# Trend Analysis of Lung Cancer Mortality and Years of Life Lost (YLL) in South of Iran, 2004-2019

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**Abstract**

**Background:** We aimed to determine the mortality rate and Years of Life Lost (YLL) due to lung cancer in Fars, Iran, during the period from 2004 to 2019.

**Methods:** All deaths due to lung cancer in Fars Province, Iran from the electronic population-based death registration system (EDRS) were obtained. Crude mortality rate, age-standardized mortality rate, YLL and YLL rate data were calculated and trends examined.

**Results:** During 2004-2019, 3346 deaths occurred due to lung cancer in Fars Province, which was 10.8% (3346/30936) of the total cancer deaths in this period. Crude mortality rate of lung cancer had increased 70% and 53% in male and female respectively from 2004 to 2019. The total YLL of lung cancer during the 16-year study period was 28,094 (0.9 per 1000) in men, 14,174 (0.5 per 1000) in women, and 42,268 (0.8 per 1000) in both sexes (sex ratio male/female=2). According to the join point regression, the 16- year trend of YLL rate due to premature mortality was increasing: APC was 2.5% (95% CI 0.9 to 4.2, *P*=0.005) for males, 1.4% (95% CI 0.3 to 2.6, *P*=0.017) for females.

**Conclusion:** The mortality rate and YLL due to lung cancer in Fars Province is increasing, although the standardized mortality has a constant trend. Tobacco control is the most effective and least expensive way to reduce the number of lung cancer patients worldwide. National and local media can also play an important role in informing people about the risk factors.

*Keywords:* Lung cancer; Trend; Years of life lost; Iran

## Introduction

Globally, lung cancer is the most common cancer and the leading cause of cancer death in men.

Moreover, it is the third most common cancer after breast and colorectal cancer in women and the

second leading cause of cancer death in women after breast cancer (1). Over the past century, lung cancer, one of the rarest cancers, has become the deadliest cancer in men. In some parts of the world, such as North America, East Asia, and Northern Europe, it has become the deadliest cancer in women (2). According to the economic level of countries, there is no difference in cancer mortality in men. However, women's lung cancer mortality rate is higher in developed countries than in developing countries (3). Increased life expectancy, aging, middle-aged population growth, and socioeconomic conditions are among the complex reasons for the increasing incidence of cancer (4). The incidence and mortality rate of lung cancer have been declining worldwide in men and increased in women in recent decades. One of the reasons was the decrease in the prevalence of smoking in men (5). In 2018, 2.09 million new lung cancer cases occurred worldwide. About 20% of cancer deaths are from lung cancer (6).

Lung cancer is a public health problem worldwide, and information on the burden of lung cancer will be critical to developing new drugs and framing health policies in the future (7). According to available statistics, the incidence of lung cancer in Iranian men and women has been steadily increasing (8). Lung cancer has a high financial burden on the health system and society. In Iran, the cost of premature death from 10 common cancers is estimated at the US $ 1.93 billion, while the cost of death from lung cancer is 10% of the cost for men and 5% for women(9). The year of life lost (YLL) are an important criterion for ranking the health status of a community and observing their challenges. According to the WHO, the value of one year of life is three times higher than the per capita gross domestic product (GDP) of each country (10).

We aimed to determine the trend analysis of mortality rate and YLL due to lung cancer in Fars, a province south of Iran.

## Methods

This cross-sectional study obtained all deaths due to lung cancer in Fars Province, Iran from the electronic population-based death registration system (EDRS). Fars Province is located in the southwest of Iran with an area of 122400 square kilometers. The information extracted and used in this study included age at death, year of death, and gender. Causes of death were coded using the 10th edition of the International Classification of Diseases (ICD-10). The code used in this study was C34.

To assess the crude mortality rate due to lung cancer, we used the national census population from 1996 to 2016. We estimated the population based on annual growth for the rest of the years. To calculate the Age Standardized Mortality Rate (ASMR) of lung cancer, we used the 2013 standard population for low- and middle-income countries.

### *Statistical analysis*

We use a standard life table to calculate YLL and determine life expectancy and the number of deaths due to lung cancer for different age and sex groups. Based on the following relationship, the calculation was performed (11).

$$\text{YLL} = N\,Ce^{(ra)} / (\beta+r)^2\,[e^{-(\beta+r)\,(L+a)}\,[-(\beta+r)\,(L+a)-1] - e^{-(\beta+r)\,a}\,[-(\beta+r)\,a-1]]$$

N= the number of deaths is at a certain age and gender.

