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# Factors Affecting the Survival Rate of Patients with Left and Right-Sided Colon Cancers

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## Abstract

**Background:** Studies show that right-sided colon cancer (RCC) is more likely to be fatal than left-sided colon cancer (LCC). This study aimed to compare survival rates and characteristics of both types. In addition, this study focused on evaluating the diagnosis of colon cancer during the COVID-19 pandemic.

**Methods:** This is a retrospective cohort study that examined 582 patients treated for left and right colon cancer from March 2012 to March 2013 in Kerman province. Data were collected from a retrospective cohort, and the outcome was death due to colon cancer. The effect of tumor location on survival was evaluated using Cox regression analysis. The impact of the coronavirus disease 2019 (COVID-19) pandemic on the trend of the number of colon cancer patients was analyzed using time series models.

**Results:** The overall 5-year survival of patients was equal to 62.6% and the mean age was 59.94 ± 15.06 years. The 5-year survival rate of the tumor location on the right side was 59.5% and on the left side was 65.6%. The risk of death from RCC was 53.6% higher than from LCC. The hazard ratio (HR) from RCC compared with LCC was higher in older patients (HR, 1.402; 95% CI, 1.001-1.976), urban areas (HR, 1.608; 95% CI, 1.158-2.235), adenocarcinoma (HR, 1.703; 95% CI, 1.254-2.312), well-differentiated (HR, 2.325; 95% CI, 1.001-5.401), and moderately differentiated tumor grade (HR, 1.421; 95% CI, 1.002-2.016). The expected number of colon cancers during the COVID-19 pandemic was 3.5, 2, and 1.9 times the identified cases in the first 3, 6, and 12 months of the COVID-19 pandemic.

**Conclusion:** The risk of death for RCC was higher than for LCC, and the risk of death from RCC was higher in older adults, urban areas, adenocarcinoma, and well-differentiated and moderately differentiated tumor grades than the risk of death from LCC. In addition, the COVID-19 pandemic led to a decline in colon cancer diagnoses.

**Keywords:** Left-sided Colon Cancer, Right-sided Colon Cancer, Survival, Trend, Covid-19, Impact

***Conflicts of Interest:*** *None declared*
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## Introduction

The most common malignancy detected in the world is related to colorectal cancer (CRC), and it is one of the main causes of death in the world (1, 2). Tumors formed on the right and left sides of the colon have different embryonic, epidemiological, clinical, and pathological characteristics that lead to changes in the natural course and outcome of the disease (3); it is possible to consider the 2 sides of the colon as 2 independent diseases (2). Recently, a systematic review showed that the survival rate of patients with RCC was shorter than that of patients with LCC, indicating a higher risk of death from RCC, but these findings have not been proven in all studies (4, 5). RCC was observed more

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***↑What is "already known" in this topic:***
Right-sided colon cancer (RCC) has a poorer prognosis and higher mortality rate than left-sided colon cancer (LCC). The COVID-19 pandemic has led to a decrease in cancer screening and diagnosis, resulting in later diagnoses and a possible increase in cancer deaths.

***→What this article adds:***
A comparative analysis of survival rates between RCC and LCC suggests an increased hazard ratio of RCC-related mortality in different populations. The COVID-19 pandemic has led to a significant drop in colon cancer diagnoses.



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in older people and women, and there were more advanced tumor stages in RCC patients (6).

Although studies attributed poorer survival to RCC (2), some researchers claimed that there was no statistically significant difference in tumor site survival among patients with colon cancer, and in some cases, better survival rates were attributed to the right side (7-9). A study by Weiss et al using Cox regression and after controlling for other variables showed no significant difference in mortality between RCC and LCC (8). Moreover, Warschkow et al showed that the survival rate in stage 1 and 3 colon cancer on the right side is better than on the left (9). Although there is still a debate about accepting the location of the tumor as an alarming factor in colon cancer (10), it seems to be one of the important factors in the survival of the patients (11, 12).

In late January 2020, the coronavirus spread in most parts of the world, and the World Health Organization (WHO) declared a health emergency for the whole world (13). The coronavirus disease 2019 (COVID-19) pandemic has killed many people in the world; the Centers for Disease Control and Prevention (CDC) encouraged people to stay at home, especially those who were elderly, immunocompromised, or had underlying illnesses such as cancer to be safe from contracting COVID-19 during the pandemic (14, 15).

