} + {}_nL_x$$

For last age *w*:

$$T_w = L_{w+}$$

Step 9: We calculate the expected number of years of life left for a person aged *x* (Pfaff & Seltzer, 2012). And it is generally referred to the life expectancy at age *x* and is given by the following formula

$$\overset{0}{e}_x = \frac{T_x}{l_x}$$

The expectation of life at birth is given by the ratio

$$\overset{0}{e}_0 = \frac{T_0}{l_0}$$

# CHAPTER FOUR
# METHODOLGY OF EXPONENTIAL SMOOTHING

## 4.1 Exponential Smoothing

Time series arise in many different contexts whenever something is observed over time. Exponential smoothing has become very popular as a forecasting method for a wide variety of time series data. The basic structures were provided independently by Robert G. Brown in about 1944 and C.C. Hold in 1957 and his student Peter Winters in 1960. The method is popular because it is simple, has low data-storage and computational effort requirements, and easily automated. But the most important reason for the popularity of exponential smoothing is the surprising accuracy that can be obtained with minimal effort in model identification.

There are many forecasting methods but the most successful forecasting methods are based on the concept of exponential smoothing. Exponential smoothing assigns exponentially decreasing weights as the observation get older. In other words, recent observations are given relatively more weight in forecasting than the older observations. Many researchers believed that exponential smoothing should be disregarded because it was either a special case of ARIMA modeling or an ad hoc procedure with no statistical rationale. Gardner (1985) proposed an excellent classification of exponential smoothing methods. Since 1985, the special case argument has been turned on its head, and today we know that exponential smoothing methods are optimal for a very general class of state-space models that is in fact broader than the ARIMA models. There is large body of research on exponential smoothing since the original work by Brown and Hold in the 1950s. The most important and critical review of research in exponential smoothing presented by Gardner (1985) and (2006).

Historically, the method was independently developed by Brown and Hold. The idea seems to have originated with Robert G. Brown in about 1944 while he was working for the US Navy as an Operations Research analyst. Independently, Charles Holt was also working on an exponential smoothing method and his method differed from Brown' with respect to the smoothing of the trend and seasonal components. Holt's work on additive and multiplicative seasonal exponential smoothing became well known through a paper by his student Peter Winters (1960). As a result, the seasonal versions of Holt's methods are usually called Holt-Winters' methods. Pegels (1969) provided a simple but useful classification of the trend and the seasonal patterns depending on whether they are additive or multiplicative.

Muth (1960) was the first to suggest a statistical foundation for simple exponential smoothing (SES) by demonstrating that it provided the optimal forecasts for a random walk plus noise. Further steps towards putting exponential smoothing within a statistical framework were provided by Box and Jenkins (1970), Roberts (1982), and Abraham and Ledolter (1983, 1986), who showed that some linear exponential smoothing forecasts arise as special cases of ARIMA models. The remarkably good forecasting performance of exponential smoothing methods has been addressed by several authors. Satchell and Timmermann (1995) and Chatfield et al. (2001) showed that SES is optimal for a wide range of data generating process. Hyndman (2001) showed that SES performed better than first order ARIMA models.

***4.1.1 Simple Exponential Smoothing (SES) Method***

Simple smoothing represents the time series $y_t = a + \varepsilon_t$ where $\varepsilon_t$ is a random component with mean zero and variance $\sigma_\varepsilon^2$ The level *a* is assumed to be constant in any local segment of the series but may change slowly over time. We would now like to estimate the current value of that coefficient *a* by some sort of an average. The new smoothed value is equal to the previous smoothed value plus a fraction α of the difference between the new observation and the previous smoothed value. That is, the forecast for the next period is

$$S_t = S_{t-1} + \alpha\left(y_t - S_{t-1}\right)$$

Where α is a constant between 0 and 1. Another way of writing (1.1) is

$$S_t = \alpha\, y_t + (1-\alpha)S_{t-1}$$

The forecast, $S_t$ is based on weighting the most recent observation $y_t$ with a weight value α, and weighting the most recent forecast $S_{t-1}$ with a weight of (1-α). Let us expand the second equation by first substituting for $S_{t-1}$ with its components to obtain

$$\begin{aligned} S_t &= \alpha\, y_t + (1-\alpha)\left[\alpha\, y_{t-1} + (1-\alpha) S_{t-2}\right] \\ &= \alpha\, y_t + \alpha(1-\alpha) y_{t-1} + (1-\alpha)^2 S_{t-2} \end{aligned}$$

If this substitution process repeated by replacing $S_{t-2}$ with its components, $S_{t-3}$ with its components, and so on, the result is

$$S_t = \alpha\, y_t + \alpha\,(1-\alpha)\, y_{t-1} + \alpha\,(1-\alpha)^2\, y_{t-2} + . \quad . \quad . \quad + \alpha\,(1-\alpha)^{t-1}\, y_1 + (1-\alpha)^t\, S_0 \quad ,$$

or the expanding equation can be written as

$$S_t = \alpha \sum_{k=0}^{t-1} (1-\alpha)^k y_{t-k} + (1-\alpha)^t S_0$$

So $S_t$ represents a weighted moving average of all past observations with weights decreasing exponentially, hence the name "exponential smoothing" and their sum is unity; We note that the weight of $S_0$ may be quite large when α is small and the time series is relatively short. The choice of starting value then becomes particularly important and is known as the initialization problem". Setting it to $y_1$ is one method of initialization, another possibility would be to average the first four or five observations. The smoothing coefficient α is a value between 0 and 1. In the extreme, if the coefficient is zero then the next period's forecast will be the same as the last period's forecast $S_t = S_{t-1}$, and if the coefficient is one, or unity, then the next period's forecast will be the same as the current period's data $S_t = y_t$. The expected value of this function of the observations is

$$E[S_t] = \alpha \sum_{k=0}^{\infty} (1-\alpha)^k E[y_{t-k}] = E[y]$$

Since the expectation of the function is equal to the expectation of the data, it is right to call it an average and the value of the coefficient in a constant model $\hat{a}_t = S_t$.

The statistics $S_t$ is an unbiased estimator of the level as well as the forecast for any period ahead. The average age is the age of each piece of data used in the average. In the exponential smoothing process, the weight given data *k* periods ago is $\alpha(1-\alpha)^k$, therefore the average age of the data used in exponential smoothing is

$$\bar{k} = 0\alpha + 1\alpha(1-\alpha) + 2\alpha(1-\alpha)^2 + . \quad . \quad . = \alpha\sum_{k=0}^{\infty} k(1-\alpha)^k = \frac{1-\alpha}{\alpha}$$

In the exponential smoothing scheme, the variance of the estimates is

$$Var[S_t] = \alpha^2 \sum_{k=0}^{\infty}(1-\alpha)^{2k} Var(y_{t-k}) = \frac{\alpha^2\sigma_\varepsilon^2}{1-(1-\alpha)^2} = \frac{\alpha}{2-\alpha}\sigma_\varepsilon^2$$

Now we have a new way of estimating the value of the coefficient in a constant model.

$$\hat{a}_t = S_t$$

When the smoothing constant is small, the function $S_t$ behaves like the average of a great deal of past data, and therefore the variance of the estimate of the coefficient is small. When the smoothing constant is large $S_t$ will respond rapidly to changes in pattern. Exponential smoothing always requires a previous value of the smoothing function. When the process is started, there must be some value that can be used as the previous value $S_{t-1}$. If there are past data at that time one starts to use exponential smoothing, then the best initial value would be a simple average of the most recent observations. Frequently there will be no past data to average then smoothing starts with the first observation. After *k* observations, the weight given to the initial value is $(1-\alpha)^k$. If we have a great deal of confidence in the prediction of initial conditions, use small value of smoothing constant. If we have very little confidence in our initial prediction, use a larger value, so that the initial conditions will quickly be discounted.

In order to calculate the forecasts using SES, we need to specify the initial value, $S_0$ and the parameter value $\alpha$. Gardner (1985) discusses various theoretical and empirical arguments for selecting an appropriate smoothing parameter. By the most of practitioners, an $\alpha$ smaller than 0.3 is usually recommended. However, in the study by Makridakis *et al.* (1982), $\alpha$ values above 0.30 frequently yielded the best forecast. Gardner (1985) concludes that it is best to estimate an optimum $\alpha$ from the data rather than to guess and set an artificially low value. In practice, the smoothing parameter is often chosen by a grid search of the parameter space so as to produce the smallest sums of squares (or mean squares) for the residuals (i.e., observed values minus one-step-ahead forecasts). Methods for computing initial value $S_0$ have been developed by a number of researchers but there is no empirical evidence favoring any particular method. Brown's (1959) original suggestion, simply using the mean of the data for $S_0$, is popular in practice.

Holt (1960) extended simple exponential smoothing to linear exponential smoothing to allow forecasting of data with trends. The forecast for Holt's linear exponential smoothing method is found using two smoothing constants, $\alpha$ and $\beta$ (with values between 0 and 1), and three equations:

Level: $$S_t = \alpha y_t + (1-\alpha)(S_{t-1} + b_{t-1})$$

Trend: $$b_t = \beta(S_t - S_{t-1}) + (1-\beta) b_{t-1}$$

Forecast: $$S_{t+h|t} = S_t + b_t h, \qquad h = 1,\ 2,\ 3,\cdots$$

# CHAPTER FIVE
# APPLICATION

In this part of the study, period life table will be formed, summarized by using death, birth and population datum which reflect demographic structure of Turkey. Source of data set will be explained as the first step. Following the analyses of the descriptive statistics of the data set, datum will smoothened with exponential smoothing method and will be compared with the real data. And finally, abridged period life tables will formed both by gender and age-groups for Turkey and by age-groups only for regions.

## 5.1 Data Sources

Life and death records in Turkey are compiled and published by Turkish Statistical Institute (TUIK). Data sets employed in this study are obtained from the information published by the TUIK under the heading 'Population and Demographical Statistics'. In this study, population, death and birth statistics are separately obtained on the basis of gender and year.

### *5.1.1 Population Data*

Population of Turkey is identified by the TUIK with periodical censuses. Total of 14 censuses held after the declaration of the republic, first of which held in 1927, second in 1935, every five years between 1935-1990 and every ten years after 1990. These censuses performed under country-wide curfew. These censuses performed to identify the size, demographical, social and economical distribution of the population within the borders of the country on the specific date of application. After the last census under curfew in 2000, the new 'Address Quoted Civil Registration System' (ADNKS) started to be utilized without curfew in 2007.

Address Quoted Civil Registration System (ADNKS) is established in 2007 to keep up-to-date information of the population of settlements and to monitor migration statistics. Address information of citizens of the Republic of Turkey and foreign nationals residing within Turkey matched with the information recorded in the MERNIS index of population data-base for Turkish nationals. Information on size and basic features of the populations with respect to settlements produced and presented annually.

Populations of the settlements are calculated with the data acquired from Address Registration System (AKS), which is updated by the Ministry of the Interior Affairs, General Directorate of Civil Registration and Nationality and taking population into account in public Institutional places. As required by the international definition, people residing in Institutional places (military settlements, penal institutions, nursing homes, dormitories etc.) counted in the population of the Institution they are in, and not in their address of residence.

Also it is taken into consideration that while populations of the provinces, towns, cities, villages and districts are determined, administrational attachments, legal entities, name alterations etc. information, which is taken from National Address Data Base taken into consideration with the requirement of the law of NVIGM (TUIK, 2012).

Age, age groups, region and gender based information acquired from ADNKS published between 2007 and 2011 used in this study.

### *5.1.2 Deaths Data*

Turkish Statistical Institute (TUIK) started to compile statistics on death in 1931 and published information on death of; the 25 most populated city centers until 1949, all of the city centers between 1950 and 1956, and all city centers along with towns after 1957. After 1982, it is aimed to compile death events from rural areas and disseminate statistical information to nation-wide; however, it could not be published because of lack of complete information that must be obtained. Thence, the application of collection of death statistics from rural areas was ended in 1986 until a new system is to be established.

When The Central Civil Registration System (MERNIS) started on line application in 2001, it is decided to keep death statistics in this data-base. For this purpose to come true, Ministry of the Interior, General Directorate of Civil Registration and Nationality and TUIK signed a protocol on data-exchange on 7th February 2006.

According to this protocol, after 2009, Turkish Statistical Institute (TUIK), started acquiring information on death statistics from the Central Civil Registration System (MERNIS) data base and publish these information with death reasons data compiled by TUIK. Since MERNIS has a dynamic structure, death statistics are continuously updated retroactively. Updated on March 31, 2012, death statistics of 2009 published on the same date with death statistics of 2010. Moreover, death statistics have been published based on the permanent residence address since 2009 (TUIK, 2012).

In this study, death statistics based on provinces and towns published by TUIK annually between the years 2002-2008, and death statistics of Turkey in general and based on regional classification published in 2009 and 2010 are utilized.

### *5.1.2 Births Data*

T.C. Birth statistics published by Turkish Statistical Institute (TUIK), are obtained from the on-line data base of MERNIS since the start of the on-line application in 2001. Updated on August 31, 2012, birth statistics of years 2001 to 2009 published on the same date with birth statistics of 2010. Moreover, after 2009, birth statistics started to be published on the basis of the permanent address of the mother, instead of the place that birth takes place (TUIK, 2011).

Birth statistics published between the years 2007-2010 are utilized in this study.

## 5.2 Descriptive Statistics

In this part, descriptive statistics of the data obtained from TUIK analyzed and interpreted. Moreover, visuals contributing to represent demographical structure of Turkey better examined.

### *5.2.1 Descriptive Statistics Per Population*

In this part, size of population, population growth rate and population data with regional classifications will be examined. While it was 13.6 million in the 1927 census, the population of Turkey is calculated to be 74.7 million according to the 2011 census based on the Central Civil Registration System (MERNIS) data base. Increasing size of population in Turkey had been stable between the years 1950-2000 and started to decrease after 2000 (TUIK, 2012).

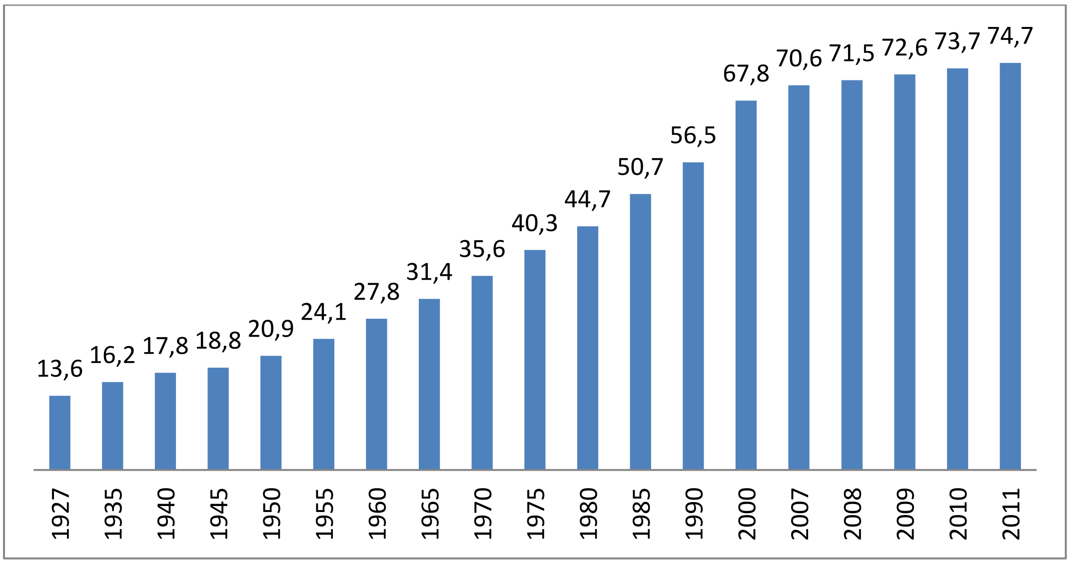



Figure 5.1 The bar graph of population size between 1927 and 2011 years.

Population growth rate in Turkey, as seen on Figure 5.2, started decreasing in 1980's and was 1.7 percent in 1990 and dropped to 1.18 percent in 2007. Nowadays, population growth rate in Turkey is as low as 10 in a thousandth. This rate is forecasted to be  9.9 in a thousandth in 2015, 8.8 in 2020 and drop down to 7.4 in 2025 (TUIK, 2009).

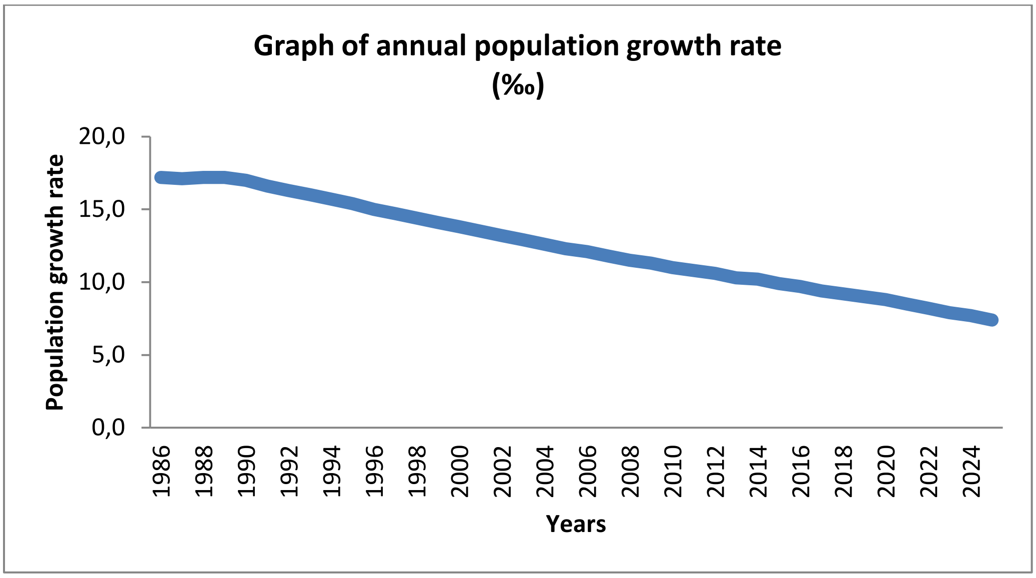



Figure 5.2 The graph of estimations and projections of population growth rate, 1986-2025, TUİK.

Examining Figure 5.1 and 5.2, it is observed that despite there is an increase in the size of the population, population growth rate is declining. According to population forecasts, the increase in the size of the population and decrease in the rate will continue. This study handles the population data from 2007 and onwards. Population-size statistics published on Address Quoted Civil Registration System (ADNKS) are in four different formats including 'Turkey in general', 'Province and Town centers', and 'rural areas' and ‘region’.

### *5.2.1 Descriptive Statistics per Deaths*

In this part, death statistics, which play an important role in determining the demographic features of a community and its' features will be examined. Death statistics in Turkey were in the form of town and province centers format between the years 2002-2008. Data in use under such format results in calculation of crude death rates in Turkey lower than the real values because it excludes the death counts in rural areas. This calculation also results in estimation of life expectancies at birth higher than actual. However, construction of a life table for the whole Turkey is enabled by retroactively updated death statistics from 2009. Here we will represent demographical structure of Turkey with visuals to be able to examine patterns of death.

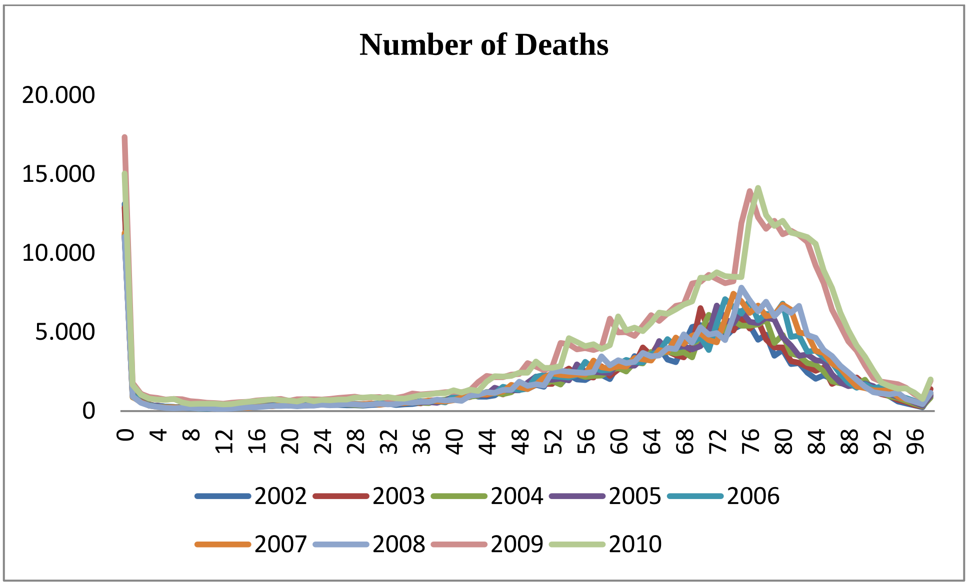



Figure 5.3 Graph of deaths between 2002 and 2010 years by age groups.

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As can be seen on Figure 5.3, death rates have increased for all age groups after addition of data from rural areas and increase in the quality of the data record system after 2009. Number of deaths in 2002 was 175,434 and increased to 206,296 in 2008. In 2009 however, number of deaths was 367,010 and in 2010, dropped to 365,076. Improved living conditions may account for this decrease.

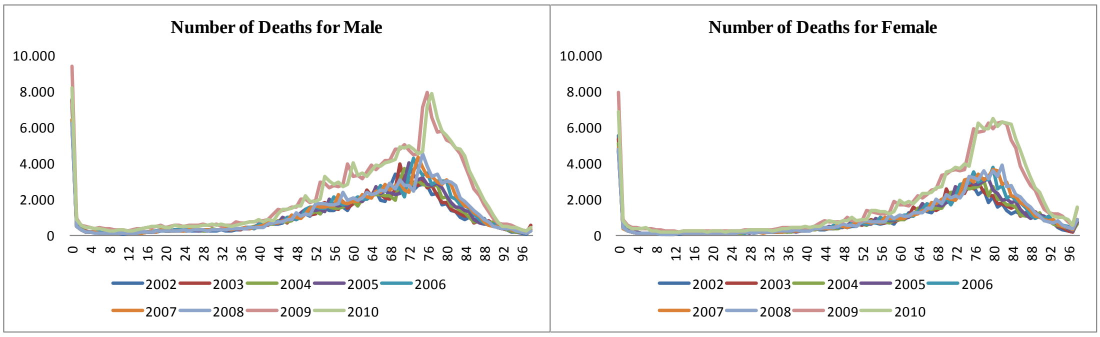


Figure 5.4 Graphs of number of deaths for male and female between 2002 and 2010 years by age groups.

Examining Figure 5.4, it is observed that deaths in males are less steady than in females. For males in city or town centers, it is observed that number of deaths for males between the ages 40-75 is higher than females. Also with the addition of rural settlements' data, number of males dying at 74 years of age is seriously decreased.

Together with these, peak value of deaths for males, this was 76 years of age in 2009, shifted to 77 in 2010. Number of deaths of males in 2002 was 98,757 and became 114,413 in 2008. In 2009, number of deaths of males in Turkey was 202,368, and dropped to 199,873 in 2010. Examining deaths of females, it is revealed that deaths of females are steadier than of males. It is observed that the interval of peak age where number of deaths increase is wider for females. This range is between the ages 75 and 85. Number of deaths of females in 2002 was 76,677 and became 91,883 in 2008. In 2009, number of deaths of females in Turkey was 164,642, and increased to 165,203 in 2010.

Purifying the dataset from random variations and then examination enables to understand death patterns better. For smoothing the data-set, moving averages method is utilized. First thing to recall when the moving averages method is of use is time-series analysis. The purpose of 'moving averages' method which is widely used for time series is to decrease the effects of random variations observed in the series by taking averages of several periods and make forecasts. It is based on arithmetical average. Moving average of m time series is represented as average of m respective time series and it is quoted as a way of taking averages allowing adjusting seasonal or conjectural constituents of the series (Brown, 1962).

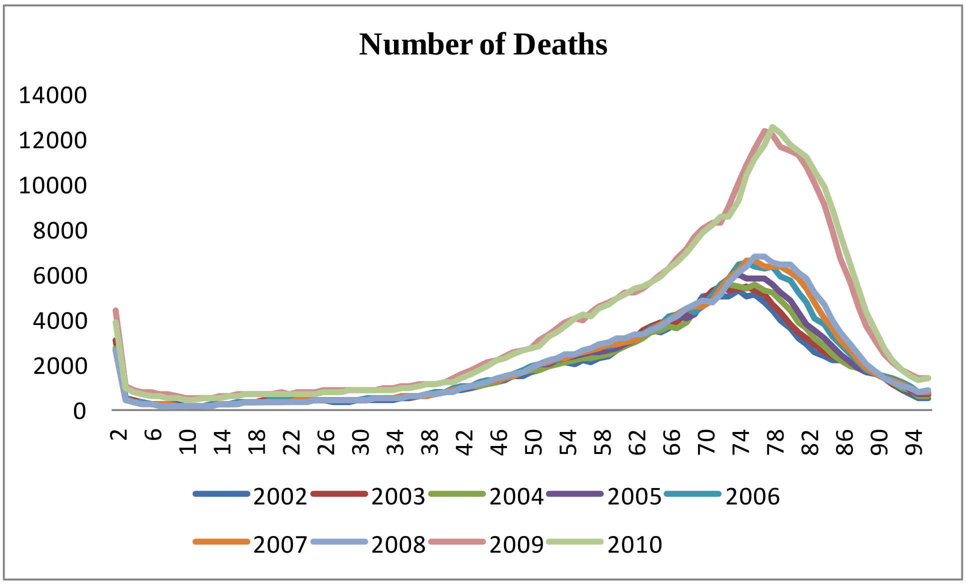


Figure 5.5 Smoothed deaths by moving average method between 2002 and 2010 years

Examination of Figure 5.5 reveals that as the years pass, increase in number of deaths shift towards older ages. The meaning of this is that people in Turkey die older as the time passes. This can be presented as a proof that lives of people living in our country is prolonged. Lowest number of deaths is observed to be between the ages 10 to 14. The highest number of deaths on the other hand, observed to be between 70 to 74 years of age in 2002 and 75 to 79 years of age in 2005.

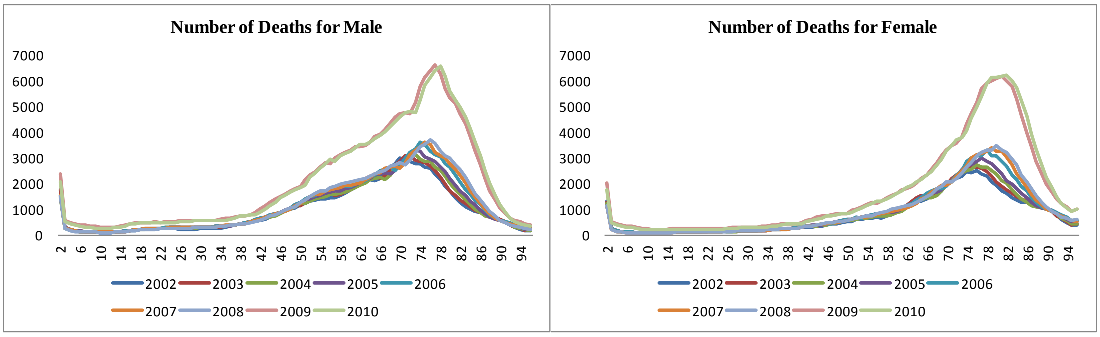


Figure 5.6 Smoothed deaths for male and female population between 2002 and 2010 years by moving average method.

