



Trend of the Incidence Rate of Kidney and Ureter Cancer in Iran from 2004 to 2016

Saeed Erfanpoor¹, Paria Dehesh², Jalil Hasani³, Fereshteh Davoodi⁴, Mohammad Esmaeil Akbari⁵, Mohammad Hadizadeh⁶ and Koorosh Etemad^{7,*}

¹Department of Epidemiology, Faculty of Health, Gonabad University of Medical Sciences, Gonabad, Iran

²Department of Epidemiology, Iran University of Medical Sciences, Tehran, Iran

³Instructor, Msc of Epidemiology, Kashmar School of Nursing, Mashhad University of Medical Sciences, Mashhad, Iran

⁴MSc in Epidemiology, Department of Epidemiology, Faculty of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran

⁵Professor of Surgical Oncology, Cancer Research Center, Department of General Surgery, Shohada-e-Tajrish Hospital, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran

⁶Cancer Research Centre (CRC), Shahid Beheshti University of Medical Sciences, Tehran, Iran

⁷Associate Professor of Epidemiology, Department of Epidemiology, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran

*Corresponding author: Associate Professor of Epidemiology, Department of Epidemiology, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Email: etemadk@gmail.com

Received 2023 August 27; Revised 2023 October 23; Accepted 2023 November 18.

Abstract

Background: Kidney and ureter cancers are two of the most prevalent urological cancers among Iranians. However, studies on the epidemiology and incidence of these cancers are primarily regional and focus on a specific period.

Objectives: The present study investigated the trend of the incidence rate of kidney and ureter cancer in Iran from 2004 to 2016.

Methods: In this study, information on kidney and ureter cancer cases in Iran from 2004 to 2016 was extracted from the Iranian National Cancer Registry (INCR). Crude and age-specific incidence rates (ASIR) were calculated, and the age-standardized rate (ASR) was measured, using the World Health Organization (WHO) standard population. The Joinpoint software program 4.9.0.1 was used to calculate the annual percent changes (APC) in the trend of the incidence rate of kidney and ureter cancers by age group, regional centers, and tumor grades across a 13-year period.

Results: During the study period, 19 659 incidences of ureter and kidney cancer occurred in Iran. The crude and ASR of kidney cancer increased from 0.98 and 1.33 per 100 000 population in 2004 to 3.1 and 3.5 per 100 000 population in 2016, respectively. In addition, the crude and ASR of ureter cancer increased from 0.04 and 0.05 per 100 000 population in 2004 to 0.9 and 1.1 per 100 000 population in 2016, respectively. The national ASR of kidney cancer APC was 22.2% ($P > 0.05$) from 2004 to 2006 and 4.8% ($P < 0.05$) from 2006 to 2016, respectively. The national ASR of ureter cancer APC was 290.8% ($P < 0.05$) from 2004 to 2006 and 7.5% ($P < 0.05$) from 2006 to 2016.

Conclusions: According to the results of this study, the incidence rate of kidney and ureter cancer increased over 13 years in Iran. Hence, the implementation of epidemiological studies in various regions and provinces is crucial for gaining a comprehensive and precise understanding of the underlying causes of kidney and ureter cancer incidence.

Keywords: Incidence, Iran, Kidney Cancer, Ureter Cancer

1. Background

Cancer is the second most common cause of mortality worldwide, accounting for approximately 10 million deaths in 2020 (1). Meanwhile, kidney cancer is the 14th most prevalent cancer globally, with over 431 000 newly diagnosed cases and 179 000 deaths in 2020, accounting for 2.4% of all cancers. The age-standardized incidence and mortality rates of kidney cancer worldwide are 4.6 and 1.8 per 100 000, respectively (2). The incidence of kidney and

ureter cancers differs across the world (3-5). Developed countries have a higher incidence of kidney cancer than less developed countries (6), with the highest incidence rate in North American countries (age-standardized incidence rate: 12.2 per 100 000), Northern Europe, Australia, and New Zealand (10.3 per 100 000), and lowest in Central Africa (1.0 per 100 000) and Southern Central Asia (1.4 per 100 000) (7). Although the incidence of kidney and ureter cancer is on the rise, especially in developed

countries (5), the relative survival rate of kidney cancer has remarkably increased in the past 3 decades (8, 9). Half of the cases of kidney cancer worldwide are diagnosed before the age of 65 years. The incidence of kidney cancer continuously increases with age, peaking at 75 years (10, 11). Several lifestyle-related risk factors, such as obesity, smoking, low consumption of fruits and vegetables, and sedentary lifestyle, increase the risk of kidney cancer (10-12).

Although few epidemiological studies have been conducted on kidney cancer in Iran, it is one of the most prevalent urological cancers with a rising trend among Iranian men and women (13-15). Kidney cancer is the 17th most prevalent cancer in Iran, accounting for 1.2% of all cancers and 1% of cancer-related deaths (16). The age-standardized incidence rate in Iran has been estimated at 1.94 and 1.36 in men and women, respectively (14). Kidney cancer is one of the 10 cancers with a high incidence rate among the southern Iranian population (17). Studies in Isfahan (Iran) reported the prevalence of kidney and ureteral cancers to be 8.1 and 0.4 per 100 00, respectively (18), and showed that urinary and kidney cancers had a rising trend of incidence, mortality, and prevalence in this region (19). In a study conducted in northern Iran, the standardized incidence of kidney and ureter cancer among women was 0.14 and 0.39, respectively (20). According to a meta-analysis, kidney cancer incidence in Iranians is comparatively lower than in several other Asian nations, including South Korea, Turkey, and Mongolia. However, it is higher compared to countries such as Indonesia, Turkmenistan, and Kyrgyzstan (14).

Assessing and monitoring the incidence of cancers within a population is crucial to effectively track the burden of this disease and plan resources accordingly. By observing shifts in cancer rates over time, we can gain valuable insights into its historical progression, identify potential social and environmental risk factors contributing to its development, and evaluate the effectiveness of interventions and policies to reduce its impact (21). Studies examining the epidemiology and incidence of kidney and ureter cancers in Iran are mainly regional and focus on specific periods. Besides, few Iranian studies have reported the incidence and trend of variations in these cancers. With regard to these gaps in the literature, this study was conducted to investigate the trend of the incidence rate of kidney and ureter cancer in Iran from 2004 to 2016.