During the COVID-19 outbreak, cancer screening decreased and the diagnosis was made in the final stages of the disease. A study in the United States showed that the incidence of colon cancer decreased by 40% to 50% due to the COVID-19 outbreak, which may be associated with an increase in the incidence of colon cancer in the future (14). Besides, some patients were forced to postpone or even cancel their treatment and follow-up, which was associated with the worsening of the disease and reduced patient survival. Moreover, the complications and deaths caused by cancer may increase in the coming years (14, 15). Thus, investigating the impact of COVID-19 on colon cancer is of great importance (16). Using the data from the Kerman Province Cancer Registry Program, Iran, the survival of patients with colon cancer was examined in this study from March 2014 to March 2021. Moreover, the factors affecting the survival rate of RCC and LCC were accurately evaluated. This study also examined the effect of the COVID-19 pandemic on the process of diagnosing the number of colon cancer patients.

## Methods

### Study Population

The data in this study included 582 patients with colon cancer from March 2014 to March 2021, which were collected from the Cancer Registry Center of Kerman University of Medical Sciences, Kerman Province, Iran. The data of the Cancer Registry Center is collected from all reports related to cancer patients from pathology laboratories, inpatient and outpatient treatment centers, urban and rural health centers, and the Department of Forensic Medicine (17). The Cancer Registry Center and the Kerman Province Health Department's Mortality System worked together to precisely record the patients' dates of death to prevent survival rate bias, minimize competitive risks, and maintain control (18).

The protocol for this study was approved by the Medical Ethics Committee of Kerman University of Medical Sciences, Kerman, Iran, with the ethics code IR.KMU.REC.1401.277, and the data were reviewed as a retrospective cohort. There was 1 missing information in this study where we did not have information on several variables, and thus was excluded.

### Variables

The outcome variable in survival analysis in this study was determined based on the duration of the disease from the moment of diagnosis until the date of colon cancer death or censoring of the patient. The duration of the disease was calculated in terms of months, and the intended outcome for this disease was death due to colon cancer, if death did not occur due to colon cancer, the patient was censored. The last follow-up for the condition of the patients was performed on August 31, 2022, which was the end of the study (19).

The exposure variable in the survival analysis was defined based on the location of the primary tumor on the right side (cecum/appendix, ascending colon, hepatic flexure, and transverse colon) and left side (splenic flexure, descending colon, and sigmoid colon). Patients with rectal cancer were excluded from the analysis due to the different treatment patterns for colon cancer (12). Other independent variables included age, which was divided into 2 subgroups (older and younger) based on the median (2), sex, and region of residence of the patients determined based on the population of the region (10,000 people) and political divisions as urban or rural districts (20), the disease grade, morphology, and disease stage (1, 2, 7, 21). Another outcome variable was the number of colon cancer patients from March 2014 to March 2021 (22). January 30, 2020, was considered the onset of the COVID-19 pandemic, which was the beginning of a change in people's lifestyles (13, 14).

### Statistical Analysis

Overall survival (OS) was analyzed using the Kaplan-Meier method and was reported for 1-, 3-, and 5-year intervals (5).

The relationship between the variables with the risk of death due to colon cancer was assessed using univariate and multiple Cox regression analysis, and the assumption of proportional hazards was evaluated using the Schoenfeld residuals test. First, univariate Cox regression was fitted and the variables, with $P < 0.2$, were selected as important variables and entered into the multiple regression model. Finally, using the multiple Cox regression model and the backward elimination method, significant variables were determined ($P < 0.05$), and the hazard ratio (HR) index and the 95% confidence interval were reported (23, 24). Moreover, the risk of death between RCC and LCC was obtained by separating the different levels of the variables. First, the variables were separated based on their levels. Afterward, the HR between RCC and LCC was estimated for each level in the presence of other variables with multiple Cox regression analyses (2, 24).