Examination of Figure 5.6, general patterns of deaths is observed for both males and females. However, number of deaths for males prior to 70 years of age is observed to be higher than females. Moreover, number of deaths is observed to increase with a higher rate for males after 70 years of age than for females. The lowest number of deaths is observed between ages 10 to 14 for both sexes. The highest number of deaths is observed to be between 70 to 74 years of age in 2002 and 75 to 79 years of age after 2007. The highest number of deaths is observed to be between 75 to 80 years of age in 2002 and 80 to 84 years of age after 2009. Interpreting visuals, life expectancies for females can be concluded to be longer than males; however, it is possible to calculate life expectancies by formation of life tables.

Table 5.1 Death rates between 2002 and 2010 years by age group.

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,075 | 0,070 | 0,061 | 0,057 | 0,054 | 0,055 | 0,052 | 0,047 | 0,041 |
| 1-4 | 0,013 | 0,013 | 0,012 | 0,012 | 0,011 | 0,010 | 0,010 | 0,013 | 0,011 |
| 5- 9 | 0,006 | 0,006 | 0,006 | 0,006 | 0,005 | 0,005 | 0,004 | 0,009 | 0,008 |
| 10-14 | 0,005 | 0,005 | 0,005 | 0,005 | 0,004 | 0,004 | 0,004 | 0,007 | 0,006 |
| 15-19 | 0,009 | 0,009 | 0,008 | 0,008 | 0,008 | 0,007 | 0,007 | 0,009 | 0,009 |
| 20-24 | 0,011 | 0,011 | 0,012 | 0,010 | 0,009 | 0,009 | 0,008 | 0,010 | 0,009 |
| 25-29 | 0,010 | 0,012 | 0,011 | 0,011 | 0,011 | 0,011 | 0,010 | 0,011 | 0,010 |
| 30-34 | 0,012 | 0,013 | 0,013 | 0,012 | 0,012 | 0,011 | 0,011 | 0,012 | 0,011 |
| 35-39 | 0,016 | 0,017 | 0,016 | 0,015 | 0,014 | 0,015 | 0,015 | 0,015 | 0,014 |
| 40-44 | 0,025 | 0,025 | 0,026 | 0,025 | 0,025 | 0,023 | 0,021 | 0,021 | 0,019 |
| 45-49 | 0,038 | 0,038 | 0,037 | 0,037 | 0,033 | 0,034 | 0,034 | 0,032 | 0,031 |
| 50-54 | 0,054 | 0,056 | 0,053 | 0,053 | 0,053 | 0,052 | 0,051 | 0,045 | 0,044 |
| 55-59 | 0,060 | 0,063 | 0,063 | 0,066 | 0,065 | 0,064 | 0,065 | 0,059 | 0,057 |
| 60-64 | 0,089 | 0,086 | 0,083 | 0,080 | 0,078 | 0,075 | 0,078 | 0,071 | 0,074 |
| 65-69 | 0,113 | 0,104 | 0,100 | 0,107 | 0,104 | 0,103 | 0,098 | 0,091 | 0,089 |
| 70-74 | 0,144 | 0,148 | 0,151 | 0,141 | 0,136 | 0,131 | 0,121 | 0,113 | 0,117 |
| 75-79 | 0,135 | 0,138 | 0,145 | 0,152 | 0,152 | 0,155 | 0,162 | 0,168 | 0,162 |
| 80-84 | 0,082 | 0,085 | 0,099 | 0,099 | 0,117 | 0,130 | 0,137 | 0,146 | 0,154 |
| 85-89 | 0,059 | 0,057 | 0,052 | 0,055 | 0,059 | 0,063 | 0,069 | 0,077 | 0,088 |
| 90+ | 0,044 | 0,045 | 0,046 | 0,047 | 0,048 | 0,045 | 0,043 | 0,042 | 0,044 |

In Table 5.1, rates of number of deaths based on age groups per total deaths are examined. While an increase in death rates is observed for city and town centers and for the age groups 55-49, 60-64 and 75-79, addition of the records from rural areas after 2009, has lowered the rate of this increase. Although there was an increase in death rates of age groups 70-74 and 85-89 until 2004, the situation reversed until 2008. In the general death records on the other hand, death rates increased in this age interval. While an increase is observed for 90 years of age and over from 2002 until 2006, a decrease is observed until 2008. Within this age range, death rates increased in years 2009 and 2010. The aim here is to acquire preliminary information on the differences patterns of death rates of urban and general areas. Examining the Table, changing the registration system, there are some variations observed for the elderly people; death rates of age groups 1-24 and 80-89 are increasing, death rates of 40-74 age group are decreasing.

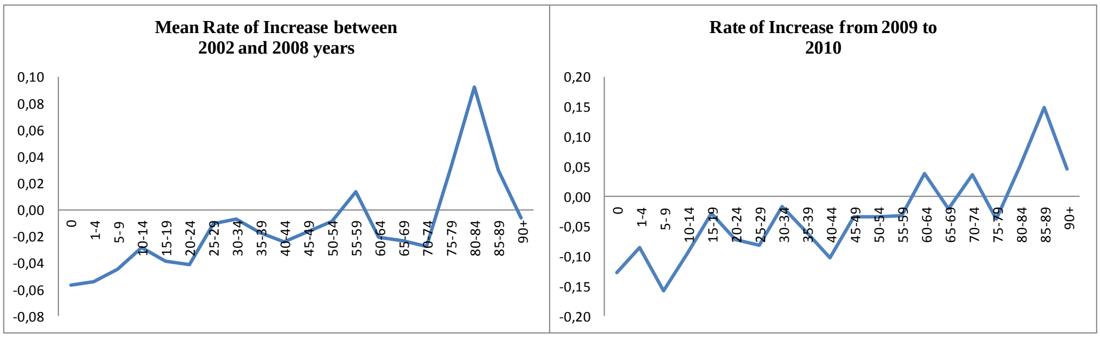


Figure 5.7 Rate of increase for 'cities & towns' and 'general' death rates by age group.

In Figure 5.7, Mean rates of increase are demonstrated on graphical format for urban area and rates of increase are demonstrated for general area by age group in Turkey. For urban, there is a decrease in death until 75 years of age and only increase is observed to be between ages 55 to 59. For 75 years of age and over, increase rates are observed to have positive values, meaning increasing deaths. For ages 90 and over on the other hand, mortalities tend to decrease. Considering mortality data for Turkey in general, while there is a decrease tendency in deaths of ages until 80, there is an increase for the age group of 60 to 64 based on the data from rural areas different from the urban. This situation can be interpreted as people living in rural areas and between ages 60-64 are more likely to lose their lives than people living in cities and towns. Although there is an increase observed for 80 years of age and over, it is remarkable that the rate is lower than the rate for urban areas. And this can be interpreted as there is an increase in the population of elderly.

Table 5.2 Crude death, birth and growth rate per thousand for Turkey between 2007 and 2010 years.

| Rate(‰) | CBR | CDR | CGR |
|---|---|---|---|
| **2007** | 18.20 | … | … |
| **2008** | 18.02 | … | … |
| **2009** | 17.29 | 5.06 | 12.24 |
| **2010** | 16.81 | 4.95 | 11.85 |

In the Table 5.2, for the years from 2007 to 2010, crude population growth rates are calculated using crude birth and death rates. Crude birth rate decreased by 8,2 %. In 2010, there was a decrease by 2.8 % compared to 2009. It is impossible to calculate crude death rates for urban areas between 2007 and 2008 since published statistics does not meet the population. Crude death rate in 2010 decreased by 2.09 % compared to 2009. Crude population growth rate of a society under assumption of zero migration, is calculated by subtraction of crude death rate from crude birth rate. Here, population crude growth rate is decreased by 3.13 % in 2010 compared to previous year.

### 5.3 Exponential Smoothing

In this section, death rates of age groups for the years between 2002 and 2008 smoothened with exponential smoothing and purified from random variations. Death rates acquired by division of number of people died in an age group by total number of people died. Choosing rate is because of elimination of numerical variation in the death registration system. Death rates for the years 2009 and 2010 are forecasted by using the smoothing method and the trend between the years 2002 and 2008.

Two version of double exponential smoothing are commonly used and the method is explained as following (Bowermen & O'Connell, 1987). The first discussed in this subsection employs one smoothing constant and, therefore, is often called one parameter double exponential smoothing. The second, Holt Winters' two parameter double exponential smoothing, employs two smoothing constants. The smoothing constant determines how much weight is attached to each time series observation. In this thesis, we use one parameter double exponential smoothing method. Supposed that a time series $y_1,.....,y_n$ is described by the model

$$y_t = \beta_0 + \beta_1 t + \varepsilon_t$$

where the parameters of $\beta_0$ and $\beta_1$ are slowly changing over time. Also suppose that in time period $T-1$ we have observed time series values $y_1, y_2,.....,y_{T-1}$ and have computed estimates $b_0(T-1)$ and $b_1(T-1)$ of the model parameters $\beta_0$ and $\beta_1$. We observed $y_T$ in time period $T$ and updated our estimates of $\beta_0$ and $\beta_1$.

We obtain updated values of the smoothed statistics $S_T$ and $S_T^{(2)}$ by using the smoothing equations as follow:

$$S_T = \alpha y_T + (1-\alpha) S_{T-1}$$

$$S_T^{(2)} = \alpha S_T + (1-\alpha) S_{T-1}^{(2)}$$

Where $S_{T-1}$ and $S_{T-1}^{(2)}$ are values of the smoothed statistics computed in time period $T-1$. Both of these equations employ the same smoothing constant $\alpha$ , which is defined to be between 0 and 1. The first of these equations are smoothed the origin time series observations. The second $S_T$ values that are obtained by using the first equation. Using $S_T$ and $S_T^{(2)}$, we obtain updated estimates as follows:

$$b_1(T) = \frac{\alpha}{1-\alpha}\left( S_T - S_T^{(2)} \right)$$

$$b_0(T) = 2S_T - S_T^{(2)} - Tb_1(T)$$

We omit the derivations of these equations; they are nor intuitive.

Given the estimates $b_1(T)$ and $b_0(T)$, a forecast made at time $T$ for the future value $y_{T+\tau}$ is:

$$\hat{y}_{T+\tau}(T) = \left( 2 + \frac{\alpha\tau}{(1-\alpha)} \right) S_T - \left( 1 + \frac{\alpha\tau}{(1-\alpha)} \right) S_T^{(2)}$$

In this application we use one parameter double exponential smoothing to forecast the death rates by age group time series. Given in Table 3, we begin by choosing a smoothing constant. It is considered to be suitable to use first real observed value for $b_0(0)$. For $b_1(0)$ on the other hand, use of calculated mean values of increase rates of previous year is considered to be more suitable. For age 0, initial values are calculated as follows.

$$S_0 = b_0(0) - \left( \frac{1-\alpha}{\alpha} \right) b_1(0)$$

$$= 0.075 - \left(\frac{1-0.3}{0.3}\right)(-0.004)$$

$$= 0.0835$$

$$S_0^{(2)} = b_0(0) - 2\left(\frac{1-\alpha}{\alpha}\right)b_1(0)$$

$$= 0.075 - 2\left(\frac{1-0.3}{0.3}\right)(-0.004)$$

$$= 0.0923$$

Therefore the forecast of $y_{2002}$ is:

$$\hat{y}_{0+1}(0) = \left(2 + \frac{\alpha(1)}{(1-\alpha)}\right)S_T - \left(1 + \frac{\alpha(1)}{(1-\alpha)}\right)S_T^{(2)}$$

$$\hat{y}_{2002}(0) = \left(2 + \frac{0.3}{(1-0.3)}\right)0.0835 - \left(1 + \frac{0.3}{(1-0.3)}\right)0,0923$$

$$= 0.0711$$

Table 5.3 Initial values for OPDES by age group.

| Alpha | Age | $b_0(0)$ | $b_1(0)$ | $S_0$ | $S_0^{(2)}$ | $\hat{y}_t(0)$ |
|---|---|---|---|---|---|---|
| **0.30** | 0 | 0.0748 | -0.0037 | 0.0835 | 0.0923 | 0.0711 |
| **0.30** | 1-4 | 0.0135 | -0.0007 | 0.0150 | 0.0165 | 0.0128 |
| **0.30** | 5- 9 | 0.0058 | -0.0002 | 0.0064 | 0.0070 | 0.0056 |
| **0.30** | 10-14 | 0.0046 | -0.0001 | 0.0049 | 0.0052 | 0.0045 |
| **0.30** | 15-19 | 0.0085 | -0.0003 | 0.0092 | 0.0100 | 0.0082 |
| **0.30** | 20-24 | 0.0106 | -0.0004 | 0.0116 | 0.0125 | 0.0102 |
| **0.30** | 25-29 | 0.0103 | -0.0001 | 0.0106 | 0.0109 | 0.0102 |
| **0.30** | 30-34 | 0.0115 | -0.0001 | 0.0118 | 0.0120 | 0.0114 |
| **0.30** | 35-39 | 0.0164 | -0.0003 | 0.0170 | 0.0177 | 0.0161 |
| **0.30** | 40-44 | 0.0249 | -0.0006 | 0.0263 | 0.0276 | 0.0243 |
| **0.30** | 45-49 | 0.0382 | -0.0006 | 0.0396 | 0.0411 | 0.0375 |
| **0.30** | 50-54 | 0.0541 | -0.0005 | 0.0552 | 0.0563 | 0.0536 |
| **0.30** | 55-59 | 0.0600 | 0.0008 | 0.0581 | 0.0562 | 0.0608 |
| **0.30** | 60-64 | 0.0891 | -0.0018 | 0.0932 | 0.0974 | 0.0873 |
| **0.30** | 65-69 | 0.1134 | -0.0026 | 0.1194 | 0.1255 | 0.1108 |
| **0.30** | 70-74 | 0.1441 | -0.0038 | 0.1530 | 0.1618 | 0.1403 |
| **0.30** | 75-79 | 0.1352 | 0.0044 | 0.1248 | 0.1145 | 0.1396 |
| **0.30** | 80-84 | 0.0816 | 0.0092 | 0.0600 | 0.0385 | 0.0909 |
| **0.30** | 85-89 | 0.0591 | 0.0017 | 0.0551 | 0.0511 | 0.0608 |
| **0.30** | 90+ | 0.0445 | -0.0003 | 0.0452 | 0.0460 | 0.0442 |

In Table 5.3, Initial constants and forecasted values are calculated with alpha values taken as 0.3 and shown in the table above. $S_{2002}$ and $S_{2002}^{(2)}$ smoothing constants are calculated for every age group using observation value of $y_{2002} = 0,075$ among $S_0$ and $S_0^{(2)}$ values.

$$S_{2002} = \alpha y_{2002} + (1-\alpha) S_0$$
$$= 0.3(0.075) + (1-0.3)(0.0835)$$
$$= 0.081$$
$$S_{2003} = \alpha y_{2003} + (1-\alpha) S_{2002}$$
$$= 0.3(0.070) + (1-0.3)(0.081)$$
$$= 0.078$$

Table 5.4 : Smoothed Constants for OPDES by age group.

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|
| 0 | 0.081 | 0.078 | 0.073 | 0.068 | 0.064 | 0.061 | 0.059 |
| 1-4 | 0.015 | 0.014 | 0.014 | 0.013 | 0.012 | 0.012 | 0.011 |
| 5- 9 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 |
| 10-14 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 |
| 15-19 | 0.009 | 0.009 | 0.009 | 0.009 | 0.008 | 0.008 | 0.008 |
| 20-24 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.010 | 0.009 |
| 25-29 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.010 |
| 30-34 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| 35-39 | 0.017 | 0.017 | 0.017 | 0.016 | 0.016 | 0.015 | 0.015 |
| 40-44 | 0.026 | 0.026 | 0.026 | 0.025 | 0.025 | 0.025 | 0.024 |
| 45-49 | 0.039 | 0.039 | 0.038 | 0.038 | 0.037 | 0.036 | 0.035 |
| 50-54 | 0.055 | 0.055 | 0.055 | 0.054 | 0.054 | 0.053 | 0.053 |
| 55-59 | 0.059 | 0.060 | 0.061 | 0.063 | 0.063 | 0.064 | 0.064 |
| 60-64 | 0.092 | 0.090 | 0.088 | 0.086 | 0.083 | 0.081 | 0.080 |
| 65-69 | 0.118 | 0.114 | 0.109 | 0.109 | 0.107 | 0.106 | 0.104 |
| 70-74 | 0.150 | 0.150 | 0.150 | 0.147 | 0.144 | 0.140 | 0.134 |
| 75-79 | 0.128 | 0.131 | 0.135 | 0.140 | 0.144 | 0.147 | 0.152 |
| 80-84 | 0.067 | 0.072 | 0.080 | 0.086 | 0.095 | 0.106 | 0.115 |
| 85-89 | 0.056 | 0.056 | 0.055 | 0.055 | 0.056 | 0.058 | 0.062 |
| 90+ | 0.045 | 0.045 | 0.045 | 0.046 | 0.046 | 0.046 | 0.045 |

In Table 5.4, values of smoothing constants calculated for every age-group are shown. Every constant calculated using forecasts of previous year and observed real value of the current year. Procedure shown above repeated for every age-group.

$$S_{2002}^{(2)} = \alpha S_{2002} + (1-\alpha) S_{0}^{(2)}$$

$$= 0.3(0.081) + (1-0.3)(0.0923)$$

$$= 0.089$$

$$S_{2003}^{(2)} = \alpha S_{2003} + (1-\alpha) S_{2002}^{(2)}$$

$$= 0.3(0.078) + (1-0.3)(0.089)$$

$$= 0.085$$

Table 5.5 Smoothed trend constants for OPDES by age group.

| Age | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|
| 0 | 0.089 | 0.085 | 0.082 | 0.078 | 0.074 | 0.070 | 0.066 |
| 1-4 | 0.016 | 0.015 | 0.015 | 0.014 | 0.014 | 0.013 | 0.012 |
| 5- 9 | 0.007 | 0.007 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| 10-14 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 15-19 | 0.010 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.008 |
| 20-24 | 0.012 | 0.012 | 0.012 | 0.012 | 0.011 | 0.011 | 0.010 |
| 25-29 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| 30-34 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| 35-39 | 0.017 | 0.017 | 0.017 | 0.017 | 0.016 | 0.016 | 0.016 |
| 40-44 | 0.027 | 0.027 | 0.026 | 0.026 | 0.026 | 0.025 | 0.025 |
| 45-49 | 0.041 | 0.040 | 0.040 | 0.039 | 0.038 | 0.038 | 0.037 |
| 50-54 | 0.056 | 0.056 | 0.055 | 0.055 | 0.055 | 0.054 | 0.054 |
| 55-59 | 0.057 | 0.058 | 0.059 | 0.060 | 0.061 | 0.062 | 0.062 |
| 60-64 | 0.096 | 0.094 | 0.092 | 0.090 | 0.088 | 0.086 | 0.084 |
| 65-69 | 0.123 | 0.120 | 0.117 | 0.114 | 0.112 | 0.110 | 0.108 |
| 70-74 | 0.158 | 0.156 | 0.154 | 0.152 | 0.150 | 0.147 | 0.143 |
| 75-79 | 0.119 | 0.122 | 0.126 | 0.130 | 0.134 | 0.138 | 0.142 |
| 80-84 | 0.047 | 0.054 | 0.062 | 0.069 | 0.077 | 0.086 | 0.094 |
| 85-89 | 0.053 | 0.054 | 0.054 | 0.054 | 0.055 | 0.056 | 0.058 |
| 90+ | 0.046 | 0.045 | 0.045 | 0.046 | 0.046 | 0.046 | 0.046 |

In Table 5.5, values of the calculated trend constant have shown for every age-group. Every constant calculated using forecasts of previous year and observed real value of the current year. Procedure shown above repeated for every age-group and for following years. In Table 5.6, forecasts shown below are obtained using smoothing constants.

$$\hat{y}_{2002+1}(2002)=\left(2+\frac{\alpha(1)}{(1-\alpha)}\right)S_{2002}-\left(1+\frac{\alpha(1)}{(1-\alpha)}\right)S_{2002}^{(2)}$$

$$\hat{y}_{2003}(2002)=\left(2+\frac{0.3}{(1-0.3)}\right)0.081-\left(1+\frac{0.3}{(1-0.3)}\right)0.089=0.070$$

$$\hat{y}_{2003+1}(2007)=\left(2+\frac{\alpha(1)}{(1-\alpha)}\right)S_{2003}-\left(1+\frac{\alpha(1)}{(1-\alpha)}\right)S_{2003}^{(2)}$$

$$\hat{y}_{2003}(2002)=\left(2+\frac{0.3}{(1-0.3)}\right)0.078-\left(1+\frac{0.3}{(1-0.3)}\right)0.085=0.066$$

Table 5.6: Smoothed forecasts for OPDES by age group

| Age | F_2002 | F_2003 | F_2004 | F_2005 | F_2006 | F_2007 | F_2008 |
|---|---|---|---|---|---|---|---|
| 0 | 0.071 | 0.070 | 0.066 | 0.060 | 0.055 | 0.050 | 0.049 |
| 1-4 | 0.013 | 0.013 | 0.012 | 0.012 | 0.011 | 0.010 | 0.009 |
| 5- 9 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 | 0.005 |
| 10-14 | 0.004 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 |
| 15-19 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 |
| 20-24 | 0.010 | 0.010 | 0.010 | 0.011 | 0.010 | 0.010 | 0.009 |
| 25-29 | 0.010 | 0.010 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| 30-34 | 0.011 | 0.011 | 0.012 | 0.013 | 0.013 | 0.012 | 0.012 |
| 35-39 | 0.016 | 0.016 | 0.016 | 0.016 | 0.015 | 0.014 | 0.014 |
| 40-44 | 0.024 | 0.024 | 0.024 | 0.025 | 0.025 | 0.025 | 0.023 |
| 45-49 | 0.038 | 0.037 | 0.037 | 0.037 | 0.037 | 0.034 | 0.033 |
| 50-54 | 0.054 | 0.053 | 0.055 | 0.054 | 0.053 | 0.053 | 0.052 |
| 55-59 | 0.061 | 0.061 | 0.063 | 0.064 | 0.066 | 0.067 | 0.066 |
| 60-64 | 0.087 | 0.087 | 0.085 | 0.082 | 0.079 | 0.077 | 0.073 |
| 65-69 | 0.111 | 0.110 | 0.104 | 0.099 | 0.100 | 0.100 | 0.100 |
| 70-74 | 0.140 | 0.139 | 0.141 | 0.144 | 0.141 | 0.136 | 0.130 |
| 75-79 | 0.140 | 0.141 | 0.143 | 0.148 | 0.154 | 0.157 | 0.160 |
| 80-84 | 0.091 | 0.095 | 0.097 | 0.105 | 0.110 | 0.121 | 0.134 |
| 85-89 | 0.061 | 0.062 | 0.060 | 0.057 | 0.056 | 0.058 | 0.062 |
| 90+ | 0.044 | 0.044 | 0.044 | 0.045 | 0.046 | 0.047 | 0.046 |

Forecast errors obtained as follows:

$$y_{2002} - \hat{y}_{2002}(0) = 0.075 - 0.070 = 0.004$$

$$y_{2003} - \hat{y}_{2003}(2002) = 0.070 - 0.066 = 0.0003$$

To be able to make correct forecasts, alpha values resulting in minimum error should be chosen. In this application separate smoothing applied for every age group. However, errors examined considering whole data-set and total error is considered while forecasting all data on death.

Table 5.7: Sum of squared error and mean squared error for smoothed forecasts

| Alpha | SSE | MSE |
|---|---|---|
| 0.01 | 0.00262 | 0.00002 |
| 0.02 | 0.00242 | 0.00002 |
| 0.04 | 0.00209 | 0.00001 |
| 0.06 | 0.00186 | 0.00001 |
| 0.08 | 0.00169 | 0.00001 |
| 0.10 | 0.00158 | 0.00001 |
| 0.12 | 0.00150 | 0.00001 |
| 0.14 | 0.00144 | 0.00001 |
| 0.16 | 0.00141 | 0.00001 |
| 0.18 | 0.00138 | 0.00001 |
| 0.20 | 0.00137 | 0.00001 |
| 0.22 | 0.00136 | 0.00001 |
| 0.24 | 0.00135 | 0.00001 |
| 0.26 | 0.00135 | 0.00001 |
| 0.28 | 0.00135 | 0.00001 |
| 0.30 | 0.00134 | 0.00001 |

In Table 5.7, sum of squares of forecasting errors and means of squares of forecasting errors are shown for various alpha values. Accordingly, 0.3 alpha value is chosen which results in minimum sum of errors and one parameter double exponential smoothing is calculated with 0.3 alpha.

In the following stage, 2009-2010 mortality data is forecasted using the trend of 2002-2008 data. Forecasted value for 2009 is calculated as follows:

$$\hat{y}_{2008+1}(2008)=\left(2+\frac{\alpha(1)}{(1-\alpha)}\right)S_{2008}-\left(1+\frac{\alpha(1)}{(1-\alpha)}\right)S^{(2)}_{2008}$$

$$\hat{y}_{2009}(2008)=\left(2+\frac{0.3}{(1-0.3)}\right)0.059-\left(1+\frac{0.3}{(1-0.3)}\right)0.066=0,049$$

$$=0.049$$

Forecasted value for 2010 is calculated as follows:

$$\hat{y}_{2008+2}(2008)=\left(2+\frac{\alpha(2)}{(1-\alpha)}\right)S_{2008}-\left(1+\frac{\alpha(2)}{(1-\alpha)}\right)S^{(2)}_{2008}$$

$$\hat{y}_{2010}(2008)=\left(2+\frac{0.6}{(1-0.3)}\right)0.059-\left(1+\frac{0.6}{(1-0.3)}\right)0.066$$

$$=0.044$$

Calculations for the following years performed as shown above.

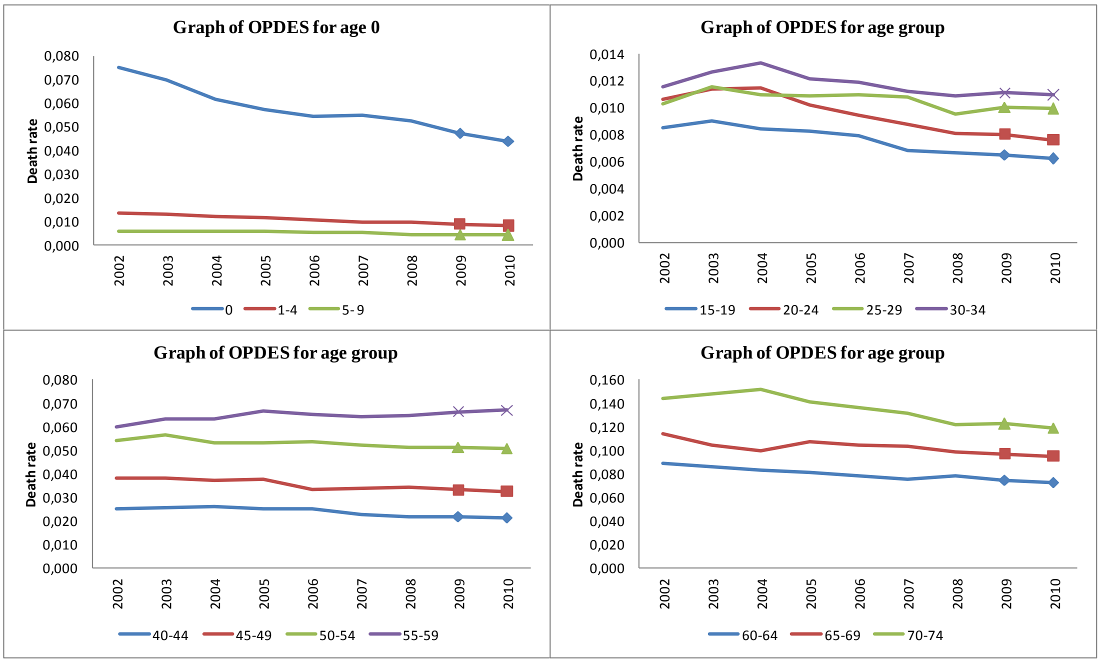


Figure 5.8 OPDES forecasts.

