Original Article

Received: 2021-09-26
Accepted: 2021-12-28

BCCR
2021, No 2, Vol 13 :105-110
www.bccrjournal.com

Spatial Clusters of Colorectal Neoplasm in the Center of Iran: A Population-based Study

Rahmatollah Moradzadeh[1*], Shahla Mirgaloybayat[2].

1

1. Department of Epidemiology, School of Health, Arak University of Medical Sciences, Arak, Iran.Email: moradzadehr@yahoo.com and moradzadehr@arakmu.ac.ir
2.Iran University of Medical Sciences, Tehran, Iran. Email:dr.sh.bayat@gmail.com

Corresponding Author:
Rahmatollah Moradzadeh.
Department of Epidemiology, School of Health, Arak University of Medical Sciences. School of Health, Golestan Street. Daneshgah Boulevard, Arak, Iran.

Tel and Fax: +98 863 367 20 28
E-Mail: moradzadehr@yahoo.com and moradzadehr@arakmu.ac.ir

ABSTRACT

Background: Identifying the local foci and clusters of diseases can help reduce incidence and mortality by making necessary interventions. This study aimed to detect possible colorectal cancer incidence clusters using spatial analyses at point-level data at small census units in Arak, Iran, from 2009 to 2014.
Methods: In this ecologic study, recorded data on colorectal cancer in Arak were collected from the Arak Cancer Registry. All records were evaluated using various methods to detect and resolve probable error events or duplicated records. Then, SaTScan software was used to explore spatial clusters. The Discrete Poisson-based Probability Model was utilized to analyze the clusters.
Results: A total of 398 incident cases of colorectal cancer were identified. The mean age at diagnosis was 62.8 ± 14.6 years. Among colorectal cancer cases, 179 (45%) and 219 (55%) were females and males, respectively. Most cases were categorized with colon topography codes (n = 119, 66.5%). Three spatial clusters of colorectal cancer using individual geocodes were detected. The most high-risk cluster was located near the southern highway in Arak, a highway with transit routes for heavy and light vehicles (p=0.0004). The second significant high-risk cluster was a district located in the vast part of the center of Arak (p=0.003). The third high-risk cluster was an area in the suburb of Arak, between Farmahin-Arak Road and Northern highway (p=0.06).
Conclusion: This study identified three essential clusters for the high incidence of colorectal cancer in Arak. The data would be useful for further evaluation of the environmental and lifestyle factors. Furthermore, the obtained pattern might be related to confounding impacts of environmental and lifestyle factors.

Keywords: Colorectal Neoplasms, Iran, Spatial Clusters

INTRODUCTION:

Colorectal cancer affects colon and rectum areas, accounting for a major contribution to the global burden of cancer (1). In 2016, about 17.2 million new cases of colorectal cancer, 8.9 million deaths, and 2,213 million disability-adjusted life-years (DALYs) from this cancer were reported worldwide (2). In 2016, 1.7 million new cases of colorectal cancer arose, and 830000 deaths were caused by colon and rectal cancers. Colorectal cancer was the cause of 17.2 million DALYs in 2016, 97% of which resulted from the years of life lost (YLL). The disease has been growing worldwide, so in just 10 years (2006-2016), a 2% increase was observed in the cases of colorectal cancer (2). About 15% to 25% of deaths from the disease can be prevented by screening (3). It is also estimated that about 7% of colorectal cancer cases can be prevented using nutritional interventions (3).

Strategic investments in cancer control and implementing effective cancer programs to provide cancer care are necessary for sustainable development goals and the World Health Organization's (WHO) Global Operational Plan (2). Therefore, by identifying the local foci and clusters of a disease, it can be hoped that the incidence rate and the number of deaths resulting from the disease decrease by making the necessary interventions. Identifying these clusters is possible by using spatial analyses. Spatial analyses have been reported in a few previous studies focusing on cities located in areas other than central Iran (4) or on larger areas with broad-level data (5). However, as each city may include high-risk and low-risk areas, provincial-level data cannot show them.

Using the location of patients, finding their geographical coordinates, and then conducting cluster analyses can play a significant role in identifying high-risk clusters of disease at the local level. This study was designed and implemented for the first time to detect possible colorectal cancer incidence clusters using spatial analyses at point-level (location-level) data at small census units in Arak, Iran, from 2009 to 2014.

Methods:

Population and data

Arak is an industrial metropolis located in the center of Iran. The city has a population of around 600,000. Cancer registration in Iran has been compulsory since 1993, following the act of the Islamic Parliament of Iran. The pathology and treatment centers send diagnosed cancer cases to the cancer registry center of every province located in the Department of Vice-Chancellor for Health Affairs of medical universities. In Cancer Registry Centers, the reported data is entered into the software and sent to the Ministry of Health.