2. Objectives

In the present study, we aimed at investigating the trend of the incidence rate of kidney and ureter cancer in Iran from 2004 to 2016.

3. Methods

In this study, information on kidney and ureter cancer incidence (19 659 patients), which included variables such as name, age, grading, year of diagnosis, and province, was extracted from the Iran National Cancer Registry System (INCRS); the data cover a period of 13 years (2004 - 2016). The International Classification of Diseases for Oncology-Third Edition (ICD-O 3rd) codes C64.9 and C65.9 were assigned for kidney cancer and C66.9 for ureter cancer. Tumor grade was categorized into I (well-differentiated), II (moderately-differentiated), III (poorly-differentiated), IV (un-differentiated), and unknown. Based on neighborhood and socio-demographic status, the provinces of Iran were categorized into 12 regions, including Tehran (Tehran, Ghazvin, and Alborz), Mashhad (North Khorasan, Razavi Khorasan, and South Khorasan), Kermanshah (Kermanshah, Kurdistan, and Ilam), Hamadan (Hamadan and Lorestan), Ahvaz (Khuzestan), Kerman (Kerman and Sistan & Baluchestan), Rasht (Gilan), Sari (Mazandaran, Golestan, and Semnan), Isfahan (Isfahan, Yazd, Chaharmahal & Bakhtiari), Tabriz (East Azerbaijan, West Azerbaijan, Ardabil, and Zanjan), Qom (Qom and Markazi), and Shiraz (Fars, Bushehr, Hormozgan and Kohgiluyeh & Boyer-Ahmad). After cleaning the data, kidney cancer and ureter cancer incidence rates were calculated for each year according to age groups, tumor grades, and regional centers.

3.1. Data Source and Preparation

All kidney and ureter cancer cases were pathologically confirmed and registered in the NCR database (the data were collected from pathology centers, hospitals, and death registries).

This study used NCR data to investigate the trend of the incidence rate of kidney and ureter cancer in Iran from 2004 to 2016. The Iranian NCR, which is overseen by the Ministry of Health, is responsible for collecting data from all provinces in the country.

Due to the high volume of cancer cases reported by these centers, there is a significant risk of errors during data entry. As a result, all data undergo thorough checking, correcting, and cleaning procedures. These procedures typically span 5 to 6 years before the data are deemed fit for publication. In this study, the dataset was subjected

to additional quality control measures in addition to the standard checking procedures performed by the NCR. Before analysis, thorough checks were conducted to identify any duplicate cases or errors within the dataset.

3.2. Statistical Analysis

To calculate the incidence rate, the mid-year populations for each age group of the Iranian population in different years from 2004 to 2016 were provided by the Iran National Statistics Center. The population count for different years was estimated based on the 2006 and 2011 national censuses. After factoring in the average annual growth rate of the country and provinces, census data were used to estimate the population for other years as follows: 2006 (2004 - 2010) and 2011 (2012 - 2016).

The crude and age-specific incidence rates (ASIR) were calculated and, then, the age-standardized rate (ASR) was measured by the World Health Organization (WHO) standard population. Age groups were < 20, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, 70 to 79, and \geq 80 years. The Joinpoint Regression based on the Log-linear Model examined the trend for different years, and Annual Percent Change described the results (APC). The analysis for the trend was performed by the Joinpoint Regression Program 4.9.0.1.

4. Results

This cross-sectional study was conducted on 19 474 patients with kidney cancer, and 625 patients with ureter cancer were diagnosed between 2004 and 2016. This study shows that both cancers have the highest number of cases in the 60 to 69 age group. Most cases of both cancers were registered in 2016, with 2 443 cases of kidney cancer and 70 cases of ureter cancer (Table 1).

The crude and ASR of kidney cancer increased from 0.98 and 1.33 per 100 000 population in 2004 to 3.1 and 3.5 per 100 000 population in 2016, respectively (Table 2). The national ASR of kidney cancer APC was 22.26% ($P > 0.05$, Figure 1) from 2004 to 2006 and 4.83% ($P < 0.05$, Figure 1) from 2006 to 2016. The highest ASR of kidney cancer was observed in the age group of 70 to 79 years. The ASR in this age group increased from 2.78 per 100 000 in 2004 to 18.2 per 100 000 in 2016 (APC 2004 - 2006, 65.34%, $P < 0.05$; and APC 2006 - 2016, 6.11%, $P < 0.05$; Figure 1).

In general, the ASR of kidney cancer has been increasing over 13 years (Appendix 1). Among the different regional centers of Iran, the highest incidence rate of kidney cancer was observed in Hamedan, northwest Iran. The incidence rate in Hamedan increased from 0.7 per 100 000 in 2004 to 21.5 per 100 000 in 2016 (APC 2004 - 2007,

216.60%, $P < 0.05$; and APC 2007 - 2016, 2.58%, $P > 0.05$; Figure 2).

The crude and ASR of ureter cancer increased from 0.04 and 0.05 per 100 000 population in 2004 to 0.9 and 1.1 per 100 000 population in 2016, respectively (Table 3). The national ASR of ureter cancer APC was 290.85% ($P < 0.05$, Figure 3) from 2004 to 2006 and 7.55% ($P < 0.05$, Figure 3) from 2006 to 2016. The highest incidence of ureter cancer in 2016 belongs to the age group of 70 to 79. The incidence rate of ureter cancer in the age group of 70 to 79 years increased from 0.22 in 2004 to 10.1 per 100 000 population in 2016 (APC 2004 - 2006, 351.95%, $P < 0.05$; and APC 2006 - 2016, 9.46%, $P < 0.05$; Figure 3). Figure 4 shows the 13-year ureter cancer incidence rate (per 100 000 population) by regional centers in Iran from 2004 to 2016. The highest incidence of ureter cancer was observed in Hamedan Province (APC 2004 - 2006, 3930.07%, $P < 0.05$; and APC 2006 - 2016, 8.80%, $P > 0.05$; Figure 4).