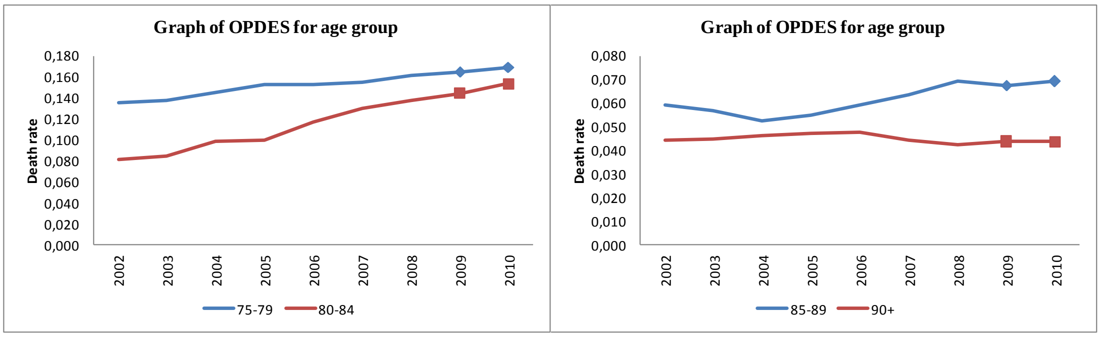


Figure 5.9 OPDES forecasts.

In Figure 5.8, results of one parameter double exponential smoothing is shown for age groups. However, forecast values obtained here are based upon the data from urban areas and actual forecast values required are deaths data covering whole Turkey. Since the published mortality data for 2009-2010 is present, a constant set for the difference between forecasted 2009-2010 mortality data for urban areas. The set constant will be as following if we represent urban areas' mortality data with $\hat{y}$ , mortality data for whole Turkey with $x$, and smoothed mortality data with $z$.

$$\beta_i = \frac{\sum_{j=2009}^{2010} \left( \frac{\left| x_{i,j} - \hat{y}_{i,j} \right|}{c_j} \right)}{2} \qquad i = 0, 1-4, 5-9, \ldots, 85-89, 90+ \quad , \quad j = 2009, 2010$$

where,

$$c = \sum_{i=0}^{90+} \left| x_i - \hat{y}_i \right|$$

Afterwards, in order to include the trend of present difference, signs of forecasted observations and smoothing constant obtained by age groups are matched. Forecasted values by city and town centers increased by smoothing constant obtained for every age group.

$$z_i = \hat{y}_i \left( 1 + \beta_i \right)$$

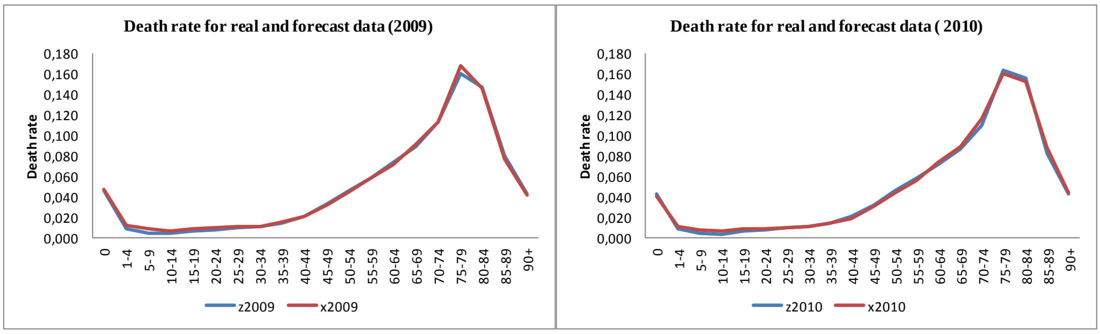


Figure 5.10 Modified forecasts values and real forecasts values for 2009 and 2010.

In Figure 5.9, mortality data for Turkey in general and mortality data obtained by using forecasting values of urban areas are shown. However, different trends these two data-sets bear do not allow the use of data from past years. In case of use, it is seen that life tables created to forecast future will result in incorrect outcomes. Hence, use of real data published in 2009 and 2010 for creating period life table and since the 2 year data is inadequate for future forecasting, analysis current structure is decided.

## 5.4 Construction of Period Life Table

In this section, for years 2009 and 2010, Abridged Period Life Table is constructed for Turkey. In order to construct this table, age-groups based mid-year population and deaths data are required. Data-set is obtained from mortality data for whole Turkey published by TUIK and population data published based upon ADNKS. Mortality data are examined in section 4.3. Mid-year population forecasts for age groups are calculated using population data of 2008, 2009 and 2010. Mid-year population forecasts of the years 2009 and 2010 for age group 0 to 4 are shown below (Preston et al, 2001).

$$r = \frac{\ln N(t) - \ln N(0)}{t} = \ln \frac{N(2009)}{N(2008)}$$

$$= \ln \frac{6.155.321}{5.998.258} = 0,02584$$

$$N_t = \frac{N(t) - N(0)}{r} = \frac{6.155.321\text{-}5.998.258}{0,02584} = 6.076.451$$

$$r = \frac{\ln N(t) - \ln N(0)}{t} = \ln \frac{N(2010)}{N(2009)}$$

$$= \ln \frac{6.178.723}{6.155.321} = 0,003794$$

$$N_{2010} = \frac{N(t) - N(0)}{r} = \frac{6.178.723 - 6.155.321}{0,003794} = 6.167.015$$

Procedure above is applied for all age groups.

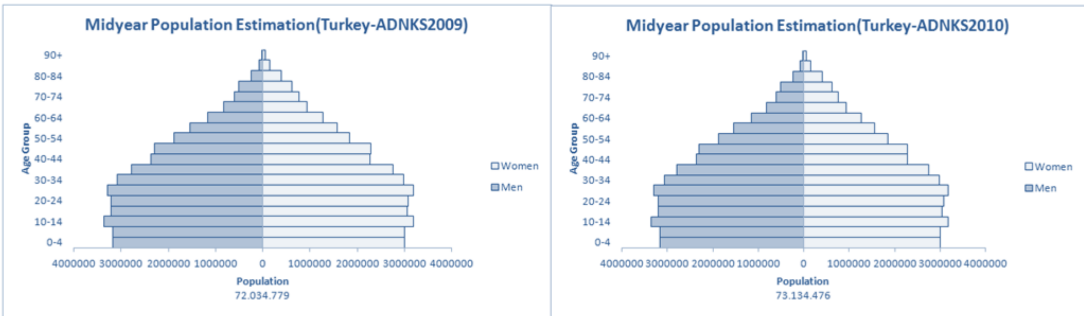


Figure 5.10 Midyear population estimation by gender, age group.

Afterwards, age specific death rates are obtained by dividing number of deaths in every age interval to alive number of person years in that specific age group. Number of person-years is equal to mid-year population forecasts. While creating life tables, infant mortality, in other words 0-age mortality is forecasted separately and instead of mid-year population data, number of newborns within that specific year is used. 0-age age specific death rates are calculated for 2009 as

$$m_0 = \frac{D_0}{B_0} = \frac{17,354}{1,272,300} = 0.0136$$

And calculated for 2010 as

$$m_0 = \frac{D_0}{B_0} = \frac{15,049}{1,238,970} = 0.0121$$

2009 age specific death rate for age group 1-4 is:

$$_4m_1 = \frac{_4D_1}{_4N_1} = \frac{4{,}564}{4{,}795{,}730} = 0.00095$$

And for 2010 is:

$$_4m_1 = \frac{_4D_1}{_4N_1} = \frac{4{,}183}{4{,}911{,}332} = 0.00085$$

Table 5.8 Age specific death rates per thousand for every age group by 2009 and 2010 years.

| | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|
| **Age Group** | **All** | **Female** | **Male** | **All*** | **Female*** | **Male*** |
| **0** | 13.55 | 13.06 | 14.61 | 12.15 | 11.40 | 12.85 |
| **1-4** | 0.95 | 0.93 | 0.99 | 0.85 | 0.82 | 0.88 |
| **5- 9** | 0.55 | 0.54 | 0.56 | 0.47 | 0.47 | 0.47 |
| **10-14** | 0.39 | 0.35 | 0.44 | 0.35 | 0.31 | 0.39 |
| **15-19** | 0.55 | 0.39 | 0.71 | 0.53 | 0.36 | 0.69 |
| **20-24** | 0.57 | 0.38 | 0.76 | 0.53 | 0.33 | 0.72 |
| **25-29** | 0.64 | 0.43 | 0.85 | 0.59 | 0.39 | 0.78 |
| **30-34** | 0.73 | 0.52 | 0.93 | 0.69 | 0.48 | 0.89 |
| **35-39** | 1.03 | 0.76 | 1.29 | 0.94 | 0.69 | 1.19 |
| **40-44** | 1.65 | 1.17 | 2.13 | 1.49 | 1.10 | 1.88 |
| **45-49** | 2.73 | 1.83 | 3.62 | 2.50 | 1.65 | 3.34 |
| **50-54** | 4.54 | 2.78 | 6.28 | 4.32 | 2.64 | 5.96 |
| **55-59** | 7.42 | 4.54 | 10.35 | 6.70 | 4.13 | 9.31 |
| **60-64** | 11.52 | 7.58 | 15.90 | 11.14 | 7.35 | 15.29 |
| **65-69** | 19.49 | 13.89 | 26.00 | 18.41 | 13.21 | 24.33 |
| **70-74** | 31.92 | 24.91 | 40.65 | 31.14 | 24.39 | 39.58 |
| **75-79** | 54.69 | 45.75 | 65.86 | 52.12 | 43.36 | 62.83 |
| **80-84** | 90.82 | 81.06 | 107.36 | 88.02 | 78.08 | 104.79 |
| **85-89** | 145.99 | 134.29 | 169.82 | 141.36 | 130.52 | 162.61 |
| **90+** | 244.53 | 229.32 | 291.09 | 231.20 | 218.52 | 269.99 |

Calculated age specific death rates are shown in Table 5.8. According to the findings, infant mortality rate is decreased by 10.3 % in the general population, by 12.7 % in the female population and by 12.1 % in the male population. Age specific death rate of the 40-44 age group is decreased by 9.7 % in the general population, by 6 % in the female population and by 11.7 % in the male population. Maximum decrease in the 60-65 age groups is in the male population with 6.4 %.

Correspondingly, lowest decrease in the age specific death rates of 90 years of age and older realized for female population with 4.7 %.

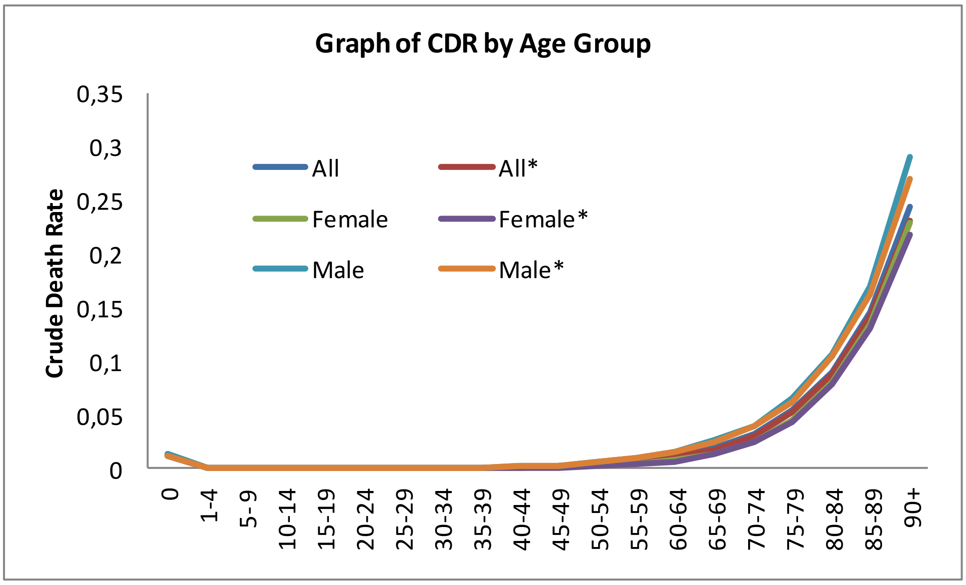


Figure 5.11 Graph of crude deaths by age groups (* shows that 2010 year).

Figure 5.11, shows crude death rates. Here it can be seen that crude death rates of males is the highest and crude death rates of females is the lowest.

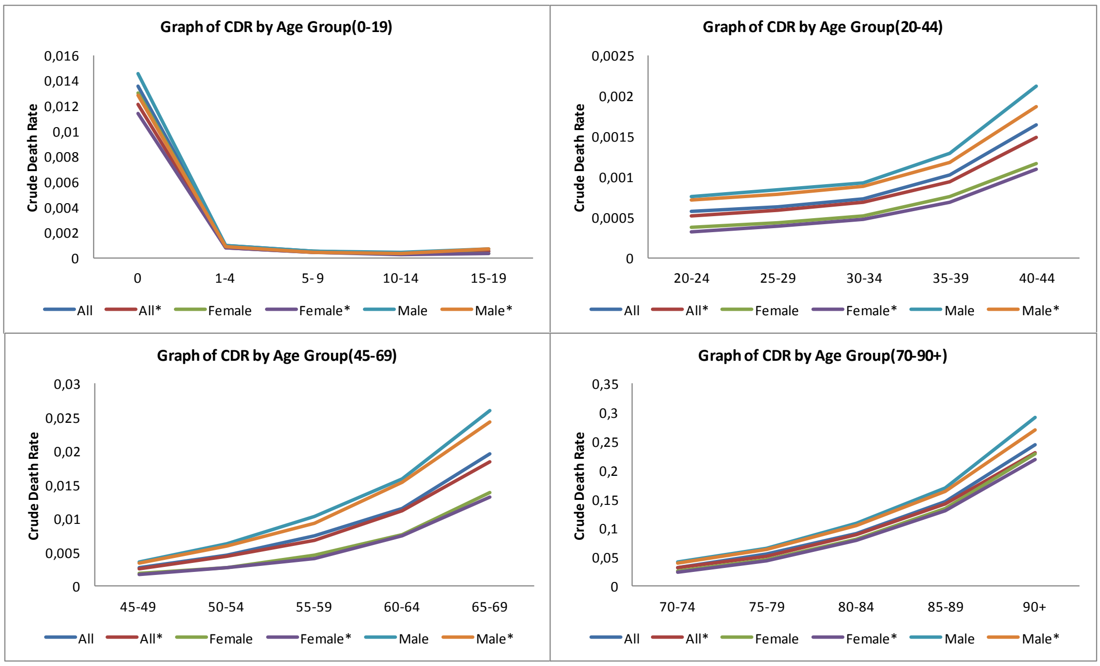


Figure 5.12 Graph of crude death rate for all age group by sex (* shows that 2010 year).

Crude death rates for various age groups are shown in Figure 5.12.

Next stage for creating life tables is to obtain age specific death rates by using crude death rates and mean number of live person-years. At this stage, number of live person-years is calculated initially using real observations. Mean number of alive people in the 1-4 age group in 2009 is calculated as

$$ {}_n a_x = \frac{d_x.(0) + d_{x+1}.(1) + d_{x+2}.(2) + d_{x+3}.(3) + d_{x+4}.(4)}{{}_n d_x} \quad , \quad n = 5 $$

$$ \frac{1{,}782(0) + 1{,}086(1) + 894(2) + 845(3)}{4{,}607} = 1.174 $$

And mean number of alive people in the 1-4 age group in 2010 is calculated as

$$ = \frac{1{,}661(0) + 1{,}028(1) + 772(2) + 722(3)}{4{,}607} = 1.133 $$

And the variable is obtained generally for male and female age groups. Afterwards, age specific death rates are calculated as follows using the equation.

$$ q_0 = m_0 = 0.0136 $$

$$ {}_4 q_1 = \frac{4.{}_4 m_1}{1 + (1 - {}_4 a_1)\, {}_4 m_1} = \frac{4(0{,}00095)}{1 + (1 - 1.174)(0.00095)} = 0.0038 $$

$$ {}_5 q_5 = \frac{5.{}_5 m_5}{1 + (1 - {}_5 a_5)\, {}_5 m_5} = \frac{5(0.00055)}{1 + (1 - 1.870)(0.00055)} = 0.0027 $$

We assume that all population is died infinite age and its' also equal

$$ q_\infty = 1 $$

For 2010,

$$q_0 = m_0 = 0.0121$$

$$_4q_1 = \frac{4._4m_1}{1+(1-{}_4a_1)\,{}_4m_1} = \frac{4(0.00085)}{1+(1-1.133)(0.00085)} = 0.0034$$

$$_5q_5 = \frac{5._5m_5}{1+(1-{}_5a_5)\,{}_5m_5} = \frac{5(0.00047)}{1+(1-1.715)(0.00047)} = 0.0023$$

$$q_\infty = 1$$

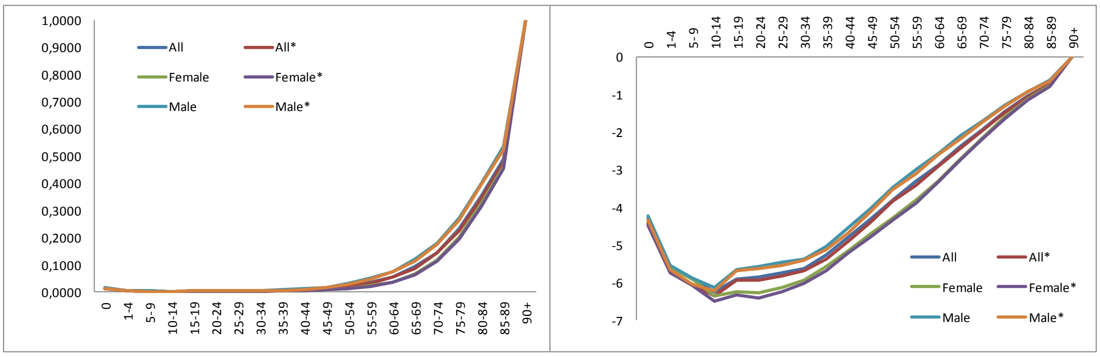


Figure 5.13 Probabilities of age specific death rates for age groups in two different forms and (* shows 2010 year).

Taking the graph of general probabilities of age specific death rates into account, there is a decrease observed in 2010 compared with 2009. Death probabilities for males take greater values than for females.

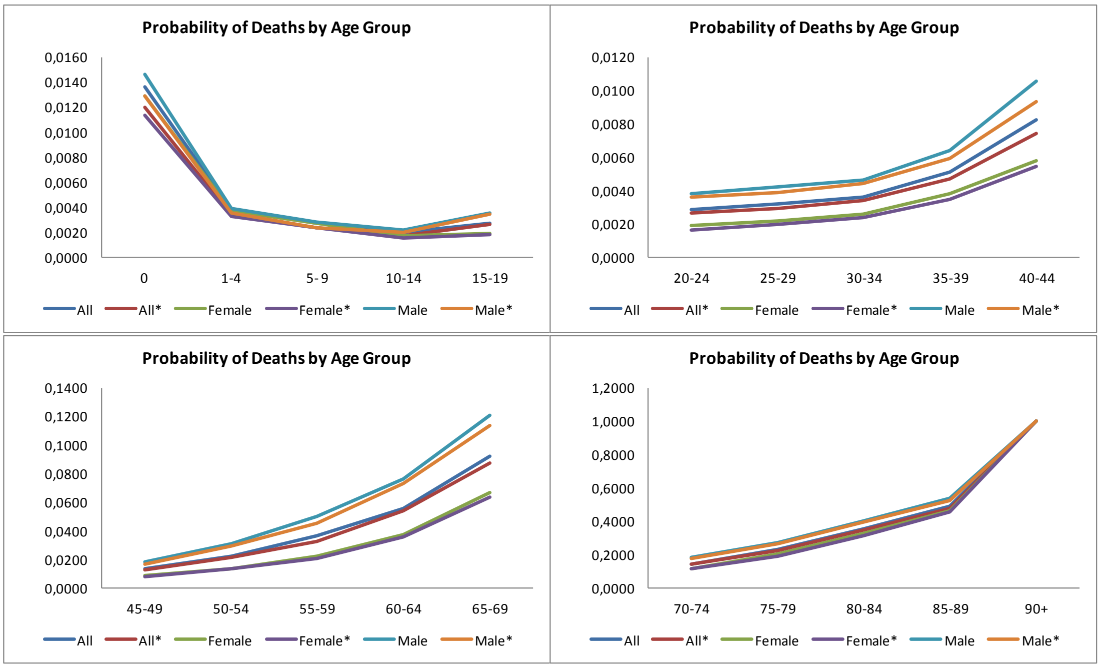


Figure 5.14 Age specific death probabilities for all age group by sex (* shows that 2010 year).

In Figure 5.14, death probabilities are examined for various age groups. Infant mortalities in 2010 decreased by 11.02 % in the general population, by 14.5 % in the female population and by 13.2 % in the male population compared with 2009. This decrease trend continues until the age of 15. While an increase trend is observed in death probabilities after the age of 15, there is a decrease in death probabilities in 2010 compared to 2009. Increase in the death probabilities of 40-44 age group is 13.9 % for males and 5.5 % for females. Increase in the death probabilities of 65-69 age group is observed to be 6.4 % for males and 4.8 % for females. Increase in the death probabilities of 75-79 age group is observed to be 3.9 % for males and 4.8 % for females. Increase in the death probabilities of 80-84 age group is observed to be 1.8 % for males and 3.04 % for females. As can be seen, decrease in the death probabilities of infants and children with years and decrease in the death probabilities of males over 70 are lower than the ones for females. And oppositely, it is higher in the middle-age interval.

According to the general probability theory, a person can either survive or die, in other words, probabilities of death and survival are complements of each other.

Therefore, survival probability of a person aged $x$ is calculated as follows and so, survival probabilities of 0 age and 1-4 age group in 2009 are:

$$p_x = 1 - q_x$$

$$p_0 = 1 - q_0 = 1 - 0.0136 = 0.9864$$

$$_n p_x = 1 - {}_n q_x$$

$$_4 p_1 = 1 - {}_4 q_1 = 1 - 0.0038 = 0.9962$$

Survival probabilities of 0 age and 1-4 age group in 2010 are:

$$p_0 = 1 - q_0 = 1 - 0.0121 = 0.9879$$

$$_4 p_1 = 1 - {}_4 q_1 = 1 - 0.0034 = 0.9966$$

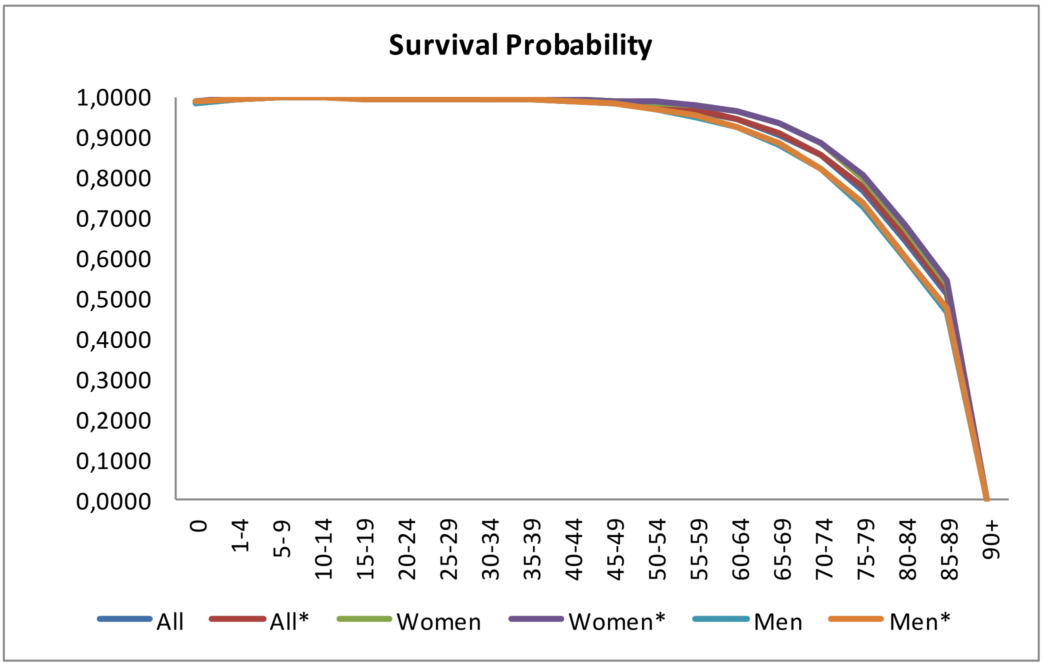


Figure 5.15 Graph of probabilities of survive by sex and age groups.

Survival probabilities of whole population, males and females in 2009 and 2010 are separately shown in Figure 5.15. As can be seen in the graph, survival probabilities of females take greater values than males.

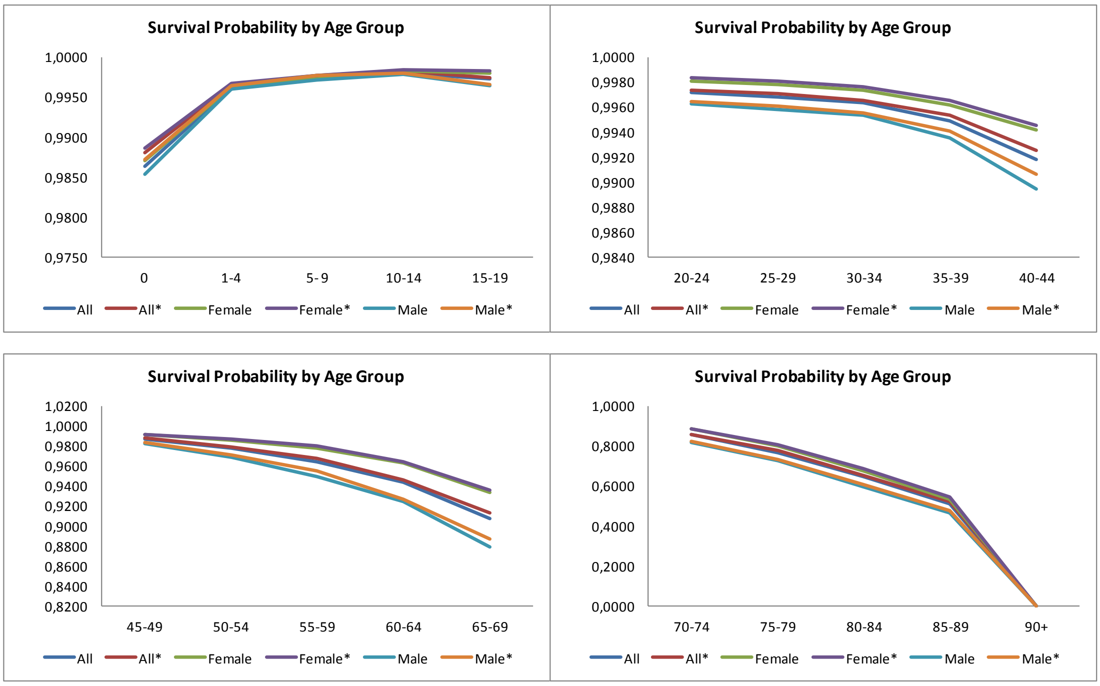


Figure 5.16 Graph of probabilities of survive for all age interval by sex (* shows that 2010 year).

