



Mortality Rates and Years of Life Lost Due to Cancer in Iran: Analysis of Data from the National Death Registration System, 2016

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Abstract

Background: Cancer incidence is a major public health concern and one of the leading causes of premature death worldwide. Therefore, this study was conducted to determine the death rate and years of life lost (YLL) due to cancer in Iran.

Methods: In this study, death registration system (DRS) data in Iran was used. The Global Health Estimates (GHE-2016) cause categories and ICD-10 codes (C00-C97 and D00-D48) were assigned for deaths due to cancer. The crude, age-standardized mortality rates (ASMR) via world standard population was measured, and also YLL due to cancer were calculated using standard life expectancy.

Results: The DRS recorded 53,492 deaths due to cancer (58.82% males and 41.18% females). The cancer mortality rate was 66.92 per 100,000 population (77.7 and 55.87 per 100,000 population in men and women, respectively) and ASMR was 96.4 per 100,000 population (115.7 and 77 per 100,000 population for males and females, respectively). The total YLL due to premature death was 736,564 in males, 580,254 in females, and 1,316,818 in both sexes. Death due to stomach cancer, tracheal, bronchus, and lung, leukemia, brain, and nervous system cancer, and breast cancer comprised the largest YLL category among different cancer sites.

Conclusions: Accounting for more than 1,300,000 YLL attributed to cancer, it is a major public health problem in Iran. Therefore, promoting the prevention and control programs and policies are necessary to improve health indicators and since some cancers are preventable, the burden can be reduced by controlling tobacco use, dietary interventions, and promoting physical activity.

Keywords: Mortality Rate, Years of Life Lost, Cancer, Iran

1. Background

Cancer incidence is a major public health issue and one of the leading causes of premature death worldwide (1). In 2020, World Health Organization (WHO) estimates showed that cancer is the first or second leading cause of death at the age younger than 70 years in 112 out of 183 countries (2). In 2017, there were 24.5 million cancer cases and 9.6 million cancer-related deaths worldwide, also cancer caused 233.5 million disability-adjusted life years (DALY), of which 97% were years of life lost (YLL) and 3% were years of life lost due to disability (YLD) (3). Furthermore, the age-standardized mortality rate (ASMR) due to cancer decreased by 4.4% from 2007 to 2017, while YLL increased by 19.6% (4).

In Iran, cancer is the second group of non-communicable diseases and the third leading cause of death after heart disease and accidents (5). Based on

the data of the Global Cancer Observatory (GLOBOCAN) project, 131,191 newly diagnosed and 79,136 cancer-related deaths were reported in Iran in 2020 (6).

Global reports indicated that the number of new patients with diagnosed cancer will increase to 27.5 million and mortality to 16.3 million by 2040 (7). In 2017, the most common cancers in men were skin, trachea, bronchial, and lung (TBL) cancer and prostate cancer (54% of all cancers), and the most common cancers in women were non-melanoma skin cancer (NMSC), breast cancer, and colorectal cancer (54% of all cancers) (3).

The reasons for rising cancer incidence and mortality are complex but reflect population growth and aging, as well as changes in the prevalence and distribution of cancer risk factors such as unhealthy diet, smoking, and physical inactivity, several of which are related to social and economic development (4).

The number of deaths alone doesn't mirror the overall burden of cancer. The YLL depends on the age at death and the frequency of deaths at every age and may resolve a number of the inconsistencies in illness impact that result from the number of deaths alone (1). It can also reflect both the number of deaths and the loss of life, which could better indicate the burden of disease and may be more useful for allocating resources and designing prevention programs.

2. Objectives

No study in Iran has examined the death rate and years of life lost to cancer at the national level. Therefore, this study was conducted to determine the death rate and YLL due to cancer in Iran.

3. Methods

3.1. Data Source

In this cross-sectional study, the information on cancer-related deaths (53,521 deaths) in Iran was obtained from the death registration system (DRS), which is under the Ministry of Health and Education of Iran. In Iran, the DRS is the best source for calculating the cause of death. Mortality data are collected from various sources including civil registration, hospital records, cemeteries, and forensic data. They cover the entire country and also record all causes of death using the International Classification of Diseases, the 10th edition (ICD-10) coding system (8). The main variables recorded in the DRS are name, age, sex, nationality, province, month and year of death, and underlying cause of death (cancer).

