

Cancer incidence in Iran in 2014: Results of the Iranian National Population-based Cancer Registry

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ABSTRACT

Background: We aimed to report, for the first time, the results of the Iranian National Population-based Cancer Registry (INPCR) for the year 2014.

Methods: Total population of Iran in 2014 was 76,639,000. The INPCR covered 30 out of 31 provinces (98% of total population). It registered only cases diagnosed with malignant new primary tumors. The main sources for data collection included pathology center, hospitals as well as death registries. Quality assessment and analysis of data were performed by CanReg-5 software. Age standardized incidence rates (ASR) (per 100,000) were reported at national and subnational levels.

Results: Overall, 112,131 new cancer cases were registered in INPCR in 2014, of which 60,469 (53.9%) were male. The diagnosis of cancer was made by microscopic confirmation in 76,568 cases (68.28%). The ASRs of all cancers were 177.44 and 141.18 in male and female, respectively. Cancers of the stomach (ASR = 21.24), prostate (18.41) and colorectum (16.57) were the most common cancers in men and the top three cancers in women were malignancies of breast (34.53), colorectum (11.86) and stomach (9.44). The ASR of cervix uteri cancer in women was 1.78. Our findings suggested high incidence of cancers of the esophagus, stomach and lung in North/ North West of Iran.

Conclusion: Our results showed that Iran is a medium-risk area for incidence of cancers. We found differences in the most common cancers in Iran comparing to those reported for the World. Our results also suggested geographical diversities in incidence rates of cancers in different subdivisions of Iran.

1. Introduction

Cancer was the second leading cause of death with over 8.7 million deaths in 2015 [1]. It is predicted that the prevalence of cancers in developed countries will increase by 45% by the year 2025 [2]. According to the Globocan 2018 estimates, the shares of cancer incidence and deaths in Asia are 48.4% and 57.3%, respectively [3–5]. Population aging, population growth and increasing trends in the prevalence of risk factors of cancer in the developing world (consisting of 82% of the world population) resulted in increasing incidence and mortality of cancers among these populations [6].

Iran, as a developing country, has been faced with the above-mentioned situations, especially the population aging and increase in cancer risk factors during the recent decades [7]. After traffic accident and cardiovascular mortality, cancer was suggested as the third leading cause of death in Iran [7,8]. Regional reports from Iran showed increasing trends in the incidence of different cancers, especially breast and colorectal cancers [9,10]. Therefore, cancer control programs are among the main agenda for the control of noncommunicable diseases (NCDs) in Iran [11].

Access to epidemiological data on cancer has a pivotal role in cancer control planning. This may be sufficiently achieved by running

population-based cancer registries. Cancer registry activities were started in Iran in 1950s [12]. In 1984 a bill mandating the report of all tissues “diagnosed or suspected as cancer tissue” was passed by the Iranian Parliament [13]. Accordingly, the Iranian Ministry of Health and Medical Education (MOHME) started its formal cancer registry activities in 1986. The plan was to collect data on cancer cases from pathology centers, called pathology-based cancer registration and results were published as different annual reports [14]. However, the major limitation of this plan was underestimation of incidence rates [15], suggesting the need for more reliable cancer data by establishing population-based cancer registries (PBCR). During early 2000s, the MOHME started collaborative works with the Digestive Diseases Research Center of Tehran university of Medical Sciences, the International Agency for Research on Cancer (IARC) and local universities to run regional PBCRs in selected provinces. These collaborations resulted in establishment of two population-based cancer registries in Ardabil [16] and Golestan provinces [9,10,17], which were accepted as voting members of the International Association of Cancer Registries (IACR) and the data of the Golestan Population-based Cancer registry (GPCR) were published in the IARC’s Cancer Incidence in Five Continents [18]. In the late 2000s, similar regional PBCRs were started in some other provinces and different reports were published [19–21]. These regional reports were used in international projects including the Globocan project [6,22,23] to estimates cancer statistics for Iran at national level. The major limitations of these regional PBCRs included lack of organizational structures, poor access to financial support and possible discrepancies in operational plans and methods of data collection.

Therefore, in early 2010s, the MOHME planned to establish an integrated Iranian national population-based cancer registry (INPCR). The main aims of the INPCR include: to develop comprehensive national guideline for population-based cancer registries, to support and supervise establishment and maintenance of regional cancer registries in provinces, to collect and aggregate regional cancer data to produce and publish national cancer statistics.

In this paper, for the first time, we report the main findings of INPCR for the year 2014 which cover 98% of Iran population.

2. Methods

2.1. Population coverage

Population statistics at provincial and national levels for the year 2014 were obtained from the statistics office of the Deputy of health of the MOHME. It was a projection from the national census data of the

year 2011 obtained from the statistical center of Iran [24]. Fig. 1 shows the population pyramid of Iran in 2014. Total population of Iran in 2014 was 76,639,000, including 38,600,000 men and 38,069,000 women.