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The trend of colon cancer was assessed from March 2014 to March 2021 using Joinpoint regression, and the average percentage of changes in the number of colon cancer patients per month was used to determine the overall (upward or downward) trend (22). The impact of the COVID-19 pandemic on the number of colon cancer patients was assessed using Autoregressive Integrated Moving Average ARIMA(p,d,q) time series models. The stationarity assumptions of the time series model were checked with the Augmented Dickey-Fuller (ADF) test, and the best model was selected based on the lowest value of Root-mean-square error (RMSE), and Akaike information criterion with a correction (AICc) index. Finally, the correlation with the residual of the final model was tested. The time series model was fitted for the pre-COVID-19 period. Then, the expected values of colon cancer patients were predicted for the period of the COVID-19 pandemic, and the difference between the expected value and the real value was calculated to determine the impact of COVID-19 on colon cancer (22, 25). In this study, SPSS software Version 25 was used to analyze the survival of patients, and Joinpoint and R software and the FPP package for time series analysis, FMA, and Forecast were used to predict the incidence of colon cancer.

## Results

### *Patient Baseline Characteristics*

The data of 582 patients with colon cancer from March 2014 to March 2021 were included in the study. A total of 212 patients (36.4%) died. The overall survival of the patients for 3 years was 69.5% (95% CI, 65.1-72.8) and 5-year survival was equal to 62.6% (95% CI, 58.2- to 66.7). A total of 301 patients (51.7%) were men and the average age of the patients was 59.94 ± 15.06 years with a median age of 61 years. In general, 302 patients (51.9%) had RCC and 280 patients (48.1%) had LCC, and the 5-year survival rate of the tumor site on the right side was 59.5% (95% CI, 53-65.3) and was 65.6% on the left side (95% CI, 59.4- 71)

