Original Paper

Socioeconomic Inequalities in Cancer Incidence: A Comparative Investigation Based on Population of Iranian Provinces

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ABSTRACT: Cancer is the second important cause of death worldwide. Cancer is one of the top health priorities in Iran. We aimed to study the socio-economic inequality of cancer incidence in Iran provinces. We conducted this cross-sectional study using provincial data. We obtained the required data from the statistical yearbook report, the Statistics Center Report and the National Cancer Registration Program Report of Iran's Ministry of Health and Medical Education (MoHME) for 2018. Socio-economic inequality of cancer incidence was analyzed by estimating the concentration index and extracting the concentration curve. Statistical analyzes were performed using STATA 14. Our findings revealed that cancer incidence was unequally distributed in terms of the socio-economic status in Iranian provinces. Cancer incidence is slightly concentrated in the provinces with higher than average literacy, per capita income and insurance coverage and household size below average. The concentration of cancer incidence has been to the detriment of the provinces that have a slightly better ranking in terms of the socio-economic index. The employment rate did not significantly affect cancer's distribution burden. We recommend policymakers facilitate early cancer detection by providing insurance coverage for screening services, payment exemptions, and public awareness.

KEYWORDS: *Socioeconomic, inequality, cancer, Iran.*

Introduction

Cancer is the second important cause of death worldwide, with 18.1 million new cases and 9.6 million deaths in 2018 [1-3].

Evidence from [4] estimates disclosed that 19.3 million new cases of cancer and approximately 10.0 million cancer attributed deaths occurred worldwide in 2020.

The most common cancers diagnosed worldwide were breast cancer (2.26 million cases), lung cancer (2.21) and prostate cancer (1.41), and the most common causes of death were lung cancer (1.79 million deaths), liver cancer (830000) and stomach cancer (769000).

It is estimated that the number of newly diagnosed cancer patients will increase to 27,500,000 by 2040, and 16,300,000 patients will die [5].

Cancer is also one top health priority in Iran.

According to a national report on cancer registration by Iran's Ministry of Health and Medical Education (MoHME) (2021), in 2017-2018, the number of new cancer cases in Iran was 134,704. 64,788 (48%) cases occurred in women and 6,916 (52%) of cancers in men.

According to this report, the crude incidence rate and the standardized age incidence of all cancers in the country's total population were 166.54 and 168.56 per 100,000 people, respectively.

The most common cancers in the population were breast, prostate, colorectal, skin (non-melanoma) and stomach cancers.

Also, 55,785 cases of cancer deaths were reported in Iran in 2018 [6].

Figure 1 illustrates the geographical distribution map of the standardized age incidence rate for all cancers in Iran in 2018.

A gloomier color indicates a higher incidence.

Two central provinces of Iran (Isfahan and Yazd) had the highest standardized cancer incidence in 2018.

In contrast, south Khorasan, Lorestan, Zanjan, Sistan-Baluchestan and Hormozgan showed the lowest incidence rate.

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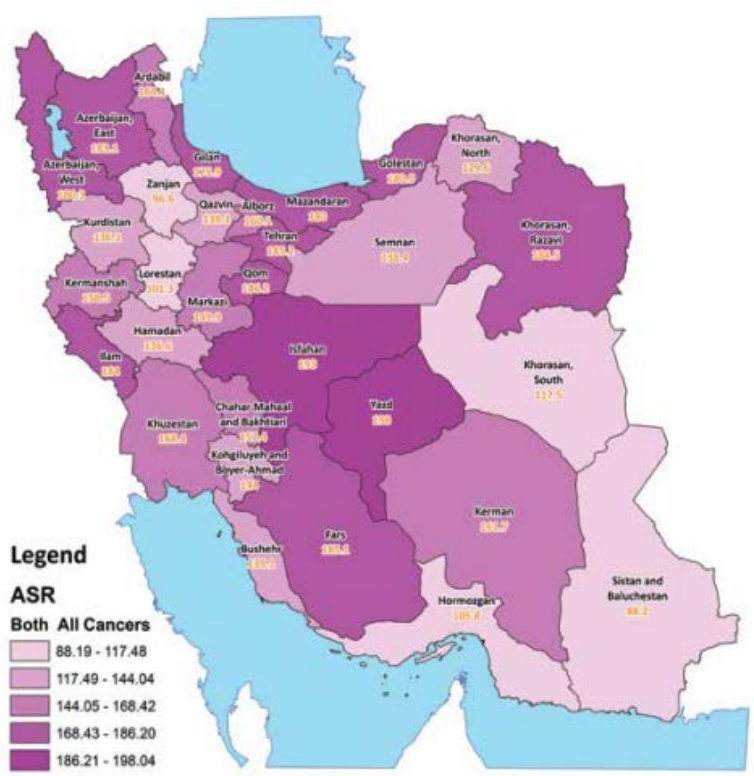

Figure 1. Map of the standardized age incidence rate (per 100,000 people) of total cancer in different provinces of Iran in 2018. Adapted from the national report on cancer registration by Iran's [7].