L= the standard of living of the deceased is the same age and gender.

r= Discounting Rate is equal to 0.03.

$\beta$ = the contract rate in calculating the age value is equal to 0.04.

C is a modified constant value equal to 0.1658 and $\beta$ is equal to 0.04 and these two numbers estimate the value of different ages (x).

a= the age at which death occurred

e is fixed and equivalent to 2.71.

To examine the trend of crude and standardized mortality and YLL rates for different years, join point regression based on the log-linear model was used. Join point regression analysis describes changing trends over successive segments of time and the number of increases or decreases within each part. The resulting line segment between join points is defined by the annual percent change (APC), based on the slope of the line segment and

the average annual percent change (AAPC). The analysis for the trend was carried out by Join point Regression Program 4.9.0.0.

The analysis of the number of YLL as a result of premature death due to lung cancer was performed using the YLL template of 2015, the WHO in Excel version spreader software version 2016.

The protocol of this study was reviewed and approved by the ethics committee of Shiraz University of Medical Sciences: IR.SUMS.REC.1399.772. All aspects of the study were conducted following the University Code of Ethics.

## Results

### *General lung cancer mortality rate and trend*
During 2004-2019, 3346 deaths occurred due to lung cancer in Fars Province, which was 10.8% (3346/30936) of the total cancer deaths in this period. Of these deaths, 69.2% (2316 cases) were

men, and 27.3% (913 cases) were in the age group of 70-79 yr. The crude mortality rate of lung cancer in men increased from 5.5 (per 100,000 population) in 2004 to 9.4 (per 100,000 population) in 2019, a 70% increase. (P for trend = 0.017, AAPC=4.2%). This crude mortality rate in women increased from 2.6 (per 100,000 population) in 2004 to 4.0 (per 100,000 population) in 2019, 53% increased. (P for trend <0.001, AAPC=3.1%). Moreover, the standardized mortality rate for men increased from 7.1 (per 100,000 population) in 2004 to 10.0 (per 100,000 population) in 2019. (P for trend = 0.449, AAPC = 2.5%). Moreover, the standardized mortality rate for women decreased from 4.0 (per 100,000 population) in 2004 to 3.7 (per 100,000 population) in 2019. (P for trend=0.613, AAPC=0.3%) (Table 1).

The highest number of deaths in both sexes was in the age group of 70-79 yr, the lowest number of deaths in men was in the age group of 5-14 yr, and in women was in the age group under five years (Fig. 1).
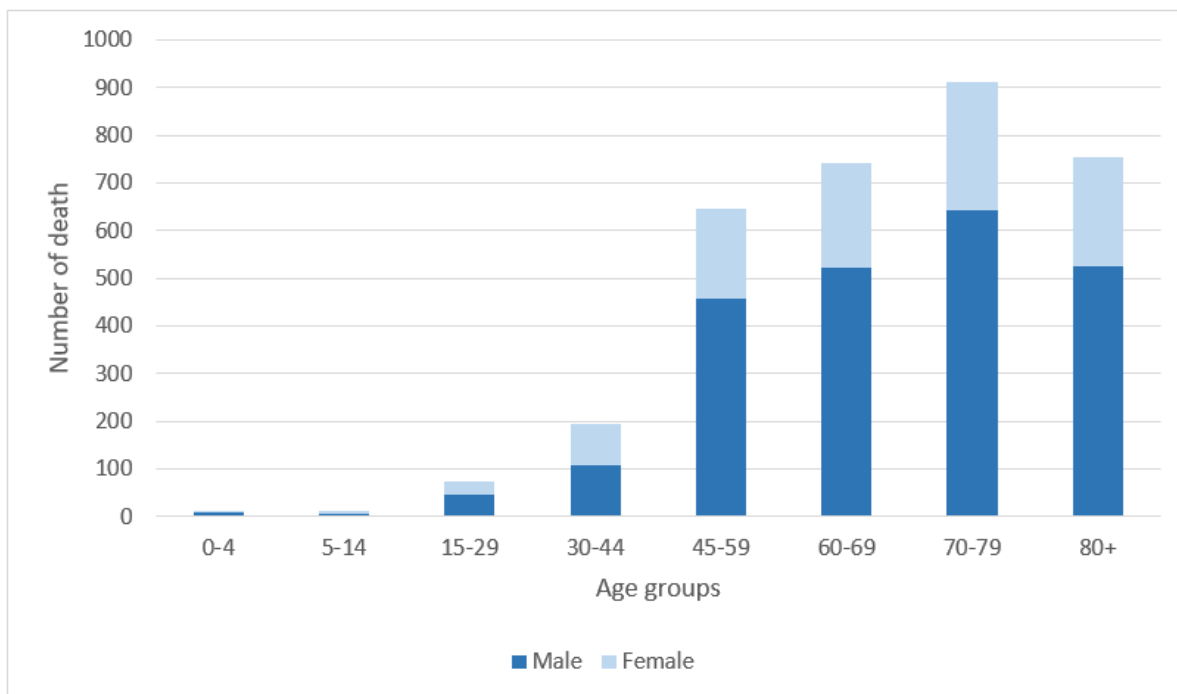


