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Investigating the Incidence of Gastric Cancer and Its Relationship with Geographical Factors in Lorestan Province During 2013 – 2016

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A B S T R A C T

Introduction: Gastric cancer is the fourth most common cancer in Iran. This study aimed to determine the incidence of gastric cancer and its relationship with geographical factors in Lorestan province between 2013-2016.

Materials & Methods: All data related to gastric cancer was collected from the comprehensive cancer registration system and national population census data in Lorestan Province. To investigate the general characteristics, descriptive tables and graphs were used. Pearson correlation and linear regression model were used to evaluate the relationship between the incidence of stomach cancer and geographical factors and Arc Gis.ver10.8 software was used to compare the incidence rate of cancer. P-value <0.05 was considered as significant in the SPSS V.18.

Results: Totally 907 patients with gastric cancer were registered during 2013-2016, of which 68.7% were men, 82.4% were from urban areas, and 17.6% from the rural areas. Mean (standard deviation) of the age of patients was 66 (15) years. The cumulative incidence rate of gastric cancer in Lorestan province was 51.5 per 100,000 populations. The annual incidence rate varied between 9.1 and 18 per 100,000 populations. The relationship between incidence of gastric cancer and geographical factors was insignificant (p>0.05).

Conclusion: The cumulative incidence rate of gastric cancer in Lorestan province was 51.5 per 100,000 that relatively is high in Iran. There was no significant relationship between the incidence of gastric cancer and geographical factors.

Keywords: Incidence, Stomach Neoplasm, Geographic Mapping

➢ **Cite this paper**
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Introduction

Based on the results of cancer registration in 2018, gastric cancer was recognized as the fifth most common cancer in the world, with 1,033,701 cases in both genders (1). The Asian continent, including the countries of Korea with 39.6 per hundred thousand, Mongolia with 33.1 per hundred thousand, and Japan with 27.5 per hundred thousand populations, respectively, had the highest incidence rates of gastric cancer (2). Today, cancer is one of the most important phenomena related to health, which imposes a heavy burden on human resources and the national economy due to high mortality, disabilities, and the high cost of its treatment (2). The pattern of this disease is varied in different geographical regions, ethnicities, and economic-social classes and in different cultures (3).

According to statistics from the World Health Organization, the incidence of all types of cancers is increasing, and this disease will be the first cause of death in the world in 2030 (1). Gastric cancer is one of those multifactorial diseases in which several risk factors have roles in its development (4). Among known cancer risk factors, researchers attribute 2 to 10 percent of cancers to the geographical factors. In some cases, researchers have separated the role of living environment and environmental factors from hereditary factors by comparing the incidence rates of cancer in immigrant and resident populations (5).

Gastric cancer is the fourth most common cancer in Iran and ranks first and fourth in men and women, respectively (6). This disease is more common in the northern part of Iran and in West Azarbaijan province; it is the first and second most common cancer in men and women, respectively (6). Gastric cancer is one of the five deadliest cancers in Iran (7). The incidence rate of gastric cancer is 12 per hundred thousand people in the Iranian population (8). The incidence rate of gastric cancer is different in the provinces of the country, so that the highest incidence rate in men was reported from Ardabil and the lowest was from Kohgiluyeh and Boyer-Ahmad, and for women, the highest rate was from Semnan and the lowest rate was reported from Hormozgan and Kohgiluyeh and Boyer-Ahmad (9). Gastric cancer can be classified based on histological patterns and gross appearance. The World Health Organization (WHO) classification recognizes four major histologic types:

Tubular adenocarcinoma, the most common type, frequently forms polypoid or fungating masses. Histologically, it features irregularly shaped tubules filled with mucin and inflammatory debris. Papillary Adenocarcinoma (Typically found in older patients, this type is characterized by epithelial projections supported by a fibrovascular core and is often associated with liver metastasis). Mucinous Adenocarcinoma (comprising about 10% of gastric cancers, this type contains large pools of extracellular mucin, making up at least 50% of the tumor volume). Poorly Cohesive Carcinoma (This includes signet ring cell carcinoma, which is known for its diffusely infiltrating growth pattern, often leading to linitis plastica, where the stomach wall becomes thickened and rigid due to tumor infiltration) (10).

