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ORIGINAL ARTICLE

Trends in life expectancy and life disparity in Türkiye before and during the COVID-19 period

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Abstract

Objective: This descriptive study examines Türkiye's life expectancy trends from 2013 to 2022, encompassing the COVID-19 period.

Methods: This study used the Turkish Statistical Institute (TURKSTAT) cause of death data and explored trends in life expectancy and life disparity by using the line-integral decomposition model.

Results: According to results, before the pandemic, increased male life expectancy and reduced disparity resulted from improved outcomes in unintentional injuries and malignant neoplasms during adulthood. Female life expectancy gains were driven by declining cardiovascular diseases in old age. However, during COVID-19, males experienced a greater loss of life expectancy than females in youth and adulthood, while females faced higher mortality rates in old age than males. The pandemic has exacerbated the female-male gap in life expectancy and disparity, with all causes of death increasing except for an improvement in malignant neoplasms among males.

Conclusion: The study suggests prioritizing policies that address the health challenges faced by elderly females and young/adult males to mitigate the pandemic's impact on public health.

Keywords: Causes of Death, Decomposition, Life Disparity, Life Expectancy, Türkiye

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INTRODUCTION

Demographers use "lifespan" to denote the maximum age individuals can reach, while "longevity" refers to survival from one year to the next.[1] Life expectancy calculates the average years a person would live in a year based on age-specific mortality rates [2]. Life expectancy doesn't precisely indicate actual lifespan; it's influenced by current mortality rates. Lifespan variation, indicating lifespan variability or life disparity, reveals uncertainty in age at death. Higher variation suggests more uncertainty.[3] Countries with higher life expectancy tend to have lower life disparity. Although life disparity and life expectancy are inversely related, populations with the same life expectancy can differ in life disparity due to age-specific mortality improvements [3–5]This study analyses the changes in life expectancy and inequality of life in Türkiye between 2013 and 2022 by forming 3 periods: 2013-2019 (pre-COVID-19 period); 2019-2021 (COVID-19 period); and 2021-2022 (post-COVID-19 period). We used decomposition analysis to identify age and cause of death influencing changes in life expectancy and life disparity. This study also examines the contribution of age and cause of death to the female-male gap in life expectancy and life disparity for the 2013-2019 and 2020-2022 periods. This research is the first to evaluate life expectancy and life disparity patterns in Türkiye by age and cause.

The main purpose of this study is to highlight the impact of the pandemic period on mortality trend and pattern and reveal the ages and causes of death contributing to the change in life expectancy and life disparity in the pre-COVID-19 and post-COVID-19 periods. In light of the findings, the study aims to contribute to health policies to further improve mortality rates. To achieve these aims the study has four interrelated objectives: 1) To calculate changes in life expectancy and life disparity by sex for the 2013-2019, 2019-2021, and 2021-2022 periods. 2) To examine the contributions of age and cause of death to changes in these measures. 3) To analyze the sex gap (female-male) in life expectancy and life disparity for the 2013-2019 (pre-COVID-19) and 2020-2022 (during and post-COVID-19) periods. 4) To make policy recommendations based on the findings, considering the role of life disparity in understanding health inequalities and future mortality scenarios.

Importance of life disparity in public health

Life disparity in public health is crucial. It measures the certainty of when people will die and helps to understand health inequalities among subgroups. Higher disparity indicates more uncertainty in expected time of death and greater health inequalities. [6,7] Researchers and policymakers should prioritize understanding life disparity.

Particular characteristic of life disparity measures is that they give a threshold age which separates the "young-age component" from "old age component".[8] This age provides vital insights into the life expectancy- life disparity relationship. As life expectancy rises, the threshold age also increases, allowing more years to save lives at younger ages, which means that mortality is compressed to older ages.[9,10] Conversely, declining mortality at older ages leads to an expansion of mortality among the elderly. [11,12] In general, increasing life expectancy accompanies decreasing life disparity due to improved mortality rates at younger and adult ages.[4] However, some

situations may see simultaneous increases in life disparity and life expectancy due to slower reductions in young and adult age mortality alongside ongoing improvements in older age mortality.[13-14]

METHODS

Data

In this study, causes of death and population dataset were obtained from Turkish Statistical Institute (TURKSTAT) by sex, year, and single age. Causes of death were provided in the ICD-10 coded form for 2013-2022 period. The data on population were obtained from the Address-Based Population System of TURKSTAT for 2013-2022. In the data preparation process, the causes of death with ICD-10 codes were grouped according to Annex Table A of WHO technical paper for Global Health Estimates.[15] Then, garbage codes were determined and distributed to the target codes as proposed by WHO.[15] After the distribution of garbage codes, we selected top 12 causes of death for analysis.

