HACETTEPE UNIVERSITY
INSTITUTE OF POPULATION STUDIES

ESSAYS ON THE COMPONENTS OF DEMOGRAPHIC CHANGE IN TURKEY: AN APPLICATION OF DECOMPOSITION METHODS

Dilek TORUN ALACA

Department of Demography
Ph.D. Thesis

Ankara
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APPROVAL PAGE

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Dilek TORUN ALACA

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ESSAYS ON THE COMPONENTS OF DEMOGRAPHIC CHANGE IN TURKEY: AN APPLICATION OF DECOMPOSITION METHODS

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ABSTRACT

This dissertation aims to examine the components of demographic change in Turkey using decomposition methods. Trends in mortality, fertility, and population growth are separated into their components for exploring the effect of age and socioeconomic factors to the demographic change over time. This study consists of two main chapters in essay type on the decomposition of mortality measures and decomposition of fertility and population growth measures.

In the first essay, long-term mortality trends are decomposed using direct and indirect mortality estimates based on demographic surveys and censuses. In addition, data sets of Turkish Demographic and Health Surveys conducted in 1993 and 2013 are used to examine the impact of social factors on mortality changes after 1990. The analysis has shown that the long-term mortality improvement was due to reductions in mortality rather than age structure. The greatest contribution to this decrease was the improvement in infant mortality rates. After 1990s, mortality levels have converged in all sub-population groups, although there was a significant disparity in age patterns of mortality.

Fertility and population growth measures are analyzed in the second essay. Fertility decompositions are conducted by using data sets of Turkish Demographic and Health Surveys conducted in 1993, 2003 and 2013; while indirect estimates from secondary data sources are used to decompose crude rate of natural increase. Decomposition analysis has shown that the effect of increasing age at marriage and fertility postponement was evident in the study period. In addition, fertility variation between population groups persisted, and educational level was the most significant socioeconomic factor contributing to fertility change.

Although Turkey’s demographic transition is nearly completed, divergences in demographic conditions persist across sub-population groups. Some of the socioeconomic factors contributing to this divergence are discussed in this study. However, it should be taken into account that cultural and ideational factors also contribute to demographic divergence. Considering the results of this study in terms of the course of demographic change in Turkey, it can be predicted that, the completion of demographic transition in all population groups is anticipated to produce further declines in fertility, which, along with decreasing mortality, will lead to population aging.

Key words: mortality, decomposition methods, fertility, population growth, socioeconomic factors

ÖZET

Bu tez, ayrıştırma yöntemlerini kullanarak Türkiye'deki demografik değişimin bileşenlerini incelemeyi amaçlamaktadır. Ölümlülük, doğurganlık ve nüfus artışı hızındaki değişimler, yaş ve sosyoekonomik faktörlerin demografik değişim üzerindeki etkisini araştırmak için bileşenlerine ayrılmıştır. Bu çalışma, ölümlülük değişkenlerinin ayrıştırılması ve doğurganlık ve nüfus artış hızı değişkenlerinin ayrıştırılması üzerine iki makaleden oluşmaktadır.

İlk makalede, uzun vadeli ölümlülük değişimi, demografik araştırmalara ve nüfus sayımlarına dayanan doğrudan ve dolaylı ölüm tahminleri kullanılarak analiz edilmiştir. Ayrıca, sosyoekonomik faktörlerin 1990 sonrası ölümlülük değişimi üzerindeki etkisini incelemek için 1993 ve 2013 yıllarında gerçekleştirilen Türkiye Nüfus ve Sağlık Araştırmalarının veri setleri kullanılmıştır. Analiz, ölümlülük düzeyindeki uzun vadeli iyileşmenin ölüm oranlarındaki azalmadan çok yaş yapısının değişiminden kaynaklandığını göstermiştir. Bu değişime en büyük katkıyı bebek ölüm oranlarındaki iyileşme yapmıştır. 1990'lı yıllardan sonra, incelenen bütün nüfus gruplarında ölümlülük düzeyi birbirine yakınsadığı halde, ölümlülüğün yaş yapısındaki farklılaşma devam etmiştir.

Doğurganlık ve nüfus artış hızına ilişkin analizler ikinci makale kapsamında gerçekleştirilmiştir. Doğurganlık değişkenleri 1993, 2003 ve 2013 yıllarında gerçekleştirilen Türkiye Nüfus ve Sağlık Araştırmalarının veri setleri kullanılarak; doğal nüfus artış hızı ise ikincil veri kaynaklarından dolaylı tahminler kullanılarak analiz edilmiştir. Ayrıştırma analizi sonuçlarına göre, çalışma döneminde evlilik yaşının yükselmesinin ve doğurganlığın ertelenmesinin etkisi belirgin şekilde kendini göstermiştir. Ayrıca, nüfus grupları arasındaki doğurganlık farklılaşması devam etmiştir. Eğitim düzeyi ise doğurganlık değişimine en çok katkıda bulunan sosyo-ekonomik faktördür.

Türkiye'nin demografik dönüşümü neredeyse tamamlanmış olsa da, nüfus grupları arasındaki demografik farklılıklar halen devam etmektedir. Bu farklılığa katkı yapan sosyoekonomik faktörlerden bazıları bu çalışma kapsamında ele alınmıştır. Ancak, kültürel ve düşünsel faktörlerin de demografik farklılaşmaya katkı yaptığını göz önünde bulundurmak gerekmektedir. Bu çalışmanın sonuçları Türkiye'deki demografik değişimin seyri açısından değerlendirildiğinde, tüm nüfus gruplarında demografik geçişin tamamlanmasının doğurganlıkta daha fazla düşüşe yol açacağı ve bunun da azalan ölüm oranlarıyla birlikte nüfus yaşlanmasına yol açacağı öngörülebilir.

Anahtar kelimeler: ölümlülük, ayrıştırma yöntemleri, doğurganlık, nüfus artışı, sosyoekonomik faktörler

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ABBREVATIONS

ABPRS	Address Based Population Registration System
ASDR	Age-Specific Death Rate
ASFR	Age-Specific Fertility Rate
CDR	Crude Death Rate
CEB	Children Ever Born
CRNI	Crude Rate of Natural Increase
HUIPS	Hacettepe University Institute of Population Studies
IMR	Infant Mortality Rate
CBR	Crude Birth Rate
TFR	Total Fertility Rate
PPR	Parity Progression Ratio
TDHS	Turkey Demographic and Health Survey
TURKSTAT	Turkish Statistical Institute
UN	United Nations

I. GENERAL INTRODUCTION AND BACKGROUND

I.1. GENERAL INTRODUCTION

Turkey has been undergoing a demographic transition since the early 1900s (Koç et al., 2010; Duben and Behar, 2014). The demographic transition is a process characterized by a shift from high to low levels of death and birth rates. Demographic transition, which emerged in conjunction with the modernization process, has resulted in considerable changes in the society's demographic and socioeconomic characteristics. Population size, age structure and growth rate were significantly affected by this transformation. Furthermore, as a consequence of modernization and urbanization, the country's socioeconomic structure has changed significantly.

The three main components of population change are changes in birth, death, and migration rates. During the demographic transition, primarily death rates decreased, while birth rates remained high for a time, resulting in rapid population growth. The population growth rate slowed as the fertility rate decreased, and as the transition progressed, low mortality and fertility levels became permanent. Migration movements, in addition to changes in birth and death rates, have played a significant role in the transition of population structure. Rapid population growth primarily triggered migration movements towards cities, the share of agricultural production gradually decreased, and cities began to grow rapidly. Both the changes in economic production and the increase in the urban population contributed to the country's socio-economic structure changing dramatically.

Another significant consequence of the transition process was a shift in the age structure of the population. The share of the young population increased in the earlier phases of the demographic transition, when mortality decreased rapidly and fertility remained high. With declining fertility levels, the population age structure has gradually shifted to an aging population. Although Turkey still maintains its young population structure, the elderly population is expected to grow rapidly in the following decades.

In Turkey, the transition process has not followed the same pace for all regions and sub-population groups. Socio-economic differentials among sub-population groups have led to diverse fertility and mortality patterns between these groups. Different regions of the country have followed divergent demographic patterns since the beginning of the transition, and this divergence still persists. In the literature, socioeconomic factors such as educational attainment, type of place of residence, ethnicity, income level, and employment status have been recognized as significant components of fertility and mortality change.

Decomposition methods are among the methods used to explain the discrepancy in demographic transition patterns. They are used in demography to analyze the factors that comprise demographic indicators. The changes in the demographic indicators are broken down into underlying components to gain further understanding of the demographic events. The aggregate measures of population change - rates, proportions, or averages - have undisputed advantages in terms of simplicity and practicability. However, when demographic measures are compared over time or by other compositional factors like age, sex, educational status, or marital status, these measures do not provide sufficient information regarding the underlying components of the change. Decomposition methods provide insight into demographic phenomena by separating the compositional effects and behavioral effects and representing the actual change in the demographic measures.

This study analyses the components of demographic change in Turkey using decomposition methods. Trends in mortality, fertility, and population growth are separated into their components for exploring the contributing factors to the demographic change over time. Furthermore, the conditions in which the demographic change occurred are explored; the sources of these changes and their relationship with the population's social and economic characteristics are examined. The migration component, which is the third factor driving population change, is not included in this study due to the limitations in obtaining data on the change in migration rates. The major contribution of this study is the application of different decomposition methods to the demographic measures and exploring the impact of the changes in age composition and social factors to the aggregate measures of mortality and fertility.

The thesis's primary objective is to interpret the components of the change in the demographic variables (mortality, fertility and population growth) in Turkey in the course of demographic transition by using decomposition methods. The secondary aims are as follows:

(1) To explore the contribution of age pattern and structural factors to the changes in mortality levels and patterns,
(2) To reveal the components of the change in the levels and social factors affecting fertility,
(3) To identify the effects of the demographic components on the change in population growth,
(4) To evaluate the decomposition results in the context of Turkey's demographic and socioeconomic characteristics and make suggestions for the future research

The dissertation contains two main chapters in essay type on the decomposition of mortality measures and decomposition of fertility and population growth measures. These chapters are preceded by a general introduction and theoretical background related to the general topic, and the last chapter involves the synthesis of the chapters and conclusion.

I.2. THEORETICAL BACKGROUND

I.2.1. Demographic Transition Theory

The theory of demographic transition has been at the center of population research since it was developed in the early 1900s. The classic formulation of the theory is usually considered to be presented by Frank W. Notestein in 1945; however, Warren S. Thompson had already proposed demographic transition theory in 1929; therefore, it is considered “born twice” (Szreter, 1993). Thompson or Notestein did not use the term “transition” for their generalizations on the change of mortality and fertility levels of populations. This term was first used by French demographer Adolphe Landry in his book “The Demographic Revolution” in 1934 (Kirk, 1996). Thus, in the early 1900s, there were three independent formulations of demographic transition, and the ones proposed by Thompson (1929) and Landry (1934) are regarded as the “forerunners of classic transition theory.”

Thompson (1929) defined three groups of countries based on their demographic characteristics. The countries categorized as Group A have diminishing population growth rates because of rapidly falling birth rates and low death rates. This group includes Western European countries and overseas countries established by immigrants from Europe. Group B counties include Eastern and Southern European countries; they have increased rates of population growth with slowly decreasing fertility levels and rapidly decreasing mortality levels. Thompson stated that the demographic characteristics of Group B countries were similar to the characteristics of Group A countries 35 to 40 years earlier from that time. The countries in the last group (Group C) have fluctuating population growth rates since birth and death rates were not under control, and this group consisted of about 70 to 75 percent of the world population (Kirk, 1996).

Landry (1934) defined three stages of demographic change as “primitive regime,” intermediate regime,” and “contemporary regime.” The stages are nearly equivalent to Thompson’s proposition and also a further definition of classic transition theory. Landry’s explanation includes the perspective that transition would follow a similar path in the global sphere. Also, the countries entering the transition phase later than the initial ones would be exposed to faster declines in fertility and mortality rates. Landry did not predict a final demographic equilibrium contrary to other authors, but a population decline because of sustained low fertility regime (Kirk, 1996).

The Office of Population Research scholars developed the "classical" theory of demographic transition at Princeton University, headed by Frank W. Notestein. Demographic transition theory explains the change in the demographic characteristics of the population in line with the modernization process. Increases in agricultural productivity, advances in living standards, improvements in health conditions and medicine in consequence of the industrial revolution caused a reduction in mortality. However, fertility was "less responsive" to the modernization process because the mechanisms behind fertility decline were not as straightforward as mortality decline. According to transition theory, fertility decline was also triggered by the effect of the industrialization process. Family size norms in urban industrial society had shifted as a result of changes in production, consumption, employment, and education. Unlike pre-modern rural families, the individual advancement of the child became a priority for the urban family. As a result, family limitation became prominent because of the increasing cost of childrearing and decreasing contribution of children to family income (Hodgson, 1983; Kirk, 1996).

Demographic transition theory focuses on the socioeconomic determinants through the modernization process and reaches a generalization that transition will occur in every country undergoing a modernization process. The phases of demographic transition are defined by accepting the onset and speed of fertility decline as the main criteria to classify societies in a three-stage framework (Hodgson, 1983). The initial state reflects the “high growth potential” with high death and birth rates before the onset of the modernization process. The second stage, “stage of transitional growth,” is characterized by declining mortality pursued by a delayed decrease in fertility. Societies are experiencing rapid population growth at this stage. Low population growth rates are considered the "stage of incipient decline" in the third stage, where fertility and mortality rates are low.

The classic formulation of demographic transition theory presents a generalization of the whole process as a transition from "pre-industrial to post-industrial demographic equilibrium" where modernization and industrialization are the triggering forces that inevitably bring demographic transition (Szreter, 1993). Therefore, theory of demographic transition is regarded as a version of the modernization theory, which assumes that societies underwent a uniform evolution from pre-industrial, rural-agricultural societies to post-industrial, urban, and modern types. The idea of modernization is generally considered equivalent to the westernization process since Western countries' experience is generalized to other countries. Demographic transition theory follows the same perspective, where non-industrialized countries are predicted to move along the path that western countries passed before.

One of the major criticisms of the classic transition theory is the “Eurocentric” explanation of demographic processes based upon the experience of western countries; it is suggested that transition theory may not reflect the experiences of non-industrialized countries. Transition theory is also criticized because of the ambiguity of timing and the course of the transition process.

The initial form of the transition theory is also criticized as inaccurately representing the historical demographic patterns in Europe since divergence in pre-modern fertility levels was not regarded in the formulation of the theory. Moreover, the assumption that mortality decline always occurs before fertility decline is another criticism regarding the theory; it was not always the case even in historical Europe (Kirk, 1996). Another criticism is related to the exclusion of diffusion in the transition process; the theory was mainly focused on the socioeconomic effects of the modernization process. However, evidence suggests that fertility levels may differ substantially in societies with similar socioeconomic status but diverse cultural and linguistic characteristics (Coale, 1984).

When the experiences of the countries undergoing demographic transition are considered, the pathways of the transition process differ between and within countries. Diverse effects of causal factors producing the transition process determine the onset and pace of demographic transition; therefore, every society follows a unique path of demographic transition. A transition may last longer or shorter, or it may start earlier and later. However, these differences do not prevent the demographic transition process from taking place when a country is experiencing a modernization process.

I.2.2. Global Demographic Transition

The demographic transition started in western countries in the eighteenth century and expanded globally over the last two centuries. According to Biraben (1980), the world population was around 700 million in 1700, and it almost reached 1 billion in a hundred years. The progress after 1800 is much more striking; there were six times more people in the world in 2000, and the world population is around 7,7 billion by 2019. The global population is expected to grow by around 1 billion people in 2030, reaching 10 billion by 2050 (United Nations, 2017).

The growth of the world population has been a consequence of demographic transition. The death rate fell sharply until the 1960s and gradually decreased since then. Length of life was around 25 years at the beginning of the transition process, more than doubled by 1970 and almost tripled by 2020. The decline in the birth rate started earlier but gained momentum after the 1970s. Prior to the transition, the total fertility rate was about 6 births per woman; it approached 2 births per woman by the beginning of the twenty-first century. Table I.2.2.1 shows the estimates of the global population trends provided from Dyson (2010) and United Nations (2019).

Table I.2.2.1. Global Population Trends, 1800 – 2020

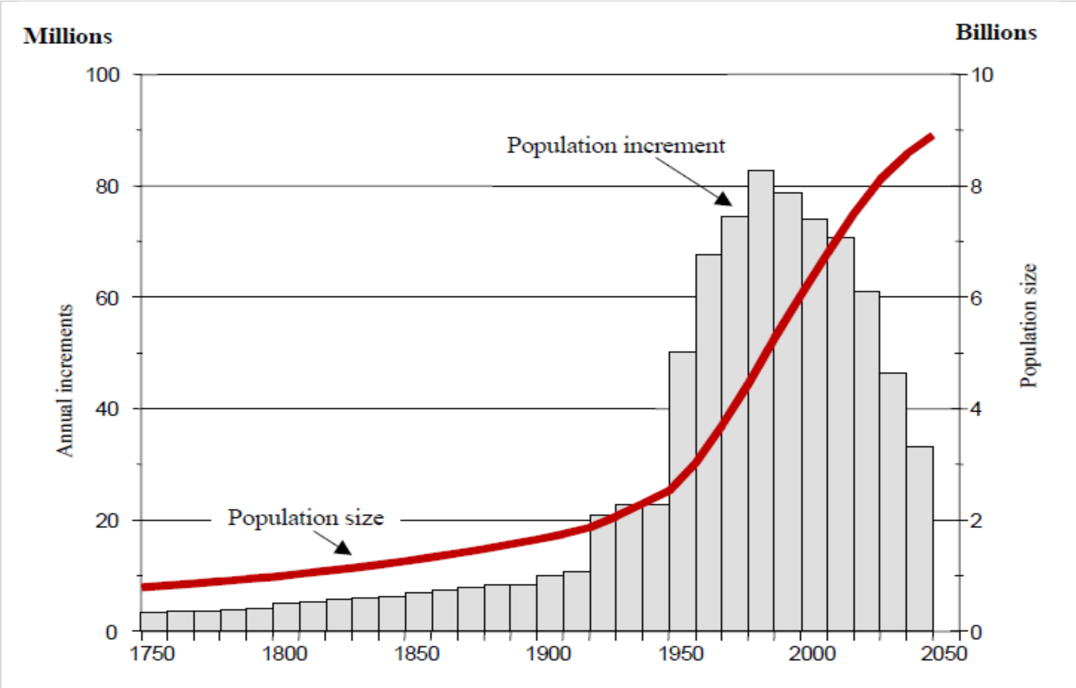
Years	Population (million)	Growth Rate (% per year)	Death Rate (per 1000)	Birth Rate (per 1000)	Life Expectancy	Total Fertility Rate	Median Age
1800	954	-	-	-	-	-	24,7
1900	1.650	0,6	40,3	46,0	25,0	5,7	24,3
1950	2.529	0,9	34,1	43,3	30,0	5,5	24,0
1960	3.023	1,8	18,4	36,3	48,1	4,9	23,2
1970	3.686	2,0	14,4	34,2	54,3	4,8	22,1
1980	4.438	1,9	11,1	29,6	59,2	4,1	23,0
1990	5.290	1,8	10,0	27,6	62,5	3,5	24,4
2000	6.115	1,4	9,2	23,6	64,6	3,0	26,7
2010	6.910	1,2	8,5	20,7	67,0	2,6	29,1
2020	7.794	1.1	7,5	18,5	72,3	2,5	30,9

Source: Dyson (2010), UN (2019)

Figure I.2.2.1 presents the historical trends in the global population. The substantial increase in the world population took place starting from the 1990s, and the population growth rate peaked after the 1960s. By around 1980, the population growth rate followed a declining trend, resulting from the interplay between fertility and mortality rates. Rapid population growth was triggered by sharply decreasing death rates, and when birth rates decreased faster than death rates, the population growth rate started to follow a decreasing pattern.

Another factor influencing population growth is age structure. As shown in Table I.2.2.1, the world population's median age showed a slightly decreasing pattern until the 1970s and started to increase after that time. Declining birth rates reduced the number of women entering reproductive ages and contributing to total fertility. The median age was 30 years in 2020, and declining fertility rates and increasing length of life will contribute to population aging in the subsequent phases of demographic transition.

Figure I.2.2.1. Global Population Growth, 1750-2050



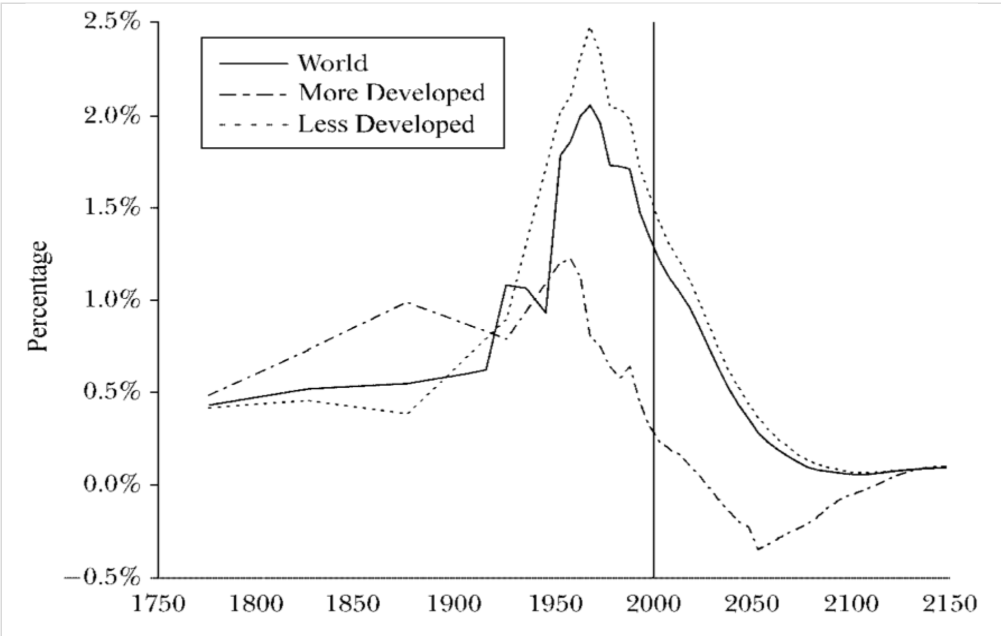
Source: UN (1999)

The demographic transition did not occur at the same tempo in all parts of the world. A significant distinction can be made between “more developed” and “less developed” countries of the world. Figure I.2.2.2 and Figure I.2.2.3 present the rates of population growth, crude birth and death rates for the world's developed and developing regions.

As shown in Figure I.2.2.2, the population growth rate showed an increasing pattern during the nineteenth century in more developed countries; it fluctuated until the mid-1990s and sharply decreased after 1960. On the other side, the population growth rate started to increase by the late 1800s in less developed regions. In the early 1990s, the pace of the increase gained momentum and outreached the rate of 2 percent. The population growth rate started to decrease in the 1970s, and decreasing pattern prevailed. The growth rate of less developed regions determined the pace of population growth at the global level especially starting from the early-1900’s, since the population size of these regions was considerably high and becoming higher over time

(Dyson, 2010). Global population growth will be close to zero by 2100, according to the medium variant projections (United Nations, 2019).

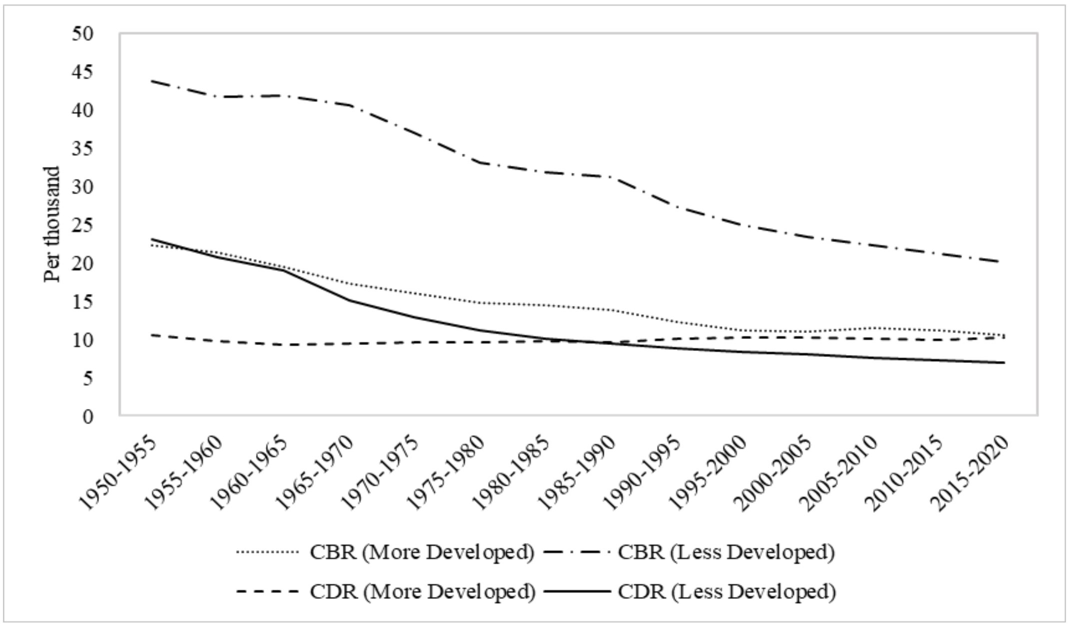
Figure I.2.2.2. Rate of Population Growth for More Developed and Less Developed Regions, 1750-2150



Source: Lee (2003)

Figure I.2.2.3 represents the trends in the death and birth rates from 1950 to 2020. In the developed world, the death rate has already been stabilized by 1950; therefore, it followed a smooth pattern in the last 60-70 years. However, in the same period, the birth rate persistently decreased, and the level of birth rate and death rate almost became identical. Although the death rate and birth rate followed a decreasing pattern in the less developed regions, population growth continued because the birth rate markedly outreached the death rate.

Figure I.2.2.3. Crude Death and Birth Rates for More Developed and Less Developed Regions, 1950 -2020

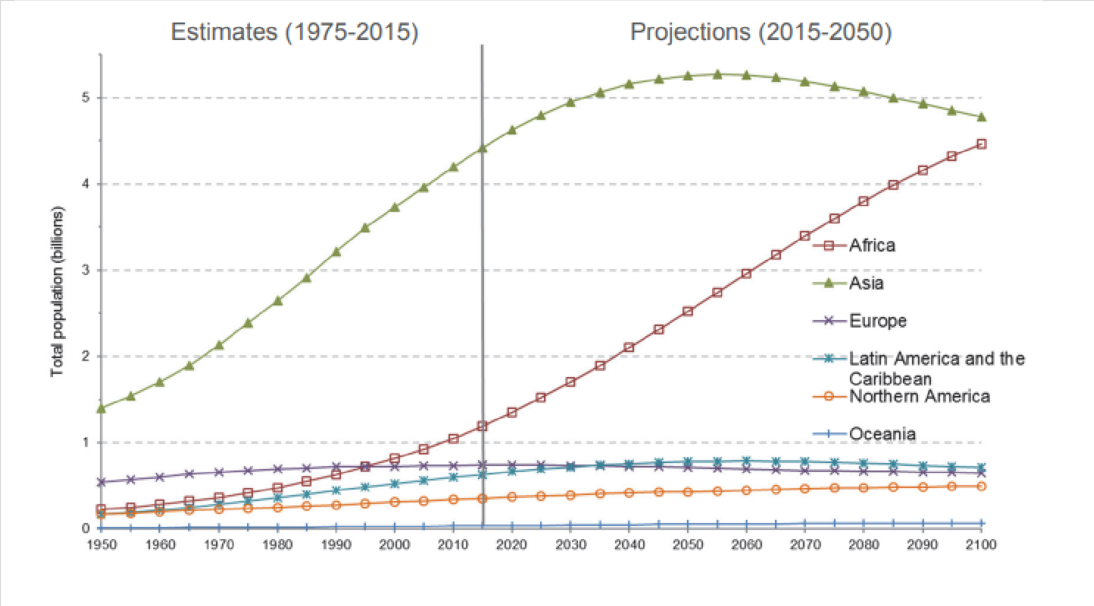


Source: UN (2019)

There has been a significant demographic variation among developed and less developed regions. In developed countries, the demographic transition started in the eighteenth century, and they almost completed their transition until now. The demographic transition started in the twentieth century for most of the developing countries, and the pace of the transition shows significant variation among these countries. Further consideration of demographic variation at the regional level provides a closer look at the contemporary transition processes.

Figure I.2.2.4 represents the estimates and projections of world population by main regions. Major geographical regions are classified as "Asia, Africa, Europe, Latin America and the Caribbean, Northern America, and Oceania." According to the recent figures, the most populous region is Asia, holding the better part of the world population itself. Africa is the second most densely populated continent, after Europe, Latin America, and the Caribbean. North America and Oceania are the least populous regions in the world by 2017.

Figure I.2.2.4. Trends in the World Population by Regions, 1950-2050

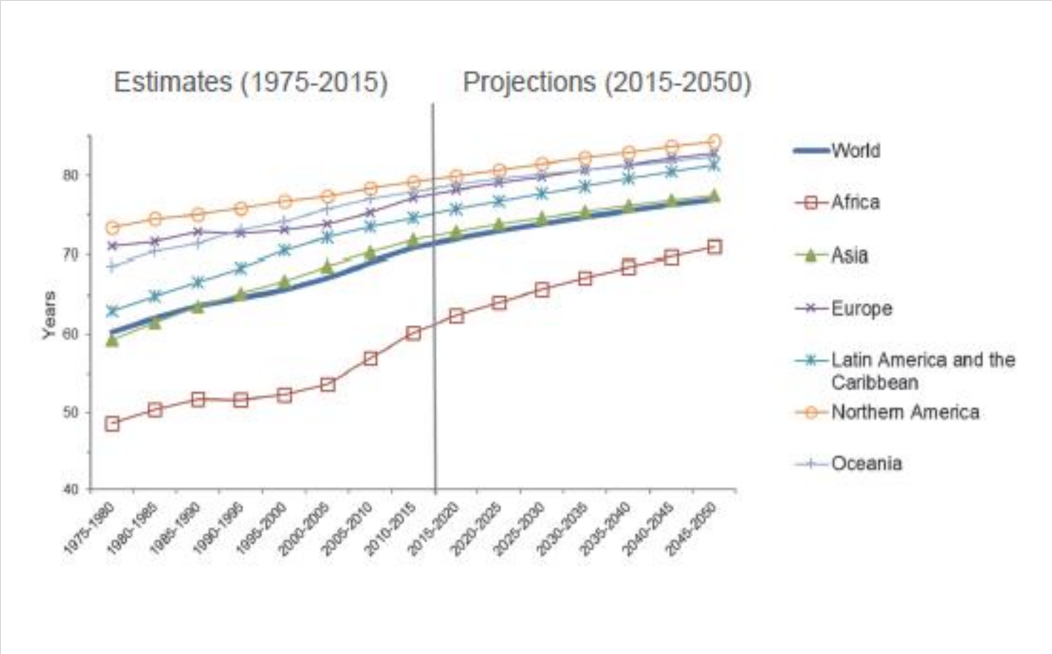


Source: UN (2017a)

By 2050, the global population is expected to reach 10 billion. The major contributor to the population growth is expected to be the African region. Asia will be the second most significant contributor, followed by Latin America and the Caribbean, Northern America, and Oceania. In 2050, Europe is expected to have less population than it has in 2017 (United Nations, 2017a).

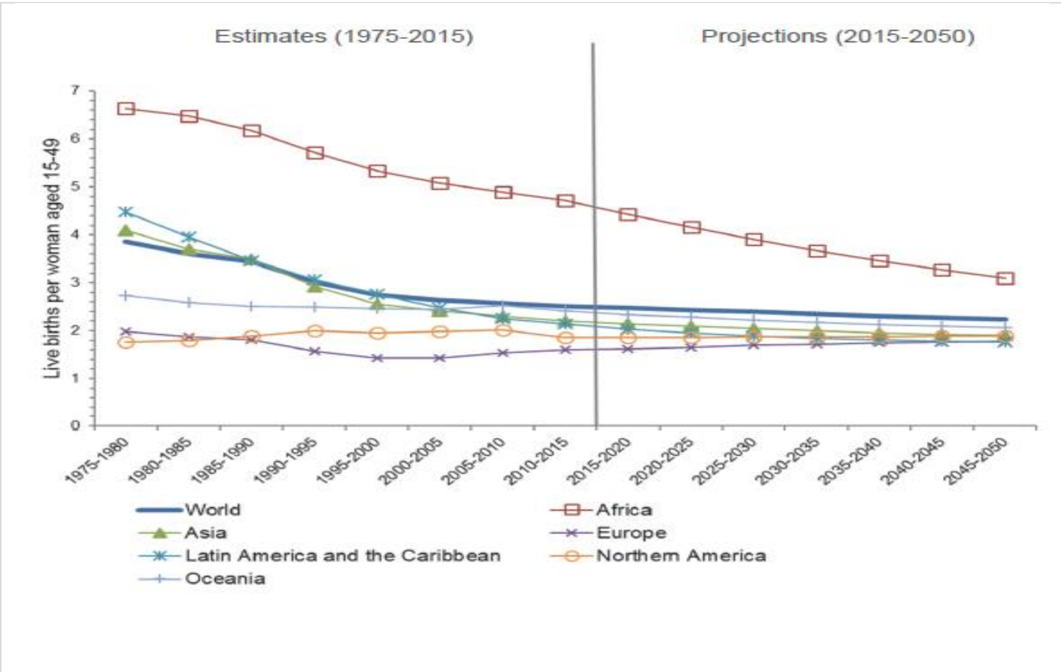
Figure I.2.2.5 shows the estimates and projections of life expectancy by regions. In the last decades, life expectancy followed an increasing pattern in all regions; however, regional divergence persisted in life expectancy levels. In the period 2010 – 2015, life expectancy is estimated at around 60 years in Africa, where it exceeds 80 years in some developed countries. The countries in North America, Europe, and Oceania experienced the highest length of life among other regions. According to the projections, life expectancy levels are predicted to improve in all regions; however, the mortality gap between regions is expected to persist by 2050.

Figure I.2.2.5. Life Expectancy at Birth by World Regions, 1975-2050



Source: UN (2017a)

Figure I.2.2.6. Total Fertility Rate by World Regions, 1975-2050



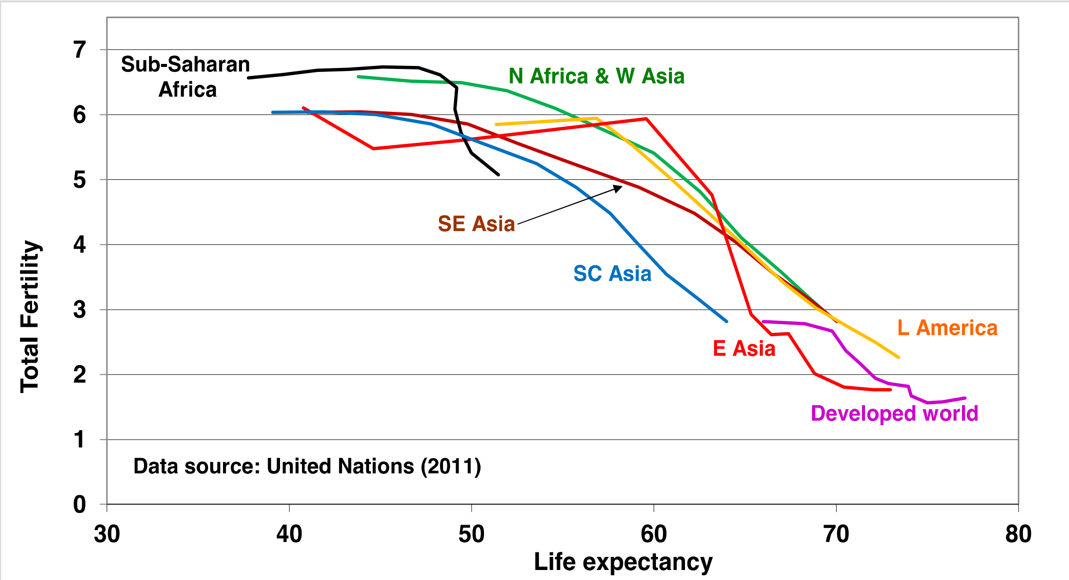
Source: UN (2017a)

Total fertility rates also vary across regions, as presented in Figure I.2.2.6. In the last 40 years, Africa has experienced the highest total fertility rate. Africa is followed by Latin America, the Caribbean, and Asia, which has achieved the most significant fertility decline over the last decades. North American and European countries experienced very low fertility levels starting from the 1990s, and they are predicted to maintain low fertility in the following decades. The fertility gap between regions, specifically between Africa and other regions, is predicted to close significantly in the following 30-40 years.

According to the demographic transition theory, populations are expected to move from pre-transitional to post-transitional demographic equilibrium. Although there is limited information on demographic characteristics of pre-transitional populations, demographers examined the existence of a demographic equilibrium analyzing historical data of Western European and East Asian countries (Lee, 1987; Chu and Lee, 1994; Wilson, 2001). The evidence suggests that, although there were short-term fluctuations, the population growth rate was almost zero in the long run in pre-transitional settings. This demographic homeostasis in the pre-transitional era is generally explained by the effect of Malthusian positive checks (famine, war, pestilence) and preventive checks (postponement of marriage or sexual abstinence). This equilibrium had changed when death rates started to decline, and the demographic transition was initiated by the end of the 18th century.

The current state of global demographic transition is far from demographic equilibrium; however, it can be claimed that regions and countries with diverse demographic characteristics are experiencing diverse stages of demographic transition. The status of the global demographic situation was examined by Reher (2004), and the transition process was considered a single, global process. Four groups of countries were categorized according to their demographic profiles, and their transition processes were compared in terms of similarities and disparities. Despite the differences between timing and pace of mortality and fertility declines, mortality decline preceded fertility decline, and trends in mortality and fertility declines were closely related to each other in all four groups of countries. Wilson (2011; 2103) examined the interplay between fertility and mortality trends and proposed a “main sequence” of demographic convergence since 1950.

Figure I.2.2.7. Total Fertility and Life Expectancy by Regions



Source: Wilson (2013)

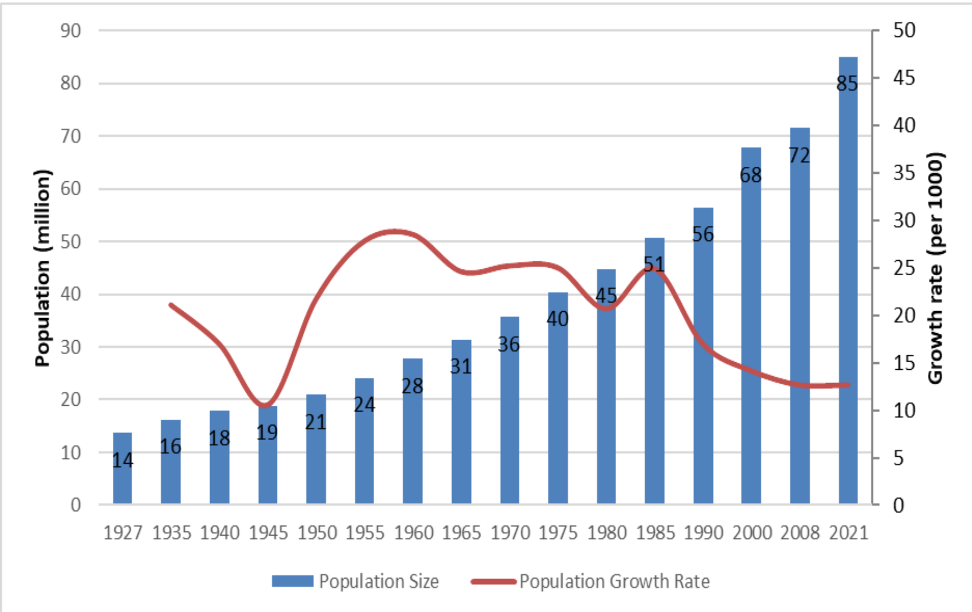
Wilson (2013) combined the total fertility rate and life expectancy by removing the time dimension as shown in Figure I.2.2.7. He argues that fertility transition is closely linked to mortality improvement, and when the countries enter into this sequence, they rapidly move along to it. The lower right of the graph, representing the developed countries, reflects the post-transitional demographic situation, where each region and country will eventually arrive. The upper left is considered the pre-transitional area, indicating Sub-Saharan Africa's delayed transition. On the other hand, Latin America, East Asia, South-East Asia, South-Central Asia, North Africa and West Asia are in different phases of demographic transition.

I.3. DEMOGRAPHIC TRANSITION IN TURKEY

I.3.1. General Population Trends

Turkey has experienced the demographic transition process starting from the 1900s. The population of about 14 million in 1927 is now nearly 85 million. The total fertility rate, which peaked at 6-7 births per woman in the 1950s and 1960s, is now around 1,8 (Koç et al., 2010; TurkStat, 2021e). Expectancy of the length of life was approximately 30-35 years in the early 1900s, but it has since increased to around 80 years.

Figure I.3.1.1. Trends in Population Size and Growth Rates, 1927-2021



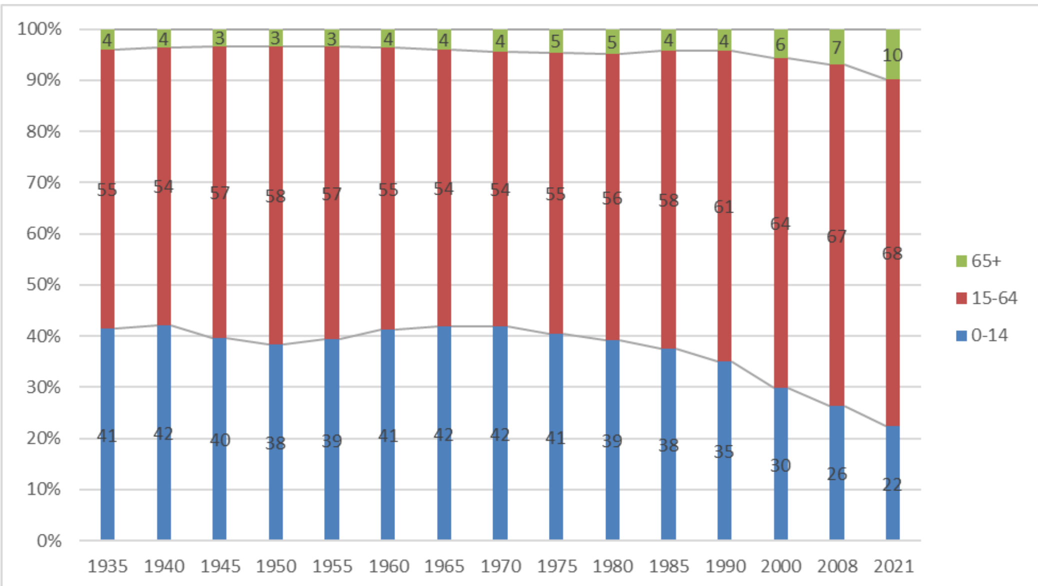
TurkStat (2015a, 2018a, 2022a)

The population of Turkey was 13,6 million in 1927, according to the first population census. Soon after the modern Republic was established in 1923, the country faced the consequences of the recent wars and economic challenges. Although pronatalist policies were preferred in this period, the population growth rate did not increase until 2nd world war ended. By the 1950s, the rate of growth had sharply increased and had reached a peak by the end of the same decade (see Figure I.3.1.1).

Population size also increased substantially over the years; it exceeded 30 million by the mid-1960s, and in every ten years, it increased more than 10 million. The growth rate fluctuated between 1960 and 1985 but never surpassed that of the 1950s. By 1985, the population growth rate started to follow a decreasing pattern as a result of anti-natalist population policies that will be discussed later in this chapter.

A significant outcome of the demographic transition process is the shift from a young age structure to the older one. Once the decline in fertility level begins, the relative percentage of working-age groups increases by the contribution of large age cohorts that emerged in the previous stage of transition. When the reproductive period of high-fertility cohorts ends, more people enter into the category of the elderly population. Figure I.3.1.2 depicts the shift in the Turkish population's age distribution between 1935 and 2021. In Turkey, the share of the young population gradually decreased in the transition process. This age group's share was around 40 percent until the 1980s and decreased to nearly 22 percent by 2021. As expected, the percentage of the working-age and the elderly population has risen in the last decades; however, a further increase is predicted in the percentage of the elderly among the total population, which will inevitably lead to population aging.

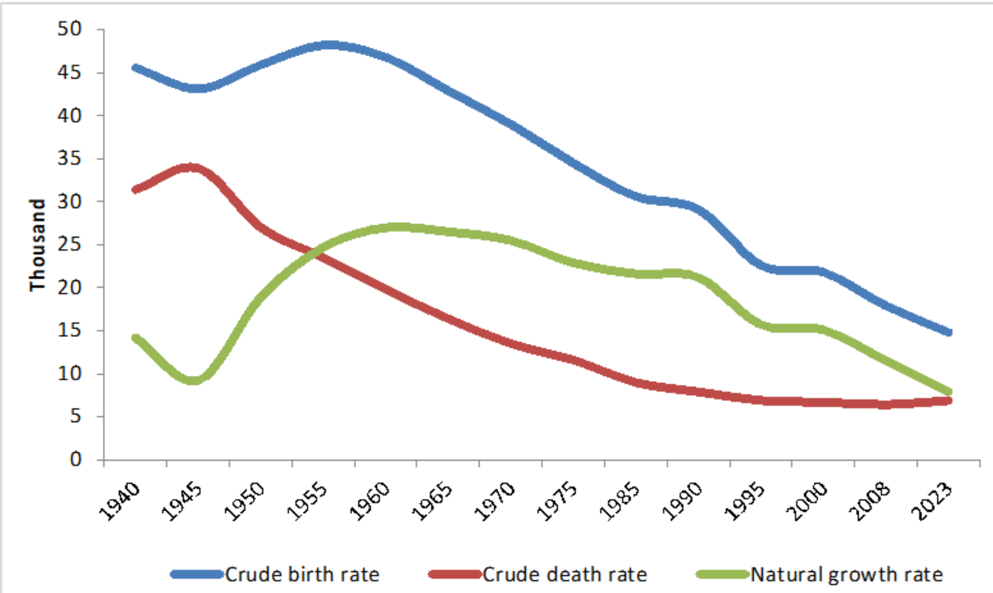
Figure I.3.1.2. Population Distribution by Broad Age Groups, Turkey, 1935-2021



Source: TurkStat (2022b)

According to Figure I.3.1.3, the CDR in the 1940s was about 30 deaths per thousand, while it was 6 deaths per thousand in the 2000s. Except for the period of 2nd world war, a significant portion of the decline emerged during the earlier stages of transition. Because of the disparity between death and birth rates, the natural growth rate was highest in the 1960s. In the 1940s, the crude birth rate was about 45 births per thousand; it increased until the late 1950s and then gradually decreased; in the 2000s, the CBR was about 20 births per thousand. After the 2050s, CDR and CBR are expected to converge, and the natural population growth rate will approach zero (Koç et al., 2010).

Figure I.3.1.3. Change in the Birth, Death and Growth Rates, Turkey, 1940-2023



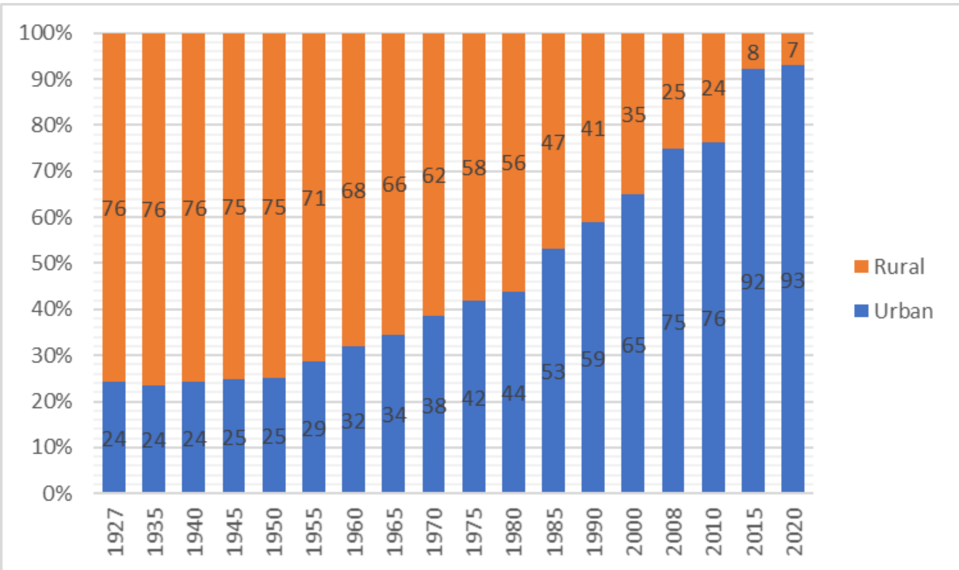
Source: Koç et.al. (2010)

I.3.2. Trends in Socioeconomic Characteristics

This section examines the trends in Turkey's socioeconomic characteristics. Trends in urban and rural populations, changes in literacy rates, educational level, and labor force participation rates, and also changes in income inequality, are investigated.

Turkey was essentially a rural agricultural country when the modern republic was founded, and it remained thus until the 1950s. Due to the pressures of population increase, decreasing job opportunities in rural areas, and the emergence of new opportunities in cities, an intense internal migration movement has started since the 1950s (Peker, 2016). As shown in Figure I.3.2.1, the share of urban population, which had never exceeded 25% before 1950, surpassed 50% in the 1980s. The economic structure has evolved since the 1980s, leading to a rise in the share of the service sector in urban areas, in addition to the industrial sector. As a result, the need for labor has increased, and labor migration from rural to urban residences has accelerated (Koç et al., 2010). The percentage of urban population, which had surpassed 70 percent in the 2000s, exceeded 90 percent in 2015. The main reason for the substantial shift in the share of urban and rural populations was the administrative division changes implemented in 2012 rather than changes in the demographic rates.

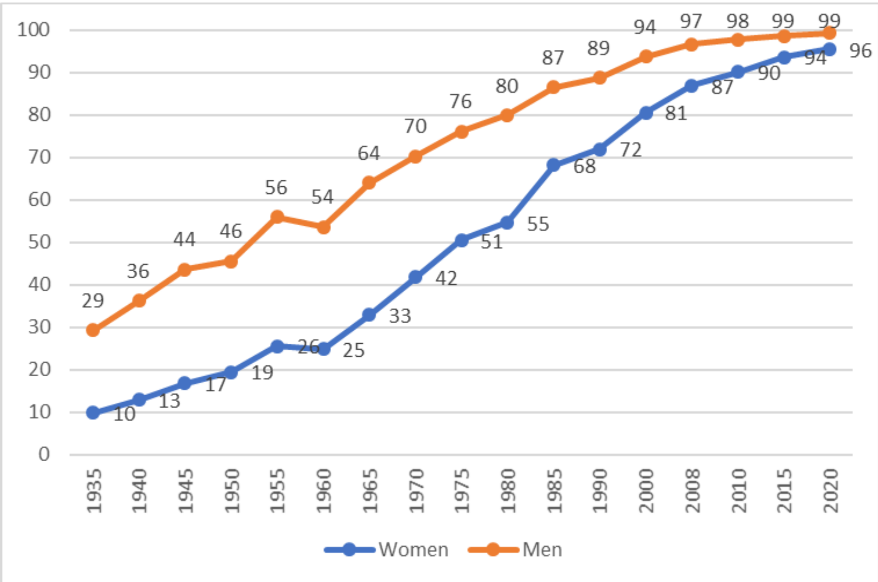
Figure I.3.2.1. Trends in Rural and Urban Populations, 1927-2020



Source: TurkStat (2022c)

Educational reforms were given considerable attention during the early 20th century. The Law of the Unification of Education was adopted in 1924, and all schools were unified under the Ministry of National Education (Güneş, 2013). In 1928, language reform was carried out, and an extensive literacy campaign has been launched immediately (Koç et al., 2010). In 1935, the Turkish population's literacy rate was only 19%, with females accounting for 10% and males accounting for 29%, as presented in Figure I.3.2.2. The literacy rate gradually increased for both women and men in the subsequent decades, but sex differences prevailed until the recent past. In 2000, the proportion of literate men was 94 percent, and the proportion of literate women was 81 percent. The gap between female and male literacy rates narrowed in the 2010s. According to latest figures, men's literacy rate is 99 percent, while it is 96 percent for women (TurkStat, 2021a).