Additionally, gastric cancers can be categorized using Lauren's classification, which distinguishes between the intestinal type, more common in older adults and often linked to environmental factors like Helicobacter pylori infection, and the diffuse type, more aggressive and typically occurring in younger individuals, and it is characterized by poorly cohesive cells that invade the gastric wall extensively. Gastric cancer staging is crucial for determining treatment options and prognosis. The most widely used system is the TNM system, which assesses three key components:

T (Tumor): Describes the size and extent of the primary tumor. T1 (tumor invades the mucosa), T2 (tumor invades the muscularis layer), T3 (tumor penetrates the outer lining), T4a (tumor invades nearby organs without distant spread), and T4b (tumor invades distant organs). N (Node): Indicates whether cancer has spread to nearby lymph nodes. N0

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(no lymph node involvement), N1 (involvement of 1-2 nearby lymph nodes), N2 (involvement of 3-6 lymph nodes), and N3a/N3b (involvement of 7-15 or more than 16 lymph nodes, respectively). M (Metastasis): Indicates whether cancer has spread to distant parts of the body. M0 (no distant metastasis) and M1 (distant metastasis present). The overall stages are as follows: Stage 0 (high-grade dysplasia or carcinoma in situ), Stage I (tumor has invaded deeper layers but not spread to lymph nodes or distant sites), Stage II (tumor may have spread to nearby lymph nodes but not beyond that), Stage III (more extensive local invasion and lymph node involvement), and Stage IV (distant metastasis present, indicating advanced disease).

Understanding these classifications and staging systems is essential for guiding treatment decisions and predicting patient outcomes in gastric cancer management (10). Considering the importance of cancer in Lorestan province and the diversity and climate differences in this region, this study was conducted to investigate the incidence of gastric cancer and its relationship with geographical factors such as rainfall, temperature, sunshine hours, and climate type.

Materials and methods

Study Design

By a descriptive-analytical method, the incidence rate of gastric cancer and its relationship with geographical and climatic factors was investigated.

Setting and participants

All patients with gastric cancer who were diagnosed between 2013 and 2016 and registered in the Sima Cancer System (Electronic Management Integration System) and had permanent residence in Lorestan province were included in the study by census. Data related to patients, including date of diagnosis, age, sex, and place of residence, were obtained from the Health Vice-Chancellor of Lorestan University of Medical Sciences. According to ICD-10 (International Classification of Diseases), code C16 was considered for gastric cancer.

Also, the data related to mean annual rainfall, mean annual temperature, mean sunny hours, and climatic zones were collected by referring to the meteorological organization of Lorestan province, and the information related to vegetation cover was also collected by referring to the water resources organization of Lorestan province. The mean rate was used for the variables of rainfall, temperature, and sunny hours.

Also, the incidence rate per hundred thousand populations was estimated based on the population between the two national censuses of 2011 and 2016 and the population growth rate between them. According to the national census of 2016, Lorestan province had 11 cities. But due to the reasons that some data related to meteorology and natural resources, as well as the addresses of some patients, were not available separately and separable between the cities of Khorramabad and Dore Chegani and Kohdasht and Romeshgan, in this study, Khorramabad and Dore Chegani cities were considered as Khorramabad city, and Kohdasht and Romeshgan cities were considered as Kohdasht city.

Sample Size

All patients with confirmed gastric cancer, by a census manner, were selected and entered into the study. In total, 907 patients with gastric cancer were registered during 2013-2016, and all these patients were selected and entered into the final analysis.

Ethical consideration

Ethical concerns included acquiring the ethics code (IR.MEDILAM.REC.1399.277), ensuring integrity in library collection and data reporting, getting signed informed permission from all participants in accordance with the Declaration of Helsinki, and adhering to principles of human intervention.

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Measurements & Validity and Reliability

Data related to patients, including date of diagnosis, age, sex, and place of residence, were obtained by an already prepared checklist from the cancer registry system, and according to ICD-10 (International Classification of Diseases) code C16, it was considered for gastric cancer. Also, data related to geographical factors were requested from the meteorological organization and water resources organization of Lorestan province via a valid and standard format.