There is a reason for choosing the 2013 as the starting year. In Türkiye, electronic death notification system was put into practice in 2013. This system has provided more complete data on deaths compared to the death registration systems in the previous year's [16,17]

Methods

In this study, we investigated the indicators of life expectancy and lifespan variation since birth. In the literature, several life dispersion indicators have been suggested to analyze the variation in lifespan.[18,19] These studies showed that since there are strong correlations between variation measures, and so used variation measure does not matter for results of the study. [4,9,18] Therefore, we used life disparity ($e^{\dagger}$), average years of life lost, to measure lifespan variation. We decomposed the age and cause of death contributions to life expectancy by using the measure of life expectancy at birth (e_0). R programming (version 4.3.0) was used for data management and further analysis. Decomposition analysis were performed with DemoDecomp package in R [20.]

Decomposition technique

Changes in life-expectancy and lifespan variation were decomposed into selected top 11 causes of death and age groups by using line-integral decomposition model proposed by Horiuchi and colleagues [21]and a general problem (the decomposition problem.

Let be differentiable function of n covariates denoted by by $x=[x_1,x_2,\ldots,x_n]$ Then y can be expressed as function of x. We can express as $y=f(x_1,x_2,\ldots,x_n)$. Any effect of x on y creates a change in . Assume that both y and x depend on time t and x is differentiable vector function of t between t_1 and t2. Then, we define the function as

$y(t)=f(x(t))=f(x_1(t),x_2(t),\ldots,x_n(t))$ and change in y between t_1 and t_2 can be expressed as,

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

For simplicity, if we drop the t from equation (1), then we get,

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

According to this equation, is the total change in y produced by . In other words, c_i is the effect of x_i on y. According to this model life disparity ($e^{\dagger}$) and life-expectancy (e_0) correspond to dependent variable y. Covariates are age and cause specific mortality rates.

RESULTS

According to Table 1, life expectancy of both sexes increased between 2013 and 2019 and it reached to 81.0 and 75.7 for females and males, respectively. However, there was a sharp decline in life expectancy in 2020 and 2021, totaling loss 2.1 years for both females and males. In 2020 and 2021 life disparity stayed almost in the same level for both sexes. In line with life expectancy, the threshold age also decreased by a total of 1.8 and 2.2 years for females and males, respectively between 2019 and 2021.

Table 1. Distribution of life expectancy, life disparity, and threshold ages by sex and years

	Year	Life expectancy (e_0)	Life disparity ($e^\dagger$)	Threshold age
Female	2013	80.5	10.6	78.0
	2014	80.1	10.5	77.8
	2015	80.2	10.4	77.9
	2016	80.0	10.4	77.9
	2017	80.5	10.3	78.4
	2018	80.8	10.2	78.6
	2019	81.0	10.1	78.7
	2020	80.1	10.2	77.8
	2021	78.9	10.3	76.9
	2022	80.4	9.8	78.6
Male	2013	75.1	11.7	72.8
	2014	75.0	11.5	73.0
	2015	75.1	11.4	73.1
	2016	74.8	11.5	72.9
	2017	75.4	11.4	73.4
	2018	75.5	11.4	73.4
	2019	75.7	11.2	73.6
	2020	74.3	11.1	71.7
	2021	73.6	11.2	71.4
	2022	75.1	11.0	73.3