Survival probabilities are shown in Figure 5.16 for various age groups. Since they are complements of death probabilities, survival probabilities behave oppositely.

After the death and survival probabilities which make up the basis for life tables, number of alive and death people are obtained. 1.000.000 people assumed to be present in the population of the research and assigned as radix. Number of live people is obtained as follows for every age group.

$$l_{x+n} = l_x \cdot {}_n p_x$$

$$l_1 = l_0 \cdot p_0 = (0.9864).(1,000,000) = 986,448$$

$$l_5 = l_1 \cdot {}_5 p_5 = (0.9962).(986,448) = 982,703$$

Number of alive people obtained is calculated for every age group according to general population, male population and female population separately for 2009 and 2010.

Number of death people for every age group is obtained as follows.

$$_nd_x = l_x - l_{x+n}$$

$$d_0 = l_0 - l_1 = 1,000,000 - 986,448 = 13,552$$

$$_4d_1 = l_5 - l_1 = 986,448 - 982,703 = 3,745$$

Number of death people obtained is calculated for every age group according to general population, male population and female population separately for 2009 and 2010. Number of deaths calculated for male and female populations are shown in the graph below. Accordingly, while the number of deaths for elderly population of males is decreasing, it continues to shift towards further ages for females.

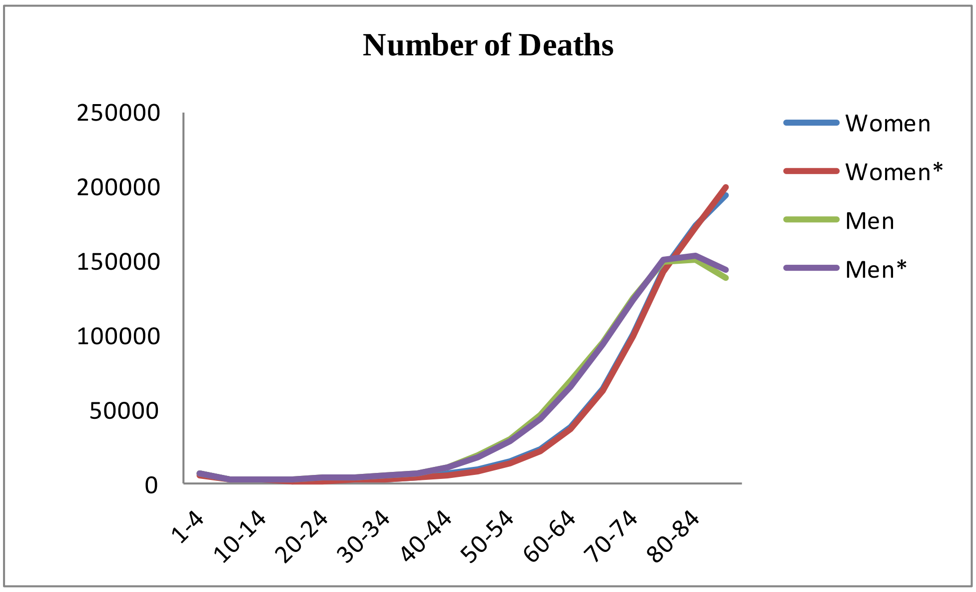


Figure 5.17 Graph of smoothed deaths by moving averages method by sex, (* show 2010 year)

The most important function of life tables is expected life spans. In order to calculate expected life spans, number of live person-years in every age group and total number of alive person-years must be identified. For every age group, number of live people is calculated using the equation and obtained as follows:

$$_nL_x = n\left(l_{x+n} + {}_na_x \cdot {}_nd_x\right)$$

$$L_0 = l_1 + (a_0 . d_0) = 986,448 + ((0.0136).(13,552)) = 986,631$$

$${}_4L_1 = 4.l_5 + 4({}_4a_1 \cdot {}_4d_1) = 4(982,703) + 4((1.174)(3,745)) = 3,935,207$$

$${}_5L_5 = 5.l_{10} + 5({}_5a_5 \cdot {}_5d_5) = 5(980,013) + 5((1.870)(2,690)) = 4,905,093$$

For calculation of number of person-years aged 90 and over, the equation is used (Preston et al, 2001).

$$L_{w+} = \frac{d_{w+}}{m_{w+}} = \frac{l_{w+}}{m_{w+}}$$

$$L_{90+} = \frac{d_{90+}}{m_{90+}} = \frac{l_{90+}}{m_{90+}} = \frac{163,728}{0.2445} = 669,569$$

Total number of live person-years for every age group is obtained as shown below and life expectancy is calculated by dividing it into number of alive people in that specific age group. Total number of live people (Cunningham, 2005):

$$T_x = T_{x+n} + {}_nL_x = \sum {}_nL_x \qquad x = 0,1,5,...,90+$$

$$T_0 = 75,806,516$$

$$T_1 = 74,820,156$$

Total number of live people at the age 90 and over:

$$T_w = L_{w+}$$

$$T_{90} = 669,569$$

As specified earlier, these calculations are given separately for general, male and female populations.

Expected life at birth in 2009 is calculated as:

$$\overset{0}{e}_x = \frac{T_x}{l_x}$$

$$\overset{0}{e}_0 = \frac{T_0}{l_0} = \frac{75{,}806{,}516}{1{,}000{,}000} = 75.8$$

And for 2010:

$$\overset{0}{e}_0 = \frac{T_0}{l_0} = \frac{76{,}508{,}760}{1{,}000{,}000} = 76.5$$

According to these findings, while the expected life of the general population in 2009 is 75.8, it is 78.5 for females and 73.1 for males. And for 2010, expected life span is increased to 76.5 for the general population, to 79.1 for females and to 73.9 for males. Expected life span of the general population is increased by 0.92 % in 2010 compared to 2009. This increase is 0.76 % for females and 1.1 % for males. Life expectancy of males achieved greater increase than female life expectancy.

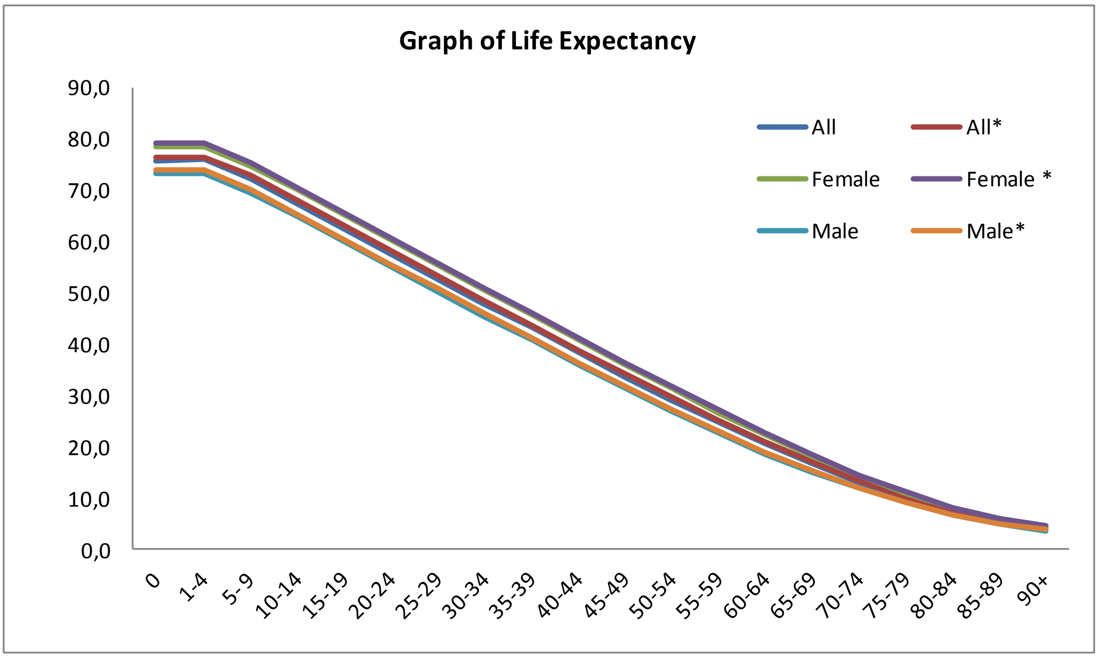


Figure 5.11 Graph of life expectancy by sex and age groups, (* shows 2010 year).

### *5.4.1 Estimate Survivors at Older Ages by Using Gompertz Law of Mortality*

Demographic features of our country shows that number of elderly population is increasing and expected life are prolonged. Thence, number of live people for age groups 90 and over is forecasted. As a way of forecasting, law of mortality developed by Gompertz is utilized. General model of Gompertz approach which is utilized for analyzing pattern of mortality of a population according to time and age, is as follows (Preston et. al., 2001):

$$l_x = C \,.\, a^{b^x}$$

Parameters obtained using last three values of the life table survival function. Parameter forecasts for total population in 2009 are as follows:

$$b = \left( \frac{\ln \frac{l_{x+2n}}{l_{x+n}}}{\ln \frac{l_{x+n}}{l_x}} \right)^{\frac{1}{n}} = \left( \frac{\ln \frac{l_{85}}{l_{80}}}{\ln \frac{l_{80}}{l_{75}}} \right)^{\frac{1}{5}} = 1.10382$$

$$a = \exp\left( \frac{\ln \frac{l_{x+n}}{l_x}}{b^x \left(b^n - 1\right)} \right) = \exp\left( \frac{\ln \frac{l_{80}}{l_{75}}}{b^{75} \left(b^5 - 1\right)} \right) = 0.99974$$

$$C = l_x \,.\exp\left(-b^x.\ln a\right) = l_{75}\,.\exp\left(-.10382^x.\ln\left(0.99974\right)\right) = 985,674.6$$

Forecast of number of alive people in 90-94 age group after parameter forecasts is calculated as follows using the general model:

$$\hat{l}_{90} = (985,674.6).\left(0.99974^{1.10382^{90}}\right) = 156,320$$

$$\hat{l}_{95} = (985,674.6).\left(0.99974^{1.10382^{95}}\right) = 48,221$$

$$\hat{l}_{100} = (985,674.6).\left(0.99974^{1.10382^{100}}\right) = 7,018$$

$$\hat{l}_{105} = (985,674.6).\left(0.99974^{1.10382^{105}}\right) = 298$$

$$\hat{l}_{110} = (985,674.6).\left(0.99974^{1.10382^{110}}\right) = 2$$

$$\hat{l}_{115} = (985,674.6).\left(0.99974^{1.10382^{115}}\right) \approx 0$$

It is applied for forecasting of number of live people for elderly population in 2009 and 2010 for whole, male and female populations. Accordingly, graphs for death probabilities are given below:

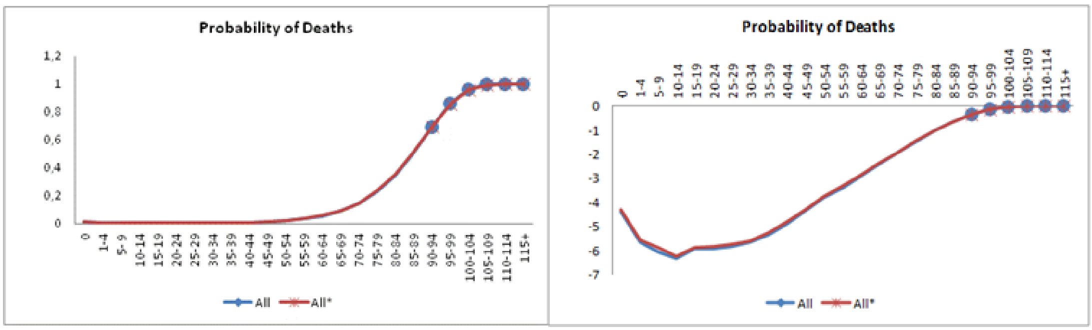


Figure 5.129 Graphs of age specific death probabilities estimations of older ages in two forms (* shows 2010 year)

In Figure 5.19, age specific death probabilities are calculated with forecast of number of live people aged 85 and over within general population and the logarithm taken values of these forecasts are shown. According to this, increase in the death probabilities continue until the age of 105. Almost everyone in Turkey dies before the age of 115.

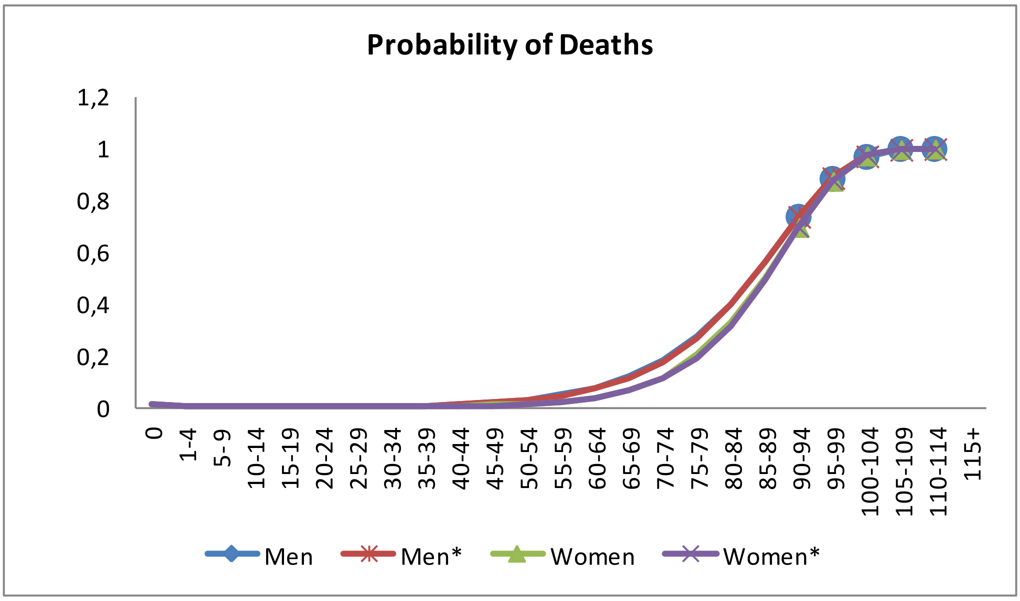


Figure 5.13 Graphs of age specific death probabilities estimations of older ages by gender

(* shows 2010 year)

In Figure 5.20, age specific death probabilities are calculated with forecast of number of live male and female populations aged 85 and over are shown. According to this, increase in the death probabilities continue until the age of 105. Almost everyone in Turkey dies before the age of 115.

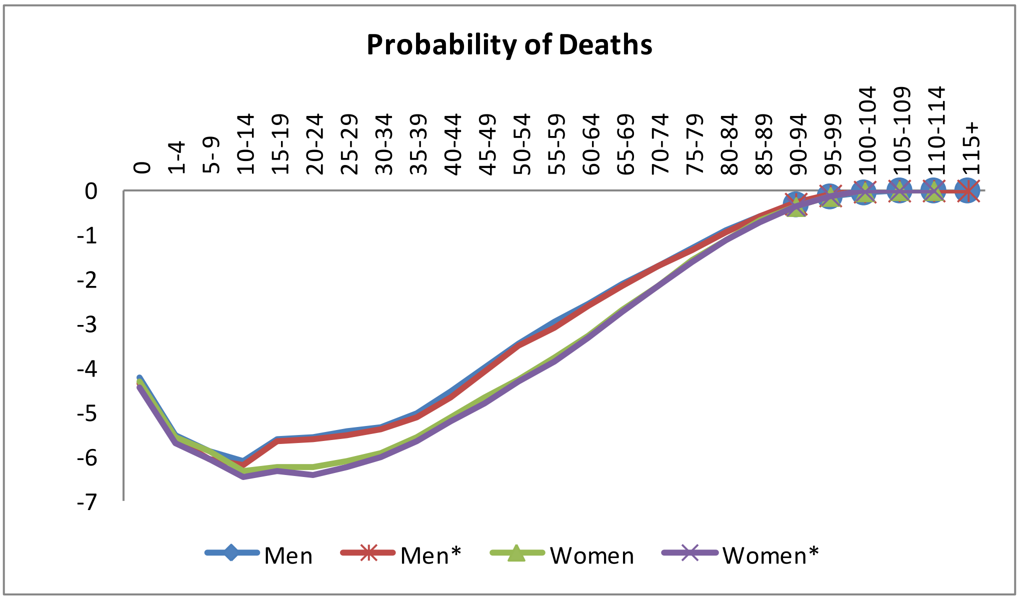


Figure 5.14 Graph of age specific death probabilities in logarithm form with estimation of older ages, (* shows 2010 year).

In Figure 5.21, logarithm taken values of death probabilities are calculated with forecast of number of live male and female populations aged 85 and over are shown.

Table 5.9 Life expectancy and rate of increase for specific age group, (* shows 2010 year).

| Age | All | All* | Rate of Increase % | Women | Women * | Rate of Increase % | Men | Men * | Rate of Increase % |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 75.8 | 76.5 | 0.9% | 78.5 | 79.1 | 0.8% | 73.1 | 73.9 | 1.1% |
| 20 | 57.6 | 58.1 | 0.9% | 60.2 | 60.7 | 0.8% | 55.0 | 55.6 | 1.1% |
| 40 | 38.3 | 38.8 | 1.2% | 40.7 | 41.1 | 1.0% | 35.9 | 36.4 | 1.5% |
| 60 | 20.5 | 20.9 | 1.7% | 22.2 | 22.6 | 1.5% | 18.6 | 19.0 | 2.0% |
| 80 | 7.4 | 7.6 | 2.8% | 7.9 | 8.1 | 2.7% | 6.6 | 6.8 | 3.1% |

In Table 5.9, expected lifetime and increase rates based upon years are shown for some specific age groups of elderly population calculated with forecasts and expected life. The greatest increase in expected lifetime is observed in males. Life spans of males are extended more than life spans of females in 2010. This can be inferred as life spans of males will increase more than life spans of females in the following years. However, while the expected life of females was 5.4 years more than males in 2009, it is 5.2 years more in 2010. Increase in the expected life spans in 2010 compared to 2009 is a sign that the population of Turkey is getting older.

### *5.4.2 Construction of Turkey Period Life Table by Region*

In this section, for years 2009 and 2010, An Abridged Period Life Table, which has been constructed in section 4.4, is expanded by region. The methodology of construction of the table is the same with section 4.4. Firstly the data set, is ordered, which include population, birth and death data by region and sex and also midyear population is estimated for years 2009 and 2010 by region. Before the tables are constructed, regions are determined with their abridgment codes. The codes which are expressed to regions as listed in Table 10:

Table 5.10 Region code for IBBS Level 1 (TUİK).

| Code | Region |
|---|---|
| TR1 | İstanbul |
| TR2 | West Marmara |
| TR3 | Aegean |
| TR4 | East Marmara |
| TR5 | Western Anatolia |
| TR6 | Mediterranean |
| TR7 | Center Anatolia |
| TR8 | Western Black Sea |
| TR9 | Eastern Black Sea |
| TRA | Northeast Anatolia |
| TRB | Middle East Anatolia |
| TRC | Southeastern Anatolia |

Table 5.11 Infant mortality and decrease rate in infant mortality for years 2009 and 2010 by region which defined İBBS level 1 by TUİK.

| İBBS (1) | TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 | TR9 | TRA | TRB | TRC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2009** | *11,1* | *13,3* | *14,0* | *12,7* | *12,7* | *13,4* | *11,9* | *13,1* | *11,7* | *12,9* | *17,3* | *17,2* |
| **2010** | *9,8* | *10,3* | *11,4* | *10,0* | *11,6* | *12,1* | *10,7* | *11,1* | *10,4* | *14,0* | *14,3* | *16,0* |
| **Rate** | *11,7%* | *22,3%* | *18,1%* | *21,5%* | *9,1%* | *9,4%* | *10,1%* | *15,5%* | *10,5%* | *7,93%* | *17,1%* | *6,8%* |

In Table 5.11 shows that a decrease rate gets a minimum value for Southeastern Anatolia, TRC and a decrease rate gets a maximum value for West Marmara, TR2 following East Marmara, TR4. The lowest infant mortality rate is 11.1 per thousand for İstanbul, TR1 and also the highest infant mortality rate is 17.3 per thousand for Middle East Anatolia, TRB at 2009. Against, the lowest infant mortality rate is 9.8 per thousand for İstanbul, TR1 and also the highest infant mortality rate is 16.0 per thousand for Southeastern Anatolia, TRC at 2010.

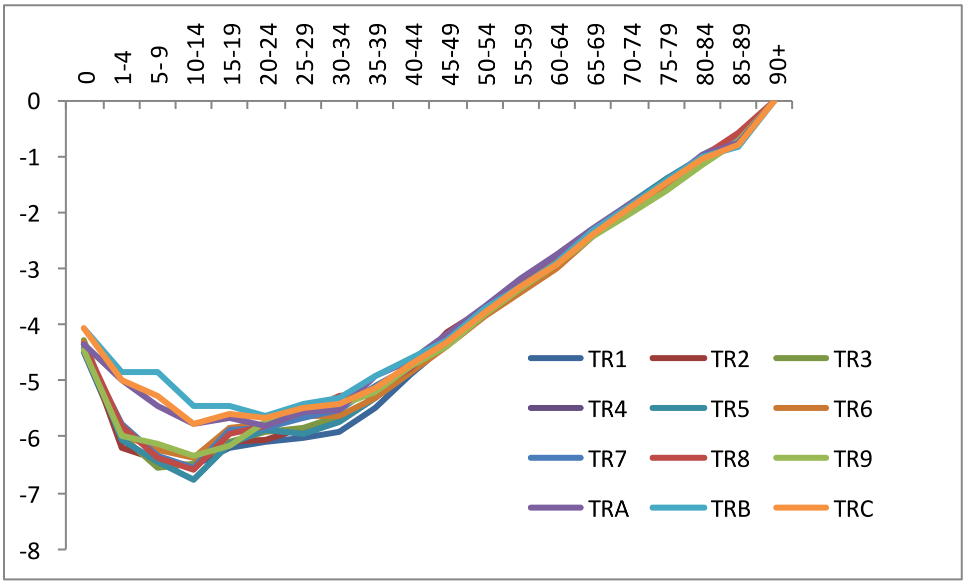


Figure 5.152 Age specific death probabilities (logarithm forms) for region, 2009.

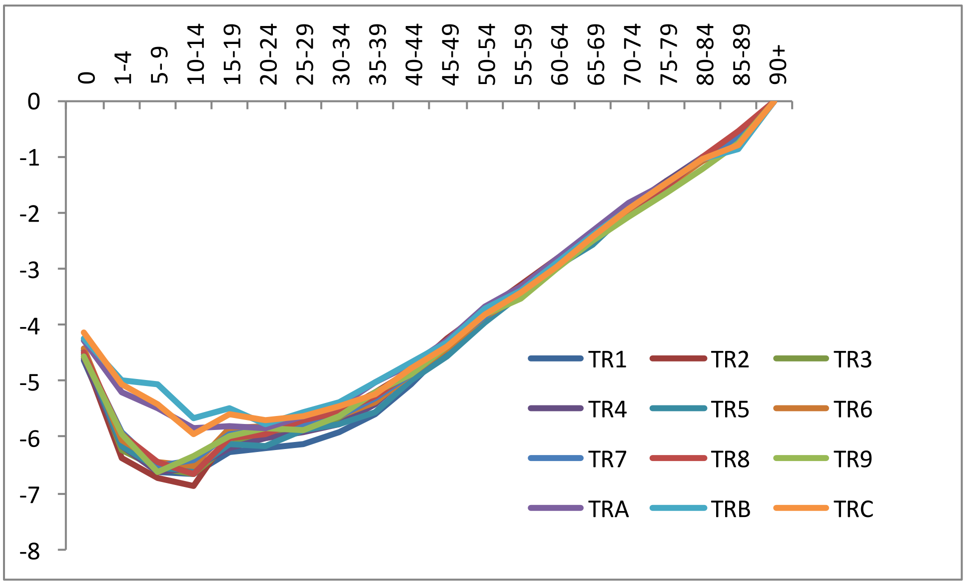


Figure 5.163 Age specific death probabilities (logarithm forms) for region, 2010.

In Figures 5.22 and 5.23, the age specific death probabilities for twelve region by 2009 and 2010 in Turkey. Infant mortalities in 2010 decreased in all region according to 2009. As can be seen, in the death probabilities of infants and children are decreasing with years and oppositely, in the middle age and older age intervals the probabilities are starts to increase.

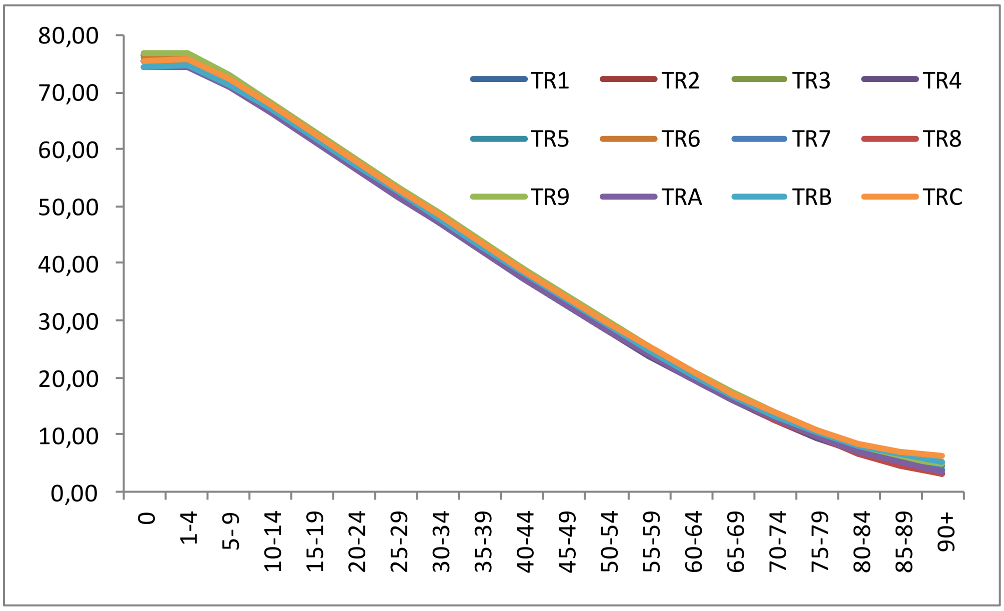


Figure 5.174 The life expectancy by regions, 2009.