Statistical and Data Analysis

AData were analyzed via SPSS-18 software. To investigate the general and specific incidence of cancer by population, city, and different years, descriptive tables and graphs were used. Pearson correlation and linear regression models have been used to evaluate the relationship between the incidence of gastric cancer and geographical factors, and ArcGIS version 10.8 software was used to compare the incidence rate of cancer by mapping cities and their relationship with geographic factors. A p-value of less than 0.05 was considered significant.

Results

Based on the results of the data related to 907 patients with gastric cancer registered in the cancer registration center between 2013 and 2016, the mean ± SD age of all patients was 66 ± 15 years (male, 66 ± 16 years, and female, 64 ± 13 years).

Among the patients, 68.7% were males and 31.3% were females. Out of the total number of gastric cancer patients, 82.4% lived in the urban areas, and 17.6% were from the rural areas. In total, between 2013 and 2016, the cumulative incidence of gastric cancer in Lorestan province was 51.5 per 100,000, with the highest annual incidence corresponding to 2013 with an incidence of 18 per 100,000 and the lowest annual incidence rate corresponding to 2015 with an incidence of 9.1 per 100,000. Comparison of the cumulative incidence rate between the cities of Lorestan province: the highest cumulative incidence rate during these 4 years was related to Dorud city, with a cumulative incidence of 64 per 100,000, and Poldakhter and Aligoderz cities, with a cumulative incidence of 63.5 and 56.1 per 100,000, were in second and third ranks, respectively.

As it is shown in table 1, the lowest cumulative incidence rate was related to Azna city with an incidence of 40.4 per 100,000 population. The incidence of gastric cancer varied in different regions of the province, but this difference was not statistically significant (p=0.89). This means that there was no statistical difference in the cumulative incidence of gastric cancer in different geographical areas in Lorestan Province. The cumulative incidence rate of cancer in men was 2.2 times more than in women.

Table 1. Gastric cancer incidence (per 100,000) by city, sex and year in Lorestan Province between 2013-2016.

County	Gender	Incidence rate in 2013	Incidence rate in 2014	Incidence rate in 2015	Incidence rate in 2016	Cumulative Incidence rate
Khorramabad	Male	26.5	18.3	12.3	9.4	66.0
	Female	12.5	9.1	7.0	7.0	35.5
	Total	19.6	13.7	9.7	8.2	50.9
Borujerd	Male	16.1	22.6	11.6	15.3	65.6
	Female	5.9	5.3	8.6	8.6	28.2
	Total	10.9	13.9	10.1	11.9	46.9

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Dorud	Male	48.1	18.0	7.9	13.5	87.1
	Female	13.8	8.2	7.0	10.5	39.9
	Total	31.3	13.2	7.5	12.0	64.0
Kohdasht	Male	25.4	18.3	16.3	11.5	70.9
	Female	11.9	11.8	5.9	3.9	33.2
	Total	18.7	15.1	11.2	7.8	52.2
Delfan	Male	14.9	5.4	8.1	32.2	60.7
	Female	9.9	4.7	7.2	17.2	37.1
	Total	12.5	5.1	7.6	25	49.2
Selseleh	Male	32.5	13.6	2.6	10.5	58.5
	Female	11.0	2.8	8.0	2.7	24.4
	Total	21.8	8.2	5.3	6.6	41.6
Aligoodarz	Male	16.8	15.4	17.0	29.7	78.8
	Female	5.8	8.7	3.0	14.9	32.3
	Total	11.4	12.1	10.2	22.5	56.1
Azna	Male	8.4	19.5	10.5	30.6	69.6
	Female	8.4	2.8	0	0	11.2
	Total	8.4	11.1	5.3	15.3	40.4
Poldokhtar	Male	52.6	18.4	16.0	5.3	92.0
	Female	18.7	2.7	0	13.3	34.6
	Total	35.8	10.6	8.1	9.3	63.5
Total Incidence	Male	25.3	17.5	11.9	15.4	70.3
	Female	10.5	7.3	6.3	8.5	32.5
	Total	18.0	12.5	9.1	12.0	51.5

Based on table 2, considering the incidence rate of gastric cancer by place of residence, the lowest incidence rate of gastric cancer in urban areas was recorded in 2015 with an incidence rate of 11.4 per 100,000, and the lowest incidence rate in rural areas was in 2014 with an incidence rate of 3 per 100,000 population. The highest rate of incidence in both urban (22.3 per 100,000) and rural areas (11 per 100,000) was recorded in 2013. The cumulative incidence rate of the urban areas was almost 3 times more than the rural areas. There was a significant difference between the incidence of gastric cancer in urban and rural areas (p=0.03).