Age and cause-specific contribution

Table 2 and Figure 1 indicate the age and cause contribution to the change in life expectancy among females and males for the 2013-2019, 2019-2021, and 2021-2022 periods. In the 2013-2019 period, except for respiratory tract infections and infectious and parasitic diseases at ages 45 and over and unknown causes, all causes of death declined and enabled 0.46 and 0.65-year gains in life expectancy for females and males, respectively (Figure 1-top and Table 2). In this period, the gain in life expectancy mainly stemmed from the improvement in infant mortality and cardiovascular diseases at ages 60-90 among females. In the period 2019-2021, COVID-19 adversely affected almost all age groups, especially those aged 50-90, leading to a total loss of 1.29 years in life expectancy for females (Figure 1 and Table 2). It is noteworthy that unknown causes decreased significantly at all ages in the 2019-2021 period. In the last period, 2021-2022, the negative impact of COVID-19 was brought under control, and mortality rates decreased significantly. In this period, life expectancy among females increased by 1.51 years. When looking at the gain and loss in life expectancy among males (Figure 1-bottom), a total of 0.65 years gain in life expectancy stemmed from the improvement in infant mortality, unintentional injuries, and malignant neoplasms in the 2013-2019 period. Males have gained more years than females due to a greater improvement in male mortality rates below age 75. However, gains in life expectancy were offset by unknown causes among males. Between 2019 and 2021, males lost 2.13 years, mainly due to COVID-19 (Table 2). Although both males and females experienced similar losses during the pandemic years, the variation between the two sexes arises from the age distribution of mortality. While females faced higher losses in years beyond the age of 80, males experienced higher losses between the ages

of 20 and 70. In the pandemic improvement of malignant neoplasms enabled gain in life expectancy. In the post-COVID period, males gained 1.49 years in life expectancy mainly from the decline of COVID-19 deaths between ages 35 and 85.

Table 2. Total gain/loss in life expectancy by period and cause of death

Female	**2013-2019**	**2019-2021**	**2021-2022**
Cardiovascular diseases	0.62	-0.33	0.28
Malignant neoplasms	0.22	0.06	0.07
Respiratory diseases	0.08	-0.04	0.09
Neurological conditions	-0.02	0.04	0.01
Genitourinary diseases	-0.05	-0.01	0.03
Diabetes mellitus	0.15	-0.05	0.04
Resp.inf. & Inf.and parasitic dis.	-0.42	-0.39	0.09
COVID-19	0.00	-1.29	0.92
Neonatal conditions	0.08	-0.03	0.01
Unintentional injuries	0.13	0.01	0.00
Unknown	-0.55	-0.06	-0.05
Other	0.21	0.00	0.01
Total	**0.46**	**-2.09**	**1.51**
Male	**2013-2019**	**2019-2021**	**2021-2022**
Cardiovascular diseases	0.47	-0.35	0.24
Malignant neoplasms	0.52	0.17	0.11
Respiratory diseases	0.13	-0.03	0.09
Neurological conditions	0.02	0.02	0.01
Genitourinary diseases	-0.01	-0.04	0.05
Diabetes mellitus	0.09	-0.05	0.02
Resp.inf. & Inf.and parasitic dis.	-0.35	-0.44	0.12
COVID-19	0.00	-1.27	0.90
Neonatal conditions	0.10	-0.02	0.00
Unintentional injuries	0.30	-0.01	0.02
Unknown	-0.85	-0.08	-0.11
Other	0.22	-0.03	0.02
Total	**0.65**	**-2.13**	**1.49**

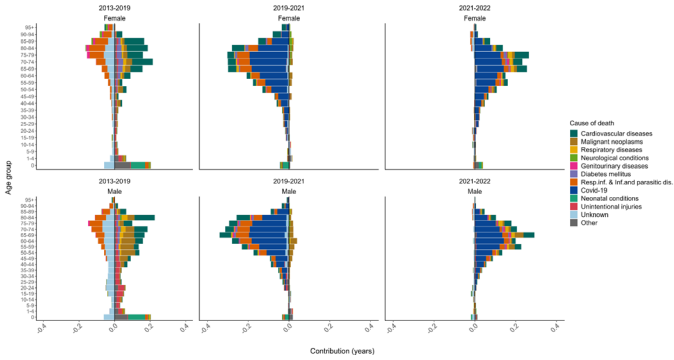

Figure 1. Age and cause-specific contribution to the change in life expectancy among females (top) and males (bottom)

In the 2013-2019 period, female life disparity decreased by 0.55 years mainly due to a decrease in neonatal diseases, and an increase in respiratory infections in aged 75 years and over (Figure 2-top). In this period, unknown causes below the age of 75 increased the life disparity. During the pandemic period, since mortality from all causes increased in all ages, all causes below age 75 increased life disparity, while all causes at age 75 and above decreased the life disparity. In total, life disparity increased 0.23 years in the pandemic period. In the 2021-2022 period, since the mortality rate of almost all causes decreased, the life disparity decreased by 0.50 years (Table 3, Figure 2-top).