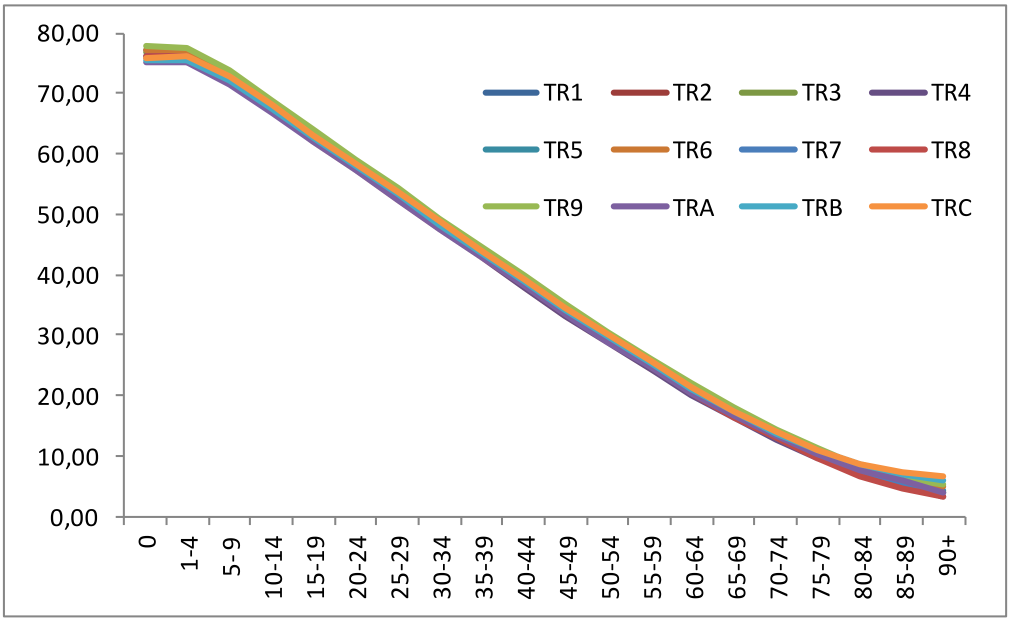


Figure 5.185 The life expectancy by regions, 2010.

The life expectancies of region are showed in Figure 5.25 and 5.24.

Table 5.12 The life expectancies of certain ages for regions and years (* shows 2010)

| Age | TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 | TR9 | TRA | TRB | TRC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 76,5 | 75,5 | 76,1 | 75,4 | 76,4 | 76,6 | 75,5 | 75,4 | 76,9 | 74,4 | 74,5 | 75,4 |
| 0* | 77,1 | 76,0 | 76,9 | 76,1 | 77,3 | 77,0 | 76,3 | 76,2 | 77,7 | 75,1 | 75,4 | 76,0 |
| 20 | 57,9 | 57,0 | 57,7 | 56,9 | 58,0 | 58,3 | 57,0 | 57,0 | 58,4 | 56,6 | 57,4 | 58,0 |
| 20* | 58,3 | 57,2 | 58,3 | 57,3 | 58,7 | 58,6 | 57,7 | 57,5 | 59,1 | 57,3 | 58,0 | 58,4 |
| 40 | 38,4 | 37,6 | 38,4 | 37,5 | 38,6 | 39,0 | 37,8 | 37,8 | 39,2 | 37,4 | 38,4 | 38,9 |
| 40* | 38,8 | 37,9 | 38,9 | 37,9 | 39,3 | 39,3 | 38,3 | 38,2 | 39,8 | 38,1 | 38,8 | 39,2 |
| 60 | 20,6 | 20,0 | 20,6 | 19,8 | 20,7 | 21,1 | 20,1 | 20,1 | 21,4 | 19,9 | 20,7 | 21,2 |
| 60* | 20,8 | 20,2 | 20,9 | 20,1 | 21,1 | 21,3 | 20,4 | 20,3 | 21,9 | 20,4 | 21,1 | 21,4 |
| 80 | 7,8 | 7,1 | 7,4 | 6,8 | 7,3 | 7,8 | 6,9 | 6,8 | 8,1 | 7,1 | 8,0 | 8,4 |
| 80* | 7,6 | 7,2 | 7,5 | 6,9 | 7,7 | 7,9 | 7,1 | 6,7 | 8,4 | 7,7 | 8,4 | 8,5 |

The highest increase of life expectancy is observed in TRB and TR5, oppositely, the lowest increase of life expectancy is observed in TR6 at age 0. As similarly, for age group 20-24, the highest increase of life expectancy is observed in TR9 and TR5, oppositely, the lowest increase of life expectancy is observed in TR2. In age group 40-44, the highest increase of life expectancy is observed in TRA and TR5, oppositely, the lowest increase of life expectancy is observed in TR6. In age group 60-64, the highest increase of life expectancy is observed in TRA and TR9, oppositely, the lowest increase of life expectancy is observed in TR1. In age group

80-84, the highest increase of life expectancy is observed in TRA and TRB, oppositely, the lowest increase of life expectancy is observed in TR1.


Figure 5 196 The life expectancies of regions at age 0 for 2009


Figure 5 207 The life expectancies of regions at age 0 for 2010

In Figure 5.26 and 5.27, life expectancies of regions are demonstrated for a period 2009 and 2010.

# CHAPTER SIX
# CONCLUSION

In the application chapter of this thesis, the real population and demographic data is used. By using the life table analysis, the age pattern and demographic structure are modeled. The life table analysis is applied for Turkey and its' region. In this study, it is observed that age specific death probabiilities are decreasing at younger population and babies, the probabilities are increasing at older population. As a result of this observation, it is demonstrated that the life expectancy is increased. The females' life expectancy is higher than the males although in this application showed us the rate of increasing in life expectancy of males is expeditiously increased according to females in time passes. Besides the life expectancy for Eastern Black Sea Region is the highest, the life expectancy for Northeast Anatolia Region is the lowest in Turkey.

Another result which is observed in this study is the death patterns of age group is not demonstrated same trend for general and urban population. So the database which includes number of deaths for urban population cannot be used for forecasting patterns of mortality of general population.

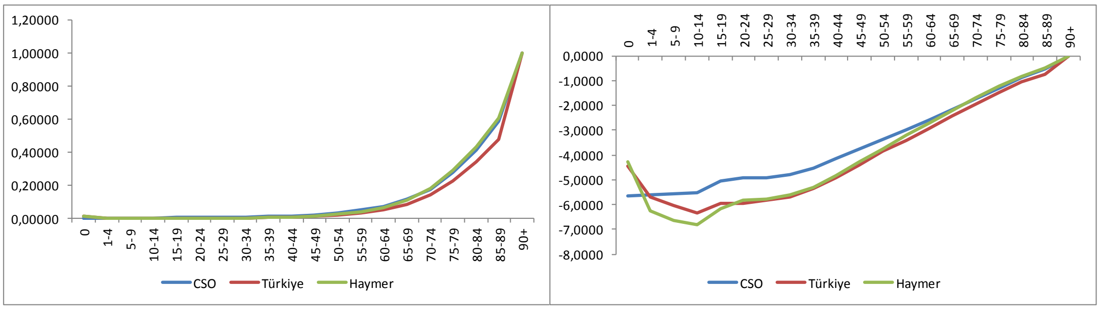


Figure 5 218: Age specific death probabilities by age group

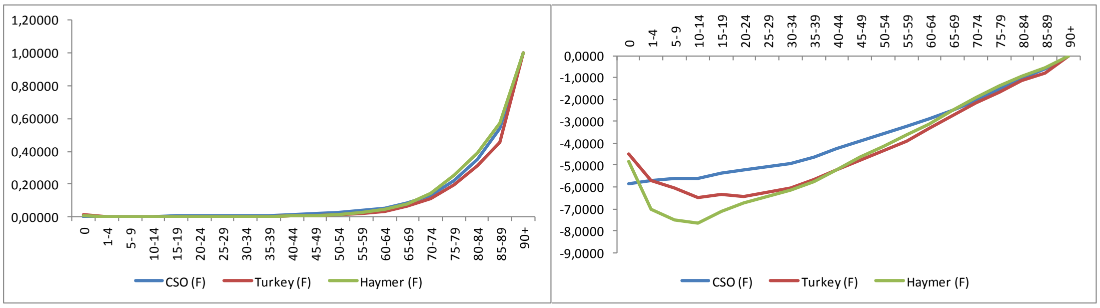


Figure 5 229: Age specific death probabilities for female by age group

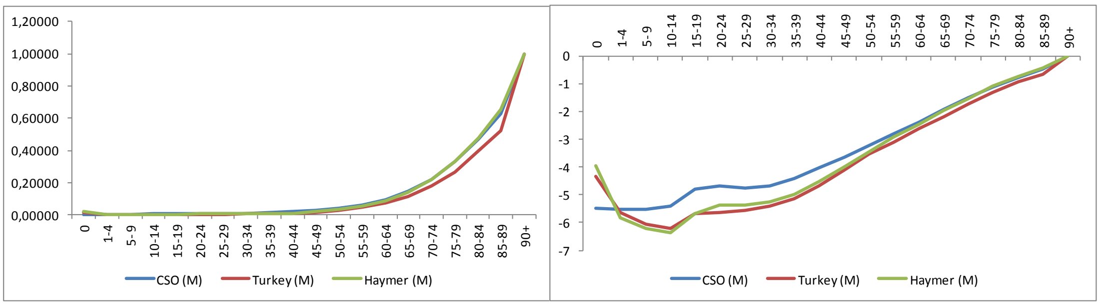


Figure 5 23: Age specific death probabilities for male by age group

In Figures 5.28, 5.29 and 5.30, the age specific death probabilities are compared for three life tables which are constructed by gender and age group. These tables are The Commissioners 1980 Standard Ordinary Mortality Table (CSO) which is actively used in our country, Turkey which is constructed in this thesis and Haymer which is constructed for Turkey by Haymer et. al. The figures showed us, the expected life in Turkey is longer than CSO. According to the HAYMER, the reasons of increasing life expectancy are lower infant and child mortality but the real data shows that the reasons are increasing older population in Turkey besides lower infant and child mortality. The life table which is demonstrated Turkey's demographic structure cannot be able to construct yet and an another country's life table is used such as The Commissioners 1980 Standard Ordinary Mortality Table (CSO) for actuarial analysis in Turkey. So many problems are available in insurance sector and in pension system. Finally The Turkey's Life Table should be constructed and actively used. This thesis summarized that:

- The life expectancy is lengthen as time passes in Turkey.
- The probabilities of dying of a newborns are regularly decreasing.
- The deaths are shifting from middle ages to older ages as time passes.

- Increase in the expected life spans in 2010 compared to 2009 is a sign that the population of Turkey is getting older. So Turkey is expeditiously getting older.