Based on table 3, amongst the different age groups, 25% of all patients were in the age group of 60-69 years, 5.7% were in the age group under 40 years, and almost 3% of patients were 90 years and older. With increasing age, the cumulative incidence increased significantly among the different age groups. The difference in the incidence rate of cancer in different age groups was statistically significant (p=0.001). From 2013 to 2015, the incidence rate of gastric cancer was decreasing in all age groups, but from 2015 to 2016, this trend increased only in the age group of 60 years and older.

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Table 2. Incidence rate (per 100,000) of gastric cancer by place of residence between 2013-2016.

Place of residence	Incidence rate in 2013	Incidence rate in 2014	Incidence rate in 2015	Incidence rate in 2016	Cumulative incidence rate	P value (chi square test)
Residence						0.03
Urban	22.3	17.6	11.4	16.4	68.9	
Rural	11.0	3.0	5.1	5.0	23.5	
Total	18.0	12.5	9.1	12.0	51.5	

Table 3. Incidence rate (per 100,000) of gastric cancer based on age groups between 2013-2016.

Age groups (year)	Incidence rate in 2013	Incidence rate in 2014	Incidence rate in 2015	Incidence rate in 2016	Cumulative incidence rate	Patient percentage	P value (chi square test)
Age groups							0.001
<40	1.5	1.3	0.7	0.6	4.0	5.7	
40-49	15.2	7.9	8.8	7.3	42.5	8.9	
50-59	35.5	27.2	22.4	17.7	107.1	16.0	
60-69	120.2	48.3	49.4	98.4	349.4	25.0	
70-79	162.7	99.1	73.7	99.9	418.7	22.2	
80-89	288.7	202.6	103.5	247.6	880.3	19.2	
≥90	282.2	530.0	70.6	187.9	1268.8	3.0	

According to the findings in Figure 1, the highest rate of gastric cancer was in Dorud City, and the lowest rate of cancer was in Azna City. Also, the cities of Dorud, Poldakhter, Aliguderz, and Kohdasht had higher incidence rates than the 4-year average of the province and were determined to be the high-risk centers and hot spots of the disease. According to figure 2, the relationship between gastric cancer in Lorestan province and the average annual rainfall showed that the highest incidence of gastric cancer (16 per 100,000) was from the areas with mean annual rainfall of 581.2±136.9 mm, and the lowest incidence rate (10 per 100,000) was from the areas with mean rainfall of 411.9±132.7 mm. The relationship between the incidence of gastric cancer and average annual rainfall was not statistically significant (p=0.06, r=0.31).

Figure 3 showed that the highest incidence rate of gastric cancer was observed in areas with a daily mean temperature of 16.8±0.3 degrees, and the lowest incidence rate was observed in areas with a daily mean temperature of 13.4±0.7 degrees. By increasing the incidence of gastric cancer, the mean daily temperature, with a little variation, was increasing, which was not statistically significant (p=0.21, r=0.22). As Figure 4 shows, in areas with average sunshine of 8.6±0.3 hours per day, the highest incidence of gastric cancer was observed, which was statistically non-significant. (P=0.48, r=0.12).

The highest rate of gastric cancer incidence was observed in wet and cold climatic regions, and the lowest incidence was observed in the semi-dry and cold climatic regions. Although the incidence rate of gastric cancer varies in different types of climates, this relationship was not statistically significant (P = 0.81) (Figure 5).