Figure 2 demonstrates the age-specific incidence for the five most common cancers in Iran for 2018.

Almost all cancers show rapid growth from the age of 50.

Only the incidence of breast cancer has accelerated from an early age.

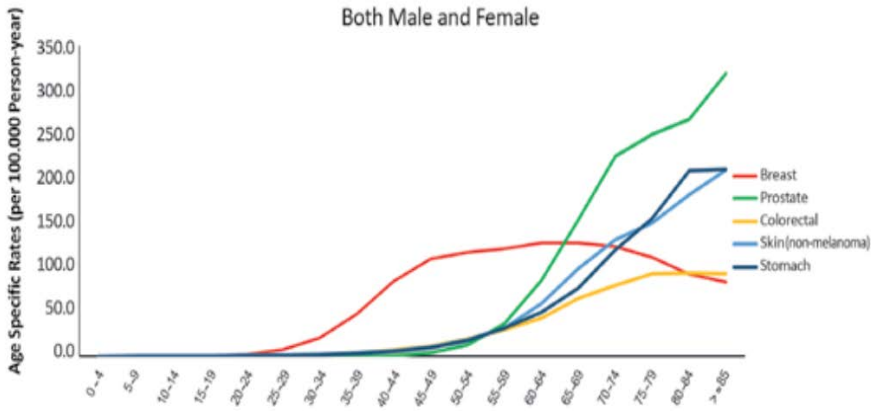

Figure 2. Age-specific incidence of five common cancers in the population of Iran in 2018. Adapted from the national report on cancer registration by Iran's [7].

The number of new cancer cases in Iran is expected to increase from 112,000 registered in 2016 to 160,000 in 2025.

That means an increase of 42.6 percent.

13.9 percent and 28.7 percent, respectively, will be due to the risk and population structure changes.

In terms of specific cancers, the most significant increase is predicted in the thyroid (113.8%), prostate (66.7%), breast (63.0%) and colon (54.1%).

Breast, colorectal and stomach cancers were the most common cancers in Iran in 2016, and it is predicted that by 2025, they will remain the leading cancers in the country.

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The increasing trend in the incidence of more common cancers in Iran reinforces the need for proper national design and implementation [8].

Modirian et al. reported 1025,443 years of life-adjusted life with cancer (DALY) in Iran, with gastric cancer having the largest share in DALY [9].

Rahmani et al. reported esophageal cancer burden in Iran from 1374 to 1394 74399 DALY [10].

One concern of health policymakers in disease control at the national level is how diseases are distributed in terms of the socio-economic characteristics of regions [11].

Socio-economic determinants can affect population health.

The World Health Organization (WHO) (2008, 2019) identifies social determinants as factors such as age and circumstances in which individuals are born, raised, live, work and disease control systems formed based on the distribution of money, power and global, national and local resources [12,13].

Siegel et al. (2019) state that despite a dramatic decline in overall cancer mortality rates from 1991 to 2016, social and economic inequalities in cancer deaths have increased in the United States [14].

It is identified that socio-economic status (SES), race, ethnicity, and residence have been causes of social inequalities in various cancer outcomes [15].

For example, a systematic review of eight studies by Redondo-Sánchez et al. [16] found that people with lower socio-economic status appear to have a higher chance of developing lung cancer and death than those of higher socio-economic class.

Patients in the lower socio-economic class also have lower cancer survival.

Mihor et al. [17] also confirm in their study that belonging to low SES increases the risk of cancers of the head and neck, esophagus, liver and gallbladder, pancreas, lungs, kidneys, bladder, penis and cervix.

Alcaraz et al. [11] have presented the social determinants of cancer equity as the conceptual framework of Figure 3.