In this study, we used the Global Health Estimates (GHE-2016) cause categories and ICD-10 codes (C00-C97 and D00-D48) for deaths due to cancer (9). Twenty-nine duplicate cases with the variables name, father's name, and cancer sites (based on ICD-10 codes) were excluded from the analysis. There were also 11 impossible age groups where these numbers were changed to missing and redistributed to different age categories proportional to their size.

3.2. Statistical Analysis

After cleaning the data, mortality rates were calculated for 53,492 deaths by age and sex groups, cancer sites, and regional centers. The population for each age and sex group was provided by the National Statistics Center of Iran and was based on the 2016 national censuses in Iran

(10). Then, the crude and age-standardized mortality rates (ASMR) were measured using the world standard population (11).

The years of life lost (YLL) was calculated as follows: $\sum N_x \times L_x$ (x is the age and sex category)

(1) The number of deaths (N): Data from DR were used to estimate cancer-related deaths by age and sex.

(2) Life expectancy (L): Standard life expectancy was used from the Global Burden of Disease 2016 (GBD-2016) studies for each age and age group. In addition, life expectancy is considered the same for men and women according to GBD (12). All analyzes were performed using Stata software (version 14).

4. Results

In 2016, the DRS recorded 53,492 deaths due to cancer (58.82% males and 41.18% females; sex ratio: 1.43 men/women). The mean age was 66.03 ± 17.49 years for males, 62.55 ± 18.19 years for females, and 64.59 ± 17.86 years for both sexes. The highest age group was 70 - 79 (24.65%) years old in males, 45 - 59 (23.15%) years old in females and 70 - 79 (23.11%) years old in both sexes (Figure 1). In total the most common cause of cancer death was stomach (14.14%) (in males: Stomach cancer (15.89%) and in females: Breast cancer (14.47%)) (Table 1). The most common causes of cancer deaths in different age groups were leukemia, brain and nervous system, stomach and prostate in males; leukemia, breast and stomach in females and both sexes (Table 2).

4.1. The Cancer Mortality Rate

The cancer mortality rate in Iran was 66.92 per 100,000 population (77.7 and 55.87 per 100,000 population in men and women, respectively) and the ASMR was 96.4 per 100,000 population (115.7 and 77 per 100,000 population in men and women, respectively). The highest mortality rates were for stomach, lung, trachea, and bronchus cancers, leukemia, cancer of the brain and nervous system, and breast cancer, and for persons aged ≥ 80 years (Table 3).

4.2. YLL Due to Cancer

The total number of years of life lost in 2016 was 736,564 (18.9 per 1,000 persons) for men, 580,254 (14.72 per 1,000 persons) for women, and 1,316,818 (16.5 per 1,000 persons) for both sexes. In all age groups, cancer had the highest

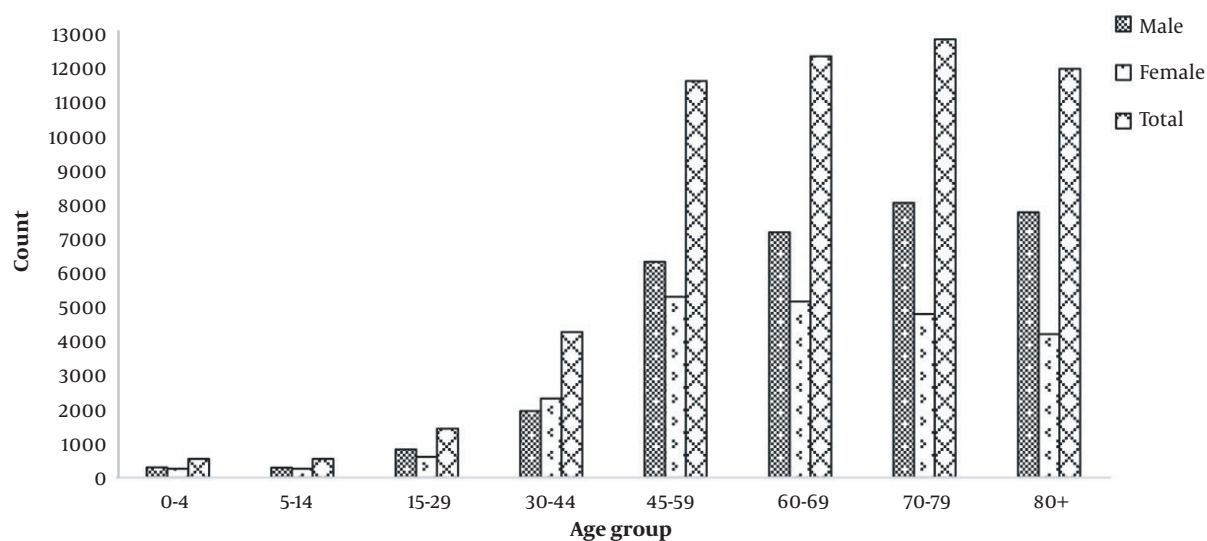


Figure 1. Frequency of death due to cancer according to the age groups by sex in Iran, 2016