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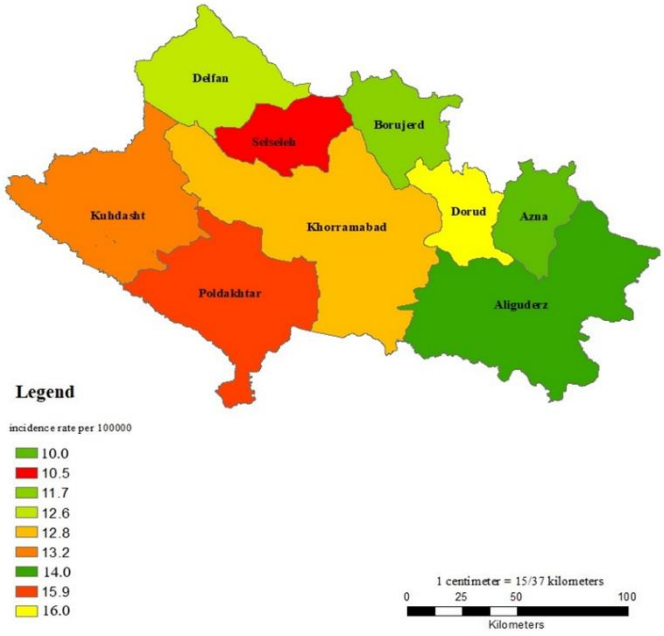


Figure 1. Four-year average incidence rate of gastric cancer by city in Lorestan province between 2013-2016.

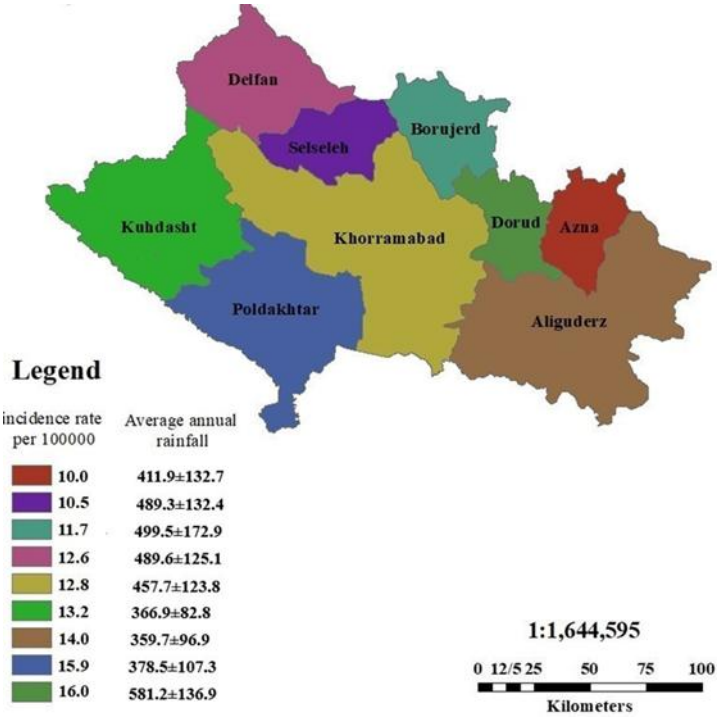


Figure 2. Four-year average incidence rate of gastric cancer based on mean annual rainfall in Lorestan province between 2013-2016.

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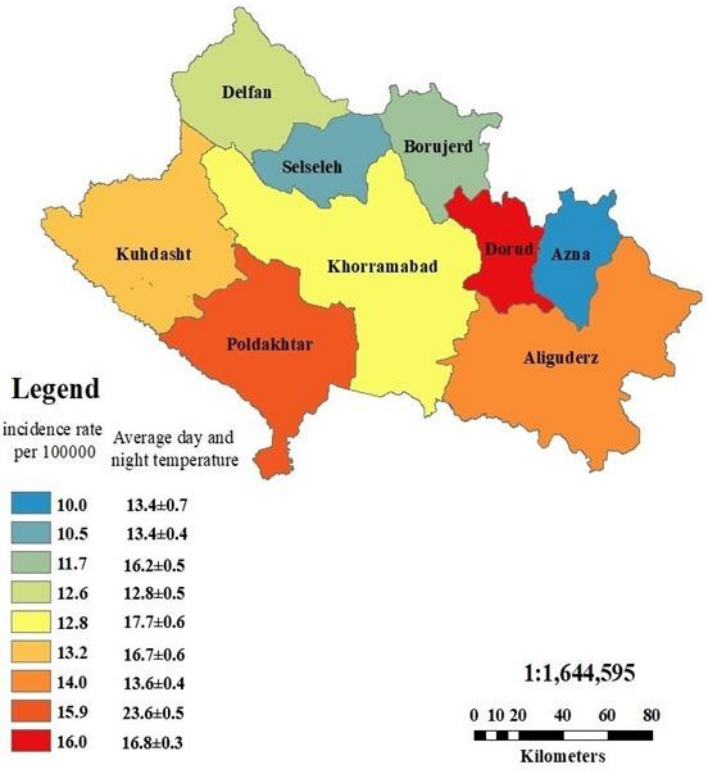