In this ecologic study, recorded data on colorectal cancer in Arak were collected from the medical university's Vice-Chancellor for Health Affairs Department. All records were evaluated one by one using various methods to detect and resolve any probable error events or duplicated records (6-8) in reporting and recording. The evaluation was done by the two authors of this study independently.

In this study, patients with colorectal cancer were entered into the software as the ICD10 C18, C19, C20, and C21 codes. After patients' reported addresses were extracted, their accuracy and completeness were evaluated and ready to enter the software. Cases with an unknown residence address were excluded from the analysis (N = 135, 25% of the total number of registered colorectal cancers).

Statistical Analysis:

After preparing and finalizing the final data using ArcMap software, each identified case of colorectal cancer was geocoded based on the location data recorded during the initial diagnosis of the disease.

Then SaTscan software was used to explore spatial clusters. A discrete Poisson-based Probability Model was used to analyze the clusters. This analysis describes the spatial variation in disease rates. Using this model, regions that deviated from the zero assumption of random distribution of disease incidence are identified. In other words, the region under study is scanned to identify areas with a high incidence within a circle that is different from the incidence outside the circle. All circles with a radial equivalent or less than what is needed to cover up to 25% of the total population are tested.

To calculate the incidence of colorectal cancer in the census blocks level, the population-count data and the number of incident cases of colorectal cancer in each census block were required. Data of the required population according to the census blocks were taken from the 2011 census. These blocks were the smallest census units in Iran's population and house census. Also, the geographical coordinates of colorectal cancer cases were obtained from GIS software in each census block. Finally, the identified clusters of colorectal cancer in the geographic region of Arak were displayed by Google Earth. The statistical significance was determined by 9999 Monte Carlo simulations ($P < .05$). The descriptive characteristics of the incident cases and population were computed using STATA version 9.0.

Results

Descriptive Results

Descriptive characteristics of diagnosed cases of colorectal cancer by age, year of diagnosis, and topography codes in Arak are presented in Table 1. From 2009 to 2014, 398 incident cases of colorectal cancer were included. The total number of Arak population within applied census blocks was 526,182. Among colorectal cancer cases, 179 (45%) and 219 (55%) were females and males, respectively. The mean age at diagnosis was 62.8 years (SD = 14.6).

Age-standardized incidence rate

According to our previous study (9), the annual age-standardized incidence rate of colorectal cancer per 100,000 population (based on standard world population) was calculated as 15.00 (95% CI: 13.72, 16.35) for both sexes in Arak in 2009-2014.

Spatial clusters of colorectal cancer

Including colorectal cancer cases from 2009 to 2014, two significant spatial clusters of colorectal cancer were detected using individual geocodes (Table 2). These clusters were located in different areas in Arak (Figure 1). The most high-risk cluster was located in the old district, Kooye-Shar-San'ati, in the south section of Arak near Arak's south highway, with transit roads for heavy and light vehicles ($p = 0.0004$). The relative risk of this cluster was found to be 75.21. The second high-risk cluster was a district located in the vast part of the center of Arak, within Imam-Khomeini, Adabjoo, Ghaem-magham Farahani, Mohseni, Daneshgah, Shahid Rajaei, Ayatollah Ghaffari, Shohada, Mirza Shirazi,

		Female N[a] (%)	Male N[a] (%)
Age at diagnosis	< 40	14 (7.8)	10 (4.5)
	40-49	23 (12.9)	33 (15.1)
	50-59	43 (24.0)	51 (23.3)
	60-69	33 (18.4)	47 (21.5)
	70-79	44 (24.6)	42 (19.2)
	> = 80	22 (12.3)	36 (16.4)
	Total	179 (100)[b]	219 (100)[b]
Topography codes	Colon (C18)	119 (66.5)	144 (65.7)
	Rectosigmoid junction (C19)	18 (10.1)	19 (8.7)
	Rectum (C20)	37 (20.7)	53 (24.2)
	Anus and anal canal (C21)	5 (2.8)	3 (1.4)
	Total	179 (100)[b]	219 (100)[b]

a N: Number of cases
b: The integer is rounded.