number of YLLs and the highest YLL rate (per 1,000 persons) in persons aged 45 - 59 and 70 - 79 years, respectively (Table 3). Deaths due to stomach cancer (159,537 and 2 per 1,000), tracheal, bronchus, and lung cancer (126,514 and 1.58 per 1,000), leukemia (125,031 and 1.58 per 1,000), cancer of the brain and nervous system (106,880 and 1.34 per 1,000), and breast cancer (99,437 and 1.24 per 1,000) constituted the largest YLL category among the different cancer sites. In addition, among men: Stomach cancer (104,339 and 2.58 per 1,000), tracheal, bronchus and lung cancer (87,245 and 2.15 per 1,000), leukemia (74,150 and 1.83 per 1,000), cancer of the brain and nervous system (59,429 and 1.47 per 1,000), and colon and rectal cancer (50,844 and 1.26 per 1,000), and among women: Breast cancer (99,062 and 2.51 per 1,000), stomach cancer (55,198 and 1.4 per 1,000), leukemia (50,882 and 1.29 per 1,000), brain and nervous system cancer (47,451 and 1.2 per 1,000), and tracheal, bronchus, and lung cancer (39,268 and 1 per 1,000) had the largest YLL (Table 4).

5. Discussion

In this study, the number of deaths due to cancer was 53,492, of which 55.52% were male and 41.18% were female. The age-standardized mortality rate was 96.4/100,000 population and 115.7 and 77/100,000 population for males and females, respectively.

In 2018, the number of deaths due to cancer in Europe was 1.93 million, of which 1.08 million were men and 850,000 were women (13). In 2016, there were 8.9 million cancer-related deaths worldwide, of which 5.172 million were men and 3.375 million were women (3). In 2014, about 2,296,000 deaths from cancer were reported in China, of which 1,452,000 were in men and 844,000 in women, and the ASMR by world standard population was 106.09 per 100,000 population (14). In 2012, the total number of cancer deaths in Iran was 53,350, of which 56.44% were men and 43.55% were women. The crude and standardized mortality rates were 70.6 and 81.9 per 100,000 population, respectively (15).

Studies have shown that the mortality rate was lower in females than males. Women are more receptive than men to health care, so they are more likely to go for screening, diagnosis, and treatment at the first symptoms of disease, so they are more likely than men to be diagnosed and treated at the early stages of the disease. This could also be due to the fact that the proportion of unhealthy lifestyles is higher in men than in women, such as smoking, alcohol consumption, and an unhealthy dietary pattern (15, 16).

Most of the age groups were 70 - 79 (24.65%) years in males, 45 - 59 (23.15%) years in females, and 70 - 79 (23.11%) years in both sexes, and the mortality rate was mainly concentrated in the middle-aged and older population. The most common cause of cancer death in males in the age group 0-29 years was leukemia, 30 - 44 years was the brain

Table 1. Frequency of Death Due to Cancer According to the Cancer Sites by Sex in Iran, 2016^a

