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Original Article

Urbanization Levels and Its Association with Prevalence of Risk Factors and Colorectal Cancer Incidence

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Abstract

Background: Colorectal cancer is one of the most common cancers in the world. This study aimed to determine the relationship between risk factors and the incidence of colorectal cancer in Urbanization levels in Iran.

Methods: This was a population-based study. Urbanization levels were determined using the census data of the Statistical Center in 2012. Data on risk factors for colorectal cancer were obtained from the information provided by the Iranian Non-Communicable Disease Control Center and the incidence of colorectal cancer from the data from the National Cancer Registry System. Negative binomial regression analysis was used to determine the relationship between colorectal cancer risk factors and urbanization levels with colorectal cancer incidence. For statistical analysis, SPSS and Stata software were used. A significant level of $P \leq 0.05$ was considered.

Results: The relationship between urbanization levels and risk factors with the incidence of colorectal cancer, nutrition Status, tobacco use, and body mass index were not significant. There was a significant relationship between physical activity and incidence at different levels and between levels of urbanization and incidence rate, indicating a lower incidence rate of colorectal cancer at lower levels of urbanization.

Conclusion: Colorectal cancer incidence is higher at higher levels of urbanization than lower levels. The difference between regions in terms of urbanization can have in flounce on access to facilities, health service, and counseling opportunities to modify the risk factors and access to proper screening and follow-up care.

Keywords: Colorectal cancer; Incidence; Risk factors; Urbanization levels

Introduction

Considering the numerous amount of studies on the incidence and mortality rate of colorectal cancer, the highest incidence rate is observed in developed countries such as USA, Australia, and North of Europe; while the lowest incidence rate is related to Asian, African, and southern Ameri-

ca countries (1). The difference between incidence rates among the countries can be due to the higher rate of potential amendable risk factor (lack of physical activity, unhealthy diet, smoking, and obesity) and lower screening (2).

Nearly 70%-80% of colorectal cancer incidence occurs due to environmental factors and unhealthy lifestyles (3). Among the risk factors of colorectal cancer, one can name obesity, low vegetable and fruit consumption, lack of physical activity, and smoking (4). The evidence shows that 12% of colorectal cancer-induced mortality are related to smoking (5). Diet also deeply affects the risk of colorectal cancer incidence and any changes in eating habits can reduce cancer risk by more than 70% (6). Fat-rich diets, especially animal fat, is one of the main risk factors of colorectal cancer (7). To prevent and reduce the risk of colorectal and other cancers, national and international organizations suggest having fruit, vegetable, whole grains, and dairy-rich diet along with low consumption of meat, and saturated fatty acids, as well as having regular physical activity and avoiding gaining excessive weight and not using alcohol (8, 9).

One of the effective factors in cancer epidemiology is urbanization. In recent decades, urbanization has been increasing worldwide, so that the urban population increased from 36.6% to 44.8%, respectively in 1970 and 1994. It is expected to increase to 61.1% by 2025 (10). Urban life is along with a change in lifestyle so that urban resident has a fat-rich diet, low physical activity, and low energy consumption (6). The present study aimed to evaluate the role of risk factor and colorectal cancer incidence rate in urbanization levels in Iran.

Methods

The present a population-based study evaluated the relationship between the prevalence of colorectal cancer risk factors and its incidence rate in a different level of urbanization in Iran.

Urbanization Levels

In order to determine the levels of urbanization, a set of variables was used, according to the data of the provinces of the country, reported by the Iranian Statistics Center in 2012 based on the 7th General Census of the country (11). In order to level the provinces in terms of urbanization, the researchers used a series of variables based on their application in different studies for urbanization levels (11-14), their impact on urbanization and their availability when the study was conducted. The variables used to determine the urbanization levels include population size, population density, household size, urbanization factor and annual growth rate, economic participation rate, unemployment rate, share of employment in agricultural, industrial and services sectors, internet penetration rate, mobile and fixed telephone penetration rate, percentage of villages with telephone lines, rate of electricity use, percentage of electricity villages, gas consumption rate, percentage of villages and cities that have gas and water consumption, ratio of general practitioners, ratio of nurses, ratio of specialists, ratio of fixed hospital beds, human development index, road density, railroad density, ratio of vehicles, per capita green space and average area of residential buildings.

Colorectal cancer incidence

The data recorded for colorectal cancer cases in the National Cancer Registry System were extracted from the Ministry of Health and Medical Education, Center for Disease Control and Management (15). Cancer is coded according to the International Classification of Diseases for Oncology *(*ICD-O*)* (Second Edition). The C18-21 code belongs to colorectal cancer. In this study, the incidence rate (Age-standardized rate (ASR)) of colorectal cancer for both men and women in all provinces in 2009 was used in this study. To get the standardized incidence of colorectal cancer, the researchers initially separated and classified the new cases by province and gender. Subsequently, after removing duplicates, they prepared the collected data for analysis and calculation of the standardized incidence rate. The standardized population of the WHO was con-

sidered as a reference population and the incidence rate was directly standardized.