Similar to females, life disparity among males decreased in the 2013-2019 period (Figure 2-bottom). The impact of improvement in young and adult mortality on the decreasing life disparity was higher among males than females in this period. This improvement was mainly driven by the improvement of unintentional injuries and malignant neoplasms below threshold age (around 75 years of age). However, in this period male's gain in life expectancy was offset by unknown causes. So, the net gain in life disparity decreased to 0.43 years (Table 3). For the period 2019-2021, males had a similar level

and pattern of life disparity to females. In the last period, since the decline of life disparity below age 75 was higher than rise of life disparity above age 75 and above, males total life disparity decreased in this period.

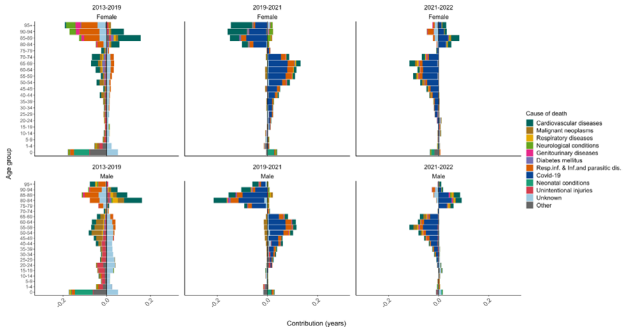

Figure 2. Age and cause-specific contribution to the change in life disparity among females (top) and males (bottom)

Table 3. Total gain/loss in life disparity (e^+) by period and cause of death

Female	**2013-2019**	**2019-2021**	**2021-2022**
Cardiovascular diseases	0.05	-0.15	0.00
Malignant neoplasms	-0.07	-0.02	-0.02
Respiratory diseases	-0.01	0.02	-0.02
Neurological conditions	-0.10	0.04	0.00
Genitourinary diseases	-0.07	0.01	-0.02
Diabetes mellitus	-0.02	-0.02	-0.01
Resp.inf. & Inf.and parasitic dis.	-0.22	0.10	-0.09
COVID-19	0,00	0.20	-0.27
Neonatal conditions	-0.07	0.03	-0.01
Unintentional injuries	-0.05	0.00	0.00
Unknown	0.14	0.04	-0.03
Other	-0.14	-0.02	-0.02
Total	**-0.55**	**0.23**	**0.50**
Male	**2013-2019**	**2019-2021**	**2021-2022**
Cardiovascular diseases	0.04	-0.08	0.01
Malignant neoplasms	-0.15	-0.05	-0.02
Respiratory diseases	0.00	0.01	0.00
Neurological conditions	-0.02	0.02	0.01
Genitourinary diseases	-0.02	0.00	0.00
Diabetes mellitus	-0.01	-0.01	-0.01
Resp.inf. & Inf.and parasitic dis.	-0.19	0.04	-0.07
COVID-19	0.00	0.02	-0.15
Neonatal conditions	-0.08	0.02	0.00
Unintentional injuries	-0.17	0.02	-0.02
Unknown	0.31	0.00	0.02
Other	-0.14	0.01	-0.01
Total	**-0.43**	**0.00**	**-0.24**

Table 3. (Countinue) Total gain/loss in life disparity (e^+) by period and cause of death

Age and cause contribution to sex gap in life expectancy

Figure 3 indicates the contribution of age groups to the female-male gap in life expectancy for each cause in the 2013-2019 and 2020-2022 periods. By this figure, if the line is above 0, it signifies that females exhibit a greater life expectancy in this cause of death, and conversely, if it is below 0, males have a longer life expectancy. As shown, females hold the advantage in all causes. The advantage females enjoy in life expectancy is mainly due to lower mortality rates than males in cardiovascular diseases, malignant neoplasms, and respiratory diseases between the ages of 45 and 80 years. While the gap in cardiovascular diseases remained almost at the same level, it narrowed significantly in malignant neoplasms between 45 and 80 years of age. At the same time, the sex gap for respiratory diseases at older ages and for unintentional injuries between ages 15 and 50 decreased, but this decline was more moderate.

On the other hand, the female-male gap in life expectancy increased due to respiratory infections, COVID-19, and other causes in the 2020-2022 period. The gap is higher between 45 and 85 for respiratory infections and COVID-19. That means respiratory infections and COVID-19 had a worse impact on males than females at these ages.

