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Incidence Pattern and Geographical Distribution of Breast Cancer among Females Using Geographic Information System in Kermanshah Province, West Iran: First Data from A Population-Based Cancer Registry in Kermanshah

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Abstract

Background: Breast cancer (BC) is the second most frequent cancer in females worldwide. In recent years, the incidence rates of BC have been increasing among Iranian women. This study aimed to examine the incidence of BC among females in Kermanshah province, west of Iran, based on the data taken from the Kermanshah Population-based Cancer Registry (KPCR) during 2014-2017.

Methods: In this registry study, data were obtained from the KPCR, a high-quality cancer registry that collects data on various cancers using standard protocols all over Kermanshah province. The crude incidence rates (CRs) and age-standardized incidence rates (ASRs) of BC were determined per 105 person-years. Further, temporal trends were assessed using joinpoint regression analysis to describe the average annual percent change (AAPC) and 95% CIs. ArcGIS software was used to map the geographic distribution of BC incidence.

Results: During 2014-2017, 1,177 new cases of BC were detected in Kermanshah province. Most of the females diagnosed with BC (cases/100,000, percentage) lived in Kermanshah county (900, 76%) compared to the other counties (277, 23%). The overall ASR of BC increased by 38.7 cases per 100,000 females-year (AAPC: 2.2; 95%CI 5.1–10.1; p=0.3). The lowest and highest ASRs were observed in 2015 (36.7/100,000) and 2017 (40.7/100,000), respectively. The maximum incidence of BC among females was reported in the age group 45-49 years.

Conclusion: The BC trend for females increased from 2014 to 2017 in Kermanshah province across all age groups, especially in the age group 45-49 years. Thus, it is essential to take a series of effective health measures to prevent and control this cancer.

Keywords: Breast Cancer, Incidence, Female, GIS, Registries

Conflicts of Interest: *None declared*
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Introduction

Breast cancer (BC) is the second most common malignancy diagnosed in females around the globe, which accounts for 24.2% of new cases of cancer (2.1 million cases)

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↑What is "already known" in this topic:
Breast cancer (BC) is the second most common malignancy and the fifth cancer-related death diagnosed in females worldwide. In recent years, the incidence rates of BC have been increasing among Iranian women. Therefore, data related to the provincial incidence of BC are necessary for national health planning measures.

→What this article adds:
In this study, we assessed the incidence of BC in females in Kermanshah province using the first data from a population-based cancer registry (2014-2017). Our results indicated that the BC trend for females increased during 2014-2017 in Kermanshah province across all age groups, especially in the age group 45-49 years.

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and 15% of the total number of deaths due to cancer (630,000 cases) in 2018 (1). The population of women constitutes 49.5 percent of the global population, a larger proportion of whom is aged >60 years (2). By 2040, the incidence of BC is expected to grow by over 46% (3). There are substantial regional differences in the BC incidence. According to the estimates of the GLOBOCAN 2018, the highest incidence rates of BC among women were reported in Australia/New Zealand, Western Europe, Northern Europe, and Northern America (approximately 90 per 100,000 people), and the minimum incidence rates were found in Central Africa and South Central Asia (~27 per 100,000 people) (1). The BC incidence rate is higher in developed countries than in developing countries, which generally reflects the higher prevalence of the cancer risk factors such as low parity, higher age at first pregnancy, use of oral contraceptive, sedentary career, use of HRT (Hormone Replacement Therapy), high-calorie diet, and alcohol ingestion in developed countries. However, the survival rate of BC is lower in less wealthy nations and in females with low-socioeconomic status (SES) and educational level (1, 4, 5). Compared to Europe and the United States, the incidence and prevalence of BC are lower in Asian countries. However, the mortality rate is much higher in low-income countries due to low BC awareness, late stage (III/IV) presentation, lack of successful implementation of a national screening program, and lack of access to healthcare facilities (6-8). Furthermore, Asia comprises about 60% of the global population (1). A series of studies have also reported that BC occurs sooner in Asian females (typically 40–50 years old) than in western females (typically 60-70 years old) (2, 9-11). Further, patients with BC are almost 10 years younger in developing countries than their counterparts in developed countries (9). The number of young cases (under the age of 35) changes from nearly 10% in developed nations to 25% in developing nations in Asia (2, 10). In Iran, BC accounts for 32% of all women with cancer and is the 6th major cause of death (4, 12). Based on the reports of the Iranian National Cancer Registry (INCR), the ASR of primary BC per year is 27.4/100,000 persons, with a crude rate of 22.6/100,000 persons (4, 13). In a previous study in Iran, the family history of BC, low parity and employment, and oral use of contraceptives were associated with an elevated risk of BC (5). Although the BC burden is still low in the country, its incidence and mortality rates have been on the rise in recent years (4, 14). Therefore, BC is expected to be a principal health problem than can put a remarkable burden on the healthcare systems of middle-income nations, including Iran, in the years ahead (15, 16). A cancer registry is a significant tool for any effective cancer control program (17). In Iran, the first formal data on cancer were reported by Habibi in 1962 (18). In nations like Iran, where risk factors such as the aging population, urbanization, and Western lifestyle are prevalent, BC will be a major challenge for the healthcare system in the near future (19, 20). Thus, it is necessary to collect data on the incidence of BC to take national health measures accordingly.