2.2. Organization of INPCR

Iran consists of 31 provinces and there are 60 medical universities in these provinces (some provinces consist of 2 or more medical universities). There are 248 public and 76 private hospitals in Iran. The number of pathology centers are 255 and 961 in public and private sectors, respectively. Treatment of cancer patients is not free of charge. According to the report of the statistical center of Iran, about 97% of Iranian population are covered by health insurance and almost all cancer patients refer to public and private hospitals in Iran for diagnostic and therapeutic services [25].

To cover all Iranian population, we needed to consider all 60 medical universities as administrative units of the MOHME. Therefore, the INPCR included a national-level secretariat (the INPCR secretariat) and 60 university-level secretariats. All of the university-level (regional) cancer registries are now active and collect cancer data from their population, prospectively. In provinces with only one medical university, the total population of the province is covered by the university cancer registry. Therefore, in these provinces, the university-level data (representative of total population of the province) were directly submitted to the INPCR secretariat. But, in provinces with two or more medical universities, university-level data were merged into provincial-level data and then the provincial-level data were submitted to the INPCR secretariat. Finally, the provincial-level data were merged into the national-level database by the INPCR secretariat.

2.3. Data collection

INPCR started data collection with data of the year 2014. The process of data collection for the year 2014 was finished in mid-2016. To ensure comparability of data, the INPCR developed a national guideline for PBCRs considering the standard protocols and operational plans suggested by international references including the IARC and IACR [26,27]. Then, the INPCR guideline was delivered to medical universities and all staff of university cancer registries were trained to follow the guideline and implement PBCRs on the population covered by their university. Three national level and 5 regional (3 days) workshops were held during which 150 cancer registry staff from all 60 universities were trained. Based on the guideline, the INPCR registered

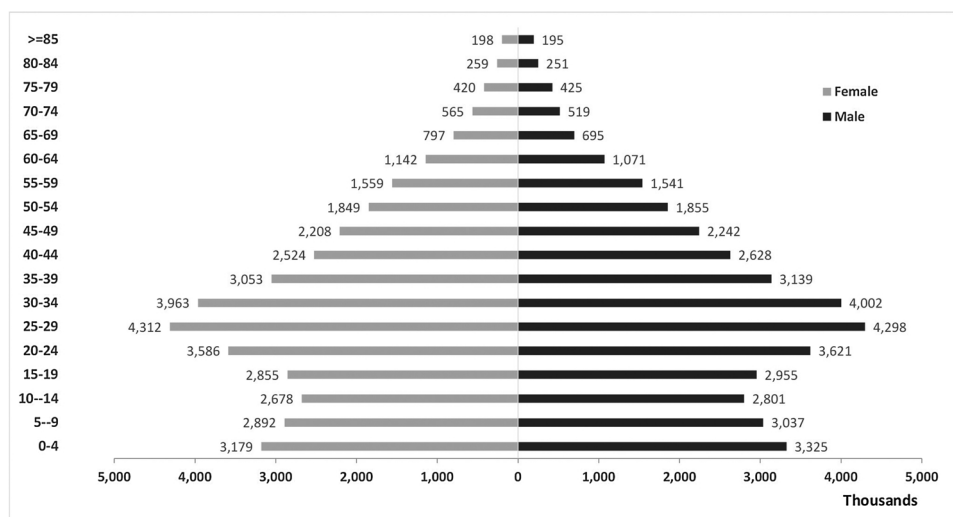


Fig. 1. Population of Iran, 2014.

only cases with new primary tumors with malignant behavior. For tumors of the central nervous system (CNS) and bladder, the INPCR registered only malignant tumors. In case of metastasis or recurrence, only initial primary tumors were registered. The multiple primary rule developed by IARC has been considered to determine occurrence of multiple primary tumors in a patient [28]. The standard patient registration form was developed considering mandatory and optional items for data collection. To ensure collection of accurate data on geographical distribution of cancers in different subdivisions, data on patients' place of residence was collected as a mandatory item.

The main sources for data collection included pathology reports from pathology centers, clinical/paraclinical data from hospitals. Overall, the data were collected from 1540 sources including 324 hospitals and 1216 pathology labs. Mortality data were also collected from death registry units of the medical universities. Using a linkage method, the mortality data were matched against cancer incidence data to identify cases with diagnosis made by death certificate only (DCO). The linkage was basically performed using patients' national identification number (national ID). But, because of lack national ID in some patients (about 40% of patients), other demographic information including first name, last name, father name, age and gender were also considered for linkage. Based on facilities available in each source, the secretariat of university cancer registries considered a combination of different methods for data collection including electronic-based or paper-based methods. In sources with electronic data collection facilities (using online or offline software), the mandatory and optional items (if applicable) were exported from the source-specific software into an excel file and the staff of university cancer registries collected the exported data files. But, in sources without these electronic facilities, the data were collected using paper-based registration forms.

The INPCR also developed a specific web-based application to facilitate and secure transmission of data from the university cancer registry secretariats to the INPCR secretariat, called Sima-ye-Saratan. Each university cancer registry secretariat could access the university dashboard using a username and password. Data could be entered into the Sima-ye-Saratan by data entry form (for individual data) or using import panel for batch files.