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# APPENDIX

# ABRİDGED PERİOD LİFE TABLES

Appendix 1: Turkey Abridged Period Life Table, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0136 | - | 0,0136 | 0,9864 | 1.000.000 | 13.640 | 986.360 | 75.806.516 | 75,8 |
| 1 | 0,0010 | 1,1741 | 0,0038 | 0,9962 | 986.360 | 3.745 | 3.934.858 | 74.820.156 | 75,9 |
| 5 | 0,0005 | 1,8700 | 0,0027 | 0,9973 | 982.615 | 2.690 | 4.904.658 | 70.885.298 | 72,1 |
| 10 | 0,0004 | 2,0485 | 0,0020 | 0,9980 | 979.926 | 1.917 | 4.893.970 | 65.980.640 | 67,3 |
| 15 | 0,0005 | 2,1152 | 0,0027 | 0,9973 | 978.009 | 2.683 | 4.882.305 | 61.086.670 | 62,5 |
| 20 | 0,0006 | 2,0526 | 0,0029 | 0,9971 | 975.326 | 2.784 | 4.868.424 | 56.204.366 | 57,6 |
| 25 | 0,0006 | 2,0498 | 0,0032 | 0,9968 | 972.542 | 3.104 | 4.853.551 | 51.335.942 | 52,8 |
| 30 | 0,0007 | 2,0023 | 0,0036 | 0,9964 | 969.438 | 3.523 | 4.836.626 | 46.482.391 | 47,9 |
| 35 | 0,0010 | 2,0388 | 0,0051 | 0,9949 | 965.914 | 4.936 | 4.814.954 | 41.645.765 | 43,1 |
| 40 | 0,0017 | 2,3455 | 0,0082 | 0,9918 | 960.978 | 7.902 | 4.783.913 | 36.830.811 | 38,3 |
| 45 | 0,0027 | 2,1649 | 0,0135 | 0,9865 | 953.076 | 12.890 | 4.728.836 | 32.046.898 | 33,6 |
| 50 | 0,0045 | 2,2713 | 0,0224 | 0,9776 | 940.186 | 21.061 | 4.643.460 | 27.318.061 | 29,1 |
| 55 | 0,0074 | 2,1821 | 0,0363 | 0,9637 | 919.125 | 33.398 | 4.501.512 | 22.674.602 | 24,7 |
| 60 | 0,0115 | 2,0985 | 0,0558 | 0,9442 | 885.727 | 49.383 | 4.285.344 | 18.173.090 | 20,5 |
| 65 | 0,0195 | 2,1600 | 0,0923 | 0,9077 | 836.343 | 77.229 | 3.962.388 | 13.887.745 | 16,6 |
| 70 | 0,0319 | 1,9883 | 0,1456 | 0,8544 | 759.114 | 110.539 | 3.462.660 | 9.925.357 | 13,1 |
| 75 | 0,0547 | 1,9660 | 0,2345 | 0,7655 | 648.575 | 152.113 | 2.781.368 | 6.462.697 | 10,0 |
| 80 | 0,0908 | 1,9127 | 0,3547 | 0,6453 | 496.461 | 176.075 | 1.938.709 | 3.681.329 | 7,4 |
| 85 | 0,1460 | 1,6240 | 0,4890 | 0,5110 | 320.387 | 156.659 | 1.073.051 | 1.742.620 | 5,4 |
| 90+ | 0,2445 | 4,0160 | 1,0000 | 0,0000 | 163.728 | 163.728 | 669.569 | 669.569 | 4,1 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 2: Turkey Abridged Period Life Table, Male, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0146 | | 0,0146 | 0,9854 | 1.000.000 | 14.609 | 985.391 | 73.125.122 | 73,1 |
| 1 | 0,0010 | 1,1825 | 0,0039 | 0,9961 | 985.391 | 3.883 | 3.930.623 | 72.139.732 | 73,2 |
| 5 | 0,0006 | 1,9033 | 0,0028 | 0,9972 | 981.508 | 2.758 | 4.898.997 | 68.209.109 | 69,5 |
| 10 | 0,0004 | 2,0932 | 0,0022 | 0,9978 | 978.749 | 2.143 | 4.887.517 | 63.310.112 | 64,7 |
| 15 | 0,0007 | 2,1886 | 0,0035 | 0,9965 | 976.606 | 3.448 | 4.873.338 | 58.422.595 | 59,8 |
| 20 | 0,0008 | 2,0656 | 0,0038 | 0,9962 | 973.158 | 3.682 | 4.854.988 | 53.549.257 | 55,0 |
| 25 | 0,0008 | 2,0279 | 0,0042 | 0,9958 | 969.476 | 4.091 | 4.835.224 | 48.694.269 | 50,2 |
| 30 | 0,0009 | 1,9783 | 0,0046 | 0,9954 | 965.386 | 4.473 | 4.813.411 | 43.859.045 | 45,4 |
| 35 | 0,0013 | 2,0333 | 0,0064 | 0,9936 | 960.912 | 6.177 | 4.786.236 | 39.045.634 | 40,6 |
| 40 | 0,0021 | 2,3287 | 0,0106 | 0,9894 | 954.735 | 10.090 | 4.746.723 | 34.259.398 | 35,9 |
| 45 | 0,0036 | 2,1793 | 0,0179 | 0,9821 | 944.645 | 16.909 | 4.675.532 | 29.512.675 | 31,2 |
| 50 | 0,0063 | 2,2578 | 0,0309 | 0,9691 | 927.737 | 28.622 | 4.560.196 | 24.837.143 | 26,8 |
| 55 | 0,0104 | 2,1793 | 0,0503 | 0,9497 | 899.114 | 45.218 | 4.368.026 | 20.276.947 | 22,6 |
| 60 | 0,0159 | 2,0828 | 0,0760 | 0,9240 | 853.896 | 64.868 | 4.080.244 | 15.908.921 | 18,6 |
| 65 | 0,0260 | 2,1245 | 0,1210 | 0,8790 | 789.028 | 95.444 | 3.670.688 | 11.828.677 | 15,0 |
| 70 | 0,0406 | 1,9521 | 0,1808 | 0,8192 | 693.583 | 125.430 | 3.085.622 | 8.157.990 | 11,8 |
| 75 | 0,0659 | 1,8506 | 0,2727 | 0,7273 | 568.154 | 154.950 | 2.352.769 | 5.072.368 | 8,9 |
| 80 | 0,1074 | 1,8566 | 0,4014 | 0,5986 | 413.204 | 165.844 | 1.544.699 | 2.719.599 | 6,6 |
| 85 | 0,1698 | 1,5563 | 0,5358 | 0,4642 | 247.360 | 132.528 | 780.412 | 1.174.900 | 4,7 |
| 90+ | 0,2911 | 1,1064 | 1,0000 | 0,0000 | 114.831 | 114.831 | 394.488 | 394.488 | 3,4 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 3: Turkey Abridged Period Life Table, Female, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0131 | | 0,0131 | 0,9869 | 1.000.000 | 13.057 | 986.943 | 78.455.381 | 78,5 |
| 1 | 0,0009 | 1,1646 | 0,0037 | 0,9963 | 986.943 | 3.655 | 3.937.409 | 77.468.438 | 78,5 |
| 5 | 0,0005 | 1,8334 | 0,0027 | 0,9973 | 983.288 | 2.650 | 4.908.049 | 73.531.029 | 74,8 |
| 10 | 0,0003 | 1,9891 | 0,0017 | 0,9983 | 980.638 | 1.703 | 4.898.063 | 68.622.979 | 70,0 |
| 15 | 0,0004 | 1,9745 | 0,0019 | 0,9981 | 978.935 | 1.899 | 4.888.930 | 63.724.917 | 65,1 |
| 20 | 0,0004 | 2,0257 | 0,0019 | 0,9981 | 977.036 | 1.854 | 4.879.667 | 58.835.987 | 60,2 |
| 25 | 0,0004 | 2,0940 | 0,0022 | 0,9978 | 975.183 | 2.098 | 4.869.816 | 53.956.320 | 55,3 |
| 30 | 0,0005 | 2,0462 | 0,0026 | 0,9974 | 973.085 | 2.544 | 4.857.910 | 49.086.504 | 50,4 |
| 35 | 0,0008 | 2,0484 | 0,0038 | 0,9962 | 970.541 | 3.676 | 4.841.854 | 44.228.594 | 45,6 |
| 40 | 0,0012 | 2,3768 | 0,0058 | 0,9942 | 966.865 | 5.624 | 4.819.570 | 39.386.739 | 40,7 |
| 45 | 0,0018 | 2,1363 | 0,0091 | 0,9909 | 961.240 | 8.756 | 4.781.127 | 34.567.169 | 36,0 |
| 50 | 0,0028 | 2,3019 | 0,0138 | 0,9862 | 952.484 | 13.147 | 4.726.949 | 29.786.042 | 31,3 |
| 55 | 0,0045 | 2,1884 | 0,0224 | 0,9776 | 939.337 | 21.074 | 4.637.436 | 25.059.093 | 26,7 |
| 60 | 0,0076 | 2,1282 | 0,0371 | 0,9629 | 918.264 | 34.072 | 4.493.471 | 20.421.657 | 22,2 |
| 65 | 0,0139 | 2,2175 | 0,0668 | 0,9332 | 884.192 | 59.107 | 4.256.493 | 15.928.186 | 18,0 |
| 70 | 0,0249 | 2,0361 | 0,1160 | 0,8840 | 825.085 | 95.682 | 3.841.836 | 11.671.693 | 14,1 |
| 75 | 0,0457 | 2,1004 | 0,2020 | 0,7980 | 729.403 | 147.308 | 3.219.878 | 7.829.858 | 10,7 |
| 80 | 0,0811 | 1,9571 | 0,3251 | 0,6749 | 582.095 | 189.250 | 2.334.603 | 4.609.980 | 7,9 |
| 85 | 0,1343 | 1,6673 | 0,4639 | 0,5361 | 392.845 | 182.224 | 1.356.926 | 2.275.377 | 5,8 |
| 90+ | 0,2293 | 2,9096 | 1,0000 | 0,0000 | 210.621 | 210.621 | 918.451 | 918.451 | 4,4 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 4: Turkey Abridged Period Life Table, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0121 | | 0,0121 | 0,9879 | 1.000.000 | 12.146 | 987.854 | 76.508.760 | 76,5 |
| 1 | 0,0009 | 1,1327 | 0,0034 | 0,9966 | 987.854 | 3.357 | 3.941.788 | 75.520.906 | 76,4 |
| 5 | 0,0005 | 1,7153 | 0,0023 | 0,9977 | 984.496 | 2.301 | 4.914.923 | 71.579.118 | 72,7 |
| 10 | 0,0004 | 2,0392 | 0,0018 | 0,9982 | 982.195 | 1.724 | 4.905.871 | 66.664.194 | 67,9 |
| 15 | 0,0005 | 2,0938 | 0,0026 | 0,9974 | 980.471 | 2.586 | 4.894.840 | 61.758.323 | 63,0 |
| 20 | 0,0005 | 2,0308 | 0,0026 | 0,9974 | 977.885 | 2.573 | 4.881.785 | 56.863.483 | 58,1 |
| 25 | 0,0006 | 2,1150 | 0,0029 | 0,9971 | 975.312 | 2.865 | 4.868.293 | 51.981.698 | 53,3 |
| 30 | 0,0007 | 1,9504 | 0,0034 | 0,9966 | 972.447 | 3.342 | 4.852.040 | 47.113.405 | 48,4 |
| 35 | 0,0009 | 2,1165 | 0,0047 | 0,9953 | 969.104 | 4.540 | 4.832.429 | 42.261.365 | 43,6 |
| 40 | 0,0015 | 2,1707 | 0,0074 | 0,9926 | 964.564 | 7.179 | 4.802.508 | 37.428.936 | 38,8 |
| 45 | 0,0025 | 2,0608 | 0,0124 | 0,9876 | 957.385 | 11.873 | 4.752.026 | 32.626.428 | 34,1 |
| 50 | 0,0043 | 2,1916 | 0,0213 | 0,9787 | 945.512 | 20.163 | 4.670.932 | 27.874.401 | 29,5 |
| 55 | 0,0067 | 1,9701 | 0,0328 | 0,9672 | 925.348 | 30.367 | 4.534.734 | 23.203.469 | 25,1 |
| 60 | 0,0111 | 1,9684 | 0,0539 | 0,9461 | 894.982 | 48.206 | 4.328.766 | 18.668.735 | 20,9 |
| 65 | 0,0184 | 2,0615 | 0,0873 | 0,9127 | 846.776 | 73.941 | 4.016.604 | 14.339.969 | 16,9 |
| 70 | 0,0311 | 2,0058 | 0,1424 | 0,8576 | 772.834 | 110.067 | 3.534.608 | 10.323.365 | 13,4 |
| 75 | 0,0521 | 2,1127 | 0,2265 | 0,7735 | 662.768 | 150.127 | 2.880.376 | 6.788.757 | 10,2 |
| 80 | 0,0880 | 1,9431 | 0,3468 | 0,6532 | 512.641 | 177.783 | 2.019.736 | 3.908.381 | 7,6 |
| 85 | 0,1414 | 1,6207 | 0,4783 | 0,5217 | 334.857 | 160.165 | 1.133.044 | 1.888.645 | 5,6 |
| 90+ | 0,2312 | 3,9820 | 1,0000 | 0,0000 | 174.692 | 174.692 | 755.601 | 755.601 | 4,3 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 5: Turkey Abridged Period Life Table, Male, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0129 | | 0,0129 | 0,9871 | 1.000.000 | 12.853 | 987.147 | 73.903.595 | 73,9 |
| 1 | 0,0009 | 1,1515 | 0,0035 | 0,9965 | 987.147 | 3.479 | 3.938.677 | 72.916.448 | 73,9 |
| 5 | 0,0005 | 1,7758 | 0,0023 | 0,9977 | 983.668 | 2.311 | 4.910.887 | 68.977.771 | 70,1 |
| 10 | 0,0004 | 2,0498 | 0,0020 | 0,9980 | 981.357 | 1.935 | 4.901.074 | 64.066.884 | 65,3 |
| 15 | 0,0007 | 2,1516 | 0,0034 | 0,9966 | 979.422 | 3.367 | 4.887.518 | 59.165.809 | 60,4 |
| 20 | 0,0007 | 2,0443 | 0,0036 | 0,9964 | 976.055 | 3.500 | 4.869.928 | 54.278.292 | 55,6 |
| 25 | 0,0008 | 2,0778 | 0,0039 | 0,9961 | 972.555 | 3.789 | 4.851.701 | 49.408.363 | 50,8 |
| 30 | 0,0009 | 1,9395 | 0,0045 | 0,9955 | 968.766 | 4.312 | 4.830.631 | 44.556.662 | 46,0 |
| 35 | 0,0012 | 2,1330 | 0,0059 | 0,9941 | 964.454 | 5.703 | 4.805.918 | 39.726.031 | 41,2 |
| 40 | 0,0019 | 2,1778 | 0,0093 | 0,9907 | 958.751 | 8.946 | 4.768.508 | 34.920.112 | 36,4 |
| 45 | 0,0033 | 2,0876 | 0,0165 | 0,9835 | 949.805 | 15.697 | 4.703.310 | 30.151.604 | 31,7 |
| 50 | 0,0060 | 2,2003 | 0,0293 | 0,9707 | 934.109 | 27.385 | 4.593.872 | 25.448.294 | 27,2 |
| 55 | 0,0093 | 1,9756 | 0,0453 | 0,9547 | 906.724 | 41.046 | 4.409.479 | 20.854.422 | 23,0 |
| 60 | 0,0153 | 1,9470 | 0,0730 | 0,9270 | 865.678 | 63.224 | 4.135.365 | 16.444.943 | 19,0 |
| 65 | 0,0243 | 2,0423 | 0,1135 | 0,8865 | 802.454 | 91.057 | 3.742.945 | 12.309.578 | 15,3 |
| 70 | 0,0396 | 1,9676 | 0,1767 | 0,8233 | 711.396 | 125.703 | 3.175.804 | 8.566.633 | 12,0 |
| 75 | 0,0628 | 2,0502 | 0,2650 | 0,7350 | 585.693 | 155.234 | 2.470.555 | 5.390.829 | 9,2 |
| 80 | 0,1048 | 1,8881 | 0,3951 | 0,6049 | 430.460 | 170.077 | 1.623.039 | 2.920.273 | 6,8 |
| 85 | 0,1626 | 1,5822 | 0,5226 | 0,4774 | 260.383 | 136.078 | 836.826 | 1.297.234 | 5,0 |
| 90+ | 0,2700 | 1,0542 | 1,0000 | 0,0000 | 124.305 | 124.305 | 460.408 | 460.408 | 3,7 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 6: Turkey Abridged Period Life Table, Female, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0114 | | 0,0114 | 0,9886 | 1.000.000 | 11.399 | 988.601 | 79.121.557 | 79,1 |
| 1 | 0,0008 | 1,1112 | 0,0033 | 0,9967 | 988.601 | 3.217 | 3.945.112 | 78.132.956 | 79,0 |
| 5 | 0,0005 | 1,6507 | 0,0023 | 0,9977 | 985.385 | 2.290 | 4.919.251 | 74.187.844 | 75,3 |
| 10 | 0,0003 | 2,0247 | 0,0015 | 0,9985 | 983.094 | 1.502 | 4.911.002 | 69.268.592 | 70,5 |
| 15 | 0,0004 | 1,9772 | 0,0018 | 0,9982 | 981.592 | 1.761 | 4.902.637 | 64.357.590 | 65,6 |
| 20 | 0,0003 | 2,0000 | 0,0016 | 0,9984 | 979.831 | 1.602 | 4.894.350 | 59.454.953 | 60,7 |
| 25 | 0,0004 | 2,1919 | 0,0019 | 0,9981 | 978.229 | 1.904 | 4.885.801 | 54.560.603 | 55,8 |
| 30 | 0,0005 | 1,9714 | 0,0024 | 0,9976 | 976.326 | 2.337 | 4.874.551 | 49.674.802 | 50,9 |
| 35 | 0,0007 | 2,0879 | 0,0034 | 0,9966 | 973.989 | 3.353 | 4.860.180 | 44.800.251 | 46,0 |
| 40 | 0,0011 | 2,1581 | 0,0055 | 0,9945 | 970.636 | 5.316 | 4.838.071 | 39.940.071 | 41,1 |
| 45 | 0,0017 | 2,0064 | 0,0082 | 0,9918 | 965.320 | 7.945 | 4.802.814 | 35.101.999 | 36,4 |
| 50 | 0,0026 | 2,1718 | 0,0131 | 0,9869 | 957.375 | 12.554 | 4.751.367 | 30.299.186 | 31,6 |
| 55 | 0,0041 | 1,9579 | 0,0204 | 0,9796 | 944.820 | 19.272 | 4.665.472 | 25.547.819 | 27,0 |
| 60 | 0,0073 | 2,0089 | 0,0360 | 0,9640 | 925.548 | 33.275 | 4.528.209 | 20.882.346 | 22,6 |
| 65 | 0,0132 | 2,0927 | 0,0636 | 0,9364 | 892.273 | 56.744 | 4.296.391 | 16.354.137 | 18,3 |
| 70 | 0,0244 | 2,0553 | 0,1138 | 0,8862 | 835.529 | 95.052 | 3.897.746 | 12.057.746 | 14,4 |
| 75 | 0,0434 | 2,1868 | 0,1932 | 0,8068 | 740.477 | 143.070 | 3.299.904 | 8.160.000 | 11,0 |
| 80 | 0,0781 | 1,9868 | 0,3161 | 0,6839 | 597.407 | 188.810 | 2.418.120 | 4.860.096 | 8,1 |
| 85 | 0,1305 | 1,6452 | 0,4539 | 0,5461 | 408.596 | 185.453 | 1.420.825 | 2.441.976 | 6,0 |
| 90+ | 0,2185 | 2,9278 | 1,0000 | 0,0000 | 223.144 | 223.144 | 1.021.151 | 1.021.151 | 4,6 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 7: Turkey Abridged Period Life Table, TR1, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0111 | | 0,0111 | 0,9889 | 1.000.000 | 11.055 | 988.945 | 76.540.448 | 76,5 |
| 1 | 0,0006 | 1,1741 | 0,0023 | 0,9977 | 988.945 | 2.314 | 3.949.241 | 75.551.503 | 76,4 |
| 5 | 0,0003 | 1,8700 | 0,0015 | 0,9985 | 986.631 | 1.489 | 4.928.494 | 71.602.262 | 72,6 |
| 10 | 0,0003 | 2,0485 | 0,0015 | 0,9985 | 985.142 | 1.451 | 4.921.427 | 66.673.768 | 67,7 |
| 15 | 0,0004 | 2,1152 | 0,0020 | 0,9980 | 983.691 | 2.014 | 4.912.645 | 61.752.341 | 62,8 |
| 20 | 0,0005 | 2,0526 | 0,0023 | 0,9977 | 981.677 | 2.234 | 4.901.800 | 56.839.696 | 57,9 |
| 25 | 0,0005 | 2,0498 | 0,0024 | 0,9976 | 979.443 | 2.353 | 4.890.272 | 51.937.896 | 53,0 |
| 30 | 0,0005 | 2,0023 | 0,0027 | 0,9973 | 977.090 | 2.604 | 4.877.645 | 47.047.624 | 48,2 |
| 35 | 0,0008 | 2,0388 | 0,0042 | 0,9958 | 974.486 | 4.068 | 4.860.385 | 42.169.979 | 43,3 |
| 40 | 0,0015 | 2,3455 | 0,0077 | 0,9923 | 970.418 | 7.466 | 4.832.273 | 37.309.594 | 38,4 |
| 45 | 0,0026 | 2,1649 | 0,0131 | 0,9869 | 962.953 | 12.658 | 4.778.877 | 32.477.321 | 33,7 |
| 50 | 0,0045 | 2,2713 | 0,0221 | 0,9779 | 950.295 | 20.966 | 4.694.262 | 27.698.445 | 29,1 |
| 55 | 0,0076 | 2,1821 | 0,0373 | 0,9627 | 929.329 | 34.689 | 4.548.894 | 23.004.183 | 24,8 |
| 60 | 0,0116 | 2,0985 | 0,0560 | 0,9440 | 894.639 | 50.073 | 4.327.908 | 18.455.289 | 20,6 |
| 65 | 0,0194 | 2,1600 | 0,0921 | 0,9079 | 844.566 | 77.769 | 4.001.970 | 14.127.381 | 16,7 |
| 70 | 0,0310 | 1,9883 | 0,1418 | 0,8582 | 766.797 | 108.766 | 3.506.416 | 10.125.411 | 13,2 |
| 75 | 0,0593 | 1,9660 | 0,2513 | 0,7487 | 658.031 | 165.380 | 2.788.397 | 6.618.995 | 10,1 |
| 80 | 0,0907 | 1,9127 | 0,3542 | 0,6458 | 492.650 | 174.487 | 1.924.556 | 3.830.598 | 7,8 |
| 85 | 0,1298 | 1,6240 | 0,4512 | 0,5488 | 318.163 | 143.568 | 1.106.128 | 1.906.042 | 6,0 |
| 90+ | 0,2183 | 4,0160 | 1,0000 | 0,0000 | 174.595 | 174.595 | 799.914 | 799.914 | 4,6 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 8: Turkey Abridged Period Life Table, TR1, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0098 | | 0,0098 | 0,9902 | 1.000.000 | 9.752 | 990.248 | 77.053.802 | 77,1 |
| 1 | 0,0005 | 1,1327 | 0,0021 | 0,9979 | 990.248 | 2.070 | 3.955.058 | 76.063.553 | 76,8 |
| 5 | 0,0003 | 1,7153 | 0,0013 | 0,9987 | 988.178 | 1.292 | 4.936.647 | 72.108.496 | 73,0 |
| 10 | 0,0003 | 2,0392 | 0,0013 | 0,9987 | 986.886 | 1.269 | 4.930.674 | 67.171.849 | 68,1 |
| 15 | 0,0004 | 2,0938 | 0,0019 | 0,9981 | 985.617 | 1.890 | 4.922.594 | 62.241.174 | 63,1 |
| 20 | 0,0004 | 2,0308 | 0,0021 | 0,9979 | 983.727 | 2.017 | 4.912.648 | 57.318.580 | 58,3 |
| 25 | 0,0004 | 2,1150 | 0,0022 | 0,9978 | 981.710 | 2.139 | 4.902.380 | 52.405.932 | 53,4 |
| 30 | 0,0005 | 1,9504 | 0,0027 | 0,9973 | 979.571 | 2.660 | 4.889.742 | 47.503.553 | 48,5 |
| 35 | 0,0008 | 2,1165 | 0,0038 | 0,9962 | 976.911 | 3.702 | 4.873.878 | 42.613.811 | 43,6 |
| 40 | 0,0013 | 2,1707 | 0,0064 | 0,9936 | 973.208 | 6.243 | 4.848.378 | 37.739.933 | 38,8 |
| 45 | 0,0024 | 2,0608 | 0,0120 | 0,9880 | 966.965 | 11.574 | 4.800.806 | 32.891.554 | 34,0 |
| 50 | 0,0042 | 2,1916 | 0,0209 | 0,9791 | 955.391 | 20.002 | 4.720.781 | 28.090.748 | 29,4 |
| 55 | 0,0067 | 1,9701 | 0,0328 | 0,9672 | 935.389 | 30.723 | 4.583.857 | 23.369.967 | 25,0 |
| 60 | 0,0112 | 1,9684 | 0,0542 | 0,9458 | 904.666 | 48.990 | 4.374.810 | 18.786.110 | 20,8 |
| 65 | 0,0186 | 2,0615 | 0,0881 | 0,9119 | 855.676 | 75.390 | 4.056.849 | 14.411.299 | 16,8 |
| 70 | 0,0305 | 2,0058 | 0,1397 | 0,8603 | 780.286 | 109.003 | 3.575.053 | 10.354.451 | 13,3 |
| 75 | 0,0560 | 2,1127 | 0,2411 | 0,7589 | 671.283 | 161.858 | 2.889.085 | 6.779.398 | 10,1 |
| 80 | 0,0892 | 1,9431 | 0,3505 | 0,6495 | 509.426 | 178.572 | 2.001.249 | 3.890.313 | 7,6 |
| 85 | 0,1271 | 1,6207 | 0,4445 | 0,5555 | 330.853 | 147.075 | 1.157.258 | 1.889.064 | 5,7 |
| 90+ | 0,2051 | 3,9820 | 1,0000 | 0,0000 | 183.778 | 183.778 | 731.806 | 731.806 | 4,0 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 9: Turkey Abridged Period Life Table, TR2, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0133 | | 0,0133 | 0,9867 | 1.000.000 | 13.296 | 986.704 | 75.486.572 | 75,5 |
| 1 | 0,0005 | 1,1741 | 0,0020 | 0,9980 | 986.704 | 1.981 | 3.941.220 | 74.499.868 | 75,5 |
| 5 | 0,0003 | 1,8700 | 0,0017 | 0,9983 | 984.724 | 1.640 | 4.918.486 | 70.558.648 | 71,7 |
| 10 | 0,0003 | 2,0485 | 0,0015 | 0,9985 | 983.084 | 1.466 | 4.911.092 | 65.640.161 | 66,8 |
| 15 | 0,0005 | 2,1152 | 0,0023 | 0,9977 | 981.618 | 2.253 | 4.901.589 | 60.729.069 | 61,9 |
| 20 | 0,0005 | 2,0526 | 0,0024 | 0,9976 | 979.365 | 2.317 | 4.889.995 | 55.827.480 | 57,0 |
| 25 | 0,0006 | 2,0498 | 0,0029 | 0,9971 | 977.048 | 2.800 | 4.876.978 | 50.937.485 | 52,1 |
| 30 | 0,0007 | 2,0023 | 0,0033 | 0,9967 | 974.248 | 3.188 | 4.861.683 | 46.060.507 | 47,3 |
| 35 | 0,0010 | 2,0388 | 0,0052 | 0,9948 | 971.060 | 5.070 | 4.840.287 | 41.198.824 | 42,4 |
| 40 | 0,0016 | 2,3455 | 0,0082 | 0,9918 | 965.990 | 7.909 | 4.808.955 | 36.358.537 | 37,6 |
| 45 | 0,0033 | 2,1649 | 0,0162 | 0,9838 | 958.081 | 15.481 | 4.746.515 | 31.549.582 | 32,9 |
| 50 | 0,0050 | 2,2713 | 0,0247 | 0,9753 | 942.600 | 23.241 | 4.649.580 | 26.803.067 | 28,4 |
| 55 | 0,0081 | 2,1821 | 0,0396 | 0,9604 | 919.359 | 36.403 | 4.494.214 | 22.153.487 | 24,1 |
| 60 | 0,0126 | 2,0985 | 0,0607 | 0,9393 | 882.955 | 53.568 | 4.259.347 | 17.659.274 | 20,0 |
| 65 | 0,0207 | 2,1600 | 0,0976 | 0,9024 | 829.387 | 80.946 | 3.917.053 | 13.399.927 | 16,2 |
| 70 | 0,0327 | 1,9883 | 0,1489 | 0,8511 | 748.441 | 111.414 | 3.406.664 | 9.482.873 | 12,7 |
| 75 | 0,0590 | 1,9660 | 0,2501 | 0,7499 | 637.028 | 159.293 | 2.701.852 | 6.076.209 | 9,5 |
| 80 | 0,0908 | 1,9127 | 0,3546 | 0,6454 | 477.735 | 169.409 | 1.865.656 | 3.374.358 | 7,1 |
| 85 | 0,1481 | 1,6240 | 0,4937 | 0,5063 | 308.326 | 152.224 | 1.027.720 | 1.508.702 | 4,9 |
| 90+ | 0,3245 | 4,0160 | 1,0000 | 0,0000 | 156.102 | 156.102 | 480.982 | 480.982 | 3,1 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 10: Turkey Abridged Period Life Table, TR2, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0103 | | 0,0103 | 0,9897 | 1.000.000 | 10.319 | 989.681 | 75.984.417 | 76,0 |
| 1 | 0,0004 | 1,1327 | 0,0017 | 0,9983 | 989.681 | 1.697 | 3.953.857 | 74.994.736 | 75,8 |
| 5 | 0,0002 | 1,7153 | 0,0012 | 0,9988 | 987.984 | 1.186 | 4.936.022 | 71.040.879 | 71,9 |
| 10 | 0,0002 | 2,0392 | 0,0010 | 0,9990 | 986.797 | 1.028 | 4.930.942 | 66.104.857 | 67,0 |
| 15 | 0,0005 | 2,0938 | 0,0026 | 0,9974 | 985.769 | 2.581 | 4.921.342 | 61.173.915 | 62,1 |
| 20 | 0,0006 | 2,0308 | 0,0028 | 0,9972 | 983.187 | 2.722 | 4.907.854 | 56.252.573 | 57,2 |
| 25 | 0,0007 | 2,1150 | 0,0033 | 0,9967 | 980.465 | 3.237 | 4.892.986 | 51.344.720 | 52,4 |
| 30 | 0,0008 | 1,9504 | 0,0039 | 0,9961 | 977.228 | 3.785 | 4.874.598 | 46.451.734 | 47,5 |
| 35 | 0,0011 | 2,1165 | 0,0054 | 0,9946 | 973.443 | 5.301 | 4.851.930 | 41.577.136 | 42,7 |
| 40 | 0,0016 | 2,1707 | 0,0080 | 0,9920 | 968.142 | 7.773 | 4.818.719 | 36.725.206 | 37,9 |
| 45 | 0,0029 | 2,0608 | 0,0141 | 0,9859 | 960.369 | 13.586 | 4.761.915 | 31.906.487 | 33,2 |
| 50 | 0,0047 | 2,1916 | 0,0234 | 0,9766 | 946.784 | 22.129 | 4.671.771 | 27.144.572 | 28,7 |
| 55 | 0,0077 | 1,9701 | 0,0376 | 0,9624 | 924.654 | 34.732 | 4.518.038 | 22.472.801 | 24,3 |
| 60 | 0,0124 | 1,9684 | 0,0598 | 0,9402 | 889.923 | 53.174 | 4.288.410 | 17.954.763 | 20,2 |
| 65 | 0,0196 | 2,0615 | 0,0926 | 0,9074 | 836.749 | 77.460 | 3.956.130 | 13.666.353 | 16,3 |
| 70 | 0,0334 | 2,0058 | 0,1520 | 0,8480 | 759.289 | 115.420 | 3.450.850 | 9.710.224 | 12,8 |
| 75 | 0,0565 | 2,1127 | 0,2429 | 0,7571 | 643.868 | 156.394 | 2.767.784 | 6.259.373 | 9,7 |
| 80 | 0,0902 | 1,9431 | 0,3535 | 0,6465 | 487.474 | 172.328 | 1.910.578 | 3.491.589 | 7,2 |
| 85 | 0,1467 | 1,6207 | 0,4904 | 0,5096 | 315.145 | 154.534 | 1.053.514 | 1.581.011 | 5,0 |
| 90+ | 0,3045 | 3,9820 | 1,0000 | 0,0000 | 160.612 | 160.612 | 527.497 | 527.497 | 3,3 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 11: Turkey Abridged Period Life Table, TR3, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0140 | | 0,0140 | 0,9860 | 1.000.000 | 13.981 | 986.019 | 76.141.599 | 76,1 |
| 1 | 0,0006 | 1,1741 | 0,0025 | 0,9975 | 986.019 | 2.447 | 3.937.161 | 75.155.579 | 76,2 |
| 5 | 0,0003 | 1,8700 | 0,0014 | 0,9986 | 983.572 | 1.379 | 4.913.543 | 71.218.419 | 72,4 |
| 10 | 0,0003 | 2,0485 | 0,0015 | 0,9985 | 982.193 | 1.513 | 4.906.499 | 66.304.875 | 67,5 |
| 15 | 0,0005 | 2,1152 | 0,0023 | 0,9977 | 980.680 | 2.260 | 4.896.880 | 61.398.376 | 62,6 |
| 20 | 0,0006 | 2,0526 | 0,0027 | 0,9973 | 978.420 | 2.687 | 4.884.180 | 56.501.496 | 57,7 |
| 25 | 0,0006 | 2,0498 | 0,0029 | 0,9971 | 975.733 | 2.822 | 4.870.340 | 51.617.316 | 52,9 |
| 30 | 0,0007 | 2,0023 | 0,0036 | 0,9964 | 972.911 | 3.507 | 4.854.045 | 46.746.975 | 48,0 |
| 35 | 0,0010 | 2,0388 | 0,0049 | 0,9951 | 969.405 | 4.784 | 4.832.857 | 41.892.931 | 43,2 |
| 40 | 0,0016 | 2,3455 | 0,0078 | 0,9922 | 964.621 | 7.544 | 4.803.078 | 37.060.073 | 38,4 |
| 45 | 0,0027 | 2,1649 | 0,0133 | 0,9867 | 957.077 | 12.756 | 4.749.219 | 32.256.996 | 33,7 |
| 50 | 0,0045 | 2,2713 | 0,0221 | 0,9779 | 944.321 | 20.841 | 4.664.734 | 27.507.777 | 29,1 |
| 55 | 0,0073 | 2,1821 | 0,0357 | 0,9643 | 923.480 | 33.003 | 4.524.399 | 22.843.043 | 24,7 |
| 60 | 0,0111 | 2,0985 | 0,0538 | 0,9462 | 890.476 | 47.915 | 4.313.353 | 18.318.643 | 20,6 |
| 65 | 0,0186 | 2,1600 | 0,0885 | 0,9115 | 842.561 | 74.598 | 4.000.948 | 14.005.290 | 16,6 |
| 70 | 0,0318 | 1,9883 | 0,1452 | 0,8548 | 767.963 | 111.530 | 3.503.920 | 10.004.342 | 13,0 |
| 75 | 0,0552 | 1,9660 | 0,2363 | 0,7637 | 656.433 | 155.147 | 2.811.456 | 6.500.422 | 9,9 |
| 80 | 0,0888 | 1,9127 | 0,3484 | 0,6516 | 501.286 | 174.629 | 1.967.297 | 3.688.967 | 7,4 |
| 85 | 0,1468 | 1,6240 | 0,4908 | 0,5092 | 326.657 | 160.336 | 1.091.991 | 1.721.670 | 5,3 |
| 90+ | 0,2641 | 4,0160 | 1,0000 | 0,0000 | 166.322 | 166.322 | 629.679 | 629.679 | 3,8 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 12: Turkey Abridged Period Life Table, TR3, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0114 | | 0,0114 | 0,9886 | 1.000.000 | 11.439 | 988.561 | 76.900.415 | 76,9 |
| 1 | 0,0005 | 1,1327 | 0,0020 | 0,9980 | 988.561 | 1.974 | 3.948.584 | 75.911.854 | 76,8 |
| 5 | 0,0003 | 1,7153 | 0,0014 | 0,9986 | 986.587 | 1.392 | 4.928.361 | 71.963.270 | 72,9 |
| 10 | 0,0003 | 2,0392 | 0,0013 | 0,9987 | 985.195 | 1.274 | 4.922.202 | 67.034.909 | 68,0 |
| 15 | 0,0004 | 2,0938 | 0,0022 | 0,9978 | 983.921 | 2.143 | 4.913.379 | 62.112.706 | 63,1 |
| 20 | 0,0005 | 2,0308 | 0,0025 | 0,9975 | 981.778 | 2.423 | 4.901.697 | 57.199.328 | 58,3 |
| 25 | 0,0006 | 2,1150 | 0,0029 | 0,9971 | 979.355 | 2.837 | 4.888.590 | 52.297.630 | 53,4 |
| 30 | 0,0007 | 1,9504 | 0,0034 | 0,9966 | 976.518 | 3.327 | 4.872.443 | 47.409.040 | 48,5 |
| 35 | 0,0010 | 2,1165 | 0,0048 | 0,9952 | 973.191 | 4.642 | 4.852.568 | 42.536.597 | 43,7 |
| 40 | 0,0015 | 2,1707 | 0,0072 | 0,9928 | 968.549 | 7.003 | 4.822.930 | 37.684.029 | 38,9 |
| 45 | 0,0024 | 2,0608 | 0,0119 | 0,9881 | 961.546 | 11.422 | 4.774.156 | 32.861.099 | 34,2 |
| 50 | 0,0040 | 2,1916 | 0,0200 | 0,9800 | 950.124 | 18.968 | 4.697.349 | 28.086.943 | 29,6 |
| 55 | 0,0065 | 1,9701 | 0,0318 | 0,9682 | 931.156 | 29.588 | 4.566.131 | 23.389.593 | 25,1 |
| 60 | 0,0110 | 1,9684 | 0,0532 | 0,9468 | 901.568 | 47.997 | 4.362.329 | 18.823.463 | 20,9 |
| 65 | 0,0175 | 2,0615 | 0,0831 | 0,9169 | 853.571 | 70.970 | 4.059.311 | 14.461.134 | 16,9 |
| 70 | 0,0305 | 2,0058 | 0,1399 | 0,8601 | 782.601 | 109.491 | 3.585.165 | 10.401.823 | 13,3 |
| 75 | 0,0525 | 2,1127 | 0,2279 | 0,7721 | 673.110 | 153.374 | 2.922.712 | 6.816.658 | 10,1 |
| 80 | 0,0875 | 1,9431 | 0,3452 | 0,6548 | 519.736 | 179.419 | 2.050.210 | 3.893.946 | 7,5 |
| 85 | 0,1423 | 1,6207 | 0,4805 | 0,5195 | 340.316 | 163.522 | 1.148.995 | 1.843.736 | 5,4 |
| 90+ | 0,2545 | 3,9820 | 1,0000 | 0,0000 | 176.794 | 176.794 | 694.741 | 694.741 | 3,9 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 13: Turkey Abridged Period Life Table, TR4, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0127 | | 0,0127 | 0,9873 | 1.000.000 | 12.731 | 987.269 | 75.422.029 | 75,4 |
| 1 | 0,0006 | 1,1741 | 0,0023 | 0,9977 | 987.269 | 2.311 | 3.942.545 | 74.434.761 | 75,4 |
| 5 | 0,0003 | 1,8700 | 0,0016 | 0,9984 | 984.958 | 1.545 | 4.919.955 | 70.492.216 | 71,6 |
| 10 | 0,0002 | 2,0485 | 0,0012 | 0,9988 | 983.413 | 1.135 | 4.913.715 | 65.572.261 | 66,7 |
| 15 | 0,0004 | 2,1152 | 0,0022 | 0,9978 | 982.278 | 2.157 | 4.905.167 | 60.658.546 | 61,8 |
| 20 | 0,0006 | 2,0526 | 0,0028 | 0,9972 | 980.121 | 2.783 | 4.892.402 | 55.753.379 | 56,9 |
| 25 | 0,0005 | 2,0498 | 0,0027 | 0,9973 | 977.338 | 2.597 | 4.879.027 | 50.860.976 | 52,0 |
| 30 | 0,0006 | 2,0023 | 0,0032 | 0,9968 | 974.741 | 3.152 | 4.864.254 | 45.981.949 | 47,2 |
| 35 | 0,0010 | 2,0388 | 0,0050 | 0,9950 | 971.589 | 4.839 | 4.843.615 | 41.117.695 | 42,3 |
| 40 | 0,0017 | 2,3455 | 0,0084 | 0,9916 | 966.750 | 8.084 | 4.812.291 | 36.274.080 | 37,5 |
| 45 | 0,0028 | 2,1649 | 0,0140 | 0,9860 | 958.666 | 13.406 | 4.755.325 | 31.461.788 | 32,8 |
| 50 | 0,0049 | 2,2713 | 0,0241 | 0,9759 | 945.260 | 22.734 | 4.664.267 | 26.706.464 | 28,3 |
| 55 | 0,0078 | 2,1821 | 0,0381 | 0,9619 | 922.527 | 35.135 | 4.513.628 | 22.042.197 | 23,9 |
| 60 | 0,0129 | 2,0985 | 0,0624 | 0,9376 | 887.392 | 55.374 | 4.276.289 | 17.528.570 | 19,8 |
| 65 | 0,0210 | 2,1600 | 0,0989 | 0,9011 | 832.018 | 82.272 | 3.926.442 | 13.252.281 | 15,9 |
| 70 | 0,0347 | 1,9883 | 0,1569 | 0,8431 | 749.746 | 117.656 | 3.394.390 | 9.325.839 | 12,4 |
| 75 | 0,0586 | 1,9660 | 0,2487 | 0,7513 | 632.091 | 157.187 | 2.683.554 | 5.931.449 | 9,4 |
| 80 | 0,0959 | 1,9127 | 0,3698 | 0,6302 | 474.903 | 175.638 | 1.832.267 | 3.247.895 | 6,8 |
| 85 | 0,1654 | 1,6240 | 0,5308 | 0,4692 | 299.265 | 158.838 | 960.088 | 1.415.629 | 4,7 |
| 90+ | 0,3083 | 4,0160 | 1,0000 | 0,0000 | 140.427 | 140.427 | 455.541 | 455.541 | 3,2 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 14: Turkey Abridged Period Life Table, TR4, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0100 | | 0,0100 | 0,9900 | 1.000.000 | 9.984 | 990.016 | 76.094.920 | 76,1 |
| 1 | 0,0005 | 1,1327 | 0,0021 | 0,9979 | 990.016 | 2.070 | 3.954.130 | 75.104.904 | 75,9 |
| 5 | 0,0003 | 1,7153 | 0,0013 | 0,9987 | 987.946 | 1.326 | 4.935.377 | 71.150.774 | 72,0 |
| 10 | 0,0003 | 2,0392 | 0,0014 | 0,9986 | 986.621 | 1.416 | 4.928.911 | 66.215.397 | 67,1 |
| 15 | 0,0004 | 2,0938 | 0,0020 | 0,9980 | 985.205 | 1.991 | 4.920.236 | 61.286.486 | 62,2 |
| 20 | 0,0005 | 2,0308 | 0,0024 | 0,9976 | 983.213 | 2.353 | 4.909.080 | 56.366.250 | 57,3 |
| 25 | 0,0005 | 2,1150 | 0,0027 | 0,9973 | 980.860 | 2.654 | 4.896.646 | 51.457.169 | 52,5 |
| 30 | 0,0006 | 1,9504 | 0,0031 | 0,9969 | 978.207 | 3.009 | 4.881.859 | 46.560.523 | 47,6 |
| 35 | 0,0009 | 2,1165 | 0,0044 | 0,9956 | 975.198 | 4.311 | 4.863.560 | 41.678.665 | 42,7 |
| 40 | 0,0016 | 2,1707 | 0,0078 | 0,9922 | 970.887 | 7.591 | 4.832.959 | 36.815.104 | 37,9 |
| 45 | 0,0028 | 2,0608 | 0,0139 | 0,9861 | 963.296 | 13.431 | 4.777.005 | 31.982.145 | 33,2 |
| 50 | 0,0045 | 2,1916 | 0,0224 | 0,9776 | 949.865 | 21.263 | 4.689.614 | 27.205.141 | 28,6 |
| 55 | 0,0071 | 1,9701 | 0,0349 | 0,9651 | 928.603 | 32.402 | 4.544.838 | 22.515.527 | 24,2 |
| 60 | 0,0118 | 1,9684 | 0,0570 | 0,9430 | 896.200 | 51.068 | 4.326.180 | 17.970.689 | 20,1 |
| 65 | 0,0203 | 2,0615 | 0,0957 | 0,9043 | 845.132 | 80.920 | 3.987.877 | 13.644.509 | 16,1 |
| 70 | 0,0334 | 2,0058 | 0,1519 | 0,8481 | 764.212 | 116.113 | 3.473.390 | 9.656.632 | 12,6 |
| 75 | 0,0565 | 2,1127 | 0,2430 | 0,7570 | 648.098 | 157.493 | 2.785.762 | 6.183.242 | 9,5 |
| 80 | 0,0957 | 1,9431 | 0,3701 | 0,6299 | 490.605 | 181.584 | 1.897.940 | 3.397.480 | 6,9 |
| 85 | 0,1606 | 1,6207 | 0,5205 | 0,4795 | 309.021 | 160.841 | 1.001.578 | 1.499.540 | 4,9 |
| 90+ | 0,2976 | 3,9820 | 1,0000 | 0,0000 | 148.180 | 148.180 | 497.961 | 497.961 | 3,4 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 15: Turkey Abridged Period Life Table, TR5, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0129 | | 0,0129 | 0,9871 | 1.000.000 | 12.914 | 987.086 | 76.381.012 | 76,4 |
| 1 | 0,0007 | 1,1741 | 0,0027 | 0,9973 | 987.086 | 2.666 | 3.940.812 | 75.393.926 | 76,4 |
| 5 | 0,0004 | 1,8700 | 0,0019 | 0,9981 | 984.421 | 1.873 | 4.916.239 | 71.453.114 | 72,6 |
| 10 | 0,0003 | 2,0485 | 0,0016 | 0,9984 | 982.547 | 1.527 | 4.908.229 | 66.536.875 | 67,7 |
| 15 | 0,0005 | 2,1152 | 0,0027 | 0,9973 | 981.020 | 2.622 | 4.897.538 | 61.628.646 | 62,8 |
| 20 | 0,0005 | 2,0526 | 0,0025 | 0,9975 | 978.399 | 2.492 | 4.884.649 | 56.731.108 | 58,0 |
| 25 | 0,0006 | 2,0498 | 0,0030 | 0,9970 | 975.907 | 2.889 | 4.871.010 | 51.846.458 | 53,1 |
| 30 | 0,0007 | 2,0023 | 0,0037 | 0,9963 | 973.018 | 3.592 | 4.854.320 | 46.975.448 | 48,3 |
| 35 | 0,0009 | 2,0388 | 0,0045 | 0,9955 | 969.425 | 4.362 | 4.834.212 | 42.121.128 | 43,4 |