To the best of our knowledge, the female Breast cancer incidence rate in Kermanshah province using the data of the cancer registry system has not yet been reported. This study aimed to assess the incidence of BC in females in Kermanshah province using the data of the cancer registry system from 2014 to 2017. The findings may help to get a better understanding of the BC incidence in females and provide the local health authorities with scientific evidence for better prevention and control of BC.

Methods

Study Design

In this epidemiological study, data were obtained from the population-based cancer registry program in Kermanshah, Iran, from 2014 to 2017. The current study was approved by the Research Ethics Committee of Kermanshah University of Medical Sciences. Kermanshah, a province with a 24,640 km^2 area (1.5% of the total area of Iran) located in district 4 of western Iran, comprises 14 counties, 31 urban districts, 86 rural districts, and 32 cities (Fig. 1). The population of this province is about 1,952,434 million, accounting for 2.4% of the whole population of Iran. Further, approximately 47.9% of the population of this province is less than 30 years old, almost 10% of whom are more than 60 years old. The majority of residents are young or middle-aged adults (ages 20–54), and women comprise 49.4 % of all persons. Information about the population of Kermanshah was collected from the Statistical Center of Iran (SCI).

Data sources

In this study, data were obtained from KPCR during 2014–2017. KPCR gathers cancer data from all public and private diagnostic and therapeutic centers, including imaging, radiotherapy, chemotherapy, laboratory and pathology centers, and medical record departments in the hospitals of Kermanshah province. Data are obtained by the registry staff of KPCR through regular visits to all centers and from other sources collecting cancer registry-related data. The collected data included demographic information, cancer duration, location, cancer type, diagnosis date and method, anatomical site and tumor histology, ICD-O code, metastasis site, and cancer stage. Typically, invasive breast cancer can be described using the 10th version of the ICD code (ICD-10 code): C50 (21). According to the International Classification of Disease 10 (ICD-10), code C-50 indicates a malignant neoplasm of the breast. In the present study, we used this classification system for tumor histology and reported all the pathological data that were C-50, indicating invasive ductal carcinoma and invasive lobular carcinoma of the breast.

The obtained data were fed into Excel software and coded by the ICD-O coding system. Then, using unique codes, the duplicate reports were excluded. Next, all cases out of Kermanshah province were removed from the final analyses, and cases with code C-50 were subjected to analysis.

Crude and Age Standardized Rate (ASR) Analysis

The results were demonstrated as the number of cases by age classes and years, with crude rate, age-specific, and ASR per 100,000 people. A crude rate (CR) represents the number of new cancer cases or cancer-related deaths by the