At the time of data entry, patient's place of residence was coded using an official list of divisions and subdivisions of Iran, obtained from the Statistical Center of Iran (SCI). The INPCR used the first revision of the 3rd edition of the International Classification of Diseases for Oncology (ICD-O-3) for coding tumor characteristics (i.e. topography, morphology, behavior and grade) [29]. Defining ICD-O code for tumor information is routinely performed by university cancer registry secretariat for all records at the time of data entry.

2.4. Data processing and quality control

After data entry, the staff of university cancer registry secretariat performed data processing and quality control using facilities provided by the Sima-ye-Saratan including person search, checking for duplicate records at patient and tumor levels and checking for internal consistency (cross checks between items including sex-tumor site, age-tumor site, ...). The data from already existing cancer registries (e.g. Golestan Polpulation-based Cancer registry) was also imported in the Sima-ye-Saratan and was processed similar to other new registries using the national guideline. At the first step, patient's information was entered into Sima-ye-Saratan. Then the registrar checked the dataset for potential duplicate records. If there was a duplicate record in the dataset, patient's information was updated and if there was no duplicate record in the dataset, the registrar continued to fill in tumor information. After entering tumor information and passing the internal consistency check, the record was confirmed as a new cancer case. If a patient referred to another province for seeking medical services, the registrar in the host province entered the code of patient's home province in the field of place of residence. Then the registrar in the patient's

hope province continued processing of patient's records (person search, ...). Therefore, there was no chance for duplicate registration of a patient when he/she referred to another province. After finishing the data processing and quality control by each university cancer registry, the university or provincial-level data were submitted to the INPCR secretariat, annually. The INPCR secretariat performed additional checks on quality of data, especially measures of the completeness and accuracy of data. If needed, the university data were returned to the university cancer registry secretariat for revisions/corrections or clarifications. After passing the final INPCR quality control, the data were accepted and used for final analysis.

2.5. Statistical analysis

Data were analyzed and reported as numbers, percent, crude incidence rates, age specific incidence rates and age standardized incidence rates (ASR) at provincial and national levels. The ASRs were calculated by Canreg-5 software [30] using the world standard population in 18 age categories of 5 years each (0–4, 5–9..., 85+). All rates were expressed per 100,000 population. The Segi-Doll world population was used to calculate ASRs [31].

3. Results

The INPCR could collect cancer incidence data for the year 2014 from 30 out of 31 Iranian provinces consisting of 76,639,000 Iranian population (98% of total population). Only one province (Qom province) was excluded from this analysis due to lack of data.

Overall, 112,060 new cancer cases (including skin cancers) were registered in INPCR in 2014. 60,432 (53.9%) of these cases were male and 51,628 cases (46.1%) were female. Patients' age was unknown in 71 (0.06%) of registered cases. The median (interquartile range) of cancer patients' age were 64 (53–75) and 56 (44–68) in male and female, respectively.

The diagnosis of cancer was made by microscopic confirmation (pathology or cytology) in 76,568 cases (68.32%). The method of diagnosis was DCO in 14,568 cases (13.00%). The remaining 21,001 patients (18.73%) were diagnosed by clinical only or clinical investigation methods. The primary site of cancer was unknown in 6298 cases (5.62%) including 3415 (5.65%) and 2883 (5.58%) in male and female, respectively. Patient's age was unknown in 37 (0.06%) men and 34 (0.06%) women. The distribution of diagnosis methods for all sites as well as for most common cancers in male and female are shown in Table 1. The distribution of methods of diagnosis by different provinces

Table 1
Distribution of diagnosis methods for most common cancers in Iranian National Population based Cancer registry (INPCR)-2014.

		MV ^a		Clinical ^b		DCO ^c	
		Number	Percent	Number	Percent	Number	Percent
Male	Stomach	4575	63.97	1123	15.70	1454	20.33
	Prostate	4199	70.57	895	15.04	856	14.39
	Colorectal	2711	71.45	610	16.08	473	12.47
	Bladder	4058	84.93	530	11.09	190	3.98
	Lung	1954	46.26	982	23.25	1288	30.49
	All sites	40730	67.40	11179	18.50	8523	14.10
Female	Breast	10498	80.00	2002	15.26	623	4.75
	Colorectal	2156	73.53	419	14.29	357	12.18
	Stomach	1911	57.06	544	16.24	894	26.69
	Thyroid	2610	89.60	266	9.13	37	1.27
	Leukemia	377	48.27	311	39.82	93	11.92
	All sites	35785	69.31	9818	19.02	6025	11.67

^a Microscopic verification (including pathology and cytology).

^b Clinical only or clinical investigations.

^c Death certificate only.

have been presented in supplementary Table 1.

The crude rate and ASR of all cancers (including skin cancers) in total Iranian population were 146.22 and 158.41 per 100,000, respectively. The ASRs of all cancers were 177.44 and 141.18 per 100,000 in male and female, respectively. The ASRs of all cancers, excluding non-melanoma skin cancer were 157.04 and 129.52 per 100,000 in male and female, respectively.