Figures 5 and 6 show the 13-year trends of kidney and ureter cancer incidence rates (per 100 000 population) by tumor grade in Iran from 2004 to 2016. The highest incidence rate (per 100 000 population) of both cancers belongs to the unknown grade (Appendix 2) (APC of kidney cancer 2004 - 2016, 9.76%, $P < 0.05$; Figure 5 and APC of ureter cancer 2004 - 2016, 10.09%, $P < 0.05$; Figure 6).

5. Discussion

This study presented an updated incidence rate profile of kidney and ureter cancers in Iran and its provinces over 13 years. According to the findings of this research, firstly, the ASR of kidney and ureter cancers has generally been increasing over the past 13 years. Secondly, the age range of 70 to 79 years showed the largest ASR of kidney and ureter cancers. Thirdly, Hamedan Province reported the greatest incidence of kidney and ureter cancers.

The results of this study indicated that the incidence rate of kidney and ureter cancers had an increasing trend over 13 years, which is similar to the results of other studies conducted in Iran (15, 18). Xu et al. showed that over the past 30 years, the ASIR of kidney cancer has tripled in China (22). The studies indicated an increasing trend for kidney cancer incidence globally, particularly in European countries (23, 24). Several studies have indicated that the increasing incidence of kidney cancer in recent decades is related to the improvement of diagnostic tools, smoking, high body mass index, occupational exposure to trichloroethylene, and the aging population (22-26). An increasing trend in both cancers in this study may be due to the age growth of the population, improving the cancer registration system, earlier diagnosis of the disease, and

Table 1. Frequency of Patients with Kidney Cancer and Ureter Cancer According to the Age Groups, Tumor Grades, and Year of Diagnosis in Iran from 2004 to 2016

Variables	No. (%)	
	Kidney Cancer	Ureter Cancer
Age groups		
< 20	1380 (7.1)	4 (0.6)
20 - 29	442 (2.3)	8 (1.3)
30 - 39	1242 (6.4)	13 (2.1)
40 - 49	2784 (14.3)	43 (6.9)
50 - 59	4694 (24)	113 (18.1)
60 - 69	7094 (36.4)	327 (52.3)
70 - 79	1183 (6.1)	74 (11.8)
≥ 80	114 (0.6)	9 (1.4)
Missing	541 (2.8)	34 (5.5)
Total	19474 (100)	625 (100)
Year of diagnosis		
2004	703 (3.6)	30 (4.8)
2005	903 (4.6)	37 (5.9)
2006	1044 (5.4)	37 (5.9)
2007	1112 (5.7)	22 (3.5)
2008	1178 (6)	32 (5.1)
2009	1350 (6.9)	41 (6.6)
2010	1320 (6.8)	38 (6.1)
2011	1707 (8.8)	45 (7.2)
2012	1571 (8.1)	62 (9.9)
2013	1732 (8.9)	68 (10.9)
2014	1978 (10.2)	33 (5.3)
2015	2020 (10.4)	61 (9.8)
2016	2443 (12.5)	70 (11.2)
Missing	413 (2.1)	49 (7.8)
Total	19474 (100)	625 (100)
Tumor grades		
I	1760 (9)	140 (22.4)
II	3266 (16.8)	108 (17.3)
III	1950 (10)	182 (29.1)
IV	386 (2)	17 (2.7)
Unknown	12112 (62.2)	178 (28.5)
Total	19474 (100)	625 (100)

Table 2. The Kidney Cancer Incidence Rate (per 100 000 Populations) by Age Groups in Iran from 2004 to 2016

Age Groups	2004		2005		2006		2007		2008		2009		2010	
	Crude Rate	ASR ^a	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR
< 20	0.26	0.31	0.25	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.3	0.4
20-29	0.2	0.2	0.09	0.09	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
30-39	0.76	0.77	0.45	0.46	0.6	0.6	0.9	0.9	0.6	0.6	0.8	0.8	0.6	0.6
40-49	2	2.01	1.87	1.88	2.4	2.4	2.3	2.3	2.4	2.5	2.8	2.8	2.3	2.4
50-59	3.35	3.42	4.57	4.57	5.4	5.4	5.3	5.4	5.4	5.5	7.0	7.1	5.5	5.6
60-69	5.61	5.61	8.12	8.03	7.5	7.5	7.8	7.8	8.4	8.4	10.7	10.7	9.8	9.9
70-79	2.78	2.77	8.18	8.09	7.9	7.9	9.1	9.1	10.3	10.3	11.2	11.2	11.7	11.7
≥ 80	0.16	0.13	5.47	4.9	12.5	6.7	9.3	5.0	7.7	7.5	9.3	9.3	8.0	8.0
Total	0.98	1.33	1.25	1.79	1.5	2.0	1.6	2.1	1.6	2.2	1.9	2.6	1.8	2.3

Age Groups	2011		2012		2013		2014		2015		2016		-	
	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	-	-
20-29	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5	-	-
30-39	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	-	-
40-49	0.8	0.8	0.6	0.7	1.0	1.0	1.0	1.0	0.9	0.9	1.3	1.3	-	-
50-59	2.8	2.8	2.4	2.4	2.4	2.4	2.9	2.9	2.3	2.4	3.0	3.0	-	-
60-69	6.6	6.7	6.5	6.6	7.1	7.1	7.6	7.6	6.6	6.6	8.0	8.0	-	-
70-79	12.3	12.4	10.6	10.7	10.9	10.9	11.6	11.6	13.4	13.6	14.9	15.0	-	-
≥ 80	14.5	14.5	11.8	11.8	12.0	12.0	14.6	14.6	15.5	15.4	18.2	18.2	-	-
20-29	10.3	10.3	9.0	9.0	10.8	10.8	13.3	13.2	13.8	13.8	15.5	15.5	-	-
Total	2.3	2.9	2.1	2.6	2.3	2.7	2.5	3.0	2.6	3.0	3.1	3.5	-	-

^a Age-standardized incidence rate using the WHO world standard population (in 100 000 people).