Rank	Cancer Sites (ICD-10)	Total	Male	Female
1	Stomach (C16)	7,566 (14.14)	5,001 (15.89)	2,565 (11.64)
2	Tracheal, bronchus and lung (C33-C34)	5,685 (10.63)	3,930 (12.49)	1,755 (7.97)
3	Colon and rectal (C18-C21)	3,843 (7.18)	2,194 (6.97)	1,649 (7.49)
4	Leukemia (C91-C95)	3,749 (7.01)	2,298 (7.3)	1,451 (6.59)
5	Liver, gallbladder and biliary tract (C22-C24)	3,559 (6.65)	1,983 (6.3)	1,576 (7.15)
6	Brain and nervous system (C70-C72)	3,302 (6.17)	1,838 (5.84)	1,464 (6.65)
7	Breast (C50)	3,205 (5.99)	18 (0.06)	3,187 (14.47)
8	Other neoplasms (D00-D48)	3,049 (5.07)	1,730 (5.5)	1,319 (5.99)
9	Prostate (C61)	2,912 (5.44)	2,912 (9.26)	0 (0)
10	Other malignant neoplasms (C46-C49, C69, C76-C80, C97)	2,372 (4.43)	1,439 (4.57)	933 (4.24)
11	Pancreas (C25)	2,029 (3.79)	1,278 (4.06)	751 (3.41)
12	Esophageal (C15)	1,833 (3.43)	1,081 (3.44)	752 (3.41)
13	Bladder (C67)	1,159 (2.17)	922 (2.93)	237 (1.08)
14	Larynx (C32)	1,027 (1.92)	806 (2.56)	221 (1)
15	Non-Hodgkin lymphoma (C82-C86, C96)	859 (1.61)	537 (1.71)	322 (1.46)
16	Other digestive organs (C26)	855 (1.6)	491 (1.56)	364 (1.65)
17	Ovary (C56)	721 (1.35)	0 (0)	721 (3.27)
18	Multiple myeloma (C88, C90)	655 (1.22)	386 (1.23)	269 (1.22)
19	Other respiratory organs (C30-31, C37-39)	642 (1.2)	378 (1.2)	264 (1.2)
20	Kidney, renal pelvis, ureter, and other (C64-C68)	611 (1.14)	391 (1.24)	220 (1)
21	Bones, joints and articular cartilage (C40-C41)	606 (1.13)	348 (1.11)	258 (1.17)
22	Corpus uteri (C54-C55)	561 (1.05)	0 (0)	561 (2.55)
23	Small intestine (C17)	523 (0.98)	308 (0.98)	215 (0.98)
24	Malignant skin melanoma and non-melanoma skin (C43-C44)	507 (0.95)	326 (1.04)	181 (0.82)
25	Mouth and oropharynx (C00-C14)	462 (0.86)	248 (0.79)	214 (0.97)
26	Hodgkin lymphoma (C81)	420 (0.79)	287 (0.91)	133 (0.6)
27	Thyroid (C73)	267 (0.5)	111 (0.35)	156 (0.71)
28	Cervix uteri (C53)	199 (0.37)	0 (0)	199 (0.9)
29	Adrenal gland (C74)	100 (0.19)	61 (0.19)	39 (0.18)
30	Other endocrine glands (C75)	94 (0.18)	58 (0.18)	36 (0.16)
31	Testicular (C62)	85 (0.16)	85 (0.27)	0 (0)
32	Other male genital organs (C60-C63)	19 (0.04)	19 (0.06)	0 (0)
33	Other female genital organs (C51-52, C56-58)	16 (0.03)	0 (0)	16 (0.07)
-	Total	53,492 (100)	31,463 (100)	22,029 (100)

^a Values are expressed as No. (%).

and nervous system, 45 - 79 years was stomach and 80 years and older was prostate, in females 0 - 29 years was leukemia, 69 - 69 years was breast and 70 years and older was stomach cancer.

In the study by Mattiuzzi and Lippi, the most common malignancies at the age of 14 years or younger were leukemia (37%), followed by cancers of the brain and nervous system (16%) and lymphoma (13%), at the age of 15 - 49 years were breast cancer (13%), followed by liver (12%) and lung cancer (9%), aged 50 - 59 years were lung cancer (18%), followed by liver (11%) and breast cancer (9%), while the most common malignancies among individuals aged

60 years or older were lung (21%), colorectal (9%), stomach (9%) and liver cancer (9%) (17).

Our study found that the top 5 cancers with the highest mortality in the general population in 2016 were stomach, lung, colorectal, leukemia, and liver. The top 5 cancers in men were stomach, lung, prostate, leukemia, and colorectal.

and in women were breast, stomach, lung, colorectal, and liver. The total number of years of life lost to premature death in 2016 was 736,564 (18.9 per 1,000 persons) for men, 580,254 for women (14.72 per 1,000 persons), and 1,316,818 (16.5 per 1,000 persons) for both sexes. Deaths

Table 2. The Most Common Cancer Sites According to the Age Groups by Sex in Iran, 2016