Gaps in unknown causes also increased between the two periods due to higher male mortality rates at other causes. Since the mortality rate from unknown causes increased among males aged 15-85, the female-male gap widened in advantage of females in the 2020-2022 period (Figure 3 and Table 4).

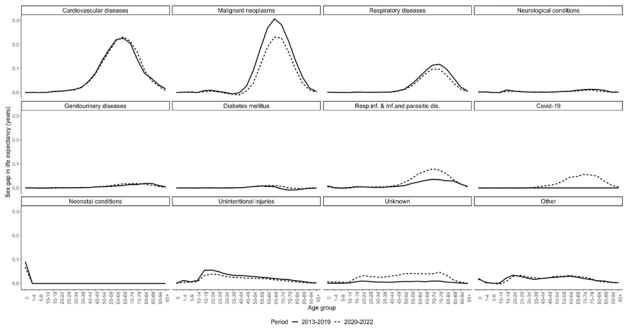

Figure 3. Sex-gap (female-male) in life expectancy by cause of death in the 2013-2019 and the 2020-2022 periods

Table 4. Female-male gap in life expectancy and life disparity by causes of death

	Life expectancy		Life disparity	
Causes of death	**2013-2019**	**2020-2022**	**2013-2019**	**2019-2022**
Cardiovascular diseases	1.47	1.48	-0.30	-0.29
Malignant neoplasms	1.61	1.12	-0.28	-0.13
Respiratory diseases	0.64	0.51	0.09	0.06
Neurological conditions	0.10	0.07	-0.01	-0.01
Genitourinary diseases	0.12	0.13	0.05	0.02
Diabetes mellitus	0.00	0.04	-0.03	-0.03
Resp.inf. & Inf.and parasitic dis.	0.28	0.50	0.04	0.02
COVID-19	0.00	0.35	0.00	0.03
Neonatal conditions	0.09	0.07	-0.08	-0.06
Unintentional injuries	0.49	0.34	-0.29	-0.2
Unknown	0.11	0.53	-0.05	-0.21
Other	0.37	0.38	-0.18	-0.19
Total gap (Female-Male)	**5.28**	**5.51**	**-1.04**	**-0.99**

Age and cause contribution to sex gap in life disparity

In Figure 4, a positive line indicates a higher life disparity for females, and a negative line suggests a higher life disparity for males. Improvements in mortality, regardless of the age at which they occur, lead to increased life expectancy; however, changes in life disparity are closely tied to the age at which mortality changes take place. In Figure 4, a consistent pattern emerges across various diseases. For cardiovascular diseases, malignant neoplasms, respiratory diseases, respiratory infections, COVID-19, and other conditions, males show greater disparity than females in young and adult ages, while females exhibit larger disparity than males at older ages. At young and adult ages, higher disparity indicates elevated mortality among males. Conversely, females' increased disparity beyond age 75 stems primarily from improved mortality in that age group. Simply put, females' mortality rate at and above 75 has consistently improved, surpassing that of elderly males and contributing to the rise in life disparity among females through the impact of 'saving lives at late ages'.

The gap in life disparity stayed almost at the same level in cardiovascular diseases. Female-male disparity gap in malignant neoplasms decreased from 2013-2019 to 2020-2022, but deaths due to malignant neoplasms are still higher among males aged 35-75. In the 2020-2022 period, males showed a higher disparity in respiratory infections and COVID-19 for ages 35-75, indicating that male mortality at those causes and ages surpassed that of females. For unknown causes, except those aged 75 and over, males exhibited higher disparity, attributed to elevated unknown male mortality in those age groups.

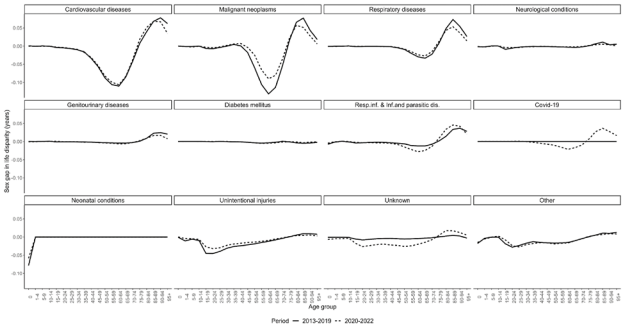

Figure 4. Sex gap (female-male) in life disparity by cause of death in the 2013-2019 and the 2020-2022 periods.

