International Journal of Epidemiologic Research
doi:10.34172/ijer.2022.14 2022 Spring;9(2):80-85 http://ijer.skums.ac.ir

Original Article

The Role of Age Groups in Improving Life Expectancy of Iran During 1976-2016

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Abstract

Background and aims: At least, during the last half-century, the mortality rate in Iran has decreased significantly, and life expectancy at birth has increased. To better understand the mechanisms of improving the health situation in Iran, this study sought to examine the contribution of age groups in improving life expectancy at birth during 1976 -2016.

Methods: The required life tables for the years 1976, 1986, and 1996 were taken from previous studies. Furthermore, life tables for 2006 and 2016 were calculated using the data from the registration system of the Ministry of Health. Then, the contribution of each age group in improving life expectancy in Iran by sex was estimated using the Arriaga decomposition method, and data analysis was conducted by creating a template in Excel software.

Results: The life expectancy at birth for men and women in Iran has increased by 18.7 and 21.5 years, respectively, during 1976–2016. Infant mortality was the most important factor in increasing life expectancy with 6.5 and 6 years for women and men, respectively. In addition, over time, the share of early deaths has decreased, and instead, old-age deaths have played a more prominent role in improving the life expectancy of men and women in Iran.

Conclusion: Today, increasing life expectancy for both sexes is mainly achieved through reducing the mortality of the older population, and achieving more years for life expectancy is mainly due to comprehensive development, especially reducing health inequalities and increasing life expectancy at older ages.

Keywords: Age group, Life expectancy, Mortality, Decomposition

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Received: 25 Dec. 2021
Accepted: 23 Feb. 2022
ePublished: 1 June 2022

Introduction

Life expectancy is increasing not only in industrial societies but all over the world. Improvements in life expectancy probably began before the industrial age; that is, before the national death toll was first collected in Sweden around 1750. Life expectancy at birth in Sweden (and possibly other parts of northwestern Europe) had risen to 38 by 1750. Over the next century, life expectancy increased slowly and erratically. However, after about 1870, this increase became more stable and faster.[1] During the first half of the twentieth century, life expectancy in industrialized countries increased very rapidly with a delay in other parts of the world.[2,3] Recently, the process of life expectancy has slowed down. The reason for the initial increase in life expectancy and then the decrease in its speed is that child mortality reduced to a very low historical level. Globally, the increase in the chance of survival from birth to age 5 explains the reason for more than half of the approximately 5 years increase in life expectancy at birth between 2000-2015.[4]

One of the main features of mortality reduction that has occurred is that the mortality rate has decreased in all ages. In addition, the distribution of ages at death shifted to the right, especially in developed countries, and became more compressed and "rectangular".[5,6] The contribution of different age groups in improving the life expectancy of countries varies greatly depending on the level of life expectancy at birth. In countries with the highest mortality rates, changes in life expectancy are mainly characterized by reduced child mortality. In contrast, among countries with the lowest mortality rates, improved life expectancy is concentrated in the oldest ages.[7] Therefore, it can be said that in countries with higher levels of development, older deaths have played a more important role in improving life expectancy; conversely, in countries with lower levels of development, younger age groups have played a more prominent role in changes in life expectancy.[8]

The mortality transition in developing countries began after World War II. Much of the improvement in life expectancy in developing countries including Iran in the post-war period was not related to improved incomes and living conditions.[9,10] Mortality in these countries has declined sharply, regardless of development, due to exogenous factors such as the introduction of medical technology, expansion of public health, control of infectious diseases, and reduction of infant mortality. The infant mortality rate decreased from about 200 per thousand live births in 1956 to less than 20 per 1000 in

2016. The crude death rate in the same period decreased from about 25 per 1000 to about 6 per 1000, and finally, the life expectancy at birth increased from 45 years in 1956 to more than 73 years in 2016. Simultaneously, with the decrease in mortality rates, there was a comprehensive transition from deaths due to infectious diseases to deaths due to chronic diseases related to lifestyle and aging in Iran. These developments, in turn, have led to an increase in the average age of death and the transfer of deaths to older ages.[11,12] Despite the significant improvements in the life expectancy of Iranians, especially in the last half-century, no comprehensive study has been conducted so far on the causes of these changes, including the role of mortality in different age groups in the country.[13-16] However, since the 1990s, the trend of increasing life expectancy in Iran has slowed down; therefore, recognizing the potential to reduce mortality and increase life expectancy (e.g., age differences in mortality) is important at present. Examining the role of age groups in improving life expectancy in the country can highlight the critical points of mortality and improve the process of increasing life expectancy in both sexes by focusing on health planning and disease prevention in a specific direction. Therefore, the purpose of this study was to investigate the role of changes in the age pattern of deaths in Iran during the period 1956-2016.