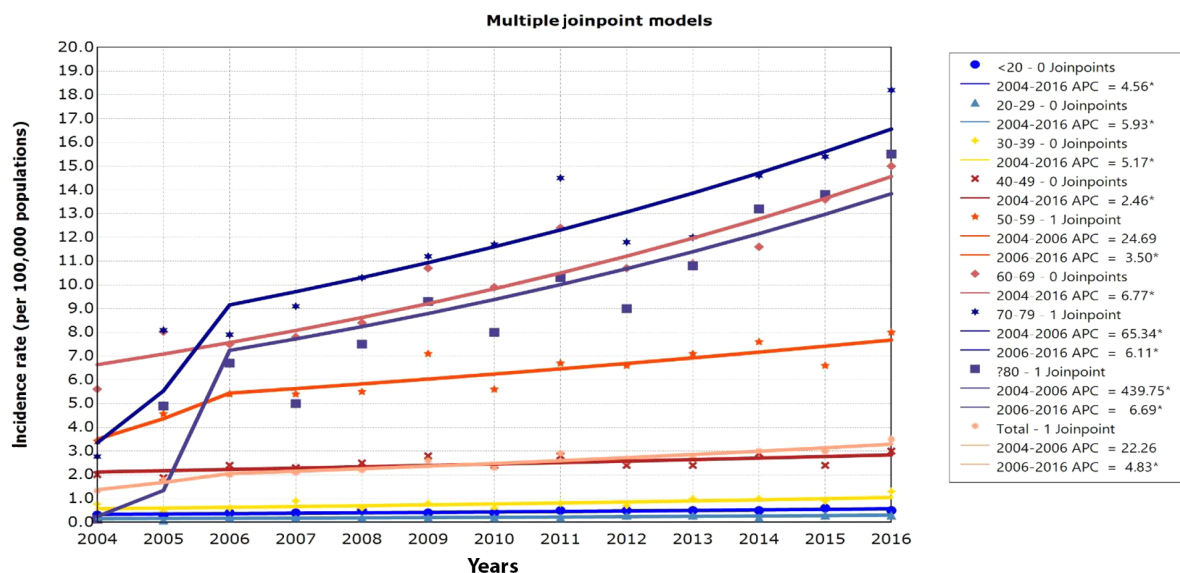


Figure 1. The 13-year trends of kidney cancer age-standardized incidence rate (per 100 000 population) by age group in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.

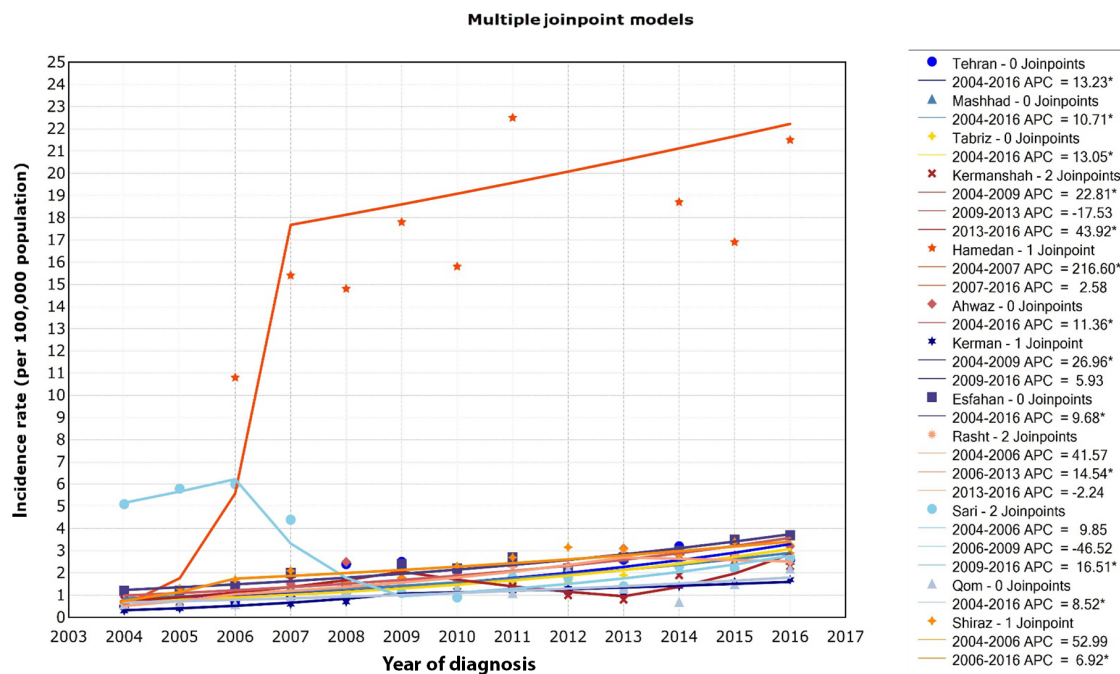


Figure 2. The 13-year trends of kidney cancer incidence rate (per 100 000 population) by regional centers in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level.

Table 3. The Ureter Cancer Incidence Rate (per 100 000 Populations) by Age Groups in Iran from 2004 to 2016