Table 1. Descriptive characteristics of colorectal cancer cases in Arak, 2009-2014, stratified by sex

Cluster number	Area	Number of cases	Expected cases	Observed / Expected	Relative risk	P-value
1	Kooye-Shar-San'ati	5	0.067	74.27	75.21	0.00044
2	Vast part of the center of Arak	146	98.06	1.49	1.77	0.0030
3	The proximity of Farmahin-Arak road and Northern highway	6	0.38	15.71	15.93	0.0674

Table 2. Characteristic of the high-risk clusters of colorectal cancer in Arak based on spatial analysis during 2009-2014

Figure.1. The map of Arak included the significant clusters for Colorectal Cancer from 2009–2014: First cluster (1), second cluster (2) and third cluster (3).

and a part of Shahid Beheshti streets ($p = 0.0030$). The third identified high-risk cluster was an area in the suburb of Arak, the proximity of Farmahin-Arak Road and Northern highway. The residents of this area have a low socioeconomic status. This cluster was statistically non-significant ($p = 0.0674$). Other identified clusters were statistically non-significant, so we did not include them.

Discussion

This study identified three clusters in Arak. The first cluster is located in the south, the second in the center, and the third in the north of Arak. The first two clusters were statistically significant, and the third cluster was not statistically significant. Kooye-Shar-San'ati, the first cluster, is a neighborhood in the old context of Arak where people with a relatively moderate economic status reside. However, no study has ever focused on this area. This neighborhood is located in the northern part of the southern beltway of Arak, where various types of intercity vehicles, both light and heavy, go from the west and southwest highways of Iran to the center and north of Iran.

Factors that may play a role in the formation of clusters associated with colorectal cancer include lifestyle and behavioral risk factors such as smoking (11), obesity (11), low physical activities (12), and inappropriate food patterns (12). Nevertheless, smoking is not very important for colorectal cancer. A meta-analysis by Edoardo et al. found a significant association with odds ratios 1.14 and 1.17 for current and former smokers, respectively.

On the other hand, since even the prevalence of these factors in the general population in Arak is unknown, the prevalence of these factors and the way they are identified should be investigated in future studies. In the case of the second cluster, there is a place in the center of Arak, which covers a relatively large area. The inhabitants of this region have a moderate economic status. But the third cluster, like the first cluster, is adjacent to the northern beltway, where light and heavy vehicles pass, but the transit traffic is far less than the southern beltway. The inhabitants of this region are economically at a low level.

The method of analyzing the spatial data in this study used to determine the spatial pattern of colorectal cancer by the location data of the patients and their spatial whereabouts has not been implemented in any other regions in Iran (12, 14). But similar studies in other parts of the world have been conducted in the United States (15, 16), Canada (11), and China (17). For example, Singh et al. (11) could not observe any clusters of colorectal cancer in the province of Manitoba, a central Canadian province with a universal health care system. Even the difference in the incidence of colorectal cancer in terms of socioeconomic status has not been reported thus fat. On the other hand, in a study in Texas, a significant relationship was found between low socioeconomic status and high colorectal cancer. Moreover, the spatial analysis found significant clusters of low colorectal cancer incidence in the bordering areas of Texas and Mexico (16). In another study carried out in Iran, Mansouri et al. (12) found high-risk areas of colorectal cancer in Tehran, where people with high socioeconomic status reside. These ecological areas also have a higher education status than other areas of Tehran. However, more research is needed to find the factors related to lifestyle and other risk factors at the individual level in Tehran. In Guangzhou, China, between 2010 and 2014, three clusters with high colorectal cancer incidence and five clusters with a meaningful low incidence were detected. The clusters with high incidence were located in the central part of the city, and suburban areas had a low incidence. The reasons for the formation of the former clusters are not clear, but some may be inappropriate food patterns, the consumption of low fiber foods, and inappropriate physical activity. In several studies, a high incidence of colorectal cancer has been attributed to the high socioeconomic status (17-19). Still, because we could not ecologically divide geographical areas into poor and rich in the present study, this cannot be considered one of the reasons for the formation of clusters. Therefore, individual-level studies can help clarify the role of the variables. Due to the use of census blocks in the smallest possible unit, this study has very high accuracy in the calculated results. The total residential area of Arak is divided into 5,502 blocks. Colorectal cancer incident cases are indicated in each block. This study has some limitations, though. Although this was a population-based study, the probability of a bias in choices could not be committed because no study has ever been done to assess the accuracy of Arak Cancer Registry reports. Because this analysis is ecological, it should be interpreted at the residential area level. Some of the patients' addresses might have been reported or recorded incorrectly, or even some could be temporary, and such problems could lead to wrong classifications (6-8). Accordingly, studies should be designed at an individual level, including case-control and cohort studies, to identify the role and importance of factors related to colorectal cancer, emphasizing the adjustment of socioeconomic variables.

Conclusion

This study identified three important clusters for the high incidence of colorectal cancer in Arak. The first cluster is located in the southern area, the second is located in the central area, and the third is located in the city's northern area. The obtained pattern might be related to confounding impacts of environmental and lifestyle factors.