Sex/Age Groups	Cancer Sites (ICD-10)	No. (%)	Mortality Rate ^a
Total			
0 - 4	Leukemia	150 (28.46)	2.11
5 - 14	Leukemia	168 (32.12)	1.38
15 - 29	Leukemia	355 (25.78)	1.77
30 - 44	Breast	620 (15.11)	2.93
45 - 59	Stomach	1,406 (12.57)	11.61
60 - 69	Stomach	1,756 (14.78)	41.27
70 - 79	Stomach	2,057 (16.64)	99.66
+80	Stomach	1,885 (16.35)	171.98
Male			
0 - 4	Leukemia	76 (27.05)	2.08
5 - 14	Leukemia	86 (31.16)	1.38
15 - 29	Leukemia	228 (28.82)	2.24
30 - 44	Brain and nervous system	271 (14.44)	2.52
45 - 59	Stomach	969 (15.92)	15.88
60 - 69	Stomach	1,149 (16.61)	55.73
70 - 79	Stomach	1,416 (18.27)	138.47
+80	Prostate	1,452 (19.41)	252.82
Female			
0 - 4	Leukemia	74 (30.08)	2.14
5 - 14	Leukemia	82 (33.2)	1.38
15 - 29	Leukemia	127 (21.67)	1.28
30 - 44	Breast	619 (27.8)	5.93
45 - 59	Breast	1,247 (24.45)	20.74
60 - 69	Breast	642 (12.94)	29.28
70 - 79	Stomach	641 (13.9)	61.54
+80	Stomach	664 (16.4)	127.26

^a Per 100,000 population

from stomach cancer (159,537 and 2 per 1,000), tracheal, bronchial, and lung cancer (126,514 and 1.58 per 1,000), leukemia (125,031 and 1.58 per 1,000), cancers of the brain and nervous system (106,880 and 1.34 per 1,000), and breast cancer (99,437 and 1.24 per 1,000) make up YLL largest category among various cancers.

In 2017, lung, liver, and stomach cancers in China had the largest ASMR in both urban and rural areas, and the YLL in urban and rural areas for men and women were 13.27 and 8.41 million and 11.39 and 6.77 million, respectively (16). The leading causes of cancer deaths worldwide in 2016

were lung, stomach, colorectal, liver, and breast cancers, causing 213.2 million DALYs, of which 98% were YLLs and 2% were YLDs. In 2016, the leading causes of DALYs due to cancer were tracheal, bronchus, lung, liver, and stomach cancers. A total of 1.7 million TBL deaths causing 36.4 million DALYs, 829,000 liver cancer deaths causing 21.1 million DALYs, and 834,000 stomach cancer deaths worldwide causing 18.3 million DALYs. More than 98% of these cancers were associated with YLLs and less than 2% with YLDs, suggesting that these cancers cause far more premature deaths than disability (3).

The most common cause of death due to cancer in Europe in 2018 was lung cancer with 388,000 deaths, followed by colorectal cancer (12.6%), female breast cancer (7.1%), and pancreatic cancer (6.6%). Lung cancer remained the most common cause of cancer death in men, followed by colon and prostate cancer. In women, breast cancer was the leading cause of death, followed by lung and colon cancer (13). In Korea, the most common causes of cancer death were lung, followed by liver, colon, rectum, stomach, and pancreas. The most common causes of cancer mortality in men were lung, liver, colorectal, stomach, and pancreas cancer, and in women were lung, colorectal, pancreas, liver, and breast cancer (18).

In our study, stomach cancer was the most common cause of cancer death, the first in men and the second in women. According to the data of GLOBOCAN 2018, stomach cancer is the third leading cause of cancer death (19). The mortality rate of gastric cancer is high in East and Central Asia and Latin America. Afghanistan, Oman, Sudan, and Yemen have the highest rates of deaths from stomach cancer despite declining mortality from 1990 to 2017 (20, 21).

Helicobacter pylori is the most important risk factor for gastric cancer, about 75% of all stomach cancers are due to *H. pylori* infection. Diet and lifestyle (smoking, coffee, and alcohol) are responsible for 33 to 50% of stomach cancers. The rate of stomach cancers was significantly lower in women than in men. Possible explanations for this could be that differences in diet, the protective effect of estrogen in women, and occupational exposure in men (21, 22). The prevalence of *H. pylori* in the Iranian population was estimated to be 54% (23). In the Iranian adult population, the current prevalence of tobacco smoking was 25.2% in men and 4.0% in women in 2016 (24). The findings of a study by Shakeri et al. showed that opium consumption is associated with stomach cancer, and opium is widely used in Iran (25). Studies have shown that people living in the north and northwest of Iran have a higher risk of stomach can-