Materials and Methods

Type of Study

This study was a secondary data analysis with data measured at the collective level.

Data Sources

Calculation of life expectancy at birth requires death and exposed population data based on age and sex for the year under study. The absence of death data, especially in terms of age pattern, has caused the life tables calculated in the country in the 2000s to be based on models and patterns of other countries or theoretical demographic models. Therefore, life tables in Iran up to 1996 have been compiled indirectly. Accordingly, in this study, life tables estimated by researchers have been used for the years 1976, 1986, and 1996. The life tables used for these 3 years are as follows:

Life table of 1976: This table was compiled by Shams in 1982. It used an indirect method the initial information of which was based on the age and sex distribution of the population from the general population and housing censuses. Shams prepared a life table with the help of the theory of fixed population and using the growth and age structure of the population, assuming that the fertility level is constant and the mortality rate is variable.[14]

Life table of 1986: It was done by Zanjani and Kooshi in 1992. Using the information of the number of live births, the number of currently alive children of women, and the number of women in the age group of 5 years, this study estimated the mortality rate in different models. Further, a multivariate regression study was employed to correct life expectancy values.[15]

Life table of 1996: This life table was done by Zanjani and Noorollahi in 2000. Life expectancy at birth is calculated by the Mazur-Palmour method, which is considered to have the lowest probability of error in estimating life expectancy in Iran.[15]

In this study, life tables in Iran during 2006-2016 have been estimated using death information by age and gender obtained from the death registration system of the Ministry of Health and Medical Education.

Data Analysis

The mortality index used in this study was life expectancy at birth, which is calculated using the standard life table technique. After calculating the life tables, the contribution of change in mortality in age groups in increasing life expectancy was investigated using Arriaga Decomposition method.[16] An increase or decrease in life expectancy at birth and life expectancy in general can be rooted in changes that occur in the mortality of different age groups over a period of time. Based on this, a number of decomposition techniques have been developed to evaluate the effect of mortality changes on life expectancy at birth. Differences in life expectancy between two populations (such as two sections) are a function of differences in mortality rates by age. Arriaga decomposition is used to answer the question of how many years of increased life expectancy at birth are due to differences in age-specific mortality rates. For this purpose, the contribution of age groups in increasing life expectancy is obtained through the following relationship:

$$n\Delta x = \frac{l_x^t}{l_a^t}\left(\frac{T_x^{t+n} - T_{x+i}^{t+n}}{l_x^{t+n}} - \frac{T_x^t - T_{x+i}^t}{l_x^t}\right) + \frac{T_{x+i}^t}{l_a^t}\left(\frac{l_x^t l_{x+i}^{t+n}}{l_{x+i}^t l_x^{t+n}} - 1\right)$$

In this formula, the absolute $n\Delta x$ is the change in life expectancy, lx is the number of survivors at age x, Tx is the total number of people aged from x onwards, t is the year at the beginning of the period, and n is the interval between the beginning and end of the period[17]. It should be noted that the calculations were performed using Excel software.

Results

Increasing life expectancy at birth is one of the important indicators of determining the level of health and well-being of people in society. The findings of the life table show that life expectancy at birth for Iranian men and women during the years 1976-2016 has increased by 17.8 years and 21.5 years, respectively. Life expectancy at birth for men has increased from 55.8 years in 1976 to 66.1 years in 1996, about 70 years in 2006, and finally 73.7 years in 2016 (Table 1). This figure for women in the country has increased from 55 years in 1976 to 68.4 years in 1996, 73.3 years in 2006, and 76.6 years in 2016.

As indicated by Figures 1 and 2, out of a hypothetical

generation of 100 000 people in 1976, about 10% did not reach the age of one year, and 900 000 people reached the age of one year. The proportion of survivors improved over the next decades so that for men in the country, the proportion of one-year survivors increased to 93% in 1986 and to about 98% in 2016. This similar situation can be observed for women in Iran. In later ages, there was a significant improvement in the survival of Iranian men and women.