Risk Factors

The required data were obtained from non-communicable diseases surveillance centers of Iran in 2011 (STEPs). The important risk factors included nutrition factors such as consumption of fruit, vegetables, dairy products, processed foods, fish, salt and oil, as well as health indexes such as body mass index (BMI), body activity, and smoking. In order to evaluate the risk factors of non-communicable diseases (NCD), risk factor data were collected using WHO, NCD risk factor questionnaire through a cross-sectional study in all province of Iran. The risk factor data were obtained from 12000 people (15-64 yr old) by systematic cluster sampling. To classified risk factors, WHO guidelines were used.

Nutrition Status

Subjects were divided into groups in terms of daily consumption of fruit and vegetables (less than 5 unit (undesirable condition), 5 units or higher) (16); daily consumption of dairy (less than 3 units (undesirable condition), 3 units or higher) (17); fish consumption (no-consumption (undesirable condition), consumption during a week); salt consumption (undesirable condition) and no-consumption; fast food consumption during a week (undesirable condition) and no-consumption; industrial drinks consumption during a week (undesirable condition) and no-consumption; no-consumption of liquid oil (undesirable condition) and its consumption.

To create a food pattern, the scoring method (18) was used and zero and one score was respectively given to the undesirable and desirable conditions of each of the food variables. In the case of consuming protective food against colorectal cancer, for desirable and undesirable conditions, respectively 1 and 0 score was considered, while in non-protective (such as fast food), the scoring was reverse (1 score for non-consumption and 0 scores for consumption). Scores were aggregated and ranged from zero (minimum) to eight (maximum), with a score of 4 and above being considered to mean proper nutritional status.

Physical Activity

To measure the physical activity of subjects, type and duration of physical activity under different conditions including in work, traveling, and recreation was asked. According to the standard questionnaire of physical activity, subjects were divided into two groups -<600 MET (an undesirable condition) and >600 Metabolic equivalents (MET)- based on the scoring, codding, and ranking (19).

Body Mass Index

Subjects also were divided into 4 groups based on BMI as follows: lower than 18.5=underweight; 18.5-24.9=normal; 25-29.9=overweight; over 30= obese (20). In the present study, subjects with 18.8-24.9 BMI were considered as a group with the desirable condition and others as the undesirable condition.

Tobacco use

In the risk factor questionnaire, subjects were asked about daily consumption of cigarette, hookah, and tobacco pipe. By a combination of these variables, substance use variable was formed and individuals who use one of them daily were considered as a consumer (an undesirable condition).

Statistical Analysis

Since the variables of the present study are numerical dependent variables (the number of colorectal cancer in each province), Poisson regression and negative binomial regression were used. The number of colorectal cancer incidence in each province (logarithm of the patient population) was entered to model as an offset term. To rank the urbanization levels, hierarchical clustering analysis was used and the results were presented by authors (11). To analyze, the risk factor in urbanization levels, one-way ANOVA test, and the Tukey test was employed. The significance level was considered to be $P \leq 0.05$ and statistical

analysis was done using SPSS (ver. 22, Chicago, IL, USA) and STATA v.12 software's.

Results

The results of urbanization showed that provinces of Iran are categorized four levels (Table 1). Provinces in each category are very similar. In this leveling, Tehran and Alborz provinces are at the highest level of urbanization, whereas Sistan and Baluchestan, Bushehr, Kerman, South Khorasan, North Khorasan and Hormozgan provinces are at the lowest level of urbanization.

Table 1: Division of the provinces according to the levels of urbanization

Urbanization Level	***Level 1***	***Level 2***	***Level 3***	***Level 4***
Province	Tehran Alborz	Esfahan, Khorasan Razavi, Khuzestan, Qom, Semnan, Yazd, Qazvin, Azarbaijan East, Markazi	Ardebil, Azarbaijan West, Golestan, Zanjan, Mazandaran, Gilan, Fars, Lorestan, Ilam, Kohkilouyeh and Boyerahmad, Chaharmahal and Bakhtiari, Hamedan, Kermanshah, Kurdistan	Bushehr, Hormozgan, Khorasan North, Khorasan South, Kerman, Sistan and Baluchestan

Table 2: Relationship between levels of urbanization and colorectal cancer risk factors