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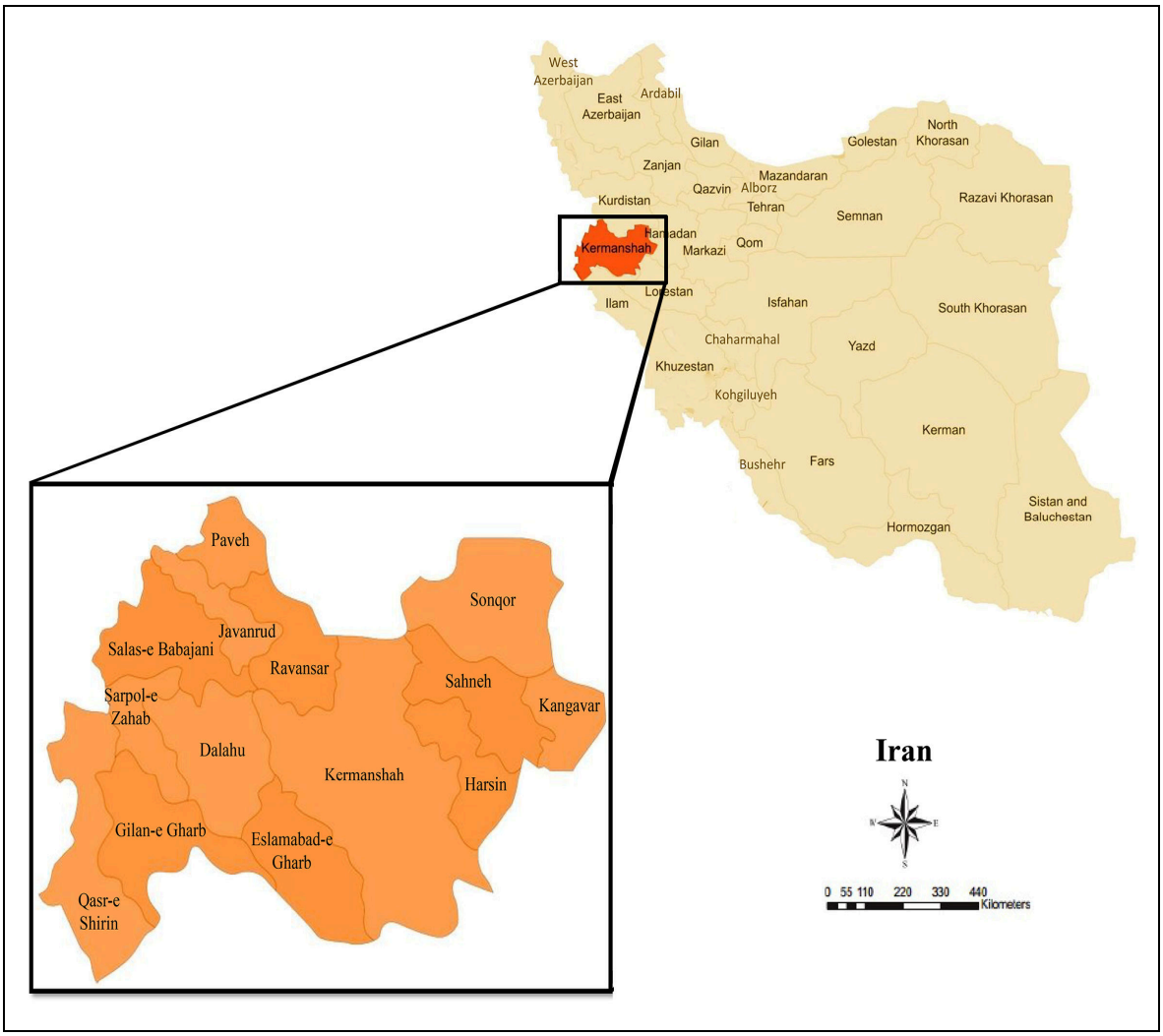

Fig. 1. Geographic situation of Kermanshah, Iran

population at risk during a certain time interval (22). World Standard Population-2000 was used to compute age-standardized incidence rates (ASRs) (per 100,000 populations - years) for 18 age groups of 5 years each (0–4, 5–9…, 85 and over) (23). The join point regression analysis program (version 4.7.0.0) was used to compute the average annual percentage change (AAPC) and the corresponding 95% confidence intervals (95%CIs). A *P*-value below 0.05 (typically ≤ 0.05) was considered statistically significant.

Mapping and Geographic Information System

The geographic information system (GIS) is a practical application that can assess the reasons by exhibiting the geographical distribution pattern of the prevalence of disease and quantitatively and qualitatively demonstrates the spatial distribution of the illness (13). After the data collection, ArcGIS software (version 10.2.2; ESRI, Redlands, CA, USA) and Microsoft Excel Worksheet were applied to map the geographic distribution of BC incidence and frequency, as described previously (24). Overall, all of these analyses were performed in the ArcMap environment. Also, the maps exhibit the most likely regions for BC incidence in red.

Results

Totally, 1,177 new cases of BC were detected in Kermanshah province from 2014 to 2017. Most of the women diagnosed with BC lived in Kermanshah (900 cases, 76%) compared to the other districts (277 cases, 23%) (Table 1). The mean (± SD) age at diagnosis was calculated to be 49.9 (± 11.9) years. The quality factors of KPCR were estimated as the number of cases with microscopic verification (MV=98.73) and cases diagnosed by death certificate only (DCO=1.27%).