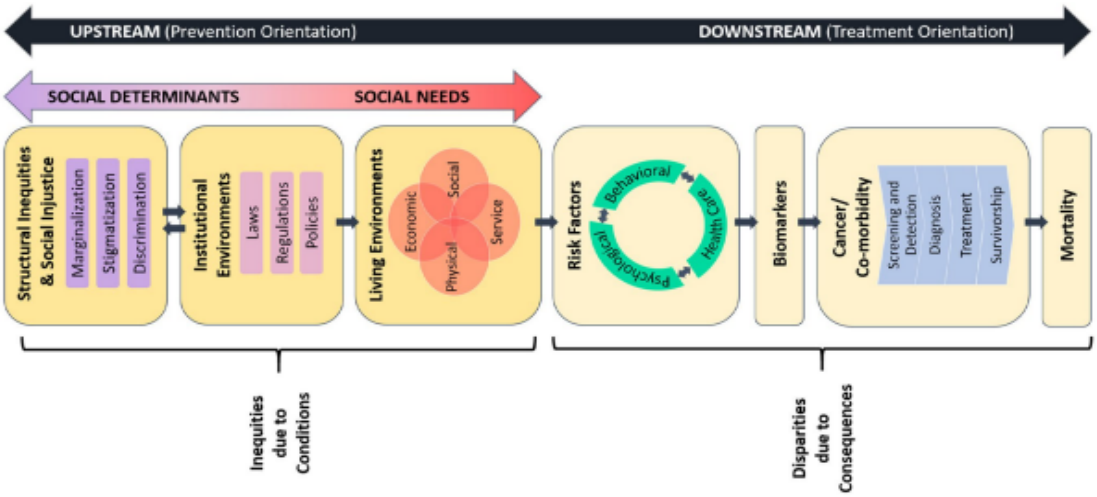

Figure 3. Integrated conceptual framework for cancer equity [11].

Given the importance of socio-economic factors in the burden of cancer, we aimed to study the distribution of cancer incidence based on the socio-economic characteristics in Iran' provinces.

Materials and Methods

This study is based on data from 2017 to 2018 and aims to describe and decompose the socio-economic distribution of cancer incidence in Iran's provinces.

We examined the distribution of cancers reported by the MoHME based on provincial variables such as average household income, population literacy rate, employment rate, insurance coverage percentage and socio-economic index.

We obtained the required data from the statistical yearbook report and the household income and the Statistics Center's expenditure report, and the national report of the National Cancer Registration Program of Iran's MoHME for 2018.

These data are reported annually for 31 provinces.

Socio-economic index for each province was created using Principal Component Analysis (PCA).

PCA is a multivariate technique whose primary purpose is to reduce the dimension of a multivariate data set as much as possible to explain the primary variables changes in the data set.

This goal is achieved by converting the primary variables into a new set of uncorrelated variables called principal components [18].

It is noteworthy that the socio-economic index comprises annual per capita income, annual per capita expenditure, literacy rate, employment rate and insurance coverage percentage for each province.

The concentration index was estimated, and the concentration curve was extracted to assess the distribution of cancer incidence based on the socio-economic characteristics of the provinces.

A concentration curve is used to identify socio-economic inequality in some health variables.

The concentration index [19,20] is calculated from the concentration curve and measures health variables' degree of socio-economic inequality [19,21].

The concentration index is equal to twice the area between the concentration curve and the 45-degree line.

When there is no socio-economic inequality in the distribution of a health variable, the concentration index is zero.

When the curve is above the 45-degree line, the index becomes negative.

It indicates that the health variable is concentrated among the poor.

A positive index value means that the concentration curve is below the equality line, showing that the health variable is concentrated among the rich.

The concentration index is defined as:

$$C=\frac{2}{N\mu}\sum_{i=1}^{n}h_i r_i - 1 - \frac{1}{N}$$

h_i is the health variable, μ is its mean, and $r_i=i/N$ is the fractional rank of individual i in the living standards distribution, with i=1 for the poorest and i=N for the richest [22].

The index is limited between-1 and 1.

All estimates and calculations were performed in the STATA 14.

The present study was approved by the ethical committee Qazvin University of Medical Sciences (ethics code IR.QUMS.REC.1400.449).

All methods were performed in accordance with the relevant guidelines and regulations.

Results

Table 1 shows the statistical parameters of the variables for 31 provinces.

The average raw incidence for 2018 was 4344.61±5163.48, and the percentage of cancer incidence in the same year was 0.15±0.04.

