

Original Article

Geographical distribution of death due to cancer in Kerman Province, Southeast Iran: A comparison of proportional mortality and age-adjusted mortality rate

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Abstract

Background: In Iran, cancer kills 30,000 people, annually. The epidemiology of cancer is gradually changing as a result of the demographic and epidemiological transition in Iran. This study aimed at presenting a geographical distribution of cancer mortality in Southeast area of Iran, and comparing proportional mortality and age-adjusted mortality rates.

Methods: The present study was a descriptive study that was performed on mortality data recorded in the Center for Statistics Management of Health Ministry at Kerman and Rafsanjan Universities of Medical Sciences in the period 2012-2016. This information was used to determine the age-standardized mortality rate per 100,000 people and proportional mortality for each district in Kerman Province.

Results: The proportional mortality for all cancers in Kerman and Rafsanjan Universities were 11.54% and 18%, respectively. Standardized mortality rates for all cancers in males in Kerman and Rafsanjan universities were also 81.9 and 81.3 per 100,000, respectively, while for females, it was 57.3 and 51.6 per 100,000 people, respectively.

Conclusion: Our results presented a general picture of the mortality due to cancer in one of the widest provinces of the country with more than 1.5 million habitants. Standardized mortality rates for all cancers in males and females in Rafsanjan universities was lower than Kerman. In spite of higher proportional mortality in Rafsanjan, the rate of death by cancer in Rafsanjan was lower than Kerman.

Keywords: Geographical distribution; Proportional mortality; Mortality rate; Cancer; Southeast Iran

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1. Introduction

Cancer is one of the most important public health problems in Iran, and many other parts of the world (1), and it is also one of the main causes of death in developed and developing countries (2). In Iran, about 30,000 people die annually of cancer (3). The epidemiology of cancer is gradually changing as a result of demographic and epidemiological transitions in Iran, such that cancer was the fifth cause of death between 1979 and 1981, the fourth cause between 1982 and 1986, and was the third cause of death in recent years (4). It is the third leading cause of death after cardiovascular diseases and accidents, and the number of cancer deaths is expected to rise to 62,000 by 2020 (3). A number of reasons have been suggested for this growing trend, including factors, such as increased aging population, lifestyle changes, environmental factors, occupational and industrial risk factors, unhealthy diets, increased tobacco consumption, medications and hormone therapy, alcohol, lack of physical activity, stress, pollution in urban areas, toxins, and infections (4,5).

The mortality rate can be a useful indicator to assess changes in cancer over time, since it is almost systematically recorded in regional or national systems (6). Geographic differences in rates are also a critical component of descriptive epidemiology. A statistical comparison of the disease in different regions can help to diagnose its cause, and can be a way to control it (7); this, of course, depends on the accuracy of the recorded data and comparability of populations. One of the aims of this study was to study the geographical model of cancer mortality rates in Kerman Province using data from

the death registration system at Kerman and Rafsanjan Universities of Medical Sciences. Kerman is one of the provinces of Iran located in the southeast and is the ninth most populous province in the country. The province has four medical universities: Kerman, Rafsanjan, Jiroft, and Bam. Rafsanjan is an agricultural area with large agricultural lands and about 88,000 hectares of pistachio garden. Therefore, about 700 tons of pistachio pesticides are used in this city every year (8). According to the reports of the authorities in this university, cancer mortality rate in Rafsanjan was higher than the national average. From the total deaths reported in Rafsanjan and Anar in 2016, about 20% of all deaths were due to the types of cancer, while the national average was between 15 and 16%.

As proportional mortality shows us how many deaths in the university were due to cancer, it can only show the major cause of death in a group at a glimpse, but it cannot determine the death risk rate of a disease. Rather, the specific mortality rate is a standard that identifies the risk of death by a disease. If the proportional mortality of a section increases, the proportional mortality of some other parts should be necessarily reduced (9). This study also aimed to compare proportional mortality with standard mortality rate in two Rafsanjan and Kerman Universities of Medical Sciences during the years 2012-2016.