The total ASR of BC was 38.7 per 100,000 persons-years. Although the trend was increasing, it was not statistically significant (AAPC: 2.2; 95%CI 5.1–10.1; p=0.303) (Fig. 2). It was higher in Kermanshah county ($53.1/10^5$) than in other districts ($20.8/10^5$), while the trend was similar for both (p=0.572) over the 4-year study period from 2014 to 2017. Table 2 presents the BC trends based on residence.

The age-specific incidence rates (ASRs) (per 100,000 persons-years) in age-subgroups of Kermanshah and other counties revealed that the incidence of BC started to grow in younger age categories (≥20 years) (Fig. 3).

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Table 1. Number, crude rate, and age-standardized incidence rates (ASRs) (per 100,000 persons-years) of BC in women; Kermanshah province, Iran (2014 to 2017).

District	Number	Crude rate (per 10^5 persons)	ASR (per 10^5 persons)	95%CI for ASR
Total	1177	38.7	38.7	36.5 to 40.9
Kermanshah	900	52.8	53.1	49.6 to 56.6
Other counties	277	20.8	20.8	18.3 to 23.2
Year				
2014	293	38.6	38.6	34.1 to 43
2015	279	36.7	36.7	32.4 to 41
2016	296	38.9	38.9	34.5 to 43.4
2017	309	40.7	40.7	36.1 to 45.2

CI: Confidence interval; The standard population in the current study was adopted from Segi's world standard population[23]

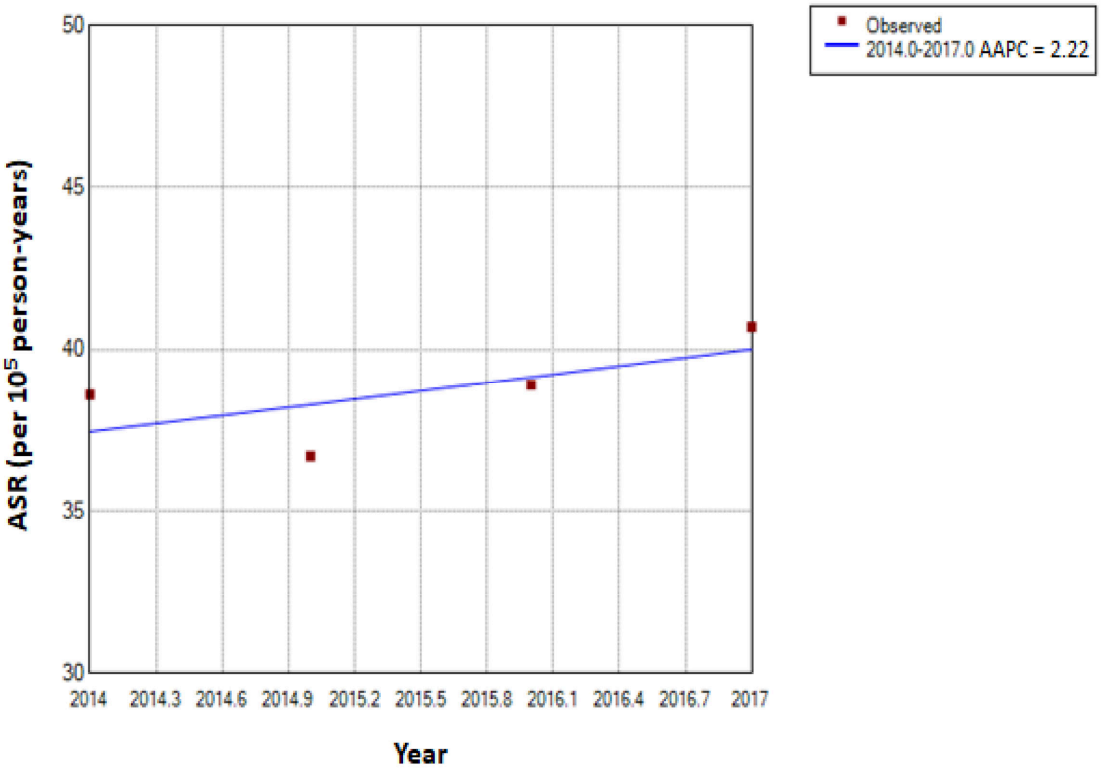

Fig. 2. Time trend analysis of the age-standardized incidence rates (ASRs) of BC in women, Kermanshah province, Iran (2014–2017). The diagram demonstrates that the average annual percentage change (AAPC) is remarkably different from zero at the alpha level =0.05. Final selected model 0 Joinpoint (s).