The highest annual per capita income was 126,000,000 Rial, and the lowest was 40,500,000 Rial.

Further, the highest and lowest indices of 2.76 and-1.90 have been calculated, respectively. Statistical descriptions of other variables are provided in Table 1.

Table 1. Statistical description of variables.

Variable	Mean	SD	Min	Max
N	2615129	2519337	586000	13,500,000
AHS	3.53	0.36	2.77	4.40
RI	4344.61	5163.48	868	27033
IR (%)	0.15	0.04	0.05	0.22
ER (%)	87.94	2.97	78.40	92.1
HIC (%)	105.64	7.69	77.43	118.81
LR (%)	86.41	3.55	76	92.9
AAPCI (Rial)	75,300,000	18,300,000	40,500,000	126,000,000
AAPCE (Rial)	66,900,000	14,600,000	35,800,000	105,000,000
SEI	-9.68e-09	1.003	-1.90	2.76

N: Population, AHS: Average of household size, RI: Raw incidence, IR: Incidence rate, ER: Employment rate, HIC: Health insurance coverage, LR: Literacy rate, AAPCI: Average of annual per capita income, AAPCE: Average of annual per capita expenditure, SEI: Socio-economic index

Table 2 presents the mean and standard deviation of the variables based on socio-economic index quartiles.

The fourth quartile had the highest raw incidence (8408.37±8084.37) and rate of cancer incidence (0.194±0.025).

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While the lowest raw incidence was in the second quartile, and the lowest rate of cancer incidence was in the first quartile.

The average household size in the first quartile (3.89±0.36) was more significant than the other quartiles.

Table 2. Mean and standard deviation of variables based on socioeconomic index quartiles.

Variable	Quartile 1th		Quartile 2th		Quartile 3th		Quartile 4th	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
N	2637571	1325756	1798875	2150314	1814000	1291476	4212875	3962038
AHS	3.89	0.36	3.55	0.33	3.47	0.27	3.26	0.23
RI	3488.85	2119.82	2544.12	3491.14	2830.12	2633.48	8408.37	8084.37
IR (%)	0.131	0.037	0.132	0.036	0.143	0.029	0.194	0.025
ER (%)	85.6	3.37	89.51	1.54	88.17	3.83	88.20	1.67
HIC (%)	105.87	5.62	109.26	5.86	108.75	4.87	98.72	9.35
LR (%)	82.87	3.49	86.16	3.14	86.77	1.90	89.41	2.67
AAPCI (Rial)	56,500,000	8,186,490	67,600,000	1,583,413	74,500,000	4,445,010	100,000,000	15,100,000
AAPCE (Rial)	52,800,000	10,700,000	60,800,000	5,764,852	67,900,000	4,235,322	84,300,000	13,500,000
SEI	-1.02	0.44	-0.42	0.08	-0.05	0.24	1.36	0.82

N: Population, AHS: Average of household size, RI: Raw incidence, IR: Incidence rate, ER: Employment rate, HIC: Health insurance coverage, LR: Literacy rate, AAPCI: Average of annual per capita income, AAPCE: Average of annual per capita expenditure, SEI: Socio-economic index

The concentration index of cancer incidence based on provincial socioeconomic variables is presented in Table 3.

All concentration indices except the employment rate index are statistically significant (P<0.05).

The concentration index of employment rates, insurance coverage and household size were negative.

Only the last two indices were statistically significant (P<0.05).

Interestingly, the index related to the provincial socioeconomic index was estimated positive and statistically significant (P<0.05).

Table 3. Erreygers concentration index of cancer incidence by provincial explanatory socioeconomics variables.

Concentration Index Based on:	Obs.	Index value	SE	p-value
Literacy rate	31	0.37	0.15	0.021
Employment rate	31	-0.09	0.01	0.956
Per capita income	31	0.56	0.13	0.002
Per capita expenditure	31	0.55	0.13	0.003
Insurance coverage	31	-0.41	0.15	0.011
Household size	31	-0.49	0.14	0.002
Socio economic index	31	0.57	0.13	0.002

Six graphs reflected in Figure 3 display the concentration curves of cancer incidence based on provincial socioeconomic variables.

Curve A displays that the cancer concentration has been very little in provinces with a higher than average literacy rank.

Curve B indicates that the cancer burden is concentrated almost equally between provinces regarding employment rate.

Curve C displays that the cancer incidence is concentrated in the provinces that are slightly better off in terms of annual per capita income.