DISCUSSION

In this study, we present the analysis of the 10-year mortality profile of Türkiye by age and cause of death, focusing on sex differences and the impact of COVID-19. This study also allows us to understand the impact of the COVID-19 pandemic period on mortality patterns.

Age and cause of death contributions to changes in e(0) and e†

Life expectancy at birth in Türkiye decreased significantly in the COVID-19 period for both sexes. It should be noted that the life expectancy at birth values in the TURKSTAT life tables are slightly different from the values found in this study [22]. This is because TURKSTAT life tables are computed using the moving average method based on three consecutive years of population and mortality data. In this study, the life expectancies are calculated for each year. A decrease in mortality contributes to increased life expectancy, regardless of the age at which it occurs. However, only a reduction in mortality below a certain threshold age results in a decrease in life disparity. This suggests that factors influencing life expectancy and those influencing life disparity may not align [23]. Our study revealed that causes leading to higher life disparity differ from those contributing to increased life expectancy. Over the 2013-2019 period, improvements in cardiovascular diseases and malignant neoplasms significantly boosted life expectancy for both sexes, while a decrease in infant mortality lowered disparity. Notably, enhancements in neonatal conditions and other diseases (mainly congenital anomalies) made the greatest contributions to both life expectancy and life disparity during this period. Additionally, improvements in male mortality from unintentional injuries between ages 1 and 35 significantly increased life expectancy and reduced life disparity. Between ages 35 and 64, a decline in deaths from malignant neoplasms and cardiovascular diseases among males contributed significantly to both measures. It's important to note that cancers positively influencing life expectancy may differ from those reducing life disparity [24], warranting further analysis of cancer types. On the other hand, the gain in life expectancy for females remained relatively small compared to males, with the most significant impact on life expectancy attributed to improved cardiovascular health in older age groups and a reduction in infant mortality.

Furthermore, due to unknown causes, males lost more than half a year in the 2013-2019 period. The loss of life expectancy due to unknown causes remained relatively low among women. In Türkiye, the death notification form is typically completed by a physician [17]. If a physician is unavailable, such as in cases of out-of-hospital deaths, other authorized individuals like the officer of the burial permit, gendarme, or village head fill out the form, excluding the cause of death section. The results show that although the death registration system is quite developed and effective compared to previous years, it is not effective enough in determining the

causes of death due to inadequacies in the health system such as insufficient personnel or not easy access to health institutions for all places.

A noteworthy discovery in this study is the significant rise in respiratory infections and infectious and parasitic diseases among individuals aged 45 and above, affecting both sexes. This resulted in the highest reduction in life expectancy for both females (0.42 years) and males (0.35 years) during the 2013-2019 period. Conversely, an uptick in mortality from respiratory infections and infectious and parasitic diseases at older ages also led to the most substantial net reductions in life disparity. This finding suggests that life disparity can be lessened in two ways: firstly, by lowering the mortality rate below the threshold age, and secondly, by elevating the mortality rate above the threshold age.[8] In the first scenario, there is an increase in life expectancy and a decrease in life disparity. In the second scenario, there is a decrease in life expectancy and a reduction in life disparity. The overall mortality trend in long-lived societies involves an augmentation of life expectancy and an increase in life disparity, reflecting a pattern of "saving lives at older ages." [5,10,13,25.]

The 2019-2021 period revealed that COVID-19 directly or indirectly heightened the risk of mortality from other causes [26–28] The findings indicate that mortality from all causes, except malignant neoplasms, significantly increased during the pandemic period. The decrease in life expectancy during this time was mainly attributed to heightened mortality rates among individuals aged 50 to 85 for both sexes. Additionally, when comparing sexes, males under 75 years of age and females aged 75 years and over experienced higher mortality rates than their counterparts.

In the 2021-2022 period, COVID-19 mortality showed improvement, resulting in a 1.5-year increase in life expectancy for both sexes. The pandemic's impact on life expectancy and life disparity was nearly eradicated, with improvements in COVID-19 mortality observed across all age groups. The most significant contribution, approximately 1 year for both sexes, stemmed from the betterment of COVID-19 outcomes. Concurrent with the enhancement in COVID-19 conditions, mortality rates from cardiovascular disease and unknown causes of death also decreased during this period. As mortality improvements spanned all age groups, life disparity decreased below the age of 75 and increased above the age of 75. Overall, there was a substantial reduction in life disparity during this timeframe. However, despite the advancements in life expectancy, Türkiye still falls below the 2019 life expectancy levels for both sexes.