As shown in Figure 4, the maximum ASR of BC was observed in the age group 45-49 years in this period. In general, ASR was continuously elevated in younger age groups, i.e. 20–49 years, over the study period in Kermanshah province. However, the older age groups, i.e. 50-85 years, indicated a continuously decreasing trend for ASR from 2014 to 2017.

Table 3 presents the CRs and ASRs of BC incidence in different cities. The ASRs of BC incidence in the other cities of Kermanshah province were: Kermanshah (53.1, 76.47%), Harsin (32.1, 3.14%), Qasr-e-Shirin (27.9, 0.76%), Paveh (23.2, 1.78%), Sonqor (23.1, 33%), Kangavar (22.4, 2.29%), Sahneh (22.2, 2.21%), Sarpol-e-Zahab (21.1, 2.21%), Gilan-e-Gharb (19.8, 1.68%), Javanrud (18.4, 1.53%), Eslamabad-e-Gharb (17.8, 3.4%), Ravansar (14.5, 0.85%), Dalahu (13.3, 0.68%), and Salas-e-Babajani (7.4, 0.25%) (Table 3).

Further, the analysis exhibited geographic variations in ASRs and crude rate of BC in women in Kermanshah province and other counties during the study period (Fig. 5). Among counties, after Kermanshah county (ASR= 53.1, CR= 52.8), the highest ASR and crude rate of BC were reported to be 32.1 and 31.3 per 100,000 in Harsin, and also the lowest ASR (7.4/100000) and crude rate (6/100000) were observed in Salas-e-Babajani from 2014 to 2017. A summary of the current study, consisting of data collection, analysis and results, has been shown in Figure 6.

Discussion

Breast cancer (BC) is the most prevalent malignancy that affects 2.1 million females per year. It is also the major cause of cancer-related female death around the world (25). Generally, compared to many low- and middle-income countries (LMICs), developed nations have higher incidence rates of BC. In comparison with Western populations, Asian populations have been reported to have lower

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Table 2. The AAPC, CI, and p-value of BC by residence in women; Kermanshah province, Iran (2014–2017).

Residence area	AAPC	95% CI for AAPC		*P*-value
		Lower CI	Upper CI	
Kermanshah: Full range (2014-2017)	0.4	-14.5	17.9	0.944
Other counties: Full range (2014-2017)	7.9	-15.8	38.3	0.303

P-value<0.05 was regarded as statistically significant. AAPC: Average Annual Percent Change; CI: confidence interval

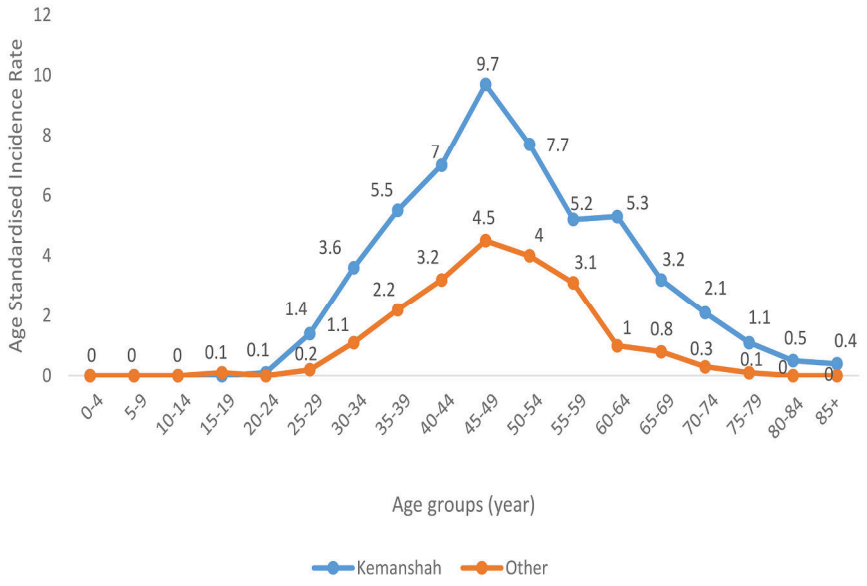

Fig. 3. The ASRs (per 100,000 person-years) of BC in women by residence, Kermanshah province, Iran (2014–2017).