Cancers of the stomach (ASR = 21.24), prostate (18.41), colorectal (16.57), bladder (14.30) and lung (12.7) were the most common cancers in men and the top five cancers in women were malignancies of breast (34.53), colorectal (11.86), stomach (9.44), thyroid (6.98) and leukemia (5.4). Table 2 shows the number, percent, crude rate and ASR of 10 most common cancers in male and female in Iran. Number of cases, percent, age specific rates, crude rates and age standardized incidence rates (ASR) (per 100,000) of all cancer sites for male and female have been shown in supplementary tables 2 and 3, respectively.

Our results suggested very low incidence rate for cervix uteri cancer in Iran. The crude rate and the ASR of cervix uteri cancer were 1.76 and 1.78 per 100,000, respectively.

Figs. 2 and 3 show age specific incidence rates of 5 most common cancers in Iran in 2014 for male and female, respectively. The highest age specific rates were seen in the age group 75–85 years in almost all cancers. The age specific rate of breast cancer showed an early peak in the age group 40–50 years.

Our findings suggested high incidence of cancers of the esophagus, stomach and lung in provinces located in North/ North West of Iran. Our results also showed higher incidence rates for malignancies of the breast, colorectal, skin, thyroid, bladder, prostate and ovary in central parts of Iran. Figs. 4 and 5 show the distribution of 10 most common cancers in different regions and provinces of Iran in 2014 for male and female, respectively.

4. Discussion

Population-based cancer registries play a crucial role in cancer control planning. This very important data is not available in many low and middle-income countries where the cancer burden is increasing. We have established the national population-based cancer registry in Iran and provide the first report of cancer incidence for year 2014.

Regarding the quality evaluation of data, our findings suggested relatively low MV (68.28%) and high proportions for DCO (12.99%) and unknown primary site (5.62%). But, Comparing the INPCR data quality indicators with those from other high-quality cancer registries in the region [32,33], our quality indices are within acceptable ranges. For example, according to the reports of the volume XI of the cancer incidence in five continents, there were lower proportions of MV and higher proportions of DCO in cancer registries from South America, Africa and parts of Asia [33]. In addition, it should be mentioned that INPCR started data collection at national level with the new population-based plan in 2014 and the resulted quality indicators are encouraging for the beginning year of a national level population-based cancer registry in a large country like Iran.

The incidence rates of all cancers, excluding non-melanoma skin cancer were 157.04 and 129.52 per 100,000 in Iranian male and female, respectively. These rates were considerably low when compared with those reported globally for men (204.9) and women (165.2) [3]. In addition, the rates were much lower comparing to incidence rates reported from developed countries and even some neighboring populations (Turkey) [6]. According to the volume XI of the cancer incidence in five continents, higher rates of cancers were reported from different cancer registries from developed countries (e.g. USA, male = 338.4, female = 282.1; Australia, male = 388.2, female = 284.5) and also some cancer registries from Turkey (e.g. Izmir, male = 318.5, female = 204.6) [33]. According to the Globocan [3,6] as well as other local reports [34], Iran is a medium-risk area for incidence of cancers. Therefore, reports suggesting Iran as a high-risk area for cancers or

local claim of cancer tsunami in Iranian population are not true.

Stomach cancer was the most common malignancy in Iranian male population. The Globocan 2018 project suggested lung cancer as the most common cancer in the World's male population. Stomach cancer was reported as the fourth cancer in male for the World population [3]. The high incidence rate of stomach cancer in Iran may be due to a high prevalence of *Helicobacter pylori* infection as well as several local specific risk factors including higher salt intake, dietary habits and opium consumption [35–40]. Further studies are warranted to clarify risk factors and consequently design appropriate programs for prevention of gastric cancer in Iran.

As reported for other populations, breast cancer was the most common cancer in Iranian female population. We also found an early-peaking age specific rates of breast cancer in young age women (Fig. 3). Different reports suggested increasing trend in the incidence of breast cancer in total as well as in young age women, especially in the developing world [41,42]. There was no screening program for breast cancer at national and regional levels in Iran. Therefore, the increasing trend may be due to increase in the prevalence of previously known risk factors (e.g. reproductive factors, obesity, dietary habits) [41,43–45]. But these known risk factors may only explain a portion of the high incidence of this cancer in high-risk population. In other words, there may be unknown risk factors for high rates of breast cancer in different population [41]. Therefore, it is recommended to consider comprehensive population-based studies to identify most important known as well as unknown risk factors of breast cancer in Iranian female population, especially in the young women. This will help policy makers to develop targeted risk reduction interventions and will consequently help designing and implementation of more effective breast cancer controlling program among Iranian population.

The ASR of cervix uteri cancer in Iran was 1.78 per 100,000. The rates of cervical cancer in Iran was considerably low comparing to the global rates reported by the Globocan project (13.1 per 100,000) [3]. Previous reports from Iran also suggested low incidence rates for this cancer in Iranian population [7]. Specific religious beliefs and rules in Iran may be considered as the main indicator for low rates of this cancer in our population. In the other hand, these religious beliefs may act as a barrier to seeking medical care and this in turn may result in under-estimation of incidence cervix uteri cancer. Further studies are

Table 2

The number, percent, crude rate and age standardized incidence rates (ASR) (per 100,000) of 10 most common cancers in male and female in Iran (2014).