| 40 | 0,0016 | 2,3455 | 0,0080 | 0,9920 | 965.064 | 7.698 | 4.804.885 | 37.286.916 | 38,6 |
| 45 | 0,0025 | 2,1649 | 0,0123 | 0,9877 | 957.366 | 11.780 | 4.753.434 | 32.482.031 | 33,9 |
| 50 | 0,0040 | 2,2713 | 0,0198 | 0,9802 | 945.586 | 18.679 | 4.676.961 | 27.728.597 | 29,3 |
| 55 | 0,0069 | 2,1821 | 0,0338 | 0,9662 | 926.907 | 31.358 | 4.546.173 | 23.051.636 | 24,9 |
| 60 | 0,0104 | 2,0985 | 0,0504 | 0,9496 | 895.549 | 45.107 | 4.346.867 | 18.505.463 | 20,7 |
| 65 | 0,0179 | 2,1600 | 0,0851 | 0,9149 | 850.443 | 72.407 | 4.046.580 | 14.158.596 | 16,6 |
| 70 | 0,0315 | 1,9883 | 0,1438 | 0,8562 | 778.036 | 111.882 | 3.553.226 | 10.112.016 | 13,0 |
| 75 | 0,0563 | 1,9660 | 0,2405 | 0,7595 | 666.154 | 160.236 | 2.844.621 | 6.558.790 | 9,8 |
| 80 | 0,0904 | 1,9127 | 0,3534 | 0,6466 | 505.918 | 178.779 | 1.977.644 | 3.714.169 | 7,3 |
| 85 | 0,1488 | 1,6240 | 0,4953 | 0,5047 | 327.139 | 162.041 | 1.088.644 | 1.736.525 | 5,3 |
| 90+ | 0,2548 | 4,0160 | 1,0000 | 0,0000 | 165.098 | 165.098 | 647.881 | 647.881 | 3,9 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 16: Turkey Abridged Period Life Table, TR5, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0116 | | 0,0116 | 0,9884 | 1.000.000 | 11.565 | 988.435 | 77.282.364 | 77,3 |
| 1 | 0,0005 | 1,1327 | 0,0021 | 0,9979 | 988.435 | 2.100 | 3.947.722 | 76.293.929 | 77,2 |
| 5 | 0,0003 | 1,7153 | 0,0014 | 0,9986 | 986.336 | 1.428 | 4.926.990 | 72.346.207 | 73,3 |
| 10 | 0,0003 | 2,0392 | 0,0014 | 0,9986 | 984.908 | 1.362 | 4.920.508 | 67.419.217 | 68,5 |
| 15 | 0,0004 | 2,0938 | 0,0022 | 0,9978 | 983.546 | 2.144 | 4.911.500 | 62.498.709 | 63,5 |
| 20 | 0,0004 | 2,0308 | 0,0021 | 0,9979 | 981.402 | 2.069 | 4.900.867 | 57.587.209 | 58,7 |
| 25 | 0,0006 | 2,1150 | 0,0028 | 0,9972 | 979.333 | 2.741 | 4.888.758 | 52.686.342 | 53,8 |
| 30 | 0,0006 | 1,9504 | 0,0031 | 0,9969 | 976.592 | 2.996 | 4.873.825 | 47.797.584 | 48,9 |
| 35 | 0,0008 | 2,1165 | 0,0039 | 0,9961 | 973.596 | 3.791 | 4.857.049 | 42.923.759 | 44,1 |
| 40 | 0,0014 | 2,1707 | 0,0068 | 0,9932 | 969.805 | 6.554 | 4.830.483 | 38.066.710 | 39,3 |
| 45 | 0,0021 | 2,0608 | 0,0106 | 0,9894 | 963.251 | 10.198 | 4.786.282 | 33.236.228 | 34,5 |
| 50 | 0,0038 | 2,1916 | 0,0190 | 0,9810 | 953.053 | 18.115 | 4.714.393 | 28.449.945 | 29,9 |
| 55 | 0,0064 | 1,9701 | 0,0315 | 0,9685 | 934.938 | 29.432 | 4.585.517 | 23.735.553 | 25,4 |
| 60 | 0,0105 | 1,9684 | 0,0509 | 0,9491 | 905.507 | 46.075 | 4.387.851 | 19.150.035 | 21,1 |
| 65 | 0,0161 | 2,0615 | 0,0770 | 0,9230 | 859.432 | 66.175 | 4.102.704 | 14.762.184 | 17,2 |
| 70 | 0,0302 | 2,0058 | 0,1383 | 0,8617 | 793.257 | 109.744 | 3.637.686 | 10.659.480 | 13,4 |
| 75 | 0,0519 | 2,1127 | 0,2256 | 0,7744 | 683.513 | 154.222 | 2.972.277 | 7.021.794 | 10,3 |
| 80 | 0,0860 | 1,9431 | 0,3405 | 0,6595 | 529.290 | 180.235 | 2.095.489 | 4.049.517 | 7,7 |
| 85 | 0,1417 | 1,6207 | 0,4791 | 0,5209 | 349.055 | 167.230 | 1.180.160 | 1.954.028 | 5,6 |
| 90+ | 0,2350 | 3,9820 | 1,0000 | 0,0000 | 181.825 | 181.825 | 773.869 | 773.869 | 4,3 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 17: Turkey Abridged Period Life Table, TR6, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0134 | | 0,0134 | 0,9866 | 1.000.000 | 13.387 | 986.613 | 76.588.003 | 76,6 |
| 1 | 0,0007 | 1,1741 | 0,0026 | 0,9974 | 986.613 | 2.572 | 3.939.184 | 75.601.390 | 76,6 |
| 5 | 0,0004 | 1,8700 | 0,0020 | 0,9980 | 984.041 | 1.921 | 4.914.192 | 71.662.207 | 72,8 |
| 10 | 0,0003 | 2,0485 | 0,0017 | 0,9983 | 982.120 | 1.647 | 4.905.738 | 66.748.015 | 68,0 |
| 15 | 0,0006 | 2,1152 | 0,0029 | 0,9971 | 980.473 | 2.825 | 4.894.215 | 61.842.277 | 63,1 |
| 20 | 0,0006 | 2,0526 | 0,0031 | 0,9969 | 977.648 | 3.030 | 4.879.311 | 56.948.062 | 58,3 |
| 25 | 0,0007 | 2,0498 | 0,0036 | 0,9964 | 974.618 | 3.527 | 4.862.686 | 52.068.751 | 53,4 |
| 30 | 0,0007 | 2,0023 | 0,0037 | 0,9963 | 971.091 | 3.548 | 4.844.821 | 47.206.066 | 48,6 |
| 35 | 0,0010 | 2,0388 | 0,0049 | 0,9951 | 967.544 | 4.741 | 4.823.680 | 42.361.244 | 43,8 |
| 40 | 0,0016 | 2,3455 | 0,0079 | 0,9921 | 962.803 | 7.577 | 4.793.901 | 37.537.564 | 39,0 |
| 45 | 0,0025 | 2,1649 | 0,0126 | 0,9874 | 955.226 | 12.041 | 4.741.993 | 32.743.663 | 34,3 |
| 50 | 0,0043 | 2,2713 | 0,0210 | 0,9790 | 943.185 | 19.814 | 4.661.857 | 28.001.670 | 29,7 |
| 55 | 0,0067 | 2,1821 | 0,0330 | 0,9670 | 923.371 | 30.452 | 4.531.044 | 23.339.813 | 25,3 |
| 60 | 0,0103 | 2,0985 | 0,0499 | 0,9501 | 892.919 | 44.584 | 4.335.231 | 18.808.768 | 21,1 |
| 65 | 0,0184 | 2,1600 | 0,0876 | 0,9124 | 848.335 | 74.309 | 4.030.639 | 14.473.537 | 17,1 |
| 70 | 0,0303 | 1,9883 | 0,1387 | 0,8613 | 774.026 | 107.380 | 3.546.734 | 10.442.898 | 13,5 |
| 75 | 0,0517 | 1,9660 | 0,2233 | 0,7767 | 666.646 | 148.883 | 2.881.525 | 6.896.164 | 10,3 |
| 80 | 0,0877 | 1,9127 | 0,3452 | 0,6548 | 517.763 | 178.732 | 2.037.014 | 4.014.638 | 7,8 |
| 85 | 0,1424 | 1,6240 | 0,4809 | 0,5191 | 339.031 | 163.025 | 1.144.782 | 1.977.625 | 5,8 |
| 90+ | 0,2113 | 4,0160 | 1,0000 | 0,0000 | 176.006 | 176.006 | 832.842 | 832.842 | 4,7 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 18: Turkey Abridged Period Life Table, TR6, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0121 | | 0,0121 | 0,9879 | 1.000.000 | 12.125 | 987.875 | 77.042.949 | 77,0 |
| 1 | 0,0006 | 1,1327 | 0,0023 | 0,9977 | 987.875 | 2.284 | 3.944.950 | 76.055.074 | 77,0 |
| 5 | 0,0003 | 1,7153 | 0,0016 | 0,9984 | 985.591 | 1.551 | 4.922.859 | 72.110.124 | 73,2 |
| 10 | 0,0003 | 2,0392 | 0,0015 | 0,9985 | 984.040 | 1.437 | 4.915.944 | 67.187.265 | 68,3 |
| 15 | 0,0006 | 2,0938 | 0,0029 | 0,9971 | 982.603 | 2.844 | 4.904.750 | 62.271.320 | 63,4 |
| 20 | 0,0006 | 2,0308 | 0,0030 | 0,9970 | 979.759 | 2.987 | 4.889.929 | 57.366.570 | 58,6 |
| 25 | 0,0006 | 2,1150 | 0,0032 | 0,9968 | 976.773 | 3.168 | 4.874.723 | 52.476.641 | 53,7 |
| 30 | 0,0007 | 1,9504 | 0,0036 | 0,9964 | 973.604 | 3.480 | 4.857.409 | 47.601.918 | 48,9 |
| 35 | 0,0009 | 2,1165 | 0,0047 | 0,9953 | 970.124 | 4.525 | 4.837.574 | 42.744.509 | 44,1 |
| 40 | 0,0015 | 2,1707 | 0,0075 | 0,9925 | 965.599 | 7.244 | 4.807.502 | 37.906.936 | 39,3 |
| 45 | 0,0024 | 2,0608 | 0,0120 | 0,9880 | 958.356 | 11.540 | 4.757.859 | 33.099.433 | 34,5 |
| 50 | 0,0043 | 2,1916 | 0,0211 | 0,9789 | 946.815 | 19.996 | 4.677.921 | 28.341.574 | 29,9 |
| 55 | 0,0063 | 1,9701 | 0,0308 | 0,9692 | 926.819 | 28.545 | 4.547.610 | 23.663.653 | 25,5 |
| 60 | 0,0110 | 1,9684 | 0,0531 | 0,9469 | 898.275 | 47.720 | 4.346.705 | 19.116.043 | 21,3 |
| 65 | 0,0176 | 2,0615 | 0,0836 | 0,9164 | 850.555 | 71.128 | 4.043.768 | 14.769.338 | 17,4 |
| 70 | 0,0294 | 2,0058 | 0,1352 | 0,8648 | 779.427 | 105.376 | 3.581.619 | 10.725.570 | 13,8 |
| 75 | 0,0492 | 2,1127 | 0,2155 | 0,7845 | 674.052 | 145.228 | 2.950.942 | 7.143.951 | 10,6 |
| 80 | 0,0847 | 1,9431 | 0,3364 | 0,6636 | 528.824 | 177.902 | 2.100.288 | 4.193.009 | 7,9 |
| 85 | 0,1403 | 1,6207 | 0,4759 | 0,5241 | 350.921 | 167.004 | 1.190.255 | 2.092.721 | 6,0 |
| 90+ | 0,2038 | 3,9820 | 1,0000 | 0,0000 | 183.918 | 183.918 | 902.466 | 902.466 | 4,9 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 19: Turkey Abridged Period Life Table, TR7, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0119 | | 0,0119 | 0,9881 | 1.000.000 | 11.876 | 988.124 | 75.466.744 | 75,5 |
| 1 | 0,0008 | 1,1741 | 0,0031 | 0,9969 | 988.124 | 3.090 | 3.943.765 | 74.478.619 | 75,4 |
| 5 | 0,0003 | 1,8700 | 0,0017 | 0,9983 | 985.034 | 1.711 | 4.919.816 | 70.534.854 | 71,6 |
| 10 | 0,0003 | 2,0485 | 0,0014 | 0,9986 | 983.323 | 1.411 | 4.912.452 | 65.615.038 | 66,7 |
| 15 | 0,0006 | 2,1152 | 0,0028 | 0,9972 | 981.912 | 2.793 | 4.901.506 | 60.702.586 | 61,8 |
| 20 | 0,0006 | 2,0526 | 0,0029 | 0,9971 | 979.120 | 2.871 | 4.887.135 | 55.801.081 | 57,0 |
| 25 | 0,0007 | 2,0498 | 0,0035 | 0,9965 | 976.248 | 3.410 | 4.871.183 | 50.913.945 | 52,2 |
| 30 | 0,0008 | 2,0023 | 0,0041 | 0,9959 | 972.839 | 3.959 | 4.852.325 | 46.042.763 | 47,3 |
| 35 | 0,0012 | 2,0388 | 0,0061 | 0,9939 | 968.879 | 5.914 | 4.826.886 | 41.190.437 | 42,5 |
| 40 | 0,0017 | 2,3455 | 0,0087 | 0,9913 | 962.966 | 8.335 | 4.792.702 | 36.363.552 | 37,8 |
| 45 | 0,0030 | 2,1649 | 0,0146 | 0,9854 | 954.630 | 13.966 | 4.733.556 | 31.570.850 | 33,1 |
| 50 | 0,0047 | 2,2713 | 0,0232 | 0,9768 | 940.664 | 21.840 | 4.643.725 | 26.837.293 | 28,5 |
| 55 | 0,0083 | 2,1821 | 0,0404 | 0,9596 | 918.824 | 37.143 | 4.489.458 | 22.193.569 | 24,2 |
| 60 | 0,0122 | 2,0985 | 0,0591 | 0,9409 | 881.682 | 52.087 | 4.257.275 | 17.704.111 | 20,1 |
| 65 | 0,0209 | 2,1600 | 0,0988 | 0,9012 | 829.594 | 81.976 | 3.915.165 | 13.446.836 | 16,2 |
| 70 | 0,0332 | 1,9883 | 0,1510 | 0,8490 | 747.619 | 112.885 | 3.398.120 | 9.531.671 | 12,7 |
| 75 | 0,0529 | 1,9660 | 0,2281 | 0,7719 | 634.734 | 144.780 | 2.734.413 | 6.133.551 | 9,7 |
| 80 | 0,0973 | 1,9127 | 0,3742 | 0,6258 | 489.954 | 183.355 | 1.883.694 | 3.399.138 | 6,9 |
| 85 | 0,1648 | 1,6240 | 0,5294 | 0,4706 | 306.598 | 162.308 | 985.036 | 1.515.445 | 4,9 |
| 90+ | 0,2720 | 4,0160 | 1,0000 | 0,0000 | 144.290 | 144.290 | 530.408 | 530.408 | 3,7 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 20: Turkey Abridged Period Life Table, TR7, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0107 | | 0,0107 | 0,9893 | 1.000.000 | 10.668 | 989.332 | 76.258.930 | 76,3 |
| 1 | 0,0007 | 1,1327 | 0,0027 | 0,9973 | 989.332 | 2.653 | 3.949.723 | 75.269.597 | 76,1 |
| 5 | 0,0003 | 1,7153 | 0,0015 | 0,9985 | 986.680 | 1.460 | 4.928.604 | 71.319.874 | 72,3 |
| 10 | 0,0003 | 2,0392 | 0,0017 | 0,9983 | 985.220 | 1.634 | 4.921.261 | 66.391.271 | 67,4 |
| 15 | 0,0005 | 2,0938 | 0,0026 | 0,9974 | 983.586 | 2.598 | 4.910.378 | 61.470.009 | 62,5 |
| 20 | 0,0006 | 2,0308 | 0,0028 | 0,9972 | 980.988 | 2.719 | 4.896.864 | 56.559.632 | 57,7 |
| 25 | 0,0006 | 2,1150 | 0,0030 | 0,9970 | 978.268 | 2.967 | 4.882.780 | 51.662.768 | 52,8 |
| 30 | 0,0007 | 1,9504 | 0,0036 | 0,9964 | 975.301 | 3.522 | 4.865.763 | 46.779.987 | 48,0 |
| 35 | 0,0010 | 2,1165 | 0,0050 | 0,9950 | 971.778 | 4.847 | 4.844.916 | 41.914.225 | 43,1 |
| 40 | 0,0015 | 2,1707 | 0,0077 | 0,9923 | 966.931 | 7.454 | 4.813.568 | 37.069.308 | 38,3 |
| 45 | 0,0026 | 2,0608 | 0,0127 | 0,9873 | 959.477 | 12.219 | 4.761.473 | 32.255.740 | 33,6 |
| 50 | 0,0043 | 2,1916 | 0,0214 | 0,9786 | 947.259 | 20.229 | 4.679.482 | 27.494.267 | 29,0 |
| 55 | 0,0071 | 1,9701 | 0,0347 | 0,9653 | 927.029 | 32.122 | 4.537.819 | 22.814.785 | 24,6 |
| 60 | 0,0113 | 1,9684 | 0,0544 | 0,9456 | 894.907 | 48.727 | 4.326.810 | 18.276.966 | 20,4 |
| 65 | 0,0194 | 2,0615 | 0,0919 | 0,9081 | 846.180 | 77.785 | 4.002.329 | 13.950.156 | 16,5 |
| 70 | 0,0326 | 2,0058 | 0,1486 | 0,8514 | 768.395 | 114.206 | 3.500.018 | 9.947.827 | 12,9 |
| 75 | 0,0515 | 2,1127 | 0,2240 | 0,7760 | 654.189 | 146.557 | 2.847.793 | 6.447.809 | 9,9 |
| 80 | 0,0938 | 1,9431 | 0,3646 | 0,6354 | 507.632 | 185.085 | 1.972.376 | 3.600.016 | 7,1 |
| 85 | 0,1624 | 1,6207 | 0,5243 | 0,4757 | 322.548 | 169.110 | 1.041.271 | 1.627.640 | 5,0 |
| 90+ | 0,2617 | 3,9820 | 1,0000 | 0,0000 | 153.438 | 153.438 | 586.369 | 586.369 | 3,8 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 21: Turkey Abridged Period Life Table, TR8, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0131 | | 0,0131 | 0,9869 | 1.000.000 | 13.086 | 986.914 | 75.418.876 | 75,4 |
| 1 | 0,0007 | 1,1741 | 0,0030 | 0,9970 | 986.914 | 2.949 | 3.939.322 | 74.431.962 | 75,4 |
| 5 | 0,0003 | 1,8700 | 0,0017 | 0,9983 | 983.965 | 1.693 | 4.914.526 | 70.492.640 | 71,6 |
| 10 | 0,0003 | 2,0485 | 0,0014 | 0,9986 | 982.272 | 1.360 | 4.907.345 | 65.578.114 | 66,8 |
| 15 | 0,0005 | 2,1152 | 0,0026 | 0,9974 | 980.912 | 2.527 | 4.897.269 | 60.670.769 | 61,9 |
| 20 | 0,0006 | 2,0526 | 0,0031 | 0,9969 | 978.385 | 2.995 | 4.883.095 | 55.773.500 | 57,0 |
| 25 | 0,0008 | 2,0498 | 0,0038 | 0,9962 | 975.389 | 3.734 | 4.865.931 | 50.890.405 | 52,2 |
| 30 | 0,0010 | 2,0023 | 0,0051 | 0,9949 | 971.655 | 4.915 | 4.843.544 | 46.024.474 | 47,4 |
| 35 | 0,0012 | 2,0388 | 0,0058 | 0,9942 | 966.740 | 5.559 | 4.817.242 | 41.180.931 | 42,6 |
| 40 | 0,0017 | 2,3455 | 0,0084 | 0,9916 | 961.182 | 8.105 | 4.784.392 | 36.363.689 | 37,8 |
| 45 | 0,0030 | 2,1649 | 0,0148 | 0,9852 | 953.076 | 14.127 | 4.725.332 | 31.579.297 | 33,1 |
| 50 | 0,0047 | 2,2713 | 0,0234 | 0,9766 | 938.950 | 21.927 | 4.634.915 | 26.853.965 | 28,6 |
| 55 | 0,0075 | 2,1821 | 0,0366 | 0,9634 | 917.023 | 33.576 | 4.490.500 | 22.219.050 | 24,2 |
| 60 | 0,0125 | 2,0985 | 0,0604 | 0,9396 | 883.446 | 53.320 | 4.262.523 | 17.728.550 | 20,1 |
| 65 | 0,0202 | 2,1600 | 0,0956 | 0,9044 | 830.127 | 79.325 | 3.925.353 | 13.466.027 | 16,2 |
| 70 | 0,0330 | 1,9883 | 0,1501 | 0,8499 | 750.801 | 112.669 | 3.414.683 | 9.540.674 | 12,7 |
| 75 | 0,0508 | 1,9660 | 0,2200 | 0,7800 | 638.132 | 140.414 | 2.764.650 | 6.125.992 | 9,6 |
| 80 | 0,0942 | 1,9127 | 0,3647 | 0,6353 | 497.718 | 181.536 | 1.928.130 | 3.361.342 | 6,8 |
| 85 | 0,1781 | 1,6240 | 0,5561 | 0,4439 | 316.181 | 175.815 | 987.352 | 1.433.212 | 4,5 |
| 90+ | 0,3148 | 4,0160 | 1,0000 | 0,0000 | 140.366 | 140.366 | 445.859 | 445.859 | 3,2 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 22: Turkey Abridged Period Life Table, TR8, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0111 | | 0,0111 | 0,9889 | 1.000.000 | 11.056 | 988.944 | 76.155.669 | 76,2 |
| 1 | 0,0006 | 1,1327 | 0,0026 | 0,9974 | 988.944 | 2.557 | 3.948.444 | 75.166.725 | 76,0 |
| 5 | 0,0003 | 1,7153 | 0,0016 | 0,9984 | 986.387 | 1.556 | 4.926.824 | 71.218.281 | 72,2 |
| 10 | 0,0003 | 2,0392 | 0,0013 | 0,9987 | 984.831 | 1.268 | 4.920.400 | 66.291.456 | 67,3 |
| 15 | 0,0005 | 2,0938 | 0,0024 | 0,9976 | 983.563 | 2.355 | 4.910.970 | 61.371.056 | 62,4 |
| 20 | 0,0005 | 2,0308 | 0,0026 | 0,9974 | 981.208 | 2.582 | 4.898.371 | 56.460.086 | 57,5 |
| 25 | 0,0007 | 2,1150 | 0,0033 | 0,9967 | 978.625 | 3.221 | 4.883.836 | 51.561.715 | 52,7 |
| 30 | 0,0008 | 1,9504 | 0,0039 | 0,9961 | 975.405 | 3.775 | 4.865.512 | 46.677.879 | 47,9 |
| 35 | 0,0010 | 2,1165 | 0,0051 | 0,9949 | 971.630 | 4.937 | 4.843.914 | 41.812.367 | 43,0 |
| 40 | 0,0016 | 2,1707 | 0,0078 | 0,9922 | 966.693 | 7.505 | 4.812.231 | 36.968.453 | 38,2 |
| 45 | 0,0028 | 2,0608 | 0,0137 | 0,9863 | 959.188 | 13.103 | 4.757.426 | 32.156.222 | 33,5 |
| 50 | 0,0045 | 2,1916 | 0,0223 | 0,9777 | 946.085 | 21.100 | 4.671.166 | 27.398.796 | 29,0 |
| 55 | 0,0067 | 1,9701 | 0,0326 | 0,9674 | 924.984 | 30.193 | 4.533.442 | 22.727.630 | 24,6 |
| 60 | 0,0114 | 1,9684 | 0,0552 | 0,9448 | 894.792 | 49.409 | 4.324.168 | 18.194.188 | 20,3 |
| 65 | 0,0189 | 2,0615 | 0,0895 | 0,9105 | 845.382 | 75.630 | 4.004.674 | 13.870.020 | 16,4 |
| 70 | 0,0318 | 2,0058 | 0,1451 | 0,8549 | 769.752 | 111.721 | 3.514.244 | 9.865.346 | 12,8 |
| 75 | 0,0493 | 2,1127 | 0,2157 | 0,7843 | 658.031 | 141.919 | 2.880.393 | 6.351.102 | 9,7 |
| 80 | 0,0926 | 1,9431 | 0,3608 | 0,6392 | 516.112 | 186.192 | 2.011.388 | 3.470.710 | 6,7 |
| 85 | 0,1870 | 1,6207 | 0,5729 | 0,4271 | 329.920 | 189.016 | 1.010.861 | 1.459.322 | 4,4 |
| 90+ | 0,3142 | 3,9820 | 1,0000 | 0,0000 | 140.904 | 140.904 | 448.461 | 448.461 | 3,2 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 23: Turkey Abridged Period Life Table, TR9, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0117 | | 0,0117 | 0,9883 | 1.000.000 | 11.659 | 988.341 | 76.897.768 | 76,9 |
| 1 | 0,0006 | 1,1741 | 0,0025 | 0,9975 | 988.341 | 2.505 | 3.946.283 | 75.909.428 | 76,8 |
| 5 | 0,0004 | 1,8700 | 0,0022 | 0,9978 | 985.835 | 2.188 | 4.922.328 | 71.963.144 | 73,0 |
| 10 | 0,0004 | 2,0485 | 0,0018 | 0,9982 | 983.647 | 1.729 | 4.913.131 | 67.040.817 | 68,2 |
| 15 | 0,0004 | 2,1152 | 0,0021 | 0,9979 | 981.918 | 2.104 | 4.903.520 | 62.127.685 | 63,3 |
| 20 | 0,0006 | 2,0526 | 0,0032 | 0,9968 | 979.814 | 3.161 | 4.889.755 | 57.224.165 | 58,4 |
| 25 | 0,0008 | 2,0498 | 0,0041 | 0,9959 | 976.653 | 4.037 | 4.871.357 | 52.334.410 | 53,6 |
| 30 | 0,0009 | 2,0023 | 0,0043 | 0,9957 | 972.616 | 4.193 | 4.850.511 | 47.463.054 | 48,8 |
| 35 | 0,0011 | 2,0388 | 0,0054 | 0,9946 | 968.423 | 5.270 | 4.826.508 | 42.612.543 | 44,0 |
| 40 | 0,0018 | 2,3455 | 0,0088 | 0,9912 | 963.153 | 8.480 | 4.793.253 | 37.786.035 | 39,2 |
| 45 | 0,0025 | 2,1649 | 0,0126 | 0,9874 | 954.673 | 12.003 | 4.739.335 | 32.992.782 | 34,6 |
| 50 | 0,0045 | 2,2713 | 0,0222 | 0,9778 | 942.670 | 20.952 | 4.656.175 | 28.253.448 | 30,0 |
| 55 | 0,0071 | 2,1821 | 0,0347 | 0,9653 | 921.718 | 32.023 | 4.518.353 | 23.597.272 | 25,6 |
| 60 | 0,0110 | 2,0985 | 0,0535 | 0,9465 | 889.695 | 47.564 | 4.310.466 | 19.078.920 | 21,4 |
| 65 | 0,0187 | 2,1600 | 0,0886 | 0,9114 | 842.131 | 74.626 | 3.998.721 | 14.768.454 | 17,5 |
| 70 | 0,0280 | 1,9883 | 0,1291 | 0,8709 | 767.505 | 99.075 | 3.539.144 | 10.769.733 | 14,0 |
| 75 | 0,0461 | 1,9660 | 0,2022 | 0,7978 | 668.430 | 135.168 | 2.932.060 | 7.230.588 | 10,8 |
| 80 | 0,0795 | 1,9127 | 0,3190 | 0,6810 | 533.263 | 170.121 | 2.141.098 | 4.298.529 | 8,1 |
| 85 | 0,1426 | 1,6240 | 0,4812 | 0,5188 | 363.142 | 174.740 | 1.225.786 | 2.157.431 | 5,9 |
| 90+ | 0,2022 | 4,0160 | 1,0000 | 0,0000 | 188.402 | 188.402 | 931.644 | 931.644 | 4,9 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 24: Turkey Abridged Period Life Table, TR9, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0104 | | 0,0104 | 0,9896 | 1.000.000 | 10.435 | 989.565 | 77.716.802 | 77,7 |
| 1 | 0,0007 | 1,1327 | 0,0026 | 0,9974 | 989.565 | 2.589 | 3.950.836 | 76.727.237 | 77,5 |
| 5 | 0,0003 | 1,7153 | 0,0013 | 0,9987 | 986.976 | 1.296 | 4.930.622 | 72.776.401 | 73,7 |
| 10 | 0,0004 | 2,0392 | 0,0018 | 0,9982 | 985.680 | 1.746 | 4.923.230 | 67.845.779 | 68,8 |
| 15 | 0,0005 | 2,0938 | 0,0025 | 0,9975 | 983.934 | 2.478 | 4.912.469 | 62.922.549 | 63,9 |
| 20 | 0,0006 | 2,0308 | 0,0029 | 0,9971 | 981.456 | 2.889 | 4.898.703 | 58.010.080 | 59,1 |
| 25 | 0,0006 | 2,1150 | 0,0028 | 0,9972 | 978.567 | 2.735 | 4.884.945 | 53.111.377 | 54,3 |
| 30 | 0,0007 | 1,9504 | 0,0036 | 0,9964 | 975.832 | 3.553 | 4.868.324 | 48.226.432 | 49,4 |
| 35 | 0,0011 | 2,1165 | 0,0056 | 0,9944 | 972.279 | 5.434 | 4.845.723 | 43.358.109 | 44,6 |
| 40 | 0,0015 | 2,1707 | 0,0076 | 0,9924 | 966.844 | 7.351 | 4.813.424 | 38.512.386 | 39,8 |
| 45 | 0,0025 | 2,0608 | 0,0125 | 0,9875 | 959.493 | 12.029 | 4.762.110 | 33.698.962 | 35,1 |
| 50 | 0,0045 | 2,1916 | 0,0224 | 0,9776 | 947.464 | 21.187 | 4.677.820 | 28.936.852 | 30,5 |
| 55 | 0,0060 | 1,9701 | 0,0294 | 0,9706 | 926.277 | 27.252 | 4.548.816 | 24.259.032 | 26,2 |
| 60 | 0,0104 | 1,9684 | 0,0505 | 0,9495 | 899.025 | 45.364 | 4.357.600 | 19.710.216 | 21,9 |
| 65 | 0,0173 | 2,0615 | 0,0824 | 0,9176 | 853.662 | 70.335 | 4.061.631 | 15.352.616 | 18,0 |
| 70 | 0,0274 | 2,0058 | 0,1266 | 0,8734 | 783.327 | 99.135 | 3.619.805 | 11.290.985 | 14,4 |
| 75 | 0,0430 | 2,1127 | 0,1914 | 0,8086 | 684.192 | 130.957 | 3.042.851 | 7.671.180 | 11,2 |
| 80 | 0,0735 | 1,9431 | 0,3000 | 0,7000 | 553.236 | 165.990 | 2.258.763 | 4.628.329 | 8,4 |
| 85 | 0,1402 | 1,6207 | 0,4755 | 0,5245 | 387.246 | 184.154 | 1.313.921 | 2.369.566 | 6,1 |
| 90+ | 0,1924 | 3,9820 | 1,0000 | 0,0000 | 203.092 | 203.092 | 1.055.646 | 1.055.646 | 5,2 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 25: Turkey Abridged Period Life Table, TRA, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0129 | | 0,0129 | 0,9871 | 1.000.000 | 12.934 | 987.066 | 74.431.056 | 74,4 |
| 1 | 0,0017 | 1,1741 | 0,0069 | 0,9931 | 987.066 | 6.796 | 3.929.060 | 73.443.990 | 74,4 |
| 5 | 0,0009 | 1,8700 | 0,0043 | 0,9957 | 980.270 | 4.239 | 4.888.082 | 69.514.930 | 70,9 |
| 10 | 0,0006 | 2,0485 | 0,0031 | 0,9969 | 976.031 | 3.018 | 4.871.247 | 64.626.848 | 66,2 |
| 15 | 0,0007 | 2,1152 | 0,0035 | 0,9965 | 973.013 | 3.423 | 4.855.190 | 59.755.601 | 61,4 |
| 20 | 0,0006 | 2,0526 | 0,0030 | 0,9970 | 969.590 | 2.881 | 4.839.459 | 54.900.410 | 56,6 |
| 25 | 0,0008 | 2,0498 | 0,0038 | 0,9962 | 966.709 | 3.679 | 4.822.693 | 50.060.951 | 51,8 |
| 30 | 0,0008 | 2,0023 | 0,0040 | 0,9960 | 963.031 | 3.817 | 4.803.710 | 45.238.258 | 47,0 |
| 35 | 0,0015 | 2,0388 | 0,0073 | 0,9927 | 959.213 | 6.971 | 4.775.424 | 40.434.549 | 42,2 |
| 40 | 0,0020 | 2,3455 | 0,0098 | 0,9902 | 952.242 | 9.339 | 4.736.419 | 35.659.125 | 37,4 |
| 45 | 0,0031 | 2,1649 | 0,0154 | 0,9846 | 942.903 | 14.520 | 4.673.349 | 30.922.706 | 32,8 |
| 50 | 0,0052 | 2,2713 | 0,0257 | 0,9743 | 928.383 | 23.862 | 4.576.800 | 26.249.357 | 28,3 |
| 55 | 0,0085 | 2,1821 | 0,0417 | 0,9583 | 904.520 | 37.699 | 4.416.370 | 21.672.558 | 24,0 |
| 60 | 0,0132 | 2,0985 | 0,0634 | 0,9366 | 866.821 | 54.954 | 4.174.653 | 17.256.187 | 19,9 |
| 65 | 0,0220 | 2,1600 | 0,1033 | 0,8967 | 811.867 | 83.902 | 3.821.057 | 13.081.534 | 16,1 |
| 70 | 0,0347 | 1,9883 | 0,1570 | 0,8430 | 727.965 | 114.293 | 3.295.610 | 9.260.477 | 12,7 |
| 75 | 0,0547 | 1,9660 | 0,2345 | 0,7655 | 613.672 | 143.924 | 2.631.698 | 5.964.868 | 9,7 |
| 80 | 0,0980 | 1,9127 | 0,3762 | 0,6238 | 469.747 | 176.728 | 1.803.123 | 3.333.169 | 7,1 |
| 85 | 0,1381 | 1,6240 | 0,4710 | 0,5290 | 293.020 | 138.015 | 999.158 | 1.530.046 | 5,2 |
| 90+ | 0,2920 | 4,0160 | 1,0000 | 0,0000 | 155.005 | 155.005 | 530.888 | 530.888 | 3,4 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 26: Turkey Abridged Period Life Table, TRA, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0140 | | 0,0140 | 0,9860 | 1.000.000 | 13.959 | 986.041 | 75.129.425 | 75,1 |
| 1 | 0,0014 | 1,1327 | 0,0056 | 0,9944 | 986.041 | 5.524 | 3.928.322 | 74.143.385 | 75,2 |
| 5 | 0,0008 | 1,7153 | 0,0041 | 0,9959 | 980.516 | 4.040 | 4.889.312 | 70.215.062 | 71,6 |
| 10 | 0,0006 | 2,0392 | 0,0029 | 0,9971 | 976.477 | 2.855 | 4.873.929 | 65.325.750 | 66,9 |
| 15 | 0,0006 | 2,0938 | 0,0030 | 0,9970 | 973.621 | 2.917 | 4.859.630 | 60.451.820 | 62,1 |
| 20 | 0,0006 | 2,0308 | 0,0029 | 0,9971 | 970.705 | 2.858 | 4.845.038 | 55.592.190 | 57,3 |
| 25 | 0,0007 | 2,1150 | 0,0036 | 0,9964 | 967.847 | 3.485 | 4.829.182 | 50.747.152 | 52,4 |
| 30 | 0,0009 | 1,9504 | 0,0044 | 0,9956 | 964.362 | 4.212 | 4.808.968 | 45.917.970 | 47,6 |
| 35 | 0,0013 | 2,1165 | 0,0067 | 0,9933 | 960.151 | 6.410 | 4.782.269 | 41.109.003 | 42,8 |
| 40 | 0,0018 | 2,1707 | 0,0090 | 0,9910 | 953.740 | 8.618 | 4.744.320 | 36.326.733 | 38,1 |
| 45 | 0,0028 | 2,0608 | 0,0141 | 0,9859 | 945.123 | 13.355 | 4.686.361 | 31.582.413 | 33,4 |
| 50 | 0,0051 | 2,1916 | 0,0250 | 0,9750 | 931.768 | 23.325 | 4.593.335 | 26.896.053 | 28,9 |
| 55 | 0,0075 | 1,9701 | 0,0367 | 0,9633 | 908.443 | 33.374 | 4.441.097 | 22.302.718 | 24,6 |
| 60 | 0,0124 | 1,9684 | 0,0596 | 0,9404 | 875.070 | 52.186 | 4.217.139 | 17.861.621 | 20,4 |
| 65 | 0,0207 | 2,0615 | 0,0976 | 0,9024 | 822.884 | 80.344 | 3.878.328 | 13.644.482 | 16,6 |
| 70 | 0,0351 | 2,0058 | 0,1590 | 0,8410 | 742.539 | 118.043 | 3.359.249 | 9.766.153 | 13,2 |
| 75 | 0,0524 | 2,1127 | 0,2276 | 0,7724 | 624.496 | 142.130 | 2.712.108 | 6.406.904 | 10,3 |
| 80 | 0,0898 | 1,9431 | 0,3524 | 0,6476 | 482.366 | 169.979 | 1.892.220 | 3.694.796 | 7,7 |
| 85 | 0,1247 | 1,6207 | 0,4387 | 0,5613 | 312.387 | 137.059 | 1.098.773 | 1.802.576 | 5,8 |
| 90+ | 0,2491 | 3,9820 | 1,0000 | 0,0000 | 175.327 | 175.327 | 703.804 | 703.804 | 4,0 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 27: Turkey Abridged Period Life Table, TRB, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0173 | | 0,0173 | 0,9827 | 1.000.000 | 17.270 | 982.730 | 74.472.203 | 74,5 |
| 1 | 0,0020 | 1,1741 | 0,0078 | 0,9922 | 982.730 | 7.655 | 3.909.287 | 73.489.473 | 74,8 |
| 5 | 0,0016 | 1,8700 | 0,0078 | 0,9922 | 975.075 | 7.624 | 4.851.512 | 69.580.185 | 71,4 |
| 10 | 0,0009 | 2,0485 | 0,0043 | 0,9957 | 967.451 | 4.170 | 4.824.949 | 64.728.673 | 66,9 |
| 15 | 0,0009 | 2,1152 | 0,0043 | 0,9957 | 963.282 | 4.158 | 4.804.414 | 59.903.724 | 62,2 |
| 20 | 0,0007 | 2,0526 | 0,0035 | 0,9965 | 959.124 | 3.396 | 4.785.611 | 55.099.310 | 57,4 |
| 25 | 0,0009 | 2,0498 | 0,0044 | 0,9956 | 955.728 | 4.195 | 4.766.265 | 50.313.699 | 52,6 |
| 30 | 0,0010 | 2,0023 | 0,0050 | 0,9950 | 951.534 | 4.793 | 4.743.300 | 45.547.434 | 47,9 |
| 35 | 0,0015 | 2,0388 | 0,0073 | 0,9927 | 946.740 | 6.893 | 4.713.292 | 40.804.134 | 43,1 |
| 40 | 0,0020 | 2,3455 | 0,0100 | 0,9900 | 939.848 | 9.370 | 4.674.365 | 36.090.842 | 38,4 |
| 45 | 0,0028 | 2,1649 | 0,0140 | 0,9860 | 930.478 | 12.980 | 4.615.589 | 31.416.477 | 33,8 |
| 50 | 0,0050 | 2,2713 | 0,0246 | 0,9754 | 917.498 | 22.612 | 4.525.785 | 26.800.888 | 29,2 |
| 55 | 0,0073 | 2,1821 | 0,0357 | 0,9643 | 894.885 | 31.942 | 4.384.419 | 22.275.103 | 24,9 |
| 60 | 0,0114 | 2,0985 | 0,0552 | 0,9448 | 862.943 | 47.591 | 4.176.629 | 17.890.684 | 20,7 |
| 65 | 0,0205 | 2,1600 | 0,0967 | 0,9033 | 815.352 | 78.873 | 3.852.764 | 13.714.055 | 16,8 |
| 70 | 0,0332 | 1,9883 | 0,1510 | 0,8490 | 736.479 | 111.174 | 3.347.575 | 9.861.291 | 13,4 |
| 75 | 0,0555 | 1,9660 | 0,2374 | 0,7626 | 625.305 | 148.476 | 2.676.058 | 6.513.716 | 10,4 |
| 80 | 0,0935 | 1,9127 | 0,3627 | 0,6373 | 476.830 | 172.929 | 1.850.264 | 3.837.658 | 8,0 |
| 85 | 0,1216 | 1,6240 | 0,4312 | 0,5688 | 303.901 | 131.033 | 1.077.138 | 1.987.394 | 6,5 |
| 90+ | 0,1899 | 4,0160 | 1,0000 | 0,0000 | 172.868 | 172.868 | 910.256 | 910.256 | 5,3 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 28: Turkey Abridged Period Life Table, TRB, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0143 | | 0,0143 | 0,9857 | 1.000.000 | 14.302 | 985.698 | 75.421.658 | 75,4 |
| 1 | 0,0017 | 1,1327 | 0,0069 | 0,9931 | 985.698 | 6.815 | 3.923.251 | 74.435.960 | 75,5 |
| 5 | 0,0013 | 1,7153 | 0,0064 | 0,9936 | 978.883 | 6.312 | 4.873.680 | 70.512.708 | 72,0 |
| 10 | 0,0007 | 2,0392 | 0,0035 | 0,9965 | 972.571 | 3.361 | 4.852.902 | 65.639.028 | 67,5 |
| 15 | 0,0008 | 2,0938 | 0,0041 | 0,9959 | 969.210 | 4.004 | 4.834.414 | 60.786.125 | 62,7 |
| 20 | 0,0006 | 2,0308 | 0,0031 | 0,9969 | 965.206 | 3.004 | 4.817.111 | 55.951.712 | 58,0 |
| 25 | 0,0008 | 2,1150 | 0,0039 | 0,9961 | 962.202 | 3.724 | 4.800.264 | 51.134.601 | 53,1 |
| 30 | 0,0009 | 1,9504 | 0,0046 | 0,9954 | 958.477 | 4.389 | 4.779.004 | 46.334.337 | 48,3 |
| 35 | 0,0013 | 2,1165 | 0,0065 | 0,9935 | 954.089 | 6.178 | 4.752.630 | 41.555.333 | 43,6 |
| 40 | 0,0019 | 2,1707 | 0,0094 | 0,9906 | 947.911 | 8.894 | 4.714.390 | 36.802.703 | 38,8 |
| 45 | 0,0027 | 2,0608 | 0,0132 | 0,9868 | 939.017 | 12.435 | 4.658.533 | 32.088.313 | 34,2 |
| 50 | 0,0050 | 2,1916 | 0,0247 | 0,9753 | 926.581 | 22.908 | 4.568.571 | 27.429.781 | 29,6 |
| 55 | 0,0069 | 1,9701 | 0,0339 | 0,9661 | 903.673 | 30.666 | 4.425.449 | 22.861.209 | 25,3 |
| 60 | 0,0113 | 1,9684 | 0,0549 | 0,9451 | 873.007 | 47.892 | 4.219.840 | 18.435.760 | 21,1 |
| 65 | 0,0195 | 2,0615 | 0,0922 | 0,9078 | 825.114 | 76.108 | 3.901.930 | 14.215.920 | 17,2 |
| 70 | 0,0323 | 2,0058 | 0,1474 | 0,8526 | 749.007 | 110.375 | 3.414.547 | 10.313.990 | 13,8 |
| 75 | 0,0534 | 2,1127 | 0,2313 | 0,7687 | 638.632 | 147.711 | 2.766.675 | 6.899.442 | 10,8 |
| 80 | 0,0907 | 1,9431 | 0,3551 | 0,6449 | 490.921 | 174.326 | 1.921.709 | 4.132.767 | 8,4 |
| 85 | 0,1164 | 1,6207 | 0,4177 | 0,5823 | 316.596 | 132.257 | 1.136.044 | 2.211.059 | 7,0 |
| 90+ | 0,1715 | 3,9820 | 1,0000 | 0,0000 | 184.338 | 184.338 | 1.075.014 | 1.075.014 | 5,8 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 29: Turkey Abridged Period Life Table, TRC, 2009.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0172 | | 0,0172 | 0,9828 | 1.000.000 | 17.200 | 982.800 | 75.401.459 | 75,4 |
| 1 | 0,0017 | 1,1741 | 0,0069 | 0,9931 | 982.800 | 6.751 | 3.912.123 | 74.418.659 | 75,7 |
| 5 | 0,0010 | 1,8700 | 0,0052 | 0,9948 | 976.049 | 5.039 | 4.864.474 | 70.506.536 | 72,2 |
| 10 | 0,0006 | 2,0485 | 0,0031 | 0,9969 | 971.010 | 3.002 | 4.846.190 | 65.642.062 | 67,6 |
| 15 | 0,0008 | 2,1152 | 0,0037 | 0,9963 | 968.008 | 3.623 | 4.829.589 | 60.795.872 | 62,8 |
| 20 | 0,0007 | 2,0526 | 0,0035 | 0,9965 | 964.385 | 3.372 | 4.811.989 | 55.966.283 | 58,0 |
| 25 | 0,0008 | 2,0498 | 0,0041 | 0,9959 | 961.014 | 3.922 | 4.793.497 | 51.154.294 | 53,2 |
| 30 | 0,0009 | 2,0023 | 0,0044 | 0,9956 | 957.092 | 4.200 | 4.772.868 | 46.360.797 | 48,4 |
| 35 | 0,0012 | 2,0388 | 0,0060 | 0,9940 | 952.892 | 5.684 | 4.747.628 | 41.587.929 | 43,6 |
| 40 | 0,0018 | 2,3455 | 0,0092 | 0,9908 | 947.208 | 8.683 | 4.712.991 | 36.840.301 | 38,9 |
| 45 | 0,0027 | 2,1649 | 0,0136 | 0,9864 | 938.525 | 12.731 | 4.656.534 | 32.127.310 | 34,2 |
| 50 | 0,0046 | 2,2713 | 0,0226 | 0,9774 | 925.795 | 20.924 | 4.571.876 | 27.470.776 | 29,7 |
| 55 | 0,0073 | 2,1821 | 0,0357 | 0,9643 | 904.870 | 32.311 | 4.433.304 | 22.898.900 | 25,3 |
| 60 | 0,0112 | 2,0985 | 0,0544 | 0,9456 | 872.559 | 47.445 | 4.225.132 | 18.465.596 | 21,2 |
| 65 | 0,0194 | 2,1600 | 0,0917 | 0,9083 | 825.114 | 75.695 | 3.910.600 | 14.240.464 | 17,3 |
| 70 | 0,0315 | 1,9883 | 0,1440 | 0,8560 | 749.419 | 107.914 | 3.422.092 | 10.329.863 | 13,8 |
| 75 | 0,0532 | 1,9660 | 0,2289 | 0,7711 | 641.505 | 146.837 | 2.762.029 | 6.907.771 | 10,8 |
| 80 | 0,0918 | 1,9127 | 0,3576 | 0,6424 | 494.668 | 176.875 | 1.927.275 | 4.145.742 | 8,4 |
| 85 | 0,1278 | 1,6240 | 0,4463 | 0,5537 | 317.794 | 141.846 | 1.110.096 | 2.218.467 | 7,0 |
| 90+ | 0,1587 | 4,0160 | 1,0000 | 0,0000 | 175.948 | 175.948 | 1.108.371 | 1.108.371 | 6,3 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.