Figure 3. Four-year average incidence rate of gastric cancer by mean daily temperature in Lorestan province between 2013-2016.

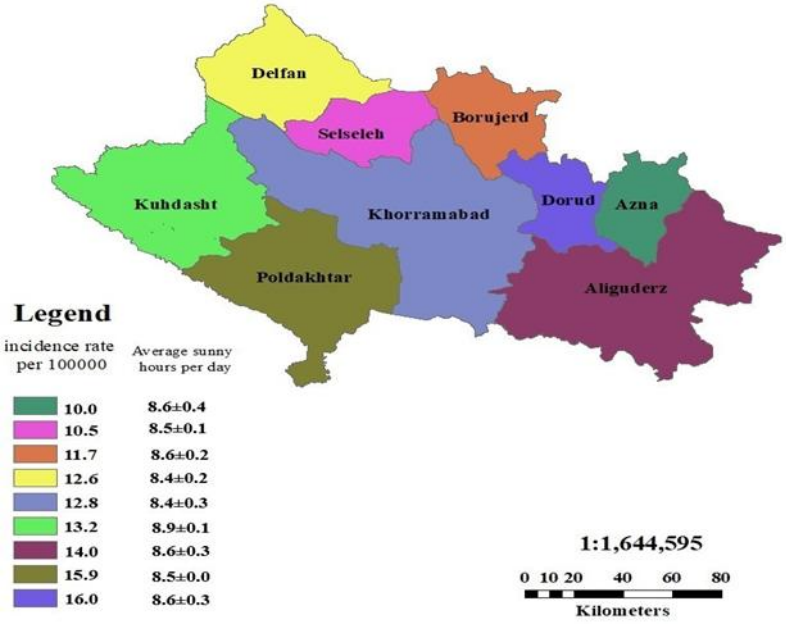


Figure 4. Four-year average incidence rate of gastric cancer based on average daily sunshine hours in Lorestan province between 2013-2016.

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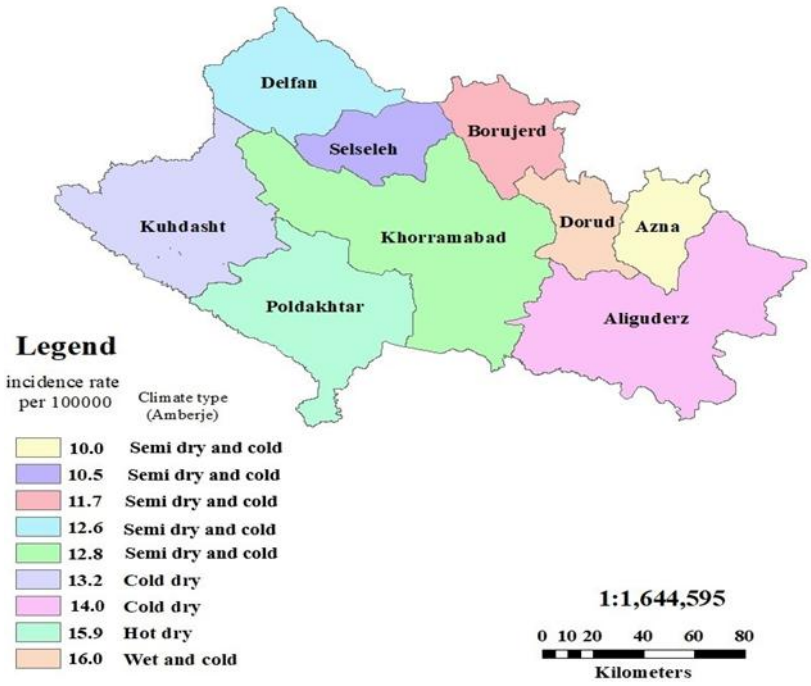


Figure 5. Four-year average incidence of gastric cancer based on the percentage of type of climate in Lorestan province between 2013-2016.