*Table 1.* Univariate and Multiple models for overall survival

| Variable | Total N (%) | Survival analysis | | | | Univariate | | | Multiple | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-Year OS* (%) 95% CI | 3-Year OS* (%) 95% CI | 5-Year OS (%) 95% CI | 7-Year OS (%) 95% CI | HR | 95% CI | *P*-value | HR | 95% CI | *P*-value |
| Location | | | | | | | | | | | |
| Left-sided colon | 302 (51.9) | 78.9 (74.2-83.8) | 63.9 (57.9-69.4) | 59.5 (53.0-65.3) | 51.9 (43.6-61.) | ref | - | - | ref | - | - |
| Right-sided colon | 280 (48.1) | 88.0 (84.0-91.0) | 73.9 (68.4-78.6) | 65.6 (59.4-71.0) | 59.1 (52.4-66..6) | 1.330 | 1.015-1.742 | 0.038 | 1.536 | 1.158-2.037 | 0.003 |
| Gender | | | | | | | | | | | |
| female | 281 (48.3) | 82.9 (78.6-87.4) | 69.0 (63.0-74.0) | 63.0 (56.0-69.0) | 53.5 (45.4-63.0) | ref | - | - | - | - | - |
| male | 301 (51.7) | 84.3 (80.3-88.5) | 69.5 (63.0-74.0) | 62.1 (55.0-67.0) | 58.1 (51.7-65.3) | 0.994 | 0.759-1.302 | 0.96 | - | - | - |
| Age | | | | | | | | | | | |
| ≤61 | 293 (50.3) | 90.4 (87.1-93.8) | 78.0 (73.0-83.0) | 73.0 (67.0-78.0) | 66.9 (59.7-74.8) | ref | - | - | ref | - | |
| >61 | 289 (49.7) | 76.8 (72.1-81.8) | 60.0 (53.4-64.9) | 51.0 (45.4-57.8) | 45.1(38.0-53.5) | 2.159 | 1.630-2.860 | <0.001 | 2.257 | 1.689-3.017 | <0.001 |
| Region | | | | | | | | | | | |
| urban | 207 (35.6) | 86.9 (82.4-91.6) | 70.9 (64.1-76.6) | 67.1 (59.7-73.3) | 65.7 (58.9-73.3) | ref | - | - | - | - | - |
| rural | 375 (64.4) | 81.8(78.0-85.8) | 68.0 (63.0-72.4) | 60.2 (54.6-65.3) | 51.1 (44.5-58.8) | 1.28 | 0.958 - 1.719 | 0.093 | - | - | - |
| Morphology | | | | | | | | | | | |
| Adenocarcinoma | 449 (77.1) | 83.0 (79.6-86.6) | 68.6 (64.0-72.8) | 61.2 (56.0-65.8) | 56.2 (50.0-62.4) | ref | - | - | ref | - | - |
| Carcinoid | 19 (3.3) | 100 (100-100) | 89.5 (64.0-97.2) | 89.5 (64.0-97.2) | 89.4 (76.6-100) | 0.225 | 0.056-0.90 | 0.036 | 0.157 | 0.038-0.653 | 0.011 |
| Mucinous adenocarcinoma | 82 (14.1) | 86.0 (79.5-94.2) | 68.8 (57.3-77.7) | 64.9 (52.7-74.6) | 45.8 (30.7-68.3) | 0.985 | 0.672-1.446 | 0.006 | 0.880 | 0.591-1.310 | 0.529 |
| Other | 32 (5.5) | 75.0 (61.4-91.6) | 64.9 (45.5-78.9) | 60.3 (40.2-75.4) | 60.2 (44.8-81.1) | 1.05 | 0.588-1.9 | 0.852 | 1.069 | 0.572-2.00 | 0.834 |
| Grade | | | | | | | | | | | |
| Well differentiated | 84 (14.4) | 85.7 (78.5-93.5) | 73.6 (62.7-81.7) | 69.1 (57.5-78.0) | 61.8 (49.9-76.6) | ref | - | - | - | - | - |
| Moderately differentiated | 357 (61.3) | 85.7 (82.1-89.4) | 70.9 (65.8-75.4) | 61.4 (55.3-66.8) | 55.6 (48.7-63.4) | 1.15 | 0.765 - 1.757 | 0.486 | - | - | - |
| Poorly differentiated | 42 (7.2) | 73.8 (61.6-8.3) | 56.0 (39.4-69.7) | 52.6 (35.8-66.9) | 52.7 (39.1-71.1) | 1.63 | 0.991-2.94 | 0.099 | - | - | - |
| Unknown | 99 (17.0) | 78.7 (71.1-87.2) | 64.2 (53.5-72.9) | 60.30 (49.0-69.3) | 48.7 (33.9-70.0) | 1.37 | 0.843-2.252 | 0.200 | - | - | - |
| Stage | | | | | | | | | | | |
| Stage I - II | 265 (45.5) | 85.0 (81.5-89.1) | 73.5 (67.7-78.5) | 68.2 (61.8-73.7) | 58.8 (51.2-67.5) | ref | - | - | ref | - | - |
| Stage III | 176 (30.2) | 88.6 (84.0-93.4) | 71.9 (64.5-78.0) | 60.3 (51.6-67.7) | 54.1 (45.5-65.2) | 1.163 | 0.843 – 1.604 | 0.772 | 1.244 | 0.901-1.719 | 0.185 |
| Stage IV | 16 (2.7) | 62.5 (42.8-91.4) | 24.3 (7.1-46.7) | 24.3 (7.1-46.7) | 23.4 (0.9-0.58) | 3.415 | 1.865 – 6.254 | 0.000 | 4.930 | 2.656-9.152 | <0.001 |
| Unknown | 125 (21.5) | 77.6 (70.6-85.2) | 62.7 (53.3-70.7) | 59.1 (49.4-67.5) | 59.1 (50.6-68.9) | 1.370 | 0.962 – 1.951 | 0.241 | 1.579 | 1.090-2.288 | 0.016 |

OS: Overall Survival



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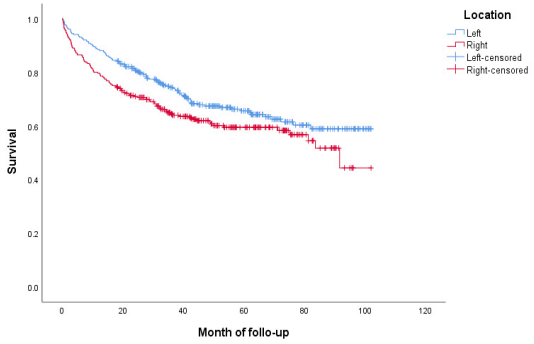


*Figure 1.* Kaplane-Meier survival estimates for patients with right- and left-sided colon cancer

(Table 1). The Kaplan-Meier survival curves demonstrated the difference between RCC and LCC in Figure 1.

### The Impact of Cancer Location on Survival

The results of multiple Cox regression analysis showed that the risk of death from RCC was 53.6% higher or 1.536 times that of LCC (HR, 1.536; 95% CI, 1.158-2.037), and the variables of age, morphology, and stage of the disease were other significant factors affecting the survival of colon cancer patients. The risk of death in older adults was 2.25 times that of younger people (HR, 2.25; 95% CI, 1.689-3.017), the risk of carcinoid was 0.15 times that of adenocarcinoma (HR, 0.15, 95% CI, 0.038-0.653), and stages 4 and unknown were 4.93 and 1.57 times that of stage 1 and 2 (HR unknown to 1-2 = 1.57; 95% CI, 1.090- -2.288; HR, 4 to 1-2:4.93; 95% CI, 2.656-9.152) (Table 1).