Variable	***Urbanization Level***				***Significance level***
	Level 1	Level 2	Level 3	Level 4	
Percentage of people who eat less than 5 units of fruit	94.70 ± 6.64	93.76 ± 5.12	93.65 ± 6.32	95.21 ± 8.01	0.960
Percentage of people who eat less than 5 units of vegetables	92.50 ± 5.65	94.95 ± 5.41	94.87 ±6.56	93.96 ± 12.10	0.972
Percentage of people who eat less than 3 servings of dairy	74.60 ± 7.63	71.75 ± 15.20	74.65 ± 16.54	76.13 ±14.81	0.954
Percentage of people who do not consume fish	47.25 ± 3.04	47.63 ± 13.19	46.90 ± 18.89	35.05 ±30.44	0.618
Percentage of people who do not use liquid oil	34.95 ± 3.04	39.03 ± 14.73	44.67 ± 17.23	47.11 ± 28.01	0.762
Percentage of people who eat fast food	27.70 ± 8.34	31.34 ± 13.38	29.17 ± 17.50	34.53 ± 15.49	0.901
Percentage of people who drink industrial drinks	58.01 ± 1.41	57.52 ± 10.28	62.28 ± 13.92	63.78 ± 14.40	0.755
Percentage of people who consume salt	49.50 ± 2.68	54.48 ± 11.50	60.60 ± 19.48	43 ± 16.63	0.198
Percentage of people who have an inappropriate nutritional status	59.25 ± 0.21	62.22 ± 15.91	66.67 ±14.04	62.71 ± 20.13	0.861
Percentage of people who use tobacco	11.15 ± 0.07	10.16 ± 2.27	10.91 ± 3.21	7.05 ± 1.34	0.037
Percentage of people with inappropriate BMI	64.40 ± 2.12	63.07 ± 6.28	60.57 ± 5.86	53.13 ± 4.37	0.013
Percentage of people who have inappropriate physical activity	48.45 ± 7.56	60.06 ± 6.47	50.32 ± 10.50	57.20 ±6.78	0.059

Higher levels of urbanization had better condition than lower levels urbanization in terms of insufficient consumption dairy (second level 71.755), liquid oil (first level 34.95), consumption of industrial drinks (first level 58.10%), and fast food (first level 27.70%). On the other hand, residents of the lower levels of urbanization had better condition than the higher levels in terms of no-consumption of fish (fourth level 35.05) and salt consumption (fourth level 43%). In terms of tobacco smoking, the first level (11.1%) had the highest percentage, decreased by a reduction in urbanization (fourth level of 7.1%). The BMI of the fourth level of urbanization showed that subjects with desirable BMI in lower levels were more than higher levels, while the higher levels had a better condition in terms of undesirable physical activity (Table 2).

The findings indicated a significant difference between tobacco smoking risk factor (*P*=0.037), undesirable BMI (*P*=0.013) and urbanization levels. While no significant difference was observed between other risk factors and urbanization level (Table 2). The results of the Tukey test showed that between third and fourth levels for tobacco smoking (*P*=0.026) and undesirable BMI (*P*=0.012) there is a significant difference. Moreover, significance was observed between the third and fourth levels (borderline) (*P*=.055) (Table 3).

Table 3: Differences between levels of urbanization in terms of significant risk factors using Tukey's test

Risk Factors	***Urbanization Level***		***Mean Difference***	***Significance level***	***Confidence interval***	
Tobacco use	1	2	0.983	0.963	-4.615	6.582
		3	0.235	0.999	-5.178	5.649
		4	4.100	0.244	-1.747	9.947
	2	3	- 0.747	0.908	-3.807	2.312
		4	3.116	0.133	-0.658	6.891
	3	4	3.864	0.026	.370	7.359
BMI	1	2	1.322	0.990	-10.772	13.4165
		3	3.828	0.807	-7.866	15.523
		4	11.266	0.093	-1.365	23.898
	2	3	2.506	0.729	-4.103	9.116
		4	9.944	0.012	1.791	18.098
	3	4	7.438	0.055	-0.111	14.987

In the Poisson regression model, the assumption of variance and mean equality is not provided. To summarize detail X1 commend (x1 is dependent variable), this assumption was evaluated. By run-

ning the command, average and variance of dependent variables are 184.83 and 300.66 respectively. Therefore, the variance was higher than the mean. The overdispersion of data indicated the improper fitting of the Poisson regression model; hence the overdispersion was balanced using negative binomial regression and fitting of the model was improved. The results of negative binomial regression in four levels of urbanization (Table 4) showed a nonsignificant relationship of undesirable nutrition status (*P*=0.331), inappropriate body mass index (*P*=0.151) and smoking (*P*=0.377) with colorectal cancer; while a significant relationship was observed between inadequate physical activity (*P*=0.022) and colorectal cancer in urbanization levels. Fewer colorectal cancers occur in lower urbanization. Therefore, in first, second, and third urbanization levels, colorectal cancer occurs respectively 10.152, 3.062, and 2.249 times more than the fourth level. Likelihood ratio test showed the overdispersion on the parameter. If α is zero in data distribution, negative binomial regression is equal with Poisson distribution. Considering the significance of alpha, Poisson distribution is not established. The results of AIC Models also showed that negative binomial regression expressed better results of the analysis and less data was lost.