Figure I.3.2.2. Changes in Literacy Rate (percent), 1935-2020

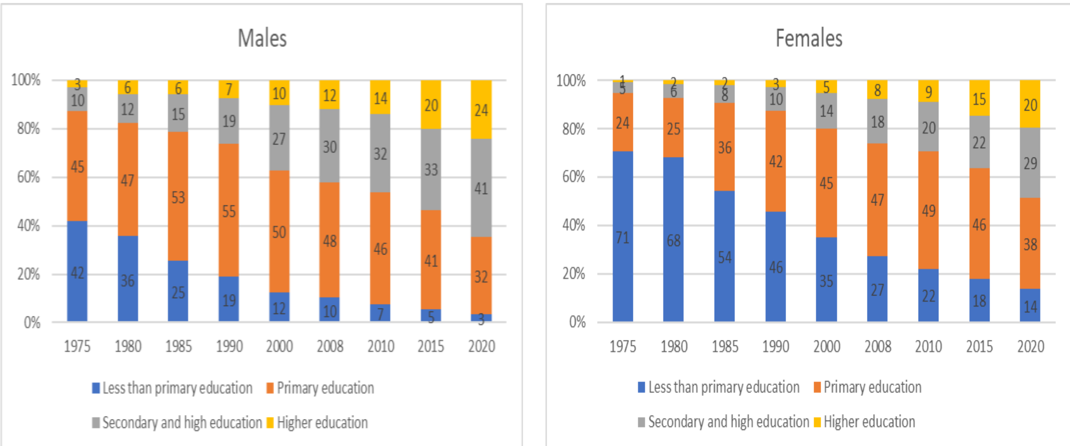


Source: TurkStat (2015b; 2021a)

Besides the literacy rates, there have been significant developments in educational attainment in the last decades. As displayed in Figure I.3.2.3, in 1975, only 29% of females and 58% of males completed primary or higher education, while the share of those who completed secondary or high school was negligible. In 2000, half of the male population completed primary school, 37% of them had secondary and higher education, while 45% of women had primary school education, and 19% graduated from secondary and higher education (TurkStat, 2015c).

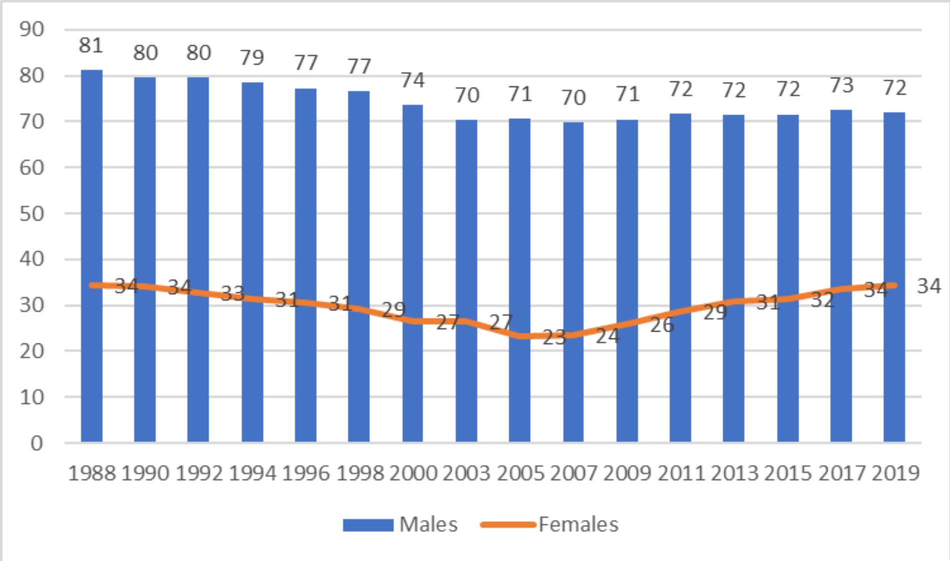
The most significant improvements in the level of education in Turkey took place after 2000. The underlying reason for this improvement was the 1997 expansion of compulsory education from five to eight years. While the share of women with a higher education increased from 9% in 2010 to 20% in 2020, the share of men with a higher education increased from 14% to 24% (TurkStat, 2021d).

Figure I.3.2.3. Distribution of the Population by Educational Level, 1975-2020



Source: TurkStat (2015c; 2021d)

Figure I.3.2.4. Labor Force Participation Rates, 1988-2020

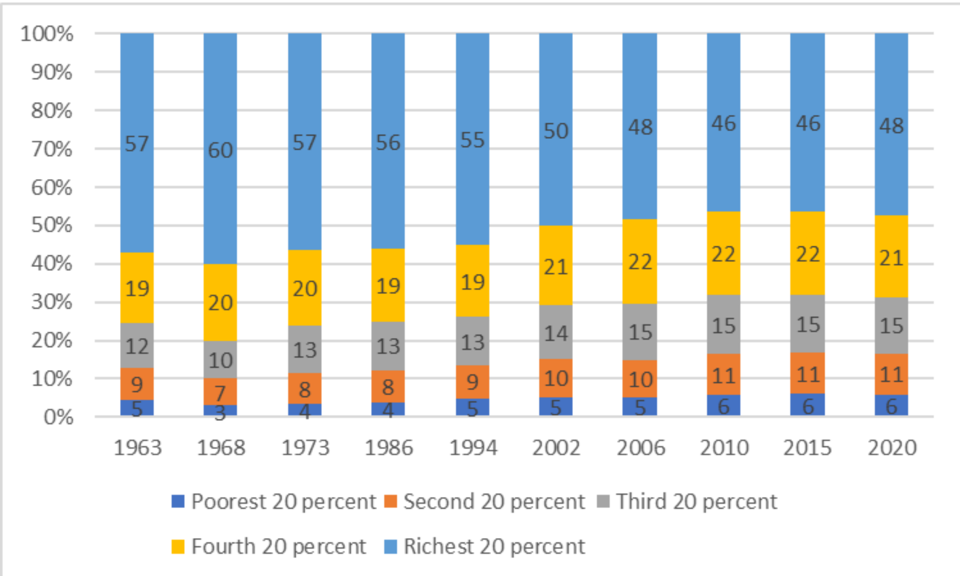


Source: TurkStat (2022d)

As seen in Figure I.3.2.4, the labor force participation rates have shown a downward trend since the 1980s. Throughout this time period, there had been a significant disparity between men and women's labor-force participation rates. In the early 1990s, male labor force participation was around 80 percent, while it was around 35 percent for women. While men's labor-force participation rate was 70 percent in the mid-2000s, women's participation rate was less than 25 percent. Women's labor force participation fell even further during this period because women who relocated from rural to urban areas and were previously included in the rural labor force were excluded from the labor force in the cities. The increased length of time women spent in education also influenced this pattern (Koç et al., 2010). Women's participation in the workforce increased after the mid-2000s, reaching 34 percent in 2019. The primary reason for this rise was an increasing number of highly educated women participating in the workforce in urban centers (Dayıoğlu and Kırdar, 2010). Despite this progress, female labor-force involvement in Turkey remains extremely low when compared to developed countries. Female labor force participation in OECD countries is roughly 65 percent, which is more than twice as high as in Turkey (OECD, 2022).

Per capita income has increased steadily over time in Turkey. In 1975, GDP per capita was roughly 1500 dollars; by the 1990s, it had risen to nearly 3000 dollars. GDP per capita, which was increasing dramatically since the mid-2000s, remained above $10,000 after 2010 (SBB, 2022). However, the increase in per capita income is not evenly distributed to all segments of the society. Figure I.3.2.5 depicts the trends in household income distribution between 1963 and 2020. The share of total income held by the richest 20 percent of the population approached 60 percent in the 1960s, then fell slightly and remained close to 50 percent after the 2000s. In the 1970s, the poorest 20 percent of the population had a percentage of total income of 4 percent, and by the 2000s, it had risen to about 6 percent.

Figure I.3.2.5. Distribution of Household Income by Quintiles, 1963-2020



Source: Yükseler (2003); TurkStat (2021c)

I.3.3. Stages of Demographic Transition

Turkey's demographic transition process is usually examined in three stages (SIS, 1995; Koç et al., 2010, Eryurt et al., 2013) by considering the population policies implemented. The first stage is considered when pronatalist policies prevailed and lasted about 35-40 years until a shift occurred in favor of anti-natalist population policies. This period starts with the establishment of the Republic in 1923 and ends with the beginning of the planned period in the early 1960s. The second stage is characterized by the shift to anti-natalist policies and lasts until anti-natalist population policies were thoroughly institutionalized at the beginning of the 1980s. In the last stage, anti-natalist population policies were established and implemented; and this stage continued until the early 2000s.

The first stage of transition

When the modern Republic of Turkey was established, the country faced the consequences of the 1st world war and the independence war. The massive loss of young men in these wars caused significant alterations in the age and sex structure of the society. Population policies were shaped to achieve a young, healthy population and build a new nation-state by including this population in the workforce. In this period, population increase was considered a prerequisite for economic development in most countries (Koç et al., 2010).

The first legislative regulation for promoting high fertility was The Law of Public Health, adopted in 1930. Prohibitive measures on the usage of contraceptives and miscarriage drugs were implemented under the scope of this Law (Koç et al., 2010). The same law was the main legal framework for the institutionalization of health services and reducing early age mortality rates. In 1926, the Turkish Criminal Code banned the practice of induced abortion, and the Turkish Civil Code lowered the minimum marriage age to 17 and 15 for males and females, respectively (Koç et al., 2010).

During the first stage of the transition, there has been a steady decline in death rates as a result of post-war improvements and the implementation of public health interventions. On the other side, fertility rates increased significantly until the late-1950s, when the permanent decline began (SIS, 1995).

By the 1920s, approximately 80% of Turkey's population was residing in rural settlements (SIS, 1995). The share of agricultural production was more than 50 percent (Koç et al., 2010). The economic situation in the earlier years of the Republic was characterized by reconstruction efforts under an open economy (Boratav, 2015). In these years, agricultural production continued to grow, and external trade was an essential contributor to the national income. By the 1930s, policies favoring import substitution became prominent, and industrialization efforts gained momentum (Koç et al., 2010).

Until the 1950s, the urban population's share did not exceed 20 percent, and population growth mainly originated from the natural increase of population. Expansion of agricultural production in rural areas immobilized the rural population; even some rural areas attracted the population (SIS, 1995). In the urban areas, new employment opportunities arose by the effect of the industrialization process, but urban population growth was sufficient for satisfying the need. Until the end of the first stage of the transition, internal migration was stagnating, and rural-urban populations were in a steady balance, but it did not take much time to change completely (SIS, 1995).

The second stage of transition

Rapid population growth and a high fertility level triggered the shift from pronatalist population policies to anti-natalist ones. The annual growth rate peaked at 2.8 percent during the 1950s. In the same years, fertility decline started and never reversed again (SIS, 1995).

Urbanization was the other driving force initiating the second stage of the transition. Increasing demand for labor force in the urban-industrial sectors compelled young adults to relocate from rural to urban settlements. Technological expansion in agricultural production, improvements in social services and living conditions in urban areas, and advancements in transportation and communication were also effective in the urbanization process (SIS, 1995).

By the end of the 1950s, pronatalist population policies started to be questioned because of unplanned urbanization, economic stagnation, and unemployment triggered by rapid population growth. In 1960, the State Planning Organization was established, and the first development plan was created to address the country's social, economic, and demographic issues. Between 1963 and 1967, the First Five-Year Development Plan was implemented, and rapid population growth was regarded as an obstacle to economic development (Koç et al., 2010).

In 1965, “Population Planning Law” was enacted, and anti-natalist population policies were officially documented for the first time. This law repealed prohibitive measures on contraceptives, and abortion was allowed in life-threatening cases. On the other hand, in 1961, the "Law on the Socialization of Health Services" was published, with the goal of strengthening the country's health care system as a whole. Widespread primary care systems, mother and child health services, and programs against infectious diseases were implemented to decrease mortality levels. Furthermore, a new migration movement of labor emigration arose in the early-1960’s, which was one of the objectives of the first development plan for decreasing unemployment levels and ensuring the remittance inflow of workers (SPO, 1963).

In this stage, family norms and family types also started to change by the effect of socioeconomic developments. Demand for children was reduced in the urban areas, and the traditional extended families were gradually replaced by the nuclear family. Also, distributed family types like single or single-parent families have emerged and started to increase (Koç et al., 2010).

The third stage of transition

The demographic profile of the third stage is characterized by an irreversible decrease in population growth rate; it decreased to 2,2 percent despite incomers due to immigration between 1985 and 1990 (SIS, 1995). A sustained downward trend of mortality and fertility rates and changing form of migration flows were observed in this period. Urban-to-urban migration became prevalent within internal migration movements, and the geographical target of emigration changed towards Arab countries and former Soviet countries (İçduygu and Sirkeci, 1998).

The socioeconomic structure of the country has substantially changed starting from the 1980s. The attempts to adopt a liberal economic program became possible after the 1980 military coup (Boratav, 2015). Import substitution industrialization was the primary economic paradigm in Turkey until this period; however, it has been replaced by a new paradigm aiming to integrate the Turkish economy with the global market. The new paradigm affected education and health systems; policies on privatization of education and health services became effective starting from this period.

The concept of family planning entered into the 1982 Constitution, and family planning was acknowledged as the State's duty. Soon after the Constitution, the "Population Planning Law" was revised in 1983. The law was more comprehensive than the 1965 version, and it legalized induced abortion and sterilization.

Current state of transition

The end of the transition process is associated with achieving replacement level fertility and further ending population growth. TFR in Turkey approached the replacement threshold in the early 2000s and then stagnated at this level. According to the findings of the TDHS 2018, the stagnation in the TFR level continued and was measured at the level of 2,3. The results of the same survey revealed that there was no significant change in the fertility divergence between urban and rural areas. Regional differentiation persisted, with the East region having the highest TFR of 3,2 children and the North region having the lowest TFR of 1,6. Furthermore, the ages at first marriage and first birth increased by 0.4 year since the previous survey, reaching 21,4 and 23,3 years, respectively (HUIPS, 2019).

Birth statistics based on registration data, on the other hand, have been published in Turkey since 2001. Between 2001 and 2008, they were published according to "place of birth," and since 2009, they have been published according to "mother's place of residence" (TurkStat, 2021e). According to the latest figures based on registration system, the total fertility rate, which was at the replacement level in 2010, did not fall below two children per woman until 2019. However, TFR decreased to 1,8 births per woman by 2020, according to birth registration data (TurkStat, 2021e). In addition, after 2050, population growth is expected to stagnate (Koç et al., 2010).

In Turkey, the first life tables based on administrative records were constructed in 2013. Life expectancy at birth was 78 years in the 2013-2015 period, and it increased to 78,6 years in the 2017-2019 period, according to the life tables. It increased from 75,3 years for males in 2013-2015 period to 75,9 years in 2017-2019 period, and from 80,7 years to 81,3 years for females (TurkStat, 2020a). On the other hand, infant mortality rate decreased from 13,9 per thousand in 2009 to 9,1 per thousand in 2019 in Turkey (TurkStat, 2020b).

Below-replacement fertility levels raise concerns about the future of the population structure. The problem of population aging emerges as a result of extremely low fertility rates, as seen in post-transitional countries. The change in the population's age structure causes significant challenges in many areas like social security, education, health, or employment. Countries with low-fertility levels take measures to increase fertility levels to overcome these challenges.

In 2008, the Prime Minister at the time expressed the new pronatalist discourse for the first time, stating "families should have at least three children." The first step for realizing this discourse as a policy was taken in 2013 with the Tenth Development Plan. With the "Action Plan to Preserve the Family and the Dynamic Structure of the Population" published in 2015, actions to increase the fertility level were determined. In this context, some legal regulations regarding maternity benefit, paternity leave and part-time working have been enacted to encourage increasing the number of children. However, based on recent decline in TFR, it seems safe to say that these arrangements regarding the one-time child allowance and the increase in paternity leave from three to five days are far from being effective.

Some European countries, particularly those in Northern Europe, have succeeded in increasing fertility levels in the last decades by implementing fertility-enhancing incentives and regulations. However, these countries' practices aimed to ensure gender equality in the public and private spheres, and also to remove barriers to having children by establishing a "work-family balance.” However, in Turkey, the proposed policy framework is more concerned with promoting marriage and family stability than with empowering women and enhancing gender equality.

II. ESSAY 1: DECOMPOSITION OF MORTALITY CHANGE IN TURKEY

II.1. INTRODUCTION

The mortality transition started in western countries two centuries ago and triggered the demographic transition process. Mortality levels decreased with the advancement of health technologies in the industrialized countries where it first emerged. By transferring these innovations, other countries have started to reduce their mortality rates. The world population grew rapidly because of declining mortality rates, and the population growth rate peaked during the 1960s. The onset of fertility decline has resulted in a decreasing trend in the population growth rate. This transformation has significantly altered the age structure and socioeconomic structure of societies (Dyson, 2010).

In Turkey, the decline in mortality started with the programs implemented in the field of health since the 1920s. At the time, the health system was focused on the fight against communicable diseases and early age mortality. The rate of mortality, which had been on a rapid decline until 1950, then continued to decline steadily. After the 1980s, as the prevalence of chronic and cardiovascular diseases increased, the focus of the health system shifted and a new phase in the mortality transition started (Bakar et al., 2017).

Life expectancy has doubled in less than 100 years during the mortality transition in Turkey. Early age and adult mortality rates diverged across subpopulation groups during the whole process. A variety of socioeconomic factors, primarily education and income level, were considered significant components of mortality variation. The age and cause patterns of mortality have also changed significantly as a result of this process. This study provides an insight into the mortality change in Turkey by considering the effects of age structure and social factors using decomposition methods.

This essay aims to explore the contribution of age pattern and structural factors to the mortality change. To examine the compositional factors behind mortality transition in Turkey, decomposition analyses are employed for subpopulation groups by region, educational level, wealth status, and place of residence. The second section presents the theoretical framework and a literature review. The third section addresses the stages of mortality transition and mortality differentials in Turkey. The fourth section covers the study's methodology and data sources. The decomposition results are presented in the fifth section, and they are discussed in the sixth section.

II.2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This section primarily presents the theoretical models explaining the historical mortality decline. Secondly, determinants of mortality change in the less-developed countries are also covered. Third part involves the inequality patterns in health and mortality. Lastly, literature on mortality differentials within countries are presented by focusing on the decomposition analysis of mortality differentials.

II.2.1. Theoretical Models Explaining the Historical Decline in Mortality

Vast knowledge on the onset of mortality transition is influenced by the experiences of the western countries due to data availability. Wrigley and Schofield (1981) interpreted the pre-transitional mortality patterns in England and Wales, and they showed that sustained mortality reduction did not begin until the mid-eighteenth century. In turn, they were experiencing short and long-term mortality crises that cannot be considered as a secular trend towards lower mortality. By the end of the 19^{th} and beginning of the 20^{th} centuries, mortality decline spread to the rest of the western industrialized countries.

The attempts to explain the determinants of historical mortality decline started soon after the 1950's when demographic transition theory had already been proposed. According to this theory, societies follow a transformation process from high to low levels of fertility and mortality rates. The decline in mortality is considered a starting point for the demographic transition process, pursued by a decrease in fertility rates. Demographic transition theory explained the change in the mortality levels in line with the modernization process. Increases in agricultural productivity, advances in transportation and communication, and improvements in health conditions and medicine all contributed to a reduction in mortality as a result of industrialization. Mortality transition is discussed in accordance with fertility decline and economic development in the demographic transition literature (Kirk, 1996).

Omran (1971) proposed a significant contribution to the theory of mortality decline by epidemiological transition theory. The theory focuses on the variations in disease and health patterns and their relationship to population dynamics. The epidemiological transition theory's propositions are based on historical patterns of mortality in various countries. According to Omran's (1971) original proposition, mortality and disease patterns have shifted during the epidemiological transition process. Three phases of mortality transition are regarded as; "the age of pestilence and famine”, “the age of receding pandemics”, and “the age of degenerative and man-made diseases."

The earliest stage of the transition reflects the pre-modern mortality pattern, with high and fluctuating mortality rates. In this phase, famines, epidemics, and wars were the main determinants of mortality, which can be considered as the Malthusian "positive checks," and life expectancy at birth ranged between 20 to 40 years.

In the second phase, life expectancy increased to around 50 years due to the lessening effect of epidemics and the reduction of infectious disease deaths. The last phase is characterized by the transition from infectious diseases to degenerative diseases, where cardiovascular diseases and cancer became the leading causes of death. Omran (1971) states that eco-biologic and socioeconomic factors mainly determined the historical mortality decline in western countries.

Omran (1971) proposed three basic models of epidemiological transition by analyzing the patterns of the mortality transition in different countries. The classical (western) model of epidemiological transition reflects the experience of western countries mainly driven by the effect of socioeconomic factors. The accelerated transition model describes the transition that occurred by the effect of social improvements and sanitary and medical advances as in Japan. The contemporary or delayed model of epidemiological transition reflects the transition in developing countries mainly after second world war, with health care programs serving as the primary determinants.

The improvements in the developed countries' mortality patterns indicated a new era of epidemiological transition starting from the 1970s. Olshansky and Ault (1986) and Rogers and Hackenberg (1987) added a fourth stage to Omran's initial proposition. "The age of delayed degenerative diseases" refers to the stage at which mortality decreases in older ages, and life expectancy surpasses 70 years due to advances in cardiovascular disease treatment.

Frenk et al. (1991) offered a broader concept of "health transition," considering the behavioral and social aspects of the mortality transition. They included the concept "health care transition" as a second component to the health transition theory, where the first component was identified as "epidemiological transition." While the epidemiologic transition is defined as the change in a society's health conditions, the health care transition reflects how societies respond to these health conditions.

Vallin and Mesle (2004) proposed a new approach to health transition by considering the global mortality change in a sequence of divergences and convergences. They proposed Omran's epidemiological transition as the first stage of health transition, where cardiovascular diseases became the primary source of life expectancy gains instead of infectious diseases. They claim that Omran's theory of epidemiological transition successfully explains the mortality pattern in Western populations until the 1960s. However, it was not the case for the developing countries where mortality levels showed significant divergence patterns in the 1950s.

The second phase of health transition is regarded as the phase of the "cardiovascular revolution." Reduction of cardiovascular mortality initiated a new phase in the developed countries; however, the improvement is not even across the developed countries. In the 1960s, societal and political changes in Eastern and Western Europe triggered a new divergence stage, but the trend reversed starting from the first years of the 1990s.

Vallin and Mesle (2004) defined the third stage as the phase of progress against aging. They identified a new divergence among the countries that proceeded or completed the phase of cardiovascular revolution; that older age groups are the main contributors to the mortality decline related to cardiovascular diseases. They predict that the new approaches in the fight against aging may lead to a new phase of health transition.

According to their approach, significant changes in health technologies produce a rapid divergence between countries in favor of the advantageous ones. Then, the spread of the improvements leads to a convergence stage until a new improvement occurs. This sequence of divergences and convergences can also be applied to the mortality differentials within countries. On the other hand, the concept of convergence is implicit in demographic transition theory because birth and death rates are proposed to stabilize in a demographic equilibrium. Accordingly, global demographic convergence and resulting inequalities in mortality drew significant attention from the researchers (Wilson, 2001; Goesling and Firebaugh, 2004; McMichael et al., 2004; Moser et al., 2005).

Researchers broadly examined the determinants of historical mortality decline in western countries, and they had diverse explanations for the causes of the mortality transition. For example, McKeown (1976) interpreted living conditions and nutrition as the leading causes of mortality decline from infectious diseases until the mid-1930s. McKeown's interpretation is criticized by many researchers as underestimating the impact of medical and public health interventions (Caldwell,2001).

Cutler et al. (2006) categorized the determinants of mortality reduction in three stages. The earliest stage covers the late eighteenth and early nineteenth centuries and is characterized by improved nutrition and economic expansion as major determinants of health. Also, public health measures had an essential effect on mortality reduction. Public health and sanitary improvements played the most crucial role in mortality reductions during the second stage, which lasted from the late 19^{th} century to the 1930s. The third stage, starting from the 1930s, is characterized by the use of medicine, specifically antibiotics and vaccination, for fighting the diseases.

Historical mortality decline in western developed countries cannot be attributed to a single factor. Indeed, these factors acted simultaneously or alternately depending on the time span and place they occurred. Improvement in economic conditions like income and living conditions, advancement in housing and sanitary conditions, and public health interventions can be regarded as the major determinants of mortality change until the mid-twentieth century.

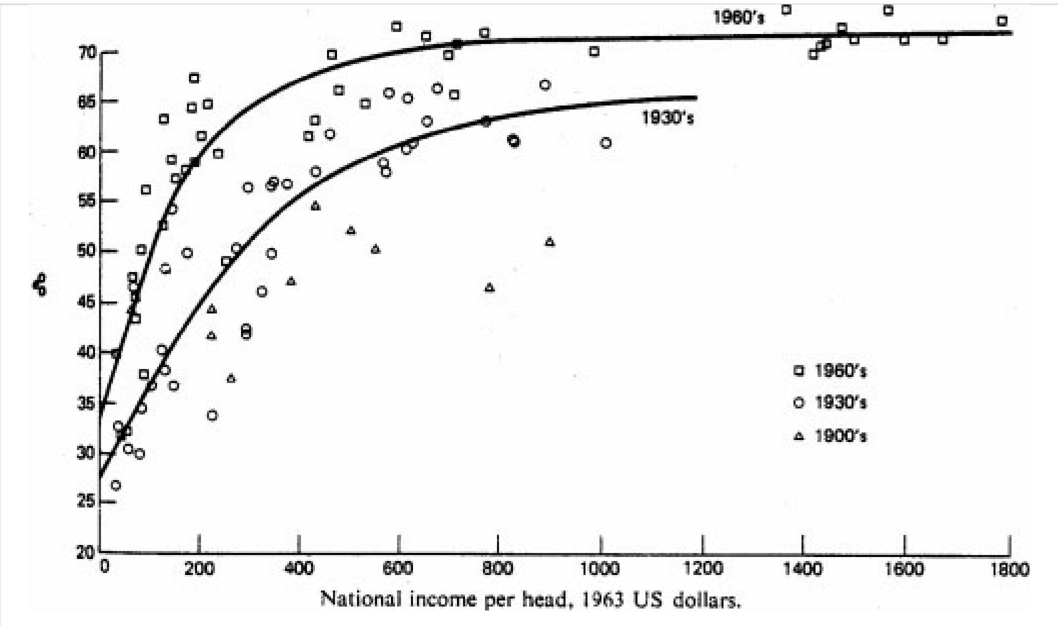
II.2.2. Mortality Differentials in the Developing World

The pattern of mortality transition in less-developed countries differed from that in western developed countries. In these countries, sustained mortality declines started in the 1950s, and the transition took place over a shorter time span for many of them. Furthermore, because of the disparities in social, economic, and cultural characteristics in developing countries, a wide range of different factors influenced the transition process.

Rising income or economic development was proposed as the primary determinant of mortality change in western countries in the initial stages of transition

(McKeown, 1976; Cutler et al., 2006). However, Preston (1975) argued that the relationship between mortality and economic development changed during the global mortality transition. He proposed the "Preston Curve" by plotting "life expectancy at birth" versus "national income per head" for different countries. As shown in Figure II.2.2.1, a positive relationship between income level and life expectancy is observed. However, Preston realized an upward movement in the curve that reflects a rise in life expectancy without improving income levels. Preston also proposed that national income levels accounted for 10 to 25% of the improvement in life expectancy from 1930 to 1960. Other 75 to 90 percent of the change was related to the factors exogenous to the income level.

Figure II.2.2.1. Preston Curve



Source: Preston (1975)

Preston curve is updated by several researchers, including Soares (2007) for 1960, 1990, and 2000. He observed a similar pattern for the corresponding years and detected an improvement in life expectancy levels for constant levels of income. Soares (2007) examined the factors influencing mortality change in developing countries after 1960. He reviewed extensive literature for exploring the age and cause patterns of mortality change in these countries. He suggested that substantial mortality reductions prevailed at low-income levels and minimum health care spending. Hence, Soares concluded that the diffusion of new health technologies was critical in the process of mortality transition in these countries. The spread of health-related knowledge, expansion of health programs, improvements in the health infrastructure, and innovations in the treatment of specific diseases were the main mechanisms through the process of diffusion of new technologies.

Soares (2007) argued that gradual transmission of health technologies led to health inequalities between and within countries. Adoption of new technology is first absorbed by more educated and well-off segments of the society and causes health inequality within the population. Subsequently, the spread of the new technology to the other segments of society leads to a decrease in inequality. The diffusion process defined by Soares (2007) is compatible with the divergence-convergence sequence proposed by Vallin and Mesle (2004) and applicable to the between-country inequalities as well as within-country inequalities.

Cutler et al. (2006) mentioned the importance of knowledge, science, and technology as the determinants of mortality decline. They also predicted an immediate increase and further decline in the health gradient within societies by the flow of knowledge, science, and technology. Both Cutler et al. (2006) and Soares (2007) proposed an increase in the mortality inequality within countries while average mortality levels are reduced.

Another line of research on the determinants of mortality change in the developing countries focused on the social and cultural determinants of mortality rather than material living conditions and medical interventions. Caldwell (1990) argued that the process of mortality transition in developing countries differs from Western developed countries' experience regarding social and cultural determinants like education, women's status or ethnic group. He emphasized that developing countries achieved low levels of mortality "at low cost"; since the medical interventions and health services were transferred from the developed countries that had already gone through the mortality transition process.

Factors other than income or material living conditions gained prominence in the process of mortality transition in the developing countries. Social determinants, particularly women’s education, medical interventions, and diffusion or spread of health technologies were the significant determinants of mortality reductions in these countries.

II.2.3. Health and Mortality Inequalities

In both developed and less-developed countries, mortality levels have declined drastically over the last century. During the mortality transition, however, socioeconomic inequalities in health and mortality persisted. The earliest studies on mortality differentials in developed countries were conducted in the 1960s (Antonovsky, 1967; Kitagawa and Hauser, 1968). Researchers have examined how variables such as social class and education level contribute to mortality inequality.

The "Black Report", published in United Kingdom in 1980, examined the morbidity and mortality differentials between occupational classes and proposed a systematic approach to social class inequalities in health and mortality. As a result of this study, four possible models have been suggested for explaining social class differentials in health: "artefact explanation”, “natural/social selection approach”, “cultural/behavioral explanation”, and “materialist/structural explanation" (Macintyre, 1997).

The artefact explanation challenges the existence of socioeconomic inequalities in health. According to this view, health inequalities only arise from differences in data, and the magnitude of the inequalities results from the variables used to capture social status (Bambra, 2011).

The natural/social selection approach claimed that health determines social class. According to this approach, social differentiation in health results from the mobility of healthy individuals to the upper social classes and the movement of unhealthy individuals to the lower social classes (Mackenbach, 2012; Bambra, 2011).

According to the cultural/behavioural explanation, inequalities in health arise from the differences in health behaviors between social classes. This approach claimed that health behaviors such as drinking, smoking, drug use, exercise, and eating habits differ between social classes and those common cultural behaviors are the basis of inequality (van Raalte and Seaman, 2020).

The materialist/structural explanation proposes that inequality in health and mortality results from the unequal distribution of resources. Structural, social and economic factors constitute the source of health inequality as they constitute social classes in society (Macintyre, 1997; van Raalte and Seaman, 2020).

In the years following the publication of the "Black Report," the debate on health inequalities continued; four explanatory approaches have been modified and alternative approaches proposed. For example, Macintyre (1997) distinguishes between "hard" and "soft" versions of each approach. Bambra (2011) discussed the psychosocial and life-course approaches in addition to the four approaches. According to the psychosocial approach, the emotional consequences of social inequality have an impact on people's health. On the other hand, life course approach suggested that the health status of older people is affected by the living conditions at early ages. Inequality between social classes emerges due to biological, social, and psychosocial inequalities that have accumulated over many years. Moreover, theories and explanations on socioeconomic health inequalities continue to evolve (Mackenbach, 2012; van Raalte and Seaman, 2020).

Inequalities in health and mortality have persisted in different epidemiological conditions despite changing health technologies (Elo, 2009). For this reason, Link and Phelan (1995) defined socioeconomic status as a “fundamental cause” for health and mortality inequality. According to this approach, individual risk factors identified by epidemiological studies are not sufficient to explain health disparities since socioeconomic factors lead to inequality in access to resources. Advantaged social classes have easier access to resources to mitigate the risk of morbidity and mortality. According to this approach, socioeconomic inequalities reproduce themselves over time, even as risk factors or disease patterns change (Link and Phelan, 1995; van Raalte and Seaman, 2020).

The variables used in studies on socioeconomic health inequality vary. For example, occupational status has been frequently used in historical studies, especially in Europe (Elo, 2009). Education level and income/wealth status are the most commonly used variables to investigate socioeconomic differentials of health. In addition, regional and racial disparities have been important determinants of health inequality in various parts of the world.

II.2.4. Literature on Decomposition of Mortality Differentials

A broad range of studies concerning the compositional factors contributes to the literature of mortality change within population groups. Mortality differentials and inequalities are analyzed to examine the pace of mortality change in these populations. The focus of the analysis on mortality differentials is mainly related to inequality patterns between different segments of society and alterations in population health patterns. Inequality patterns are examined by socioeconomic differentials like economic situation, social class, education or racial differences, regional or geographical differentials, or health differentials in mortality. Literature on socioeconomic mortality differentials, regional/geographical mortality differentials, and health differentials are reviewed in three parts.

<u>Studies on socioeconomic mortality differentials</u>

Martikainen et al. (2001) examined life expectancy differentials for males and females by age, social status, and cause of death between 1971 and 1995. Two social classes are constructed as “manual workers” and “non-manual workers”. "Manual workers" comprise both skilled and unskilled employees, as well as farm and forestry employees. Managers, administrative personnel, and clerical personnel are examples of "non-manual workers." In the 20 years, life expectancy for non-manual workers at age 35 increased more than manual workers for women and men. This difference is attributable to a slower decrease in cardiovascular mortality among manual workers and an increase in alcohol-related mortality, accidents, and suicide among them. They hypothesized that social inequality among manual and non-manual workers plays a role in the difference between life expectancy changes among these social classes. Martikainen et al. (2001) also mentioned the importance of recognizing older ages' contribution to life expectancy differences since the more significant increase is related to ages above 64.

Seaman et al. (2015) analyzed the mortality inequalities between Scottish cities by their deprivation profiles. Glasgow is compared to different Scottish cities in order to determine the influence of deprivation on low life expectancy levels. Glasgow city is compared with other Scottish cities to evaluate the impact of deprivation profile on low life expectancy levels. They quantified deprivation using the "Scottish Index of Multiple Deprivation (SMID)" and decomposed the change in life expectancy using Arriaga's method. According to their findings, more than 90% of the difference in life expectancy between Glasgow and the other three cities resulted from deprivation. Moreover, the mortality age distribution of Glasgow and the other Scottish cities did not differ significantly. As a result, high levels of deprivation were regarded as an explanation of health disparities between Glasgow and other cities. They concluded that reducing life expectancy inequalities among Scottish cities could be possible by reducing the level of socioeconomic deprivation.

Andreev et al. (2009) assessed trends in men's mortality patterns at working ages in Latvia and Russia between 1970 and 1989. According to the previous studies, mortality rates showed an increasing pattern after 1965 in the Soviet Union. According to their findings, the decline in life expectancy in urban Latvia and Russia between 1970 and 1979 was primarily due to increased mortality rates among manual workers. On the other hand, there was a contradiction between the country's improving socio-economic situation and rising mortality rates, where the economy was starting to grow, and society's educational level and living conditions were improving. Andreev et al. explained this contradiction by the incompleteness of the modernization process and the absence of a healthy lifestyle perspective among citizens.

Tarkiainen et al. (2012) analyzed the Finnish population's mortality trends by income groups in the period 1988-2007. They created five income quantiles by using household taxable income data provided by the Finnish tax administration. According to the decomposition analysis, life expectancy for ages 35 and above increased in all income quantiles in the 20 years, but the increase was insignificant among the less wealthy. As a result, during the study period, the income gap between the low and high-income groups widened. Tarkiainen et al. (2012) also examined the cause of death patterns by income groups. They concluded that the disparity between highest and lowest income groups resulted from increasing mortality levels caused by alcohol-related diseases, cancers, and a relatively slow decline in ischemic heart disease-related mortality among the lowest income quantile.

Jung-Choi et al. (2014) decomposed educational differentials in South Korean mortality by age and cause of death. According to their study, younger age groups with less educational attainment have a more significant contribution to the life expectancy change. Low-educated young people are socially marginalized, and they experienced the neo-liberal economic policies in the periods of economic crisis and banking crisis in the last decades. Furthermore, the highest suicide rates are observed in Korea among OECD countries during periods of economic and banking crises. The results of the study reflect that suicide has been one of the major contributors to the change in life expectancy for the young population, and educational attainment has a significant impact on life expectancy change in Korea.

Shkolnikov et al. (2012) analyzed the mortality divergence by educational level in Finland, Norway, and Sweden between 1971-2000. They emphasized the socioeconomic mortality inequality that gained predominance in industrialized countries since the 1980s. They used data from three countries with comparable educational systems for exploring the absolute and relative mortality differences in these countries. Three broad categories of educational level are used as high, middle, and low education. They interpreted a significant increase in the mortality disparities in Finland, Norway, and Sweden. Also, the mortality disparity between educational groups differed by country and sex, and mortality contributed significantly to the overall change in male mortality in Norway and Sweden.

Shkolnikov et al. (2006) examined the mortality-education relationship in former Soviet countries between 1988-1989 and 1998-1999. Decomposition methods were used to analyze educational disparities in life expectancy in the Czech Republic, the Russian Federation, Estonia, and Finland. Three educational categories are created as “high (university) education”, “medium (secondary) education”, and “low (less than secondary) education”, and data from death statistics and censuses are used to calculate life expectancies for each group. The contributions of mortality effect “M effect” and population composition “P effect” on life expectancy changes are interpreted for these countries. They used "the stepwise replacement algorithm" to track changes in educational category size as well as changes in mortality rates within educational categories. According to the study's findings, life expectancy has increased in all educational categories in Finland and the Czech Republic, and the gap between educational levels widened slightly over a 10-year period. The improvements in the mortality levels within educational groups made the most significant contribution to the increase in life expectancy. On the other hand, life expectancy decreased in the middle and low education groups in the Russian Federation and Estonia, and the mortality difference between higher and lower educational categories expanded in 10 years. Shkolnikov et al. (2006) concluded that Russia and Estonia experienced a less egalitarian health transition process than the Czech Republic and Finland, and improvement in educational composition played an essential role in the whole process.

Luy et al. (2019) examined the relationship between mortality and educational composition in Denmark, Italy, and the United States between 1990 and 2010. They decomposed life expectancy change into "education-specific mortality effect" and "educational composition effect." They used three educational categories as "low," "medium," and "high" based on the “ISCED-97 (International Standard Classification of Education)” scale. The educational composition has remarkably changed in these countries; the share of low education groups diminished as the share of higher education groups increased in the 20 years. However, the educational gap in life expectancy between the high-educated and the low-educated widened in the same time period. According to the results of decomposition analysis, life expectancy increase is mainly resulting from the effect of education-specific mortality levels. However, the change in the populations' educational composition has a substantial effect on the life expectancy change, between 15 percent for males in the USA and 40 percent for females in Denmark. As a result, they concluded that educational attainment and life expectancy have a strong positive relationship in all three countries in the 20 years.

Harper et al. (2007) examined the differences in life expectancy between blacks and whites in the USA from 1983 to 2003. They used Arriaga's decomposition approach to investigate the effect of age and cause patterns on mortality change. The disparity between whites and blacks widened during the early 1980s and then gradually declined. The narrowing gap is attributable to the relative improvements in the mortality related to homicide, unintentional injuries and HIV, and heart disease among females. However, the decrease in the black-white life expectancy gap does not reflect an improvement in blacks' mortality; it is attributable to the mortality improvement for particular ages and causes of death. Harper et al. (2007) mentioned that public health precautions should be taken to reduce the inequalities between blacks and whites regarding health and life expectancy.

Firebaugh et al. (2014) developed a method for separating age and incidence components of the cause of death decompositions. They examined the reduction in racial disparities in mortality in the USA between 2000 and 2010. Their method enabled them to distinguish the reasons behind black-white mortality differences. They concluded that blacks in the United States have a shorter lifespan than whites, and they interpreted the age and cause pattern of mortality. According to their analysis, whites have a higher life expectancy for all causes of death. However, gains in life expectancy from chronic diseases caused a faster increase in blacks' life expectancy than whites over the 10-year period. 60 percent of the narrowing gap between blacks and whites was attributed to the declining age component for three leading causes of death. The remaining 40 percent of the reduction was due to a shift in the cause of death patterns of blacks and whites.

Zhao and Dempsey (2006) investigated the mortality variation between Indigenous and non-Indigenous communities in Australia from 1981 to 2000. In the 20 years, there was a remarkable shift in the cause patterns contributing to the mortality gap; however, the gap did not narrow. As the contribution of non-contagious diseases increased in the 20 years, the impact of contagious diseases and maternal and nutritional conditions substantially decreased in the same period. Zhao et al. (2013) further analyzed the risk factors affecting the mortality gap between two Australian communities. They concluded that socioeconomic disadvantage was the leading risk factor d of the life expectancy gap. Smoking and obesity were also significant risk factors for the Indigenous population.

Studies on geographical mortality differentials

Saikia et al. (2009) examined the trends in mortality disparities across India's regions. They reviewed the mortality trends by age, sex, and region from 1970 to 2000 and discovered a convergence pattern between regions. However, there were still substantial longevity differences between the north and south in the 2000s. The results of age - decomposition reflects a mortality reduction in the younger ages. However, India still faces the challenge of further reduction in infant mortality and reduction of chronic and human-made diseases at older ages.

Grigoriev and Pechholdova (2017) assessed the role of the reunification process in mortality patterns in Germany by analyzing the cause of death patterns. First, they have adjusted the distortions in the mortality data caused by the changes in the coding systems and data acquisition procedures in East Germany following reunification. They used Andreev's decomposition method for estimating the effect of age and cause patterns on mortality differences in the two states. As a result, they proposed three main processes in East Germany before and after reunification. Firstly, there was a sustained mortality reduction before reunification; secondly, mortality levels temporarily increased soon after the reunification because of the socially sensitive causes of death like accidents and alcohol-related diseases; and lastly, a convergence process took place after reunification mainly related to the mortality decline from cardiovascular diseases. According to Grigoriev and Pechholdova (2017), the mortality reduction in Eastern Germany in the 1980s might be considered "the first signs of a cardiovascular revolution" driven by individual behavior shifts. On the other side, improvements in medical care have mainly occurred after reunification by adopting the Western health care system. They concluded that; German reunification accelerated the convergence process rather than initiating it since the mortality trends were already changing in East Germany before reunification.

Timonin et al. (2017) analyzed mortality differentials among Russia's different regions from 2003 to 2014. In this period, life expectancy has risen by 6.6 years and 4.6 years for males and females, respectively. It followed an increasing trend in all 80 regions of the country; however, the pace of mortality improvement was not uniform for all regions. Regional disparities in life expectancy are primarily examined using population-weighted standard deviation, which reduced moderately in the study period. They applied "the stepwise replacement algorithm" to decompose the age and cause components of regional differentials in mortality. According to the results of decomposition analysis, stagnating level of regional disparity resulted from the compensating effects of mortality divergence at older ages and mortality convergence among young and middle age groups. Furthermore, Moscow and Saint Petersburg, the biggest cities in Russia, were leading mortality improvements and were making the most significant contribution to the divergence between regions of Russia.

Studies on health differentials in mortality

Gómez-Redondo and Boe (2005) examined life expectancy change in Spain by age and sex from 1971 to 2000. They mentioned that Spanish life expectancy decline was slower than that of the Northern European countries prior to the 2nd world war. Death rates changed rapidly after the war, and Spain achieved higher life expectancy levels than other Western countries after 1970. They used Pollard's decomposition method to examine the change in life expectancy during this time period. In the three decades between 1970 and 2000, the older ages were the primary contributors to mortality improvement, reflecting the fourth phase of epidemiological transition. The contribution of the young and young-adult ages to life expectancy gains in Spain decreased after 1980 because of the socioeconomic and behavioral changes in society. Gómez-Redondo and Boe emphasized the impact of traffic accidents, alcohol consumption, AIDS, and drugs on the younger population's life expectancy levels. They also mentioned that sex differences in mortality became more prominent after the 1980s, mainly in the older ages, which caused a "feminization" of the older population.

González and Manuel (2014) analyzed the long-term improvement in life expectancy in Spain. Firstly, they covered the change in Spanish life expectancy between 1910 and 2009. In this period, average life expectancy increased by 40 years, and this increase was explained by two major stages. The first stage was characterized by the improvement in the early age mortality pattern. In the second stage, starting from 1970, mortality levels decreased in the older age groups. González and Manuel (2014) examined the variation in the mortality pattern of the elderly between 1980 and 2009 for understanding the relationship between lifespan and social change. They concluded that the increased survival of the elderly could explain the mortality improvement over the study period. The primary drivers of this transformation were advancements in health, medical care, living conditions, and welfare policies.

Zhao and Kinfu (2005) examined the life expectancy patterns in East Asia by analyzing data from five countries. Hong Kong, Japan, Korea, Mainland China, and

Taiwan have undergone non-simultaneous mortality transitions over the last half-century under diverse socioeconomic conditions, but changes in age and sex patterns have shown similarities. During the mortality transition process, the contribution of younger age groups to mortality reduction decreased and shifted to the middle and older age groups. Furthermore, the divergence between male and female life expectancy has remarkably increased during this period. Zhao and Kinfu (2005) also analyzed the shift in the cause of death patterns in these countries. During the early stages of the mortality transition, infectious and communicable diseases were the primary contributors to the mortality change. Afterwards, cancers and cardiovascular diseases became the major causes, contributing to life expectancy improvements.

Shkolnikov et al. (2013) interpreted the components of the decrease in Russian mortality from 2004 to 2010. In this period, Russian life expectancy substantially increased after a decline in the 1990s. They analyzed the age and cause pattern of this positive trend and concluded that life expectancy improvement could be primarily associated with a decrease in the impact of alcohol-related causes between the ages of 15 and 60. Mortality disparities between Russia and Western countries are connected to cardiovascular diseases, alcohol-related conditions, and violence. They mentioned that the improvement in alcohol-related mortality mainly resulted from the measures taken against the production and sale of ethanol.

II.3. MORTALITY TRANSITION IN TURKEY

II.3.1. Stages of Mortality Transition

Turkey's demographic and socioeconomic profile has substantially changed since the modern republic was founded in 1923. During this period, the country's mortality pattern has shifted in line with the demographic transition process. The mortality pattern was strongly associated with the transformations in the health system as well as other socioeconomic determinants of health (Kasapoğlu, 2016; Bakar et al.,2017).

The mortality transition in Turkey can be understood by interpreting the changes in the country's health system and epidemiological profile. The mortality transition process can be categorized into three main stages by considering the health system transformations in Turkey after 1923. Several researchers used similar categorizations considering Turkey's health care system and epidemiological profile (Akdur, 2008; Kasapoğlu, 2016; Kohlwes, 2014; Bakar et al.,2017).

The first stage, from 1923 to 1960, was characterized by the institutionalization of the health system. In the Ottoman Empire, health had not been offered as a public service to the vast majority of the population; the efforts to promote public health service began in the 19th century with modernization movements (Kasapoğlu, 2016). In the first decades of the Republic, public health infrastructure was established as modernization efforts gained momentum in the government's new system. Ministry of Health was founded in 1920 by The Grand National Assembly of Turkey, which was already established before the new Republic's declaration in 1923. The Law of Public Health, announced in 1930, was the main legislative framework for the institutionalization of the healthcare system.

The main concern of the Turkish government was to build a nation-state with a "healthy and numerous population" for gaining military and economic power after World War I and Independence War that the country has gone through in the near past

(Shorter, 2000; Kohlwes, 2014). The immediate effects of these wars on society's health patterns were the spread of epidemics and increasing levels of infectious diseases. Therefore, control of these diseases was the main priority of the health care system that was being established at that time. In this period, the efforts to build the basic infrastructure for the health care system resulted successfully. However, by the end of this stage, infectious diseases remained among the leading causes of death (Bakar et al., 2017).

The main feature of the second stage that lasted from 1960 to 1980 was the socialization of the health services. In this period, the state policies were focused on promoting a welfare state and achieving economic development by a strong programmatic character (Kohlwes, 2014). The focus of “the Law on Socialization of Health Care”, which was published in 1961, was providing state financing and provision of health care, and improving the country's primary care system. The effect of neoliberalism, which has been on the rise in Turkey and around the world since the 1970s, has disrupted the socialization process in the health system (Akdur, 2008).

In this period, the battle against infectious diseases and infant mortality gained momentum by the effect of widespread primary health care services, maternal and childcare services, new programs on infectious diseases, and vaccinations across the country. Also, the effect of cardiovascular diseases started to increase while infant mortality and infectious diseases started to lose their predominance (Bakar et al., 2017).

The third phase of the mortality transition started in 1980 due to significant alterations in the country's socioeconomic structure. Neoliberal policies gained dominance in areas such as economy and education, as well as in the field of health. Privatization of health care services and changing role of government from providing health care services to regulating and supervising them were the main aspects of this era. The primary structural change following the path of neoliberal policies enacted in 2003 by "The Health Transformation Program (HTP)." The main components of the HTP were: providing universal health insurance, introducing business models and family medicine scheme in public health care, improving health information systems, and encouraging private sector participation in health care (Kohlwes, 2014).

In this stage, the effect of infectious diseases gradually diminished starting from the 1960s, and chronic diseases and cancers were the leading causes of death. In the earliest years of this stage, vaccination campaigns and immunization programs were still being implemented (Bakar et al., 2017). However, by the end of this stage, the emphasis of public health programs had shifted to chronic and cardiovascular diseases. Table II.3.1 represents the stages of Turkey's mortality transition.

Bakar et al. (2017) demonstrated Turkey's demographic and epidemiological transitions between 1931 and 2013. They assessed the health policies and cause of death trends by using historical mortality data. They suggested that Turkey's epidemiological transition pattern fits the "contemporary or delayed model of epidemiological transition" proposed by Omran (1971), which is mainly driven by the implementation of health care programs in developing countries.

Table II.3.1.1. Stages of Mortality Transition in Turkey

Period	Characteristics of the health system	Epidemiological profile of the country
1923-1960	- Institutionalization of health system - Foundation of Ministry of Health - The Law of Public Health	-Efforts on the control of epidemics and infectious diseases - Infectious diseases as the leading causes of death
1960-1980	- Socialization of health services - Law on Socialization of Health Care - State financing and provision of health care - Strengthening the primary care system in the entire country	- Battle against infectious diseases and infant mortality - Increase in the effect of cardiovascular diseases
1980-	- Privatization of health care services - Changing role of government from providing health care services to regulating and supervising them - Health transformation program	- Cardiovascular diseases and cancers as the leading causes of death - Shift in the age of death

Sources: Akdur, 2008; Kasapoğlu, 2016; Kohlwes, 2014; Bakar et al.,2017

Epidemiological transition and health transition theories explained the evolution of cause of death patterns from infectious to chronic or cardiovascular diseases as a significant transformation in the health structure of a society. In Turkey, an apparent shift occurred from infectious diseases to cardiovascular diseases after the 1960s. Further transformations in the cause of death patterns are predicted as a decline in cardiovascular diseases and delay in old-age mortality, respectively. In Turkey, cardiovascular mortality followed a decreasing pattern in the last 20 years (Dinç et al., 2013; Ünal et al., 2013). Therefore, it can be suggested that Turkey is currently in the phase of the cardiovascular revolution, and the delay in old-age mortality is on the way.

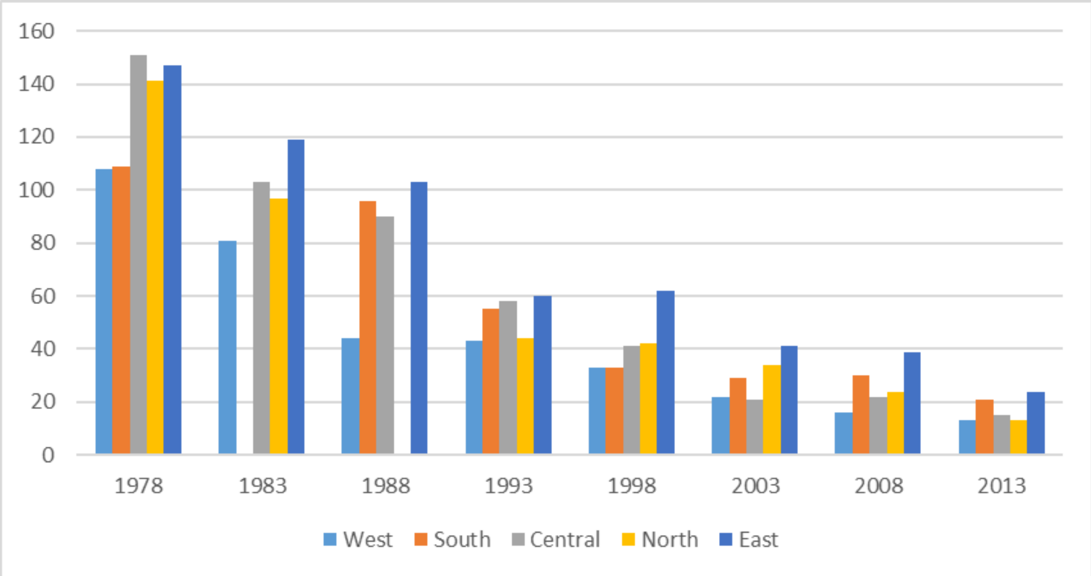
II.3.2. Mortality Differentials in Turkey

Mortality change in Turkey did not occur at the same pace in all sub-population groups. Shorter and Macura (1982) provided the earliest estimates of regional variation in mortality levels. According to their estimates, the rural central region's infant mortality rate decreased from 344 per thousand in 1945 to 155 per thousand in 1967. In the same period, the infant mortality rate, 280 per thousand and 227 per thousand in rural eastern and western regions decreased to 166 per thousand for both regions. In urban areas, however, the IMR level was lower, though it varied by region. In the 1945-1967 period, the infant mortality rate in metropolitan cities decreased from 160 to 99 per thousand. In the same period, it decreased from 181 to 134 per thousand in the western urban areas and from 211 to 139 per thousand in urban areas in the central regions (Shorter and Macura, 1982).