### Comparison and Survival Differences Between RSCC and LSCC in Different Subgroups

The effect of tumor location was similar in terms of sex, age, residential area, grade, and stage of the disease ($P > 0.05$), but it was significantly different in terms of morphology ($P < 0.05$). The distribution of adenocarcinoma colon cancer was greater on the left side of the colon than the right side (64.6% R vs 88.7% L) and the distribution of carcinoid colon cancer (6.8% R vs 0% L), mucinous adenocarcinoma (21.4% R vs 7.3% L) and others (7.1% R vs 4% L) were observed mostly on the right side (Table 2).

The differences in the risk of death between RCC and LCC in terms of levels of different variables were assessed separately. The results showed that the risk of death from RCC in older patients was 1.4 times that of LCC (HR, 1.402; 95% CI:1.001-1.976). In urban areas, the risk of death from RCC was 1.6 times that of LCC (HR, 1.608; 95% CI,1.158-2.235). Concerning adenocarcinoma, the risk of death from RCC was 1.7 times that of LCC (HR, 1.703; 95% CI, 1.254-2.312). The risk of death from RCC in the well-differentiated grade was 2.3 times that of LCC (HR=, 2.325; 95% CI, 1.001-5.401), and the risk of death from RCC in the moderately differentiated grade was 1.4 times that of LCC (HR, 1.421; 95% CI, 1.002-2.016) and there was no significant difference in other categories (Table 2).

### Colon Cancer Trends

The incidence of colon cancer before the COVID-19 pandemic and from March 2014 to January 2020 increased on average by 1% per month (AMPC, =1%; 95% CI, 0.6% to1.5%; $P = 0.001$), accounting for 7.2 patients per month on average (95 CI%, 6.55 to 7.9). The incidence of colon

*Table 2.* Differences in survival and clinicopathological characteristics between RSCC and LSCC in different subgroups

| Variable | Comparison between right-sided and left-sided colon cancer | | | Survival difference between RSCC and LSCC in different situations | |
|---|---|---|---|---|---|
| | Right-sided colon (%) | Left-sided colon (%) | *P*-value | HR (Ref= Left) | *P*-value |
| Gender | | | | | |
| female | 128(45.7) | 153(50.7) | 0.233 | 1.4(0.94-2.075) | 0.094 |
| male | 152(54.3) | 149(49.3) | | 1.38(0.95-2.027) | 0.090 |
| Age | | | | | |
| ≤61 | 146(52.1) | 147(48.7) | 0.403 | 1.3(0.829-2.067) | 0.278 |
| >61 | 134(47.9) | 155(51.3) | | 1.402(1.001-1.976) | 0.049 |
| Region | | | | | |
| rural | 104(37.1) | 103(34.1) | 0.445 | 1.164 (0.689-1.968) | 0.570 |
| urban | 176(62.9) | 199(65.9) | | 1.608(1.158-2.235) | 0.005 |
| Morphology | | | | | |
| Adenocarcinoma | 181(64.6) | 268(88.7) | <0.001 | 1.703(1.254-2.312) | <0.001 |
| Carcinoid | 19(6.8) | 0(0.0) | | - | - |
| Mucinous adenocarcinoma | 60(21.4) | 22(7.3) | | 0.998(0.432-2.305) | 0.996 |
| Other | 20(7.1) | 12(4.0) | | 0.944(0.248-3.595) | 0.933 |
| Grade | | | | | |
| Well differentiated | 40(14.3) | 44(14.6) | 0.056 | 2.325(1.001-5.401) | 0.049 |
| Moderately differentiated | 161(57.5) | 196(64.9) | | 1.421(1.002-2.016) | 0.049 |
| Poorly differentiated | 28(10.0) | 14(4.6) | | 0.520(0.191-1.418) | 0.202 |
| Unknown | 51(18.2) | 48(15.9) | | 1.609(0.834-3.074) | 0.150 |
| Stage | | | | | |
| Stage I and II | 129(46.1) | 136(45.0) | 0.737 | 1.408(0.923-2.149) | 0.113 |
| Stage III | 79(28.2) | 97(32.1) | | 1.566(0.961-2.553) | 0.072 |
| Stage IV | 8(2.9) | 8(2.6) | | 1.177(0.12-11.391) | 0.888 |
| Unknown | 64(22.9) | 61(20.2) | | 1.194(0.667-2.137) | 0.550 |