Age Groups	2004		2005		2006		2007		2008		2009		2010	
	Crude Rate	ASR ^a	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR
< 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20-29	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0
30-39	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0.1	0.1
40-49	0.07	0.07	0.05	0.05	0.4	0.4	0.5	0.5	0.4	0.4	0	0	0.2	0.2
50-59	0.11	0.1	0.17	0.17	1.1	1.1	0.8	0.9	1.5	1.5	1.4	1.5	0.5	0.5
60-69	0.38	0.38	0.3	0.3	5.3	5.2	1.8	1.8	3.8	3.9	6.9	6.9	4.2	4.3
70-79	0.22	0.22	0.67	0.66	5.5	5.7	3.2	3.2	4.2	4.2	4.9	4.9	6.6	6.4
≥ 80	0.16	0.13	0.63	0.65	7.7	6.4	4.4	3.8	1.4	1.2	7.3	6.3	7.1	6.8
Total	0.04	0.05	0.05	0.08	0.5	0.8	0.3	0.5	0.4	0.6	0.6	0.9	0.5	0.7
Age Groups	2011		2012		2013		2014		2015		2016		-	
	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	Crude Rate	ASR	-	-
20-29	0 ^a	0	0	0	0	0	0	0	0.1	0.1	0	0	-	-
30-39	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0	0	-	-
40-49	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-
50-59	0.2	0.2	0.7	0.7	0.8	0.8	0.3	0.3	0.3	0.3	0.4	0.4	-	-
60-69	1.6	1.7	1.6	1.6	1.2	1.2	1.9	1.9	2.4	2.4	1.6	1.6	-	-
70-79	4.7	4.6	2.9	3	7.8	8	3.7	3.6	4.8	4.9	5.2	5.4	-	-
≥ 80	5.4	5.5	9.8	10	7.8	7.7	6.8	7	7.8	7.7	10.2	10.1	-	-
20-29	5.4	5.2	10.5	10.2	6.1	6	4.9	4.8	1	0.9	9.1	9	-	-
Total	0.6	0.8	0.8	1	0.9	1.2	0.7	0.9	0.8	1	0.9	1.1	-	-

^a Age-standardized incidence rate using the WHO world standard population (in 100 000 people).

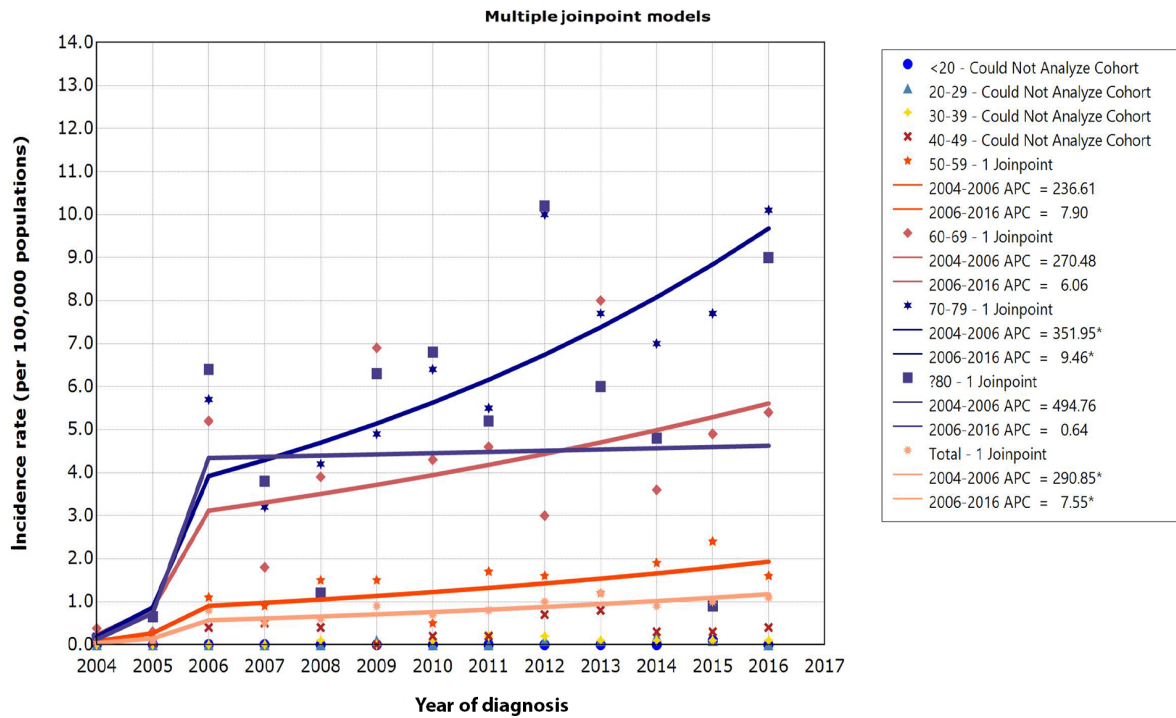


Figure 3. The 13-year trends of ureter cancer age-standardized incidence rate (per 100 000 population) by age group in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. #in age groups < 20, 20 - 29, 30 - 39, and 40 - 49 most of the records for a cohort have zero counts, then the cohort is NOT processed.

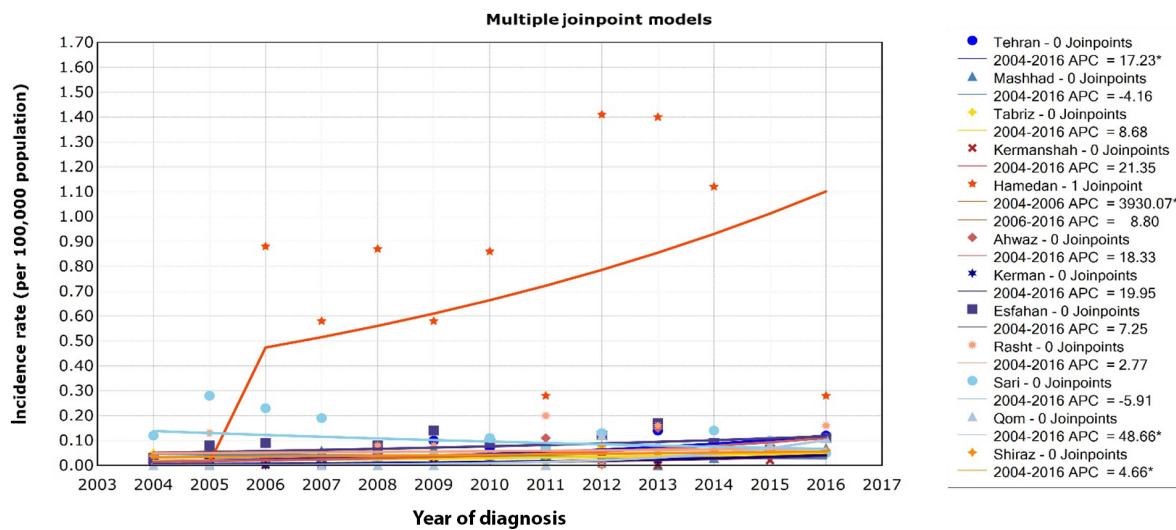


Figure 4. The 13-year trends of ureter cancer incidence rate (per 100 000 population) by regional centers in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level