2. Materials and Methods

This is a descriptive study in which mortality data recorded at the Center for Statistics Management of Health Ministry at Kerman and Rafsanjan Universities of Medical Sciences, from 2012 to 2016, were analyzed. Data were collected by experts

working in the ward of registering deaths, from death certificates, forensic statistics, cemeteries, as well as reports from health centers after removal of duplicates. The data recorded in the study checklist included both demographic and cancer related characteristics, such as the date of birth, age, gender, race, nationality, place of residence, place of death, and also the type of cancer (according to the International Classification of Oncology Diseases). To provide comparable data in this study, all mortality data related to the cancer were collected. Since the results of previous studies have shown that the quality of the recorded data for the incidence of cancer was low, and also, data of cancer morbidity in the areas of study, areas covered by Kerman University of Medical Sciences and Rafsanjan, was not complete, therefore, in this study, only mortality rates were compared. Information about the demographic characteristics of people living in all cities of the province, such as age and gender were received from the Center for Statistics of the Department of Health in each university.

This information was used to determine the standardized death rate per 100,000 people and proportional mortality for each district in Kerman Province. Standardized mortality rates for total cancer were calculated based on region, gender, and the year using the direct standardization method. The total population of the regions in 2015 was used as the standard population in the process of standardization.

Based on the existing classification, the cities of Arzouiyeh, Baft, Bardsir, Rober, Ravar, Sirjan, Shahrbabak, Kerman, and Kuhbanan are covered by Kerman University of Medical Sciences, and the cities of Rafsanjan and Anar are covered by

Rafsanjan University of Medical Sciences. Data analysis was performed using Microsoft Excel sheet and STATA Software, while ARC GIS 10.4.1 was used to display data on maps. The Quantile method was used to categorize cities and to color them. In this method, classification was performed based on the lowest to the highest rate. Also, non-Iranians were excluded from the study. (Ethical Code: IR.RUMS.REC.1394.260)

3. Results

Generally, between 2012 and 2016, 38,207 deaths (32,812 cases in Kerman and 5395 in Rafsanjan) occurred in the areas covered by Kerman and Rafsanjan Universities of Medical Sciences of which 4756 cancer deaths occurred in the areas covered by medical universities of Kerman (3787 cases) and Rafsanjan (969 cases). Of this, 2841 cases (59.73%) were in males (2235 cases in the area covered by Kerman, and 606 cases in the area were covered by Rafsanjan) and 1915 cases (40.26%) were in females (1552 cases in Kerman and 363 in Rafsanjan). The male to female ratio of cancer deaths was 1.48. Raw and standardized death rates for all cancers in both universities were found to be higher in males than in females. Raw and standardized death rates for all cancers in males in Kerman and Rafsanjan universities were 81.9 per 100,000 (raw mortality rate=79.6) and 81.3 per 100,000 (raw mortality rate=79.6), respectively, while for females, it was 57.3 per 100,000 (raw mortality rate=56.9) and 51.6 per 100,000 people (raw mortality rate=51), respectively. The proportional mortality for all cancers in both Kerman and Rafsanjan universities were then 11.54 and 18%, respectively.

Figure 1 shows the pattern of geographical distribution of age standardized mortality rates for all cancers (in 100,000 people). According to the results of this study, there was a clear geographical difference in

mortality rates; thus among the different regions covered by these two universities in the years of the study, there was a variation from 38.9 in Sirjan to 110.9 in Kerman.