**Fig. 1:** Number of deaths from lung cancer by gender and age groups

**Table 1:** The crude and standardized mortality rate (per 100,000 population) and YLL due to Lung cancer by gender and year in Fars Province during 2004-2019.

| Year | No. Death | | Crude mortality rate | | Standardized mortality rate (95% CI) | | YLL | | | |
| | | | | | | | No. | | (per 1000) | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 102 | 47 | 5.5 | 2.6 | 7.1 (6.1-8.1) | 4.0 (3.2-4.8) | 1356 | 693 | 0.7 | 0.4 |
| 2005 | 101 | 43 | 5.5 | 2.4 | 6.9 (5.8-8.0) | 3.0 (2.3-3.7) | 1255 | 666 | 0.7 | 0.4 |
| 2006 | 143 | 60 | 7.7 | 3.3 | 10.1 (8.8-11.4) | 4.6 (3.8-5.4) | 1836 | 874 | 1.0 | 0.5 |
| 2007 | 146 | 59 | 7.8 | 3.2 | 9.5 (8.2-10.8) | 3.7 (2.9-4.5) | 1751 | 949 | 0.9 | 0.5 |
| 2008 | 130 | 52 | 6.9 | 2.8 | 7.8 (6.7-9.0) | 3.3 (2.6-4.0) | 1496 | 742 | 0.8 | 0.4 |
| 2009 | 115 | 52 | 6.0 | 2.8 | 6.4 (5.3-7.5) | 3.4 (2.6-4.2) | 1198 | 691 | 0.6 | 0.4 |
| 2010 | 137 | 55 | 7.1 | 2.9 | 7.7 (6.5-8.9) | 3.3 (2.5-4.1) | 1674 | 761 | 0.9 | 0.4 |
| 2011 | 141 | 53 | 7.3 | 2.8 | 8.2 (7.0-9.4) | 3.2 (2.5-3.9) | 1783 | 792 | 0.9 | 0.4 |
| 2012 | 122 | 79 | 6.2 | 4.1 | 6.4 (5.3-7.5) | 3.8 (2.9-4.7) | 1639 | 866 | 0.8 | 0.4 |
| 2013 | 138 | 71 | 6.9 | 3.6 | 7.3 (6.1-8.5) | 3.7 (2.9-4.5) | 1578 | 965 | 0.8 | 0.5 |
| 2014 | 148 | 68 | 7.3 | 3.4 | 7.4 (6.2-8.6) | 3.6 (2.8-4.4) | 1798 | 1021 | 0.9 | 0.5 |
| 2015 | 156 | 66 | 7.6 | 3.3 | 8.2 (7.0-9.4) | 3.4 (2.6-4.2) | 2000 | 929 | 1.0 | 0.5 |
| 2016 | 163 | 73 | 7.9 | 3.6 | 8.0 (6.8-9.2) | 3.5 (2.7-4.3) | 1904 | 988 | 0.9 | 0.5 |
| 2017 | 186 | 85 | 8.9 | 4.2 | 9.3 (8.0-10.6) | 4.1 (3.2-5.0) | 2135 | 1076 | 1.0 | 0.5 |
| 2018 | 190 | 86 | 9.1 | 4.2 | 9.7 (8.4-11.0) | 4.1 (3.2-5.0) | 2425 | 1087 | 1.2 | 0.5 |
| 2019 | 198 | 81 | 9.4 | 4.0 | 10.0 (8.7-11.3) | 3.7 (2.9-4.6) | 2266 | 1074 | 1.1 | 0.5 |
| Total | 2316 | 1030 | 7.4 | 3.3 | 8.2 (7.9-8.5) | 3.7 (3.5-3.9) | 28094 | 14174 | 0.9 | 0.5 |
| *P* value | - | - | 0.017 | <0.001 | 0.449 | 0.613 | - | - | 0.005 | 0.017 |

*Temporal trends of lung cancer mortality by age groups*

In the 0-44 age group, there were stable trends in men (AAPC= –3.3%, *P*=0.182) and women (AAPC=–0.6%, *P*=0.763).