Table 3. The Mortality Rate Per 100,000 Population, Years of Life Lost (YLL) Count and Rate Per 1,000 Persons by Sex, Iran, 2016

Age Groups	Mortality Rate (Per 100,000 Pop)			YLLs (y)			YLL Rate (Per 1,000 Persons)		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
0 - 4	7.42	7.69	7.14	44,902	23,942	20,960	6.3	6.53	6.09
5 - 14	4.32	4.45	4.18	40,161	21,199	18,962	3.3	3.42	3.21
15 - 29	6.86	7.78	5.92	86,836	49,975	36,861	4.3	4.92	3.73
30 - 44	19.39	17.49	21.35	200,293	91,932	108,361	9.5	8.57	10.39
45 - 59	92.38	99.78	84.86	381,745	206,706	175,038	31.5	33.89	29.13
60 - 69	279.28	336.61	226.32	281,549	163,688	117,861	66.2	79.4	53.76
70 - 79	599.02	758.11	442.82	188,663	118,105	70,558	91.4	115.5	67.75
+80	1051.88	1302.45	776.06	92,669	61,016	31,653	84.5	106.24	60.67
Total	66.92	77.7	55.87	1,316,818	736,564	580,254	16.5	18.19	14.72
ASMR	96.4	115.7	77	-	-	-	-	-	-

^a Abbreviation: ASMR, age-standardized mortality rate.

cer than in other areas (26).

Tracheal, bronchial, and lung cancers are the most common causes of cancer-related death worldwide (27), which were the second most common in this study. The causes of the increasing incidence and mortality of lung cancer are complex but are related to increasing age and population growth, and changes in the prevalence and distribution of major risk factors, together with industrialization, urbanization, and global pollution (28). Smoking is the single largest risk factor for lung cancer, accounting for more than 90% of lung cancer cases. According to the report by WHO, about 80% of worldwide smokers live in low- and middle-income countries (28, 29).

Consistent with the world, colorectal cancer (CRC) in this study as well as the third leading cause of cancer-related death (30). Colorectal cancer is the deadliest cancer in men in three countries, Saudi Arabia, Oman, and the United Arab Emirates, and the deadliest cancer in women in five countries: Algeria, Belarus, Japan, Spain, and Portugal (31).

For females, breast cancer is the leading cause of cancer death in this study and worldwide. In 2016, breast cancer caused 15.1 million DALYs, which was 95% of YLLs and 5% of YLDs (32). In 2014, a study in China, India, and Russia found that breast cancer was the second leading cause of death among females after lung cancer (33). In the Eastern Mediterranean Region (EMR), including Iran, breast cancer has the highest incidence and mortality rate among females compared to other cancers (32, 34). Breast cancer risk factors include reproductive, hormonal, and lifestyle risk factors (2, 32, 34).

Limitations of the present study included the lack of further variables and the lack of study of the geographical distribution of cancers and the strength of this study was that we conducted a comprehensive nationwide analysis of mortality and YLL rates for all sites of cancer.

5.1. Conclusions

With more than 1,300,000 YLL attributable to cancer, cancer is one of the most important non-communicable diseases and the leading cause of death in Iran. In addition, the top 5 cancers with the highest mortality in the general population were stomach, lung, colorectal, leukemia, and liver.

Therefore, promoting the prevention and control programs and policies are necessary to improve health indicators and also, to reduce the death and burden of cancers. Since some cancers are preventable, the burden can be reduced through tobacco control, a healthy lifestyle, dietary measures, promotion of physical activity, control of indoor and outdoor air pollution, and expansion of access to the screening program.

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Footnotes

Authors' Contribution: N. I: Contribution to study concept and design, acquisition, analysis and interpretation

Table 4. The Years of Life Lost (YLL) Count, Rate Per 1,000 Persons and Percentage YLL to Total YLL by Cancer Sites and Sex, Iran, 2016