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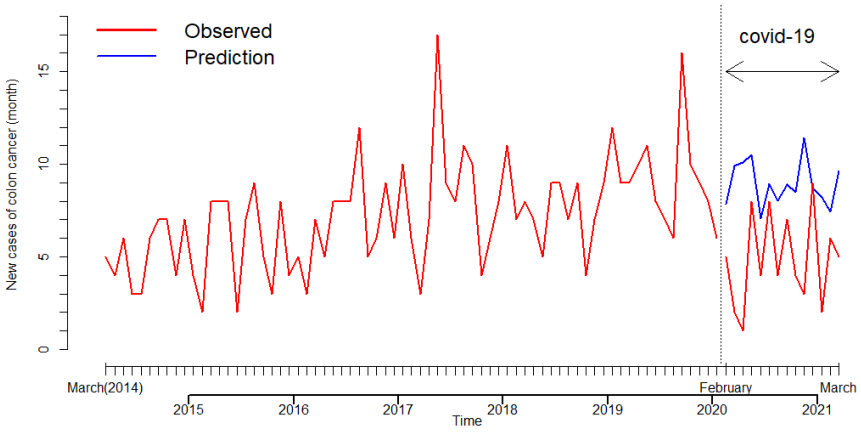


*Figure 2.* The number of colon cancer patients identified from March 2014 to March 2021 is marked in red, and the expected number of patients during the COVID-19 pandemic from February 2020 to March 2021 is marked in blue.

cancer during the COVID-19 pandemic from February 2020 to March 2021 became uniform (AMPC, 3.6%; 95% CI, −5.5% to 13.6%; $P = 0.415$), and 4.8 patients on average were diagnosed (95% CI, 3.4 to 6.2).

The COVID-19 pandemic has caused a change in the number of people diagnosed with colon cancer as shown in Figure 2. The expected number of colon cancers during the COVID-19 pandemic was estimated with the time series model ARIMA (7, 1, 8). The expected numbers were 3.5, 2, and 1.9 times of the identified cases in the first 3 months, the first 6 months, and 12 months of the COVID-19 pandemic, generally indicating a decrease in the number of colon cancer patients diagnosed during the COVID-19 pandemic. Furthermore, in March and April 2020, the expected number was 5 and 10 times the identified cases, showing the greatest decrease during the COVID-19 pandemic.

## Discussion

The 5-year survival rate of colon cancer patients in Kerman, the largest city located in southeast Iran, was equal to 62% in this study. In their systematic review and meta-analysis, Maajani et al showed that the 5-year survival rate for colon cancer in Iran is equal to 60% (26). The American Society of Clinical Oncology reported the 5-year survival rate of colon cancer patients to be equal to 64%, as evident in the present study (27). In this study, the prognosis of patients with LCC was better than that of RCC, and the risk of death from RCC was 53.6% higher than that of LCC. This confirms a greater risk on the right side and the disease can be better controlled by differentiating between the 2 sides of the colon. The better prognosis of LCC has been confirmed in many studies (4, 5, 28). However, contrary to the present study, some studies found no correlation between tumor location and survival of patients or better survival on the right side possibly due to the complexity of the pathological and clinical relationship between tumor location and survival of patients (8, 9).

The distribution of tumor location in terms of sex, age, region of residence, grade, and stage of the disease showed no significant difference. A study by Dae Ro Lim et al showed no significant difference in the mean age and sex ratio between the right and left sides of the colon, as was observed in the present study (12). However, in some studies, a greater number of older adults and women suffered from RCC (6).

The distribution of the tumor site was significantly different in terms of morphology. Adenocarcinoma was located in a higher proportion on both sides of the colon, as confirmed in other studies (9). The carcinoids were located on the right side of the colon, and an analysis of population data showed that carcinoids were located in the small intestine (45%), rectum (20%), appendix (17%), and colon (11%). Considering the percentage of the appendix, a high percentage of carcinoids on the right side of the colon was expected (29).