Demographic surveys provided more reliable estimates of mortality rates starting from the 1970s. As seen in Figure II.3.2.1, IMR levels decreased significantly in all regions, but interregional differentiation did not disappear. In 35 years, the IMR level in the central region has declined from 151 to 15 per thousand. The eastern region's IMR was estimated to be 24 per thousand in 2013, the highest value among all regions. The lowest IMR levels were calculated as 13 per thousand in the West and

North regions. Furthermore, infant mortality rates differed between urban and rural areas. In 1983, the IMR was 67 per thousand in urban areas, while it was 128 per thousand in rural settlements. In 2013, these rates were measured as 18 and 26 per thousand, respectively.

Figure II.3.2.1. Change in the Infant Mortality Rates by Region, 1978-2013



*Due to the small number of cases in the 2008 and 2013 surveys, the calculations are based on 10-year period preceding the survey.

Infant and child mortality levels in Turkey have remained persistently high for many years compared to the socioeconomic level of the country. Gürsoy-Tezcan (1992) defined this situation as a "Turkish puzzle of infant mortality." Since the 1990s, there has been a rapid improvement trend in early-age mortality rates. From 1990 to 2007, the under-five mortality rate decreased by more than 70 %, one of the largest declines in the world (UNICEF, 2009). Yüksel and Koc (2010) discussed the change in early age mortality levels considering the "Turkish puzzle of infant mortality." The study results, which was carried out using the 1993 and 2003 TDHS data, showed that early age mortality is still a problem for Turkey, and sociocultural factors contribute to the infant mortality puzzle.

Some studies have been carried out on the socioeconomic differentials of early age mortality levels in Turkey since the 1970s (Adlakha, 1970; Cerit, 1975; Tezcan, 1985). These earliest studies showed that social factors such as parents' educational attainment, income level, occupation, and urban/rural residence contributed to the differentiation in early age mortality levels (Akşit and Akşit, 1989).

One of the studies on socioeconomic differentials of early age mortality was carried out by Yanıkkaya and Selim (2010) using 1998 and 2003 TDHS data. According to them, the determinants of mortality variation in regions and urban-rural areas were different from each other. While the high IMR level in the eastern region was more closely related to the parents' educational level, the increase in the income level had a greater effect in the other regions. They also concluded that the difference in IMR between rural and urban settlements resulted from lower levels of education and income in rural areas.

Eryurt and Koç (2009) used 2003 TDHS data to examine the impact of household wealth status on child mortality. Their study shows that wealth status plays a significant role in early age mortality differences. Furthermore, the less wealthy parents had a lower educational level; a significant part of them did not have health insurance, hygienic conditions were not adequately provided in the houses, and they could not benefit from pre-and post-natal health services adequately.

In addition to the studies on socioeconomic determinants of early age mortality, a few studies have been conducted in the field of health inequalities. These studies examined the relationship between socioeconomic factors like income and education with health and mortality levels. Dedeoğlu (1990) discussed the effect of socioeconomic changes on health inequalities between 1970 and 1985. According to Dedeoğlu (1990), the changes in the economic system had a significant impact on the population's health, and health inequalities widened. During this period, those living in the rural settlements of Eastern, Northern, and Central Anatolia and those living in the slums of the cities had the most disadvantaged position in terms of health.

Çoban (2008) examined the relationship between mortality level, income, and education inequality for Turkey and the Euro Area. The relationship between the variables was assessed by implementing panel data analysis and time series analysis for the 1980-2006 period. According to the study results, income inequality in Turkey affected infant and adult mortality (above age 25). In addition, the increase in educational inequality contributed to the increase in both infant mortality and income inequality.

Özdemir et al. (2011) used the Gini coefficient to examine the life span inequality in Turkey. The study covered the period from 1990 and 2008, and Gini coefficients were created using life table functions. Variability in length of life was also calculated. During the determined period, life expectancy has increased by 9.3 years, while the inequality coefficient decreased by 36 percent. Özdemir et al. (2011) stated that although the level of inequality among individuals has decreased over time, the level of inequality is still not as low as the inequality level in developed countries.

Çukur and Bekmez (2011) used regional data from 1975 to 2001 to evaluate the effect of income and income inequality on infant and child mortality rates in Turkey. The study results showed that the increase in the income level contributed to the reduction in early age mortality rates, while the income inequality caused an increase, particularly in the infant mortality rates. Manavgat and Çelik (2017) conducted a spatial analysis for 81 provinces to examine the determinants of health status. In the study, infant mortality rate was regarded as an indicator of health status. According to the study's findings, income level was the most important determinant of health status, and health status was better in provinces with a higher share of the population covered by the social security system.

II.4. METHODOLOGY AND DATA

This chapter includes the interpretation of methods used for decomposing mortality differentials, data sources and adjustment procedures used in decomposition analysis, and the construction procedure of life tables needed for decomposition analysis. Lastly, different decomposition methods are employed, and results are compared.

II.4.1. Decomposition Methods

In this section, decomposition methods are reviewed in three main parts. The first decomposition method proposed by Kitagawa (1955) and the method further expanded by Das Gupta (1978) are reviewed in the first section. In the second section, life expectancy decomposition methods proposed by Arriaga (1984), Andreev (1982), Pressat (1985), and Pollard (1982) are reviewed. General frameworks proposed by Andreev et al. (2002) and Horiuchi et al. (2008) are presented in the last section.

II.4.1.1. First Decomposition Method

The idea of decomposition is based on the standardization methods used to compare the rates in two or more populations. The effect of compositional factors is eliminated by applying standard rates to the populations under concern. Kitagawa (1955) developed a decomposition method based on standardized rates for explaining “the components of the differences between two rates." In this components framework, the difference between two rates is broken into two elements; one representing the differences in rates, the other represents the differences in their composition. Decomposition analysis allows for the interpretation and comparison of the components of the change in overall rates. Kitagawa's decomposition technique can be considered the origin of several other decomposition methods used in demographic analysis.

In Kitagawa's framework, the difference between the two rates is estimated by:

$$\Delta = \sum \frac{t_i + T_i}{2} \left(\frac{n_i}{n_.} - \frac{N_i}{N_.} \right) + \frac{\frac{n_i}{n_.} + \frac{N_i}{N_.}}{2} (t_i - T_i) \qquad \text{(II.4.1.)}$$

where n_i and N_i are the number of persons in the i^{th} category of the corresponding populations and t_i and T_i are the rates of the persons in the i^{th} category.

When Kitagawa's formulation is applied to crude death rate, the difference in death rates between two populations is calculated as:

$$CDR^2 - CDR^1 = \sum(M_x^2 - M_x^1) * \frac{(P_x^1 + P_x^2)}{2} + \sum(P_x^2 - P_x^1) * \frac{(M_x^1 + M_x^2)}{2} \qquad \text{(II.4.2.)}$$

where M_x^1 and M_x^2 are the age specific death rates and P_x^1 and P_x^2 are the age distributions of population 1 and population 2, respectively.

The first part of the equation reflects the mortality component, the second part is the structural component, which in this situation is the impact of population age structure. Therefore, the overall change is broken down into two terms; one reflecting the contribution of the change in mortality levels and the other reflecting the contribution of the age distribution. In Kitagawa's formulation, the difference in mortality schedules is weighted by average age structure, and the difference in age structure is weighted by average age-specific death rates.

Das Gupta (1978) elaborated Kitagawa's decomposition method by applying a more complex formulation. According to Das Gupta, the Kitagawa method is successfully applied to the data classified by one factor; however, when two or more factors are involved, it is difficult to interpret the interaction terms formulated by Kitagawa. Das Gupta proposed a decomposition method for separating the difference between two rates into several components, which could be implemented to data that has been cross-classified by any number of factors.

Das Gupta's decomposition procedure for two-factor data, I and J, is proposed as:

$$I(I,J) = \sum\sum \frac{t_{ij}+T_{ij}}{2} \frac{\frac{n_{ij}}{n_{i.}}+\frac{N_{ij}}{N_{i.}}}{2} \left(\frac{n_{i.}}{n_{..}} - \frac{N_{i.}}{N_{..}}\right)$$

$$J(I,J) = \sum\sum \frac{t_{ij}+T_{ij}}{2} \frac{\frac{n_{i.}}{n_{..}}+\frac{N_{i.}}{N_{..}}}{2} \left(\frac{n_{ij}}{n_{i.}} - \frac{N_{ij}}{N_{i.}}\right) \quad \text{(II.4.3.)}$$

where;

t_{ij} and T_{ij}: rate of people in the (i,j) category,

n_{ij} and N_{ij}: number of people in the (i,j) category,

$n_{i.}$ and $N_{i.}$: number of people in the *i*th category of I,

$n_{..}$ and $N_{..}$: total number of people in the relevant populations.

The main difference between the methods proposed by Kitagawa and Das Gupta is the number of factors that can be handled by the method. Kitagawa's decomposition method successfully works for data classified by one factor; however, when two or more factors are included in the analysis, the Das Gupta method is applicable.

The original decomposition method proposed by Kitagawa and other methods based on Kitagawa's formulation is mainly applicable for the decomposition problem of the rates expressed as an additive function of their covariates. In the scope of this thesis, these methods are used to decompose the analyze the change in crude rates of population change.

II.4.1.2. Life Expectancy Decomposition

In the 1980s, four different researchers developed techniques for decomposing life expectancy change. Andreev (1982), Arriaga (1984), and Pressat (1985) proposed discrete methods for the decomposition problem; Pollard (1982) developed a continuous type of the method.

Arriaga (1984) defined a concept of "temporary life expectancy" to identify the life expectancies between two age groups and comparing them. Temporary life expectancy from age x to $x+i$ is represented as "the average number of years that a group of persons alive at age x will live from age x to $+i$:"

$$ {}_{i}e_{x} = (\frac{T_x - T_{x+i}}{l_x}) \qquad \text{(II.4.4.)} $$

Life expectancy change is explained by direct, indirect and interaction effects based on the "temporary life expectancies" in each age category. The direct effect represents "the change in life years within a particular age group as a consequence of the mortality change in that age group." The indirect effect is "the number of life years added to a given life expectancy because the mortality change within a specific age group will produce a change in the number of survivors at the end of the age interval." The interaction effect reflects "the effect of the overall mortality change on life expectancy that cannot be explained by or assigned to particular age groups" Arriaga (1984).

The system suggested by Arriaga includes direct effect, indirect effect, and interaction effect as follows:

$$ \text{Direct effect (DE)} = \frac{l_x^1}{l_0^1}\left(\frac{T_x^2 - T_{x+i}^2}{l_x^2} - \frac{T_x^1 - T_{x+i}^1}{l_x^1}\right) \qquad \text{(II.4.5.)} $$

$$ \text{Indirect effect (IE)} = \frac{T_{x+i}^1}{l_0^1}\left(\frac{l_x^1\, l_{x+i}^2}{l_{x+i}^1\, l_x^2} - 1\right) \qquad \text{(II.4.6.)} $$

$$ \text{Interaction effect} = \frac{T_{x+i}^2}{l_0^1}\left(\frac{l_x^1}{l_x^2} - \frac{l_{x+i}^1}{l_{x+i}^2}\right) - IE \qquad \text{(II.4.7.)} $$

where;

l_x^1 and l_x^2: number of people left alive at age x at time points 1 and 2,

l_{x+i}^1 and l_{x+i}^2: number of people left alive at age $x+i$ at time points 1 and 2,

T_x^1 and T_x^2: person years lived at age x at time points 1 and 2,

T_{x+i}^1 and T_{x+i}^2: person years lived at age $x+i$ at time points 1 and 2.

Shkolnikov et al. (2001) shown that Andreev (1982) and Pressat (1985) developed decomposition methods that are essentially equivalent to the method proposed by Arriaga (1984).

According to Andreev (1982), difference in life expectancies between time points 1 and 2:

$$e_0^2 - e_0^1 = \sum_x {}_i\delta_x^{2,1} = \sum_x [l_x^2(e_x^2 - e_x^1) - l_{x+i}^2(e_{x+i}^2 - e_{x+i}^1)] \quad \text{(II.4.8.)}$$

$$e_0^1 - e_0^2 = \sum_x {}_i\delta_x^{1,2} = \sum_x [l_x^1(e_x^1 - e_x^2) - l_{x+i}^1(e_{x+i}^1 - e_{x+i}^2)] \quad \text{(II.4.9.)}$$

where l_x and l_{x+i} are the number of people left alive and e_x and e_{x+i} are the life expectancies at ages x and $x+i$, respectively.

Since ${}_i\delta_x^{2,1} \neq {}_i\delta_x^{1,2}$, Andreev (1982) and Pressat (1985) used their average for obtaining a "symmetrical" decomposition of life expectancy differences:

$${}_n\varepsilon_x = \frac{1}{2}({}_i\delta_x^{2,1} - {}_i\delta_x^{1,2}) \quad \text{(II.4.10.)}$$

According to Shkolnikov et al. (2001), decomposition formula by Arriaga (1984) can be interpreted as:

$$e_0^2 - e_0^1 = \sum_x {}_i\Delta_x^{2,1} = \sum_x \left[l_x^1 \left(\frac{L_x^2}{l_x^2} - \frac{L_x^1}{l_x^1} \right) - T_{x+i}^1 \left(\frac{l_x^1}{l_x^2} - \frac{l_{x+i}^1}{l_{x+i}^2} \right) \right] \quad \text{(II.4.11.)}$$

Since $T_x = l_x * e_x$ and ${}_iL_x = l_x * e_x - l_{x+i} * e_{x+i}$, ${}_i\Delta_x^{2,1}$ can be simplified as:

$${}_i\Delta_x^{2,1} = l_x^1(e_x^2 - e_x^1) - l_{x+i}^1(e_{x+i}^2 - e_{x+i}^1) \quad \text{(II.4.12.)}$$

Therefore, the comparison of (II.4.11.) and (II.4.12.) shows that ${}_i\Delta_x^{2,1} = -{}_i\delta_x^{1,2}$. It implies that Arriaga (1984)'s formula is approximately identical to the formula proposed by Andreev (1982) and Pressat (1985), except that Arriaga did not use the symmetrical form of the formula (Shkolnikov et al., 2001).

Pollard (1982) developed a decomposition procedure based on a continuous approach to compare the difference between life expectancies. Mortality differentials are examined as a weighted function changes in mortality rates, as well as the interaction effects of the corresponding changes. Pollard assumed that interaction effects are minimal except when life expectancy at birth is smaller than 55 years. He did not separate the interaction terms while deriving the decomposition formula since interaction terms are not easy to compute, and their interpretation is difficult.

According to Pollard (1982), the change in life expectancy between time point 1 and time point 2 can be expressed as one of the following formulas:

$$e_0^2 - e_0^1 = \int_0^{\infty} (\mu_x^1 - \mu_x^2)\, {}_x p_0^2 e_x^1 d_x \tag{II.4.13.}$$

$$e_0^2 - e_0^1 = \int_0^{\infty} (\mu_x^1 - \mu_x^2)\, {}_x p_0^1 e_x^2 d_x \tag{II.4.14.}$$

where;

μ_x^1 and μ_x^2: instantaneous rate of mortality or force of mortality at time points 1 and 2,

${}_x p_0^1$ and ${}_x p_0^2$: probability of surviving from birth to age x at time points 1 and 2,

e_x^1 and e_x^2: life expectancy at age x at time points 1 and 2.

Formulas (II.4.13.) and (II.4.14.) represent the weighted averages of the mortality change between time point 1 and time point 2. According to Pollard (1982), there is no theoretical reason to choose ${}_x p_0^2 e_x^1$ or ${}_x p_0^1 e_x^2$ as a weighting function and suggests using their arithmetic mean or, in other words, the symmetrical form of the formula. Therefore, the difference between the two mortality schedules are quantified by using the formula:

$$e_0^2 - e_0^1 = \int_0^{\infty} (\mu_x^1 - \mu_x^2)\, w_x d_x, \quad w_x = \frac{1}{2}\left({}_x p_0^2\, e_x^1 + {}_x p_0^1\, e_x^2\right) \tag{II.4.15.}$$

where w_x is a weighting function.

Pollard (1982) proposed a numerical approximation of the formula as follows:

$$ {}_{n}Q_{x} = \int_0^n \mu_{x+t}\, dt = -\ln\left(\frac{l_{x+n}}{l_x}\right) \qquad \text{(II.4.16.)} $$

$$ e_0^2 - e_0^1 = ({}_1Q_0^1 - {}_1Q_0^2)w_{\frac{1}{2}} + ({}_4Q_1^1 - {}_4Q_1^2)w_3 + ({}_5Q_5^1 - {}_5Q_5^2)w_{7\frac{1}{2}} + ({}_5Q_{10}^1 - {}_5Q_{10}^2)w_{12\frac{1}{2}} + .. \qquad \text{(II.4.17.)} $$

The approximation gives more precise results when complete life tables are used, and life tables are not cut off at low ages (Caselli et al.,2005).

Pollard (1988) shown that the discrete formula of decomposition proposed by Arriaga (1984) can be expressed in terms of the continuous formula presented by Pollard (1982) depending on the age intervals. When age intervals get smaller, direct, indirect, and interaction effects in the discrete formulation, converge to the continuous formula's total effect.

As mentioned before, decomposition methods proposed by Andreev (1982), Arriaga (1984), and Pressat (1985) are essentially equivalent. However, Arriaga's method allows the separation of direct, indirect, and interaction effects, and it is more practical to apply. Therefore, the discrete method developed by Arriaga (1984) and the continuous form of the method proposed by Pollard (1982) are employed to decompose life expectancy change in Turkey in the scope of this study.

II.4.1.3. General Frameworks

Decomposition formulas presented in Section II.4.1.2 are used for specific purposes such as decomposing differences in life expectancy between two groups or variation in life expectancy over time within a group. It is not possible to compare more than two populations or other measures than life expectancy by using these formulas. Hence, general algorithms gained attention in the 2000s for the decomposition problem. This Section reviews "the algorithm of stepwise replacement" by Andreev et al. (2002) and “the model of continuous change” by Horiuchi et al. (2008).

Andreev et al. (2002) proposed an “algorithm of stepwise replacement” for decomposition of demographic measures by age and other compositional factors. Their method is based on the assumption that each demographic measure aggregates a matrix of elementary rates into a single measure. The change in a demographic indicator is presented by replacing elements from one matrix with the corresponding elements of the other matrix. Their method enables to decompose the changes in life expectancy and healthy life expectancy, as well as fertility measures such as parity-progression ratio and the total fertility rate. The stepwise decomposition method has the advantage of being generalizable, as it allows for the decomposition of a wide range of demographic measures in various population sub-groups.

Timonin et al. (2016) explained the general idea of the stepwise decomposition method as follows:

Let an index $f(.)$ includes 3 factors x, y, z identified at two-time points 1 and 2. The difference between two-time points can be estimated as:

$$
\begin{aligned}
f(x_2, y_2, z_2) - f(x_1, y_1, z_1) &= f(x_2, y_1, z_1) - f(x_1, y_1, z_1) \\
&+ f(x_2, y_2, z_1) - f(x_2, y_1, z_1) \\
&+ f(x_2, y_2, z_2) - f(x_2, y_2, z_1)
\end{aligned}
$$

Each of the three differences in the formula reflects the contribution of the shift of the relevant factor from time point 1 to time point 2. When a factor is moved from point 1 to point 2 (i.e., $x_1 - x_2$), it remains as x_2 in the replacement sequence. The number of replacement sequences depends on the number of factors; in this case, it equals 6 (all possible pathways among 3 factors). Stepwise replacement is employed for all replacement sequences, and the final components are estimated by averaging the resulting components from these sequences.

In the general stepwise algorithm, the replacement sequence of age components is suggested to run from young to old ages in life expectancy decomposition by Andreev et al. (2002). This approach guarantees that the results of stepwise decomposition are equal to the results of the existing formula by Andreev (1982), Arriaga (1984), and Pressat (1985).

Decomposition of life expectancies by a general stepwise algorithm is estimated by the formula (Andreev et al., 2002):

$$e_0^2 - e_0^1 = \sum_{x=0}^{w} \delta_x^{2-1} \quad \text{(II.4.18.)}$$

where, δ_x^{2-1} is the contribution of the age interval $(x, x+1)$ to the total difference:

$$\delta_x^{2-1} = \delta_{0|x+1}^{2-1} - \delta_{0|x}^{2-1} = e_0 M^{[x+1]} - e_0 M^{[x]} \quad \text{(II.4.19.)}$$

where $M^{[x]}$ is the vector consisting the age specific death rates ${}_1m_y^2$ at ages $y < x$ and ${}_1m_y^1$ at ages $y \geq x$ and w is the last age group.

Horiuchi et al. (2008) proposed a decomposition method based on "a model of continuous change." Their method is a part of the general framework that allows decomposing the difference in any aggregate measure. However, it differs from the stepwise replacement algorithm in terms of the assumption that; "values of the covariates change continuously along an actual or hypothetical dimension." The model of continuous change does not produce interaction terms and does not necessitate a consequential ordering of covariates. A large number of covariates can be handled by using this method. The model of continuous change is described as follows (Horiuchi et al.,2008):

Let y is a function of $x = [x_1, x_2, \ldots, x_n\ ]$ by n covariates at time t:

$$y(t) = f(x_1(t), x_2(t), \ldots, x_n(t)) \quad \text{(II.4.20.)}$$

The difference in y between time points t_1 and t_2 can be written as:

$$y(t_2) - y(t_1) = \int_{t_1}^{t_2} \frac{d}{dt} y(t) dt \qquad \text{(II.4.21.)}$$

Rearranging the equation leads to:

$$y(t_2) - y(t_1) = \int_{t_1}^{t_2} \left\{ \sum \frac{\partial}{\partial x_i(t)} y(t). \frac{d}{dt} x_i(t) \right\} dt = \sum_{i=1}^{n} \int_{x_i(t_1)}^{x_i(t_2)} \frac{\partial}{\partial x_i(t)} y(t) dx_i(t) \qquad \text{(II.4.22.)}$$

The simplified version of the equation is written by dropping t in $y(t)$ and $x(t)$:

$$y_2 - y_1 = \sum_{i=1}^{n} c_i \text{ , where } c_i = \int_{x_{i1}}^{x_{i2}} \frac{\partial y}{\partial x_{i1}} dx_i \qquad \text{(II.4.23.)}$$

In this formulation, c_i reflects the effect of x_i on y. Therefore, when formulating decomposition of life expectancy differences, c_i can be considered as the effect of the death rate of the i^{th} age group on total life expectancy change from time point 1 to time point 2.

$$c_i = \int_{M_{i(1)}}^{M_{i(2)}} \frac{\partial e_0(t)}{\partial M_i(t)} dM_i(t) \qquad \text{(II.4.24.)}$$

In this case, life expectancy is a function of age-specific death rates as follows:

$$e_0(t) = f(M_1(t), M_2(t), \ldots, M_n(t)) \qquad \text{(II.4.25.)}$$

Numerical approximation for c_i is presented by Horiuchi et.al. (2008) as follows:

First, for each value of x_i, the period between x_{i1} and x_{i2} is divided into N equal intervals:

$$\Delta x_i = (x_{i2} - x_{i1})/N \qquad \text{(II.4.26.)}$$

Two vectors are defined for changing the value of x_i in the k^{th} interval while others are constant:

$$x_{ik+} = [x_j \mid x_j = x_{ik+} \; if \; j = i; \; x_j = x_{ik\blacksquare} \; if \; j \neq i]$$
$$x_{ik-} = [x_j \mid x_j = x_{ik-} \; if \; j = i; \; x_j = x_{ik\blacksquare} \; if \; j \neq i] \qquad \text{(II.4.27.)}$$

where $x_{ik+} = x_{i1} + k\,\Delta x_i$, $x_{ik\blacksquare} = x_{i1} + (k - 0.5)\,\Delta x_i$ and $x_{ik-} = x_{i1} + (k - 1)\Delta x_i$ and x_{ik+}, $x_{ik\blacksquare}$ and x_{ik-} are the values of x_i at the end, midpoint and beginning of the k^{th} interval, respectively.

Therefore, the difference in the function y between time point 1 and time point 2 can be approximated as:

$$y_2 - y_1 \cong \sum_{i=1}^{n} \hat{c}_i \text{ , where } \hat{c}_i = \sum_{k=1}^{N} \{f(x_{ik+}) - f(x_{ik-})\} \qquad \text{(II.4.28.)}$$

The computational procedure is based on the assumption that the covariates will change linearly as they gradually shift between two-time points. Total change in the dependent variable (y) is considered an accumulation of small steps while covariates move along a linear path in the interval x_{i1} and x_{i2}. The number of intervals, N, has to be chosen large enough to make the proportional error close to zero, and 20 is usually large enough for producing accurate results.

The model of continuous change does not produce interaction terms as the covariates are assumed to change continuously, which interaction effects are not allowed to enter the decomposition equation. Horiuchi et al. (2008) claim that interaction effects in the previous decomposition methods reflect an incomplete separation procedure for examining each variable's contribution to the total difference. According to Horiuchi et al. (2008), the stepwise replacement algorithm also avoids interaction effects by shifting the value of covariates in a particular order.

General frameworks reviewed in this section can be used for decomposing several demographic measures and decomposing them by various dimensions. In this study's scope, a stepwise replacement algorithm and model of continuous change are employed for decomposing life expectancy differences in Turkey.

II.4.2. Data Sources

Information on Turkish mortality was mainly derived from census and survey data due to ineffective death registration system until recent past. From 1931 to 1949, the Turkish Statistical Institute (TurkStat) collected death statistics for the most highly populated 25 city centers, from 1950 to 1956 for all city centers, and from 1957 to 2009 for all city and district centers. In these periods, besides the coverage problem, there were severe underreporting and misreporting problems in the death statistics.

In 2009, the death registration system underwent a structural transformation by changing the data collection procedure and collecting data for the whole country. However, this study aims to assess the long-term mortality trends by using decomposition methods. Historical data on mortality levels needed for this study is mainly obtained from direct and indirect estimates based on demographic surveys and censuses. The first population census in Turkey was held in 1927, and subsequent censuses were held every five years between 1935 and 1990. The last population census was applied in 2000, and starting from 2007, population data is collected by Address Based Population Registration System (ABPRS). Furthermore, starting from 2021, register based “Population and Housing Census (PHC)” will be implemented by TurkStat.

In Turkey, on the other hand, “Hacettepe University Institute of Population Studies (HUIPS)” has been conducting demographic surveys for over 50 years. The first demographic survey was the "1968 Survey on Family Structure and Population Problems in Turkey". Subsequent surveys were; "1973 Survey on Population Structure and Population Problems in Turkey", "1978 Turkish Fertility Survey", 1983 and 1988

"Turkish Population and Health Survey" and "Turkey Demographic and Health Surveys 1993, 1998, 2003, 2008, and 2013."

Decomposition methods reviewed in Section II.4.1 require detailed death records and population distribution by age and sex. However, due to the lack of register data, life tables are constructed using model life tables within the scope of this study. The following information is required for decomposing the change in crude death rates and life expectancies in Turkey in the specified periods:

- Life tables for Turkey for each 5-year period between 1920 and 2015.
- Life tables for specified sub-population groups for the period 1990-2015.
- Population distribution by age and sex.

Life tables needed for decomposition analysis are constructed by using direct and indirect estimates of mortality rates. Estimation procedures of life table distribution are presented in Section II.4.3. and II.4.4.

II.4.3. Construction of Life Tables for Turkey

Life tables provide the required information for decomposing life expectancy change. In Turkey, the first empirical life tables were constructed based on the 1968 survey. Shorter and Macura (1982) constructed a national life table for 1966-67; they also estimated the past trends in early age mortality based on the same survey. Their estimates provide information on historical mortality trends. They estimated the infant mortality rates (IMR) for the 1945-70 period using the Macura birth survival method to the 1968 survey data. Infant mortality rates for the earlier ten years, 1935 to 1945, were estimated by using reverse extrapolation of the gap between adult and child mortality between 1945-50 and 1955-60 periods (Shorter and Macura,1982).

Table II.4.3.1. Indirect Estimates of Infant Mortality Rates, 1935-1990

Year	Period	Shorter/Macura	SIS 1995[1]	Hancıoğlu
1935				
1936				
1937	1935-1940		0,273	
1938				
1939				
1940				
1941				
1942	1940-1945		0,306	
1943				
1944				
1945		0,274		
1946				
1947	1945-1950	0,270	0,360	
1948				
1949		0,255		
1950				
1951		0,245		
1952	1950-1955		0,233	
1953		0,235		
1954				
1955		0,224		
1956				
1957	1955-1960	0,212	0,203	
1958				
1959		0,199		
1960				
1961		0,189		
1962	1960-1965		0,176	
1963		0,178		
1964				
1965		0,169		
1966				0,169
1967	1965-1970	0,156	0,151	0,168
1968				0,164
1969				0,161
1970				0,157
1971				0,154
1972	1970-1975		0,139	0,151
1973				0,147
1974				0,140
1975				0,139
1976				0,133
1977	1975-1980		0,126	0,129
1978				0,128
1979				0,123
1980				0,121
1981				0,119
1982	1980-1985		0,109	0,115
1983				0,111
1984				0,101
1985				0,091
1986				0,081
1987	1985-1990		0,067	
1988				
1989				
1990				

[1] Mortality estimates of Shorter and Macura (1982) are presented for 5-year periods between 1935-1970.

On the other side, SIS (1995) provided mortality estimates for 5-year periods between 1935 and 1990. They presented estimates of Shorter and Macura (1982) for the period 1935-1970. From 1970 to 1990, they presented a census-based estimation of infant mortality rates. Hancıoğlu (1991) estimated infant mortality rates from 1966 to 1986 using information from demographic surveys. Indirect estimates of infant mortality for the period 1935-1990 are shown in Table II.4.3.1.

Direct estimates of mortality rates are available from demographic surveys starting from the late 1960s. Demographic surveys also provide information on the mortality levels by socioeconomic variables like region, residence, or educational status. The estimates of infant mortality from demographic surveys are presented in Table II.4.3.2.

Table II.4.3.2. Direct Estimates of Infant Mortality Rates

Survey	Period	IMR
1968	1965-1968	0,165
1978	1972-1977	0,134
1983	1979-1982	0,095
1988	1985-1987	0,078
1993	1989-1993	0,053
1998	1994-1998	0,043
2003	1999-2003	0,029
2008	2004-2008	0,017
2013	2009-2013	0,013

Infant mortality rates used for the trend estimates of life expectancy between 1920 and 2015 are shown in Table II.4.3.3. Therefore, indirect estimates of Shorter and Macura for the 5-year periods between 1935 and 1970; indirect estimates of SIS for the periods between 1970 and 1990; mid-period estimates from TDHS for the periods after 1990 are used for obtaining trend estimates of infant mortality rates for Turkey.

Table II.4.3.3. Infant Mortality Rates and Data Sources, 1920-2015

Reference Period	IMR	Source
1920-1925	-	-
1925-1930	-	-
1930-1935	-	-
1935-1940	0,273	Shorter/Macura
1940-1945	0,306	Shorter/Macura
1945-1950	0,260	Shorter/Macura
1950-1955	0,233	Shorter/Macura
1955-1960	0,203	Shorter/Macura
1960-1965	0,176	Shorter/Macura
1965-1970	0,151	Shorter/Macura
1970-1975	0,139	SIS 1995
1975-1980	0,126	SIS 1995
1980-1985	0,109	SIS 1995
1985-1990	0,067	SIS 1995
1989-1993	0,053	TDHS 1993
1994-1998	0,043	TDHS 1998
1999-2003	0,029	TDHS 2003
2004-2008	0,017	TDHS 2008
2009-2013	0,013	TDHS 2013

The following steps are applied for obtaining trend estimates for IMR (combined), IMR (males), and IMR (females) for the period 1920-2015. Trend estimates of IMR for both sexes combined are obtained by using the first three steps; IMR's for males and females are estimated separately by using the subsequent steps.

Step 1: Estimation of mid-period IMR's for the periods between 1990-2015

As shown in Table II.4.3.3, reference periods for IMR's are 5-year periods between 1920-25 and 1985-90. However, reference periods of IMR values from TDHS surveys depend on the survey date. For obtaining IMR values compatible with previous periods, mid-period estimates are obtained for the periods between 1990-2015 by using linear interpolation. Mid-period estimates are presented in the first column of Table II.4.3.4.

Step 2: Estimation of mortality trends for the periods between 1920-1935

Direct or indirect estimates of IMR shown in Table II.4.3.3 does not include the mortality levels for the periods 1920-25, 1925-30, and 1930-35. Since there is no information on the infant mortality trends for these periods, values are extrapolated using the TREND function of Excel, which returns values by fitting a straight line along data points using the method of least squares. A linear trend is assumed for each of the periods under consideration. The second column of Table II.4.3.4 demonstrates the extrapolated values.

Step 3: Smoothing IMR's for the whole period

After obtaining the estimates for the periods 1920-25, 1925-30, and 1930-35, a smoothing procedure is needed for obtaining trend estimates of IMR's from different data sources and estimation procedures. LOESS (locally estimated scatterplot smoothing), a nonparametric and locally weighted regression method, was introduced by Cleveland (1979) and Cleveland and Devlin (1988). LOESS fits a series of local regressions along each point of the data series, and more weight is given to the closest points to the point being predicted. The size of the neighborhood is determined by a "span" or "alpha" value that usually takes values between 0 and 1. The smoothness of the trend estimate depends on the span value; as the span value increases, the smoothness of the trend estimate also increases and vice versa. As a final step, local regressions for each point are connected to each other with a line for obtaining a trend estimate of the data set.

"Loess" function of R Statistical Software is used to perform a smoothing procedure for the infant mortality rates, and a span of 0.5 is chosen to capture the trend of the data. The results of LOESS smoothing are shown in the last column of Table II.4.3.4.

Table II.4.3.4. Trend Estimates of IMR, 1920-2015

Reference Period	Original	TREND	LOESS
1920-1925	-	0,320	0,315
1925-1930	-	0,304	0,306
1930-1935	-	0,288	0,298
1935-1940	0,273	0,273	0,290
1940-1945	0,306	0,306	0,283
1945-1950	0,260	0,260	0,267
1950-1955	0,233	0,233	0,235
1955-1960	0,203	0,203	0,202
1960-1965	0,176	0,176	0,176
1965-1970	0,151	0,151	0,154
1970-1975	0,139	0,139	0,140
1975-1980	0,126	0,126	0,124
1980-1985	0,109	0,109	0,101
1985-1990	0,067	0,067	0,074
1990-1995	0,050	0,050	0,051
1995-2000	0,039	0,039	0,036
2000-2005	0,027	0,027	0,024
2005-2010	0,016	0,016	0,017
2010-2015	0,012	0,012	0,013

Step 4: Segregation of IMR procedure

After achieving trend estimates of IMR's for both sexes combined, IMR (males) and IMR (females) are estimated using TDHS results. In Turkish Demographic and Health Surveys, the infant mortality rate estimates are provided for both sexes combined for 5 years preceding the survey. Infant mortality rates by sex of the child are also available from the TDHS for 10 years preceding the surveys.

Segregation of the IMR procedure developed by Toros (2000) is used to calculate IMR for males and females for five years preceding the survey. The procedure requires IMR (combined) for five years preceding the survey, IMR for males and females for ten years preceding the survey, and sex ratio at birth.

The segregation procedure is applied to the results of TDHS 1993 to TDHS 2013, and results are shown in Table II.4.3.5.

Segregation of IMR Procedure:

1- IMR = (male deaths + female deaths) / (male births + female births
   = (total infant deaths) / (total births)
2- SRB (sex ratio at birth) = 1,05
3- Female births = 100000
4- Male births = 105000
5- Total infant deaths = (IMR * total births)

Determination of female and male death rates:

6- Sex ratio for deaths = ((IMR males-10 years)*(cohort size males)) / ((IMR females-10 years)*(cohort size females)), where

   Cohort size males = 105

   Cohort size females = 100

7- Female deaths = (total infant deaths*share of female deaths)
8- Male deaths = (total infant deaths - female deaths)

Calculation of IMR for males and females:

9- IMR (females-5 years) = (female deaths/size of birth cohort)
10- IMR (males-5 years) = (male deaths/size of birth cohort)

Source: Toros (2000)

Table II.4.3.5. Infant Mortality Rates from TDHS, 1993-2013

Source	IMR (combined)	IMR (males) (10 years)	IMR (females) (10 years)	IMR (males) (segregated)	IMR (males) (segregated)
TDHS 1993	0,053	0,071	0,066	0,055	0,051
TDHS 1998	0,043	0,051	0,046	0,045	0,041
TDHS 2003	0,029	0,039	0,036	0,030	0,028
TDHS 2008	0,017	0,028	0,023	0,019	0,015
TDHS 2013	0,013	0,015	0,020	0,011	0,015

Step 5: Initial estimates of IMR's for females and males

Initial estimates of the trends in IMR (males) and IMR (females) are obtained by using the smoothed trend estimates of IMR (combined) and segregated IMR values coming from TDHS 1993, 1998, 2003, and 2008. TDHS 2013 is excluded from calculations because of the low number of cases that complicates the subdomain level of estimates (HUIPS, 2014).

First, segregated IMR values shown in Table II.4.3.5 are interpolated to mid-periods. The mean of the differences between IMR (combined) and segregated IMR for each sex from TDHS results are assumed to be equal to the difference between estimated IMR's combined and IMR's for each sex. The mean differences shown in Table II.4.3.6 are used to obtain the initial estimates of IMR (males) and IMR (females) by subtracting them from the estimated IMR's for both sexes for each period between 1920 and 2015. Initial estimates of IMR (males) and IMR (females) are shown in the second and third columns of Table II.4.3.7.

Table II.4.3.6. Estimated Differences for Initial Estimates of IMR (males) and IMR (females)

Reference Period	IMR (combined)	IMR (males)	IMR (females)	IMR - IMR(males)	IMR – IMR(females)
1990-1995	0,0503	0,0522	0,0482	-0,0020	0,0021
1995-2000	0,0394	0,0413	0,0374	-0,0019	0,0020
2000-2005	0,0265	0,0277	0,0252	-0,0012	0,0013
2005-2010	0,0161	0,0169	0,0152	-0,0008	0,0009
Mean				-0,0015	0,0016

Step 6: Final estimates of IMR’s

Once the initial IMR’s for males and females are estimated separately, sex differentials in the IMR trends are derived using the “General pattern” of the United Nations model life tables. The difference between the initial estimates of male and female IMR’s is equal for each reference period between 1920 and 2015. The mortality gap between males and females is assumed to be widened retrospectively. The difference between male and female mortality rates in the first and last levels of the General pattern life table is accepted as the difference between the first and last periods (1920-25 and 2010-2015). The mean difference (0.0025) is added backwardly starting from the difference for the latest period, and estimated differences between male-female infant mortality patterns are derived. Lastly, an increase per period is applied to the initial IMR estimates for males and females for the periods between 1920 and 2015 by adding half of the increase to the male IMR’s and subtracting the other half from female IMR’s for each period. The difference between the final estimates of IMR’s for males and females is equal to the estimated difference derived from the model life table pattern. The estimation procedure and final estimates of IMR’s are shown in Table II.4.3.7. The graphical representation of the original and estimated IMR’s and final estimates of IMR for both sexes, males and females are shown in Figure II.4.3.1 and Figure II.4.3.2, respectively.

Table II.4.3.7. Trend Estimates of IMR (males) and IMR (females) from General Pattern

Reference Period	IMR (combined)	Initial IMR (males)	Initial IMR (females)	Increase per period	Final IMR (males)	Final IMR (females)
1920-1925	0,3147	0,3162	0,3132	0,0442	0,3383	0,2911
1925-1930	0,3062	0,3076	0,3046	0,0417	0,3285	0,2837
1930-1935	0,2981	0,2996	0,2966	0,0393	0,3192	0,2769
1935-1940	0,2895	0,2910	0,2880	0,0368	0,3094	0,2696
1940-1945	0,2830	0,2845	0,2815	0,0344	0,3017	0,2643
1945-1950	0,2666	0,2681	0,2650	0,0319	0,2840	0,2491
1950-1955	0,2355	0,2370	0,2339	0,0295	0,2517	0,2192
1955-1960	0,2019	0,2034	0,2003	0,0270	0,2169	0,1868
1960-1965	0,1757	0,1772	0,1742	0,0246	0,1895	0,1619
1965-1970	0,1541	0,1556	0,1526	0,0221	0,1667	0,1415
1970-1975	0,1396	0,1410	0,1380	0,0196	0,1509	0,1282
1975-1980	0,1244	0,1259	0,1228	0,0172	0,1345	0,1142
1980-1985	0,1014	0,1029	0,0998	0,0147	0,1103	0,0925
1985-1990	0,0745	0,0760	0,0729	0,0123	0,0821	0,0668
1990-1995	0,0514	0,0529	0,0498	0,0098	0,0578	0,0449
1995-2000	0,0361	0,0376	0,0345	0,0074	0,0412	0,0308
2000-2005	0,0243	0,0258	0,0227	0,0049	0,0283	0,0203
2005-2010	0,0166	0,0181	0,0150	0,0025	0,0193	0,0138
2010-2015	0,0126	0,0141	0,0111	0,0000	0,0141	0,0111
Total difference between first and last levels of model LT					0,0442	
Difference per level					0,0025	

Figure II.4.3.1. Original and Estimated IMR's, 1920-2015

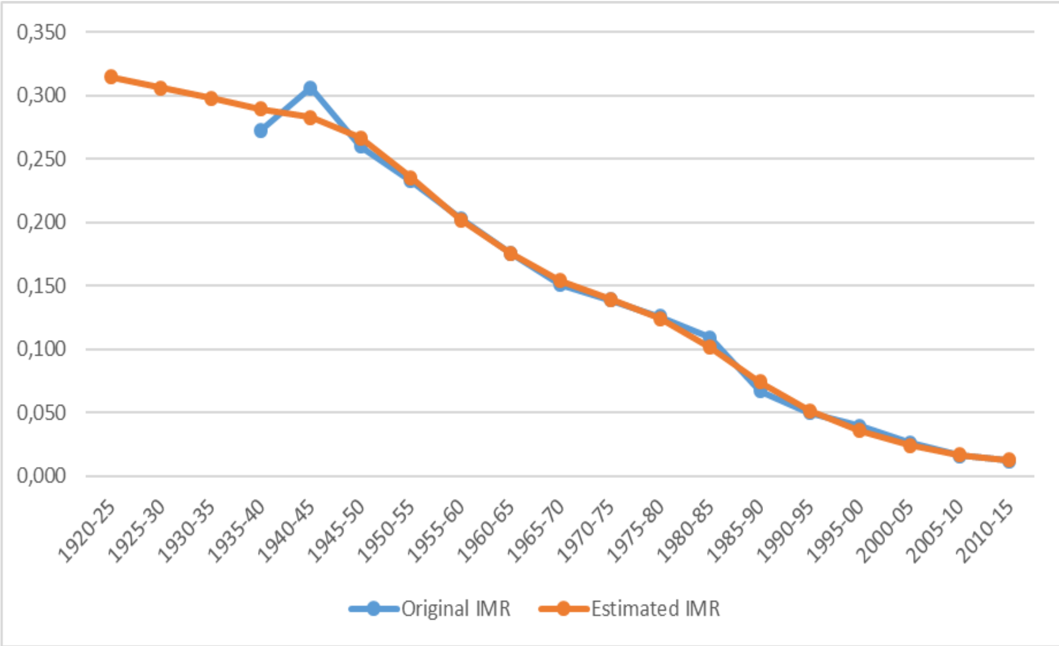
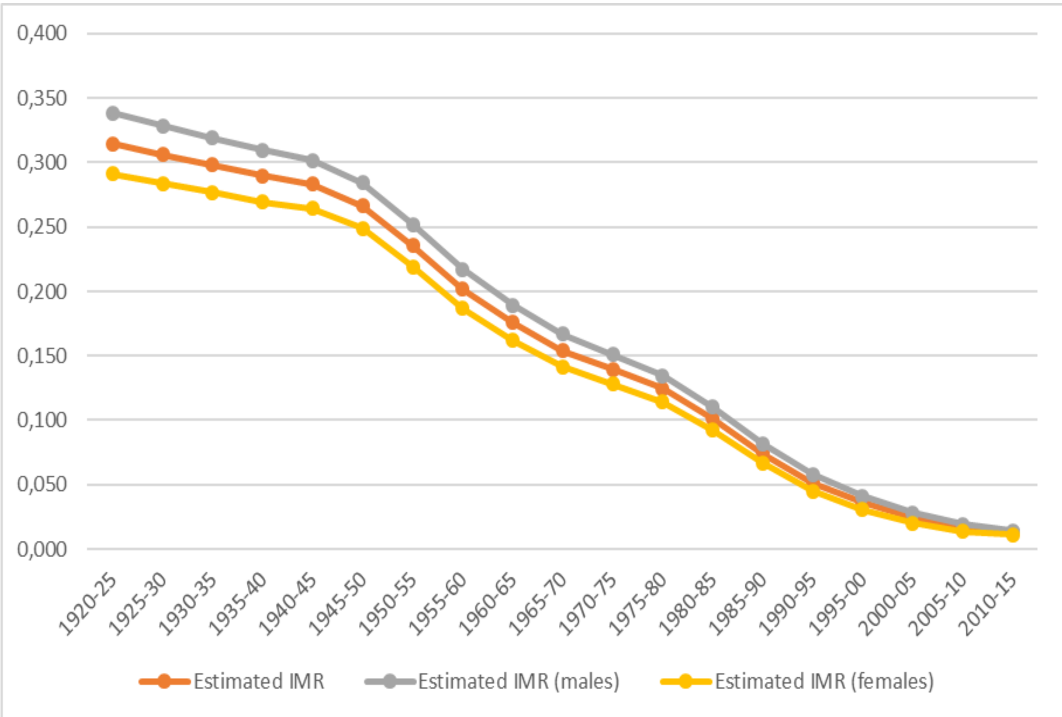


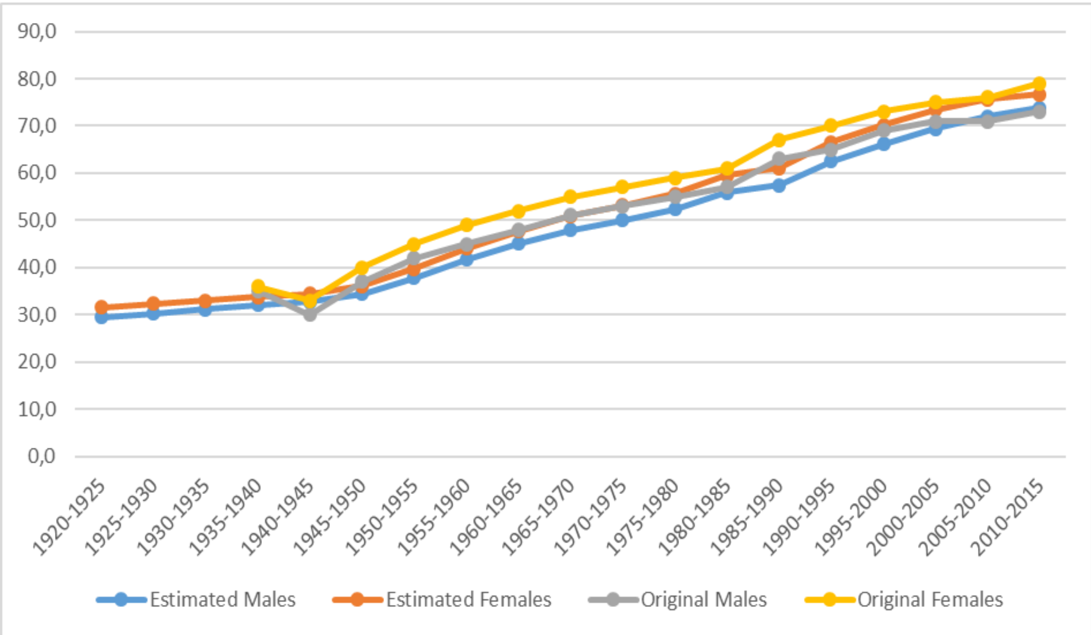
Figure II.4.3.2. Final Estimates of IMR, 1920-2015



Step 7: Construction of Life Tables

The life tables for the 19 periods between 1920 and 2015 are constructed by the MATCH application of the MORTPAK software package. MATCH application requires the mortality level and model life table pattern for each sex for constructing the life tables. Estimated IMR values are used for specifying mortality levels. The model life table pattern is chosen according to the demographic characteristics of the corresponding periods. For the periods between 1920 and 1985, the Coale-Demeny East Model life table family is used. Coale-Demeny West Model is selected as a model life table pattern for the periods between 1985 and 2015. The cut point is selected according to the original IMR values; there is a sharp decrease between the periods 1980-85 and 1985-90. The mortality pattern is assumed to be shifted to the "West" model in the 1985-90 periods. Figure II.4.3.3 displays the original and estimated life expectancies for males and females from 1923 to 2013.

Figure II.4.3.3. Original and Estimated Life Expectancies Based on Trend Estimates of IMR



Source (original LE): Koç et al. (2010)

II.4.4. Construction of Life Tables for Sub-Population Groups

Life expectancy differences by education, wealth status, place of residence, and region are compared for the period 1993-2013[2] by using TDHS data sets. Because the number of observations in the TDHS 2018 data set was insufficient to perform detailed computations for sub-population groups, the decomposition analyses were limited to the 1993-2013 period. Furthermore, while it was possible to obtain mortality rates from the registration data by adjusting for coverage, underreporting, and misreporting issues, the details of the sub-population groups were not available for the specified period. Therefore, TDHS 1993 and TDHS 2013 data sets were used to analyze the mortality change by background characteristics.

TDHS 1993 and TDHS 2013 are part of the series of quinquennial demographic surveys held by HUIPS. The purpose of the TDHS 1993 was to collect data on fertility trends and levels, early-age mortality, maternal and child health, and family planning. The survey's goal was to produce estimates of indicators for the entire country, urban and rural settlements, and the country's five major regions. Fieldwork was implemented from August to October 1993, and 6519 women in 8619 households were successfully interviewed (HUIPS, 1994).

The “household questionnaire” and the “individual questionnaire for ever-married women of childbearing age” were used in TDHS 1993. The household questionnaire was designed to collect data on all regular members and visitors to the selected households, as well as data on their socio-economic level. The individual questionnaire for ever-married women gathered information about fertility characteristics, contraceptive prevalence, health and women's status, and infant and child mortality.

The tenth national-level demographic and health survey undertaken by HUIPS was the TDHS-2013. The major goal of the TDHS-2013 was to produce data on socio-economic features of households and women aged 15 to 49, as well as fertility and

[2] Reference periods are 1988-1993 and 2008-2013, respectively.

marriage patterns, maternal and child health, early-age mortality, women's and children's nutritional status, family planning and reproductive health. The findings of the survey were presented for the entire country, urban and rural settlements, five major regions and 12 NUTS1 regions. Fieldwork was implemented between September 2013 - January 2014, and 9746 women in 11794 were interviewed successfully (HUIPS, 2014).

In TDHS 2013, the household and the individual questionnaires were employed. They were designed using the model questionnaires from the DHS Program as well as previous questionnaires used in Turkish population and health surveys. The TDHS-2013 individual questionnaire was created to collect data from all women, independent of their marital status (HUIPS, 2014).

In the scope of this study, infant mortality rates are calculated for each compositional factor for constructing life tables for each factor. Infant mortality rates by educational level, wealth status, region, and residence are used to analyze their effect on overall life expectancy. The mortality differentials between five regions of Turkey and between urban and rural settlements are examined using the variables "region" and "type of place of residence." Infant mortality rates are calculated for each of the five regions and rural-urban residences for males and females, separately.

Three educational categories are created by using the variable “education in single years” for examining the mortality differentials between educational levels. 0-4 years of education is categorized as “no education/primary incomplete”; 5-7 years as “primary/secondary incomplete” and 8 and higher years as “secondary and higher.”