Rank	Cancer Sites (ICD-10)	YLLs (y)			YLLs (%)			YLL Rate (Per 1,000 Persons)		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Stomach (C16)	159,537	104,339	55,198	12.11	14.16	9.51	2	2.58	1.4
2	Tracheal, bronchus and lung (C33-C34)	126,514	87,245	39,268	9.61	11.84	6.77	1.58	2.15	1
3	Leukemia (C91-C95)	125,031	74,150	50,882	9.49	10.07	8.77	1.56	1.83	1.29
4	Brain and nervous system (C70-C72)	106,880	59,429	47,451	8.12	8.07	8.18	1.34	1.47	1.2
5	Breast (C50)	99,437	374	99,062	7.55	0.05	17.07	1.24	0.01	2.51
6	Colon and rectal (C18-C21)	89,924	50,844	39,080	6.83	6.90	6.74	1.13	1.26	0.99
7	Other neoplasms (D00-D48)	82,103	45,431	36,672	6.23	6.17	6.32	1.03	1.12	0.93
8	Liver, gallbladder and biliary tract (C22-C24)	78,836	43,846	34,990	5.99	5.95	6.03	0.99	1.08	0.89
9	Other malignant neoplasms (C46-C49, C69, C76-C80, C97)	61,970	36,559	25,410	4.71	4.96	4.38	0.78	0.9	0.64
10	Pancreas (C25)	44,263	28,201	16,062	3.36	3.83	2.77	0.55	0.7	0.41
11	Prostate (C61)	39,867	39,867	0	3.03	5.41	0.00	0.98	0.98	0
12	Esophageal (C15)	36,721	21,485	15,236	2.79	2.92	2.63	0.46	0.53	0.39
13	Non-Hodgkin lymphoma (C82-C86, C96)	27,495	17,339	10,156	2.09	2.35	1.75	0.34	0.43	0.26
14	Larynx (C32)	22,679	17,939	4,740	1.72	2.44	0.82	0.28	0.44	0.12
15	Bones, joints and articular cartilage (C40-C41)	21,563	12,404	9,159	1.64	1.68	1.58	0.27	0.31	0.23
16	Bladder (C67)	20,726	16,771	3,955	1.57	2.28	0.68	0.26	0.41	0.1
17	Ovary (C56)	20,122	0	20,122	1.53	0.00	3.47	0.51	0	0.51
18	Other digestive organs (C26)	18,598	10,696	7,902	1.41	1.45	1.36	0.23	0.26	0.2
19	Other respiratory organs (C30-31, C37-39)	18,140	10,895	7,245	1.38	1.48	1.25	0.23	0.27	0.18
20	Multiple myeloma (C88, C90)	15,773	9,180	6,592	1.20	1.25	1.14	0.2	0.23	0.17
21	Kidney, renal pelvis, ureter and other (C64-C68)	14,838	9,280	5,558	1.13	1.26	0.96	0.19	0.23	0.14
22	Hodgkin lymphoma (C81)	14,744	9,880	4,864	1.12	1.34	0.84	0.18	0.24	0.12
23	Corpus uteri (C54-C55)	14,422	0	14,422	1.10	0.00	2.49	0.37	0	0.37
24	Small intestine (C17)	12,091	7,418	4,673	0.92	1.01	0.81	0.15	0.18	0.12
25	Mouth and oropharynx (C00-C14)	11,012	6,124	4,888	0.84	0.83	0.84	0.14	0.15	0.12
26	Malignant skin melanoma and non-melanoma skin (C43-C44)	10,606	6,424	4,181	0.81	0.87	0.72	0.13	0.16	0.11
27	Thyroid (C73)	6,192	2,622	3,569	0.47	0.36	0.62	0.08	0.06	0.09
28	Cervix uteri (C53)	5,452	0	5,452	0.41	0.00	0.94	0.14	0	0.14
29	Adrenal gland (C74)	4,561	2,601	1,960	0.35	0.35	0.34	0.06	0.06	0.05
30	Testicular (C62)	3,592	3,592	0	0.27	0.49	0.00	0.09	0.09	0
31	Other endocrine glands (C75)	2,387	1,407	980	0.18	0.19	0.17	0.03	0.03	0.02
32	Other female genital organs (C51-52, C56-58)	519	0	519	0.04	0.00	0.09	0.01	0	0.01
33	Other male genital organs (C60-C63)	280	280	0	0.02	0.04	0.00	0.01	0.01	0

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Ethical Approval: All procedures performed in the study were in accordance with the ethical standards of the Cancer Research Center, Shahid Beheshti University of Medical Sciences committee, approval ID = IR.SBMU.CRC.REC.1399.038 (Webpage of ethical approval code: ethics.research.ac.ir/EthicsProposalView.php?id=188031), and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards

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