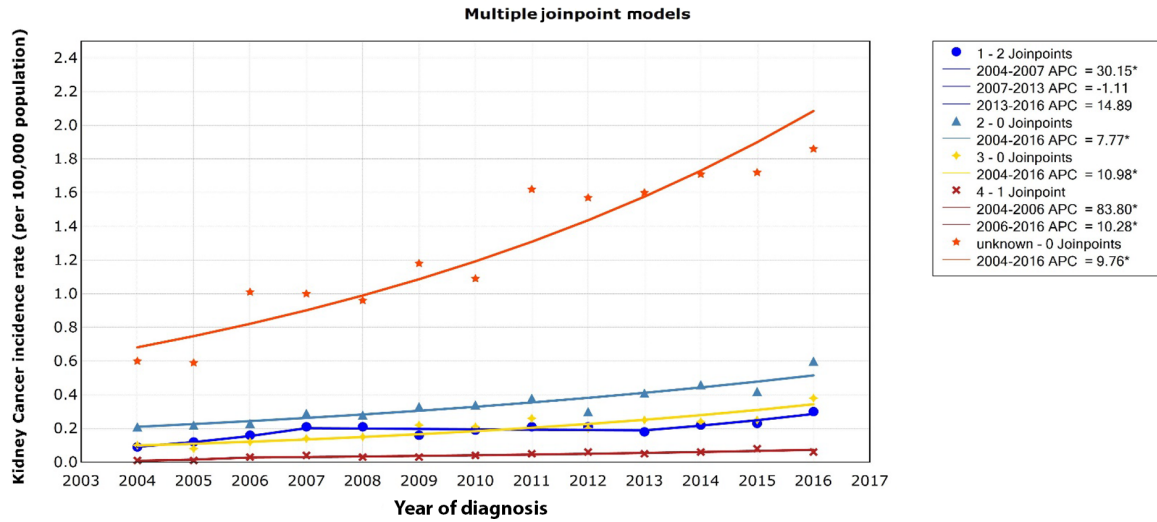


Figure 5. The 13-year trends of kidney cancer incidence rate (per 100 000 population) by tumor grades in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level. #in tumor grade 4, most of the records for a cohort have zero counts, then the cohort is NOT processed.

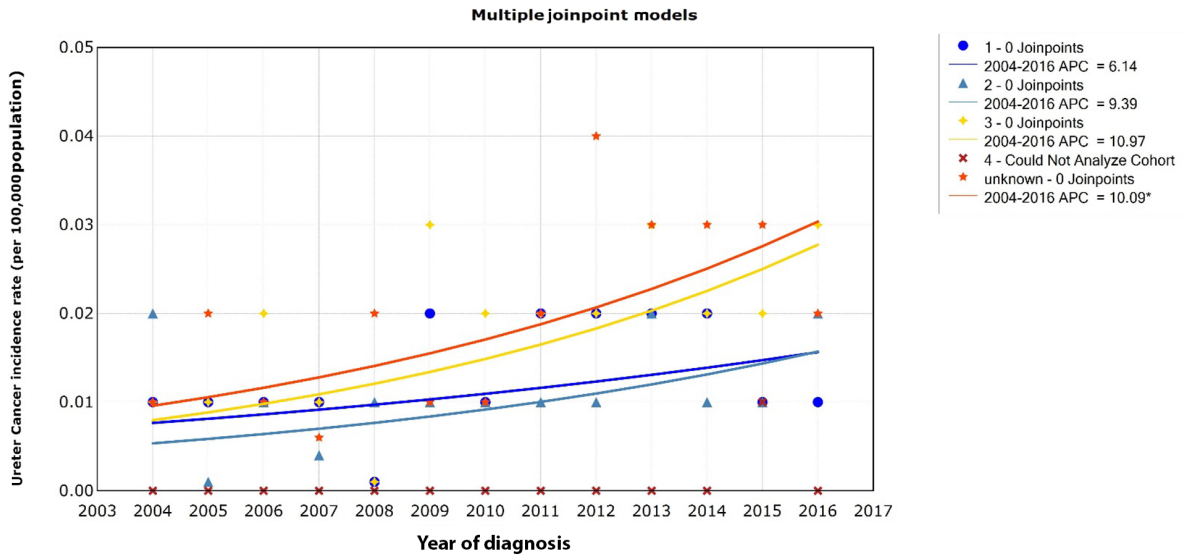


Figure 6. The 13-year trends of ureter cancer incidence rate (per 100 000 population) by tumor grades in Iran from 2004 to 2016. APC: Annual Percent Change. * Indicates that the Annual Percent Change (APC) is significantly different from zero at the alpha = 0.05 level

increasing the frequency of cancer risk factors such as obesity and smoking (27).

In this study, similar to other studies conducted in Iran and some other countries, the highest incidence rate was observed in the age group over 60 years (6, 15, 28). This result is in line with the study that shows the highest incidence of urologic cancers in the north of Iran and is among the age group over 60 years (20). Goodarzi et al. also indicated that the highest incidence rates of kidney cancer are in patients aged 75 years and older (29). Iran is classified as a developing country and has an aging population. Age is a key risk factor for cancer, as there are multiple biological changes associated with the natural aging process that can contribute to this disease. Due to the continuously aging population of Iran, the number of older individuals diagnosed with cancer is rising significantly (30).

The results of the meta-analysis study showed that among the provinces of Iran, Fars and Ardabil provinces have the highest incidence of kidney cancer, and Kerman Province has the lowest incidence of kidney cancer in both genders (14). In the current study, the Hamedan region had the highest incidence of kidney and ureter cancers, and the Kerman region had the lowest incidence of both cancers over 13 years. This difference may be related to the prevalence of risk factors, such as smoking, high BMI, low physical activity, hypertension, environmental and occupational risk factors, population's socioeconomic status, lifestyle, and the existence of other illnesses and malignancies (6, 31); however, this claim requires further investigation.