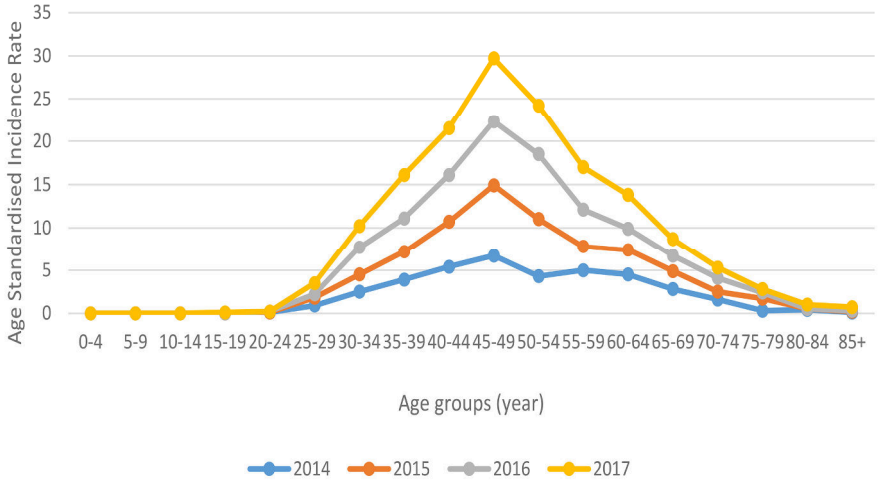

Fig. 4. Age-standardized incidence rate of BC per 10^5 by 5-year age groups in females in Kermanshah Province, Iran 2014-2017.

incidence rates (1, 5). Wide variations in the incidence patterns of BC show the risk factors and the availability of screening mammography (2). Additionally, in HICs, BC is usually detected early, with a good prognosis. However, in LMICs, BC is often detected later and is associated with a lower survival rate (2, 26). Despite the lower incidence rate in Asian countries than in European nations and the United States, the BC death rate is substantial in Asia (27). As a developing nation, Iran is experiencing an increase in BC (5,14). Based on the population pyramid, the population of Iranian young people is decreasing, and the population of aged people is expected to escalate to the maximum level before 2050 (28). According to GLOBOCAN 2018 statistics, ASR was found to be $31/10^5$ for BC in Iranian females. Moreover, 13,776 (27%) new cases and 3,526 new deaths were reported in 2018 in this country (1). The BC incidence rate varies in different parts of Iran depending on their lifestyles, age range, and behavior (29). PCR (Population-based Cancer Registry) records data on cancer incidence and deaths to describe and investigate epidemics in specified regions (30).

Our work reports an overview of BC incidence rates and

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Table 3. ASRs, CRs, and number of cases per 10^5 by cities (2014-2017).

County	2014-2017		
	N (%)	CRs	ASRs
Kermanshah	900 (76.47)	52.8	53.1
Harsin	37 (3.14)	31.3	32.1
Qasr-e-Shirin	9 (0.76)	26.3	27.9
Paveh	21 (1.78)	22.7	23.2
Sonqor	33 (2.8)	25.6	23.1
Kangavar	27 (2.29)	22.6	22.4
Sahneh	26 (2.21)	23.3	22.2
Sarpol-e-Zahab	26 (2.21)	19.8	21.1
Gilan-e-Gharb	19 (1.61)	20.8	19.8
Javanrud	18 (1.53)	16.4	18.4
Eslamabad-e-Gharb	40 (3.4)	18.2	17.8
Ravansar	10 (0.85)	14.1	14.5
Dalahu	8 (0.68)	13.9	13.3
Salas-e-Babajani	3 (0.25)	6	7.4

N: number; CRs: Crude incidence rates (per 10^5); ASRs: age-standardized incidence rates (per 10^5) using the standard world population