A three-category wealth index is constructed using the variables related to housing characteristics and ownership of durable goods for each survey. The principle components analysis approach is used to create the wealth index (Filmer and Pritchett, 2001). Three categories are defined as "lowest," "middle," and "highest." Three categories are aggregated by selecting the cut-off points for wealth index factor scores, which is a variable derived during principal component analysis. The wealth index variable is constructed in household data set and merged with women data set for achieving infant mortality rates for every category of the wealth index.

The calculations are employed for 5-year preceding the surveys for both sexes combined and for 10-year preceding the surveys for females and males for avoiding the potential irregularities because of the low number of cases in each category. Then, segregation of IMR procedure explained in Section II.4.3 is applied for obtaining infant mortality rates for males and females separately. 5-year IMR values for sub-population groups for 1993 and 2013 are shown in Table II.4.4.1.

Table II.4.4.1. 5-year IMR Values for Sub-Population Groups, Both Sexes Combined

Groups	Categories	1993	2013
Wealth Status	Lowest	0,0675	0,0171
	Middle	0,0493	0,0118
	Highest	0,0262	0,0112
Educational attainment	No education /primary incomplete	0,0681	0,0148
	Primary/secondary incomplete	0,0515	0,0124
	Secondary and higher	0,0132	0,0135
Type of place of residence	Urban	0,0440	0,0128
	Rural	0,0654	0,0149
Region	West	0,0427	0,0109
	South	0,0554	0,0146
	Central	0,0579	0,0178
	North	0,0442	0,0090
	East	0,0600	0,0138

Before segregating the IMR's for males and females, IMR values for educational groups are adjusted for the highest education group (secondary +) because of the inconsistencies of the IMR values for the corresponding education group in Table II.4.4.1. 5-year IMR values for the years between 1993-2013 are calculated for the same educational categories for capturing the trend in the IMR values as shown in Table II.4.4.2. IMR values for the highest educational group for 1993 and 2013 are adjusted as presented in Table II.4.4.2. The mean of the ratio of the change in the other two educational groups in the consecutive years is used to adjust the IMR values for the highest educational group.

Table II.4.4.2. Adjustment of IMR

	IMR (combined) - 5 years Educational groups			Ratio of change between 1993 -98		Mean of ratios	Adjusted IMR
	No/prim.in.	Pri.	Sec.	No/prim.in.	Primary		Secondary
1993	0,0681	0,0515	0,0132	0,8886	0,7431	0,8159	0,0358
1998	0,0605	0,0383	0,0292				
2003	0,0450	0,0252	0,0181	Ratio of the change between 2008-13			
2008	0,0211	0,0190	0,0118				
2013	0,0148	0,0124	0,0135	0,7019	0,6523	0,6771	0,0080

By using the segregation procedure, 10-year IMR values are estimated for males and females. Table II.4.4.3 displays the segregated IMR's for males and females.

Table II.4.4.3. 10-year IMR Values for Sub-Population Groups

		10-year IMR			
		Females		Males	
		1993	2013	1993	2013
Education	No/prim.in.	0,0854	0,0326	0,1001	0,0194
	Primary/sec.in.	0,0621	0,0178	0,0533	0,0209
	Secondary	0,0139	0,0161	0,0319	0,0067
Wealth	Lowest	0,0863	0,0253	0,0910	0,0261
	Middle	0,0626	0,0195	0,0688	0,0139
	Highest	0,0303	0,0151	0,0304	0,0035
Residence	Urban	0,0558	0,0188	0,0601	0,0141
	Rural	0,0799	0,0251	0,0853	0,0185
Region	West	0,0500	0,0182	0,0498	0,0088
	South	0,0588	0,0203	0,0711	0,0219
	Central	0,0673	0,0178	0,0773	0,0124
	North	0,0578	0,0132	0,0772	0,0126
	East	0,0882	0,0263	0,0837	0,0227

However, the segregation procedure did not give consistent results for some of the categories, specifically for 2013. Inconsistencies of the 10-year IMR's are adjusted as follows:

1- Sex ratio (male/female) of the 10-year IMR's are calculated

2- Sex ratios of IMR's are assumed to be 1,13 for 1990s; 1,10 for 2000s[3]

3- Sex ratios out of the range 0,8-1,4 are adjusted by expected ratios. (For example, the sex ratio of infant mortality is 2,29 for the highest educational group in 1993; it is replaced by an expected ratio of 1,13, and 10-year IMR's are ignored. Segregated IMR's are directly calculated from 5-year IMR for both sexes and sex ratio of IMR)

4- Segregation procedure is applied, adjusted, and segregated IMR's are achieved (Table II.4.4.4.)

[3] Retrieved from Sawyer (2012) (https://doi.org/10.1371/journal.pmed.1001287.s002)

Table II.4.4.4. Segregated and Adjusted 5-year IMR Values

		Females		Males	
		1993	2013	1993	2013
Education	No/prim.in.	0,0626	0,0141	0,0734	0,0155
	Primary	0,0555	0,0114	0,0477	0,0134
	Secondary	0,0336	0,0076	0,0380	0,0083
Wealth	Lowest	0,0657	0,0169	0,0693	0,0174
	Middle	0,0469	0,0112	0,0516	0,0123
	Highest	0,0261	0,0107	0,0262	0,0117
Residence	Urban	0,0423	0,0122	0,0456	0,0134
	Rural	0,0632	0,0142	0,0675	0,0156
Region	West	0,0428	0,0104	0,0426	0,0114
	South	0,0500	0,0140	0,0605	0,0151
	Central	0,0538	0,0169	0,0618	0,0186
	North	0,0377	0,0092	0,0504	0,0088
	East	0,0616	0,0148	0,0585	0,0128

Once infant mortality rates are obtained, life tables are produced for each category using the MATCH application of MORTPAK software. Coale - Demeny West Model is used as a model life table pattern for each category. Each category's population composition is enumerated from household-level data for males and females by age groups.

II.4.5. Comparison of the Methods of Life Expectancy Decomposition

Life expectancy differences between the periods 1920-25 and 2010-15 are decomposed by using four different methods proposed by Arriaga (1984), Pollard (1982), Andreev et al. (2002), and Horiuchi et al. (2008). As mentioned in Section II.4.1, decomposition results are more precise when complete life tables are used, particularly for Pollard's method (1982). Therefore, complete life tables are constructed by using the UNABR procedure of the MORTPAK software. UNABR procedure estimates single-year death probabilities by graduating the abridged age-specific probabilities of dying.

The decomposition method proposed by Arriaga is applied by using the formulas II.4.5, II.4.6, and II.4.7, as shown in Section II.4.1. The corresponding formulas reflect the “direct, indirect, and interaction effects”; their sum equals the total contribution of each age to the overall change. Numerical approximation of Pollard’s method is used as shown in the formulas II.4.16 and II.4.17 in Section II.4.1.

Stepwise replacement algorithm by Andreev et al. is implemented by using the “DemoDecomp” package in R Statistical Software (Riffe, 2018). The decomposition algorithm of stepwise replacement is based on formulas II.4.18 and II.4.19 and “stepwise_replacement” function of the DemoDecomp package is used for implementing the analysis. The calculations with “stepwise_replacement” function require an argument that converts age specific death rates to life expectancy at birth; that is defined as “LTabr” function in the package. “LTabr” function implements the abridged life table formulas for returning life expectancy at birth. However, our analysis requires unabridged version of the function. For this reason, a function (ex.per) provided by Jdanov and Shkolnikov (2014) is borrowed for the unabridged case.

The model of continuous change by Horiuchi et al. is also applied using the “DemoDecomp” package based on formulas II.4.27 and II.4.28 as shown in Section

II.4. The function “horiuchi” is already defined in the package and the same function (ex.per) is used as an argument for the unabridged life table.

Horiuchi et al. (2008) suggest that aggregating decomposition results for multiple subintervals give more precise results than applying single decomposition for the whole period. Therefore, life expectancy changes between 1920/25-2010/15 are decomposed in two different ways. First, changes in each five-year period are decomposed and aggregated for the whole period. Results are presented in Table II.4.5.1 for males and Table II.4.5.2 for females. Secondly, the change in the 90 years is decomposed using the first and last periods; results are displayed in Table II.4.5.3 and II.4.5.4. For each case, the effects of single age groups are aggregated for age categories, as shown in the corresponding tables.

Table II.4.5.1. Aggregated Results of Decomposition Analysis, Males, 1920-2015

Age	Arriaga	Pollard	Andreev	Horiuchi
0	18,78	18,43	18,47	18,47
1-4	7,60	7,60	7,60	7,60
5-14	2,55	2,56	2,56	2,56
15-24	2,37	2,38	2,38	2,38
25-34	2,79	2,82	2,82	2,82
35-44	2,56	2,60	2,60	2,60
45-54	2,63	2,68	2,68	2,68
55-64	2,61	2,68	2,68	2,68
65-74	1,83	1,91	1,90	1,90
75+	0,56	0,60	0,60	0,60
Total	44,29	44,26	44,29	44,29

Table II.4.5.2. Aggregated Results of Decomposition Analysis, Females, 1920-2015

Age	Arriaga	Pollard	Andreev	Horiuchi
0	16,80	16,46	16,49	16,48
1-4	7,95	7,92	7,92	7,92
5-14	3,11	3,12	3,12	3,12
15-24	2,81	2,82	2,82	2,82
25-34	3,19	3,21	3,21	3,21
35-44	2,66	2,70	2,70	2,70
45-54	2,36	2,40	2,40	2,40
55-64	2,53	2,58	2,58	2,58
65-74	2,49	2,56	2,56	2,56
75+	1,71	1,83	1,81	1,81
Total	45,61	45,60	45,61	45,61

The results of the analysis aggregated from 18 decompositions show that; general stepwise replacement algorithm (Andreev) and model of continuous change (Horiuchi) gives almost identical results, as presented in Table II.4.5.1 and II.4.5.2. Methods by Arriaga and Pollard produced different results, particularly for the first age group. Still, results from all four methods can be considered close to each other in the aggregated case.

When the results of the single decomposition shown in Table II.4.5.3 and II.4.5.4 are considered, the differences between the results from decomposition methods are greater than the aggregated case. In Tables II.4.5.1 and II.4.5.2, the results for general stepwise replacement algorithm (Andreev) and model of continuous change (Horiuchi) were almost identical; however, when a single decomposition is applied for an extended period, they produced slightly different results. Methods by Arriaga and Pollard produced notably different results; furthermore, the value of the total change contradicts the previous value of total change for Pollard’s method.

Table II.4.5.3. Results of Decomposition Analysis, Males, 1920-2015

Age	Arriaga	Pollard	Andreev	Horiuchi
0	24,25	19,51	19,29	18,98
1-4	7,69	7,82	7,82	7,96
5-14	2,24	2,53	2,53	2,57
15-24	1,93	2,23	2,23	2,27
25-34	2,22	2,68	2,68	2,75
35-44	1,91	2,46	2,46	2,52
45-54	1,69	2,38	2,38	2,45
55-64	1,40	2,32	2,32	2,37
65-74	0,76	1,76	1,76	1,72
75+	0,19	0,83	0,82	0,68
Total	44,29	44,52	44,29	44,28

Table II.4.5.4. Results of Decomposition Analysis, Females, 1920-2015

Age	Arriaga	Pollard	Andreev	Horiuchi
0	22,01	17,38	17,25	16,76
1-4	8,44	8,13	8,13	8,21
5-14	2,93	3,12	3,12	3,16
15-24	2,50	2,74	2,74	2,79
25-34	2,69	3,11	3,11	3,17
35-44	2,07	2,55	2,55	2,61
45-54	1,69	2,22	2,22	2,28
55-64	1,62	2,33	2,33	2,43
65-74	1,25	2,29	2,29	2,42
75+	0,42	1,90	1,88	1,76
Total	45,61	45,78	45,61	45,60

II.5. DECOMPOSITION ANALYSIS

In this chapter, decomposition methods are employed to the differences in crude death rates and life expectancies in the period 1920 - 2015. In the first section, crude death rates are decomposed for the period 1945 - 2015 for Turkey. The second section covers the detailed decomposition analysis of life expectancy change by age in the period 1920-2015. In the last part, decomposition analyses are implemented for comparing the differences by educational attainment, region, wealth status, and place of residence for the period 1990-2015.

II.5.1. Decomposition of the Change in Crude Death Rates

The change in crude death rate between the periods 1945/50 – 1960/65, 1960/65 – 1980/85, and 1980/85 – 2010/15 are decomposed using Kitagawa's method as shown in Formula II.4.2. in Section II.4. The formula requires age-specific death rates (ASDR) and population composition by age categories. Therefore, ASDRs are obtained from life tables constructed using trend estimates of IMR's as explained in Section II.4.3. Population data is obtained from population censuses and registration system. Census data includes an unknown age category and it is distributed proportionately among the other age categories. Since ASDRs reflect the mortality situation of 5-year periods, population data is interpolated to the mid-periods for the corresponding years.

Population age distribution and ASDRs for the periods 1945-50, 1960-65, 1980-85, and 2010-15 are shown in Figure II.5.1.1 and Figure II.5.1.2. Mid-period population estimates, and age specific death rates are also displayed in Appendix A (Tables A.1-4).

Figure II.5.1.1. Population Age Distribution by Age Groups, 1945-2015

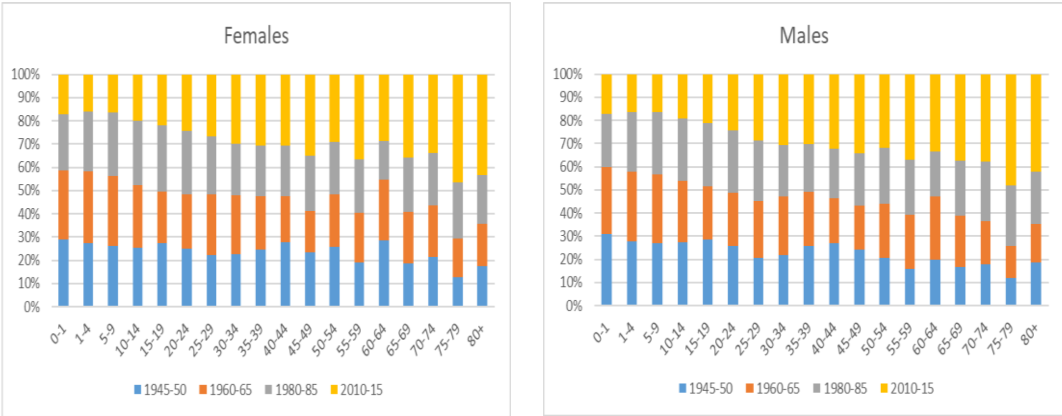
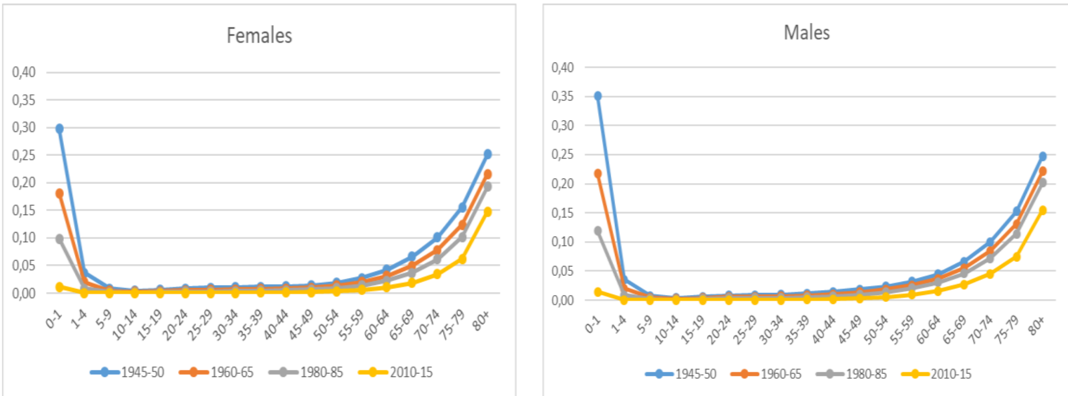


Figure II.5.1.2. Age Specific Death Rates, 1945-2015



Age distribution of population did not change significantly between the periods 1945-50 and 1980-85. Although there were fluctuations among age groups, the young age pattern was prominent in these years. However, in 2010-15, the population's age distribution significantly altered and started to shift to the older age groups.

Age-specific death rates gradually declined for almost all age categories in the study period, and the most striking decrease was observed in the (0-1) age group. The oldest age groups had slightly lower levels of mortality in the 2010-15 period.

Table II.5.1.1 shows the crude death rates estimated from ASDRs and population age distribution.

Table II.5.1.1. Crude Death Rates for Females and Males (per 1000)

Periods	Females	Males
1945-50	26,00	26,26
1960-65	17,66	17,88
1980-85	10,59	11,35
2010-15	6,62	6,19

The crude death rate decreased by 19,4 for females and 20,1 for males per 1000 population in 1945-1015. According to the decomposition analysis results, mortality decline contributed more than 100 percent for both sexes in this period. As displayed in Table II.5.1.2 and Table II.5.1.3, mortality change was the main contributor to the overall decline in all three periods between 1945-50 and 2010-15. In the first period, the mortality effect exceeded the total change in CDR for both sexes, and the increasing effect of age structure worked in the counter direction. However, the effect of age structure was much smaller than the mortality effect. In the second period, both mortality and age structure contributed to the decline; however, the substantial contribution originated from mortality decline for both sexes.

Table II.5.1.2. Decomposition of the Change in Crude Death Rates, Females

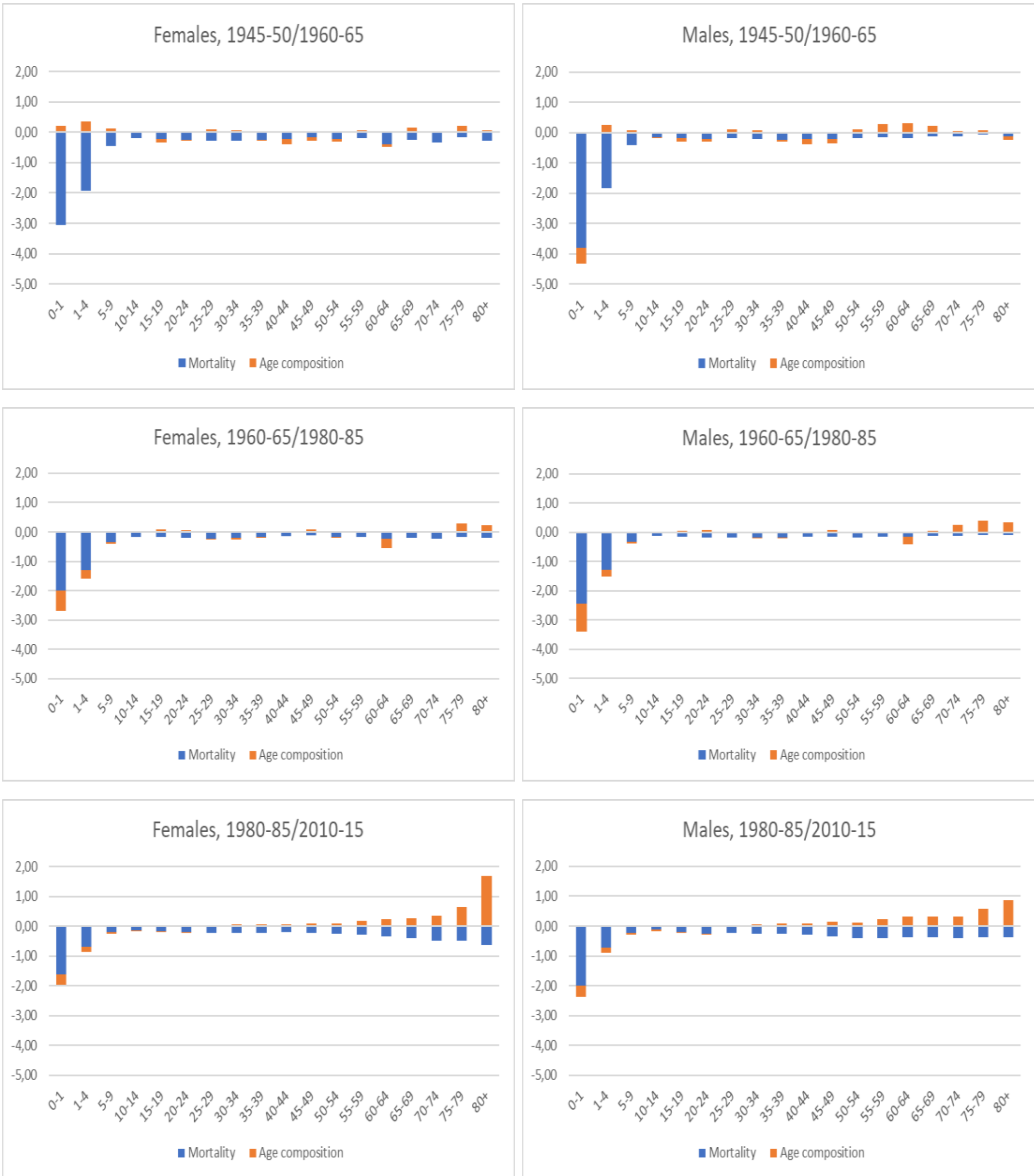
Periods	Total change	Change due to:	
		Mortality	Age structure
1945-50/1960-65	-8,35	-9,11	0,76
1960-65/1980-85	-7,07	-6,48	-0,58
1980-85/2010-15	-3,97	-7,05	3,08
1945-50/2010-15	-19,39	-22,25	2,86

Table II.5.1.3. Decomposition of the Change in Crude Death Rates, Males

Periods	Total change	Change due to:	
		Mortality	Age structure
1945-50/1960-65	-8,38	-8,63	0,25
1960-65/1980-85	-6,53	-6,25	-0,28
1980-85/2010-15	-5,16	-7,59	2,43
1945-50/2010-15	-20,07	-21,85	1,78

In the last period, two effects acted in the opposite direction, while mortality effect contributed to the decline, age structure effect tended to increase the death rate. The increasing effect of age structure in the last period can be followed from Figure II.5.1.3. The increasing share of the older population in this period led to an increasing impact on overall change. The decrease in early age mortality levels has been the main contributor to the overall decline in the first two periods.

Figure II.5.1.3. Contribution of Mortality and Age Composition to the Overall Change in Crude Death Rate



II.5.2. Decomposition of Life Expectancy Change by Age

Table II.5.2.1 displays the life expectancy values based on life tables constructed using trend estimates of IMR's explained in Section II.4.3. Over the entire period, men's and women's life expectancy increased by 44,4 and 45,2 years, respectively.

Table II.5.2.1. Life Expectancy at Birth, Turkey

Reference Period	$e_0(Males)$	$e_0(Females)$
1920-1925	29,4	31,5
1925-1930	30,3	32,3
1930-1935	31,1	33,0
1935-1940	32,0	33,8
1940-1945	32,8	34,4
1945-1950	34,5	36,1
1950-1955	37,8	39,7
1955-1960	41,7	44,0
1960-1965	45,0	47,7
1965-1970	47,9	51,0
1970-1975	50,0	53,2
1975-1980	52,3	55,6
1980-1985	55,8	59,5
1985-1990	57,4	61,1
1990-1995	62,5	66,5
1995-2000	66,1	70,2
2000-2005	69,4	73,4
2005-2010	72,0	75,6
2010-2015	73,8	76,7

For the specified periods, life expectancy is decomposed using Arriaga's method for exploring the direct and indirect effects. The periods are selected in accordance with the stages of mortality transition as presented in Section II.3. Therefore, decomposition analyses are conducted for three periods (1923-1963, 1963-1983, 1983-2013)[4] as presented in Table II.5.2.2.

[4] 5-year reference periods hereinafter referred to as mid-years of the periods.

Table II.5.2.2. Decomposition of the Life Expectancy Change, 1923-2013

Age	Females Direct effect	Females Indirect effect	Females Interaction effect	Females Total effect	Females Percent of total	Males Direct effect	Males Indirect effect	Males Interaction effect	Males Total effect	Males Percent of total
					1923-1963					
0	0,08	5,60	1,62	7,30	45,0	0,10	6,44	1,66	8,21	52,6
1-14	0,86	3,20	0,60	4,67	28,8	0,79	2,82	0,45	4,05	26,0
15-49	1,35	1,33	0,27	2,96	18,2	1,11	1,14	0,18	2,43	15,6
50-64	0,32	0,38	0,10	0,80	4,9	0,27	0,29	0,05	0,61	3,9
65-79	0,33	0,10	0,03	0,45	2,8	0,21	0,06	0,01	0,28	1,8
80+	0,03			0,03	0,2	0,02			0,02	0,2
Total	3,0	10,6	2,6	16,2	100,0	2,5	10,7	2,4	15,6	100,0
					1963-1983					
0	0,04	3,88	0,60	4,52	38,4	0,05	4,32	0,57	4,94	45,8
1-14	0,54	2,43	0,27	3,24	27,5	0,49	2,11	0,19	2,79	25,8
15-49	1,08	1,33	0,16	2,57	21,8	0,88	1,10	0,10	2,09	19,3
50-64	0,29	0,46	0,06	0,81	6,9	0,25	0,33	0,03	0,61	5,6
65-79	0,39	0,17	0,02	0,57	4,9	0,23	0,09	0,01	0,33	3,1
80+	0,06			0,06	0,5	0,04			0,04	0,4
Total	2,4	8,3	1,1	11,8	100,0	2,0	7,9	0,9	10,8	100,0
					1983-2013					
0	0,05	5,25	0,98	6,28	36,6	0,06	5,93	1,17	7,16	39,8
1-14	0,44	2,30	0,38	3,13	18,2	0,44	2,15	0,39	2,98	16,6
15-49	1,32	2,02	0,45	3,79	22,1	1,48	2,18	0,52	4,18	23,2
50-64	0,53	1,01	0,29	1,82	10,6	0,68	1,08	0,29	2,06	11,5
65-79	1,01	0,61	0,18	1,80	10,5	0,81	0,43	0,13	1,37	7,6
80+	0,34			0,34	2,0	0,24			0,24	1,3
Total	3,7	11,2	2,3	17,2	100,0	3,7	11,8	2,5	18,0	100,0

When we look at the first period (1923-1963), both females and males' life expectancy improved by around 16 years. The contribution of the 0-1 age group had an impact on the total change in years lived of roughly 45 percent for females and 52 percent for males. Between 1923 and 1963, the direct effect, which represents the contribution of deaths within an age group, made the most significant contribution to the mortality reduction in the 15-49 age group. However, when the indirect effect is considered, which reflects the impact of the additional survivors at the end of the corresponding age groups, the ages 0-1 and 1-14 had the largest share of the life expectancy gains.

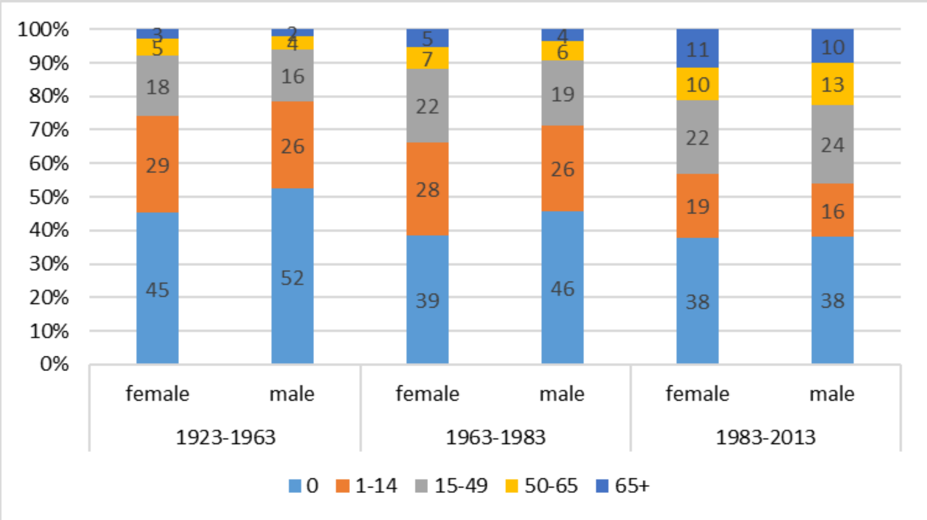
Between 1963 and 1983, female life expectancy increased by nearly 12 years, while male life expectancy raised by 11 years, and the impact of infant mortality was around 39 percent for females and 46 percent for males. In the last period, females gained roughly 17 years of life expectancy and males acquired 18 years, as presented in Table II.5.2.2. Early age mortality continued to have the most significant effect on overall changes in life expectancy, although its total magnitude showed a decreasing pattern in this period. The contribution of direct effect considerably shifted to the older age groups, contrary to the findings for the first two periods.

Despite its gradual decline, infant mortality rates contributed the most to increased life expectancy across all time periods. More than half of the contribution in the improvement in male life expectancy resulted from the infant mortality for the 1923-1963 period; it eventually reduced to 40 percent in the last period. During the same time span, the contribution of female infant mortality reduced from 45 percent to 37 percent.

Figure II.5.2.1 depicts the shift in the percentage contribution of age groups to gained years of life expectancy from young to old ages. Between the first and last periods, the percentage contribution of age groups over 50 increased from 8% to 21% for females and from 6% to 23% for males. The 15-49 age group's contribution shows an increasing pattern throughout the selected periods; also, the 15-49 age group made up the majority of the gains in life expectancy among the ages above 1.

According to the findings of the decomposition analysis conducted for the 1923-2013 period, the life expectancy change in the youngest ages contributed the most to the overall change in all three periods. Older age groups have a substantially increasing impact during the 90 years, while the contribution of infant mortality has been consistently high.

Figure II.5.2.1. Percentage of Total Contribution in Increased Life Expectancy by Age Groups, 1923-2013



In the last decades, high early age mortality levels are considered a demographic challenge in Turkey. Early age mortality was persistently high, contradicting the country's other socioeconomic and demographic characteristics, and this situation is described as a "Turkish puzzle" of infant mortality (Gürsoy-Tezcan, 1992). Infant and child mortality rates, on the other hand, have decreased significantly between 2000 and 2013 (HUIPS, 2016). In the light of all these improvements, the 1983-2013 period needs further investigation in terms of decomposition analysis. Therefore, the 1983-2013 period is divided into three sub-groups (1983-1993, 1993-2003, and 2003-2013), and decomposition analyses are conducted for each sub-group.

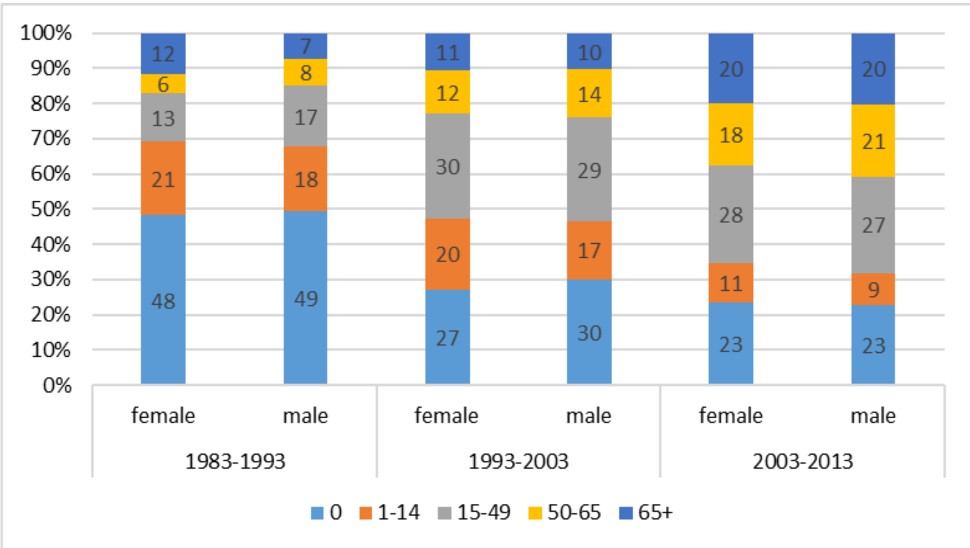
Table II.5.2.3 displays the results of the decomposition analysis for three sub-periods. A rapid decline is observed in the contribution of infant mortality between the first and second sub-periods. In the 2003-2013 period, more than one-fifth of life expectancy gains were attributed to the youngest age group. Ages 15-49 made the most significant contribution to the mortality change in the 1993-2003 period among females. However, infant mortality had a considerable impact on the total contribution resulting from the indirect effect. In the 1993-2003 period, the 0-1 age group's contribution was 27 and 30 percent for females and males, respectively. Furthermore, the 15-49 age group's contribution exceeded the gains from 0-1 age group in the last period, and older age groups had an increasing effect on life expectancy change. In the last period, older age groups produced the greater part of gains resulting from direct effect, with ages 15-49 accounting for the largest share of total change.

Table II.5.2.3. Decomposition of the Life Expectancy Change, 1983-2013

	Females					Males				
Age	Direct effect	Indirect effect	Interaction effect	Total effect	Percent of total	Direct effect	Indirect effect	Interaction effect	Total effect	Percent of total
					1983-1993					
0	0,03	3,07	0,19	3,29	47,2	0,03	3,24	0,19	3,46	51,9
1-14	0,24	1,18	0,06	1,47	21,1	0,21	0,96	0,04	1,21	18,2
15-49	0,39	0,55	0,04	0,98	14,0	0,42	0,58	0,04	1,04	15,6
50-64	0,12	0,26	0,03	0,41	5,8	0,18	0,28	0,02	0,48	7,2
65-79	0,38	0,24	0,04	0,65	9,3	0,24	0,13	0,02	0,38	5,7
80+	0,17			0,17	2,5	0,09			0,09	1,4
Total	1,3	5,3	0,4	6,96	100,0	1,2	5,2	0,3	6,66	100,0
					1993-2003					
0	0,02	1,69	0,13	1,84	26,6	0,02	1,93	0,15	2,10	30,3
1-14	0,18	1,00	0,07	1,25	18,1	0,19	0,99	0,07	1,25	18,0
15-49	0,74	1,21	0,10	2,06	29,8	0,75	1,17	0,10	2,03	29,2
50-64	0,28	0,58	0,05	0,91	13,2	0,32	0,54	0,05	0,90	13,0
65-79	0,42	0,28	0,02	0,72	10,4	0,35	0,19	0,02	0,56	8,1
80+	0,13			0,13	1,9	0,10			0,10	1,4
Total	1,8	4,8	0,4	6,91	100,0	1,7	4,8	0,4	6,93	100,0
					2003-2013					
0	0,01	0,68	0,02	0,71	21,7	0,01	1,00	0,05	1,06	24,0
1-14	0,04	0,26	0,01	0,31	9,3	0,06	0,37	0,02	0,45	10,2
15-49	0,27	0,56	0,03	0,86	26,1	0,41	0,76	0,06	1,23	27,9
50-64	0,18	0,43	0,03	0,64	19,3	0,27	0,54	0,04	0,86	19,5
65-79	0,35	0,27	0,01	0,64	19,3	0,39	0,26	0,02	0,67	15,2
80+	0,14			0,14	4,2	0,14			0,14	3,2
Total	1,0	2,2	0,1	3,3	100,0	1,3	2,9	0,2	4,4	100,0

Figure II.5.2.2 illustrates the percentage contribution in increased life expectancy by age categories. From 1983 to 2013, the percentage contribution of the age groups above age 50 increased from 18% to 38% for females and 15% to 41% for males. The age pattern of mortality changed significantly between 1983 and 2013, and the impact of older age groups on life expectancy change has increased. Infant mortality remained a significant contributor during the same period, but its impact has significantly decreased over the last decade.

Figure II.5.2.2. Percentage of Total Contribution in Increased Life Expectancy by Age Groups, 1983-2013



II.5.3. Decomposition of Life Expectancy Change by Background Characteristics

Effects of socioeconomic factors on life expectancy change in Turkey are examined for 1993-2013[5]. A stepwise replacement algorithm is used to decompose the effect of population composition and mortality rates within each category. Decomposition analyses are employed by region, educational level, wealth status, and place of residence.

The stepwise decomposition method is employed using an excel spreadsheet provided by Andreev and Shkolnikov (2012). Implementation of the method requires "age-group specific death rates" and "age-group specific population weights." Age-group specific death rates are provided from life tables constructed by educational level, wealth status, region, and type of place of residence as explained in Section II.4.4. Age-group specific population weights are enumerated from household-level data from TDHS 1993 and 2013.

The results of the stepwise replacement algorithm indicate the contributions of group-specific compositional changes (P effect) and the group-specific mortality changes (M effect) to the overall change in life expectancy. M effect is further subdivided into the contributions of each sub-population group. On the other hand, the method is based on the idea that age specific death rates are weighted sums of "age-group specific death rates" and "age-group specific population weights." Therefore, the mortality contributions of sub-population groups are affected by both the mortality level and population weight of these groups.

[5] Reference periods are 1988-1993 and 2008-2013, respectively.

Decomposition of life expectancy change by educational level:

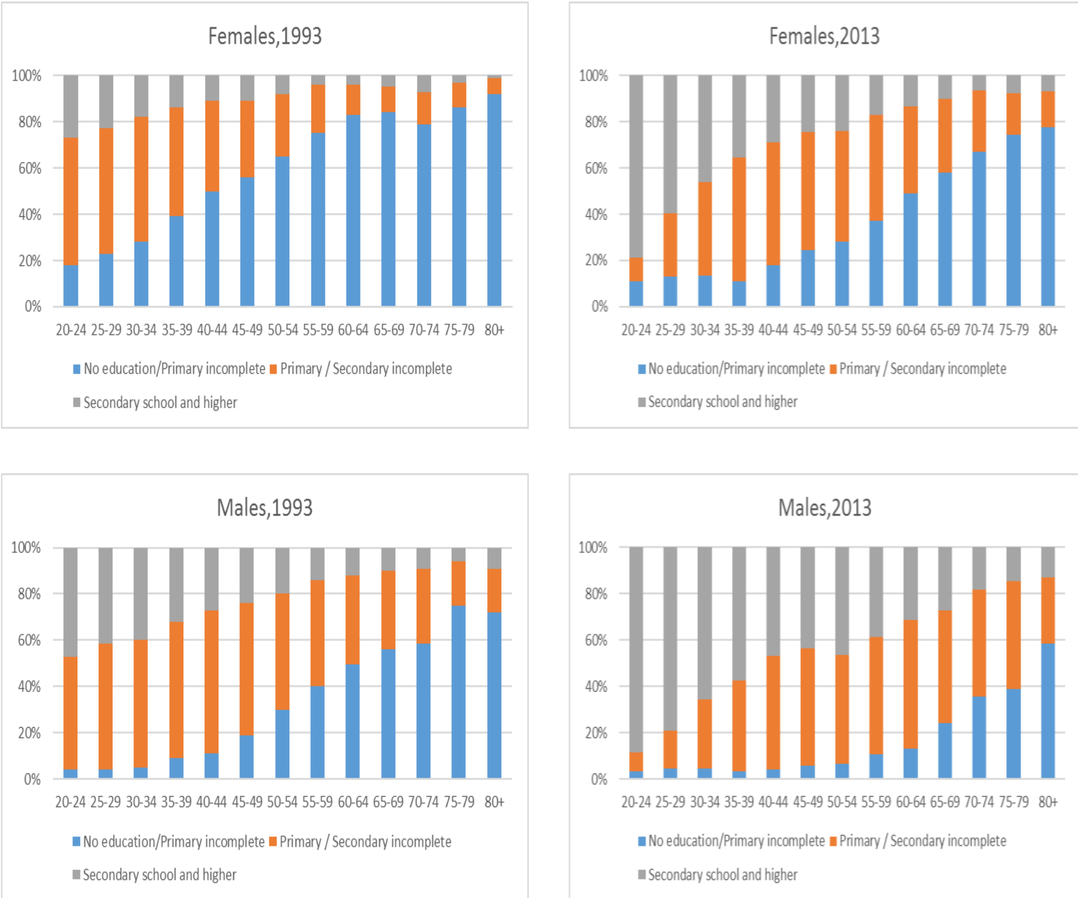
Table II.5.3.1 presents the life expectancy levels and population composition by educational groups. Life expectancy improved at all educational categories for both sexes. Besides that, the life expectancy levels of less-educated groups sharply increased, and the population composition of educational groups considerably shifted in the 20 years. The proportion of the education groups less than secondary education diminished, and the proportion of highest education group increased for both sexes. The change in the population composition by age groups can be followed from Figure II.5.3.1. The share of higher education among younger age groups considerably increased during the period 1993-2013.

Age-educational group specific population distribution and age-educational group specific death rates are presented in Appendix A (Table A.5-8).

Table II.5.3.1. Life Expectancy and Population Composition by Educational Groups at Age 20

	Life expectancy at age 20					
	Females			Males		
Educational Status	1993	2013	Difference	1993	2013	Difference
No educ./Pri. incomplete	49,5	57,0	7,4	47,1	55,0	7,9
Primary/ Sec. incomplete	50,4	57,7	7,3	49,8	55,5	5,7
Secondary and higher	53,2	59,0	5,8	50,9	57,1	6,2
Total	50,3	57,6	7,4	49,4	56,0	6,6
	Proportion of population aged 20 years and above					
	Females			Males		
Educational Status	1993	2013	Difference	1993	2013	Difference
No educ./Pri. incomplete	0,457	0,264	-0,193	0,196	0,091	-0,105
Primary/ Sec. incomplete	0,394	0,383	-0,011	0,507	0,369	-0,138
Secondary and higher	0,149	0,353	0,204	0,297	0,540	0,243

Figure II.5.3.1. Population Composition of Educational Groups by Age



Decomposition results are shown in Table II.5.3.2. Women's life expectancy has risen by 7,4 years at the age of 20, while men's life expectancy increased by 6,6 years. Around 92 percent of total change was originated from mortality changes within educational groups for both sexes. Almost half of the contribution is from the lowest educational group for women, and more than one-third of the contribution originated from the middle educational group for men. The improvement in the population's educational level accounts for almost 7-8 percent of the life expectancy change.

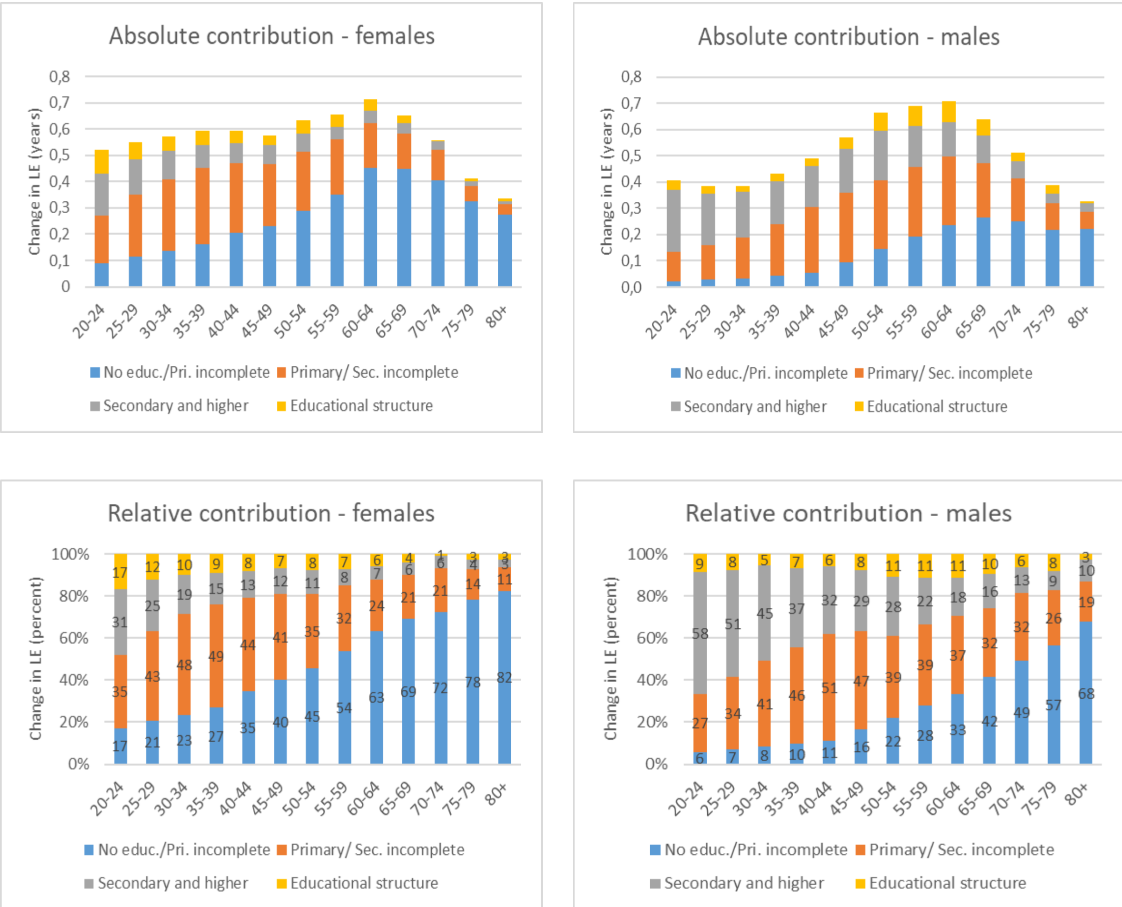
Table II.5.3.2. Components of Life Expectancy Change by Educational Level, 1993-2013

	Females		Males	
	Years	Percent	Years	Percent
Total change in e_{20}	7,4	100,0	6,6	100,0
M effect (mortality)	6,8	92,6	6,0	91,7
No educ./Pri. incomplete	3,5	47,3	1,8	27,4
Primary/ Sec. incomplete	2,4	33,1	2,4	37,0
Secondary and higher	0,9	12,3	1,8	27,3
P effect (structure)	0,5	7,4	0,6	8,3

Relative and absolute contributions of mortality change and educational composition by age groups are shown in Figure II.5.3.2. Low-educated older women were the major contributors to the mortality improvement. Among women in the second education group, a more significant contribution was observed in the younger ages. Life expectancy improvement was significant among low educated, older men and younger men with middle education. Improvement in the educational level was more effective in the younger ages than older ages for both women and men.

It is evident that the change in the composition of educational groups had a considerable effect on life expectancy improvement during the study period. Also, mortality improvements within lower educational levels were significant and educational attainment can be regarded as a major factor affecting life expectancy change in Turkey in the study period.

Figure II.5.3.2. Contributions of Mortality and Educational Composition Changes by Age Groups



<u>Decomposition of life expectancy change by wealth status:</u>

Table II.5.3.3 presents life expectancy and population composition by wealth status categories. Life expectancy increase was around 13 years among the lowest wealth status groups for both sexes. The middle wealth status group experienced a ten-year increase in both females and males. Minor improvement was observed among males and females in the wealthiest category. The proportion of the lowest wealth group diminished, and middle and highest wealth groups increased for both sexes, as shown in Table II.5.3.3 and Figure II.5.3.3.

Age-wealth group specific population distribution and age-wealth group specific death rates are presented in Appendix A (Table A.9-12).

Table II.5.3.3. Life Expectancy and Population Composition by Wealth Status

	Life expectancy at birth					
	Females			Males		
Wealth Status	1993	2013	Difference	1993	2013	Difference
Lowest	61,3	74,5	13,2	60,0	72,7	12,7
Middle	66,0	76,6	10,7	63,9	74,5	10,6
Highest	71,6	76,8	5,3	70,0	74,7	4,7
Total	65,1	75,9	10,8	63,4	73,9	10,5
	Proportion of population					
	Females			Males		
Wealth Status	1993	2013	Difference	1993	2013	Difference
Lowest	0,388	0,279	-0,109	0,382	0,274	-0,108
Middle	0,353	0,417	0,064	0,355	0,424	0,069
Highest	0,259	0,304	0,045	0,263	0,302	0,039

Figure II.5.3.3. Population Composition of Wealth Groups by Age

Women's life expectancy has improved by 10.8 years over the 20 year-period, while men's life expectancy has improved by 10.5 years, as shown in Table II.5.3.4. Around 95 percent of the change was originated from the mortality effect; population composition contributed about 5 percent to the overall change. Among wealth status groups, less wealthy made a greater contribution to the mortality differential, nearly 45 percent for both sexes. Middle and highest wealth status groups followed the low wealth group in terms of contribution to the overall life expectancy change.

Table II.5.3.4. Components of Life Expectancy Change by Wealth Status, 1993-2013

	Females		Males	
	Years	Percent	Years	Percent
Total change in e_0	10,8	100,0	10,5	100,0
M effect (mortality)	10,3	95,2	10,0	94,6
Lowest	5,0	46,2	4,8	45,7
Middle	4,1	38,0	4,1	38,6
Highest	1,2	11,1	1,1	10,4
P effect (structure)	0,5	4,8	0,6	5,4

Absolute and relative contributions of wealth status groups are shown in Figure II.5.3.4. In absolute terms, the contribution of the 0-1 and 1-4 age groups dominated the life expectancy improvement. In relative terms, the contribution of less wealthy women distributed evenly among age groups, except for a slight decrease in the middle ages. The wealthiest men made a positive contribution to the life expectancy change in all age groups, showing an increasing pattern in the middle ages.

Figure II.5.3.4. Contributions of Mortality and Wealth Composition Changes by Age Groups

<u>Decomposition of life expectancy change by region:</u>

Life expectancy at birth and population composition by region are shown in Table II.5.3.5. Life expectancy increase was highest (12.9) in East region for females, followed by South region. 9-10 years of increase was observed for women in West, Central and North regions. Life expectancy increase of males followed a more uniform pattern among regions. The most significant improvement was in the East region; 12 years and slightest improvement were in the West region; 9 years.

The share of the population in the West region increased for males and females, and share of all other regions decreased in 20-years period. The increasing population in the west region was distributed evenly across age groups, as presented in Figure II.5.3.5. Age-regional population distribution and age-region specific death rates are presented in Appendix A (Table A.13-20).

Table II.5.3.5. Life Expectancy and Population Composition by Region

	Life expectancy at birth					
	Females			Males		
Region	1993	2013	Difference	1993	2013	Difference
West	67,0	77,0	9,9	65,9	74,9	9,0
South	65,2	75,5	10,4	61,9	73,4	11,6
Central	64,2	74,5	10,3	61,6	72,3	10,7
North	68,4	77,5	9,1	64,2	76,0	11,8
East	62,3	75,2	12,9	62,3	74,3	12,0
Total	65,1	75,9	10,8	63,3	74,0	10,7
	Proportion of population					
	Females			Males		
Region	1993	2013	Difference	1993	2013	Difference
West	0,322	0,412	0,090	0,330	0,419	0,089
South	0,155	0,124	-0,030	0,157	0,126	-0,031
Central	0,231	0,199	-0,032	0,219	0,201	-0,018
North	0,092	0,074	-0,018	0,084	0,069	-0,015
East	0,200	0,191	-0,009	0,210	0,185	-0,025

Figure II.5.3.5. Population Composition of Regions by Age

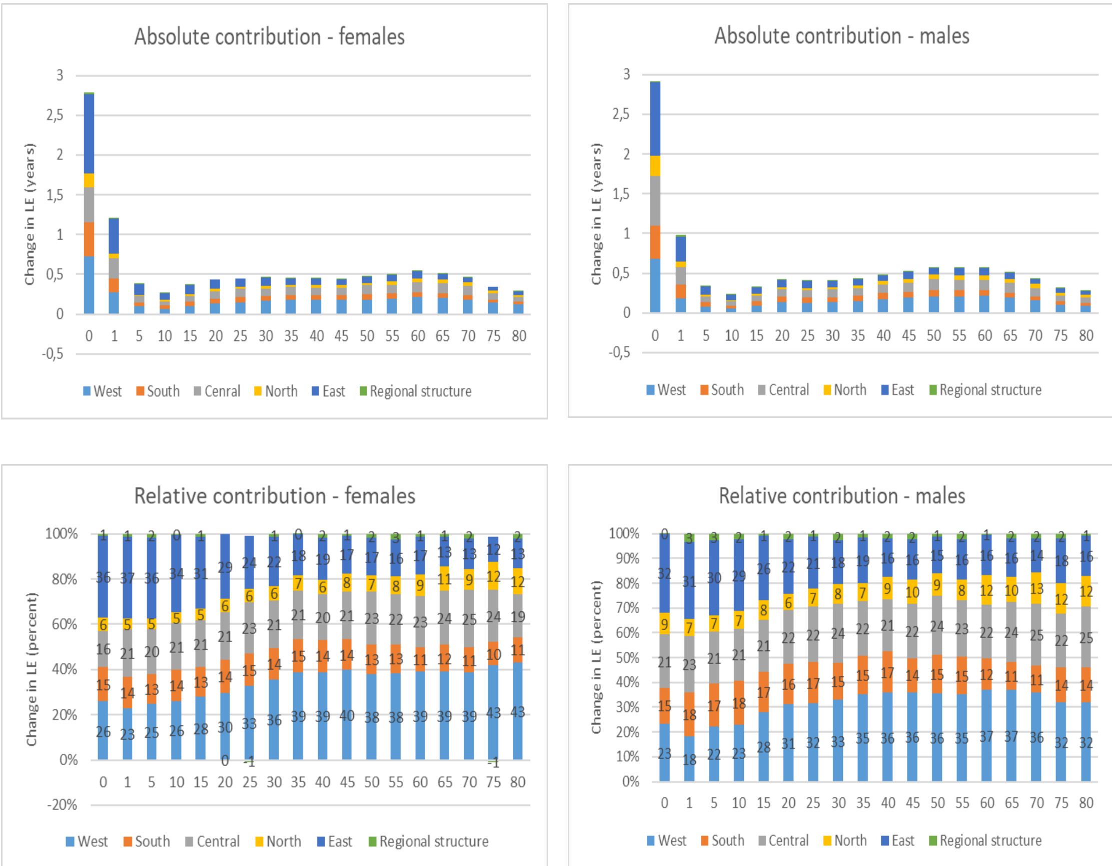
Table II.5.3.6 shows that in the 20 year-period, life expectancy has risen by 10.8 and 10.7 years for females and males, respectively. The contribution of population composition was 1 % for females and 1.4 % for males. Around 99 percent of life expectancy increase was originated from the mortality effect. West region made the highest contribution to the mortality effect for both males and females. East region is the second-highest contributor to females' life expectancy change, where North region has the lowest effect. For males, the Central and East regions made the most significant impact after the West region. The slightest improvement was observed in the North region for males.