In the 45-59 age group, there were stable trends in men (AAPC = 1.8%, *P*=0.230) and women (AAPC= 0.2%, *P*=0.905).

In the 60-74 age group, there were stable trends in men (AAPC = 1.3%, *P*=0.307) and women (AAPC= -0.1%, *P*=0.990).

In the +75 age group, there were stable trends in men (AAPC = -0.3%, *P*=0.733) and women (AAPC=2.1%, *P*=0.207).

*Temporal trends of lung cancer YLL rate*

The total YLL of lung cancer during the 16-year study period was 28,094 (0.9 per 1000) in men, 14,174 (0.5 per 1000) in women, and 42,268 (0.8 per 1000) in both sexes (sex ratio male/female=2) (Table 1). The average number of YLL to lung cancer was 12.1 yr for men, 13.8 yr for women, and 12.6 yr for both sexes.

The highest YLL in both sexes was in the age group of 45-59 yr and the lowest in men was in the age group of 5-14 yr and in women in the age group under 5 yr (Fig. 2).
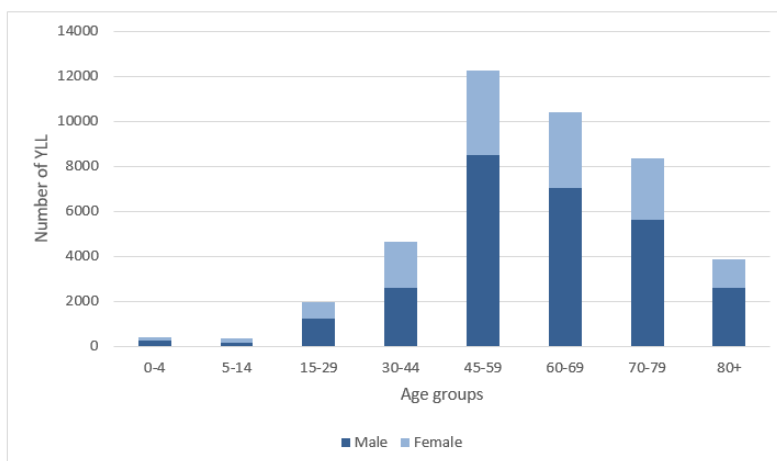
**Fig. 2:** Number of years of life Lost due to lung cancer by gender and age groups

According to the join point regression, the 16-year trend of YLL rate due to premature mortality was increasing: APC was 2.5% (95% CI 0.9 to 4.2, *P*=0.005) for males, 1.4% (95% CI 0.3 to 2.6,

*P*=0.017) for females, and 1.9% (95% CI 0.8 to3.1, *P*=0.003) for both sexes. The model did not show any join point, and hence, the AAPC is the same as APC (Figs. 3, 4).
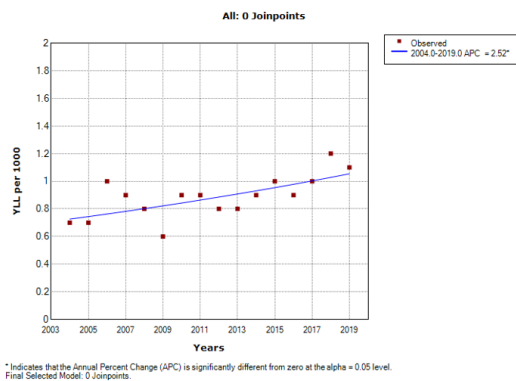


**Fig. 3:** The trend of years of life lost due to lung cancer in men during 2004-2019
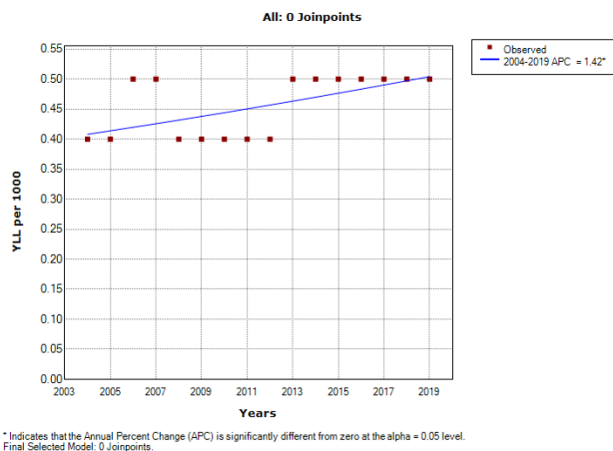


**Fig. 4:** The trend of years of life lost due to lung cancer in women during 2004-2019

# Discussion

The aim of this study was to investigate the mortality rate and YLL due to lung cancer in southern of Iran from 2004-2019. This is the first study that examines the mortality rate and YLL due to lung cancer in a 16-year period in Iran. The crude mortality rate of lung cancer in men and women increased significantly from 2004 to 2019. However, standardized mortality rates have increased in men and decreased in women over the same period. Moreover, the total YLL due to lung cancer was more in men.