Discussion

The present study was conducted to determine the incidence rate of gastric cancer and its relationship with the geographical factors in Lorestan province between 2013 and 2016. According to the findings of the present study, the mean age of patients with gastric cancer was 66±15 years, and 68.7% of patients were male, with a male-to-female ratio of 2.2. Also, 82.4% of patients were from urban areas. In Iran, the annual incidence of gastric cancer is estimated to be approximately 30,000 new cases. This figure represents about 5.6% of all new cancer cases reported in the country each year (11). A study from West Azarbaijan Province reported that the mean age of patients with gastric cancer was 66.4 ± 12.5 years, of which 69.4% were male and 56.1% of them lived in urban areas (6). Also, another study from Kermanshah Province reported that the mean age of patients with gastric cancer was 66.5±13 years, 70.5% of these patients were male, and the ratio of male to female was 2.38 (12). The mean age of patients with gastric cancer in a study conducted in Kurdistan Province was 63.5 ± 11 years (13). In a study by Kalbasi et al., from the Mazandaran Province, the mean age of patients was 64.7±8.6 years (14). The results reported by all mentioned studies are consistent with the findings of the present study and show that the highest incidence of gastric cancer occurs in the 6th decade of life.

The male/female incidence ratio of gastric cancer in the current study was 2.2, and this ratio in similar studies, including a study by Rahimi et al. (15), Enayatrad et al. (9), and Somi et al. (16), was 2.7, 2.5, and 2.5, respectively, which are almost more than double. It seems that men are more involved with cancer risk factors than women, or women are more sensitive to personal health care than men. The current study showed that the annual incidence rate of gastric cancer during 4 years of study in Lorestan Province was between 9.1 and 18 per hundred thousand populations. A study by Rahimi et al. reported the incidence rate of gastric cancer in Hamedan Province between 5.9 and 7.8 per 100,000, in Kermanshah Province between 2.9 and 7.9 per 100,000, and in Ilam Province between 0.5 and 6.5 per 100,000 populations (15). In a study by Haidari et al., the incidence of gastric cancer in Iran was between 2.8 and 9.1 per 100,000 population (17). In a study that examined the trend of cancer incidence

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in the country, the incidence rate in men and women was reported as 11.37 to 19.16 and 5.20 to 10 per 100,000 population, respectively (9). High consumption of red meat, especially in the form of grilling on charcoal, is one of the characteristics of the culture of meat consumption among the people of Lorestan province. Grilling meat at a high temperature causes the production of aromatic hydrocarbons (carcinogens) (18). Considering the existence of a strong relationship between the high consumption of meat and its cooking method with the types of cancers known in humans (19), it can partially justify the high incidence rate of gastric cancer in Lorestan province. In some studies, the incidence of gastric cancer is higher in urban areas than in rural areas, which is consistent with the present study (20). Inactivity, smoking, environmental pollution, psychological factors, better diagnostic opportunities, and better socioeconomic status are more common in urban areas compared to rural areas, which may partially explain the difference in cancer in urban and rural areas (20, 21). While several studies have reported the incidence of gastric cancer in urban areas as less than that in rural areas (22, 23). Genetic/ethnic differences in populations (24), variations in the type of diet in different communities (25), and other factors can be effective in differences in these results.