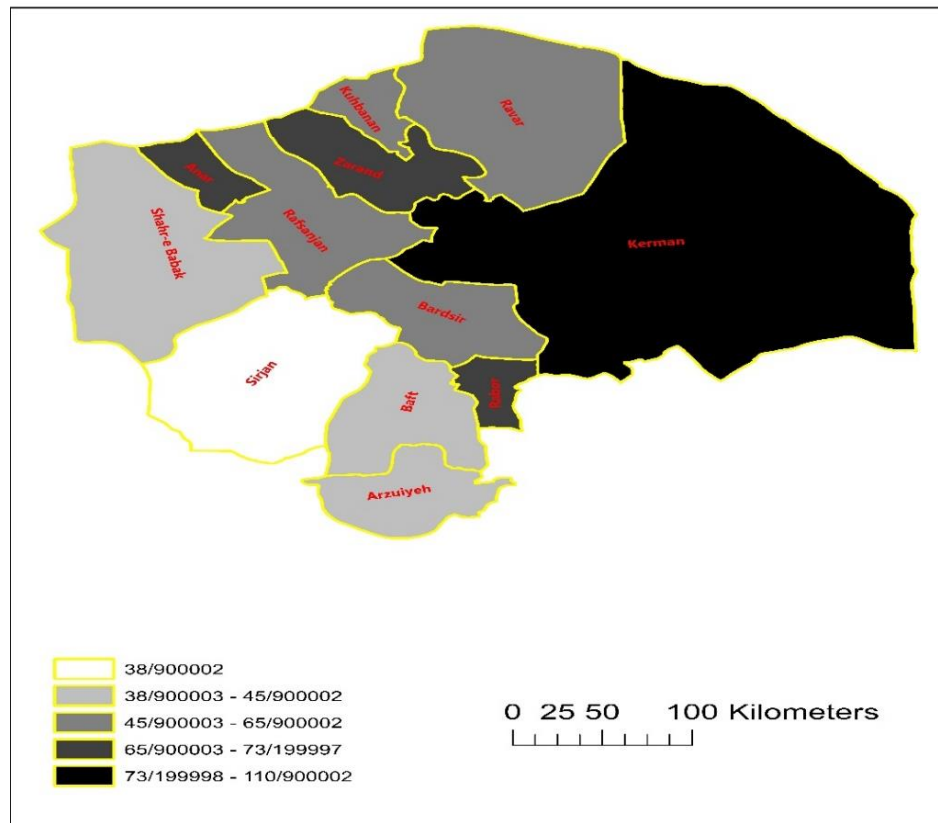


Figure 1. The geographic distribution of the age-standardized mortality rate of all cancers in 2012–2016

Figure 2 and Table 1 describe the geographical distribution of age standardized mortality rates for all cancers in both genders in different regions. The

highest and lowest rates in males were 126.5 and 48, and in females, they were found to be 95.3 and 29.5, in Kerman and Sirjan, respectively.