		Number	Percent	Crude rate	ASR
Male	Stomach	7150	11.83	18.52	21.24
	Prostate	5949	9.84	15.41	18.41
	Colorectal	5644	9.34	14.62	16.57
	Bladder	4776	7.90	12.37	14.30
	Lung	4222	6.99	10.94	12.70
	Leukaemia	2888	4.78	7.48	8.32
	Brain, nervous system	2412	3.99	6.25	6.66
	Esophagus	2178	3.60	5.64	6.47
	Non-Hodgkin lymphoma	1929	3.19	5.00	5.32
	Larynx	1418	2.35	3.67	4.32
	All sites	60432	100	156.56	177.44
	All site, but C44	53662	–	139.02	157.04
	Female	Breast	13120	25.41	34.49
Colorectal		4217	8.17	11.09	11.86
Stomach		3348	6.48	8.80	9.44
Thyroid		2912	5.64	7.66	6.98
Leukaemia		1891	3.66	4.97	5.40
Lung		1844	3.57	4.85	5.21
Brain, nervous system		1810	3.51	4.76	4.88
Esophagus		1776	3.44	4.67	5.13
Ovary		1657	3.21	4.36	4.52
Uterus		1304	2.53	3.43	3.67
All sites		51628	100	135.72	141.18
All site, but C44		47574	–	125.07	129.52

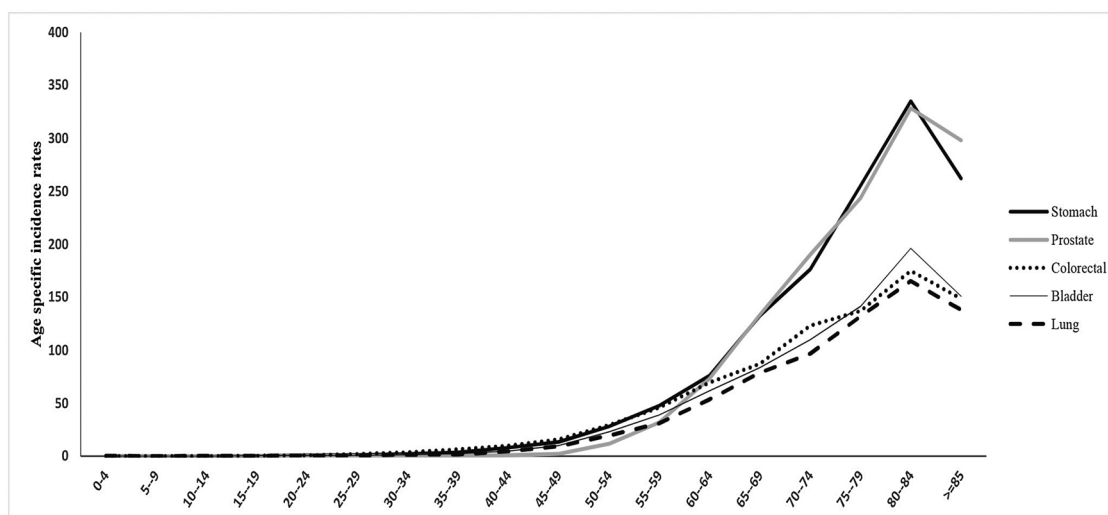


Fig. 2. Age specific incidence rates (per 100,000) of most common cancers in Iran, 2014 (Male).

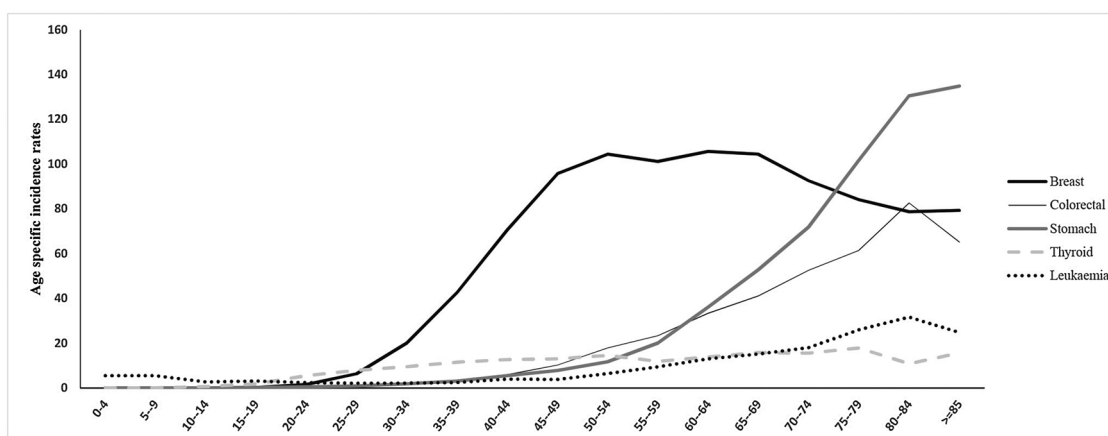


Fig. 3. Age specific incidence rates (per 100,000) of most common cancers in Iran, 2014 (Female).

warranted to clarify the point in Iranian population.