The present study showed that, from 2013 to 2015, the frequency of gastric cancer in all age groups was decreasing, but from 2015 to 2016, this trend was increasing in the age groups above 60 years. The incidence of gastric cancer is different in many studies, so that in the study by Najafi et al. (26), Somi et al. (27), and a study from China (28), gastric cancer had a downward trend with the passage of time. In a study conducted in Gilan Province, the incidence of gastric cancer was relatively constant over a period of 15 years (29). Also, a study by Enayatrad et al. (9) and another study in western Iran showed the incidence of gastric cancer increased over a period of 6 years (15). The etiological factors of gastric cancer have not been fully identified yet, but genetic background (21), Helicobacter pylori infection, environmental factors such as nutrition and health status (30), socio-economic factors (31), and gastric reflux (32) can play a role in the incidence of this disease. Therefore, it seems a set of different factors determine the occurrence of gastric cancer, and by considering only one factor, the cause of its rising or declining could not be clearly determined. Based on the results of the present study, there was a non-significant relationship between the incidence of gastric cancer and the average annual rainfall. Also, a correlation was observed between the incidence of gastric cancer and the average annual temperature, which was not statistically significant. In a study by Ramezani et al., in the months with decreased rainfall, the number of patients with gastric cancer increased, and vice versa. Also, the visits of cancer patients increased in the months when the temperature increased (33).

A decrease in rainfall and an increase in temperature, which may affect the concentration of minerals, including salt, in drinking water and agricultural products, could be among the reasons for gastric cancer rising (34). In some studies, birth in a certain season of the year was also related to gastric cancer (35). The results of this study showed a non-significant relationship between the incidence of gastric cancer and average hours of sunshine, which is in line with the results of other studies. In an ecological study conducted by Najafi et al., they reported a strong negative correlation between the incidence of gastric cancer and ultraviolet radiation (36). Also, a negative correlation was reported between the mortality rate due to gastric cancer and ultraviolet radiation (37). In addition, in a study from Spain, there was no significant relationship between the rate of death from gastric cancer and ultraviolet radiation (38). Lack of vitamin D increases the risk of cancer (39), and exposure to the sun helps to strengthen the body's immune system as well as the body's natural production of vitamin D; that may be the reason behind this concept. The highest incidence rate of gastric cancer was observed in semi-humid

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and cold climatic regions, and the lowest incidence was observed in semi-arid and cold climatic regions. Although there was a relationship between the incidence of gastric cancer and the type of climate, this association was insignificant. In a study conducted in Khozestan Province by Rostami et al., although there was a relationship between the incidence of gastric cancer with vegetation and climate, this relationship was also statistically insignificant, which is consistent with the present study (40). In another study from Golestan Province, the highest incidence of gastric cancer was reported in dry climate areas, which is not consistent with the present study (2). Climate fluctuations can affect people's diets. When the weather is cold and humid, they often prefer to consume warm foods containing carbohydrates that are rich in energy in their diet, which may exclude many protective foods (containing antioxidants), such as fresh vegetables, from the food chain of these people and reduce the body's natural defense against cancer.

Strengths and Limitations

The strength of this study was evaluating any relationship between geographical factors and gastric cancer, which has not already been investigated in Lorestan province, and a relatively high sample size of participants. However, the effects of different geographical factors in different counties of Lorestan province did not show a significant association with the annual incidence of gastric cancer and could be considered a weakness in this study. This weakness may be solved by comparison of two different provinces with high variation of temperature or rainfall in future studies.

Conclusion

The results of this study showed that Lorestan Province is one of the high-risk areas for gastric cancer, and the incidence of this disease in this province varies by city, such that Dorud has the highest and Azna has the lowest incidence rate of gastric cancer. The average annual rainfall shows a relationship with the higher incidence rate of gastric cancer, but no significant relationship was found between the incidence of this disease and geographical factors. It is recommended that future studies investigate the ecological and epidemiological factors related to the occurrence of gastric cancer with larger sample sizes to achieve more reliable results in order to infer the causal relationship between the geographical variables and gastric cancer.

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Conflict of interest

There are no conflicts of interest to declare.

Authors' contributions

Conceptualization: AK, MBM, AG, Methodology: AK, MBM, NH, AG, SK, Validation, Formal Analysis: SK, MBM, Supervision: AK, Data Curation, Visualization: MBM, AK, SK, Investigation, Writing– Original Draft Preparation: MBM, Writing– Review & Editing: AK, SK, AG, NH, Project Administration: Ilam University of Medical Sciences.

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