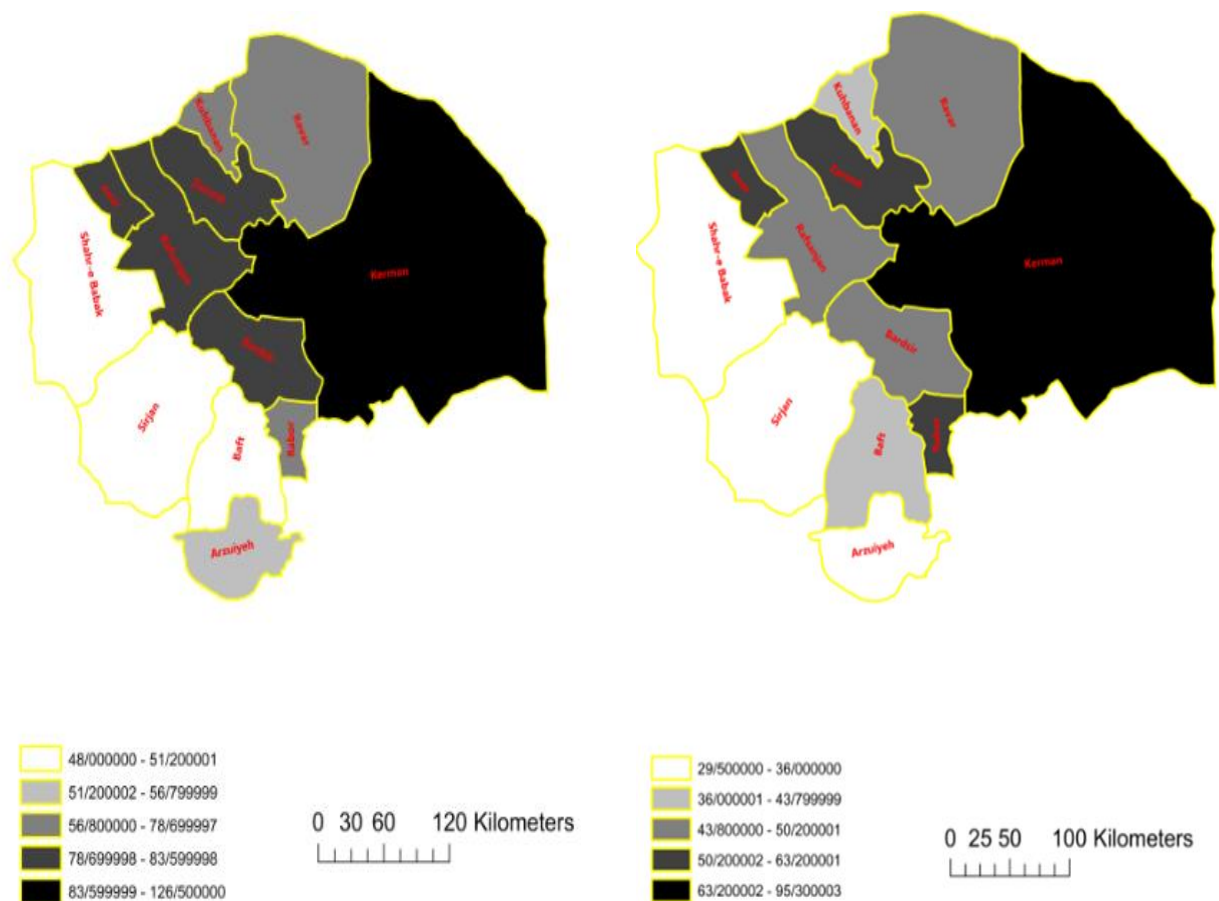


Figure 2. The geographic distribution of the age-standardized mortality rate of all cancers in 2012–2016, by sex (A: male, B: female)

Table 1. The statistics of all Cancers according to sex and Region

Region	Male				Female				total			
	Fre	CR	ASMR	Rank	Fre	CR	ASMR	Rank	Fre	CR	ASMR	Rank
Arzuieh	49	49.37	56.8	9	28	29.12	31.4	11	77	39.41	43.8	10
Baft	100	56.14	49.6	11	84	47.08	42.7	9	184	51.60	45.9	9
Bardsir	147	88.02	83.6	2	78	48.03	46.6	7	225	68.30	64.4	6
Rabor	83	111.49	78.7	6	56	74.09	55.6	3	139	92.65	66.9	4
Ravar	68	74.13	73.6	8	42	47.64	48.1	6	110	61.15	61.4	8
Zarand	263	77.35	83.2	3	174	52.24	53.7	4	437	64.92	68.2	3
Sirjan	292	41.67	48	12	179	27	29.5	12	471	34.54	38.9	12
Shahr-e Baba	117	60.38	51.2	10	75	40.78	36	10	192	50.84	43.5	11
Kerman	1066	117.43	126.5	1	807	90.2	95.3	1	1873	103.94	110.9	1
Kuhbanan	50	89.08	78.5	7	29	53.18	43.8	8	79	71.40	61.5	7
Rafsanjan	539	79.88	81.1	5	315	49.92	50.2	5	854	65.40	65.9	5
Anar	67	77.25	82.2	4	48	59.07	63.2	2	115	68.46	73.2	2

Table 2 shows that the highest rates of cancer in both genders in the areas covered by both universities was in the year 2016. The results of age standardized mortality

rates showed an increasing trend at Rafsanjan University of 58.1 in 2012 to 79 in 2016, and 72 to 82.6 at Kerman University.