Relative and absolute contributions of mortality change and regional population composition by age groups are shown in Figure II.5.3.6. The 0-1 and 1-4 age groups contributed the most to the absolute change in life expectancy for both sexes. Young men and women made greater part of the contribution in the Eastern region; however, in the Western region, older adults had a larger effect on increasing life expectancy levels. Age categories had a uniformly distributed impact on life expectancy change in the other three regions.

Table II.5.3.6. Components of Life Expectancy Change by Region, 1993-2013

	Females		Males	
	Years	Percent	Years	Percent
Total change in e_0	10,8	100,0	10,7	100,0
M effect (mortality)	10,7	99,0	10,6	98,6
West	3,5	32,1	3,1	29,3
South	1,5	13,6	1,6	14,9
Central	2,2	20,3	2,4	22,3
North	0,8	6,9	0,9	8,8
East	2,8	26,1	2,5	23,2
P effect (structure)	0,1	1,0	0,1	1,4

Figure II.5.3.6. Contributions of Mortality and Regional Composition Changes by Age Groups



<u>Decomposition of life expectancy change by place of residence:</u>

Table II.5.3.7 shows that, female life expectancy has increased by 9,1 and 13,6 years in urban and rural settlements, respectively. Males experienced 8,8 years of gain in urban settlements and 12,9 years of gain in rural settlements. In the 20 year-period, females' proportion in the urban areas has increased by 18 percent, while males' proportion has increased by 17,3 percent.

When the change in the population's age structure is considered, the most significant increase was observed in the share of young adults in the urban settlements, as displayed in Figure II.5.3.7. Age-residence population distribution and age-residence specific death rates are presented in Appendix A (Table A.21-24).

Table II.5.3.7. Life Expectancy and Population Composition by Place of Residence

	Life expectancy at birth					
	Females			Males		
Residence	1993	2013	Difference	1993	2013	Difference
Urban	67,1	76,2	9,1	65,3	74,1	8,8
Rural	61,9	75,5	13,6	60,4	73,3	12,9
Total	64,9	76,0	11,1	63,2	73,8	10,7
	Proportion of population					
	Females			Males		
Residence	1993	2013	Difference	1993	2013	Difference
Urban	0,595	0,776	0,180	0,613	0,786	0,173
Rural	0,405	0,224	-0,180	0,387	0,214	-0,173

Figure II.5.3.7. Population Composition of Urban and Rural Residences by Age

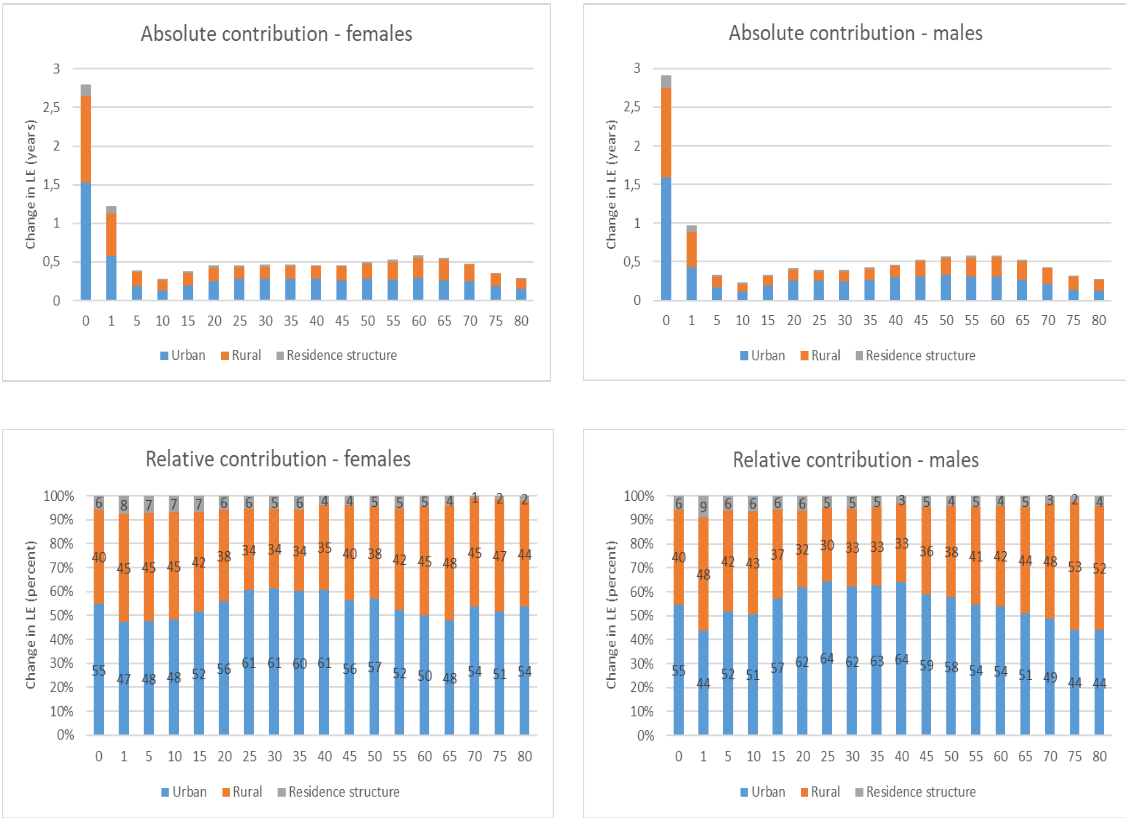
As shown in Table II.5.3.8, female life expectancy has risen by 11,1 years, while male life expectancy increased by 10,7 years over the 20-year period. The contribution of population composition was around 5 percent for both sexes. For both males and females, the contribution of mortality increase in urban areas was around 10% higher than in rural areas.

Table II.5.3.8. Components of Life Expectancy Change by Place of Residence, 1993-2013

	Females		Males	
	Years	Percent	Years	Percent
Total change in e_0	11,1	100,0	10,7	100,0
M effect (mortality)	10,5	94,8	10,1	94,8
Urban	6,0	53,8	5,8	54,5
Rural	4,5	41,0	4,3	40,3
P effect (structure)	0,6	5,2	0,6	5,2

Relative and absolute contributions of mortality change and residential population composition by age groups are presented in Figure II.5.3.8. The youngest age groups (0-1 and 1-4) contributed the most to the absolute change in female and male life expectancy. In the urban areas, mortality improvement was most significant among young and middle age groups; youngest and older ages made greater contribution in rural areas for both males and females.

Figure II.5.3.8. Contributions of Mortality and Residence Composition Changes by Age Groups



II.6. DISCUSSION

This chapter primarily focused on the theoretical approaches to historical change in mortality. The epidemiological transition theory was developed to reveal the determinants of mortality change, considering the underlying causes of death. The debates about the epidemiological transition have evolved over time into approaches that consider the social and behavioral aspects of mortality change. According to the long-term observations, the change in mortality levels first occurred in developed countries where health-related improvements were seen faster and then spread to other countries. This process led to a divergence pattern between countries and tended to converge with the spread of health technologies.

The divergence-convergence framework proposed by Vallin and Mesle (2004) as a new approach to health transition can also be adapted to the mortality variation within countries. According to this approach, since mortality change affects different layers of the society at different pace, inequality in favor of the advantaged segments of the society occurs, and over time, this inequality decreases, and the mortality levels converge.

Income level has been one of the most significant factors affecting mortality divergence, starting from the first stages of the transition. However, as the transition process progressed, the effect of income changed, and mortality levels decreased even though the income level was low, especially in developing countries. Medical interventions and diffusion of health technologies, and also other socioeconomic factors, contributed to this decrease. Social factors such as income inequality, differentiation in educational levels and occupational groups have been indicated as the major factors contributing to mortality inequality. Theoretical approaches related to the socioeconomic inequalities in health and mortality still attract significant attention in mortality research.

In Turkey, mortality levels continuously decreased since the establishment of the modern Republic. After the 1920s, the health transformation in Turkey gained momentum with the institutionalization of the health system and the fight against infectious diseases. In the 1960s, the socialization and dissemination of health services became an important milestone in the health transition process. Privatization of health services became a priority after 1980, and the health transformation program, which began in the 2000s, resulted in significant changes to the health system. During the mortality transition process in Turkey, the infant mortality rate remained persistently high until the recent past. It has decreased significantly in the last decades, but differential mortality patterns still prevail across sub-population groups. Mortality inequalities are usually associated with socioeconomic factors like income level or educational attainment.

This chapter involves the analysis of the change in mortality level in Turkey since the establishment of the Republic. The effect of age composition on mortality change is analyzed using different decomposition methods. In addition, different methods used for life expectancy decomposition are compared. Furthermore, social factors affecting mortality differentials are analyzed using decomposition methods for the last 30 years.

Decomposition methods are ideally implemented using register data. However, Turkey's registration system does not provide complete and reliable mortality data for the study period. In this study, data is obtained from direct and indirect estimates based on demographic surveys and censuses. The variables created for the analysis of social factors are created by considering the limitations of the TDHS data set. There is no information on income level in the TDHS datasets; therefore, an index for household wealth is created and used in the analyses. Educational categories are created in accordance with the TDHS-1993 and TDHS-2013 data sets. This essay also includes the regional and urban-rural differentials of mortality change in Turkey.

Mortality change is primarily analyzed by decomposing the changes in the crude death rates. The age composition of the population did not change significantly between 1950 and 1980. Therefore, the decline in the CDR resulted from the actual change in mortality levels rather than the age structure. However, as a result of the falling fertility rate from the 1980s to the 2010s, the proportion of the young population decreased, while the share of the elderly began to grow. This shift had an increasing effect on the crude death rate, but it continued to decrease, especially since the pace of decline in early-age mortality was still high.

In the 80-year period covered by this study, life expectancy has improved by over 40 years. According to the findings, the decrease in infant mortality rate was the most significant contributor to the long-term improvement in life expectancy. The decrease in infant mortality rate during the first years of the Republic accounted for nearly half of the overall decrease in mortality level. During the same period, a decrease in young and middle-age mortality also made significant impact to increased life expectancy. The reduction in mortality in the early years of the Republic could be attributed to the fight against infant mortality and infectious diseases. The contribution of the decrease in infant mortality and deaths caused by infectious diseases at young ages is again very evident in the post-1960 period. During these years, while infant mortality contributed less to the increase in life expectancy, young age mortality contributed more. There has been a slight improvement in older ages, but the main improvement in these ages occurred in the post-1990 period. Although the contribution of the infant mortality rate to mortality recovery has decreased in this period, it has been at a relatively high level. The contribution of old-age mortality to improved life expectancy has increased, particularly since 2000. Advances in the treatment of cardiovascular diseases, in particular, may have contributed to the mortality decline in older age groups.

When the overall pattern in 1923-2013 is considered, a more significant part of the mortality difference resulted from the indirect effect rather than direct and interaction effects. The contribution of the direct effect on the total change shifted to the older ages during the 90 years, and the trend is more notable in the last 30 years. The significant contribution of the interaction effect was resulting from the significant changes in the mortality level. However, the contribution of interaction effect did not exceed the contribution of direct effect in any of the periods

Analyzes of the socioeconomic components of mortality change are conducted for the post-1990 period. First, the effect of changing educational attainment on mortality rates was investigated. In the specified period, the education level of both women and men increased, the share of the highest education group increased, and the share of other education groups decreased. According to the findings, the decrease in mortality rates in the educational groups accounted for more than 90% of the improvement in mortality rates. The lowest education group for women and the middle education group for men made the most significant contribution to the mortality improvement. The remaining change is due to an increase in the population's educational level. In this period, the life expectancy difference between educational levels decreased. It can be argued that the decrease in mortality in older ages, especially at low education levels, contributes to the general pattern. The shift in the population's educational structure, on the other hand, has made a visible contribution, particularly for young women.

From 1990 to 2015, the share of the lowest wealth status group in the total population decreased by about 10 percent, while the share of middle and highest wealth groups increased. Life expectancy levels increased for each wealth group. However, due to the high increase in low and middle wealth status groups, the difference between the life expectancy levels of the groups decreased to approximately two years. The change in the household wealth status of the population contributed approximately 5 percent for both sexes, contributing 0.5 years to the approximately 11-year increase in life expectancy level. Mortality improvement in the lowest wealth group contributed approximately five years to life expectancy increase. The middle and high wealth groups, on the other hand, led to four years and one-year life expectancy improvement, respectively. According to the findings, life expectancy levels of wealth groups converged significantly in the study period. The gender gap is not as pronounced as it is in the educational categories since the wealth index does not reflect sex differences; it is formed by using durable consumer goods and housing characteristics at the household level.

When the regional mortality differentials are considered, the life expectancy of the regions with low life expectancy levels increased more than the regions with high levels, and the difference between regions diminished. The western region's share of the total population has increased, while the other regions' shares have decreased. This change can be associated with a migration movement from other regions to the western region. However, the contribution of changes in regional population structure to changes in life expectancy is meager. The western region contributed the most to the mortality decline, followed by the eastern and central regions. While early ages were primarily responsible for the decrease in mortality in the eastern region, advanced ages played a larger role in the western region. This disparity may be explained by the continued improvement in early-age mortality in the eastern region and the decline in old-age mortality in the western region. However, further examination of the disease and cause of death patterns is needed to reach a more precise conclusion.

The distribution of the population by place of residence has changed significantly in the examined period. The proportion of people living in rural areas decreased for women and men, while the urban population increased by almost 20 percent. In addition, the life expectancy gap between urban and rural settlements has nearly closed. Structural change in residential populations contributed 0.6 years to the LE level, which increased approximately 11 years in total. Mortality improvement in urban areas made greater contribution to the life expectancy increase, but rural recovery also contributed significantly.

The decomposition analysis of mortality differentials in terms of age and social factors provided significant findings. Firstly, the improvement in infant mortality rate has made the most significant contribution to mortality change until recently. Infant mortality rates have decreased to expected levels, albeit with a delay, but there is still a need for improvement at the regional level. The improvement in mortality in advanced ages can be regarded as the beginning of the "cardiovascular revolution", as defined by the epidemiological transition theory. The analysis of disease and cause of death patterns can enable a more comprehensive assessment of this issue. The analysis of changes in the cause of death pattern can help guide the development of health policies, the delivery of health services, and, in particular, meeting the needs of the elderly population.

While there was a significant mortality gap between subpopulation groups in Turkey in the 1990s, this difference has decreased over the study period. It can be claimed that the convergence-divergence framework defined in the health transition approach worked for Turkey. According to this view, improvements in health primarily affect the wealthy, well-educated, urban population resulting in a divergence pattern. Then mortality levels converge when the health improvements spread to the whole population.

The results of the analysis revealed that especially educational level and household wealth status contributed to mortality change. Although life expectancy increase was primarily due to the mortality effect, changes in the population's educational structure also contributed to this increase. In Turkey, educational level has improved significantly, especially for women, in the post-1990 period. This improvement mainly resulted from the implementation of the 8-year compulsory education policy in this period. On the other hand, educational level affects health and mortality indicators in various ways. Increased level of education provides the opportunity to have a higher income, thus, to access health services more easily, live in better conditions, adopt a healthy lifestyle, and work in less risky jobs. In addition, the increase in the educational level of mothers greatly contributes to the decline in infant mortality rates.

The contribution of the household wealth status to the mortality change does not provide explicit information on the income inequality-mortality relationship. This study has determined that the life expectancy of low wealth status groups has increased significantly and converged to the high wealth status groups. However, there was no significant improvement in income inequality in Turkey during this period. Until the 1990s, the richest twenty percent had 15-20 times more income than the poorest twenty percent, while this rate decreased to 10 times in the 2000s, and today it is in the range of 7-8 times (Çalışkan, 2010; TurkStat, 2021c). However, Turkey remains one of the OECD member countries with the highest coefficient of income inequality (UNDP, 2016). Income inequality negatively affects poor people's access to health services, and it can lead to results such as insufficient public investments in health and social security and low quality of health services. When interpreting the relationship between income inequality and mortality, factors such as health-care delivery, maternal and child health, and social security coverage should be taken into account. In addition, the change in morbidity and cause of death patterns can provide further information on the subject.

III. ESSAY 2: DECOMPOSITION OF THE CHANGE IN FERTILITY AND POPULATION GROWTH IN TURKEY

III.1. INTRODUCTION

Fertility decline has been a universal phenomenon since the demographic transition process initiated in the 18th century. Since then, the global fertility rate has substantially decreased, and the world population has increased more than ever. The fertility transition was initiated in the industrialized western countries and gradually spread to other countries. Today, with a few exceptions, all countries are experiencing the transition process or have already completed it. The pace of fertility reduction varied across countries and population groups throughout the fertility transition process.

In Turkey, the onset of the demographic transition process can be dated back late 19th century. Fertility levels increased until the 1950s, when they began to decrease dramatically. The rate of population growth peaked in the 1950s and then declined precipitously after the mid-1980s. Turkey is currently experiencing the last stage of its demographic transition, and differential fertility patterns prevail across regions and sub-population groups. This study provides an insight into the change in fertility patterns in Turkey across age groups and social groups by using decomposition methods.

This chapter aims to interpret the components of the change in fertility and population growth. To investigate the socioeconomic differentials of fertility change in Turkey, decomposition analyses are employed for subpopulation groups by educational level, wealth status, region, and residence. The theoretical framework and a literature review are covered in the second section. The third section discusses the study's methodology and data sources. Fourth section presents the findings of the decomposition analysis, and the findings are discussed in the final section.

III.2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

III.2.1. Theories of Fertility Decline and Post-Transitional Fertility

This section presents the major theories of fertility decline and post-transitional fertility patterns. Fertility theories are discussed, considering the changing patterns of fertility in a historical context. In addition, fertility trends and variations in post-transitional countries are examined.

Theories of fertility decline

As mentioned in Section I.2.1., demographic transition theory explained the change in society's demographic behavior in line with the modernization process. The classical theory of demographic transition focuses on the macro-economic determinants through the modernization process. It reaches a generalization that demographic transition will occur in every country undergoing a modernization process. According to the classic transition theory, with industrialization and urbanization in the early 1800s in Europe, the technological innovations promoted substantial changes that made lower death rates possible. Improvement of transportation, increased productivity in agriculture, improvement in personal sanitation and medicine caused a reduction in mortality (Coale, 1984). Fertility decline followed the mortality decline by the effect of socioeconomic changes triggered by the industrialization and urbanization processes.

Classical demographic transition theory focused on the impact of structural changes on fertility and mortality levels. The structural changes have significantly affected the economic structure in countries undergoing modernization. Starting from the 1950s, the study of fertility transition primarily focused on the effect of socio-economic changes. Economic theories of fertility gained prominence in this context.

In the area of fertility research, two main economic approaches emerged since the 1960s (Sanderson, 1976). The first approach is the "new home economics" framework, a variant of microeconomic theory (Becker, 1960). Easterlin (1975) presented the second approach as a synthesis of economic and sociological paradigms.

The new home economic theory of fertility emphasizes micro-level fertility choices of parents. Former theories of fertility decline considered macro-level structural changes like urbanization or industrialization as the driving force for fertility decline. Becker (1960) argued that fertility choice could be explained using the economic framework analyzing the demand for durable goods. He explains fertility reduction as a choice of rational people determined by household income and costs of children. The income-fertility relationship is contingent upon a "quantity-quality tradeoff." The inclusion of "child quality" to the fertility choice model suggests a solution for the economic puzzle about European countries' historical experience where fertility fell as incomes increased (Robinson, 1997).

The new home economics approach is criticized as static when considering reproductive decisions and being strictly demand-oriented (DeBruijn, 2006). Easterlin (1975) added a sociological variable to the microeconomic theory of fertility: “the supply of children.” In this framework, fertility is explained in three determinants: "the demand for children”, that is, “the number of surviving children parents would want if fertility regulation were costless”; “the potential output or the supply of children”, or “the number of surviving children parents would have if they did not deliberately limit fertility” and “the costs of fertility regulation - including both subjective (psychic) costs and objective costs, the time and money required to learn about and use specific techniques” (Easterlin,1975). According to this approach, the interplay between the supply and demand for children determines actual fertility.

Contemporary studies on the economics of fertility has frequently concentrated on the opportunity cost of women's time and relationship between fertility and labor force participation rather than the quantity-quality dimension. However, “quantity-quality tradeoff” has remained a major aspect in the less-developed countries still experiencing the demographic transition, since the opportunity cost of education is still high in these countries (Doepke, 2015). Becker et al. (1990) developed a growth model by placing “quantity-quality tradeoff” at the center of the theory by the concept of human capital. They identified two steady states characterized by the level of return to human capital, income growth, and population growth. The first steady state expresses the pre-industrial economies with low human capital returns, high birth rates, and economic stagnation; the second refers to the industrial economies with growing human and physical capital with low birth rates. They reflect the demographic and economic differences between developed and underdeveloped countries.

In addition to economic theories, approaches focusing on the impact of social structures on fertility emerged early on. One of the most prominent theories is the wealth flow theory introduced by Caldwell in the 1970s and discussed the changing function of the family.

Caldwell (1976) has offered the theory of intergenerational wealth flows as a restatement of demographic transition theory. According to Caldwell (1976), pre-transition fertility behavior is regarded as "irrational" in classical transition theory. He criticizes the widely used concept of "economically rational" and argues that this perspective is “highly ethnocentric and laden with Western values.” In the context of wealth flows theory, all societies, even pre-transitional societies, are economically rational. Social conditions determine the rationale of fertility decisions.

The primary concern of the theory is the magnitude and direction of intergenerational wealth flows (Caldwell, 1976). In pre-transitional settings, wealth flows from children to older generations. The concept of "wealth" includes money, goods, resources, or services. Fertility reduction is triggered by the reversal in the direction of wealth flows. The main reason for this reversal is the emergence and increasing prevalence of child-centered nuclear families. Nucleated family norms spread out to the other countries by the cultural transmission of western values. Mass media and mess education were the main tools of the diffusion process (Caldwell, 1976).

The concepts of modernization and westernization are distinguished in the theory of wealth flows; the former refers to structural changes, while the latter refers to copying (Kirk, 1996). Caldwell (1976) argued that modernization and the onset of fertility reduction are not closely related. Westernization is the major cause of fertility reduction through the reversal of intergenerational wealth flow. Therefore, economic analysis cannot foresee the timing of the reversal of wealth flow and fertility reduction on its own.

According to Van de Kaa (1996), Caldwell's effort was to adapt the theory of demographic transition to the less-developed societies since the results of the newly started demographic surveys did not support the predictions of the classical theory. Large-scale research efforts on fertility determinants emerged in the 1950s when demographic transition gained momentum in a large number of countries. Rapid population growth in less-developed countries was among the main concerns in population research after second world war. “The Knowledge, Attitude, and Practice (KAP) Surveys” have been widely implemented in the 1950s and 1960s, with the goal of measuring the unmet need for family planning, particularly in low-income countries. The findings of KAP surveys have helped to justify family planning programs and provide political support for them (Hodgson, 1983).

“The World Fertility Survey (WFS)” was designed to provide nationally representative and internationally comparable data on the fertility behavior of societies. The program focused on fertility patterns and differentials in each country and was conducted between 1972 and 1984. In 1984, WFS was replaced by “The Demographic and Health Survey (DHS)” program, which is still being conducted in developing countries and is used as a primary demographic data source.

Unlike the KAP Surveys and the World Fertility Survey, “The European Fertility Project (EFP)” was a study conducted in the 1960s and 1970s to examine the historical development of fertility in Europe. The Office of Population Research scholars in Princeton University, headed by Ansley J. Coale, organized the EFP. The project's goal was to examine the course of fertility change in Europe during the nineteenth and early twentieth centuries, as well as to test the relationship between the onset of fertility decline and socioeconomic development. According to Coale (1984), the first significant downturn began in France and spread throughout Europe in the late 18^{th} century. Between 1890 and 1920, 50 percent of European provinces experienced a fertility decline. By the 1950s, almost every Western European country had a fertility rate lower than three, and some countries were at replacement level fertility.

Coale (1984) characterized the fertility transition as the replacement of a moderate fertility regime by a low fertility regime. The classic demographic transition theory argues that a high fertility regime is the main character of any pre-transitional country. However, Coale explains pre-transition fertility as a “moderate level” of fertility. The biological balance of natural fertility and mortality was achieved by moderate reproduction of pre-transition populations. The moderate levels were ensured by the constraints like postponement of marriage, no marriage, prolonged lactation, and discouragement of widow remarriage. The low fertility regime within marriage is attained by parity-specific limitation of fertility contrary to the pre-transition non-parity-related practices within marriage.

Classic transition theorists explained the widespread acceptance of voluntary fertility control by the social and economic changes that are part of modernization. According to this perspective, industrialization and urbanization were the pioneers of the decline in fertility, with a change in motives, rather than the advances in new techniques, causing the reduction in fertility. The EFP’s findings contradict this perspective. The fertility decline was expected to begin in the urban part of provinces with higher literacy and non-agricultural employment levels. Although such a relationship is ensured in some countries, the expected relationship of fertility decline with socioeconomic characteristics was not found when findings are examined in detail. For example, in England, the industrial revolution's forerunner, fertility decrease did not start until the 1870s (Coale, 1984).

European Fertility Project was unable to find a precise threshold of socioeconomic indicators required for the onset of fertility. Instead, Coale (1984) pointed out that; “a sufficiently complete degree of modernization was accompanied by the general use of parity-related methods of controlling fertility and much reduced rates of childbearing by married women.” The emergence of cultural factors contributing to the onset and pace of controlled fertility was among the EFP’s most striking findings. The fertility regimes of the specific cultural or linguistic regions were similar, although they did not share common socioeconomic characteristics. In addition, fertility decline started earlier in the European populations with a more secular orientation.

Large-scale surveys contributed to the exploration of the determinants of fertility change at the global level. Furthermore, the results of these surveys led to the emergence of factors other than structural factors in fertility theories. Starting from the 1980s, various researchers emphasized the significance of ideational and cultural changes on fertility transition.

Lesthaeghe (1983) defined the historical process of fertility transition and family change as **“**successive manifestations of a long-term shift in the Western ideational system.” According to him, the transformation in the ideational system took place due to a series of factors. The emergence of capitalism and the spread of nuclear families in the industrialized western countries resulted in an increasing significance of children’s welfare and individual self-fulfillment. In Lesthaeghe’s view, both economic development and secular individualism fueled the process of fertility transition. Increasing income levels and emerging new job opportunities enabled individuals to be more engaged in defining and achieving their goals.

On the other hand, Cleland and Wilson (1987) presented an ideational theory of fertility decline as a refutation of demand theories (Van de Kaa, 1996). They criticized micro-economic theories of fertility for not providing a plausible explanation of fertility change. They argued that fertility change is more closely related to ideational settings such as educational level or cultural groupings than structural/economic factors. Evidence from large-scale surveys demonstrates the significance of cultural settings in fertility transition timing. They also argued that a few years of schooling causes a change in ideas, perceptions, and aspirations related to birth control. According to this viewpoint, the main factors affecting the decline in fertility levels are the spread of knowledge and the adoption of new ideas.

Leshtaeghe and van de Kaa (1986) emphasized the effect of ideational and cultural factors on fertility change in the theory of second demographic transition (SDT) in the mid-1980s. SDT is characterized by below-replacement fertility related to the delayed motherhood, rising age at marriage and out of wedlock births, and emerging living arrangements other than marriage. This new pattern is explained by the shift that occurred from material needs to higher-order needs. Adult self-realization and individual autonomy are regarded as the societies' main characteristics undergoing the SDT. At the political level, democratization and secularization are essential determinants of the SDT. Macro-level structural determinants or micro-level economic explanations are not considered sufficient in the SDT; they are recognized as necessary. Cultural change is considered an additional force on fertility levels. In the countries undergoing SDT, mortality levels exceeded fertility for the first time in history.

Post-transitional fertility

Fertility rates in many European and East Asian countries fell well below the replacement level beginning in the 1990s. Meanwhile, fertility declines in many developing countries have accelerated, approaching the replacement level threshold. The sharp difference between the fertility levels of "developed" and "less-developed" regions and countries has been blurred except sub-Saharan Africa (Wilkins, 2019; Sobotka, 2017). Almost half of the global population now lives in a country with below replacement fertility level. According to medium-variant projections, over than two-thirds of the global population will reside in a country with sub-replacement fertility level by 2050 (United Nations, 2019).

Many countries in southern, eastern, and central Europe experienced the "lowest-low fertility" levels that reflect TFR values below 1.3 in the 1990s (Kohler et al., 2002). Soon after that, period TFR levels of some East Asian countries sharply decreased and reached the threshold level of "lowest-low fertility." Starting from the mid-2000s, the lowest period fertility rates - in the range of 1.0 and 1.4 - were recorded in these countries (Wilkins, 2019; United Nations, 2019).

Fertility levels in some of Europe's earliest "lowest-low fertility" countries started to re-increase in the 2000s. The tempo effect resulting from the postponement of childbearing is the demographic explanation of this phenomenon (Goldstein et al., 2009; Bongaarts and Sobotka, 2012). However, various post-transitional patterns emerged in the 2000s and 2010s. According to the current figures, countries in Northern and Western Europe, Australia, and North America experience moderately low levels of fertility, averaging 1.7 to 2.2 children per woman. Countries that previously had the lowest-low fertility levels, on the other hand, still have a period TFR of 1.6 or less children per woman (Wilkins, 2019).

Wilkins (2019) reviewed the social, cultural, and economic determinants that influence fertility variation in post-transitional settings in three main groups: ideational change or the changing structure of the family, "gender revolution" and economic uncertainty. Sobotka (2017) included the expansion of higher education as a key factor explaining the differentiation in post-transitional fertility. However, educational attainment is not a factor specific to the low fertility countries; it is also a crucial factor in mid-transitional countries.

Theory of second demographic transition predicted sustained below-replacement fertility levels associated with individualization and changing family characteristics, mainly driven by a decline in marriage and its substitution by cohabitation. However, no direct association was found between low fertility levels and the progression of the second demographic transition. For example, Nordic countries, the Netherlands and France, have fertility rates close to replacement level, although they have the greatest progress in terms of SDT characteristics (Sobotka, 2008). In these countries, fertility recuperation is achieved at older reproductive ages following the postponement of births at younger ages. Higher gender equality in the private domain is the most important feature that distinguishes these countries from other countries experiencing a postponement transition.

Since the mid-1990s, the issue of gender equality has gained prominence in theories of fertility decline. Women's increasing educational level and the subsequent increase in labor force participation has resulted in improved equality between women and men in the public sphere. However, persistent traditional family norms and unequal division of labor at home produced an inequality pattern in the private sphere (McDonald, 2000). Many scholars regarded contradicting gender roles in the public and private sphere as the prominent reason for lowest-low fertility rates in post-transitional countries (McDonald, 2000; Goldscheider et al., 2015; Esping- Andersen and Billari, 2015). This is a two-part "gender revolution," according to Goldscheider et al. (2015). The first phase, characterized by the structural shifts in the public sphere, leads to decreasing fertility levels since the family norms do not change immediately. Men's engagement in the private sphere brings the second phase of the "gender revolution." Goldscheider et al. (2015) predict a new trend towards union stability as well as increased fertility rates as a result of the gender revolution.

Institutional arrangements for combining work and childbearing are also important determinants contributing to fertility growth in low-fertility countries. The incompatibility between fertility and women's employment that results from increased female labor-force participation can be mitigated by the implementation of childcare-supportive policies. The countries that have managed to increase their fertility level implemented policies like improvement of parental leave policies, provision of public childcare services, and availability of flexible work arrangements (Wilkins 2019).

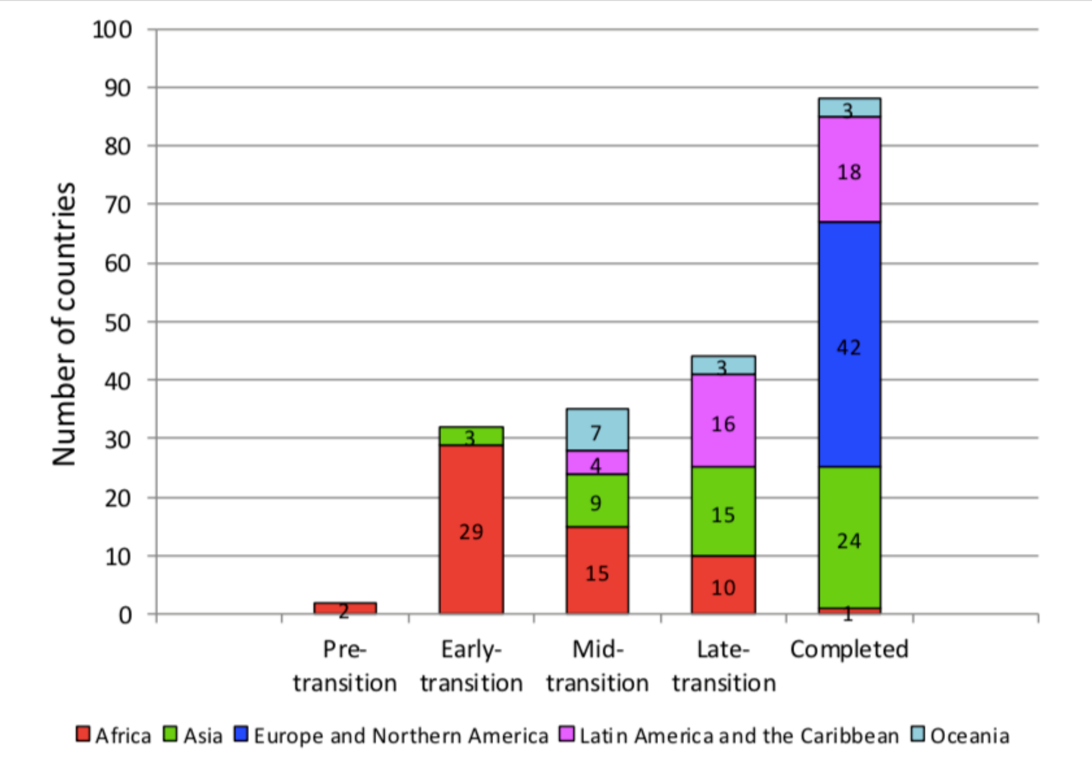
Economic uncertainty is regarded as a significant factor affecting the fertility behavior of young adults. Throughout history, young people have tended to delay marriage and childbearing during times of economic insecurity. For instance, during the latest recession in North America and Europe in 2008, the previous increase in the lowest-low fertility levels has stagnated or declined in many post-transitional countries (Sobotka et al., 2011). However, over the previous four decades, young people in many developed countries had already faced economic uncertainty (Billari, 2008; Sobotka, 2017; Wilkins, 2019). Youth unemployment increased due to reduced job opportunities resulting from technological change, neoliberal economic and labor market policies promoting poor-paid temporary and precarious employment, and also migration of labor force from poor countries competing with local workers (Sobotka, 2017).

III.2.2. Fertility Differentials in the Developing World

While post-transitional fertility trends have emerged in several European, East Asian, and North American countries, other countries are at various phases of fertility transition. According to the United Nations (2017b) figures, 88 out of 201 countries reached the replacement level fertility and completed fertility transition by 2015. Among transitional countries, three stages are identified as: late-transitional countries with fertility rates greater than replacement level and less than 3.0; mid-transitional countries with fertility rates between 3.0 and 4.5, and early-transitional countries with fertility rates greater than 4.5. Moreover, countries whose fertility rates have not decreased by 10 percent from their most recent peak are classified as pre-transitional countries (UN, 2017b).

Figure III.2.2.1 represents the phases of the fertility transition in the world's main regions. In the period 2010-2015, 44 countries were in the late-transitional stage, mostly in Asia, Latin America and the Caribbean. 10 African countries and 3 Oceanian countries had reached the late-transitional phase. 35 countries were identified in the mid-transitional phase, the majority of which were in Africa and Asia. Almost all of the early-transitional and pre-transitional countries were located in Sub-Saharan Africa (UN, 2017b).

Figure III.2.2.1. Stages of the Fertility Transition by Countries, 2010-2015



Source: UN (2017b)

In the initial stages of the transition, socioeconomic development and a resulting decrease in the demand for children was regarded as the main drivers of fertility change in the developing countries (Anker, 1978; Gregory et al., 1973; Bulatao, 1984). As the fertility transition progressed in a wide number countries, the roles of diffusion and social interaction processes gained prominence as key factors explaining fertility change. According to Bongaarts (2002), each transitional stage is characterized differently. In the pre-transitional settings, fertility is initially unresponsive to socioeconomic development. However, soon after the onset of the transition, fertility changes rapidly due to the diffusion of reproductive behaviors. In the final phases of the transition, the rate of fertility decline slows due to a reduction in the effect of diffusion and social interaction processes. In these phases, fertility transition is closely related to the development indicators (Bongaarts, 2002).

Cleland (2001) also proposed a complementary approach for the two distinct explanations of fertility change. According to the “blended theory,” structural modernization is a prerequisite for the onset of decline, but fertility decline may not start immediately. The speed and mechanisms of the fertility change depend on the diffusion process and spread of knowledge related to reproductive decisions. According to Cleland (2001), “the engine of demographic change is the structural transformation of societies, and diffusion is the lubricant.”

The pace of the fertility transition significantly varies by regions, areas, and countries (United Nations, 2017). Differential fertility patterns are associated with several socioeconomic and demographic factors like education, female employment, income, urbanization, life expectancy, and so forth. Evidence on differential fertility patterns indicates the contribution of these factors in transitional settings. For example, Skirbekk (2008) examined the fertility-social status relationship from a historical perspective. He used education, income/wealth, and occupation/social class as status measures and conducted analysis across world regions. According to the results, contemporary fertility variation among status groups is considerably narrower than the historical ones because of the partial convergence in fertility levels. The convergence resulted from the diminishing effect of income/wealth and occupation/social class measures, giving place to education as the most common measure of social status in the course of the transition (Skirbekk, 2008). Murtin (2013) also used historical data for analyzing the long-term economic determinants of fertility change and concluded that the effect of primary schooling, rather than child mortality or income standards, is the primary socioeconomic determinant of the fertility transition.

Vogl (2016) examined the socioeconomic patterns of differential fertility in developing countries. In the pre-transitional and early-transitional settings, children from high-income families received more education than the low-income ones. As the transition proceeded, the pattern has reversed. As a result, the previously positive link between social status and fertility has turned negative. According to Vogl (2016), the turnaround of the differential fertility trend is attributed mostly to the parent's generation's improved educational level. However, there is little evidence indicating the role of GDP per capita, child mortality, female labor force participation, or urbanization on the reversal pattern. Papagni (2019) examined the fertility transition patterns in low-income countries and emphasized women’s increased education and declining infant mortality as key factors of fertility change.

Jain and Ross (2012) examined the associations between socioeconomic conditions, family planning program efforts, and fertility. They used Human Development Index for measuring the overall level of development and separate indicators of the poverty level, female education, and infant mortality rate as socioeconomic indicators. Their analysis revealed that improvement in a country’s development level is linked to the successful implementation of family planning programs and a reduciton in fertility. Furthermore, reduced infant mortality and increased female education are associated with fertility decline, but no association is found between fertility and poverty. Bloom et al. (2008) investigated the impact of the social interaction process on fertility decisions. They suggest that, in addition to socioeconomic characteristics, social interaction and diffusion processes also affect the pattern of fertility decline.

One of the most well-studied socioeconomic determinants of fertility change is educational differentials (Bongaarts, 2003). Two theoretical models are proposed for explaining the trends in educational divergence during the fertility transition: the “permanent difference” model and the “leader-follower/temporal” model (Cleland, 2002; Bongaarts, 2003). According to the temporal model, early adopters of the fertility transition are well-educated women. They are followed by low-educated women and the fertility disparity between educational groups widens in the mid-transitional stage. As transition proceeds, the gap first narrows and eventually disappears by the end of the transition. Therefore, differential fertility patterns are considered “temporal” in the leader-follower model (Cleland, 2002). The underlying assumption of the temporal model is that convergence of fertility levels near the completion of the transition is mainly attributable to diffusion and social interaction processes (Yoo, 2014). In this view, the alteration of reproductive behaviors emerges in the upper strata and spreads to the other parts of society.

On the other hand, the permanent difference model assumes that fertility differentials by educational groups prevail in every phase of the transition, not just in the mid-transitional phase (Bongaarts, 2003). This model is built on the assumption that fertility decline is mainly attributable to socioeconomic development and the significance of educational composition prevails in the later stages and after the transition. Bongaarts (2003) assessed the patterns of educational differentials in less developed transitional countries and concluded that the permanent difference model is more consistent than the leader-follower model.

These theoretical models of the fertility-education relationship have not been extensively tested due to a lack of empirical evidence on fertility differentials over all stages of fertility transition (Yoo, 2014). However, some studies have shown evidence supporting the propositions of the leader-follower model by using more extensive socioeconomic determinants of fertility change. Skirbekk (2008), in his work about the fertility-social status relationship, concluded that fertility levels first decrease at high-status groups and low-status groups follow them. The fertility gap between high and low-status groups diminishes by the end of the transition. Dribe et al. (2014) came to a similar conclusion in their work related to the socioeconomic patterns in the demographic transition: forerunners of the fertility decline are the upper classes, and social diffusion is the predominant mechanism behind this change. Lerch (2019) examined the rural-urban fertility differentials in major regions of the developing world. The findings show that during the transition process in less-developed countries, rural excess fertility first increased and then decreased. Regional disparities in rural excess fertility levels were attributed to the temporal gap between rural and urban fertility reductions.

III.2.3. Literature on Decomposition of Fertility Differentials

Decomposition methods are used to explore the components of the fertility change in different settings by partitioning the effects of underlying components of the change. They are useful tools for examining fertility differentials within a country or between countries/regions. Decomposition analysis usually focuses on the socioeconomic aspects of fertility behavior like education, income, and so on. Also, biological determinants of fertility, age at marriage or childbearing, are examined using these methods. This section addresses selected studies on the decomposition of fertility differentials in different regions of the world.

Zeng et al. (1991) examined the trends in crude birth rates in China during the 1980s. They decomposed the increase in the birth rates into three elements: age structure, marital fertility, and marriage pattern. They revealed that the increase in fertility levels was associated with rising share of women of reproductive age and declining marriage ages. Increased marital fertility, on the other hand, had a negligible impact. Large cohorts of people born 20 years ago have reached reproductive age, causing a change in the age structure. The legal regulations that lowered the marriage age from 23 to 20 years old resulted in a decrease in the marriage age. The rise in fertility has raised concerns that China's population expansion is out of control. However, the results indicated that there was no sharp reversal in fertility trends.

Smith et al. (1996) used standardization and decomposition methods for providing an explanation for the rise in the non-marital fertility level in the U.S., where non-marital childbearing gained an increased acceptance in the previous decades. They decomposed the change in nonmarital fertility into components of marriage pattern, age structure, marital fertility, and non-marital fertility. The increasing proportion of unmarried women and increasing rates of out-of-wedlock childbearing contributed to the increasing nonmarital fertility ratios. According to Smith et al. (1996), these trends are resulting from declining economic incentives to get married and diminishing rates of abortion.

Abbasi-Shavazi (2000) examined fertility trends in Iran between 1976 and 1996. Fertility change is decomposed into the effects of marital fertility and marriage pattern. In Iran, fertility level increased in the first part of the specified period, began to decrease in the second part, and sharply decreased since 1988. According to the results, the major part of the change in fertility resulted from marital fertility, suggesting that women controlled their fertility within marriage. Abbasi-Shavazi (2000) argues that the progress of development, increasing educational level, promotion of family planning services, and improvement of health systems contributed to the fertility decline.

Lindstrom and Woubalem (2003) investigated the causes of Addis Abeba's fertility decline. In 1994, the fertility rate fell below the replacement threshold for the first time in history. They examined the fertility change by decomposing the effects of proportion married, and marital and non-marital fertility. According to the findings, decline in marital and non-marital fertility contributed the most to the overall decline. Delayed marriage also had an impact on the change, particularly in younger ages.

Neels and De Wachter (2010) examined cohort fertility patterns in Belgium. They employed decomposition analysis for women who were born between 1930-1980. They assessed the effect of educational differentials on the postponement pattern and focused on the temporal variation in fertility differentials. The findings show that differential fertility patterns already existed in the earliest cohort's tempo fertility and have expanded over the following cohorts. The educational expansion made a significant contribution to the fertility change when the cohorts born between 1946-1950 and 1951-1975 are compared: nearly half of the difference in fertility level in the latter cohort is resulting from rising educational levels.

Gubhaju et al. (2014) assessed the ethnic differentials in fertility levels in Fiji by using decomposition analysis. Fertility levels substantially declined in Fiji in the last decades, but there was a significant variation between fertility levels of Fijians and Indians. They decomposed the fertility change among Fijians and Indians into the effects of marital fertility and nuptiality between 1966-2007. According to the findings, both Fijians and Indians' fertility was reduced mostly due to marital fertility. The impact of the shift in nuptiality patterns, on the other hand, has been more prominent in last decades.

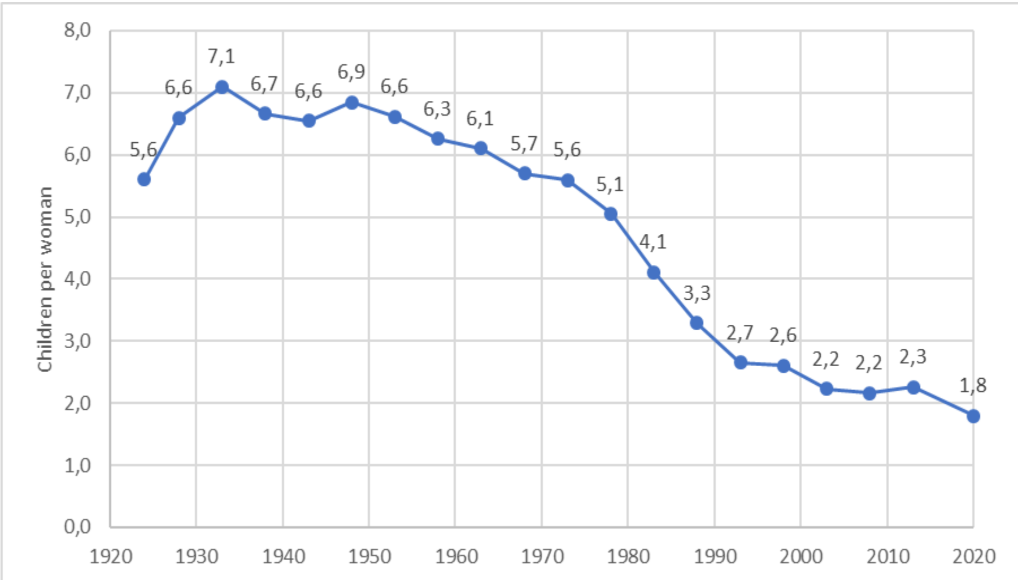
Bagavos and Tragaki (2017) investigated the effects of employment status and educational attainment on male and female fertility in Greece during the "Great Recession." They used “a mixed method of standardization and decomposition” to estimate the employment and education-specific fertility rates for men and women from 2000 to 2014. The pace of fertility decline varied across sexes, employment statuses, and educational levels, according to the findings. Also, male and female fertility changes were influenced by diverse factors. Among women, fertility change was triggered by the fertility effect. The decline in employment level, on the other side, was the main contributor to the fertility change among men.

Zeman et al. (2018) examined the fertility change in low-fertility countries in a cohort perspective. They investigated the impact of parities to the fertility reduction in Europe, North America, East Asia, and Australia. They analyzed the change in completed fertility of birth cohorts from 1940 to 1970 using data from 32 countries. According to the findings, fertility decline has mainly resulted from the decline in third and higher-order births of birth cohorts between 1940 and 1955. In the latter cohorts, however, the pattern of fertility change varied across regions. Fertility change in Central and Eastern Europe was influenced significantly by reductions in second-order births, while decreases in first-order births had an impact on fertility change in German-speaking countries, Southern Europe, and East Asia.

III.2.4. Fertility Trends and Differentials in Turkey

As mentioned in Section I.3, Turkey is getting to the end of its demographic transition. A sustained downward fertility trend is one of the main characteristics of the final stage of the transition. In late-transitional countries, fertility rates are expected to decrease to replacement level or even below-replacement level. Figure III.2.4.1 shows the historical change in the total fertility rates. Fertility rates followed an increasing pattern in the first decades of the Republic when the pronatalist policies were in force. Fertility levels peaked in the 1930s and fluctuated about 6-7 children per woman for the next 30 years. After the 1970s, TFR values have steadily decreased and reached the replacement level in the 2000s. According to the latest figures TFR decreased to 1,8 births per woman by 2020 (TurkStat, 2021e).

Figure III.2.4.1. Trends of the Total Fertility Rates in Turkey, 1920-2020



Source: Shorter and Macura (1982), SIS (1995), HUIPS (1994, 1999, 2004, 2009, 2014), TurkStat (2021e)

In Turkey, fertility levels did not follow a homogeneous pattern across sub-population groups. Regional fertility disparities have been recorded even in the late-Ottoman period. According to censuses held in 1885 and 1907, Istanbul's total fertility rate was estimated to be 3.50 and 3.88, respectively. The total fertility rate of 3.88 observed in İstanbul in 1907 was less than the pre-transitional fertility levels of European countries. In addition, in the 1920s and 1930s, women's first marriage ages were significantly higher than the rest of the country (Duben and Behar, 2014).

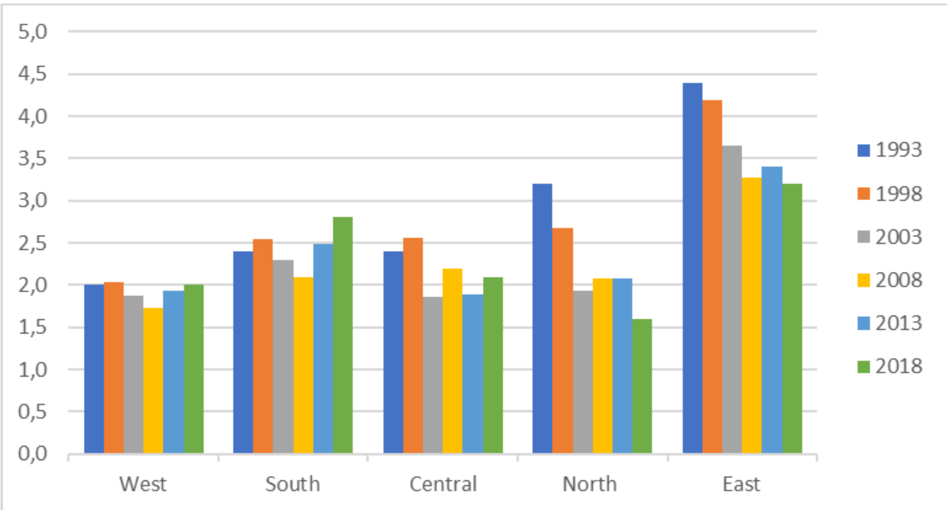
Differential trends in fertility rates were also observed in the period 1945-1968 (Shorter and Macura, 1982). In this period, the total fertility rate for İstanbul and İzmir (combined) fluctuated between 2.5 and 3.0; the fertility rate for other urban areas was 4.36 in 1945 and 4.70 in 1968. On the other hand, the birth rate per woman was around 7 in rural areas in the same period.

Studies on fertility variation in subpopulation groups have assessed the stages of these groups' fertility transition. Eryurt (2002) investigated the socioeconomic and cultural groups that played a leading role in the fertility transition or experienced it with a delay. According to the study, which used TDHS 1998 data, the fertility rate of educated, secular women living in the western region, working in the urban industry or service sectors, or living in households with high income levels fell below the replacement level. Women in urban areas with a lower education level, living in middle-income households, or working in agriculture had fertility rates ranging from 2-3 births per woman. The TFR of women living in rural areas, with low income and education was higher than 3. Eryurt (2002) also discussed the proximate determinants that influence cultural and socioeconomic differentiation in fertility.