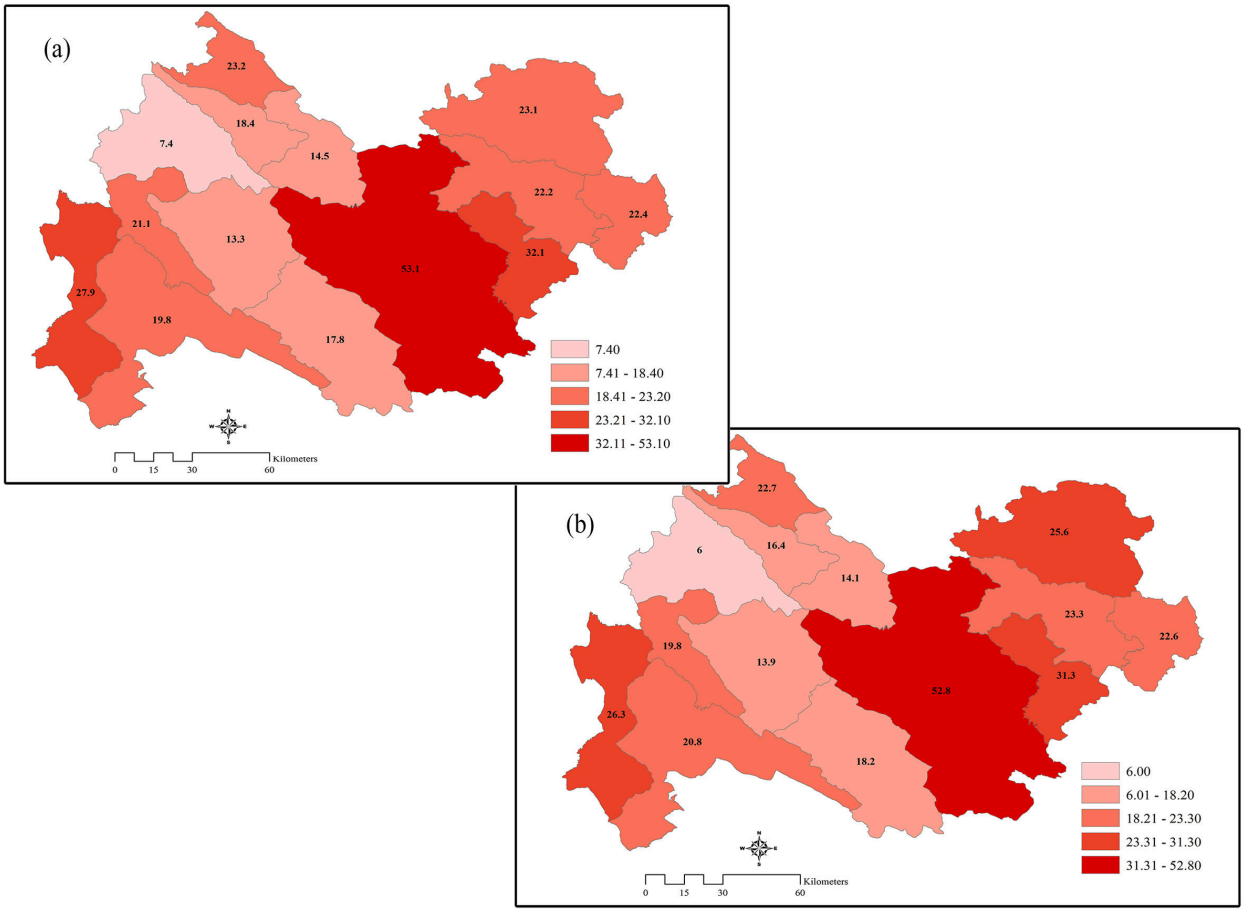

Fig. 5. BC incidence mapping was performed in the geographic information system (GIS). (a) ASRs and (b) crude rates of BC in females in various geographical regions of Kermanshah province, Iran (2014–2017). Colored bars represent ASRs and crude rates per 100,000 persons.

trends in females in Kermanshah province based on cancer registry system data during 2014-2017. The results indicated that the ASR of BC in Kermanshah decreased from 38.6/10^5 to 36.7/10^5 in 2015, which increased to 38.9/10^5 in 2016. This trend increased again to 40.7/100000 in 2017. Accordingly, a rising trend was observed in the ASR of BC from 2014 to 2017. According to statistics, ASR was over 80 per 10^5 in developed countries and lower than 40 per 10^5 in developing countries, which was in line with the results of the present study (20). Further, various studies performed in different areas of Iran have revealed similar findings. A study by Beyranvand et al. (31) demonstrated the ASRs of BC in Kermanshah province increased from 12.40 per 100,000 women in 2003 to 25.12 per 100,000 women in 2009. Further, considering the human development index (HDI) scores, this province already had a low HDI value (mean HDI=0.727). Taheri examined ASR for BC during a 5-year period in Markazi province in 2019. ASR rose from