Curve D shows that cancer incidence is concentrated in provinces ranked above average in annual per capita expenditure.

The E curve shows that cancer incidence is slightly concentrated in provinces with poorer insurance coverage.

Finally, The F curve demonstrates that cancer incidence is concentrated in provinces that are below average rank in terms of household size.

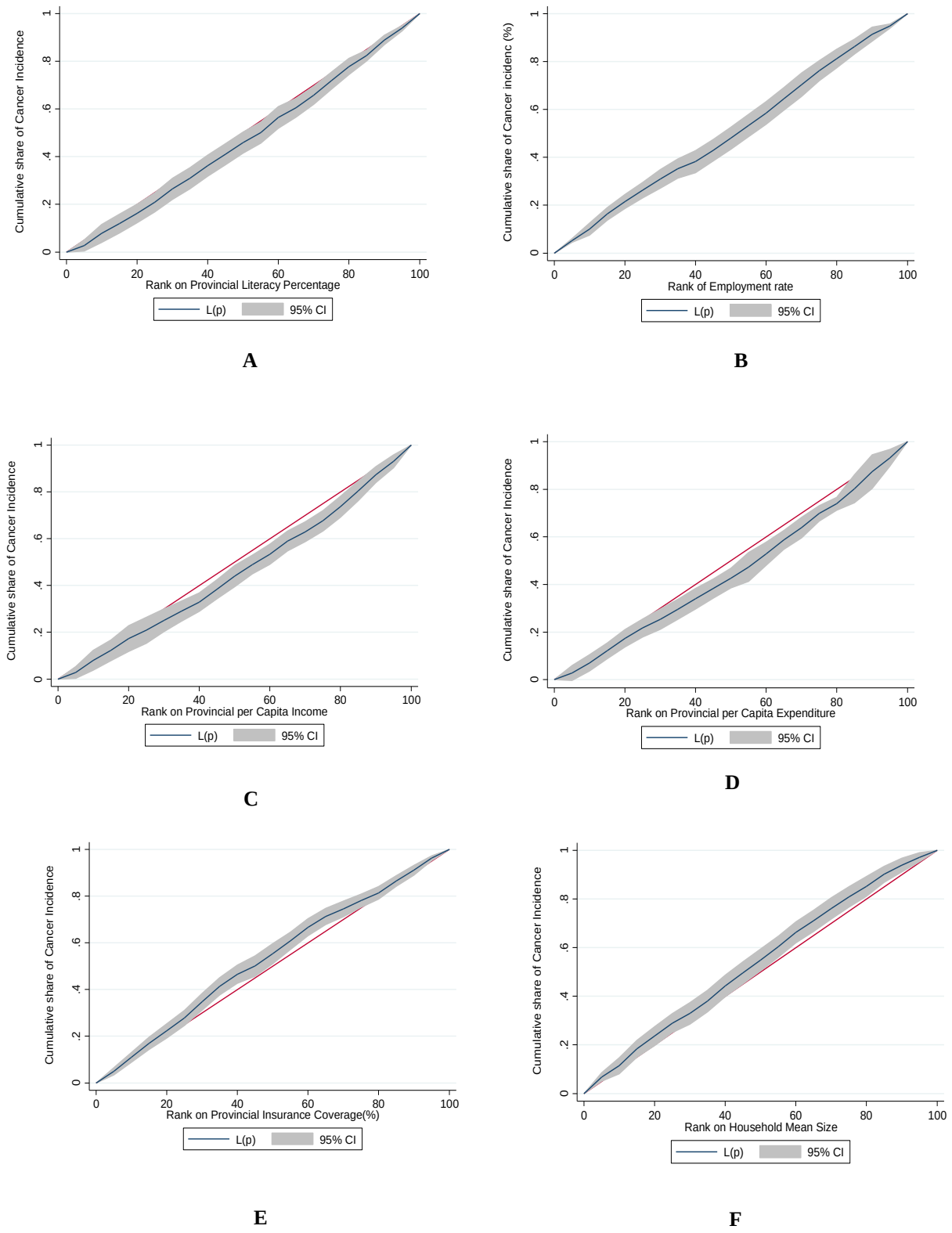

Figure 4. Concentration curves of cancer incidence based on provincial socio-economic variables.

According to Figure 4, the distribution of cancer burden among provinces based on a socio-economic index is similar to that of annual per capita income.