As mentioned, life expectancy at birth in Iran for both men and women improved dramatically over the past 4 decades. Reducing mortality in the under-one age group was the most important factor in increasing life expectancy in Iran during the study period. Mortality changes in the age group of 1-4 years also made a significant contribution to improving life expectancy in Iran, comprising about 2.5 years and 2 years of increasing life expectancy at birth in both men and women. A reduction in deaths of later age groups played a smaller role in these developments. Further, the age groups of 84-80 years and 85 years and above during the last 4 decades played the least significant role in improving the life expectancy of both sexes in Iran, and the amount of increase in life expectancy caused by these two age groups did not even reach 0.5 years (Figure 3).

As Table 2 illustrates, mortality changes in under 15 years of age group in Iran during the period 1976-86 and 1986-96 comprised about half of the increase in life expectancy. The share of initial age groups in increasing life expectancy during the next period (1996-2006) for the Iranian men and women was 51% and 39%, respectively. In addition, mortality of 15-59 years old during the period 1976-86 accounted for 46% and 42% of the changes in life expectancy of men and women in the country,

Table 1. Life Expectancy at Birth in Iran by Gender During 1976-2016

Year	Male	Female
1976	55.8	55.0
1986	59.8	63.4
1996	66.1	68.4
2006	70.1	73.3
2016	73.7	76.6

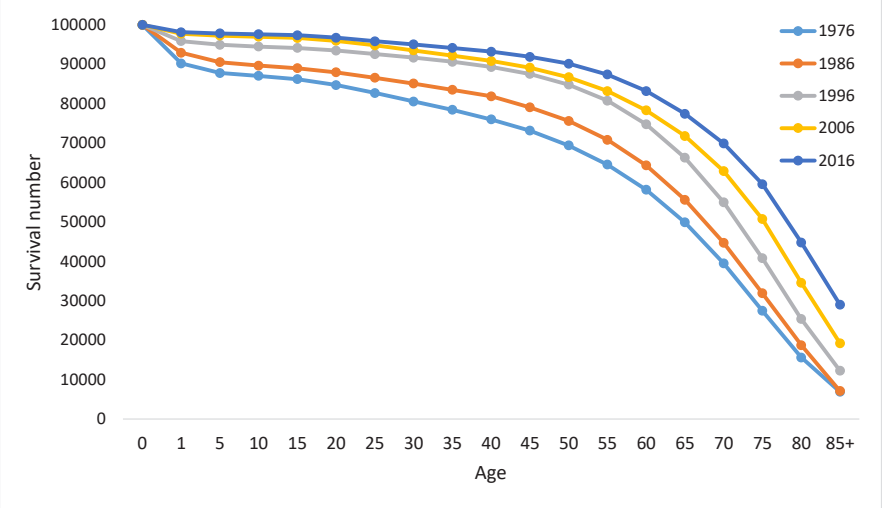

Figure 1. The Number of Generation Survivors at the Exact Age x for Men in Iran During 1976-2016

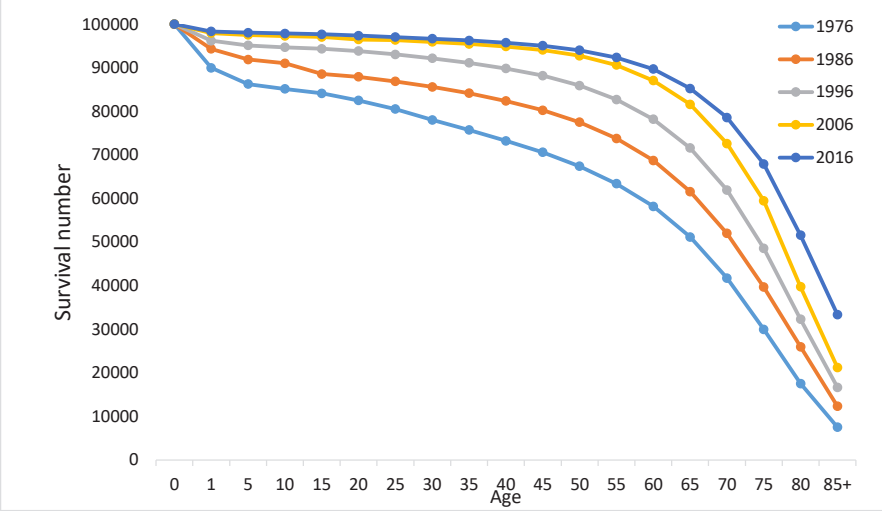

Figure 2. The Number of Generation Survivors at the Exact Age x for Women in Iran During 1976-2016