Another study on differential fertility patterns was carried out using data from the TDHS 2008 (HUIPS, 2010). According to the study, employed women with a high level of education and a high wealth status have completed the transition process. Moreover, the TFR of women working in a job with social security has decreased to 1 births per women. Population groups in the late transitional period mostly consisted of those living in the northern, southern and central Anatolian regions. Also, population groups living in rural areas, with low and medium wealth and low education levels were in the late transitional stage. Those who lived in the eastern region, were uneducated, and had the lowest level of wealth experienced a delayed fertility transition.

Figure III.2.4.2 presents the trends in total fertility rates by five main regions in the last three decades. TFR in the west region had already decreased to replacement level by the 1990s. Fertility levels in the southern, central and northern regions converged to the replacement threshold by the 2000s. However, TFR values recorded in the eastern region were still more than three children per woman in the late-2010s, which is similar to the fertility level of Turkey in the 1980s.

Figure III.2.4.2. Trends of the Total Fertility Rates by Region, 1993-2018



Source: HUIPS (1994, 1999, 2004, 2009, 2014, 2019)

Regional fertility differentials in Turkey are mainly associated with the ethnic composition and cultural differences. Yüceşahin and Özgür (2008) examined the regional divergences in fertility between 1980 and 2000, focusing on fertility fluctuations in eight cities in the southeast region. They explained the regional fertility differentials by the diffusion process. They proposed that ethnicity and cultural differences were significant factors contributing to high fertility levels in the east and southeast regions. The Kurdish population living in these regions has been out of the social interaction process that enables modern reproductive behavior because of cultural and linguistic barriers and maintained high fertility behavior.

Yavuz (2006) and Koç et al. (2008) examined the ethnic disparities in fertility levels in Turkey. Yavuz (2006) examined the fertility levels by mother tongue groups, emphasizing third birth dynamics. In the final phase of the transition, the transition to third birth is regarded as a significant determinant of fertility transition. Due to socioeconomic differences between the two groups, third-birth risks are smaller for Turkish mother tongue groups than for Kurdish mother tongue groups in Turkey. According to Yavuz (2006), cultural factors, as well as socioeconomic factors, should be considered to explain fertility change in Turkey. Koç et al. (2008) examined the demographic differentials of the Turkish and Kurdish population in Turkey. They concluded that there are significant demographic divergences between two population groups, and they are at different phases of demographic transition.

Greulich et al. (2016), on the other hand, indicated the significance of socioeconomic differentials in regional fertility variation. They examined the fertility differentials by merging region and educational level in their study and discovered that among well-educated women, regional inequalities in fertility levels dropped significantly. Thus, the main determinants of regional fertility differences were socioeconomic factors rather than ethnic or cultural differences in Turkey. According to Greulich et al. (2016), the impact of female employment was strongly related to the educational status, and highly educated women employed in the formal sector were the main contributors to the fertility decline.

Socioeconomic factors are largely emphasized for explaining the fertility divergence in the early and mid-transitional phases of the transition in Turkey. Internal migration, which was triggered by industrialization and urbanization processes, was the major structural shift in the 1950s. The rural-to-urban migration movement started with the effect of economic factors; rising labor demand in urban-industrial areas motived young individuals to relocate from rural areas to cities. Liberal economic policies based on the export-led growth model were introduced after the 1980s. This new economic structure required more workforce for the service sector in urban settlements; therefore, rural-to-urban migration accelerated in this period (Koç et al., 2010).

Before 1950, around 25% of Turkey's population resided in province and district centers; this percentage continuously climbed until it reached 50% in the 1980s (TurkStat, 2022c). In 2008, the urban population's share was 75%, and it continued to increase until now. According to the latest figures, 93% of the population resided in urban settlements in 2021.

In Turkey, the direction of the migration flow started to shift to urban-to-urban migration by the middle of the 1970s, and urban-to-urban movement has become the primary direction (Kocaman, 1998). The share of urban-to-urban migrants rose from 48.9% in 1975-80 to 57.8% in 1995-2000. Between 1995 and 2000, 17.46% of internal migrants relocated from rural to urban settings (Kocaman, 1998).

According to Shorter in SIS (1995), major determinants of the fertility reduction between 1960 to 1993 were selective internal migration and changing population composition. During the time period under consideration, the eastern region had the greatest total fertility rate, and the western region had the lowest, dropping from 8.27 to 4.4 and 4.35 to 2, respectively. As a consequence of the trend of rural-to-urban migration, the proportion of people living in cities has increased, and out-migrants tended to adopt the fertility patterns of the western-urban population. Therefore, the compositional effect of rural areas decreased, and urban areas increased, contributing to the overall fertility decline. Evidence also confirms that the reproductive behavior of migrants is shaped by the values and norms of the place of destination (Eryurt and Koç, 2012).

According to the latest figures, divergent fertility patterns persist between rural and urban settlements in Turkey. TFR fluctuates around the replacement level since the 2000s in the urban areas. In the same years, total fertility rates in rural areas decreased to around 2.6 births per woman and stagnated around that level. It is quite likely that the regional differences have a significant contribution to the rural-urban fertility differentials. As shown in Figure III.2.4.2, fertility levels substantially decreased in all regions except the eastern region. Therefore, high rural fertility can be associated with the fertility levels of the eastern region.

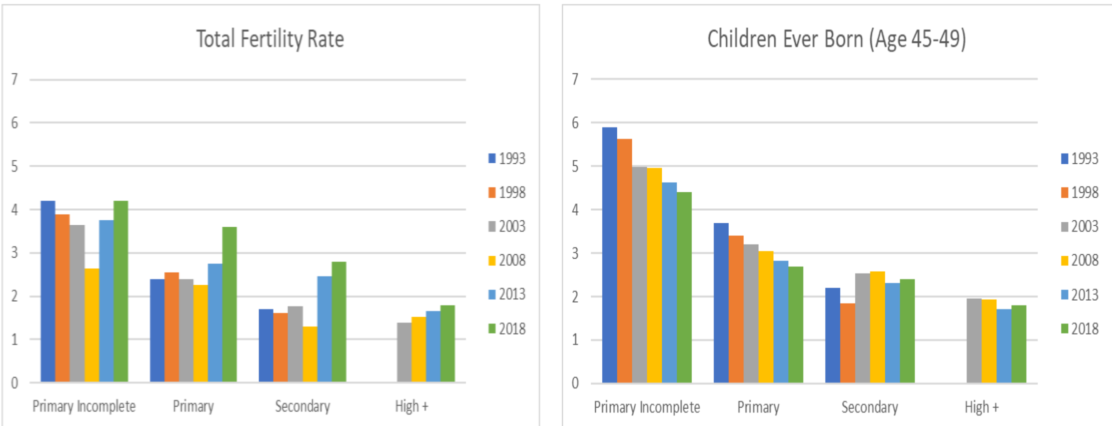
Education is usually considered as the most significant determinant of fertility divergence in Turkey (Tuncer, 1971; Farooq and Tuncer, 1974; Tanfer, 1984; Selim and Üçdoğruk, 2005). Tuncer (1971) and Farooq and Tuncer (1974) investigated the effect of socio-economic variables on fertility levels in Turkey. They examined a range of explanatory variables and concluded that literacy (or education) has been the most significant factor explaining Turkey's differential fertility regimes. Selim and Üçdoğruk (2005) examined the fertility levels in Turkey by using the "quantity versus quality" approach proposed by Becker (1960). They concluded that educational attainment and women's employment were the primary factors affecting fertility levels in Turkey. Although women's employment was usually related to the educational level, it was regarded as one of the essential factors affecting fertility. Of course, employment type was critical in terms of its effect on fertility. For example, homemakers and unpaid family workers in the agricultural production had relatively high fertility than women working in a paid job (Selim and Üçdoğruk, 2005).

In Turkey's modernization process, educational reforms made a significant influence. In 1935, women had a literacy rate of 10% while men had a literacy rate of 29% (TurkStat, 2015b). Although the literacy rate has steadily increased for both sexes, inequality between men and women has persisted until recently. The gap between female and male literacy rates narrowed in the 2010s. According to current figures, men's literacy rate is 99 percent, while it is 96 percent for women (TurkStat, 2021a).

There have also been considerable improvements in educational level over the last decades. Compulsory schooling was expanded from 5 to 8 years in 1997, resulting in a significant improvement in educational attainment, particularly among women. Women's and men's educational levels have increased dramatically, with the proportion of primary school graduates rising to 88 percent for females and 98 percent for males in 2020 (TurkStat, 2021b). Güneş (2013) and Kırdar et al. (2018) examined the effect of compulsory schooling law on fertility levels in Turkey. They focused on adolescent marriage and fertility and found that the extension of compulsory education was substantially effective in reducing teenage births and marriages.

Figure III.2.4.3 presents the trends in the educational differentials in the 1993-2018 period. The total fertility rate (TFR) indicates current fertility, while the children ever born (CEB) reflects a woman's completed fertility at the end of her reproductive years. The difference between TFR and CEB reveals the pattern of fertility change. The most significant fertility decline is observed in the least educated group, where the difference between TFR and CEB is highest in the years between 1993 and 2018. Other educational groups are also experiencing a fertility decline, but the pace of the decline is not as fast as the less-educated groups.

Figure III.2.4.3. Trends of the Total Fertility Rates and Completed Fertility by Education, 1993-2018



Source: HUIPS (1994, 1999, 2004, 2009, 2014, 2019)

Women's increasing educational level is usually associated with greater participation in the labor force. In Turkey, female employment rates have shown two divergent patterns (Greulich et al., 2016). Women's employment rate has decreased since the 1980s, due to increasing time spent in education and a rural-to-urban migration pattern. (Koç et al., 2010). Employment rate started to increase after the mid-2000s, as women started to overcome their educational disadvantage and engaged to the labor force in the urban settlements (Dayıoğlu and Kırdar, 2010). However, women’s employment rate is significantly lower than male employment, as well as the European average for females (Greulich et al., 2016).

In Turkey, there is mixed evidence on the relationship between fertility and women’s labor force participation. Some earlier studies found little or no association between fertility and employment status (Farooq and Tuncer, 1974; Özar and Günlük-Şenesen, 1998). However, recent evidence mostly supports a negative relationship between fertility and female employment (Şengül and Kıral, 2006; Üçler and Kızılkaya, 2014; Greulich et al., 2016). Abbasoğlu Özgören et al. (2018) suggested that the association between fertility and employment switched from insignificant to negative because of the sectoral shift in women’s jobs. Since the 1960s, women have been increasingly employed in service sector jobs rather than agricultural jobs.

III.3. METHODOLOGY AND DATA

III.3.1. Decomposition Methods

This section presents the decomposition methods used for exploring the components of the change in fertility and population growth measures in four sub-sections: decomposition of the change in crude birth rate, total fertility rate, parity progression ratio, and crude rate of natural increase.

III.3.1.1. Crude Birth Rates

The decomposition approach suggested by Kitagawa (1955) can be used to examine the differences between any two rates. Original representation of Kitagawa is successfully used for decomposition problem when data is classified by one factor. Several scholars extended her methodology for capturing the differences between demographic rates classified by two or more factors. Cho and Retherford (1973), Das Gupta (1978), and Kim and Strobino (1984) presented variations of Kitagawa's approach for decomposing differences between two rates in the case data is cross-classified by two or more factors.

On the other hand, some researchers concentrated on decomposition of fertility measures like crude birth rates and total fertility rates. Zeng et al. (1991) presented a decomposition method for crude birth rates based on the standardization approach. Anderson (1975) and Retherford and Ogawa (1978) used a variation of Kitagawa's approach for decomposing age-specific birth rates and total fertility rates.

Zeng et al. (1991) suggested a method for decomposing crude birth rate into age structure, marriage pattern, and marital fertility. They adapted the method from the approach of "double standardization," and they call it "triple standardization."

They defined crude birth rate as a function of the "proportion of women in total population ($p(x)$), the proportion of ever-married women ($pm(x)$) and marital fertility rate ($fm(x)$)":

$$CBR = \sum p(x)pm(x)fm(x) \tag{III.3.1.}$$

The change in the confounding factors between time points 1 and 2 is represented as

$$\begin{aligned} \Delta p(x) &= p_2(x) - p_1(x) \\ \Delta pm(x) &= pm_2(x) - pm_1(x) \\ \Delta fm(x) &= fm_2(x) - fm_1(x) \end{aligned} \tag{III.3.2.}$$

And, the change in the crude birth rates between time points 1 and 2 is:

$$CBR_2 - CBR_1 = \sum p_2(x)pm_2(x)fm_2(x) - \sum p_1(x)pm_1(x)f_{m1}(x) \tag{III.3.3.}$$

$$CBR_2 - CBR_1 = \sum p_2(x)pm_2(x)fm_2(x) - \sum[pm_2(x) - \Delta p(x)][pm_2(x) - \Delta pm(x)]\,[fm_2(x) - \Delta fm(x)]$$

The substitution of the formula yields to an approximation as follows:

$$CBR_2 - CBR_1 \cong \sum \Delta p(x)fm_2(x)pm_2(x) + \sum p_2(x)\Delta pm(x)fm_2(x) + \sum p_2(x)pm_2(x)\Delta fm(x) \tag{III.3.4.}$$

$p(x)$: proportion of women in total population at age x

$pm(x)$: proportion of married women at age x

$fm(x)$: marital fertility rate at age x

Three terms on the right side of the equation reflect the main effect of the changes in age structure, marriage pattern, and marital fertility, respectively. The formula is an approximation because interaction terms are considered negligible when $\Delta m(x)$, $\Delta p(x)$ and $\Delta f(x)$ are relatively smaller than the initial values of the confounding factors.

The formulation proposed by Zeng et al. (1991) reflects the marital fertility pattern assuming that births occur within marriage. Canudas Romo (2003) extended the formula for unmarried women. Zeng et al. also implied that the cross-products of confounding factors at time 2 are used as the standard in the decomposition analysis. The usage of cross-products at time 1 would give similar results when the difference between the two standards is not significant. According to them, the results will not be distorted by choice of the standard when data belongs to the same population at two different time points rather than two different populations.

The formula presented by Zeng et al. (1991) is used for decomposing crude birth rates for Turkey.

III.3.1.2. Total Fertility Rates

Retherford and Ogawa (1978) and Retherford and Rele (1989) suggested a decomposition approach for decomposing total fertility rate into marital fertility and marriage pattern components. TFR can be calculated as the product of age-specific marital fertility rates and proportions married as follows:

$$TFR = 5\sum pm(x).fm(x), \text{ where} \qquad \text{(III.3.5.)}$$

$pm(x)$: proportion of married women at age x
$fm(x)$: marital fertility rate at age x

Therefore, the difference between two TFR's (ΔTFR) is decomposed by the formula:

$$\Delta TFR = 5\sum\overline{fm}(x)\ \Delta pm(x) + 5\sum\overline{pm}(x)\Delta fm(x) \qquad \text{(III.3.6.)}$$

where $\overline{fm}(x)$ and $\overline{pm}(x)$ reflect the averages over the specified time period, and $\Delta pm(x)$ and $\Delta fm(x)$ reflect the changes in the proportion of married women and marital fertility rate, respectively. The first component of the decomposition formula represents the marriage pattern's contribution to the total change in TFR; the second component represents marital fertility's contribution.

The use of averages as a weighting factor in the decomposition formula avoids the existence of interaction terms. The decomposition formula can be broken down into age-specific components and be used to decompose differences between total fertility rates of sub-population groups.

Retherford et al. (2004) suggested another variation of fertility decomposition for decomposing the total fertility rate into three components. They proposed a formula for decomposing the fertility trends by educational attainment, but their formulation can be applied for other compositional factors.

They defined TFR as the product of age-component specific birth rates and age-component specific proportions of women:

$$TFR = 5\sum p_{xk}.f_{xk} \qquad \text{(III.3.7.)}$$

Therefore, the difference between two TFR’s (ΔTFR) is decomposed by the formula:

$$\Delta TFR = 5\sum \bar{f}_{xk}\Delta p_{xk} + 5\sum \bar{p}_{xk}\Delta f_{xk}, \text{ where} \qquad \text{(III.3.8.)}$$

p_{xk}: proportion of women in the xth age group who are in the compositional group k
f_{xk}: age-component specific birth rate

A more detailed breakdown is suggested by the formula:

$$\Delta TFR = 5\sum \bar{f}_{xk}\Delta p_{xk} + 5\sum \bar{p}_{xk}\bar{f}_{xkm}\Delta p_{xkm} + 5\sum \bar{p}_{xk}\bar{p}_{xkm}\Delta f_{xkm} \qquad \text{(III.3.9.)}$$

p_{xkm}: proportion of the x-kth age-component group in marital status m
f_{xkm}: age-component-marital status-specific birth rate

TFR is decomposed into three elements by this formula: the compositional effect of composition (i.e., educational attainment) of women within each age group, the compositional effect of marital status in each component-age group, and the effect of marital fertility in each component-age group.

In the scope of this study, fertility rates by background characteristics are decomposed by using both formulations proposed by Retherford and Ogawa (1978) and Retherford et al. (2004).

III.3.1.3. Parity Progression Ratios

Ní Bhrolcháin (1987) and Pullum et al. (1989) developed a method for decomposing the changes in TFR into effects of parity progression ratios. Barkalov (1999) further extended the method.

The mean parity of a cohort is presented as:

$$TFR^c = P_0 + P_0P_1 + P_0P_1P_2 + \cdots = \sum_{i=0}^{\infty} \prod_{j=0}^{i} P_j \qquad \text{(III.3.10.)}$$

where $P_j = \frac{P_{j+1}}{P_j}$ is the parity progression ratio from parity j to parity $j+1$. P_j and P_{j+1} reflects the number of women at parity j and parity $j+1$, respectively.

Pullum et al. (1989) developed a procedure for obtaining the difference between two cohort TFR's by taking the difference in each parity as follows:

$$\Delta TFR^c = \sum_i \left(\frac{\partial TFR^c}{\partial P_i}\right) \Delta P_i \qquad \text{(III.3.11.)}$$

Following Barkalov (1999), Zeman et al. (2018) expressed the computational formula for decomposition between time c_1 and c_2 as:

$$\Delta TFR^{c} = TFR^{c2} - TFR^{c1} = \sum_{i}\left(\frac{TFR_{i}^{c2}}{TFR_{i}^{c2}} - \frac{TFR_{i+1}^{c2}}{TFR_{i+1}^{c2}}\right)\sum_{j=1} TFR_{j}^{c1} \qquad \text{(III.3.12.)}$$

The contribution of each parity to the total change is estimated “by fixing the values of the subsequent progressions to higher parities at the level of the initial cohort” (Zeman et al., 2018). For example, for calculating the contribution of the first birth progression rate, a standardized value $TFR^{c}(0)$ is calculated by using the value of P_0 at time c_2 and values of time c_1 for the remaining $P_i's$.

$$TFR^{c}(0) = P_0^{c2} + P_0^{c2}P_1^{c1} + P_0^{c2}P_1^{c1}P_2^{c1} + P_0^{c2}P_1^{c1}P_2^{c1}P_3^{c1} + .. + P_0^{c2}P_1^{c1} .. P_{\frac{n+}{n+1}}^{c1} / (1 - P_{\frac{n+}{n+1}}^{c1}) \qquad \text{(III.3.13.)}$$

The last term on the right side of the formula is used to combine higher-order births as a single indicator.

Then, progression to first birth (Δp_0) is estimated by:

$$\Delta p_0 = TFR^{c}(0) - TFR^{c1} \qquad \text{(III.3.14.)}$$

The contribution of the progression to the second birth is calculated by calculating a standardized value $TFR^{c}(1)$ by fixing the values of P_0 and P_1 at time c_2 and the remaining values at time c_1:

$$TFR^{c}(0,1) = P_0^{c2} + P_0^{c2}P_1^{c2} + P_0^{c2}P_1^{c2}P_2^{c1} + P_0^{c2}P_1^{c2}P_2^{c1}P_3^{c1} + ... + P_0^{c2}P_1^{c2} .. P_{\frac{(n-1)+}{n+}}^{c1} / (1 - P_{\frac{(n-1)+}{n+}}^{c1}) \qquad \text{(III.3.15.)}$$

The contribution of progression from first to second birth (Δp_1) is:

$$\Delta p_1 = TFR^{c}(0,1) - TFR^{c}(0) \qquad \text{(III.3.16.)}$$

The remaining contributions of the birth orders are calculated following the same logic, and the contribution of the last birth order is calculated by:

$$\Delta p_{n+} = TFR^{c2} - TFR^{c}(0,1,..,n-1) \qquad \text{(III.3.17.)}$$

Δp_0, Δp_1, Δp_2,..., Δp_{n+} represent the contribution of each parity to the total change between two time points, and their total adds to the difference between the total fertility rates at these time points.

III.3.1.4. Measures of Population Growth

Das Gupta (1993) proposed a method for decomposing the crude rate of natural increase (CRNI) of a population into the effects of CBR and crude CDR. CRNI (R) is stated as the difference between CBR (b) and CDR (d):

$$R = b - d \qquad \text{(III.3.18.)}$$

The difference between CRNI between time point 1 and time point 2 is:

$$\Delta R = (b_2 - d_2) - (b_1 - d_1) \qquad \text{(III.3.19.)}$$

Crude rate of natural increase is decomposed into birth effect and death effect by using the formulas:

Birth effect: $\frac{[(b_2 - d_2) - (b_1 - d_2)] + [(b_2 - d_1) - (b_1 - d_1)]}{2}$

(III.3.20.)

Death effect: $\frac{[(b_2 - d_2) - (b_2 - d_1)] + [(b_1 - d_2) - (b_1 - d_1)]}{2}$

The birth rate effect is calculated by standardizing the death rate as birth rate differs in two populations as it did, and the birth rate is standardized for estimating the death rate effect. The two effects add to the difference between CRNI between time point 1 and time point 2.

Keyfitz (1968) decomposed the difference between two intrinsic growth rates into the effects of age-specific fertility and mortality rates. Das Gupta (1993) reviewed the method considering intrinsic growth rate as a "function of vector-factors" following the same logic as the previous decomposition of the crude rate of natural increase. Life table person-years (L_x) from female life table and age-specific rate of bearing female children (m_x) are needed for calculating intrinsic growth rates. Horiuchi et al. (2008) also decomposed intrinsic growth rates for the Swedish population between 1778-2002 by using the model of continuous change, a general decomposition method.

III.3.2. Data Sources

In Turkey, birth events are registered as part of the civil registration system. However, a significant level of births was unregistered until the 2000s. During the 1990s, the proportion of unregistered children aged under five was over 20 percent. Since the beginning of the 2000s, it decreased to 16 percent and then to 6 percent (Koç and Eryurt, 2010). According to the latest figures, the percentage of unregistered births decreased to about 1 percent by the end of 2015 (Keskin, 2016).

The aim of this chapter is to investigate fertility differentials since the 1990s. Turkish Demographic and Health Surveys (TDHS) are used as the main data source due to the incompleteness of birth registration data during the specified period. Crude birth rates, total fertility rates, and parity progression ratios are estimated using TDHS data sets. Besides, indirect estimates of CBR and CDR from different sources (Shorter and Macura, 1982; Kocaman, 1998; DPT, 2001; MoH, 2010) are used for decomposing crude rate of natural increase.

TDHS 1993, TDHS 2003, and TDHS 2013 are part of the quinquennial demographic surveys and detailed information on these surveys is presented in Chapter II.4.2. In the scope of this study, household member data set and birth history data set are constructed by using the household data set and women data set.

Age-specific fertility rates by compositional factors (education, wealth status, region, type of place of residence) are calculated by using birth history data set for 3-years preceding the surveys. Population composition in each age-compositional group and proportion of currently married women in each group is achieved using women data set; the proportion of women in the total population in each age category is achieved from household member data set. Age-specific marital fertility rates are calculated by dividing age-specific fertility rates by the proportion of married women for each age-composition group.

Fertility variation between rural and urban residences and between five regions is examined using the variables “type of place of residence” and “region.” For examining the fertility differentials between educational groups, three educational categories are created by using the variable “education in single years.” 0-4 years of education is categorized as “no education/primary incomplete”; 5-7 years as “primary/secondary incomplete” and 8 and higher years as “secondary and higher.”

A three-category wealth index is constructed using the variables related to housing characteristics and ownership of durable goods for each survey. The wealth index is created by using the principal components analysis method (Filmer and Pritchett, 2001), and three categories are defined as "lowest," "middle," and "highest." Three categories are aggregated by selecting the cut-off points for wealth index factor scores, which is a variable derived during principal component analysis. The wealth index variable is constructed in household data set and merged with women data set for achieving total fertility rates for each category of the index.

III.4. DECOMPOSITION ANALYSIS

III.4.1. Decomposition of the Change in Crude Birth Rates

Change in the crude birth rates between 1993-2003, 2003-2013, and 1993-2013 is decomposed into the components of marriage pattern, marital fertility, and age structure. Age-specific fertility rates, the proportion of currently married women, and the proportion of women in the total population are used for employing decomposition analysis. Age-specific marital fertility rates are estimated by dividing age-specific fertility rates by the proportion of married women for each age group. Proportion of currently married women, proportion of women in the total population and age-specific marital fertility rates are shown in Appendix B (Table B.1).

Age-specific fertility rates, crude birth rates, and total fertility rates for the years 1993, 2003, and 2013 are shown in Table III.4.1.1. In the period 1993-2013, age-specific fertility rates decreased in the younger ages. However, a more significant part of births occurred before age 30 in this period; more than 70 percent in 1993 and 2003; and about 64 percent in 2013. In 1993 and 2003, women aged 20 to 24 experienced the highest fertility level; however, in 2013, the 25-29 age group experienced the highest fertility. Trends in age-specific fertility rates reflect the postponement pattern from 1993 to 2013.

The TFR decreased from 2,5 to 2.23 births per woman from 1993 to 2003 and then stabilized around the replacement level until 2013. The crude birth rate was 21,7 per 1000 population in 1993; it declined to 19,7 in 2003 and 17,5 in 2013.

Table III.4.1.1. Age Specific and Total Fertility Rates and Crude Birth Rates in Turkey, 1993 - 2013[6]

Age group	1993	2003	2013
15-19	55	46	31
20-24	168	136	124
25-29	139	134	136
30-34	86	78	104
35-39	42	38	48
40-44	13	12	7
45-49	1	2	2
TFR	2,51	2,23	2,26
CBR	21,7	19,7	17,5

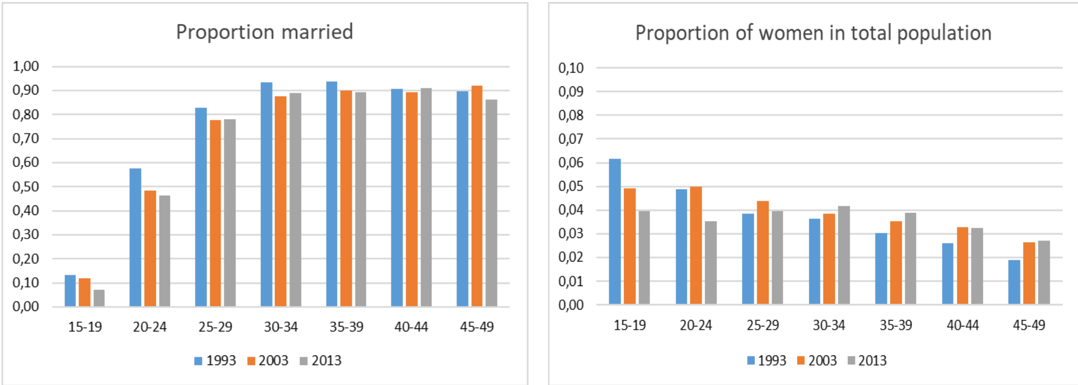
ASFR are per 1000 women, CBR are per 1000 population.

Trends in the share of married women and the share of women in the total population in 1993, 2003, and 2013 are shown in Figure III.4.1.1. Since marriage is a well-accepted form of partnership in Turkey, the proportion of currently married women was about 90 percent after age 30 in the whole period. The share of married women in 15-19 and 20-24 age groups followed a decreasing pattern in 1993-2013. Since childbearing is mainly practiced within marriage in Turkey, rising age at marriage and fertility postponement are closely related to each other.

When the age structure of women is considered, the proportion of younger ages has decreased while the proportion of older ages has increased over the 20 year-period. This shift is the result of a change in age composition of the population during the demographic transition.

[6] Results are based on 3 year-periods preceding the surveys.

Figure III.4.1.1. Proportion of Currently Married Women and Proportion of Women in Total Population by Age Groups



Decomposition results are presented in Table III.4.1.2. The decline in the CBR between 1993 and 2013 mainly resulted from the changes in the marriage pattern, according to the decomposition analysis. In other words, rising marriage age is the primary cause of this period's fertility decrease. Changes in the population age structure, or the share of women of reproductive ages, also acted to decrease the crude birth rate in this period. When the age-specific contributions of compositional factors are examined, younger women significantly contributed to the fertility reduction between 1993 and 2013, as shown in Figure III.4.1.2. Postponement of marriage and changes in population age structure were the main components of the change in the 15-19 and 20-24 age groups. Changing marital fertility levels in the 30-34 and 35-39 age groups acted to increase the fertility levels, reflecting a postponement pattern in childbearing.

Change in the marriage pattern was the main contributor to the CBR decline in the 1993-2003 period. For women aged 20-24, the decline in the age-specific proportions married accounts for a significant part of the decrease in the CBR in this period. The population's age composition acted to increase the CBR for women aged 25-29, contrary to women aged 15-19.

Table III.4.1.2. Decomposition of the Change in Crude Birth Rates, 1993-2013

	1993-2003		2003-2013	
	Absolute contribution	Percentage contribution	Absolute contribution	Percentage contribution
Total change in CBR	-1,94	100,0	-2,25	100,0
Change due to:				
Age structure	0,70	-35,8	-2,16	95,8
Marriage pattern	-2,23	114,9	-0,96	42,5
Marital fertility	-0,33	17,1	1,23	-54,6
Interaction	-0,07	3,9	-0,37	16,3

	1993-2013	
	Absolute contribution	Percentage contribution
Total change in CBR	-4,19	100,0
Change due to:		
Age structure	-1,20	28,6
Marriage pattern	-2,81	67,0
Marital fertility	1,00	-23,8
Interaction	-1,18	28,2

The change in women's age distribution was primarily responsible for the CBR decline between 2003 and 2013. The marriage pattern was also a factor in the CBR decrease; however, the increase in marital fertility operated in the opposite direction in this period. When age-specific contributions are examined, the greatest contribution is resulting from younger age groups. Age structure and marriage pattern are the main contributors to the decline. Marital fertility in the 30-34 and 35-39 age groups increased the fertility levels.

Figure III.4.1.2. Contribution of Age Composition, Marriage Pattern and Marital Fertility to the Overall Change in Crude Birth Rate, 1993-2013

III.4.2. Decomposition of the Change in Total Fertility Rates by Background Characteristics

The results of the decomposition analysis of the change in total fertility rates by educational attainment, wealth status, region, and place of residence for the period 1993-2013 are presented in this section. Decomposition analyses are implemented in two parts for each component. First, the overall effect of the components on TFR change is determined by decomposing the change into effects of composition, marriage pattern, and marital fertility. Then, decomposition analyses are extended to show the changes in each compositional group.

Decomposition of TFR change by educational level:

In the first part, TFR change between 1993 and 2013 is decomposed into the effects of educational level, marital fertility, and marriage pattern. Age-education-specific fertility rates, the proportion of currently married women by educational groups, and women's distribution by educational groups are used for employing decomposition analysis. Age-education-specific marital fertility rates are estimated using age-education-specific fertility rates and the proportion of currently married women by educational groups. Age-education-specific marital fertility rates, women's distribution and proportion of currently married women by educational groups are presented in Appendix B (Table B.2-4).

Age-specific and total fertility rates by educational groups are shown in Table III.4.2.1. The TFR followed a decreasing pattern with increasing educational levels in both years. In 1993, TFR was 3,81 births for less educated women and 1,58 births for highly educated women. TFR values for the lowest and highest educational groups were 3,77 and 1,98 in 2013.

As mentioned in Section III.4.1, TFR declined from 2,5 to 2,26 births per woman from 1993 to 2013 in Turkey. However, TFR values for two educational groups considerably increased in the 20 years, from 2,28 to 2,73 births for lowest educated women and from 1,58 to 1,98 among women in the highest education category. One of the reasons for this unexpected pattern can be the composition of educational groups created from TDHS data. In the scope of this study, the highest educational level is determined as “secondary school and higher” because of the educational status of the population in 1993. In that time, only 20 percent of women of reproductive ages completed secondary school or higher. Therefore, the highest educational category remained as “secondary school and higher” to avoid the low number of cases in calculations. However, secondary level education could be considered a high level of education for women in 1993, which was not the case in 2013. Women with relatively low education levels (primary-secondary) maintained a high fertility trend in 2013 in the specified educational categories.

Table III.4.2.1. Age Specific and Total Fertility Rates by Educational Groups, 1993 - 2013

Age group	1993			2013		
	No educ./Pri. incomplete	Primary/ Sec. incomplete	Secondary and higher	No educ./Pri. incomplete	Primary/ Sec. incomplete	Secondary and higher
15-19	114	57	14	104	75	24
20-24	248	176	96	215	192	98
25-29	181	129	117	195	135	122
30-34	129	69	64	139	94	104
35-39	70	20	20	76	42	47
40-44	20	4	4	21	6	0
45-49	2	0	0	4	2	0
TFR	3,81	2,28	1,58	3,77	2,73	1,98

The distribution of educational categories, on the other hand, has shifted dramatically over the last 20 years, as illustrated in Figure III.4.2.1. In 1993, over than 50 percent of the reproductive aged women had primary level education and 27 percent had lower than primary school education. In 2013, more than 50 percent of women aged 15 to 49 had completed secondary or higher-level education, with roughly one-third having completed primary school. The educational level increased for younger age groups in both years, while there was a considerable shift in educational groups' share in 2013. By 2013, approximately 90 percent of women aged 15 to 19 and approximately 80 percent of women aged 20 to 24 had completed secondary and higher education. This shift can be explained by the implementation of 8-year compulsory primary education starting from 1997.

Figure III.4.2.1. Percentage Distribution of Women by Age and Educational Groups, 1993 – 2013

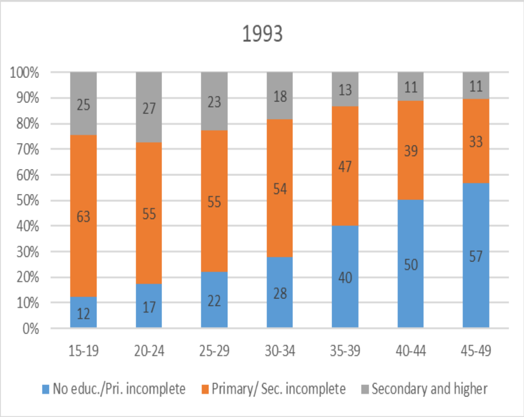
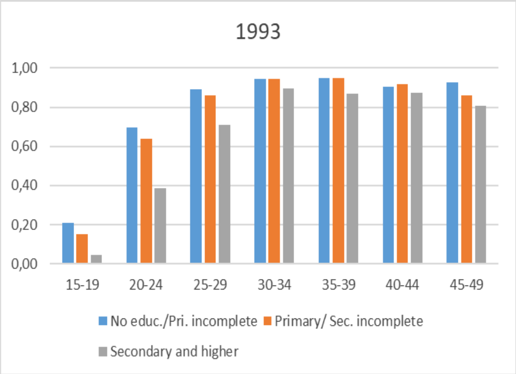
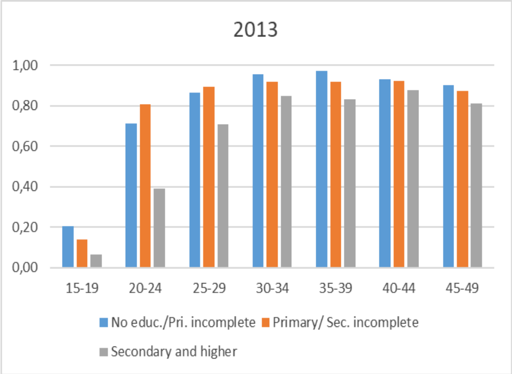


Figure III.4.2.2 depicts the proportion of currently married women by age and educational groups. The share of currently married women in the higher education group is smaller than other groups in both years. Women with higher educational attainment get married later than women in other educational groups. Age trends are similar for the years 1993 and 2013.

Figure III.4.2.2. Proportion of Currently Married Women by Age and Educational Groups, 1993 – 2013



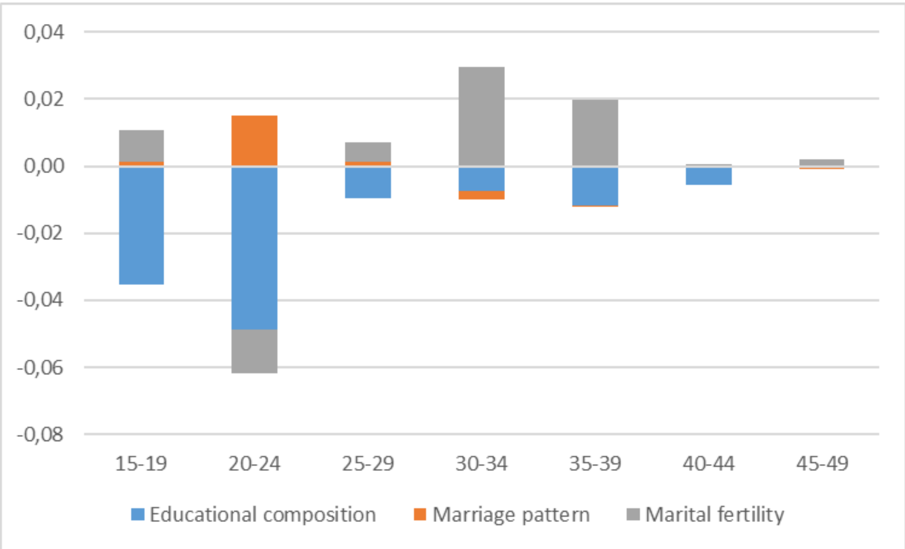


Decomposition results are displayed in Table III.4.2.2. and Figure III.4.2.3. Changes in educational composition contributed the most to the reduction in fertility, particularly among the younger generations. At these ages, an increasing level of education tends to decrease fertility due to the postponement of childbearing. On the contrary, marital fertility of women in the 30-34 and 35-39 age groups tended to increase the fertility levels in the 1993-2013 period.

Table III.4.2.2. Decomposition of TFR Change into Components of Educational Composition, Marriage Pattern and Marital Fertility

	1993-2013	
	Absolute contribution	Percentage contribution
Total change in TFR	-0,25	100,0
Change due to:		
Educational composition	-0,60	235,1
Marriage pattern	0,07	-29,0
Marital fertility	0,27	-106,1

Figure III.4.2.3. Contribution of Educational Composition, Marriage Pattern and Marital Fertility to the Overall Change in TFR by Age Groups, 1993-2013



In the second part, further decomposition analyses are employed for each educational group to examine the role of marital fertility and marriage pattern in the TFR change. Table III.4.2.3 and Figure III.4.2.4 show the results of the decomposition analyses. The overall decrease in the lowest education group resulted from the decline in marital fertility of women in the younger age groups. However, the increasing effect of marital fertility in women over the age of 25 compensated for the decreasing effect of marital fertility in the younger ages. The TFR of the higher educational groups increased in the period 1993-2013. The marital fertility of women over the age 30 made a substantial contribution to the increased fertility levels for both educational groups.

Table III.4.2.3. Decomposition of TFR Change by Educational Groups

	1993-2013	
	Absolute contribution	Percentage contribution
	No educ./Pri. incomplete	
Total change in TFR	-0,04	100,0
Change due to:		
Marriage pattern	0,01	-13,9
Marital fertility	-0,05	113,9
	Primary/ Sec. incomplete	
Total change in TFR	0,46	100,0
Change due to:		
Marriage pattern	0,20	43,0
Marital fertility	0,26	57,0
	Secondary and higher	
Total change in TFR	0,40	100,0
Change due to:		
Marriage pattern	0,00	0,3
Marital fertility	0,40	99,7

Figure III.4.2.4. Contribution of Age Groups to the TFR Change by Educational Groups

<u>Decomposition of TFR change by wealth status:</u>

The age-specific and total fertility rates by wealth status groups are shown in Table III.4.2.4. The total fertility rate decreased with increasing wealth status in 1993 and 2013. Women in the lowest wealth group had 3,20 children in 1993 and 2,90 children in 2013. TFR in the middle wealth group decreased from 2,38 to 2,29, and in the wealthiest group, TFR decreased from 1,93 to 1,73. In 1993, women aged 20 to 24 had the highest age-specific fertility rates of all wealth groups; however, in 2013, fertility rates of women in middle and highest wealth groups reached the highest level in the ages 25 to 29. Age-wealth group-specific marital fertility rates, women's distribution and proportion of currently married women by wealth groups are presented in Appendix B (Table B.5-7).

Table III.4.2.4. Age Specific and Total Fertility Rates by Wealth Status, 1993 - 2013

	1993			2013		
Age group	Lowest	Middle	Highest	Lowest	Middle	Highest
15-19	53	54	61	40	37	15
20-24	194	160	135	173	125	76
25-29	159	140	113	159	144	109
30-34	126	82	56	119	98	101
35-39	81	29	18	72	44	39
40-44	28	8	3	17	5	5
45-49	0	3	0	1	4	0
TFR	3,20	2,38	1,93	2,90	2,29	1,73

The composition of women by age and wealth status is depicted in Figure III.4.2.5. Over the study period, the percentage of women in the lowest wealth status group decreased in all age categories, with the youngest ages showing the most significant reduction. The share of middle and highest wealth groups increased almost in all age groups in the same period.

Figure III.4.2.6 depicts the share of currently married women by wealth status and age. For all wealth status groups, the share of married women in the 15-19 and 20-24 age groups decreased; and the change was more prominent in the highest wealth group.

Figure III.4.2.5. Percentage Distribution of Women by Age and Wealth Status, 1993 - 2013

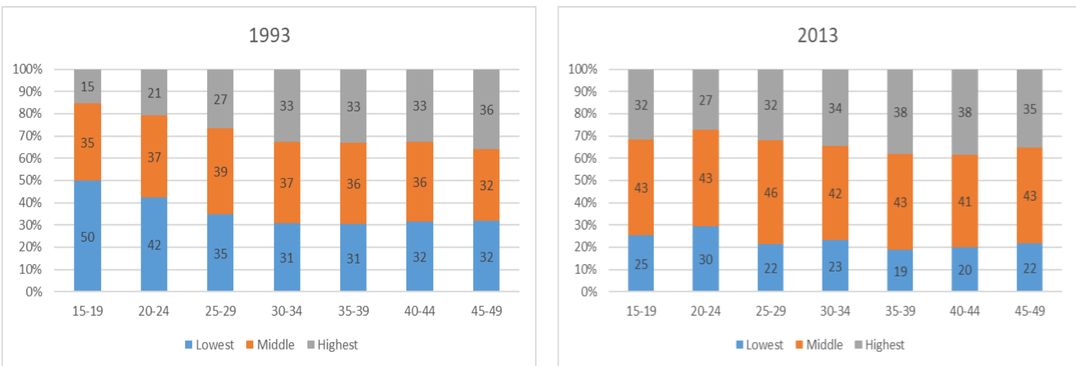
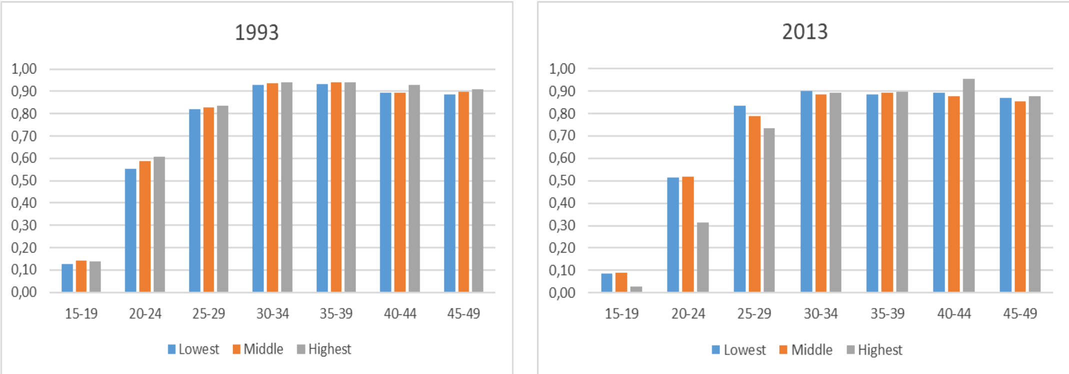


Figure III.4.2.6. Proportion of Currently Married Women by Age and Wealth Status, 1993 – 2013



The results of the decomposition analysis are displayed in Table III.4.2.5 and Figure III.4.2.7. Marriage pattern was the primary contributor to the fertility decrease, especially at younger ages. The change in the composition of wealth groups also contributed to the fertility reduction from 1993 to 2013. During this time period, the change in marital fertility of women in the 30-34 and 35-39 age groups acted to increase fertility levels. Figure III.4.2.7 demonstrates the pattern of late marriage and postponement of childbearing.

Table III.4.2.5. Decomposition of TFR Change into Components of Wealth Composition, Marriage Pattern and Marital Fertility

	1993-2013	
	Absolute contribution	Percentage contribution
Total change in TFR	-0,25	100,0
Change due to:		
Wealth composition	-0,11	43,1
Marriage pattern	-0,34	132,0
Marital fertility	0,19	-75,1

Figure III.4.2.7. Contribution of Wealth Composition, Marriage Pattern and Marital Fertility to the Overall Change in TFR by Age Groups, 1993-2013

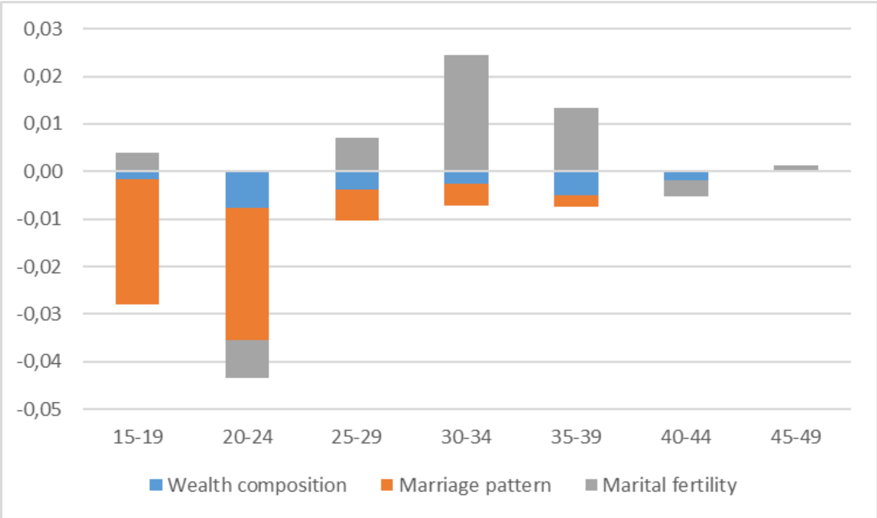


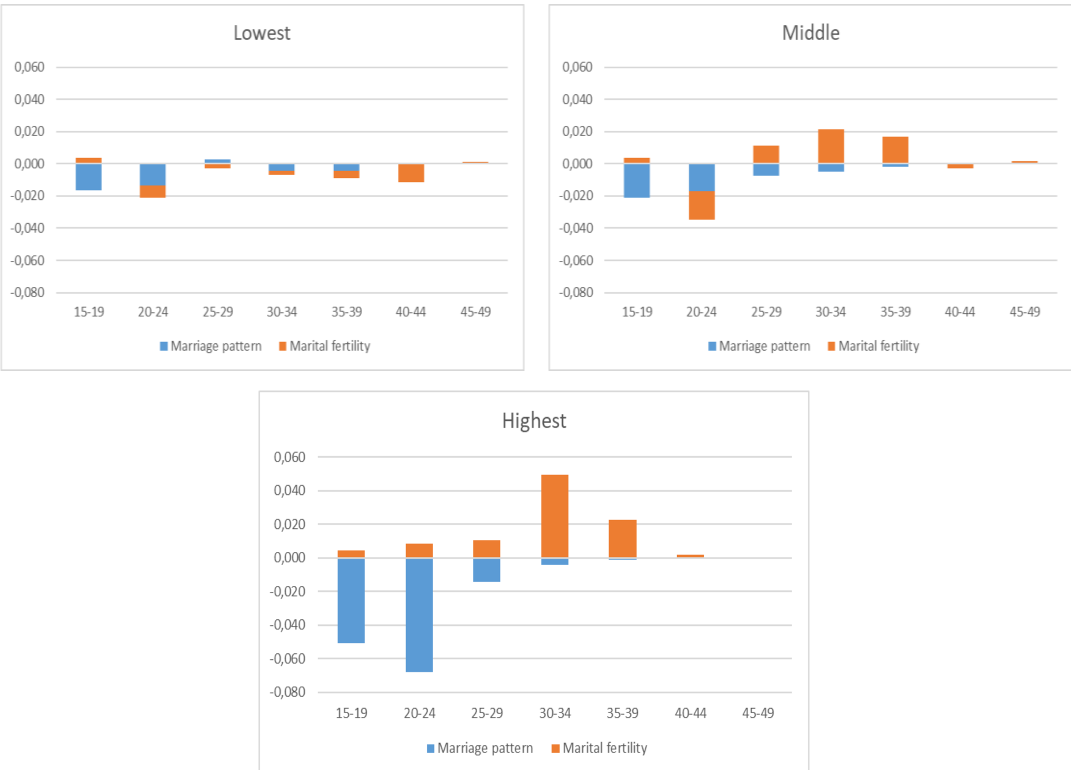
Table III.4.2.6 and Figure III.4.2.8 present the results of the decomposition analysis for each wealth group. In the lowest wealth status group, around 60 percent of TFR decrease originated from the change in marriage pattern; the remaining 40 percent resulted from the change in marital fertility. The effect of marriage pattern was significant in young age groups, and the effect of marital fertility was prominent in older ages.

TFR of the middle wealth group has decreased slightly over the 20 year-period. The shift in marriage patterns, particularly among younger women, contributed to the TFR decrease; the effect of marital fertility of women aged 25-40 acted to increase fertility rates. In the highest wealth group, late marriage was the main contributor to the TFR reduction, as shown in Figure III.4.2.8. Marital fertility acted to increase the TFR in the older ages. In this group, the effect of the postponement-recuperation pattern was particularly noticeable.

Table III.4.2.6. Decomposition of TFR Change by Wealth Status

	1993-2013	
	Absolute contribution	Percentage contribution
	Lowest	
Total change in TFR	-0,30	100,0
Change due to:		
Marriage pattern	-0,18	59,7
Marital fertility	-0,12	40,3
	Middle	
Total change in TFR	-0,09	100,0
Change due to:		
Marriage pattern	-0,26	289,8
Marital fertility	0,17	-189,8
	Highest	
Total change in TFR	-0,21	100,0
Change due to:		
Marriage pattern	-0,69	335,4
Marital fertility	0,49	-235,4

Figure III.4.2.8. Contribution of Age Groups to the TFR Change by Wealth Status



Decomposition of TFR change by place of residence:

Table III.4.2.7 shows the age-specific and total fertility rates by place of residence for the years 1993 and 2013. Over the 20 year-period, TFR has decreased in both urban and rural settlements. In urban areas, the TFR fell from 2,31 to 2,16, while in rural areas, it fell from 2,87 to 2,73. Women in the age group 20-24 had the highest age-specific fertility rates in rural residences in both years. However, in 2013, the fertility rates of women aged 25-29 living in urban residences reached the highest level. Age-specific fertility rates of women aged 30-34 and 35-39 substantially increased in the urban areas in the 20-year period. Age-residence-specific marital fertility rates, women's distribution and proportion of currently married women by place of residence are presented in Appendix B (Table B.8-10).

Table III.4.2.7. Age Specific and Total Fertility Rates by Place of Residence, 1993 - 2013

	1993		2013	
Age group	Urban	Rural	Urban	Rural
15-19	55	50	28	45
20-24	154	192	114	168
25-29	131	154	131	161
30-34	76	106	102	111
35-39	34	55	46	54
40-44	9	19	7	7
45-49	2	0	3	1
TFR	2,31	2,87	2,16	2,73

The age composition of women by residence is shown in Figure III.4.2.9. The share of women in urban residences expanded in all age groups in the study period, with the youngest age groups experiencing the greatest increase. Figure III.4.2.10 indicates that the share of married women diminished among younger ages in urban areas but did not change significantly in rural areas.