REFERENCES

1. Kachuri L, Villeneuve PJ, Parent M-É, Johnson KC, the Canadian Cancer Registries Epidemiology Research G, Harris SA. Workplace exposure to diesel and gasoline engine exhausts and the risk of colorectal cancer in Canadian men. Environmental Health. 2016;15:4.
2. Global Burden of Disease Cancer C. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 29 cancer groups, 1990 to 2016: A systematic analysis for the global burden of disease study. JAMA Oncology. 2018.
3. Oddone E, Modonesi C, Gatta G. Occupational exposures and colorectal cancers: A quantitative overview of epidemiological evidence. World Journal of Gastroenterology : WJG. 2014;20(35):12431-44.
4. Pakzad, R., et al., Spatial Analysis of Colorectal Cancer in Iran. Asian Pacific Journal of Cancer Prevention, 2016. 17(S3): p. 53-57.
5. Askarian, M., et al., The Geographical Clusters of Gastrointestinal Tract Cancer in Fars Province, Southern Iran. International Journal of Preventive Medicine, 2014. 5(7): p. 857-864.
6. Moradzadeh R, Mansournia MA, Baghfalaki T, Ghiasvand R, Noori-Daloii MR, Holakouie-Naieni K. Misclassification Adjustment of Family History of Breast Cancer in a Case-Control Study: a Bayesian Approach. Asian Pacific Journal of Cancer Prevention. 2015;16(18):8221-6.
7. Moradzadeh R, Mansournia MA, Baghfalaki T, Nadrian H, Gustafson P, McCandless LC. The impact of maternal smoking

during pregnancy on childhood asthma: adjusted for exposure misclassification; results from the National Health and Nutrition Examination Survey, 2011–2012. Annals of Epidemiology. 2018;28(10):697-703.
8. Moradzadeh R, Golmohammadi P, Ghaitasi B, Nadrian H, Najafi A. Incidence of Esophageal Cancer in Iran, a Population-Based Study: 2001–2015. Journal of Gastrointestinal Cancer. 2018.
9. Moradzadeh R, Nazari J, Golmohammadi P, Mirgaloybayat S. Trend of Colorectal Cancer in the Central area of Iran; 2009-2014, Application of Joinpoint regression. Unpublished. 2022.
10. Turner MC, Krewski D, Diver WR, Pope CA, Burnett RT, Jerrett M, et al. Ambient Air Pollution and Cancer Mortality in the Cancer Prevention Study II. Environmental Health Perspectives. 2017;25(8):087013-1-10.
11. Singh H, Nugent Z, Decker K, Demers A, Samadder J, Torabi M. Geographic variation and factors associated with colorectal cancer incidence in Manitoba. 2018. 2018;108(5-6):7.
12. Mansori K, Solaymani-Dodaran M, Mosavi-Jarrahi A, Motlagh AG, Salehi M, Delavari A, et al. Spatial Inequalities in the Incidence of Colorectal Cancer and Associated Factors in the Neighborhoods of Tehran, Iran: Bayesian Spatial Models. Journal of Preventive Medicine and Public Health. 2018;51(1):33-40.
13. Botteri E, Borroni E, Sloan EK, Bagnardi V, Bosetti C, Peveri G, et al. Smoking and Colorectal Cancer Risk, Overall and by Molecular Subtypes: A Meta-Analysis. Official journal of the American College of Gastroenterology | ACG. 2020;115(12).
14. Mahaki B, Mehrabi Y, Kavousi A, Schmid VJ. Joint Spatio-Temporal Shared Component Model with an Application in Iran Cancer Data. Asian Pacific Journal of Cancer Prevention. 2018;19(6):1553-60.
15. Yan L, C. WM. Geographic Variations of Colorectal and Breast Cancer Late-Stage Diagnosis and the Effects of Neighborhood-Level Factors. The Journal of Rural Health. 2017;33(2):146-57.
16. Liu Z, Zhang K, Du XL. Risks of developing breast and colorectal cancer in association with incomes and geographic locations in Texas: a retrospective cohort study. BMC Cancer. 2016;16:294.
17. Li K, Lin G-Z, Li Y, Dong H, Xu H, Song S-F, et al. Spatio-temporal analysis of the incidence of colorectal cancer in Guangzhou, 2010–2014. Chinese Journal of Cancer. 2017;36:60.
18. Aarts MJ, Lemmens VEPP, Louwman MWJ, Kunst AE, Coebergh JWW. Socioeconomic status and changing inequalities in colorectal cancer? A review of the associations with risk, treatment and outcome. European Journal of Cancer. 2010;46(15):2681-95.
19. Cramb SM, Moraga P, Mengersen KL, Baade PD. Spatial variation in cancer incidence and survival over time across Queensland, Australia. Spatial and Spatio-temporal Epidemiology. 2017;23(Supplement C):59-67.