From 1990 to 2010, the mortality rate of cancer in Iran increased by 8.5%. Moreover, neoplasms after cardiovascular and circulatory disorders had the highest YLL and the lowest YLD among non-communicable diseases (12). In China, in line with the present study, from 1999 to 2016, there were 93,358 deaths from lung cancer in Tianjin, accounting for 38% of all cancer deaths. Crude mortality rate due to lung cancer also increased by 58.5% from 1999 to 2016 (5). From 1973 to 2019, there were 42,229 deaths from lung cancer. The crude mortality rate and the standard age mortality rate were 2.43% and 27.79% of the population, respectively. YLL due to immature lung cancer deaths was 481,779.14 yr and YLL rate was 598 per 100,000 people. Crude mortality rate and YLL had a significant increase in men, women and the general population. The crude mortality rate in the total population increased by 2.86% per year during the study period (13).

In this study, AAPC was not significant in any of the age groups. APC was significant in men and women as well as in the general population, APC was 2.5% in men, 1.4% in women and 1.9% in the total population. Since no join point was observed, AAPC is similar to APC. In another study, the age-standard YLL rate in 2016 was 13.3% lower than in 1999 (AAPC = -0.8%, *P*<0.01) with a stable trend in men (AAPC = -0.2%) and a significant downward trend in women (AAPC = -1.4%) (3). In Poland, over a 16-year period, the standardized mortality rate of lung cancer in the study period decreased from 74.5 to 68.3 per 100,000 (AAPC=-0.6%). In men the standardized mortality rate decreased from 148.8 to 114.5 (AAPC= -1.7%), while in women it increased from 27.5 to 37.6 (AAPC=2.35) (14).

Differences in the mortality trend and the number of YLL due to lung cancer were also observed in men and women in Germany. In 1952-2021, the number of Years Potential Life Lost (YPLL) increased from 6.6 to 11.3, while in men it increased from 1978-1989.

Positive changes in mortality in men and negative changes in women may be attributed to the percentage of smokers. In Iran, 30.22% of men and 0.64% of women are smokers (15).

Where, from 1952 to 2012, the number of YPLL increased from 6.6 to 11.3 in women. In the case of men, this amount increased during the period 1978-1989 but gradually began to decrease. Finally, in the years 2006-2012, this amount was fixed, but gradually began to decrease, and in the period 2006-2012, this amount was fixed (16).

Therefore, global and national efforts must be made to reduce the burden of lung cancer. Global action should be taken in collaboration with the WHO, the International Association for the Study of Lung Cancer (IASLC) and the Union for International Cancer Control (UICC) (17). Global measures include promoting key policies to control smoking and air pollution, agreeing on essential cancer drugs based on universal health coverage (18, 19), fairer methods of pricing and reducing cancer drugs (19), and developing appropriate clinical practice guidelines. National level and international/regional research and training programs for healthcare professionals and the public. Improving and promoting equality in health by addressing inequalities in cancer care and cancer outcomes is essential to address inequalities. Factors that affect these inequalities include gender, race, and ethnicity, geographical and socio-economic factors (10) that should work to reduce health inequality.

Risk factors for lung cancer can also be corrected. These factors may significantly reduce the risk of this disease. One of the major risk factors for lung

cancer is smoking. Therefore, it is necessary to have the necessary training people are given cigarettes about its side effects. It also encouraged smokers to quit smoking and eventually screened for lung cancer if available to smokers.

A limitation of the present study was that YLL was not evaluated throughout the whole of Iran due to the unavailability of the necessary data. This study was of high quality and with a strong study design, large sample size, and extensive time-period of data analyzed.

## Conclusion

The mortality rate and YLL due to lung cancer in Fars Province is increasing, although the standardized mortality has a constant trend. Tobacco control is the most effective and least expensive way to reduce the number of lung cancer patients worldwide. National and local media can also play an important role in informing people about the risk factors and methods of prevention, symptoms, early diagnosis and timely treatment of lung cancer.

## Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

## Acknowledgements

## Conflict of interest

The authors declare that there is no conflict of interests.

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