Figure III.4.2.9. Percentage Distribution of Women by Age and Place of Residence, 1993 – 2013

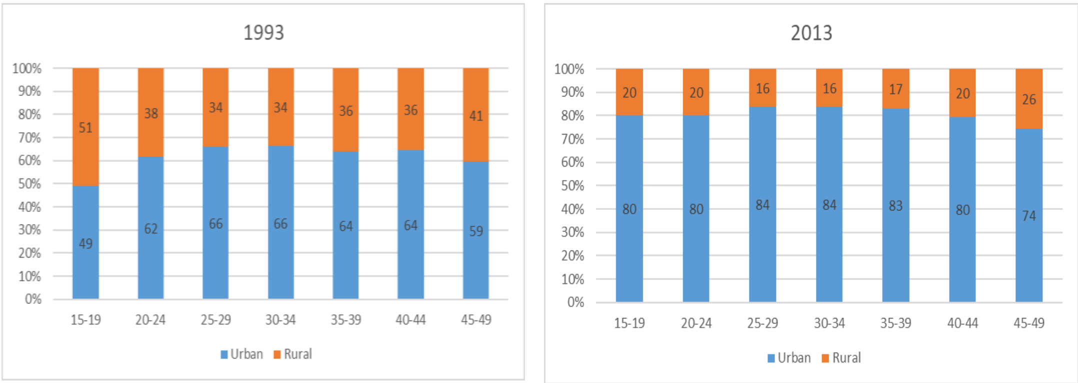
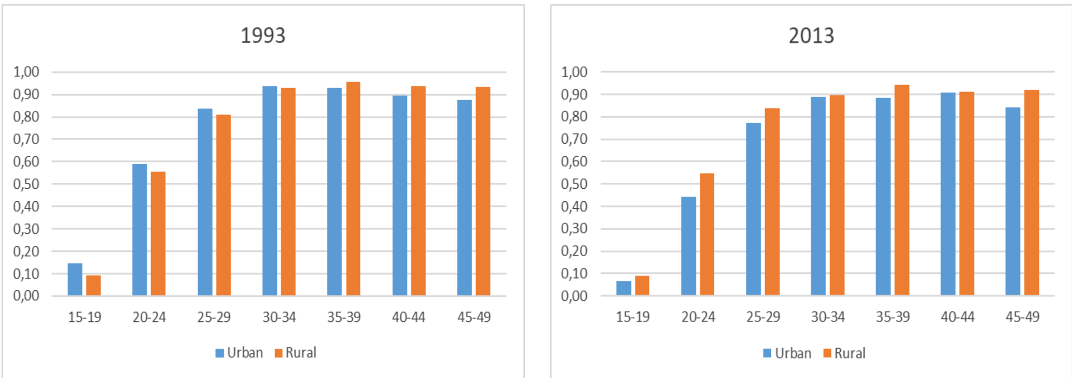


Figure III.4.2.10. Proportion of Currently Married Women by Age and Place of Residence, 1993 – 2013



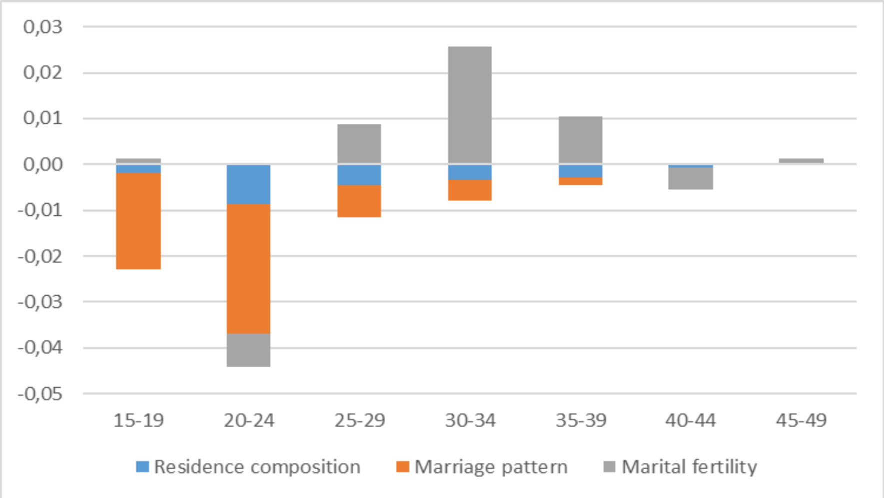
The change in TFR is broken down into components produced by changes in residence composition, marital fertility, and marriage pattern; the results are shown in Table III.4.2.8 and Figure III.4.2.11.

The primary contributor to the fertility reduction over the 20-year period was a change in the marriage patterns of women in age groups 15-19 and 20-24. The marital fertility change has worked in the opposite direction in the 30-34 and 35-39 age groups.

Table III.4.2.8. Decomposition of TFR Change into Components of Residence Composition, Marriage Pattern and Marital Fertility

	1993-2013	
	Absolute contribution	Percentage contribution
Total change in TFR	-0,25	100,0
Change due to:		
Residence composition	-0,11	44,36
Marriage pattern	-0,31	128,08
Marital fertility	0,18	-72,44

Figure III.4.2.11. Contribution of Residence Composition, Marriage Pattern and Marital Fertility to the Overall Change in TFR by Age Groups, 1993-2013



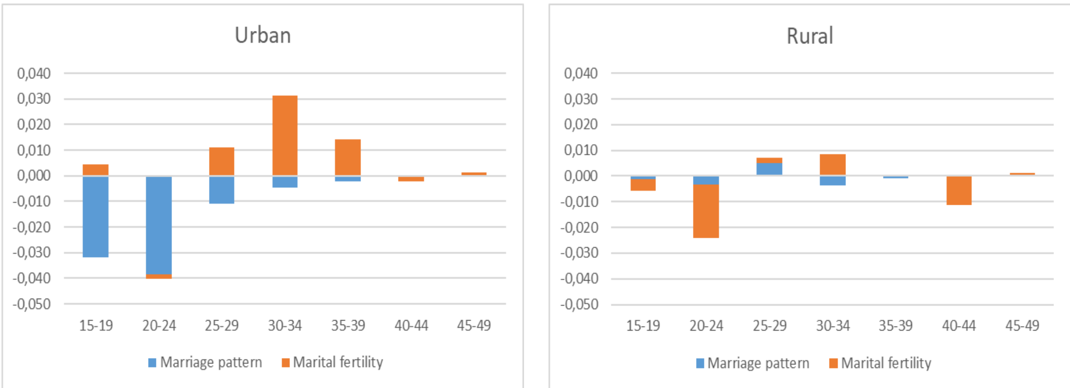
The results of the analyses for urban and rural residences are shown in Table III.4.2.9 and Figure III.4.2.12. Fertility decline among urban women was primarily driven by a shift in the marriage pattern. Young women in urban areas tended to postpone marriage in this period. The effect of marital fertility acted to increase TFR, especially at ages older than 30.

In rural areas, the decrease in TFR was primarily caused by changes in marital fertility patterns, which accounted for more than 83 percent of the decrease. The decline was prominent in the 20-24 age group. The change in the marriage pattern was responsible for 16 percent of the change in this period in rural areas.

Table III.4.2.9. Decomposition of TFR Change by Place of Residence

	1993-2013	
	Absolute contribution	Percentage contribution
	Urban	
Total change in TFR	-0,15	100,0
Change due to:		
Marriage pattern	-0,44	292,6
Marital fertility	0,29	-192,6
	Rural	
Total change in TFR	-0,14	100,0
Change due to:		
Marriage pattern	-0,02	16,1
Marital fertility	-0,12	83,9

Figure III.4.2.12. Contribution of Age Groups to the TFR Change by Place of Residence



Decomposition of TFR change by region:

Table III.4.2.10 demonstrates the age-specific and total fertility rates by region. TFR has decreased in East, Central, and North regions over the 20 year-period; remained unchanged in the West region and increased in the South region. The age pattern of fertility shifted to the older ages in the West region, and the fertility rates of younger women declined significantly. Age-specific fertility rates of women aged 25-29 and 30-34 followed an increasing pattern in the 20 year-period in the South region.

In Central, North, and East regions, young women's fertility levels decreased, and it has not significantly for women aged 25 and older.

Table III.4.2.10. Age Specific and Total Fertility Rates by Region, 1993 -2013

1993					
Age group	West	South	Central	North	East
15-19	50	48	51	61	67
20-24	145	141	181	198	207
25-29	122	135	116	157	202
30-34	52	88	89	82	166
35-39	15	39	39	40	118
40-44	1	12	13	13	46
45-49	0	0	0	0	8
TFR	1,93	2,31	2,44	2,76	4,07
2013					
Age group	West	South	Central	North	East
15-19	23	40	37	24	37
20-24	99	142	110	110	173
25-29	116	155	116	157	186
30-34	95	106	78	82	172
35-39	43	45	32	41	93
40-44	6	8	4	2	19
45-49	4	0	0	0	2
TFR	1,93	2,48	1,89	2,08	3,41

The age composition of women by region is represented in Figure III.4.2.13. The share of women in the West region considerably increased in the 20-year period in all age groups. A slight decrease was observed in women's share in the other four regions in the same period.

The share of married women diminished in the youngest ages in all regions, and after age 30 proportion of married women was around 90 percent in all regions, as presented in Figure III.4.2.14.

Age-region-specific marital fertility rates, women's distribution and proportion of currently married women by region are presented in Appendix B (Table B.11-13).

Figure III.4.2.13. Percentage Distribution of Women by Age and Region, 1993 – 2013

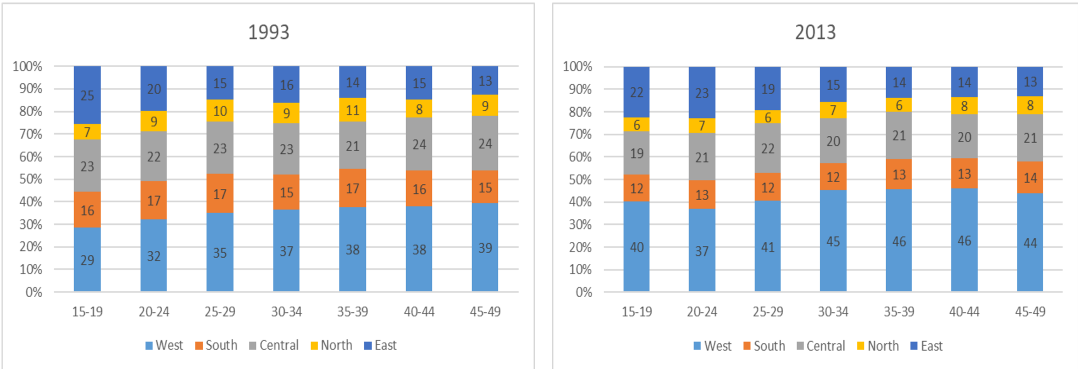
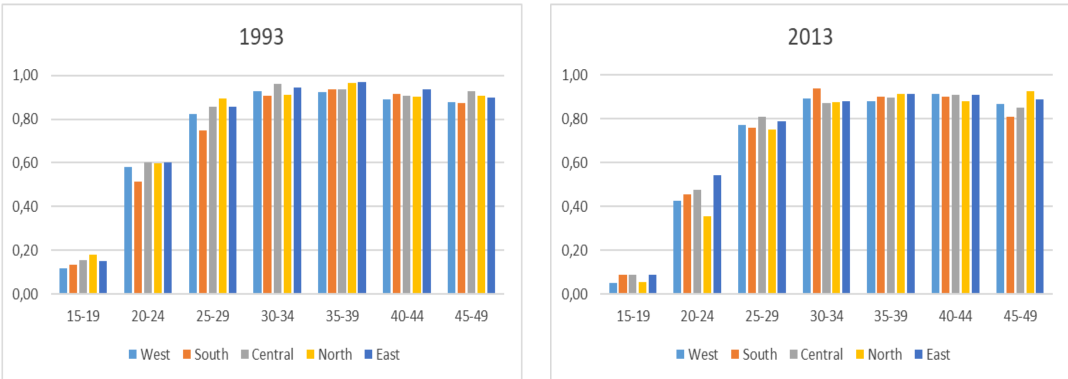


Figure III.4.2.14. Proportion of Currently Married Women by Age and Region, 1993 - 2013

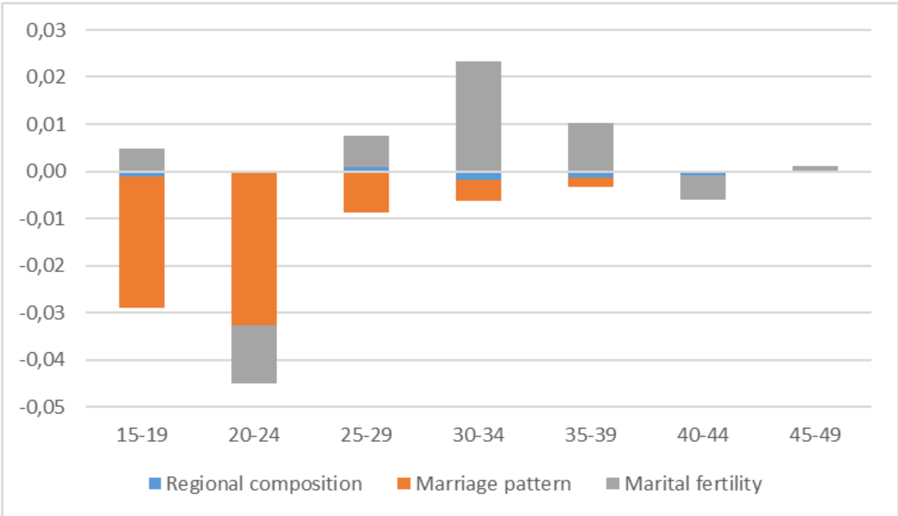


Results of the decomposition analysis are shown in Table III.4.2.11 and Figure III.4.2.15. The compositional changes in regional distribution had almost no contribution to the TFR change. The main contributor was the postponed marriage pattern of younger age groups, and marital fertility acted in the opposite direction in the 30-34 and 35-39 age groups.

Table III.4.2.11. Decomposition of TFR Change into Components of Regional Composition, Marriage Pattern and Marital Fertility

	1993-2013	
	Absolute contribution	Percentage contribution
Total change in TFR	-0,25	100,0
Change due to:		
Regional Composition	-0,02	7,29
Marriage pattern	-0,38	149,25
Marital fertility	0,14	-56,55

Figure III.4.2.15. Contribution of Regional Composition, Marriage Pattern and Marital Fertility to the Overall Change in TFR by Age Groups, 1993-2013



The results of decomposition analysis for five regions are displayed in Table III.4.2.12 and Figure III.4.2.16. In the west region, the overall change in TFR is almost zero; however, when the contributions of age groups are considered, it can be seen that the effect of late marriage and postponed fertility counteracted each other.

In the south region, TFR increase of 0,17 births resulted from the rise in marital fertility across almost all age categories. In the young age groups, the marriage pattern acted in the opposite direction, but its effect was insufficient to cause a decrease in the TFR of the south region.

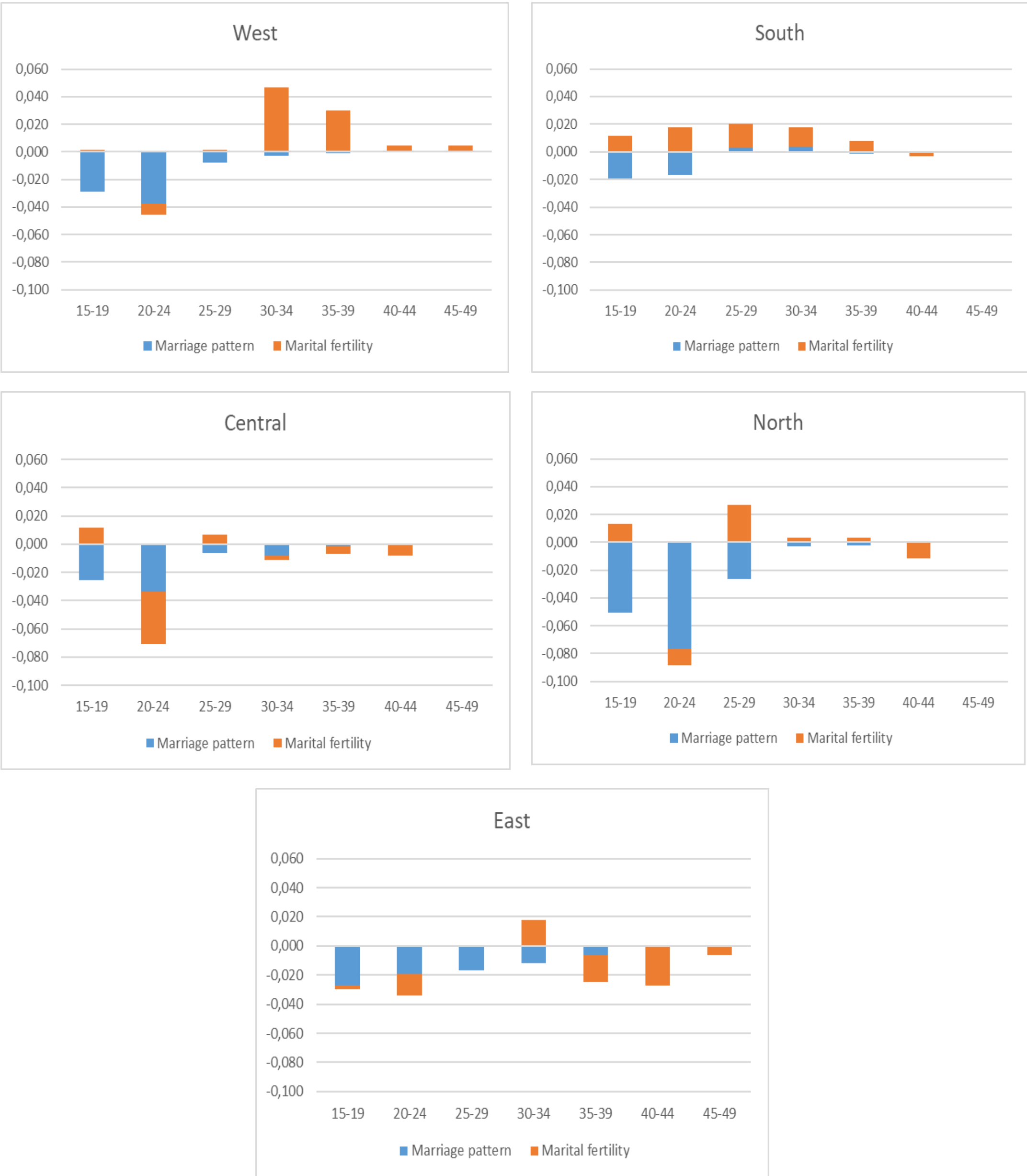
TFR of the central region substantially decreased between 1993 and 2013. About two-thirds of the decrease resulted from the change in marriage pattern, and the rest was due to the effect of marital fertility. The 20-24 age group was the main contributor to the decline resulting from both marriage pattern and marital fertility. 15-19 group has also made a significant contribution to the decline in this region.

In the north region, TFR decreased by 0,68 per woman, and the decline was resulting from the change in marriage pattern. The age categories 15-19, 20-24, and 25-29 all contributed to the decline during this time period. The decline in the eastern region resulted from the effect of both marital fertility and marriage pattern in almost all age groups.

Table III.4.2.12. Decomposition of TFR Change by Region

	1993-2013	
	Absolute contribution	Percentage contribution
	West	
Total change in TFR	0,01	100,0
Change due to:		
Marriage pattern	-0,39	-4689,9
Marital fertility	0,40	4789,9
	South	
Total change in TFR	0,17	100,0
Change due to:		
Marriage pattern	-0,16	-93,1
Marital fertility	0,33	193,1
	Central	
Total change in TFR	-0,55	100,0
Change due to:		
Marriage pattern	-0,37	67,2
Marital fertility	-0,18	32,8
	North	
Total change in TFR	-0,68	100,0
Change due to:		
Marriage pattern	-0,80	117,9
Marital fertility	0,12	-17,9
	East	
Total change in TFR	-0,66	100,0
Change due to:		
Marriage pattern	-0,41	61,9
Marital fertility	-0,25	38,1

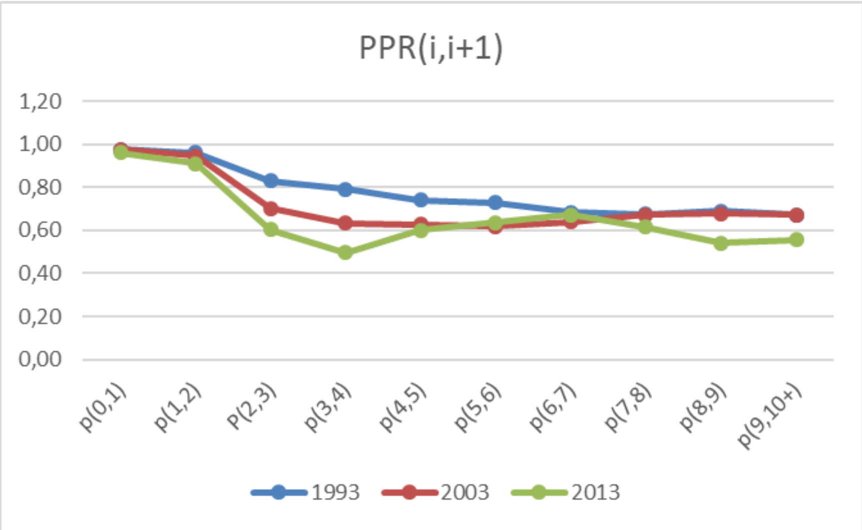
Figure III.4.2.16. Contribution of Age Groups to the TFR Change by Region



III.4.3. Decomposition of the Change in Parity Progression Ratios

Data on children ever born to women between the ages of 40 and 49 are used to calculate parity progression ratios. TFRs based on parity progression ratios are estimated as 4.8 for women aged 40-49 in 1993, 3.7 for 2003, and 3.04 for 2013. These figures reflect the fertility experiences of the cohorts who already have finished childbearing. The trend in the parity progression ratios is shown in Figure III.4.3.1. During the period 1993-2013, the transition to third and fourth births significantly decreased in Turkey. More than 95 percent of women progressed to the first birth, and more than 90 percent of them progressed to the second birth in all three years. However, the transition to third birth declined from 83 to 60 percent over the time period between 1993 and 2013. Likewise, progression to fourth birth declined dramatically between 1993 and 2013. Higher-order births also followed a decreasing pattern in the same period.

Figure III.4.3.1. Parity Progression Ratios, Turkey, 1993-2013



The results of the decomposition analysis of cohort fertility based on PPRs are presented in Table III.4.3.1 and Figure III.4.3.2. In the period 1993-2003, declines in the transition from 2nd to 3rd births and 3rd to 4th births accounted for more than 70 % of the reduction in cohort TFR. In the same period, transitions to 1st and 2nd births have a negligible effect on fertility decline. However, in the next period, the contribution of transitions to 1st and 2nd births sharply increased and constituted almost one-fourth of the TFR decline. The primary contributors to the fertility reduction between 2003 and 2013 were progression to 3rd and 4th order births.

Table III.4.3.1. Decomposition of TFR Based on Parity Progression Ratios

	1993-2003		2003-2013	
	Absolute contribution	Percentage contribution	Absolute contribution	Percentage contribution
Total change in TFR[c]	-1,11	100,0	-0,65	100,0
Δp_0 (from 0 to 1)	0,00	0,3	-0,05	7,9
Δp_1 (from 1 to 2)	-0,05	4,8	-0,10	16,1
Δp_2 (from 2 to 3)	-0,44	39,9	-0,24	36,8
Δp_3 (from 3 to 4)	-0,35	31,1	-0,20	31,4
Δp_4 (from 4 to 5)	-0,15	13,6	-0,02	3,2
Δp_5 (from 5 to 6)	-0,09	8,0	0,01	-1,2
Δp_6 (from 6 to 7)	-0,02	1,9	0,01	-1,5
Δp_7 (from 7 to 8)	0,00	0,1	-0,01	1,8
Δp_8 (from 8 to 9)	0,00	0,2	-0,02	2,7
Δp_{9+} (from 9 to 10+)	0,00	0,0	-0,02	2,8

Figure III.4.3.2. Percentage Contribution of PPRs to the Overall Change in TFR

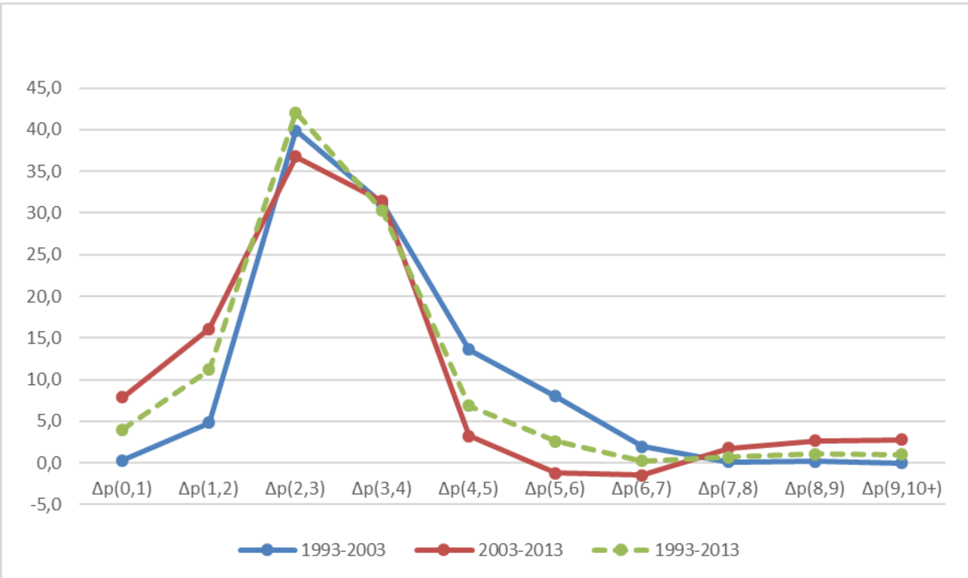


Figure III.4.3.3 represents the percentage contribution of parities to the fertility change by educational groups. The primary contributor to the overall decline in the lowest educational group was a decline in the progression from 3rd to 4th birth. The transition from 2nd to 3rd birth, as well as higher-order births, contributed to the fertility reduction in the lowest educational group. For the middle educational group, declines in the transition from 2nd to 3rd births and 3rd to 4th births accounted for nearly 80 percent of the fertility reduction. The contribution of transitions to 1st and 2nd order births were significantly greater in the highest educational group than in the other two educational groups.

Figure III.4.3.3. Percentage Contribution of PPRs to the Overall Change in TFR by Educational Groups, 1993-2013

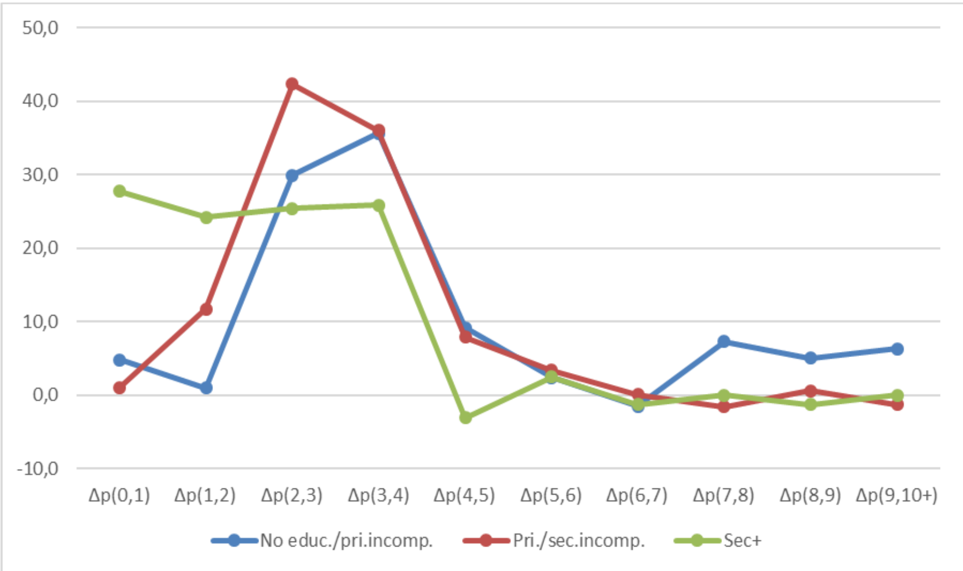
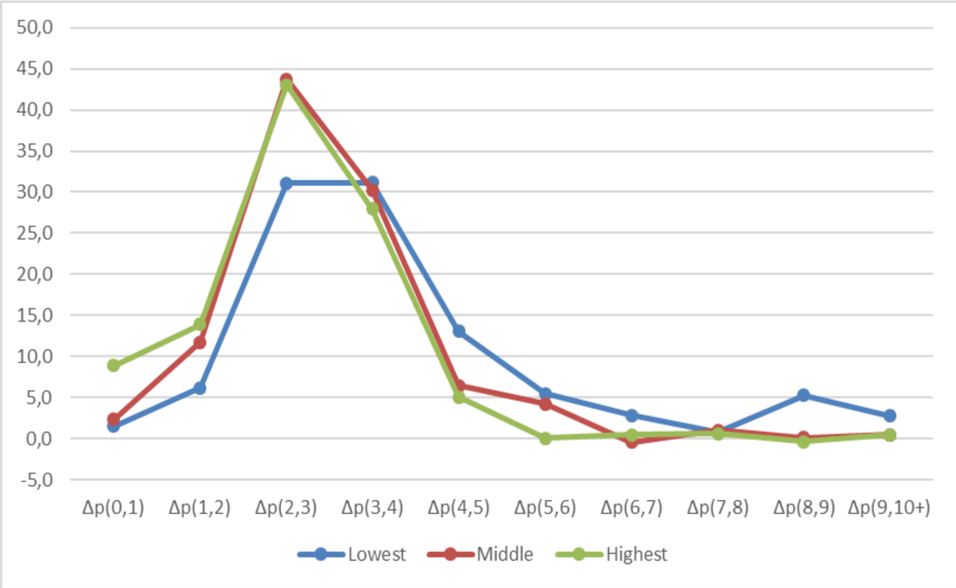


Figure III.4.3.4 shows the percentage contribution of parity progression ratios by wealth status. In all wealth groups, progression from 2nd to 3rd birth made the most outstanding contribution to the fertility decline; and middle and high wealth groups made a more significant contribution than the lowest wealth group. The contribution of higher-order births in the lowest wealth group was greater than the contribution of other groups. The contribution of transition to 1st birth is greater for the highest wealth group than for the other two wealth groups.

Figure III.4.3.4. Percentage Contribution of PPRs to the Overall Change in TFR by Wealth Status, 1993-2013



The results of the decomposition analysis by place of residence and region are depicted in Figures III.4.3.5 and III.4.3.6. The transition from 2nd to 3rd birth made the most significant contribution for both rural and urban settlements. The contributions of birth orders differ slightly between rural and urban residences. Except for the north region, the decline in the progression from 2nd to 3rd birth made the most significant contribution to the overall decrease. The share of the change in the transition to the 1st birth was greater in the south and west regions, and the contribution of higher-order births was greatest in the east region.

Figure III.4.3.5. Percentage Contribution of PPRs to the Overall Change in TFR by Place of Residence, 1993-2013

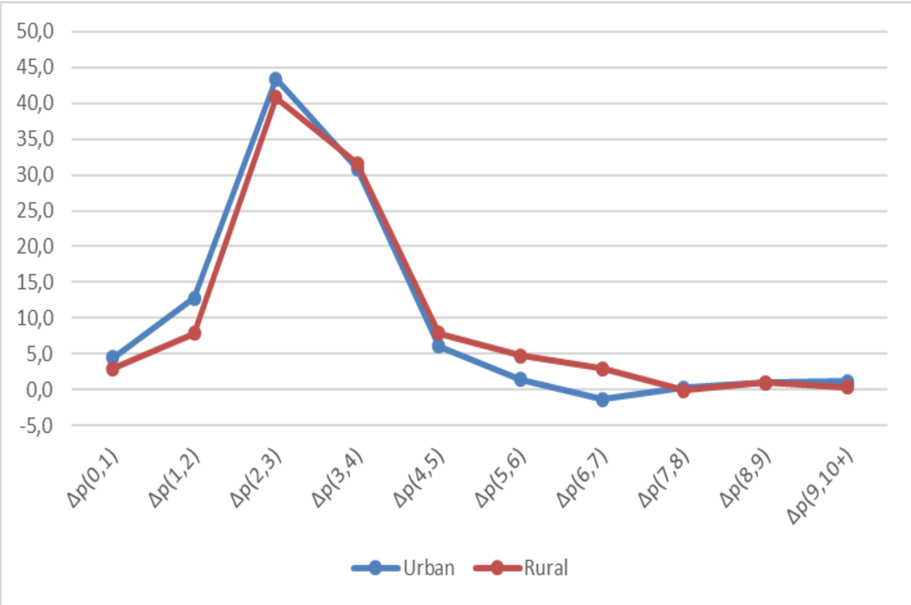
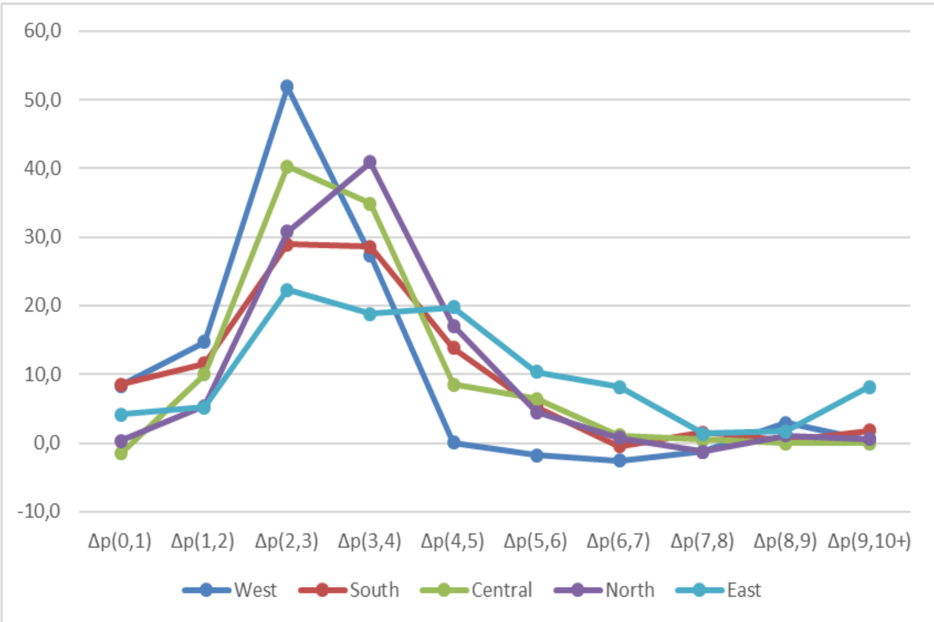


Figure III.4.3.6. Percentage Contribution of PPRs to the Overall Change in TFR by Place of Residence, 1993-2013



III.4.4. Decomposition of the Change in Crude Rate of Natural Increase

Using the data in Table III.4.4.1, the crude rate of natural increase (CRNI) is decomposed into the effects of changes in birth and death rates. CBR and CDR are derived from secondary data sources and estimates from general censuses implemented by TurkStat. For the periods between 1935 and 1975, CBR and CDR are estimated by Shorter and Macura (1982) using reverse projection methods. In the period 1975-2000, estimates of CBR and CDR based on general censuses are derived from Kocaman (1998), DPT (2001), MoH (2010). Demographic indicators published by TurkStat (2018b) are used for the period 2005-2015.

Table III.4.4.1. Crude Rates of Birth, Death and Natural Increase, 1935-2015

Year	CBR	CDR	CRNI
1935-40	45,8	31,4	14,4
1940-45	43,3	33,9	9,4
1945-50	46	27	19
1950-55	48,3	23,5	24,8
1955-60	47	19,8	27,2
1960-65	43,2	16,4	26,8
1965-70	38,8	13,5	25,3
1970-75	34,9	11,6	23,3
1975-80	32,2	10	22,2
1980-85	30,8	9	21,8
1985-90	29,9	7,8	22,1
1990	24,1	7,1	17
1995	22,6	6,9	15,7
2000	20,3	6,6	13,7
2005	18,2	5,89	12,31
2010	17,2	5,01	12,19
2015	17	5,18	11,82

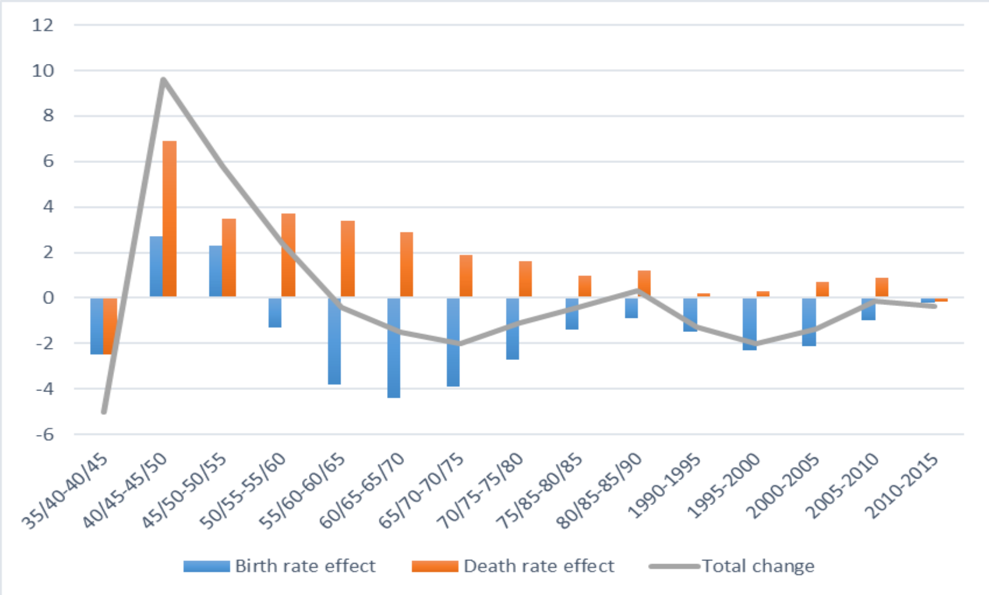
Sources: Shorter and Macura (1982), Kocaman (1998), DPT (2001), MoH (2010), TurkStat (2018b)

The results of the decomposition analysis of CRNI for each period are shown in Table III.4.4.2 and Figure III.4.4.1. Except for the period of second world war, when fertility and mortality rates fluctuated, the crude rate of natural increase showed an increasing pattern until the 1960s. The rate of natural increase gradually decreased starting from the mid-1960s until the 2010s. According to the decomposition results, from the period 1935-40 to 1940-45, decreasing birth rate and increasing death rate equally contributed to the reduction in the CRNI. Mortality levels sharply decreased, and fertility levels started to increase after the war. Until the 1960s, mortality reduction and fertility increase both contributed to population growth, while mortality reduction had a more significant impact. After 1960, a sharp decrease in fertility levels resulted in declining population growth rates despite the sustaining positive impact of mortality reduction. Following the 1980s, the rate of natural increase changed due to the sustained downward trend in mortality and fertility rates.

Table III.4.4.2. Decomposition of the Change in Crude Rate of Natural Increase, 1935-2015

Period	Total change	Birth rate effect	Death rate effect
1935-40/1940-45	-5	-2,5	-2,5
1940-45/1945-50	9,6	2,7	6,9
1945-50/1950-55	5,8	2,3	3,5
1950-55/1955-60	2,4	-1,3	3,7
1955-60/1960-65	-0,4	-3,8	3,4
1960-65/1965-70	-1,5	-4,4	2,9
1965-70/1970-75	-2	-3,9	1,9
1970-75/1975-80	-1,1	-2,7	1,6
1975-80/1980-85	-0,4	-1,4	1
1980-85/1985-90	0,3	-0,9	1,2
1990/1995	-1,3	-1,5	0,2
1995/2000	-2	-2,3	0,3
2000/2005	-1,39	-2,1	0,71
2005/2010	-0,12	-1	0,88
2010/2015	-0,37	-0,2	-0,17

Figure III.4.4.1. Decomposition of the Change in Crude Rate of Natural Increase, 1935-2015



III.5. DISCUSSION

This essay primarily focused on the major theories of fertility decline and post-transitional fertility patterns in developed regions. After the 1990s, post-transitional countries, primarily those in Europe, East Asia, and North America, experienced the lowest-low fertility levels. Some of these countries were successful in increasing their fertility rates in the following decades, while others remained at extremely low levels. Variation in the post-transitional settings has been linked to factors such as ideational change, change in the family structure, gender revolution, economic uncertainties, and expansion of higher education.

Meanwhile, the fertility transition progressed differently in early and mid-transitional countries. Although many countries have completed or are about to complete the fertility transition, there are still some that are in the early stages. Theories of fertility decline focused on two main explanations: the first line of research suggested that structural socio-economic factors were the primary determinants of fertility change. In contrast, the second argued that the ideational change and diffusion process were the primary drivers of fertility transition. In line with these perspectives, the components of the fertility transition in less-developed countries were discussed.

In addition to differences between countries and regions, within-country fertility variation is also evident in all countries. The variation among sub-population groups is generally associated with socioeconomic characteristics such as education, female employment, income level, urbanization, or migration.

Turkey is getting to the end of its demographic transition, with fertility levels reaching replacement level in a large part of the country. However, not all population groups followed the same pattern in the transition process and divergent fertility regimes emerged in the sub-population groups. This chapter focused on the socioeconomic differentials of the fertility change for providing an understanding of the fertility pattern in Turkey in the last decades. The components of the change in fertility levels were examined by employing decomposition analyses for sub-population groups by educational level, wealth status, region, and type of place of residence.

As evidence suggests, increasing marriage age and postponement of childbearing are significant aspects of late-transitional countries. In Turkey, first marriage age and age at first birth gradually increased over the last three decades. According to the TDHS findings, the median age at first marriage increased by two years between 1993 and 2013, rising from 19 to 21 years. Although there was no substantial difference in first marriage age between regions or urban/rural residences, there was a significant difference in educational levels. In 1993, the lowest and highest educated women's ages at first marriage were 17.6 and 22.6 years, respectively. In 2013, age at first marriage for less-educated women only increased to 18.9, and it increased to 24.6 years for highly educated women. Over the 20-year period, the median age at first birth increased correspondingly, but educational disparities were not as pronounced as the marriage level.

Decomposition results reveal the contribution of increasing age at marriage and postponement of childbearing among women in Turkey. The change in the CBR is separated into the effects of population age structure, marriage pattern, and marital fertility. In the specified period, the crude birth rate decreased from 21.7 to 17.5. The main contributor to the overall decline in CBR was the decline in the proportion of married women in younger ages. When the contribution of age categories is considered, the decrease in the marriage level under age 25 brings down the fertility level. The increase in marital fertility over age 30 somewhat compensated for the previous decline. It can be said that, particularly after 2000, with the effect of late childbearing, the total fertility rate was prevented from falling below the replacement level.

Increasing marriage age and fertility postponement are closely connected to women's improved educational level and employment status. According to the socioeconomic hypotheses of fertility transition, highly educated women postpone marriage due to the increasing time they spent in education and the increasing possibility of adopting new ideas on childbearing. They also have better opportunities to participate in the workforce and having waged jobs. These progressions raise the opportunity costs of rearing children while also contributing to the declining fertility levels. This study examined the fertility differentials by educational level; labor force participation was not included in the decomposition analyses due to data availability.

Between 1993 and 2013, there was a significant shift in women's educational composition. In 1993, more than half of the younger generation of women graduated from primary school. After 20 years, nearly 90 percent of women aged 15 to 19 had completed secondary or higher education. This striking increase was primarily the result of the 1997 extension of mandatory education from five to eight years. According to the descriptive results, highly educated women get married later than less educated, confirming the relationship between postponement pattern and educational level.

According to the decomposition of total fertility rate into components of educational composition, marital fertility, and marriage pattern; the composition effect makes the most significant contribution to the decrease in the fertility level. Therefore, if young women had not attended 8 years of compulsory education, the decline in fertility level would have been much less than the current decline.

The dynamics of fertility change considerably vary among educational groups. While the decrease in marital fertility at young ages is effective in the less-educated group, the effect of increasing birth rates in older ages is prevalent in the highly educated group. While recuperation of fertility is largely evident in the higher educated groups, the less-educated group did not follow an increasing fertility pattern in older ages. Consequently, there was no dramatic in fertility among less-educated women. The results also suggest that the change in the nuptiality pattern has little impact on fertility change in all settings. The underlying reason for the fertility differentials within education groups is related to the changes in marital fertility.

Wealth status is another factor affecting fertility decline. Higher wealth groups are expected to have fewer children than lower wealth groups, which is the case in Turkey in the corresponding years. In the specified period, fertility levels decreased for each income group, but the most significant decrease was observed in the lowest income group. From 1993 to 2013, the share of women in middle and highest wealth groups tended to increase with age. This increase could be attributed to rising household incomes as well as increased female labor-force participation. The findings also indicate that as income level increased, age at marriage decreased over the specified time period.

When the effect of changing wealth status on TFR change is examined, postponement of marriage was the primary contributor to the overall decline. However, increasing fertility at later ages acted in the opposite direction. The change in the composition of wealth groups did not make a significant contribution to the overall decline. Therefore, fertility change could be mainly attributed to the postponement-recuperation pattern rather than the change in the share of the wealth status groups.

When fertility changes within wealth status groups are considered, the pattern of postponed marriage is evident in all wealth groups. However, marital fertility at later ages did not have an increasing effect in the lowest income group, which explains why this income group had the greatest decrease in TFR. It can be concluded that declining fertility was linked to a decline in the effect of higher-order births in the lowest income group. Furthermore, the recuperation pattern was quite strong in the highest income group. This difference reflects that the economic conditions have a substantial effect on fertility levels.

Fertility differentials between urban and rural residences persisted over the 20-year period. The effect of rural-to-urban migration was visible; the share of women residing in cities increased in every age group. Although the share of married women was relatively low in urban areas, there was no significant variation in the marriage patterns of women in rural and urban residences.

Among the compositional factors of residence composition, marriage pattern, and marital fertility, postponement of marriage made the greater impact on overall fertility decline. Compositional change has a declining effect on fertility level, which can be explained by the increasing share of urban residents characterized by lower fertility levels due to the rural-to-urban migration flow.

Fertility decline within urban residences is strongly associated with marriage postponement despite the relative increasing effect of the recuperation pattern. It can be stated that those who moved from rural to urban residences adjusted to urban fertility patterns. Fertility decline in rural areas is primarily due to fertility control within marriage; the nuptiality pattern had little effect on the fertility change.

The fertility level of the five regions varied considerably in the 20 years. While there was no significant change in the western region, where the fertility level was the lowest, there was a significant decrease in eastern, central, and northern regions. The change in the population distribution in five regions reflects the evident pattern of migration movement from other regions to the western region. The western region has attracted immigrants for many years, as it involves the main industrial areas of Turkey as well as big cities such as İstanbul and İzmir. Eastern and northern regions were mainly characterized by out-migration flows to the other regions. In contrast, the southern region received migrants from the eastern region and sent migrants to the western region (Kocaman 1998).

The change in the marriage pattern made the most significant contribution to the decrease in fertility level. Part of the declining effect resulting from the postponement of marriage is compensated by increased fertility in advanced ages. However, the change in the regional population distribution had a negligible effect on the decrease in TFR. It can be stated that the change in the TFR is due to the dynamics within the regions themselves.

When the fertility changes within regions are considered, in the eastern, central, and northern regions, where the highest fertility decline is experienced, marriage postponement made the most significant contribution to the decline. In the eastern region, the level of early-age marriages decreased, but the effect of recuperation was limited at later ages. Therefore, the decrease in marital fertility at later ages contributed to the region's declining fertility rate. This decrease implies a downward trend in family size in this region, which is characterized by large families. In the northern and central regions, the effect of postponing marriage was prominent in the last decades.

In the western region, no significant change was observed in the fertility level in the 20-year period. However, when the effect of age groups was examined, the decrease resulting from the postponement of marriage at young ages was compensated by increased marital fertility at older age groups. The southern region was the only region whose fertility level has increased in the 20-year period. This increase resulted from the upward trend of marital fertility almost in every age group. Although there was a decreasing effect owing to marriage postponement at young ages, an increase in marital fertility in all age groups led to an increase in fertility level. This pattern can be explained by the fact that the southern region has received migration from the southeastern region, which is characterized by a particularly high fertility level. It can be suggested that women who migrated from the eastern region to the southern region maintained high fertility behavior.

The effect of birth orders on fertility change is examined by decomposing parity progression ratios. When the parity trends are considered, the fertility reduction after the 1990s was mainly driven by the diminishing effect of the transition from 2nd to 3rd and 3rd to 4th births. The contribution of birth orders to the overall change indicates the significance of the reduction in third and fourth-order births from 1993 to 2013. In the second part of the specified period, the contribution of second and first-order births increased compared to the earlier period.

The contribution of birth orders to fertility change considerably varies among sub-population groups. While the decrease in 3rd and 4th order births made the most significant contribution among less-educated women, the reduction in 1st and 2nd order births contributed to the fertility improvement among highly educated group. Unlike other wealth status groups, the effect of higher-order births was most pronounced in the low-wealth status group. There was also considerable variation in the birth-order pattern among regions. While the decline in higher-order births was effective in the east region, second and third-order births made the greatest contribution in other regions.

Decomposition analysis of the CRNI indicates the impact of birth and death rates since the 1930s. When the results are examined, the phases of demographic transition are evident. Until the 1960s, in the first phase of the transition, the increase in population growth was strongly associated with increasing fertility and declining mortality levels, except for the period of second world war. In the second phase, the decline in population growth was caused by a decrease in fertility levels resulting from population policy changes and the adoption of family planning programs. After the

1980s, in the third stage, the sustained downward trend in fertility and low levels of mortality reduced the rate of natural increase.

The findings of the decomposition analyses carried out in this section show that structural factors still have great significance in the fertility transition process in Turkey. Divergent fertility trends prevail by the effect of socioeconomic components like educational level, urbanization, social status or income level. In addition, although different fertility patterns persist in different regions of the country, a convergence pattern was observed in regions other than the eastern region in the last decades. This convergence pattern partly confirms the hypothesis that the fertility change first occurs in the educated, urban and wealthy parts of the society and then spreads to other parts of the society. Although structural differences are the main explanations for the variation in fertility levels in Turkey, it can be suggested that diffusion and social interaction processes are also effective when the recent convergence process is considered.

One of the reasons for the dominance of structural factors in explaining fertility change is the variables used in this study. They are constructed within the limitations of the TDHS data set. To explore the contribution of cultural or ideational factors, other variables related to ethnicity, women's status, or fertility preferences should have been involved in the analyses. However, it is not always possible to distinguish the effect of structural factors from the effect of ideational factors. In the macro-level cross-sectional studies, when the changes of socioeconomic factors and cultural factors act simultaneously, the effect of socioeconomic variables tends to be more dominant than ideational factors. Measurement of the change in ideas or perceptions requires long-term longitudinal data at the individual level rather than macro-level studies.

Based on the findings of this chapter, it can be argued that the postponement pattern in marriage and childbearing and resulting fertility decline will continue in Turkey. When the experiences of post-transitional countries are considered, sub-population groups in the earlier phases of fertility transition will move forward to the later phases with declining fertility rates. Progress of the transition will affect the growth rate and population age composition. Population growth rate will continue to decline, as will the share of the young aged population, while the share of the elderly will increase. The share of the oldest age group (65+) is predicted to rise from 8,7 % in 2018 to 25,6 % in 2080, according to the latest projections. The share of the youngest age groups and working-age groups will increase correspondingly (TurkStat, 2018c). The implications of these changes in the age composition of the population will be significant in the development of social policies relating to social security, health, education, and employment, among other things.

Women's educational attainment has improved significantly in Turkey; however, their labor-force participation remains low. Besides, the labor market does not have a family-friendly structure. However, as education levels rise and women are increasingly employed in service sector jobs, their labor force participation is expected to rise. Fertility rates, which are already falling in Turkey, are at risk of falling to very low levels as female employment increases. Experiences of some post-transitional countries reflect that; fertility levels may strikingly fall unless women’s increasing involvement in the public sphere is not complemented with policies to ensure gender equality in the private sphere and measures are taken to ensure fertility-employment balance.

Increased educational level and improved communication opportunities may contribute to the ideational change in Turkey that was previously experienced by the countries undergoing second demographic transition. As a result of the ideational change, postponement pattern, and diminishing family size, household structures such as single-person and single-parent households, which were not common before, will increase. The change in the family structure will result in a shift in intergenerational relationships. As a result, younger generations will take a lesser part in elderly care, and older people will be at risk of being isolated due to a lack of social interaction.

The consequences of the fertility decline should be considered in policy development. In Turkey, population policies aiming to increase fertility levels are being employed in the last decade; however, these policies focus on the number of children. Both population policies and social policies should be developed considering the changing population structure, and they should address the changing needs of younger generations, women and the elderly.

IV. SYNTHESES

This chapter will synthesize the study by addressing the research aims and summarizing the key findings of the study, as well as discussing the main contributions and limitations and presenting recommendations for future research.