Our results suggested geographical variations among different subdivisions (provinces) of Iran. We found higher rates of cancers of the esophagus, stomach and lung in provinces located in North/ North West of Iran. Similar trends were previously reported for Northern parts of Iran and its neighboring countries in West of Asia [46,47]. This may be due to higher prevalence of risk factors including smoking in these regions [48]. Differences in life style and behavioral factors related to geographical latitude and altitude may also partly explained higher incidence of these malignancies in North/ North West of Iran. One possible explanation is related to cold weather and consequently higher usage of biomass as the primary fuel for cooking and heating in poorly ventilated houses in the northern areas. This may in turn result in producing considerable amounts of polycyclic aromatic hydrocarbons (PAH)-a known risk factor for upper GI and lung cancers [49,50]. Further regional, national and even international studies are needed to determine specific risk factors for high rates of upper gastrointestinal and lung cancers in these high-risk areas.

We also found higher incidence rates for malignancies of the breast and colorectal cancers in central parts of Iran. Central parts of consist of very big cities with higher rates of urbanization and consequently higher prevalence of risk factors related to westernized life style (e.g. obesity, un-healthy diet, low physical activity). Reports from a national wide study on risk factors for non-communicable diseases also suggested higher prevalence of these risk factors in these areas [51]. As reported, these are known risk factors for different types of cancers

including breast and colorectal cancers further epidemiological studies may elucidate the role of known risk factors and investigate possible unknown risk factors in these high-risk areas [41,45].

Our results showed relatively high incidence of CNS and bladder cancers in Iran. There are no evidence available regarding the etiologies of high rates of these cancer in Iran, although some risk factors were proposed for bladder cancer including infectious disease (schistosomiasis and human papillomavirus) and smoking [52]. Further studies are need to clarify the reasons for high rates of these cancers in Iran.

The most important limitation of this study was relatively low quality of data, although the indices of data quality were almost acceptable according to similar data reported in international project including cancer incidence if five continents. Anyway, the author are aware regarding the necessity of improving the quality of INPCR data and different procedures have been considered and the will hopefully result in improvement in the data quality in next years.

In conclusion, our findings suggested that comparing the incidence of rates of cancers in Iran with the average rates reported for the World, Iran is a medium-risk area for incidence of cancer. Cancers of the stomach and breast were the most common cancers in Iranian male and female, respectively. Our results also suggested geographical discrepancies in incidence rates of cancers in different subdivisions of Iran. Cancers of the stomach, esophagus and lung were more common in North and North whiles higher rates of cancers of the breast and colorectal were found in central parts of Iran. INPCR data may be helpful to inform local and national planners of the most common cancers at