Table 4: Negative binomial regression model for the relationship between the incidence of colorectal cancer and risk factors in levels of urbanization

Variable		*Estimate*	*Exp(β)*	*Confidence interval*		*Significance level*
Urbanization Level	1	2.317	10.152	4.265	24.166	0.001
	2	1.119	3.062	1.706	5.496	0.001
	3	0.810	2.249	1.225	4.125	0.009
	4*	-	-	-	-	-
Inappropriate Nutrition Status		0.006	1.006	1.001	1.118	0.311
Inappropriate Physical Activity		0.022	1.022	1.018	1.042	0.022
Inappropriate BMI		0.027	1.028	1.006	1.106	0.151
Tobacco use		0.030	1.030	1.035	1.100	0.377

* The fourth level of urbanization is considered as a reference.

Discussion

The results of this study showed that there is a significant difference in the incidence of colorectal cancer in urbanization levels so that in lower levels of urbanization, the incidence of colorectal cancer is also low. In the USA, the lower incidence of colorectal cancer was indicated in a rural area compared to urban areas (21). The studies performed in the USA also showed a difference between the colorectal cancer-induced mortality rates in rural and urban areas (22). Paquette et al (23) showed a significant difference between rural and urban areas in terms of colorectal cancer incidence. However, no significant difference was found between rural and urban areas in terms of colorectal cancer incidence (24). In Africa (25), a significant relationship between residence in urban and non-urban areas and the incidence of colorectal cancer.

Urbanization is associated with changes in diet, especially an increase in meat consumption, meat products, and energy intake. Living in places with a low level of urbanization has an inverse relationship with preventive behaviors (26). The difference between areas can be due to access to facilities, health services, and counseling opportunities to modify the risk factors and access to proper screening and follow-up care (27).

In the present study, there was no significant relationship between undesirable nutrition and colorectal cancer incidence in different levels of urbanization. Based on a study performed in the United States, there was no relationship between a healthy diet and a reduction in the risk of colon cancer. There was a significant relationship between the risk of colon cancer and western food pattern (28). Another study in the United States showed that fruit and vegetable-rich food pattern is associated with a low risk of colorectal cancer (29). Dickson et al studied two food patterns and showed that healthy diet balanced other factors and had no relationship with colon cancer and age adjustment and received energy the risk of colon cancer was 14% reduced. Besides, the risk of colon cancer was increased among men by controlling all interfering factors of the western food pattern, but there was not such a relationship in women (30). Among the case-control studies performed on vegetables, 75% of them showed that in people who had higher vegetable consumption, the risk of colorectal cancer was reduced by 20%. A case-control study showed that the risk of colorectal cancer is reduced by at least 20% by fruit consumption (31).

In this study, there was no significant relationship between smoking and a high incidence of colorectal cancer in urbanization levels. However, tobacco smoking was significantly different in urbanization levels and was less at lower levels. In Ardabil Province, Iran, a significant relationship was observed between tobacco smoking and colorectal cancer. The analysis showed that smoking increases the colorectal cancer incidence by 1.8 times (32).

The results of the present study showed that there is no significant relationship between inappropriate BMI and high occurrence of colorectal cancer in urbanization levels. However, a significant difference was observed between urbanization levels and BMI, so that in a higher level, the BMI was also high. Low physical activity and prevalence of obesity in residence of higher urban levels result in an increase in mean of BMI (33). Besides, in India, prevalence of obesity and abdominal obesity in urban residence was higher than those in rural areas and prevalence of overweight, obesity, and abdominal obesity was significantly low in a rural area (34, 35). In China (36), the prevalence of obesity and overweight were significantly higher than in rural areas.

In the present study, a significant relationship was observed between the physical activity and incidence rate of colorectal cancer in urbanization levels. Moreover, in a higher level of urbanization, the physical activity is less than the lower levels. There was a significant reverse relationship between physical activity and colon cancer (37). In India, physical activity of urban residents was less than rural ones (34). The prevalence of low physical activity among residents of a higher levels of urbanization can be due to industrialization and modernization of these communities. The differences between the risk factor of colorectal cancer in different levels of urbanization show that the residents of the lower levels of urbanization have less exposure to risk factors.

Conclusion

There was significant difference between the incidences rates of colorectal cancer in urbanization levels so that in a higher level, the incidence of colorectal cancer was higher than lower levels. The difference between regions in terms of urbanization can have influence in access to facilities, health service, and counseling opportunities to modify the risk factors, accessing proper screening and follow-up care. On the other hand, urbanization life study including inappropriate diet and inactivity can result in the higher incidence of colorectal cancer.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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