Appendix 30: Turkey Abridged Period Life Table, TRC, 2010.

| Age | $_nm_x$ | $_na_x$ | $_nq_x$ | $_np_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x^0$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0,0160 | | 0,0160 | 0,9840 | 1.000.000 | 16.022 | 983.978 | 75.978.780 | 76,0 |
| 1 | 0,0016 | 1,1327 | 0,0064 | 0,9936 | 983.978 | 6.286 | 3.917.889 | 74.994.801 | 76,2 |
| 5 | 0,0009 | 1,7153 | 0,0044 | 0,9956 | 977.692 | 4.349 | 4.874.175 | 71.076.912 | 72,7 |
| 10 | 0,0005 | 2,0392 | 0,0026 | 0,9974 | 973.343 | 2.547 | 4.859.175 | 66.202.737 | 68,0 |
| 15 | 0,0007 | 2,0938 | 0,0037 | 0,9963 | 970.796 | 3.625 | 4.843.448 | 61.343.562 | 63,2 |
| 20 | 0,0007 | 2,0308 | 0,0034 | 0,9966 | 967.172 | 3.296 | 4.826.072 | 56.500.114 | 58,4 |
| 25 | 0,0007 | 2,1150 | 0,0036 | 0,9964 | 963.876 | 3.429 | 4.809.487 | 51.674.042 | 53,6 |
| 30 | 0,0009 | 1,9504 | 0,0044 | 0,9956 | 960.447 | 4.184 | 4.789.475 | 46.864.555 | 48,8 |
| 35 | 0,0011 | 2,1165 | 0,0054 | 0,9946 | 956.263 | 5.139 | 4.766.497 | 42.075.080 | 44,0 |
| 40 | 0,0017 | 2,1707 | 0,0085 | 0,9915 | 951.124 | 8.047 | 4.732.853 | 37.308.583 | 39,2 |
| 45 | 0,0025 | 2,0608 | 0,0123 | 0,9877 | 943.077 | 11.643 | 4.681.163 | 32.575.730 | 34,5 |
| 50 | 0,0044 | 2,1916 | 0,0219 | 0,9781 | 931.434 | 20.401 | 4.599.876 | 27.894.567 | 29,9 |
| 55 | 0,0067 | 1,9701 | 0,0330 | 0,9670 | 911.033 | 30.022 | 4.464.202 | 23.294.691 | 25,6 |
| 60 | 0,0106 | 1,9684 | 0,0512 | 0,9488 | 881.011 | 45.123 | 4.268.260 | 18.830.489 | 21,4 |
| 65 | 0,0189 | 2,0615 | 0,0897 | 0,9103 | 835.889 | 74.940 | 3.959.232 | 14.562.229 | 17,4 |
| 70 | 0,0315 | 2,0058 | 0,1438 | 0,8562 | 760.948 | 109.438 | 3.477.059 | 10.602.997 | 13,9 |
| 75 | 0,0525 | 2,1127 | 0,2280 | 0,7720 | 651.510 | 148.542 | 2.828.662 | 7.125.938 | 10,9 |
| 80 | 0,0902 | 1,9431 | 0,3536 | 0,6464 | 502.967 | 177.857 | 1.971.144 | 4.297.276 | 8,5 |
| 85 | 0,1291 | 1,6207 | 0,4495 | 0,5505 | 325.110 | 146.124 | 1.131.759 | 2.326.132 | 7,2 |
| 90+ | 0,1499 | 3,9820 | 1,0000 | 0,0000 | 178.987 | 178.987 | 1.194.374 | 1.194.374 | 6,7 |

Note: For figures in columns Lx, dx, px, qx and mx the age interval relates to a 5-year period except for: age 0 which relates to a 1-year period, age 1 which relates to a 4-year period, and age 90 which relates to remaining life span.