Region	Povince	Total population	All cases	Stomach	Prostate	Colorectal	Bladder	Lung	Leukaemia	Nervous system	Esophagus	Non-Hodgkin lymphoma	Larynx	All sites	All sites_But C44*
North/ North West	Ardabil	642,000	1,055	48.38	12.79	15.19	10.56	14.74	11.28	4.66	13.09	3.03	3.21	191.19	173.2
	Golestan	935,000	1,302	24.79	15.47	17.68	10.22	18.72	8.57	7.09	15.81	5.97	5.51	180.44	170.38
	Guilan	1,251,000	1,939	18.69	13.58	14.68	12.89	9.59	4.79	4.93	4.67	3.40	3.21	134.98	122.24
	Mazandaran	1,581,000	2,651	25.26	16.24	14.78	10.61	10.48	8.37	3.46	6.64	4.69	3.47	160.84	148.35
	North Khorasan	445,000	620	35.83	8.31	11.64	10.11	9.22	5.02	5.40	16.20	3.39	11.64	172.38	155.33
	East Azarbayjan	1,918,000	3,989	34.22	19.46	20.77	13.82	21.18	5.21	6.64	12.69	2.94	4.21	206.93	186.5
	Kurdistan	761,000	994	27.64	8.72	10.91	9.81	15.99	5.22	5.24	10.83	3.40	2.82	148.91	133.92
	West Azarbayjan	1,613,000	2,984	32.21	17.76	15.63	20.67	23.48	11.31	10.12	12.66	5.51	4.60	224.04	201.74
Zanjan	526,000	1,062	48.08	16.08	14.42	11.30	13.93	7.41	9.60	16.80	3.37	2.34	225.34	208.45	
West	Hamedan	895,000	1,373	18.93	17.57	12.10	12.64	13.13	7.55	6.30	3.87	4.43	2.72	157.48	138.23
	Ilam	290,000	335	26.53	17.94	12.72	6.48	5.03	6.44	3.37	10.64	1.22	1.74	138.54	121.03
	Kermanshah	989,000	1,247	13.55	9.34	10.50	10.58	9.17	12.06	6.04	3.99	7.01	4.05	134.93	124.4
	Khozestan	2,376,000	2,886	13.52	18.13	15.21	12.95	12.60	8.73	6.32	2.88	7.86	3.83	166.93	148.22
	Lorestan	905,000	986	20.85	8.20	9.38	8.19	10.08	6.18	5.03	4.36	5.00	2.66	129.17	110.43
	Alborz	1,286,000	1,469	16.60	17.40	14.94	9.03	9.33	4.03	5.17	4.22	3.07	2.43	136.36	122.26
Center	Chaharmahal_Bakhteiari	465,000	607	14.63	10.01	13.39	14.87	9.76	2.95	4.03	2.62	6.14	3.63	156.9	131.88
	Ghazvin	628,000	927	19.66	13.99	16.13	13.38	9.66	11.64	7.86	6.21	5.38	3.69	173.16	145.28
	Isfahan	2,538,000	4,769	13.17	22.88	19.36	17.18	10.79	15.83	7.19	3.27	5.90	3.69	194.92	168.1
	Kerman	1,548,000	2,228	14.10	13.93	12.08	27.26	19.16	10.18	8.51	2.71	6.43	10.78	189.39	171.13
	Kohkilooye_Boyerahmad	347,000	445	23.51	18.53	6.39	12.22	8.13	10.08	5.52	7.20	5.06	3.57	163.91	143.9
	Markazi	736,000	939	17.52	8.77	10.06	9.82	10.77	5.64	7.52	3.75	2.26	3.68	126.82	113.33
	Semnan	335,000	567	22.44	16.94	24.29	13.51	12.10	5.17	8.63	10.10	2.98	4.95	177.9	158.66
	Tehran	6,329,000	12,388	19.14	26.56	23.38	16.93	11.88	7.86	7.47	4.17	6.23	4.37	200.91	173.47
	Yazd	550,000	1,093	10.73	28.05	22.19	24.91	10.90	13.06	9.96	3.75	8.71	5.22	234.43	198.17
	Razavi Khorasan	3,133,000	5,399	32.66	15.97	19.95	13.37	12.12	6.73	7.44	12.55	6.41	5.76	205.82	178.72
East	Sistan_Baloochestan	1,361,000	765	12.80	4.28	7.82	6.41	5.56	3.89	2.93	5.40	5.27	3.43	98.44	92.08
	South Khorasan	382,000	517	18.15	11.95	13.33	11.02	12.71	6.40	7.06	11.78	5.37	6.06	151.9	141.5
	Hormozgan	852,000	581	7.16	8.96	7.18	8.28	14.79	5.71	2.56	2.35	5.22	3.26	104.34	98.27
South	Bushar	599,000	617	10.50	15.05	10.76	18.54	15.53	11.54	6.08	3.95	2.69	4.09	152.71	145.53
	Fars	2,384,000	3,698	13.24	27.46	12.19	15.74	10.51	10.97	7.53	2.18	6.36	4.48	175.02	153.77