Table 2. The statistics of all Cancers according to sex and year

	Year	Fr	Cr	ASMR	Rank	Fr	Cr	ASMR	Rank	Fr	Cr	ASMR	Rank
Kerman	91	731	70	72	3	321	62.28	63.5	2	410	77.45	80.3	3
	92	620	58.056	60.7	4	255	48.45	50.2	3	365	67.39	71.2	4
	93	642	57.8	58.6	5	262	47.81	48	5	380	67.48	68.9	5
	94	841	72.67	72.9	2	328	57.56	57	4	513	87.33	89.1	2
	95	953	82.35	82.6	1	386	67.73	67.3	1	567	96.52	98.3	1
Rafsanjan	91	162	56.2	58.1	5	72	51.72	53.7	2	90	60.44	62.5	5
	92	166	57.44	59.8	4	50	35.75	37.2	5	116	77.77	80.8	3
	93	189	63.64	64.7	3	70	48.66	49.7	4	119	77.72	79.5	4
	94	215	71.71	71.4	2	76	52.52	51.9	3	139	89.60	89.8	2
	95	237	79.04	79	1	95	65.65	65.3	1	142	91.53	92.3	1

The results of the Cochran-Armitage test for linear trend showed that there was a significant linear trend for age standardized mortality rate at Rafsanjan University from

2013 to 2016 ($p = 0.040$), but this trend was not significant at Kerman University ($p = 0.197$). (Figure 3).

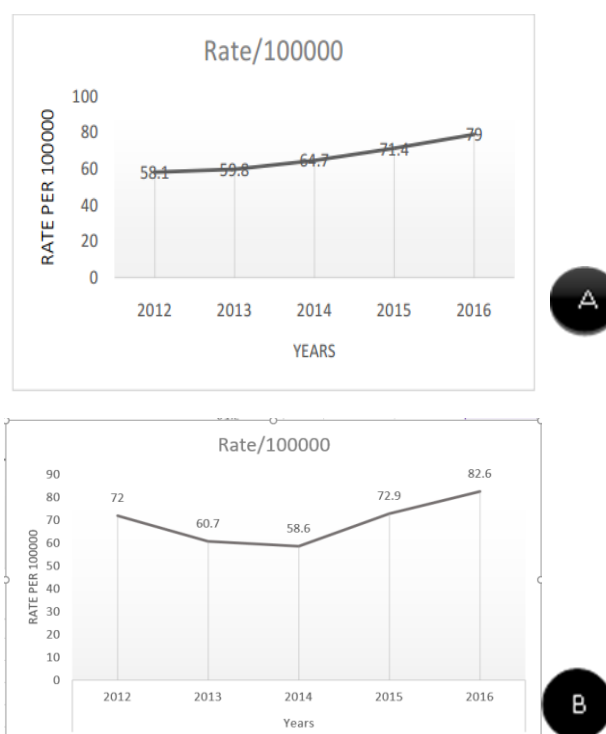


Figure 3. Trend of age-standardized mortality rate of all cancers in 2012–2016, by university (A: Rafsanjan, B: Kerman)

The age distribution for all causes of cancer deaths shown in Figure 4 indicates an increasing trend in cancer deaths with aging. The highest death rates in Kerman

and Rafsanjan Universities were in the 75-79 years and above 75 years age groups, respectively.