The concentration of cancer incidence has been to the detriment of the provinces that have a slightly better ranking in terms of the socio-economic index.

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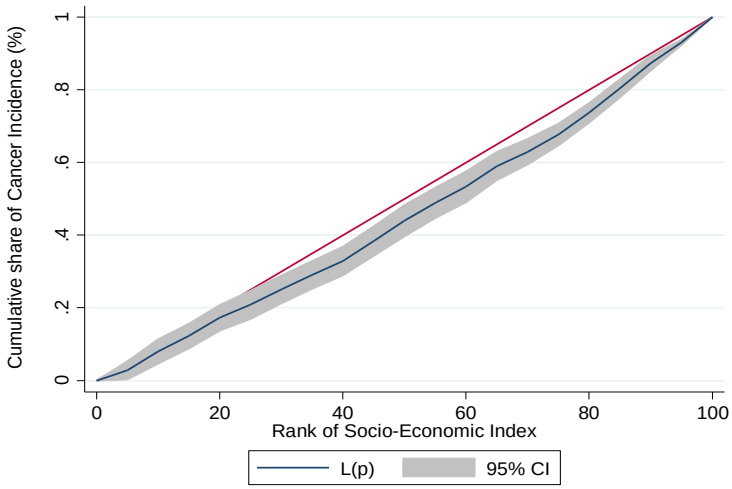

Figure 5. Concentration curve of cancer incidence based on provincial socioeconomic index.

Discussion

Cancer has increased as an epidemiological consequence in Iran, and the best way to control this disease is to prevent it through social policymaking and a healthy lifestyle [23].

In line with this goal, we aimed to study the socioeconomic inequality in the distribution of cancer burden among Iran's provinces.

For this purpose, cross-sectional data for 2018 were analyzed using the concentration index estimation and the extraction of the cancer incidence concentration curve.

Evidence from our analysis revealed that, according to the socioeconomic index, the burden of cancer had been unequally distributed among Iran's provinces in 2018.

This inequality was to the detriment of the provinces that were slightly better off in this index.

Provinces with above-average socioeconomic status had a slightly higher burden of cancer.

According to our search, very few studies have been conducted on cancer burden inequality among Iranian provinces.

In line with our findings, Enayat Rad et al. [24], in an ecological study, found a positive correlation between colorectal cancer incidence and human development index(HDI).

Nouraeimotlagh et al. [25] also showed that the incidence of leukaemia is higher in areas with better socio-economic status.

In a study in Tehran, researchers concluded that areas with higher socio-economic status had more cancer incidence [26].

Evidence from studies in other countries has also confirmed the existence of socio-economic inequalities (SDI) in the distribution of cancer burden.

For example, in confirmation of our findings, the highest age-standardized incidence rates occurred in high SDI and high-middle SDI countries [27] O'Connor et al. [28] also found significant social and economic inequalities in cancer mortality rates across US cities.

Sharma [29] also concluded that the burden of colorectal was on the shoulders of developed countries and positively correlated with HDI.

A study by Pakzad et al. [30] in Asian countries also confirms the positive relationship between the HDI and the standardized incidence of lung cancer.

A study in Italy indicated that socio-economic status is directly and indirectly related to mortality from lung cancer [31].

Tweed et al. [32] also confirmed the relationship between socio-economic status and cancer incidence.

In the case of colorectal cancer, it was shown that areas with higher living standards and better socio-economic status have a higher incidence rate [33-35].

Contrary to our findings, studies in the United States have shown that the risk of colorectal cancer is associated with low socio-economic status (SES) at both the individual and regional levels[36-38].

Danos et al. [39] also, unlike us, found a significant increase in CRC risk among residents of areas with low SES.

It is identified that factors such as socio-economic status have been the cause of social inequalities in various cancer outcomes [15].

A systematic review of eight studies by Redondo-Sánchez et al. [16] found that people of lower socio-economic status appear to have a higher chance of developing lung cancer and death than those of higher socio-economic class.

Patients in the lower socio-economic class also have lower cancer survival.

Mihor et al. [17] also confirm in their study that belonging to low SES increases the risk of cancers.

Perhaps one reason for the heterogeneity among the evidence from different studies is the type of cancer being studied.

The other reason for discrepancies in our results with the mentioned studies may be due to confounding variables and unobservable heterogeneities affecting the cancer incidence.

Various factors play a role in determining cancer risk and the likelihood of survival.