Fig. 4. Population number, total cases and age standardized incidence rates (per 100,000) of 10 most common cancers and all cancers in different regions and provinces of Iran, 2014 (Male). *C44 = non-melanoma skin cancer. (The red and green colors indicate the highest and the lowest incidence rates, respectively). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Region	Povince	Total population	All cases	Breast	Colorectal	Stomach	Thyroid	Leukaemia	Lung	Nervous system	Esophagus	Ovary	Uterus	All sites	All sites_But C44*
North/ North West	Ardabil	631,000	739	12.68	10.39	20.62	5.96	7.58	4.70	5.13	11.10	2.80	2.81	124.6	113.69
	Golestan	936,000	1,146	33.15	13.85	10.95	3.20	5.95	8.04	4.57	11.71	4.23	1.56	140.16	134.8
	Guilan	1,274,000	1,585	26.32	10.01	9.05	8.06	2.99	2.55	3.69	3.36	2.87	2.54	102.1	94.63
	Mazandaran	1,573,000	2,178	31.93	10.25	11.83	4.90	4.81	3.65	1.65	4.50	3.39	3.95	123.45	116.91
	North Khorasan	452,000	506	22.63	7.85	11.02	2.77	4.59	4.39	7.02	15.47	2.58	3.10	126.71	118.87
	East Azarbayjan	1,891,000	3,130	23.69	15.69	18.08	7.18	3.05	10.25	5.58	9.69	3.58	3.93	155.04	142.48
	Kurdistan	762,000	669	15.07	6.27	13.05	1.90	3.61	4.19	3.67	8.71	1.66	1.35	96.51	87.1
	West Azarbayjan	1,587,000	2,291	24.85	12.52	17.32	3.76	6.91	9.07	8.31	11.11	5.10	2.37	157.26	144.73
Zanjan	525,000	831	22.22	10.86	20.32	4.84	2.15	5.84	8.57	17.52	4.80	13.56	163.55	153.77	
West	Hamedan	893,000	965	19.59	9.15	6.47	5.50	5.81	3.74	3.88	2.59	3.90	0.91	102.62	93.96
	Ilam	285,000	292	31.12	14.97	9.37	4.35	5.87	3.04	1.13	11.42	0.98	1.39	124	108.98
	Kermanshah	981,000	1,100	28.15	10.24	4.89	4.89	7.36	5.09	3.25	3.89	3.04	1.75	112.59	105.12
	Khozestan	2,347,000	2,623	38.43	9.82	6.32	5.95	6.49	5.43	4.54	2.64	3.88	2.53	136.65	122.96
	Lorestan	897,000	733	14.71	5.69	10.13	4.37	2.46	5.33	1.65	4.72	2.19	1.18	87.66	77.8
	Alborz	1,260,000	1,305	31.61	10.36	7.06	2.86	3.24	2.74	2.57	3.20	4.51	3.28	111.41	103.18
Center	Chaharmahal_Bakhteiari	460,000	482	23.42	9.89	5.96	12.13	2.62	3.11	2.24	1.91	3.38	1.69	115.8	104.84
	Ghazvin	610,000	736	23.11	9.95	8.31	7.77	6.18	4.38	4.51	2.81	3.60	2.28	124.96	112.39
	Isfahan	2,469,000	4,368	42.65	13.33	6.42	12.99	12.21	4.50	5.60	2.13	6.01	5.03	170.91	155.6
	Kerman	1,524,000	1,840	29.93	8.01	7.32	9.94	5.73	5.72	4.99	1.60	5.22	3.64	141.12	127.87
	Kohkilooye_Boyerahmad	345,000	387	21.82	9.71	13.15	16.24	5.61	3.98	3.35	3.53	1.34	1.36	141.68	118.8
	Markazi	719,000	803	21.84	9.67	8.16	2.55	5.03	4.55	5.46	1.72	4.47	1.69	104.6	97.23
	Semnan	327,000	501	46.93	16.64	10.23	2.59	5.25	5.01	6.81	4.95	6.15	3.45	153.46	142.72
	Tehran	6,228,000	10,850	51.00	15.78	7.81	6.87	4.47	4.70	5.58	3.05	6.32	5.63	164.22	150.45
	Yazd	517,000	1,002	47.50	15.35	4.54	15.59	9.38	5.30	9.91	3.33	6.45	6.55	200.53	181.47
	Razavi Khorasan	3,130,000	4,978	45.89	14.76	10.11	7.47	4.34	5.40	5.27	10.34	4.36	3.78	173.24	158.37
East	Sistan_Baloochestan	1,364,000	743	16.36	6.20	5.59	3.54	2.48	2.67	3.24	5.93	2.60	1.41	87.77	82.48
	South Khorasan	379,000	435	22.87	12.79	9.65	4.83	5.20	6.99	6.07	7.51	2.91	0.94	119.45	112.67
	Hormozgan	822,000	608	26.42	6.13	5.28	4.68	5.31	3.94	2.44	2.39	4.50	1.51	99.33	93.26
South	Bushar	501,000	575	31.97	5.75	9.21	7.53	5.69	14.26	3.81	2.27	3.13	1.64	140.08	130.6
	Fars	2,350,000	3,227	35.79	8.75	6.31	11.74	7.11	4.70	6.35	1.77	5.26	4.26	142.26	129.07

Fig. 5. Population number, total cases and age standardized incidence rates (per 100,000) of 10 most common cancers and all cancers in different regions and provinces of Iran, 2014 (Female). *C44 = non-melanoma skin cancer. (The red and green colors indicate the highest and the lowest incidence rates, respectively). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

regional and national levels and may help them to design and implement targeted effective controlling programs for these cancers.

Authorship contribution

GR: designed the study, performed statistical analysis and wrote the manuscript; RMalekz: conceptualized and designed the study, edited, and critically reviewed manuscript; AlG, KZ, HoP, AO, GJ, AlR: initiated the study, interpreted data and critically reviewed manuscript; EP, FeS, SH, GoM, MoK, Asa: collaborated in data analysis and quality control at national level, edited, and critically reviewed manuscript; MD, ST: collaborated in data processing at national level and critically reviewed manuscript; HA, AA, MB, MC, LD, RD, FE, SE, MoF, SF, MaF, SV, ArG, MH, NH, HH, MI, AlJ, MaJ, AhJ, MeJ, PJ, YK, MKh, MKo, AM, RMalekp, AB, ZM, HM, GhM, RiM, MN, SN, HaP, AP, GP, AmR, BR, ZR, KR, AbR, GS, ASH, MeS, ZS, FaS, ASo, MaS, ZT, SY, MY, HZ, AZ: collaborated in collection of cancer incidence data at regional/university level, collaborated in data processing at regional/university level, collaborated in data analysis and quality control at regional/university level and critically reviewed manuscript; All authors read and approved the final manuscript.

Conflict of interest statement

The authors declare no conflicts of interest for this article.

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Appendix A. Supplementary data

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