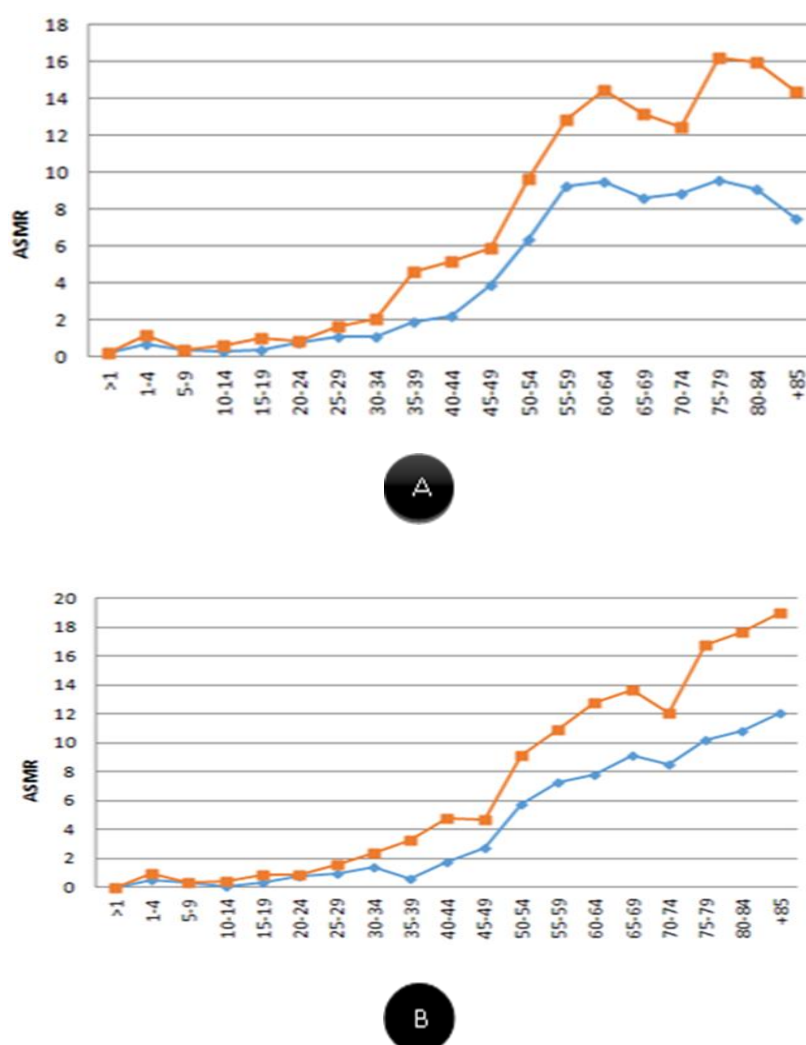


Figure 4. The age-standardized mortality rate of cancer per 100 000 population in female and male in 2013–2017, by university (A: Kerman, B: Rafsanjan)

Table 3. Proportional mortality by university and year

Year	Kerman University			Rafsanjan University		
	Total death	Death from cancer	Proportional mortality	Total death	Death from cancer	Proportional mortality
1391	6296	731	11/61	1023	162	15/84
1392	5845	620	10/61	951	166	17/46
1393	6271	642	10/24	1086	189	17/40
1394	7195	841	11/69	1105	215	19/46
1395	7205	953	13/23	1230	237	19/27

Table 3 shows the proportional mortality in the two universities within the study period (2012 to 2016). Despite the lower standardized mortality rate for cancer deaths in the University of Rafsanjan, the proportional mortality was higher in this university.

4. Discussion

In this study, the mortality rate for all cancers was evaluated from 2012 to 2016 in the areas covered by Kerman and Rafsanjan Universities of Medical Sciences. Cancer is one of the most important public health problems in Iran and many other parts of the world (1). In 2012, 53,350 cancer deaths were reported among Iranian population (ASMR=81.9 per 100,000), of which 30,115 cases occurred in men (ASMR=90.4), and 23,235 cases in women (ASMR=72.7).

The male to female ratio cancer deaths was 1.3. In the present study, 38,207 deaths occurred in some areas of Kerman Province of which 4756 deaths were due to cancer; 3787 cases were from Kerman University and 969 cases were from Rafsanjan University. 73.59% of the cases occurred in men and 40.26% in women. Gender ratio of cancer death was 1.48 in this study. It should be said that in both universities in all studied years, the mortality rate was higher in men than in women. In addition to the higher incidence of some cancers in men, women were found more sensitive than men to healthcare, therefore they were referred for diagnosis and treatment with the onset of the first signs of the disease.