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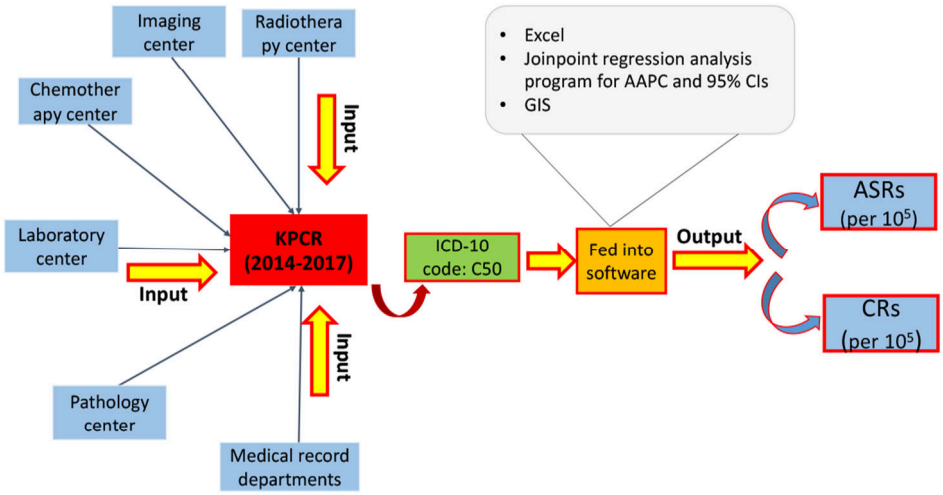

Fig. 6. Schematic summary of the current study

$27/10^5$ in 2010 to $31.5/10^5$ in 2014 (32). Another study performed by Roshandel et al. (16) in Golestan province showed an increase in BC incidence from 2004 to 2013 in all age groups, beginning in the female age group ≥20. The ASR of BC also elevated from 18.3/100000 in 2004 to 31.7/100000 in 2013. BC was the most prevalent cancer (cases/100,000, percentage) in Kurdish females (18.38, 24%), in Kurdistan (west of Iran) during 2010-2015 (28). In our research, the 0 joinpoints (Full model) were selected for the adjusted ASR for the woman. Similarly, Rafiemanesh et al. (33) studied the epidemiology of cancers in Sistan and Baluchestan province and reported a 0 joinpoint model for women.

The current study showed the maximum rate of BC in females belonging to the 45-49 age group. Various risk factors such as consumption of exogenous hormones (oral contraceptives and menopausal hormone replacement therapy), unhealthy lifestyle, physical inactivity, excess body weight, and genetic predisposition are probably responsible for the increased BC incidence in this age group (25, 34). The maximum incidence rate of BC was observed in the age range 40-49 years during 1998-2005 in Iran (35).

In the present study, BC incidence was significantly higher in females living in Kermanshah county than in those living in other places, confirming the results of other studies (16, 36, 37). This difference in the prevalence rate was obvious in both areas, which may in part be associated with the improvement of the cancer recording system, easier access to healthcare facilities in the center of this province, and changes in the risk factors (16, 20, 38). The highest and lowest total ASRs for females were found for Kermanshah county (ASR=53.1) and Salas-e-Babajani county (ASR=7.4), respectively. Moreover, several other probable reasons may have contributed to the increasing trend of BC in Kermanshah county, including obesity, more availability of technology, decreased physical activity and adoption of a sedentary lifestyle, higher age at the time of marriage and first pregnancy, and having few children (20, 39-41).

This study had some limitations. First, data in the current registry system were restricted to pathology, sex, residence, and age, whereas other data such as food habits, job, lifestyle, socioeconomic status (SES), and other risk factors have a key role in susceptibility to this cancer. Second, there was insufficient information about the date of patients' death, because of which we were not able to estimate the post-diagnosis survival rate. Third, there was no access to data on the tumor stage at diagnosis.

Conclusion

In conclusion, our findings demonstrated that the incidence of BC increased in Kermanshah province during 2014–2017 across all ages, starting with females aged ≥20. Moreover, the maximum BC rate was found in females in 45-49 age group, which can greatly influence society. Thus, according to the BC features in our province, the following measures need to be taken so as to successfully control the BC hazard: promoting the cancer registration system of the province, careful evaluation of BC risk factors, conducting synthetic prevention, reinforcing early detection and screening programs, performing basic and in-depth clinical studies, combining prevention programs, and controlling preventable risk factors.

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Ministry of Health and Health Education, distinguished Deputies of Health Affairs of Kermanshah University of Medical Sciences, experts, technicians, specialists, and the staff at Kermanshah Population-based Cancer Registry center, all public and private diagnostic and therapeutic centers, including imaging, radiotherapy, chemotherapy, laboratory and pathology centers and medical record departments in the hospitals of Kermanshah, as well as the collaboration of all those involved in the project are greatly appreciated.

Ethical approval

This study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (Code: IR.KUMS.REC.1398.880).

Conflict of Interests

The authors declare that they have no competing interests.

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