5.1. Conclusions

The results of this study showed that the incidence rate of kidney and ureter cancer in Iran from 2004 to 2016 has an increasing trend. Hence, the implementation of epidemiological studies in various regions and provinces is crucial for gaining a comprehensive and precise understanding of the underlying causes influencing the incidence of kidney and ureter cancers. This will ultimately facilitate targeted and measurable interventions to effectively address this health concern.

Supplementary Material

Supplementary material(s) is available [here](#) [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Acknowledgments

The authors would like to acknowledge the Kidney Diseases Research Center, Shahid Beheshti University of Medical Sciences in Tehran, Iran, for allowing access to the Iran National Cancer Registry data for this study.

Footnotes

Authors' Contribution: S. E., K. E., and P. D. drafted the manuscript, J. H., M. H., S. E., and F. D. performed the statistical analysis, K. E., S. E., P. D., and M. E. A. designed the study and edited the manuscript. All authors read and approved the final manuscript.

Conflict of Interests: The authors declare that they have no competing interests. One of the author (Mohammad Esmail Akbari) is the editorial board member of journal.

Data Reproducibility: The dataset presented in the study is available on request from the corresponding author during submission or after publication. The data are not publicly available due to containing information that could compromise the privacy of research participants.

Ethical Approval: This study has an ethics code from the Shahid Beheshti University of Medical Sciences in Tehran, Iran (IR.SBMU.CRC.REC.1400.021). The research complies with the provisions of the Declaration of Helsinki (as revised in 2013).

Funding/Support: No funding.

References

1. Global Burden of Disease Cancer C, Fitzmaurice C, Akinyemiju TF, Al Lami FH, Alam T, Alizadeh-Navaei R, et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 29 cancer groups, 1990 to 2016: A systematic analysis for the global burden of disease study. *JAMA Oncol.* 2018;4(11):1553-68. [PubMed ID: 29860482]. [PubMed Central ID: PMC6248091]. <https://doi.org/10.1001/jamaoncol.2018.2706>.
2. Turajlic S, Swanton C, Boshoff C. Kidney cancer: The next decade. *J Exp Med.* 2018;215(10):2477-9. [PubMed ID: 30217855]. [PubMed Central ID: PMC6170181]. <https://doi.org/10.1084/jem.20181617>.
3. Bai X, Yi M, Dong B, Zheng X, Wu K. The global, regional, and national burden of kidney cancer and attributable risk factor analysis from 1990 to 2017. *Exp Hematol Oncol.* 2020;9:27. [PubMed ID: 33005476]. [PubMed Central ID: PMC7525971]. <https://doi.org/10.1186/s40164-020-00181-3>.
4. Cai Q, Chen Y, Qi X, Zhang D, Pan J, Xie Z, et al. Temporal trends of kidney cancer incidence and mortality from 1990 to 2016 and projections to 2030. *Transl Androl Urol.* 2020;9(2):166-81. [PubMed ID: 32420123]. [PubMed Central ID: PMC7215038]. <https://doi.org/10.21037/tau.2020.02.23>.
5. Wong MC, Jiang JY, Goggins WB, Liang M, Fang Y, Fung FD, et al. International incidence and mortality trends of liver cancer: A global profile. *Sci Rep.* 2017;7:45846. [PubMed ID: 28361988]. [PubMed Central ID: PMC5374459]. <https://doi.org/10.1038/srep45846>.