Thus, the likelihood of diagnosis and treatment of the disease in its early stages in women was higher than in men (11), which could be as one of the reasons for lower deaths in women than men. Also, according to the results of the current study, there was found a clear geographical difference in

mortality rate. In general, the highest mortality rate of all cancers in these areas was related to the cities of Kerman, Anar, and Zarand, respectively, while the lowest rate in the cities of Sirjan, Shahrbabak, and Arzouiyeh. In males, the highest rates were in the cities of Kerman, Bardsir, and Zarand, and the lowest rates were documented in the cities of Sirjan, Shahrbabak, and Baft, respectively; in females, the highest rate was in the cities of Kerman, Anar, and Rober, and the lowest rate was in the cities of Sirjan and Shahrbabak, respectively. When a high accumulation of mortality from a disease is seen in one place, we cannot conclude that these events happen incidentally, as there is the need to examine what causative mechanism might have led to this accumulation.

There are several mechanisms that have made cancer rates different in different regions. Cancer is a multifaceted condition caused by a combination of genetic and environmental factors that are simultaneously effective (12). Most scientific evidence has shown that the role of environmental factors in this area is most prevalent in most cancers (12). Differences in lifestyle, environmental risk factors, socioeconomic status, diet, exposures to chemical agents (such as pollutants in industrial areas), air pollution, food, drinking water, the use of pesticides, and biological carcinogenic factors (specific viruses) in different regions can be amongst the reasons for different rates of cancer in different regions of Kerman Province. Nonetheless, further studies are needed to explain this geographical variation, especially on the potential impact of environmental factors. In general, using the maps of this area and the geographical points do not indicate the causes of cancer,

rather it shows in which areas we can examine a hypothesis. Researchers can focus on areas with high rates, because they may be exposed to risk factors or specific lifestyle, and areas with lower rates may possess some specific protective factors. The above question will be available when accurate and reliable information are available over time from different regions, and this clearly indicates the importance of accessing accurate and reliable local information.

Also, based on the results of this study, the proportional cancer mortality rate in the areas covered by Rafsanjan University has been higher in all years compared to areas covered by Kerman University. In spite of the higher proportional mortality in Rafsanjan, the cancer death rate in Rafsanjan University was lower than in Kerman University. Proportional mortality shows us the number of cancer deaths; it can also show the major reason for death in a group at a glance, but it cannot measure the risk of death from a disease; however, the standardized and causative specific mortality rates can determine the risk of death from a disease.

In this study, an increasing trend was observed in the mortality rate in both genders from 2014 to 2016. However, the studies conducted in European countries reported an increasing and decreasing trend in cancer in men and women, respectively (11, 13). However, according to the studies conducted in Iran, an increasing trend in cancer prevalence in both genders was predicted by 2015(11), which was consistent with the results of the present study. In a study conducted in Kerman Province on the cancer incidence, an increasing trend was observed in both genders (3), as in the present study. Considering some factors, including

community awareness about signs and symptoms of cancer, advances in diagnostic techniques and equipment, improved registration systems, increased exposure to cancer risk factors, inactive lifestyle, changes in dietary habits and increasing proportion of the elderly in the society, the incidence and death rate of cancer have been increasing among Iranian population. Finally, due to the high prevalence of cancer risk factors in Iran, the incidence rate is growing, thus the number of cancer cases is expected to increase rapidly in the future. Therefore, the development, creation, and implementation of comprehensive National Cancer Control Program should be among the priorities of health policy makers and other authorities. It is also suggested to conduct more studies to evaluate the trend and geographical distribution of cancer rates and the causes of these differences.

Our results presented a general picture of the mortality due to cancer in one of the widest provinces of the country with more than 1.5 million inhabitants. The proportional mortality for all cancers in Kerman and Rafsanjan Universities were 11.54% and 18%, respectively. Mortality rates in males in Kerman and Rafsanjan were also 81.9 and 81.3, while for females, it was 57.3 and 51.6 per 100,000 people, respectively. In spite of the higher proportional mortality in Rafsanjan, the cancer death rate in Rafsanjan University was lower than in Kerman University.