The study's findings can be summarized as follows: Persistent advancements in combating infant mortality, malignant neoplasms, and unintentional injuries below the threshold age contributed to the increase in life expectancy for males during the 2013-2019 period. The male population's gains in life expectancy resulted from improved young and adult mortality (compression of mortality). In contrast, females experienced increases in life expectancy due to improvements in older ages (expansion of mortality). Research evidence in the literature suggests that some countries achieved high life expectancy by leveraging advantages in old-age mortality [5,10,13] Moreover, respiratory

infections and infectious and parasitic diseases emerged as the primary factors reducing life expectancy and increasing life disparity during this period which shows that the prevalence of communicable diseases had already risen before the pandemic. The 2013-2019 period also exposed the shortcomings of the health system, as the quality of cause-of-death data significantly declined due to a substantial increase in unknown causes of death, particularly among males. Findings of the study highlighted the substantial impact of COVID-19 on existing mortality differentials in Türkiye. In the 2019-2021 period, mortality rates worsened for both sexes across all age groups, except for malignant neoplasms, all diseases with COVID-19 playing a significant role. On the other hand, in the 2021-2022 period, the pandemic's impact gradually diminished, leading to improvements in both life expectancy and life disparity.

Age and cause of death contributions to the female-male gap in e(0) and e†

The results indicated that females have a survival advantage over males at all ages and for all causes of death in terms of life expectancy. Consistent with our findings, previous research also demonstrated the female advantage in life expectancy across all age groups and causes.[29,30] Over the periods 2013-2019 and 2020-2022, the narrowing gap in life expectancy between females and males was primarily attributed to improvements in malignant neoplasms among males. Respiratory diseases and unintentional injuries also played a role in reducing the female-male gap due to improvements in these causes among males. This finding is consistent with the result of Glei and Horiuchi's study [31], which emphasized that since females' deaths are less evenly distributed across age groups, the reduction in male mortality rates contributes to the narrowing of the female-male gap in life expectancy. On the other hand, during the pandemic period, an increase in mortality from respiratory infections, infectious and parasitic diseases, COVID-19, and unknown causes of death widened the female-male gap in life expectancy. Life disparity was higher among males, driven by elevated mortality rates among males under 75 years of age for respiratory infections, infectious and parasitic diseases, COVID-19, and unknown causes. For females, life disparity was higher among those aged 75 years and older for the same causes of death. Similar to this finding, a comprehensive study that estimated changes in life expectancy during the COVID-19 period across Europe, the United States, and Chile—encompassing a total of 29 countries—also revealed that due to higher excess deaths among males, the female-male gap in life expectancy widened in favor of females. [32]

CONCLUSION

In summary, a comprehensive analysis of mortality in Türkiye from 2013 to 2022 reveals that changes in life expectancy and life disparity were primarily driven by contributions from young and adult ages (below 75) among males and elderly ages (75 and above) among females. The impact of COVID-19 was significant across all ages and both sexes. The rise in respiratory infectious and parasitic diseases during the 2013-2019 period added an extra burden during the pandemic.

The critical question now is whether Türkiye will be able to regain the life expectancy levels seen in 2019. Presently, females and males

in Türkiye are trailing behind the 2019 life expectancy by 0.6 year. Therefore, addressing mortality rates, particularly for males below 75 and females above 75, may contribute to recovering the loss in life expectancy.

Limitations of the study

The study has three main limitations. Firstly, it lacks data on the migrant population, particularly the substantial Syrian migrant community in Türkiye, which has distinct age and sex distributions compared to the native population. This absence of information hampers our ability to offer a definitive assessment of mortality patterns in Türkiye. Secondly, the cause of death data provided only includes age and sex breakdowns. As a result, this study focuses on analyzing life expectancy and life disparity for the overall population without delving into mortality patterns among different socioeconomic groups, such as educational or occupational classes. Other studies have explored variations in life expectancy and life disparity across different socioeconomic groups [6,14,27,33] The last limitation is that probability of misclassification and underreporting of COVID-19 deaths. Some COVID-19 deaths may be attributed to other causes of death like cardiovascular diseases or infectious diseases. Furthermore, dying outside of the hospital may cause the underreporting of COVID-19 deaths.[34,35]

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