6. Safiri S, Kolahi AA, Mansournia MA, Almasi-Hashiani A, Ashrafi-Asgarabad A, Sullman MJM, et al. The burden of kidney cancer and its attributable risk factors in 195 countries and territories, 1990-2017. *Sci Rep.* 2020;**10**(1):13862. [PubMed ID: 32807856]. [PubMed Central ID: PMC7431911]. <https://doi.org/10.1038/s41598-020-70840-2>.
7. Miller KD, Goding Sauer A, Ortiz AP, Fedewa SA, Pinheiro PS, Tortolero-Luna G, et al. Cancer Statistics for Hispanics/Latinos, 2018. *CA Cancer J Clin.* 2018;**68**(6):425-45. [PubMed ID: 30285281]. <https://doi.org/10.3322/caac.21494>.
8. Bowman IA, Bent A, Le T, Christie A, Wardak Z, Arriaga Y, et al. Improved survival outcomes for kidney cancer patients with brain metastases. *Clin Genitourin Cancer.* 2019;**17**(2):e263-72. [PubMed ID: 30538068]. [PubMed Central ID: PMC6534272]. <https://doi.org/10.1016/j.clgc.2018.11.007>.
9. Innos K, Sepp T, Baburin A, Kotsar A, Lang K, Padrik P, et al. Increasing kidney cancer incidence and survival in Estonia: Role of age and stage. *Acta Oncol.* 2019;**58**(1):21-8. [PubMed ID: 30280624]. <https://doi.org/10.1080/0284186X.2018.1512158>.
10. Scelo G, Larose TL. Epidemiology and risk factors for kidney cancer. *J Clin Oncol.* 2018;**36**(36):CO2018791905. [PubMed ID: 30372394]. [PubMed Central ID: PMC6299342]. <https://doi.org/10.1200/JCO.2018.79.1905>.
11. Assouad E, El Hage S, Safi S, El Kareh A, Mokled E, Salameh P. Kidney cancer trends and risk factors in Lebanon: a 12-year epidemiological study. *Cancer Causes Control.* 2022;**33**(2):303-12. [PubMed ID: 34839395]. <https://doi.org/10.1007/s10552-021-01525-y>.
12. Tahbaz R, Schmid M, Merseburger AS. Prevention of kidney cancer incidence and recurrence: Lifestyle, medication and nutrition. *Curr Opin Urol.* 2018;**28**(1):62-79. [PubMed ID: 29059103]. <https://doi.org/10.1097/MOU.0000000000000454>.
13. Basiri A, Shakhssalim N, Jalaly NY, Miri HH, Partovipour E, Panahi MH. Difference in the incidences of the most prevalent urologic cancers from 2003 to 2009 in Iran. *Asian Pac J Cancer Prev.* 2014;**15**(3):1459-63. [PubMed ID: 24606483]. <https://doi.org/10.7314/apjcp.2014.15.3.1459>.
14. Hassanipour S, Namvar G, Fathalipour M, Salehiniya H. The incidence of kidney cancer in Iran: A systematic review and meta-analysis. *Biomedicine (Taipei).* 2018;**8**(2):9. [PubMed ID: 29806587]. [PubMed Central ID: PMC5992926]. <https://doi.org/10.1051/bmdcn/2018080209>.
15. Mirzaei M, Pournamdar Z, Salehiniya H. Epidemiology and trends in incidence of kidney cancer in Iran. *Asian Pac J Cancer Prev.* 2015;**16**(14):5859-61. [PubMed ID: 26320463]. <https://doi.org/10.7314/apjcp.2015.16.14.5859>.
16. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, et al. Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer.* 2015;**116**(5):E359-86. [PubMed ID: 25220842]. <https://doi.org/10.1002/ijc.29210>.
17. Masoompour SM, Lankarani KB, Honarvar B, Tabatabaee SH, Moghadami M, Khosravizadegan Z. Changing epidemiology of common cancers in southern Iran, 2007-2010: A cross sectional study. *PLoS One.* 2016;**11**(5). e0155669. [PubMed ID: 27219458]. [PubMed Central ID: PMC4878731]. <https://doi.org/10.1371/journal.pone.0155669>.
18. Tolou-Ghamari Z. Prevalence of kidney, renal pelvis, and ureter cancers in Isfahan province, Iran. *J Archives in Military Medicine.* 2019;**7**(1-2). <https://doi.org/10.5812/jamm.95457>.
19. Tolou Ghamari Z. Cancers of urinary system; prevalence, demographic. *Jund J Chron Dis Care.* 2019;**8**(4). <https://doi.org/10.5812/jjcdc.95732>.
20. Moosazadeh M, Janbabaei G, Ashrafi M, Ghazizadeh Z, Afshari M, Mousavi R, et al. Incidence and epidemiology of urologic cancers in North of Iran. *Clinical Cancer Investigation J.* 2018;**7**(6). https://doi.org/10.4103/ccij.ccij_52_18.
21. Alsadhan N, Almainan A, Pujades-Rodriguez M, Brennan C, Shuweihdi F, Alhurishi SA, et al. Statistical methods for measuring trends in colorectal cancer incidence in registries: A systematic review. *Front Oncol.* 2022;**12**:1049486. [PubMed ID: 36531079]. [PubMed Central ID: PMC9748480]. <https://doi.org/10.3389/fonc.2022.1049486>.
22. Xu Q, Zhang T, Xia T, Jin B, Chen H, Yang X. Epidemiological trends of kidney cancer along with attributable risk factors in China from 1990 to 2019 and its projections until 2030: An analysis of the global burden of disease study 2019. *Clin Epidemiol.* 2023;**15**:421-33. [PubMed ID: 37013109]. [PubMed Central ID: PMC10066698]. <https://doi.org/10.2147/CLEP.S400646>.
23. Huang J, Leung DK, Chan EO, Lok V, Leung S, Wong I, et al. A global trend analysis of kidney cancer incidence and mortality and their associations with smoking, alcohol consumption, and metabolic syndrome. *Eur Urol Focus.* 2022;**8**(1):200-9. [PubMed ID: 33495133]. <https://doi.org/10.1016/j.euf.2020.12.020>.
24. Jani C, Abdallah N, Mouchati C, Jani R, Sharma R, Bhatt P, et al. Trends of kidney cancer incidence and mortality from 1990 to 2019 in European Union 15 + countries and World Health Organization regions. *Sci Rep.* 2022;**12**(1):22368. [PubMed ID: 36572700]. [PubMed Central ID: PMC9792551]. <https://doi.org/10.1038/s41598-022-25485-8>.
25. Xing M. BRAF mutation in papillary thyroid microcarcinoma: The promise of better risk management. *Ann Surg Oncol.* 2009;**16**(4):801-3. [PubMed ID: 19159982]. [PubMed Central ID: PMC2692039]. <https://doi.org/10.1245/s10434-008-0298-z>.
26. Bach PB. Limits on Medicare's ability to control rising spending on cancer drugs. *N Engl J Med.* 2009;**360**(6):626-33. [PubMed ID: 19176475]. <https://doi.org/10.1056/NEJMp0807774>.
27. Mansour-Ghanaei F, Varshi G, Joukar F, Ashoobi MT, Esmailpour J, Gharibpoor A, et al. Prevalence of pre-cancerous colon lesions in referred patients under patronage of a local relief foundation in Guilan province. *J Med Life.* 2019;**12**(2):133-9. [PubMed ID: 31406514]. [PubMed Central ID: PMC6685299]. <https://doi.org/10.25122/jml-2018-0074>.
28. Mangone L, Marinelli F, Tarantini L, Masini C, Navazio A, Di Girolamo S, et al. Trends in incidence and mortality of kidney cancer in a northern Italian province: An update to 2020. *Biology (Basel).* 2022;**11**(7). [PubMed ID: 36101426]. [PubMed Central ID: PMC9311977]. <https://doi.org/10.3390/biology11071048>.
29. Goodarzi E, Dehghani SL, Khazaei Z. Incidence and mortality rates of kidney cancers in Iran compared to its proportion throughout the world. *J Nephrology.* 2018;**7**(2):137-44. <https://doi.org/10.15171/npj.2018.28>.
30. Berben L, Floris G, Wildiers H, Hatse S. Cancer and aging: Two tightly interconnected biological processes. *Cancers (Basel).* 2021;**13**(6). [PubMed ID: 33808654]. [PubMed Central ID: PMC8003441]. <https://doi.org/10.3390/cancers13061400>.
31. Sajadi A, Zahedi MJ, DARVISH MS, Nouraei M, ALI MM, Ghorbani A, et al. The first population-based cancer survey in Kerman Province of Iran. *Iran J Public Health.* 2007.