These factors include genetic, environmental, behavioral, health and social factors [40], lifestyle, geographical features [41,42].

For example, based on Ostadghaderi et al. findings [43], the spatial relationship of cancer with the variables of physical activity, body mass index and smoking was confirmed.

Accordingly, the northern and central provinces had the highest risk of colorectal cancer compared to other parts of the country due to these risk factors [43].

In a study in Tehran, the findings revealed that deaths from breast and colorectal cancers were concentrated in parts of the city that mainly used private vehicles for transportation and had low walking ability indicators [42].

However, the authors declare that more research is needed on different scales to confirm these findings (block, neighborhood and urban area).

The critical point in the published evidence is that the identified inequality in its distribution among socio-economic classes cannot be concluded.

Socio-economic factors can lead to inequality in cancer burden distribution in two ways.

The first is through the impact on people's lifestyles, and the second is through the impact on effective access to preventive services.

Cancer incidence can be affected by the rate of diagnostic procedures and access to health care services [44].

In low SEI provinces, low access to cancer control and prevention services could lead to low incidence registries, explaining our results.

One contribution of our study was that we also examined the distribution of cancer by the component of the index, besides the socio-economic index.

Our findings indicated that the cancer incidence is concentrated in the provinces that are slightly better off in terms of annual per capita income.

There is mixed evidence about the relationship between income and cancer outcomes.

In line with our findings, the results of a study by Bradley et al. [45] disclosed that living in areas with high-income inequality was directly related to mortality.

Dos Santos Figueiredo and Adami [46] determined that income inequality is positively associated with increased breast cancer mortality in Brazil.

Another study showed a relationship between household income and cancer risk concluding that this correlation could vary depending on the type of cancer [47].

The Coughlin et al. [33] study revealed that poverty and neighborhood deprivation factors play an important role in diagnosing and surviving breast cancer

Contrary to our findings, Herrera-Serna et al. [44] found a negative correlation between income and oral cancer.

Studies have examined the relationship between income and cancer, show conflicting evidence.

One reason for the inadequate evidence could be the relationship between income and health [48].

We also found that the cancer incidence was distributed unequally according to the literacy level, so the cancer incidence has been slightly concentrated in provinces with higher than average literacy rates.

Mohseni et al. [49] also found that the level of education was associated with breast cancer survival.

The researchers found that the prevalence of breast cancer increased with increasing education [50].

A significant association between the education index and oral cancer was not detected in the study of Herrera-Serna et al. [44].

Garner et al. [51] did not find a statistically significant difference in survival based on the adults with a high school degree.

Khullar et al. [52] also did not find a statistically significant relationship between education and survival.

Our findings differ from other studies because those unobservable confounding variables can

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affect the relationship between education and cancer incidence [53].

The finding that cancer incidence is concentrated in provinces with a higher than average literacy rate can be interpreted as follows: people demand more screening services in provinces with higher literacy rates [54].

Our findings revealed that cancer incidence is slightly concentrated in provinces with poorer insurance coverage.

In line with our results, the researchers systematically reviewed 29 observational studies and argued that deficiencies in insurance coverage were significantly associated with receiving less cancer care and poorer cancer outcomes [55].

Studies in the United States have also shown that lack of insurance coverage is one of the most important explanations for the poor consequences of cancer [56-58].

Compared to people with health insurance coverage, uninsured people are less likely to receive health care, including prevention and screening, diagnosis, and treatment [57,58].

People without insurance are also more likely to have a poor diagnosis [59,60].

Conclusion

Cancer incidence was unequally distributed in terms of the socio-economic status of Iranian provinces in 2018.

The cancer incidence is slightly concentrated in the provinces with higher than average literacy and per capita income and insurance coverage and household size below average.

The concentration of cancer incidence has been to the detriment of the provinces with a slightly better socio-economic index ranking.

The employment rate did not play a significant role in the distribution of the cancer burden.

It is suggested that policymakers facilitate early detection of cancer by providing insurance coverage for screening services, payment exemptions, and public awareness.

Our study had two limitations.

First, we could not examine the temporal dynamics of the cancer burden inequality due to the unavailability of the data.

It was not possible to study the cancer burden distribution with offsetting the effect of screening uptake rate due to the lack of required data.

We could not analyze the cancer burden inequality by mortality due to a lack of data.

It is suggested that researchers analyze changes in inequality over time and between individuals in future studies, using longitudinal and individual mortality data.

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Conflict of interests

None to declare.

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