respectively. Further, during 1986-2006, this share for men decreased sharply and finally increased again in the last decade. Mortality changes over the age of 60 played a more significant role in increasing the life expectancy of women in the country during 2006-2016 than in previous periods.

According to Figures 4 and 5, during the period 1976-86, about 2.5 years and 2 years of improvement in the

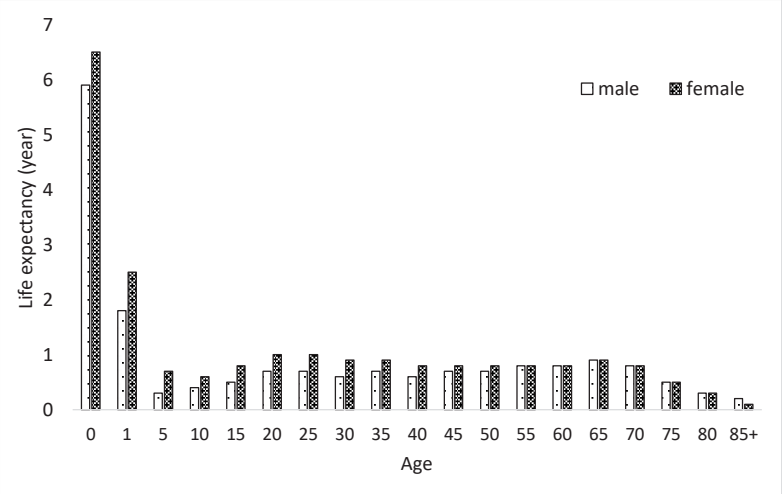

Figure 3. The Role of Age Groups in Increasing Life Expectancy at Birth in Iran During 1976-2016

Table 2. Percentage Distribution of the Role of Large Age Groups in Increasing Life Expectancy at Birth in Iran During 1975-2016

	1976-1986		1986-1996		1996-2006		2006-2016	
	Male	Female	Male	Female	Male	Female	Male	Female
0-14	48.7	46.9	52.7	59.9	42.2	39.3	13.7	14.6
15-59	46.7	42.6	34.4	28.2	45.5	53.3	43.6	20.6
60+	4.6	10.5	12.9	11.9	12.3	15.4	42.7	64.8
Total	100	100	100	100	100	100	100	100

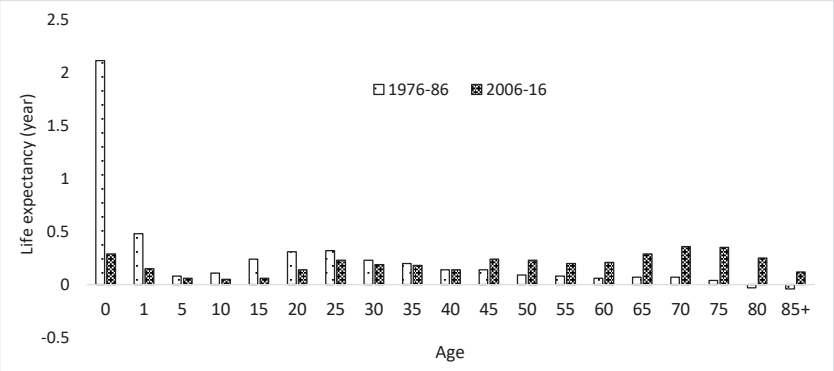

Figure 4. The Role of Age Groups in Increasing Life Expectancy at Birth for Men in Iran During 1976-86 and 2006-2016