Since the beginning of the twentieth century, the transition process proposed in demographic transition theory has emerged in developing countries, including Turkey. Mortality reduction in these countries has occurred more rapidly than in the industrialized western countries, which were the pioneers of the demographic transition. Substantial reduction in mortality levels in developing countries, notably after 1930, fueled rapid population growth. Fertility decline had just recently begun in less-developed countries in the 1950s, as Western countries neared completion of their demographic transition, but the timing and pace of decline varied by country.

Turkey's demographic change has followed a nearly identical pattern to that of other countries with similar socioeconomic characteristics. Improvements in public health, which dates back to the early years of the Republic, contributed to a reduction in mortality rates. The second world war interrupted the declining mortality trend that had begun prior to the war. Following the war, the drastic reduction in death rates and increase in birth rates resulted in increased rate of population growth. This pattern, associated with the initial stage of the demographic transition, maintained until the 1960s.

After 1960, the planned period began, with population planning policies put in place to control population growth. The fertility rate started to fall in this period, decelerating the rate of population growth. Moreover, mortality rates proceeded to decrease at a slower rate than in previous decades. The decline in birth and death rates decelerated after 1980. During this time, Turkey experienced a faster decline in fertility and mortality than other developing countries. As a result, Turkey's fertility rate and life expectancy have reached levels comparable to those of developed countries.

In Turkey, rapid mortality decrease during the initial phases of the demographic transition process led to migration movements alongside with the urbanization process. The increase in the size of rural households, as well as the inability of agricultural production to meet the needs resulting from this increase, has been a push factor for the people who live in these households. Simultaneously, the increase in job opportunities in cities has become a pull factor, and a movement towards urban areas has started. This transformation has also led to changes in fertility patterns and family structure. In urban areas, having fewer children and starting a nuclear family has become an increasingly common norm, in contrast to those who work in agriculture. In addition, children's participation in education has become increasingly important. Consequently, country's socioeconomic structure has changed substantially. In less than a century, Turkey has evolved from a rural agrarian society to one where the large portion of the population resides in cities and works in the service and industrial sectors. Although education levels have improved over time, women's educational disadvantage has persisted throughout the transition process. Although the vast majority of women complete compulsory education today, their participation in higher education remains lower than that of men. Women's disadvantage in labor-force participation has also persisted throughout the whole process.

Turkey's age structure has changed significantly throughout the demographic transition period as a consequence of decreased fertility and mortality levels. The share of younger ages in the total population was much higher than the share of other age groups during the period of high fertility. This pattern, which continued until the 1980s, changed with the effect of the decrease in fertility; the share of the young population started to decrease and that of the elderly population started to increase. The share of the elderly population has been steadily increasing since the end of the 1990s. Under current demographic conditions, it is predicted that the proportion of older people will gradually increase, and population aging will emerge.

Population aging has emerged as a significant issue in post-transitional countries. In these countries, where fertility was below replacement, the proportion of the elderly population has increased as the share of the young and working ages has decreased. The major consequence of population aging is to disrupt the balance between the working-age and elderly populations, reducing the viability of the social security system and causing economic challenges. Another potential issue is a lack of infrastructure to fulfill the elderly population's healthcare requirements. Furthermore, the elderly population is at greater risk of social exclusion and poverty. All of these challenges emerge as issues that Turkey will face and must overcome in the near future.

Fertility and mortality transitions in Turkey have progressed heterogeneously across regions and socioeconomic groups. The divergence between regions and sub-population groups has sustained since the beginning of the demographic transition. Today, TFRs are below replacement level in the urban areas and Western, Central and Northern regions of the country; these regions are about the complete the demographic transition process. However, the rural settlements and Southern and Eastern regions have not yet reached this stage and it can be claimed that there are still diverse demographic conditions in different parts of the country.

Demographic divergence was influenced by a variety of cultural and socioeconomic factors. Education, income level, and employment status all played a role in the heterogeneity of fertility and mortality levels. Furthermore, ethnic and cultural differences influenced demographic variables. The groups that have completed the demographic transition process include women with high education and income levels, participating in working life, and mostly living in cities. However, the demographic structure of the population groups, particularly those living in rural settlements and the Eastern region and with a low level of education, is similar to that of Turkey 30 years ago (Koç et al., 2010).

The aim of this thesis was to examine the components of demographic change in Turkey using decomposition methods. The effect of age and socioeconomic factors on the change of fertility and mortality indicators was investigated. In addition, the components of the change in population growth were examined. This study analyzed long-term mortality trends using data from censuses and surveys. TDHS datasets were used to examine the impact of social factors on mortality and fertility changes after 1990. Decomposition methods used in the study demonstrated the role of changing societal characteristics in the demographic transition process. The findings of the study provided information regarding the overall pattern of demographic transition as well as country-specific characteristics.

The findings of this thesis reflect that, the primary contributor to long-term mortality improvement was a reduction in early-age mortality. Because there was no significant change in the population's age distribution prior to 1980, age structure had no significant impact on the mortality change during these periods. However, the impact of age composition became apparent, particularly after 1990. The elderly population's percentage of the overall population has risen, and there has been a noticeable decrease in old-age mortality. The significant contribution of early-age mortality has ensured the continuation of the downward trend in mortality rates.

In the literature, the persistently high level of infant mortality is referred to as the "Turkish puzzle of infant mortality" (Gürsoy-Tezcan, 1992). Despite significant improvements in demographic and socioeconomic indicators, particularly in the 1990s, infant mortality rates remained extremely high when compared to countries with comparable socioeconomic levels. The most important factor contributing to the high infant mortality rate was socioeconomic differentiation in sub-population groups. Socioeconomic factors including educational attainment, region, income level, and residence were important predictors of mortality inequalities in both early ages and adult ages.

This study discussed the pattern of socioeconomic mortality differentials for the post-1990 period. Life expectancy in all subpopulation groups converged over the study period. This pattern is consistent with expectations, as improvements in mortality first occur in the more advantaged social classes and then spread to the rest. Among the variables under study, the effect of structural change was most evident in educational level. The improvement in mortality rates among the less educated and less wealthy population groups were striking. The contribution of age groups to mortality change also varied between socioeconomic groups. While mortality improvements at younger ages made greater contribution to the overall change in low education groups, the contribution of older ages was more pronounced among highly-educated. A comparable trend was recognized in the eastern and western regions, with the eastern region experiencing a mortality decline at young age groups and the western region experiencing a mortality decline among the elderly. This pattern can be explained by socioeconomic differences on morbidity and mortality patterns; with lower socioeconomic groups experiencing early-age mortality and higher socioeconomic groups experiencing longer lifespans. Although the study's findings show that mortality rates have converged, there is still a significant disparity in age patterns of mortality.

The convergence of mortality rates across population groups supports the divergence-convergence framework. This approach predicts that mortality recovery first occurs in population groups with high socioeconomic status and then spreads to other groups. Mortality differentiation, which was significant at the beginning of the study period, diminished at the end of this period as health improvement affected all population groups. However, age and cause patterns of mortality varied by population groups. Early age mortality rates continued to improve in low socioeconomic groups, while older age mortality improved significantly in high socioeconomic groups. It could be argued that these groups are at different stages of the mortality transition.

Socioeconomic divergences in fertility levels are more evident than that of mortality levels. Despite the fact that fertility rates decreased in almost every subpopulation group in the study period, the divergence persisted, in contrast to mortality rates. The study's findings revealed that the compositional effect caused by increased female education was the primary determinant of fertility reduction. The findings clearly demonstrated that extension of compulsory education to eight years resulted in a significant decrease in fertility at young ages during the study period. Furthermore, the increase in fertility due to fertility postponement, particularly by highly educated women, had an increasing effect on fertility in these groups. Women's fertility patterns in urban areas, the west, and with high wealth status have all changed in a similar way. Postponing marriage by young women had a decreasing effect on fertility in these groups, whereas fertility recuperation at older ages had an increasing effect on fertility. While lower socioeconomic groups were more likely to postpone marriage, fertility recuperation was less common. Fertility rates in later ages, on the other hand, have tended to decline, particularly in the eastern region, rural areas, and low-income areas, contributing to the decline in TFR. According to decomposition analyses of parity progression ratios, the decline in these groups was attributed to a decrease in the higher-order births.

The final phases of the demographic transition are characterized by rising age at first marriage and fertility postponement. In the examined time period, these patterns were quite evident in Turkey. Given the pattern of demographic change in Turkey, this trend is likely to continue, with the number of children per woman decreasing over time. This pattern is anticipated to produce further declines in fertility, which, along with decreasing mortality, will lead to population aging. Many low-fertility countries, including Turkey, have introduced fertility-enhancing measures to avoid the negative consequences of population aging. It should be emphasized that these policies should consider issues such as promoting gender equality and work-family balance, and improvement of public services for childcare.

The study's findings revealed the present situation of Turkey's demographic transition process, and also fertility and mortality differentials. Despite the fact that Turkey's demographic transition is nearly completed, socioeconomic disparities persist. These disparities could be affected by structural factors like education and income level, as well as cultural factors. The variables used in this study mostly revealed the effect of structural factors, but it should be considered that cultural interaction also contributes to the change in demographic characteristics.

Fertility decline is associated with two main sets of explanations in the literature regarding the structural and ideational factors. The effect of socioeconomic structural factors is more significant in the early stages of the transition, and higher socioeconomic groups play a leading role in this stage. In the later stages of the transition, other population groups engage in the process with a lag due to the effect of diffusion of reproductive knowledge. In Turkey, the groups with low education levels, living in rural areas, and primarily in the eastern region, are those who are experiencing the transition process with a delay. While fertility levels converge in other population groups, it is possible to argue that cultural, linguistic and ethnic differences contribute to high levels of fertility of these groups.

According to the findings of this thesis, mortality levels in population subgroups converged after the 1990s. For the same period, the results of Özdemir et al. (2011)'s study are also consistent with the results of this study. Their findings revealed that life span inequality decreased between 1990 and 2008. Furthermore, according to previous studies conducted in Turkey (Adlakha, 1970; Cerit, 1975; Tezcan, 1985; Yanikkaya and Selim 2010), socioeconomic variables like educational level and income level have had a significant impact on mortality differentiation. The contribution of these factors to mortality variation was quantified in this study.

Fertility levels, in contrast to mortality levels, did not converge across population groups. During the study period, different population groups were at different phases of the fertility transition. Regional differences were particularly noticeable; however, due to the nature of the data sources, analyses of cultural differences and ethnicity influencing these differences could not be employed in this study. Among the socioeconomic variables investigated in the scope of the study, women's educational level was the indicator that made the greatest impact on fertility differentiation. This study's findings corroborate previous research on the socioeconomic determinants of fertility in Turkey (Tuncer, 1971; Farooq and Tuncer, 1974; Tanfer, 1984; Selim and Üçdoğruk, 2005).

This is the first study in which demographic decomposition methods are used in analyzing components of demographic change in Turkey. This thesis contributes to the literature by applying various decomposition methods to analyze the change in fertility and mortality levels in Turkey over time. Also, the contribution of changes in age composition and social factors to aggregate demographic measures is quantified in the scope of this study. Widely used aggregate measures of mortality and fertility are influenced by the population age structure, marriage patterns, or structural factors. Thus, compositional effects and behavioral effects are separated from each other by using decomposition methods. The sources of the demographic change are examined, specifically considering how much socio-economic variables contributed to the overall change.

This study has certain limitations. The main limitation was the inadequacy of registration data in the specified period. Therefore, demographic surveys, censuses and indirect estimates from secondary data sources were used as the primary data source. Fertility measures and population composition of sub-population groups were estimated using TDHS data instead of the actual number of births and population composition. Mortality measures were estimated by using the estimates from secondary data sources as well as censuses and TDHS data sets.

Another limitation is related to the sub-population categories; they were created to examine the change in mortality and fertility patterns, and the same categories were used for each year to achieve comparability. However, changing socioeconomic conditions in 20 years led to an unexpected pattern in some results. For example, educational level was classified into three categories. Nevertheless, the highest category of education in 1993 does not correspond to a high level in 2013. Due to the category size in 1993, it was not possible to create a new educational category for higher education groups. Therefore, the findings should be interpreted considering this shortcoming.

Another limitation is related to the decomposition method itself; it does not reveal the causes of the change; instead, it identifies the sources. The decomposition method investigates how different factors contribute to the overall change but does not explain the reasons or mechanisms of the change. It should also be mentioned that this study examined the effect of the socioeconomic factors on demographic change separately, not on a multivariate basis. The contribution of one variable is quantified by assuming that other variables remain constant.

This study measured the effect of macro-level structural variables on demographic change. However, it did not reveal the underlying causes of the change or the relationship between the variables. Therefore, further research could be conducted using qualitative analysis to reveal the causes of change and multivariate analyses to understand the relationship of variables with one another.

Complete and timely collected registration data is the most appropriate type of data for the application of decomposition methods. Registration data collected in Turkey during the period examined in this study do not meet these criteria. However, there has been a significant improvement in the registration of birth and death events, particularly since 2010. This improvement will make it easier to apply decomposition methods. Further research using decomposition methods will be possible, as well as making comparisons with other countries. Improved data sources will allow for a more precise application of decomposition analysis by various socioeconomic characteristics. Moreover, it will be possible to decompose the cause of death patterns, which is a widely used application of decomposition methods. The findings of these types of analyses will help to develop and improve population and health policies, as well as social policies.

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APPENDIX A. SUPPLEMENTARY TABLES FOR ESSAY 1

Table A.1. Mid-period population estimates, males, 1945-2015

	1945-50		1960-65		1980-85		2010-2015	
	N	%	N	%	N	%	N	%
0-1	294.046	2,9	417.100	2,8	531.650	2,2	616.232	1,6
1-4	1.142.613	11,4	1.854.783	12,3	2.559.191	10,6	2.567.174	6,8
5-9	1.344.279	13,5	2.247.738	14,9	3.269.533	13,5	3.142.460	8,3
10-14	1.281.014	12,8	1.876.076	12,4	3.049.241	12,6	3.360.696	8,9
15-19	1.160.642	11,6	1.399.280	9,3	2.661.586	11,0	3.263.530	8,6
20-24	890.522	8,9	1.195.706	7,9	2.260.540	9,3	3.162.436	8,4
25-29	606.064	6,1	1.107.155	7,3	1.893.180	7,8	3.197.883	8,5
30-34	628.153	6,3	1.084.387	7,2	1.553.209	6,4	3.296.360	8,7
35-39	648.242	6,5	874.468	5,8	1.249.785	5,2	2.863.676	7,6
40-44	547.499	5,5	605.903	4,0	1.046.594	4,3	2.498.170	6,6
45-49	450.826	4,5	528.356	3,5	1.020.516	4,2	2.386.888	6,3
50-54	336.422	3,4	580.827	3,9	953.403	3,9	1.969.565	5,2
55-59	192.843	1,9	437.513	2,9	710.304	2,9	1.721.553	4,6
60-64	198.615	2,0	411.227	2,7	466.878	1,9	1.262.022	3,3
65-69	104.551	1,0	212.358	1,4	362.716	1,5	888.160	2,4
70-74	81.655	0,8	129.918	0,9	290.326	1,2	660.841	1,8
75-79	32.246	0,3	56.221	0,4	169.024	0,7	490.829	1,3
80+	46.600	0,5	61.409	0,4	135.993	0,6	396.090	1,0

Table A.2. Mid-period population estimates, females, 1945-2015

	1945-50		1960-65		1980-85		2010-2015	
	N	%	N	%	N	%	N	%
0-1	255.387	2,6	387.091	2,7	508.700	2,2	583.397	1,6
1-4	1.092.446	11,1	1.784.736	12,3	2.436.354	10,4	2.432.589	6,5
5-9	1.241.161	12,6	2.089.945	14,4	3.103.069	13,2	2.979.095	8,0
10-14	1.078.860	10,9	1.650.410	11,4	2.815.151	12,0	3.190.236	8,5
15-19	1.026.224	10,4	1.212.518	8,4	2.540.274	10,8	3.098.038	8,3
20-24	833.408	8,4	1.131.182	7,8	2.168.698	9,2	3.042.905	8,1
25-29	686.253	6,9	1.169.900	8,1	1.825.047	7,8	3.090.573	8,3
30-34	645.972	6,5	1.060.854	7,3	1.489.625	6,3	3.223.921	8,6
35-39	589.867	6,0	814.800	5,6	1.249.316	5,3	2.818.284	7,5
40-44	577.479	5,8	613.049	4,2	1.091.910	4,6	2.419.247	6,5
45-49	412.417	4,2	465.065	3,2	993.341	4,2	2.355.865	6,3
50-54	453.395	4,6	586.421	4,0	937.712	4,0	1.946.252	5,2
55-59	240.090	2,4	392.526	2,7	693.271	2,9	1.744.946	4,7
60-64	354.487	3,6	481.732	3,3	497.102	2,1	1.355.481	3,6
65-69	138.788	1,4	242.652	1,7	410.186	1,7	1.010.121	2,7
70-74	136.017	1,4	208.336	1,4	341.374	1,5	814.907	2,2
75-79	44.149	0,4	86.527	0,6	203.550	0,9	619.390	1,7
80+	75.449	0,8	114.952	0,8	212.358	0,9	706.024	1,9

Table A.3. Age specific death rates, males, 1945-2015

	1945-50	1960-65	1980-85	2010-15
0-1	0,3508	0,2170	0,1190	0,0143
1-4	0,0353	0,0198	0,0087	0,0004
5-9	0,0075	0,0046	0,0023	0,0003
10-14	0,0037	0,0025	0,0014	0,0002
15-19	0,0057	0,0040	0,0025	0,0005
20-24	0,0084	0,0058	0,0036	0,0007
25-29	0,0086	0,0059	0,0037	0,0007
30-34	0,0096	0,0066	0,0041	0,0007
35-39	0,0118	0,0081	0,0050	0,0010
40-44	0,0147	0,0103	0,0067	0,0016
45-49	0,0185	0,0135	0,0094	0,0030
50-54	0,0238	0,0184	0,0139	0,0054
55-59	0,0319	0,0257	0,0205	0,0097
60-64	0,0448	0,0369	0,0303	0,0161
65-69	0,0666	0,0553	0,0461	0,0270
70-74	0,1000	0,0847	0,0723	0,0452
75-79	0,1526	0,1308	0,1137	0,0749
80+	0,2476	0,2213	0,2015	0,1546

Table A.4. Age specific death rates, females, 1945-2015

	1945-50	1960-65	1980-85	2010-15
0-1	0,2972	0,1809	0,0986	0,0112
1-4	0,0365	0,0200	0,0085	0,0004
5-9	0,0081	0,0047	0,0022	0,0002
10-14	0,0046	0,0028	0,0014	0,0001
15-19	0,0063	0,0039	0,0020	0,0002
20-24	0,0082	0,0052	0,0027	0,0003
25-29	0,0097	0,0061	0,0032	0,0004
30-34	0,0108	0,0068	0,0037	0,0006
35-39	0,0119	0,0077	0,0044	0,0009
40-44	0,0127	0,0085	0,0052	0,0014
45-49	0,0142	0,0100	0,0067	0,0024
50-54	0,0188	0,0136	0,0094	0,0039
55-59	0,0276	0,0200	0,0141	0,0063
60-64	0,0424	0,0310	0,0224	0,0104
65-69	0,0659	0,0493	0,0368	0,0190
70-74	0,1012	0,0784	0,0616	0,0344
75-79	0,1558	0,1241	0,1018	0,0621
80+	0,2517	0,2158	0,1931	0,1482

Table A.5. Age-educational group specific population distribution, males (percentage)

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
20-24	4,0	49,1	46,9	3,2	8,0	88,8
25-29	4,2	54,5	41,3	4,3	16,5	79,2
30-34	5,3	54,8	39,9	4,5	29,7	65,7
35-39	8,9	59,0	32,1	3,4	39,1	57,5
40-44	10,6	62,0	27,4	4,0	49,2	46,8
45-49	19,3	56,6	24,1	5,6	50,8	43,6
50-54	30,4	49,7	19,9	6,6	46,7	46,6
55-59	40,2	46,1	13,7	10,4	50,8	38,8
60-64	49,6	38,8	11,6	13,2	55,5	31,3
65-69	56,0	33,9	10,1	24,2	48,5	27,3
70-74	58,4	32,4	9,2	35,7	46,1	18,2
75-79	74,4	19,4	6,2	38,7	46,8	14,5
80+	72,0	18,9	9,1	58,4	28,8	12,8

Table A.6. Age-educational group specific population distribution, females (percentage)

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
20-24	17,7	54,9	27,4	10,8	10,2	78,9
25-29	22,5	54,0	23,4	13,1	27,1	59,8
30-34	28,1	53,6	18,3	13,4	40,6	45,9
35-39	39,1	46,8	14,1	11,1	53,4	35,5
40-44	49,7	39,0	11,3	17,7	53,4	28,9
45-49	55,7	32,9	11,4	24,3	51,4	24,3
50-54	65,1	27,0	7,9	28,0	48,1	23,9
55-59	75,2	21,2	3,6	37,0	46,1	16,9
60-64	82,8	13,5	3,7	49,1	37,4	13,5
65-69	84,5	10,8	4,7	58,0	31,9	10,1
70-74	78,7	14,3	7,0	67,0	26,5	6,5
75-79	86,7	10,8	2,5	74,2	18,2	7,6
80+	92,2	6,9	0,9	77,6	15,7	6,7

Table A.7. Age-educational group specific death rates, males

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
20-24	0,0034	0,0022	0,0018	0,0008	0,0007	0,0004
25-29	0,0036	0,0023	0,0018	0,0007	0,0006	0,0004
30-34	0,0041	0,0026	0,0021	0,0008	0,0007	0,0004
35-39	0,0050	0,0032	0,0026	0,0011	0,0009	0,0006
40-44	0,0066	0,0045	0,0038	0,0018	0,0016	0,0010
45-49	0,0091	0,0068	0,0060	0,0032	0,0029	0,0021
50-54	0,0132	0,0104	0,0094	0,0056	0,0052	0,0040
55-59	0,0193	0,0162	0,0149	0,0101	0,0094	0,0077
60-64	0,0290	0,0249	0,0232	0,0167	0,0158	0,0133
65-69	0,0436	0,0385	0,0364	0,0277	0,0266	0,0231
70-74	0,0669	0,0605	0,0577	0,0462	0,0446	0,0398
75-79	0,1039	0,0956	0,0918	0,0763	0,0740	0,0674
80+	0,1857	0,1766	0,1727	0,1561	0,1537	0,1467

Table A.8. Age-educational group specific death rates, females

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
20-24	0,0029	0,0025	0,0014	0,0005	0,0004	0,0002
25-29	0,0034	0,0029	0,0017	0,0006	0,0005	0,0003
30-34	0,0039	0,0034	0,0020	0,0008	0,0006	0,0004
35-39	0,0046	0,0041	0,0025	0,0011	0,0009	0,0006
40-44	0,0055	0,0050	0,0034	0,0017	0,0014	0,0010
45-49	0,0071	0,0066	0,0049	0,0028	0,0024	0,0019
50-54	0,0100	0,0093	0,0072	0,0044	0,0039	0,0031
55-59	0,0141	0,0133	0,0107	0,0071	0,0064	0,0053
60-64	0,0218	0,0206	0,0168	0,0116	0,0106	0,0089
65-69	0,0338	0,0324	0,0277	0,0206	0,0192	0,0167
70-74	0,0550	0,0531	0,0469	0,0368	0,0347	0,0310
75-79	0,0889	0,0866	0,0786	0,0653	0,0624	0,0573
80+	0,1730	0,1708	0,1636	0,1512	0,1485	0,1438

Table A.9. Age-wealth group specific population distribution, males (percentage)

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
0	47,85	35,95	16,20	31,10	42,90	26,01
1-4	46,35	34,31	19,34	30,42	43,79	25,79
5-9	43,11	34,60	22,29	30,64	44,69	24,67
10-14	40,02	35,99	23,98	32,21	40,62	27,17
15-19	37,59	36,97	25,44	27,21	41,63	31,16
20-24	35,58	35,71	28,70	28,67	44,42	26,91
25-29	34,76	37,67	27,56	24,38	43,68	31,94
30-34	31,60	38,75	29,65	23,49	43,51	32,99
35-39	28,38	36,80	34,82	22,81	41,09	36,10
40-44	22,35	37,99	39,66	20,46	40,99	38,55
45-49	31,90	32,30	35,80	21,41	41,78	36,81
50-54	37,46	29,77	32,76	22,43	38,57	39,00
55-59	42,21	32,46	25,33	24,44	39,57	35,99
60-64	46,20	32,98	20,82	28,01	45,68	26,31
65-69	45,75	36,44	17,81	30,69	48,46	20,85
70-74	48,41	34,52	17,06	41,99	42,96	15,05
75-79	56,06	31,82	12,12	45,56	41,53	12,90
80+	62,80	25,00	12,20	53,40	33,33	13,27

Table A.10. Age-wealth group specific population distribution, females (percentage)

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
0	43,43	36,46	20,11	29,79	45,90	24,32
1-4	44,31	34,67	21,02	30,75	42,52	26,73
5-9	42,86	34,96	22,18	32,49	40,10	27,41
10-14	39,63	36,21	24,16	30,52	39,96	29,52
15-19	40,57	33,71	25,72	27,22	41,96	30,83
20-24	38,59	36,18	25,23	29,99	41,99	28,02
25-29	33,51	36,97	29,51	22,46	45,53	32,01
30-34	31,16	36,03	32,81	23,34	41,86	34,80
35-39	29,82	37,60	32,58	19,38	41,61	39,01
40-44	30,61	35,95	33,43	21,24	40,24	38,52
45-49	32,28	31,87	35,85	22,13	42,13	35,73
50-54	37,90	32,33	29,77	23,74	41,86	34,40
55-59	44,79	35,75	19,45	25,52	43,93	30,55
60-64	46,01	36,98	17,01	31,99	45,25	22,76
65-69	50,28	33,15	16,57	38,94	43,57	17,50
70-74	43,32	37,65	19,03	43,91	39,57	16,52
75-79	47,15	35,77	17,07	55,87	31,11	13,02
80+	48,85	29,03	22,12	47,76	34,08	18,16

Table A.11. Age-wealth group specific death rates, males

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
0	0,0732	0,0538	0,0269	0,0177	0,0125	0,0119
1-4	0,0063	0,0037	0,0012	0,0006	0,0004	0,0003
5-9	0,0018	0,0013	0,0006	0,0003	0,0002	0,0002
10-14	0,0014	0,0010	0,0005	0,0003	0,0002	0,0002
15-19	0,0022	0,0017	0,0009	0,0006	0,0004	0,0004
20-24	0,0032	0,0024	0,0013	0,0008	0,0006	0,0006
25-29	0,0034	0,0025	0,0012	0,0008	0,0006	0,0005
30-34	0,0038	0,0028	0,0014	0,0009	0,0006	0,0006
35-39	0,0047	0,0035	0,0018	0,0012	0,0009	0,0008
40-44	0,0063	0,0048	0,0028	0,0019	0,0015	0,0014
45-49	0,0088	0,0072	0,0046	0,0035	0,0027	0,0027
50-54	0,0128	0,0108	0,0076	0,0060	0,0050	0,0048
55-59	0,0189	0,0167	0,0127	0,0106	0,0091	0,0089
60-64	0,0284	0,0256	0,0202	0,0174	0,0153	0,0150
65-69	0,0428	0,0393	0,0325	0,0287	0,0259	0,0256
70-74	0,0659	0,0615	0,0526	0,0476	0,0438	0,0432
75-79	0,1027	0,0969	0,0850	0,0781	0,0729	0,0721
80+	0,1843	0,1781	0,1653	0,1580	0,1524	0,1517

Table A.12. Age-wealth group specific death rates, females

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
0	0,0691	0,0488	0,0267	0,0171	0,0113	0,0108
1-4	0,0076	0,0043	0,0015	0,0007	0,0004	0,0003
5-9	0,0020	0,0013	0,0005	0,0003	0,0002	0,0002
10-14	0,0016	0,0010	0,0004	0,0002	0,0001	0,0001
15-19	0,0023	0,0015	0,0007	0,0004	0,0002	0,0002
20-24	0,0031	0,0021	0,0010	0,0006	0,0004	0,0003
25-29	0,0035	0,0024	0,0012	0,0007	0,0005	0,0004
30-34	0,0041	0,0029	0,0015	0,0009	0,0006	0,0006
35-39	0,0048	0,0035	0,0020	0,0013	0,0009	0,0008
40-44	0,0058	0,0044	0,0028	0,0019	0,0014	0,0013
45-49	0,0073	0,0059	0,0042	0,0031	0,0024	0,0023
50-54	0,0103	0,0085	0,0063	0,0049	0,0039	0,0038
55-59	0,0145	0,0123	0,0095	0,0077	0,0063	0,0062
60-64	0,0223	0,0192	0,0152	0,0125	0,0105	0,0103
65-69	0,0345	0,0306	0,0255	0,0219	0,0191	0,0187
70-74	0,0558	0,0507	0,0438	0,0387	0,0346	0,0341
75-79	0,0900	0,0835	0,0746	0,0679	0,0622	0,0616
80+	0,1740	0,1680	0,1598	0,1535	0,1483	0,1477

Table A.13. Age-regional population distribution, males, 1993 (percentage)

Age	West	South	Central	North	East
0	28,86	13,67	21,01	12,15	24,30
1-4	25,30	16,63	21,36	9,61	27,10
5-9	26,58	16,23	20,94	7,58	28,66
10-14	27,02	16,29	21,94	8,19	26,57
15-19	32,97	15,96	19,29	8,53	23,25
20-24	35,25	16,56	21,03	6,88	20,29
25-29	37,35	17,05	19,68	8,25	17,67
30-34	37,61	15,76	23,96	8,61	14,05
35-39	41,17	14,27	21,29	7,26	16,01
40-44	39,71	17,75	21,01	8,72	12,82
45-49	37,60	13,34	24,39	9,03	15,63
50-54	36,42	14,65	25,18	8,53	15,22
55-59	32,56	16,42	24,27	8,28	18,46
60-64	37,69	11,70	22,64	10,33	17,63
65-69	35,48	14,11	25,81	8,06	16,53
70-74	35,86	9,96	29,48	8,76	15,94
75-79	32,82	16,03	24,43	6,87	19,85
80+	30,49	15,85	26,83	10,98	15,85

Table A.14. Age-regional population distribution, males, 2013 (percentage)

Age	West	South	Central	North	East
0	32,17	12,06	18,77	5,09	31,90
1-4	36,40	13,36	16,59	6,11	27,54
5-9	36,41	14,65	17,31	6,29	25,34
10-14	36,14	15,28	17,16	6,01	25,42
15-19	38,12	13,31	19,93	6,51	22,14
20-24	44,52	11,81	19,84	5,16	18,67
25-29	43,16	12,13	20,40	5,74	18,58
30-34	46,77	10,17	19,86	6,22	16,99
35-39	46,42	12,35	18,96	6,41	15,86
40-44	46,96	12,17	18,69	7,72	14,47
45-49	46,75	12,03	19,33	8,50	13,39
50-54	43,96	14,03	23,98	7,40	10,63
55-59	46,06	12,38	24,16	6,45	10,95
60-64	42,87	11,94	23,87	9,62	11,69
65-69	44,59	7,72	26,83	8,88	11,97
70-74	41,02	11,17	26,21	12,14	9,47
75-79	35,74	12,05	24,90	13,25	14,06
80+	37,65	11,42	28,09	9,26	13,58

Table A.15. Age-regional population distribution, females, 1993 (percentage)

Age	West	South	Central	North	East
0	26,01	16,35	19,57	9,92	28,15
1-4	26,10	15,55	23,60	9,56	25,19
5-9	26,08	15,04	23,05	8,78	27,05
10-14	28,61	15,35	21,68	9,42	24,94
15-19	28,13	15,95	23,39	8,71	23,82
20-24	31,69	17,32	22,45	8,87	19,67
25-29	34,87	16,82	23,47	9,91	14,93
30-34	36,08	15,53	22,76	9,09	16,54
35-39	39,33	15,82	21,52	9,94	13,40
40-44	38,61	15,83	22,98	7,66	14,92
45-49	38,74	14,42	24,31	9,62	12,91
50-54	36,27	14,29	23,44	7,81	18,19
55-59	33,52	15,18	24,62	9,44	17,24
60-64	36,83	11,54	23,67	10,65	17,31
65-69	37,13	13,99	26,31	10,07	12,50
70-74	34,82	14,57	30,36	8,50	11,74
75-79	40,98	9,02	27,87	13,93	8,20
80+	40,09	13,36	20,74	10,60	15,21

Table A.16. Age-regional population distribution, females, 2013 (percentage)

Age	West	South	Central	North	East
0	34,95	15,81	13,07	6,38	29,79
1-4	36,41	13,33	16,46	6,63	27,18
5-9	37,53	12,93	15,99	5,89	27,66
10-14	36,60	13,24	18,20	5,80	26,16
15-19	39,78	11,08	17,81	6,43	24,91
20-24	37,90	12,00	18,75	6,88	24,47
25-29	40,29	12,11	20,27	6,21	21,12
30-34	44,85	12,09	18,63	7,58	16,84
35-39	45,18	13,61	19,89	6,77	14,54
40-44	45,76	13,10	18,30	7,74	15,10
45-49	44,22	13,52	19,22	8,54	14,50
50-54	42,64	12,94	26,51	7,75	10,16
55-59	45,77	11,87	23,36	8,17	10,83
60-64	42,60	10,65	25,71	9,35	11,69
65-69	40,82	10,12	26,59	11,49	10,98
70-74	41,74	9,13	26,30	10,43	12,39
75-79	40,95	12,06	24,76	10,16	12,06
80+	45,64	10,29	22,37	12,98	8,72

Table A.17. Age-region specific death rates, males, 1993

Age	West	South	Central	North	East
0	0,0442	0,0635	0,0649	0,0525	0,0613
1-4	0,0025	0,0050	0,0052	0,0035	0,0047
5-9	0,0010	0,0015	0,0016	0,0012	0,0015
10-14	0,0008	0,0012	0,0012	0,0010	0,0011
15-19	0,0014	0,0020	0,0020	0,0017	0,0019
20-24	0,0020	0,0028	0,0028	0,0023	0,0027
25-29	0,0020	0,0029	0,0030	0,0024	0,0028
30-34	0,0023	0,0033	0,0034	0,0027	0,0032
35-39	0,0029	0,0041	0,0042	0,0034	0,0040
40-44	0,0042	0,0056	0,0057	0,0047	0,0054
45-49	0,0064	0,0080	0,0081	0,0070	0,0078
50-54	0,0099	0,0118	0,0120	0,0107	0,0116
55-59	0,0155	0,0178	0,0179	0,0165	0,0175
60-64	0,0241	0,0270	0,0272	0,0254	0,0267
65-69	0,0375	0,0411	0,0413	0,0391	0,0407
70-74	0,0592	0,0638	0,0641	0,0612	0,0632
75-79	0,0938	0,0998	0,1003	0,0965	0,0992
80+	0,1749	0,1813	0,1817	0,1776	0,1805

Table A.18. Age-region specific death rates, males, 2013

Age	West	South	Central	North	East
0	0,0115	0,0154	0,0189	0,0089	0,0130
1-4	0,0003	0,0005	0,0007	0,0002	0,0004
5-9	0,0002	0,0003	0,0004	0,0002	0,0002
10-14	0,0002	0,0003	0,0003	0,0001	0,0002
15-19	0,0004	0,0005	0,0007	0,0003	0,0005
20-24	0,0006	0,0007	0,0009	0,0004	0,0006
25-29	0,0005	0,0007	0,0009	0,0004	0,0006
30-34	0,0006	0,0008	0,0010	0,0005	0,0007
35-39	0,0008	0,0011	0,0013	0,0006	0,0009
40-44	0,0014	0,0017	0,0021	0,0011	0,0015
45-49	0,0026	0,0032	0,0036	0,0022	0,0028
50-54	0,0048	0,0056	0,0063	0,0041	0,0051
55-59	0,0088	0,0100	0,0109	0,0079	0,0093
60-64	0,0149	0,0165	0,0178	0,0135	0,0155
65-69	0,0253	0,0276	0,0293	0,0235	0,0262
70-74	0,0429	0,0460	0,0484	0,0403	0,0442
75-79	0,0717	0,0759	0,0792	0,0681	0,0734
80+	0,1512	0,1557	0,1591	0,1474	0,1530

Table A.19. Age-region specific death rates, females, 1993

Age	West	South	Central	North	East
0	0,0443	0,0521	0,0562	0,0389	0,0647
1-4	0,0036	0,0048	0,0055	0,0028	0,0068
5-9	0,0011	0,0014	0,0015	0,0009	0,0018
10-14	0,0009	0,0011	0,0012	0,0007	0,0014
15-19	0,0014	0,0016	0,0018	0,0012	0,0021
20-24	0,0019	0,0022	0,0024	0,0016	0,0028
25-29	0,0022	0,0026	0,0028	0,0019	0,0033
30-34	0,0026	0,0031	0,0033	0,0023	0,0038
35-39	0,0032	0,0037	0,0040	0,0028	0,0045
40-44	0,0041	0,0046	0,0049	0,0037	0,0055
45-49	0,0056	0,0062	0,0064	0,0052	0,0070
50-54	0,0081	0,0088	0,0091	0,0076	0,0099
55-59	0,0118	0,0127	0,0131	0,0112	0,0140
60-64	0,0184	0,0197	0,0203	0,0176	0,0216
65-69	0,0297	0,0313	0,0321	0,0286	0,0336
70-74	0,0495	0,0516	0,0526	0,0481	0,0547
75-79	0,0820	0,0846	0,0860	0,0802	0,0886
80+	0,1666	0,1690	0,1703	0,1650	0,1727

Table A.20. Age-region specific death rates, females, 1993

Age	West	South	Central	North	East
0	0,0105	0,0142	0,0172	0,0093	0,0150
1-4	0,0003	0,0005	0,0007	0,0003	0,0006
5-9	0,0002	0,0002	0,0003	0,0001	0,0002
10-14	0,0001	0,0002	0,0002	0,0001	0,0002
15-19	0,0002	0,0003	0,0004	0,0002	0,0003
20-24	0,0003	0,0005	0,0006	0,0003	0,0005
25-29	0,0004	0,0006	0,0007	0,0004	0,0006
30-34	0,0005	0,0008	0,0009	0,0005	0,0008
35-39	0,0008	0,0011	0,0013	0,0007	0,0011
40-44	0,0013	0,0017	0,0019	0,0012	0,0017
45-49	0,0023	0,0028	0,0032	0,0021	0,0029
50-54	0,0037	0,0044	0,0049	0,0035	0,0046
55-59	0,0061	0,0071	0,0077	0,0058	0,0072
60-64	0,0101	0,0116	0,0126	0,0096	0,0119
65-69	0,0185	0,0206	0,0220	0,0178	0,0210
70-74	0,0338	0,0368	0,0388	0,0327	0,0374
75-79	0,0612	0,0653	0,0679	0,0597	0,0661
80+	0,1474	0,1511	0,1536	0,1460	0,1518

Table A.21. Age-residence population distribution, males (percentage)

	1993		2013	
Age	Urban	Rural	Urban	Rural
0	59,85	40,15	78,55	21,45
1-4	58,17	41,83	77,70	22,30
5-9	59,90	40,10	77,28	22,72
10-14	57,82	42,18	76,69	23,31
15-19	61,62	38,38	80,06	19,94
20-24	65,42	34,58	85,37	14,63
25-29	69,94	30,06	85,46	14,54
30-34	68,07	31,93	83,91	16,09
35-39	68,23	31,77	83,12	16,88
40-44	70,17	29,83	80,36	19,64
45-49	61,37	38,63	78,91	21,09
50-54	59,60	40,40	76,19	23,81
55-59	53,49	46,51	74,23	25,77
60-64	52,96	47,04	71,74	28,26
65-69	47,88	52,12	70,66	29,34
70-74	48,21	51,79	63,20	36,80
75-79	44,27	55,73	56,85	43,15
80+	40,24	59,76	62,35	37,65

Table A.22. Age-residence population distribution, females (percentage)

	1993		2013	
Age	Urban	Rural	Urban	Rural
0	60,32	39,68	78,72	21,28
1-4	59,56	40,44	78,26	21,74
5-9	55,95	44,05	76,64	23,36
10-14	57,21	42,79	76,86	23,14
15-19	58,16	41,84	78,90	21,10
20-24	62,05	37,95	80,11	19,89
25-29	66,15	33,85	83,75	16,25
30-34	66,76	33,24	83,39	16,61
35-39	64,42	35,58	83,22	16,78
40-44	65,73	34,27	79,32	20,68
45-49	59,62	40,38	74,58	25,42
50-54	58,48	41,52	77,75	22,25
55-59	51,78	48,22	74,38	25,62
60-64	50,59	49,41	70,26	29,74
65-69	48,04	51,96	65,69	34,31
70-74	58,70	41,30	63,12	36,88
75-79	54,92	45,08	61,90	38,10
80+	55,76	44,24	66,14	33,86

Table A.23. Age-residence specific death rates, males

	1993		2013	
Age	Urban	Rural	Urban	Rural
0	0,0474	0,0711	0,0136	0,0158
1-4	0,0028	0,0060	0,0004	0,0005
5-9	0,0011	0,0018	0,0003	0,0003
10-14	0,0008	0,0013	0,0002	0,0003
15-19	0,0015	0,0022	0,0005	0,0005
20-24	0,0021	0,0031	0,0007	0,0008
25-29	0,0022	0,0033	0,0006	0,0007
30-34	0,0024	0,0037	0,0007	0,0008
35-39	0,0031	0,0046	0,0009	0,0011
40-44	0,0043	0,0061	0,0016	0,0018
45-49	0,0066	0,0086	0,0029	0,0032
50-54	0,0102	0,0126	0,0052	0,0057
55-59	0,0159	0,0186	0,0095	0,0101
60-64	0,0246	0,0281	0,0158	0,0167
65-69	0,0381	0,0424	0,0266	0,0278
70-74	0,0600	0,0655	0,0446	0,0463
75-79	0,0949	0,1021	0,0741	0,0764
80+	0,1759	0,1837	0,1537	0,1562

Table A.24. Age-residence specific death rates, females

	1993		2013	
Age	Urban	Rural	Urban	Rural
0	0,0439	0,0664	0,0123	0,0144
1-4	0,0035	0,0071	0,0004	0,0005
5-9	0,0011	0,0019	0,0002	0,0002
10-14	0,0008	0,0015	0,0002	0,0002
15-19	0,0013	0,0022	0,0003	0,0003
20-24	0,0018	0,0029	0,0004	0,0005
25-29	0,0022	0,0034	0,0005	0,0006
30-34	0,0026	0,0039	0,0007	0,0008
35-39	0,0031	0,0046	0,0009	0,0011
40-44	0,0040	0,0056	0,0015	0,0017
45-49	0,0056	0,0072	0,0026	0,0028
50-54	0,0080	0,0100	0,0041	0,0044
55-59	0,0118	0,0142	0,0066	0,0071
60-64	0,0184	0,0219	0,0109	0,0116
65-69	0,0296	0,0340	0,0196	0,0207
70-74	0,0494	0,0552	0,0354	0,0369
75-79	0,0819	0,0892	0,0633	0,0654
80+	0,1665	0,1732	0,1493	0,1512

APPENDIX B. SUPPLEMENTARY TABLES FOR ESSAY 2

Table B.1. Proportion of currently married women, proportion of women in the total population and age-specific marital fertility rates

	Proportion of women in the total population			Proportion of currently married women			Age-specific marital fertility rates		
Age	1993	2003	2013	1993	2003	2013	1993	2003	2013
15-19	0,0617	0,0491	0,0394	0,1337	0,1184	0,0706	0,4087	0,3907	0,4402
20-24	0,0489	0,0499	0,0354	0,5771	0,4850	0,4626	0,2905	0,2808	0,2671
25-29	0,0385	0,0438	0,0396	0,8281	0,7765	0,7815	0,1678	0,1723	0,1740
30-34	0,0365	0,0384	0,0416	0,9351	0,8773	0,8907	0,0915	0,0890	0,1165
35-39	0,0302	0,0352	0,0388	0,9387	0,9001	0,8923	0,0445	0,0421	0,0536
40-44	0,0259	0,0329	0,0324	0,9054	0,8920	0,9103	0,0139	0,0138	0,0079
45-49	0,0190	0,0265	0,0271	0,8962	0,9192	0,8630	0,0010	0,0019	0,0026

Table B.2. Distribution of women by age and educational groups

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
15-19	0,1222	0,6325	0,2453	0,0216	0,0732	0,9052
20-24	0,1728	0,5528	0,2744	0,1085	0,0927	0,7988
25-29	0,2199	0,5546	0,2255	0,1247	0,2862	0,5891
30-34	0,2776	0,5403	0,1821	0,1240	0,4173	0,4581
35-39	0,4011	0,4652	0,1337	0,1091	0,5423	0,3485
40-44	0,5027	0,3863	0,1110	0,1696	0,5444	0,2859
45-49	0,5679	0,3270	0,1051	0,2216	0,5374	0,2400

Table B.3. Proportion of currently married women by age and educational groups

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
15-19	0,2072	0,1500	0,0475	0,2059	0,1391	0,0625
20-24	0,6961	0,6394	0,3848	0,7103	0,8049	0,3901
25-29	0,8917	0,8598	0,7081	0,8649	0,8946	0,7088
30-34	0,9462	0,9434	0,8975	0,9536	0,9174	0,8480
35-39	0,9498	0,9488	0,8699	0,9697	0,9160	0,8327
40-44	0,9048	0,9183	0,8725	0,9286	0,9201	0,8782
45-49	0,9280	0,8616	0,8056	0,8991	0,8716	0,8097

Table B.4. Age-education-specific marital fertility rates

	1993			2013		
Age	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher	No educ. / Primary incomp.	Primary / Secondary incomp.	Secondary school and higher
15-19	0,5492	0,3790	0,3016	0,5074	0,5356	0,3764
20-24	0,3558	0,2757	0,2497	0,3024	0,2387	0,2525
25-29	0,2027	0,1500	0,1659	0,2249	0,1509	0,1727
30-34	0,1364	0,0728	0,0715	0,1456	0,1029	0,1231
35-39	0,0736	0,0211	0,0231	0,0787	0,0460	0,0560
40-44	0,0221	0,0047	0,0041	0,0229	0,0067	0,0005
45-49	0,0018	0,0000	0,0000	0,0043	0,0029	0,0000

Table B.5. Distribution of women by age and wealth groups

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
15-19	0,4998	0,3458	0,1544	0,2532	0,4294	0,3174
20-24	0,4229	0,3690	0,2081	0,2954	0,4331	0,2715
25-29	0,3468	0,3865	0,2667	0,2158	0,4638	0,3204
30-34	0,3082	0,3664	0,3254	0,2331	0,4221	0,3448
35-39	0,3056	0,3641	0,3303	0,1878	0,4319	0,3803
40-44	0,3160	0,3572	0,3268	0,2011	0,4144	0,3845
45-49	0,3187	0,3231	0,3582	0,2187	0,4286	0,3528

Table B.6. Proportion of currently married women by age and wealth groups

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
15-19	0,1260	0,1410	0,1395	0,0879	0,0889	0,0301
20-24	0,5545	0,5869	0,6054	0,5152	0,5199	0,3140
25-29	0,8213	0,8288	0,8355	0,8354	0,7876	0,7343
30-34	0,9298	0,9348	0,9404	0,8986	0,8835	0,8942
35-39	0,9341	0,9422	0,9391	0,8838	0,8931	0,8957
40-44	0,8935	0,8936	0,9302	0,8916	0,8757	0,9538
45-49	0,8853	0,8959	0,9102	0,8711	0,8523	0,8757

Table B.7. Age-wealth group-specific marital fertility rates

	1993			2013		
Age	Lowest	Middle	Highest	Lowest	Middle	Highest
15-19	0,4220	0,3834	0,4394	0,4557	0,4160	0,4906
20-24	0,3497	0,2726	0,2236	0,3355	0,2407	0,2422
25-29	0,1931	0,1695	0,1354	0,1898	0,1834	0,1484
30-34	0,1353	0,0873	0,0595	0,1323	0,1111	0,1135
35-39	0,0863	0,0312	0,0189	0,0810	0,0494	0,0436
40-44	0,0312	0,0087	0,0037	0,0185	0,0056	0,0056
45-49	0,0000	0,0033	0,0000	0,0015	0,0052	0,0000

Table B.8. Distribution of women by age and place of residence

	1993		2013	
Age	Urban	Rural	Urban	Rural
15-19	0,4894	0,5106	0,8015	0,1985
20-24	0,6164	0,3836	0,8024	0,1976
25-29	0,6616	0,3384	0,8390	0,1610
30-34	0,6627	0,3373	0,8377	0,1623
35-39	0,6392	0,3608	0,8320	0,1680
40-44	0,6449	0,3551	0,7958	0,2042
45-49	0,5944	0,4056	0,7444	0,2556

Table B.9. Proportion of currently married women by age and place of residence

	1993		2013	
Age	Urban	Rural	Urban	Rural
15-19	0,1456	0,0923	0,0659	0,0897
20-24	0,5903	0,5557	0,4422	0,5455
25-29	0,8368	0,8107	0,7708	0,8375
30-34	0,9381	0,9292	0,8901	0,8976
35-39	0,9298	0,9569	0,8832	0,9409
40-44	0,8936	0,9356	0,9087	0,9130
45-49	0,8744	0,9314	0,8409	0,9205

Table B.10. Age-residence-specific marital fertility rates

	1993		2013	
Age	Urban	Rural	Urban	Rural
15-19	0,3795	0,5431	0,4211	0,4962
20-24	0,2606	0,3458	0,2568	0,3081
25-29	0,1568	0,1895	0,1705	0,1917
30-34	0,0808	0,1139	0,1151	0,1233
35-39	0,0369	0,0572	0,0525	0,0577
40-44	0,0104	0,0198	0,0079	0,0080
45-49	0,0018	0,0000	0,0031	0,0012

Table B.11. Distribution of women by age and region

	1993					2013				
Age	West	South	Central	North	East	West	South	Central	North	East
15-19	0,2870	0,1562	0,2321	0,0708	0,2540	0,4039	0,1164	0,1947	0,0604	0,2246
20-24	0,3234	0,1670	0,2229	0,0880	0,1986	0,3698	0,1257	0,2111	0,0651	0,2283
25-29	0,3515	0,1709	0,2336	0,0969	0,1471	0,4058	0,1227	0,2207	0,0570	0,1938
30-34	0,3651	0,1542	0,2303	0,0902	0,1602	0,4520	0,1189	0,2008	0,0735	0,1547
35-39	0,3772	0,1671	0,2100	0,1050	0,1406	0,4574	0,1342	0,2082	0,0635	0,1368
40-44	0,3804	0,1565	0,2370	0,0772	0,1489	0,4609	0,1324	0,1953	0,0751	0,1364
45-49	0,3921	0,1472	0,2420	0,0918	0,1268	0,4373	0,1429	0,2099	0,0797	0,1302

Table B.12. Proportion of currently married women by age and region

	1993					2013				
Age	West	South	Central	North	East	West	South	Central	North	East
15-19	0,1166	0,1346	0,1553	0,1818	0,1503	0,0505	0,0870	0,0882	0,0526	0,0878
20-24	0,5794	0,5135	0,6025	0,5962	0,6023	0,4242	0,4556	0,4770	0,3563	0,5443
25-29	0,8214	0,7469	0,8567	0,8921	0,8578	0,7706	0,7609	0,8116	0,7529	0,7869
30-34	0,9286	0,9082	0,9612	0,9091	0,9442	0,8912	0,9409	0,8726	0,8783	0,8802
35-39	0,9225	0,9344	0,9348	0,9652	0,9675	0,8817	0,9010	0,8987	0,9158	0,9126
40-44	0,8886	0,9167	0,9083	0,9014	0,9343	0,9143	0,9024	0,9091	0,8817	0,9112
45-49	0,8773	0,8713	0,9277	0,9048	0,8966	0,8667	0,8095	0,8519	0,9259	0,8881

Table B.13. Age-region-specific marital fertility rates

	1993					2013				
Age	West	South	Central	North	East	West	South	Central	North	East
15-19	0,4316	0,3554	0,3283	0,3352	0,4438	0,4503	0,4594	0,4223	0,4486	0,4205
20-24	0,2498	0,2742	0,3008	0,3327	0,3438	0,2342	0,3112	0,2314	0,3086	0,3184
25-29	0,1486	0,1801	0,1352	0,1758	0,2353	0,1504	0,2037	0,1432	0,2086	0,2360
30-34	0,0559	0,0973	0,0924	0,0898	0,1755	0,1071	0,1128	0,0890	0,0937	0,1951
35-39	0,0160	0,0416	0,0418	0,0414	0,1224	0,0490	0,0504	0,0355	0,0451	0,1024
40-44	0,0014	0,0130	0,0138	0,0148	0,0496	0,0062	0,0093	0,0048	0,0017	0,0209
45-49	0,0000	0,0000	0,0000	0,0000	0,0094	0,0051	0,0000	0,0000	0,0000	0,0025