Limitations

Since the quality of the recorded data for the incidence of cancer is low, and also, the data of cancer morbidity in the areas of study areas covered by Kerman and Rafsanjan Universities of Medical Sciences is not complete, in this study, only mortality rates were compared. Also, to provide the

comparable data in the current study, all mortality data related to cancer which were collected and analyzed were not conducted for types of cancer.

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References

1. Rafiemanesh H, Rajaei-Behbahani N, Khani Y, Hosseini S: Incidence trend and epidemiology of common cancers in the center of Iran. *Global journal of health science*. 2016; 8(3):146. [DOI: 10.5539/gjhs.v8n3p146] [PMID: 26493417]
2. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A: Global cancer statistics, 2012. *CA: a cancer journal for clinicians*. 2015; 65(2):87-108. [DOI:org/10.3322/caac.21262]
3. Keyghobadi N, Rafiemanesh H, Mohammadian-Hafshejani A, Enayatradd M, Salehiniya H: Epidemiology and trend of cancers in the province of Kerman: southeast of Iran. *Asian Pacific Journal of Cancer Prevention*. 2015; 16(4):1409-1413. [DOI:org/10.7314/APJCP.2015.16.4.1409]
4. Esmaeizadeh N, Salahi-Moghaddam A, Khoshdel A: Geographic distribution of important cancers in Iran. *Bimonthly Journal of Hormozgan University of Medical Sciences*. 2015; 19(2):66-76. [In Persian]
5. Jemal A, Center MM, DeSantis C, Ward EM: Global patterns of cancer incidence and mortality rates and trends. *Cancer Epidemiology and Prevention Biomarkers*. 2010; 19(8):1893-1907. [DOI: 10.1158/1055-9965]
6. Moradpour F, Fatemi Z: Estimation of the projections of the incidence rates, mortality and prevalence due to common cancer site in Isfahan, Iran. *Asian Pacific Journal of Cancer Prevention*. 2013; 14(6):3581-3585. [DOI:org/10.7314/APJCP.2013.14.6.3581]
7. Mohebbi M, Mahmoodi M, Wolfe R, Nourijelyani K, Mohammad K, Zeraati H, Fotouhi A: Geographical spread of gastrointestinal tract cancer incidence in the Caspian Sea region of Iran: spatial analysis of cancer registry data. *BMC cancer*. 2008; 8(1):137. [DOI:org/10.1186/1471-2407-8-137]
8. Vazirinejad R, Khalili P, Rezaeian M, Jamalizadeh A, Puorkarami A: The impact of exposure to pesticides on the risk of gastrointestinal cancer among pistachio farmers; a case-control study. *journal of Occupational Health and Epidemiology*. 2015; 4(4):205-212. [In Persian]
9. Gordis L. *Epidemiology*. 4th. Phila PA: Saunders Elsevier; 2009.[book]
10. Khalili D, Mosavi-Jarrahi A, Eskandari F, Mousavi-Jarrahi Y, Hadaegh F, Mohagheghi M, Azizi F: Evaluation of cause of deaths' validity using outcome measures from a prospective, population based cohort study in Tehran, Iran. *PloS one*. 2012; 7(2):e31427. [DOI:org/10.1371/journal.pone.0031427]
11. Almasi Z, Mohammadian-Hafshejani A, Salehiniya H: Incidence, mortality, and epidemiological aspects of cancers in Iran; differences with the world data. *Journal of BU ON*. 2016; 21(4):994-1004. [In Persian]
12. Simonds N, Aoko I, et al. Review of the Gene- Environment Interaction Literature in Cancer: What Do We Know?. *Genetic epidemiology*. 2016; 40(5): 356-365. [DOI:org/10.1002/gepi.21967]
13. Sánchez M, Payer T, De Angelis R, Larrañaga N, Capocaccia R, Martinez C, Group CW: Cancer incidence and mortality in Spain: estimates and projections for the period 1981-2012. *Annals of oncology*. 2010; 21(suppl_3):iii30-iii36. [DOI: org/10.1093/annonc/mdq090]