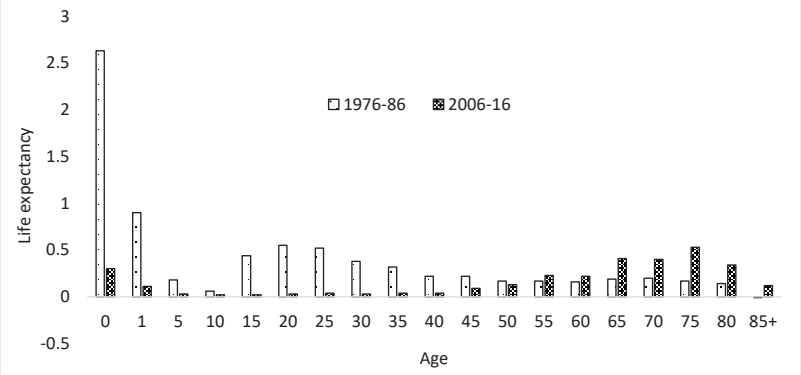

Figure 5. The Role of Age Groups in Increasing Life Expectancy at Birth for Women in Iran During 1976-86 and 2006-2016

life expectancy of men and women in Iran was due to the reduction of infant mortality. During the final period of 2006-2016, this share in both sexes decreased sharply and reached about 0.3 years. Moreover, the role of the ages after infancy and especially up to about 40 years old decreased, especially for women in Iran, during 2006-2016. On the contrary, the role of changes in old age deaths in increasing life expectancy increased in both sexes.

Discussion

Over the past century, most countries have experienced significant improvements in their health status, and life expectancy has steadily increased. Improving life expectancy in Iran, like other developing countries, began, especially after World War II, and today, life expectancy in Iran has reached about 75 years. The analysis of increasing life expectancy in Iran since 1976 showed that death changes in age groups have played different roles in increasing life expectancy. These findings have practical applications that can provide useful information for more effective allocation of health resources and more efficient implementation of public health-related policies in Iran. Life expectancy in the beginning is an important and valid indicator for recognizing the health status of the population; in addition, it is easy to interpret for professionals and ordinary people. In this study, the application of the analysis method for explaining the changes in life expectancy also considers the short time periods (10 years). These short periods allow the immediate impact of changes in lifestyle and economic, political, and social living conditions on the mortality rate to determine age-specific changes in short-term life expectancy.

The results showed that infant mortality under one year has the greatest role in improving life expectancy for men and women in Iran during the study period and has caused an increase in life expectancy in Iran for more than one quarter of about 20 years. With the passage of time and the increase in life expectancy by about 70 years, it was observed that the role of elementary age groups has decreased significantly. However, in the last decade, the decline in the mortality of individuals aged under one year has accounted for about 10 percent of the increase in life expectancy at birth for both sexes. Therefore, the decrease in infant mortality has been the main reason for the transfer of mortality and the increase of life expectancy in Iran, and as expected, the role played by this age group in increasing life expectancy has decreased with the increase in life expectancy.

On the other hand, increasing life expectancy for both sexes is mainly achieved through reducing the mortality rate of the older population, and gaining more years for life expectancy is mainly possible through comprehensive development, especially reducing health inequalities and increasing life expectancy at older ages. The findings of this study in Iran are consistent with studies in other countries such as Italy, Germany, Hong Kong, and Spain.[18,19] The reason for the limited role of young people in increasing life expectancy can be attributed to the transfer of the mortality age pattern towards "rectangularization of the survival curve". The decrease in the number of deaths in childhood groups has greatly increased life expectancy in Iran, especially since the 1940s. Today, however, the decline in mortality among the elderly is a major factor leading to this improvement.

It should be noted that this study also has some limitations. First, the life tables of Iran for the years 1976, 1986, and 1996 have been compiled by indirect methods and the application of demographic models. Although these methods provide a good estimate of life expectancy at birth, the age pattern of death obtained with these methods may not be completely consistent with the reality of death in Iran since the age pattern of the deceased is not used in their calculations.

Conclusion

With the changes in the mortality profile in Iran, especially the reduction of child mortality, the increase in life expectancy in Iran over the coming decades is similar to that of developed countries by delaying the mortality of old age. In this regard, it is necessary to provide the necessary measures, especially in the field of medical services.

Acknowledgments

I sincerely thank the Technology and Information Group of the Network Management Center of the Ministry of Health for providing the required information to the author for the years 2006 and 2016.

Conflict of Interest Disclosures

The author declares that there is no conflict of interests.

Ethical Approval

This study was approved by the Ethics Committee of NIPR (code: 10.4276).

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