The risk of colon cancer death on the right side was higher than on the left side in older adults, urban areas, adenocarcinoma, and well and moderately differentiated grades. The risk of death on the right side of the colon in older patients was 40% higher than on the left side. Contrary to the present study, Miao-Zhen Qiu et al showed that the risk of death from RCC compared to LCC was higher in younger people (aged <69 years). The risk of colon cancer death on the right side in people living in urban areas was 60% higher than on the left side. Rogers et al showed that the risk of death did not differ between RCC and LCC in urban areas (30), possibly due to lifestyle and diet in urban areas affecting the risk of death from RCC and LCC, which requires more studies (31). In all stages, the risk of dying from colon cancer for RCC and LCC was equal, but tumor location in stage 3 ($P = 0.07$) may play an important role. In some studies, the effect of the location of the tumor was the same in the disease stages (9) but was different in other studies (2).

Colon cancer is one of the most common malignant tumors in Iran. Following the data from the Kerman Province





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Cancer Registry Center, this study analyzed the changing trend of colon cancer from March 2014 to March 2021 and showed the incidence of colon cancer was increasing from March 2014 to January 2020, that is, before the COVID-19 pandemic, and the incidence of colon cancer became stable after the COVID-19 pandemic, that is, from February 2020 to March 2021. Besides, the number of colon cancer patients diagnosed in this period decreased compared with the pre-COVID-19 era. A study conducted by Nikbakht et al in Kerman from 2001 to 2010 showed that colon cancer is generally increasing, which is consistent with the results of this study for the period before the COVID-19 pandemic (22). Thus, emphasis on people's use of cancer prevention methods—such as lifestyle and nutrition changes and physical activity—to reduce the incidence of cancer is of particular importance (31).

In the present study, the expected number of colon cancer patients during the COVID-19 pandemic was estimated, and the results indicated the expected number was 3.5 and 10 times higher than the number of diagnosed patients in the first 3 months of the pandemic and in April 2020 respectively. A study in the United States compared the difference in cancer diagnosis between the first 4 months of 2019 and 2020 and showed a significant decrease in the diagnosis of cancer during the COVID-19 pandemic. Besides, the largest decrease was related to April 2020 with a 39.9% decrease compared to April 2019 (15).

The fear of contracting COVID-19 caused cancer patients to postpone their diagnosis and treatment, which led to a decrease in the number of diagnosed patients. Besides, during the COVID-19 pandemic, hospitals completely took care of patients with COVID-19, which created some problems in the process of diagnosing non-COVID-19 diseases. Delayed diagnosis and treatment may increase the diagnosis of patients in higher stages and the demand for colon cancer screening methods will increase (14).

### Limitations

This study was conducted with several limitations. For instance, this study employed a retrospective design, while exploring cause-and-effect relationships in prospective and interventional studies can provide more reliable results. Besides, the relationships reported in this study are not necessarily definitive, because there may be confounders and we were not able to identify and control them in the study. However, the present study reported similar results to the findings of previous studies. Another limitation of this study was the failure to predict the number of cancer cases due to the existence of different approaches and behaviors during the COVID-19 pandemic. Deaths from the COVID-19 pandemic may reduce the number of people diagnosed with colon cancer before the tumor becomes malignant (32). The increased risk of cancer may also be related to the cumulative effect of different aspects of the coronavirus infection, which are not yet known (33).

## Conclusion

The data in this study indicated that tumor location, age, morphology, and stage of the disease were among the factors that were related to the survival of colon cancer patients. The risk of death was found to be higher for colon cancer on the right side than on the left, older people than younger people, adenocarcinoma patients than carcinoid and stage 4, and indeterminate than stages 1 and 2. The survival difference between the right and left sides of the colon in terms of each level of the variable showed that the risk of death is higher in older adults, urban areas, adenocarcinoma, and well and moderately differentiated grades in the right side of the colon. The number of colon cancer patients decreased due to the COVID-19 pandemic, and it caused a delay in the identification of new cancer patients and treatment, which is assumed to increase colon cancer incidence and death in the coming years. Besides, more serious measures should be taken to prevent and control colon cancer in Kerman Province (34).

### Authors' Contributions

Moghaddameh Mirzaee: conceptualization, design, formal analysis, writing-reviewing, and editing. Farshid Sharifi: conceptualization, software, formal analysis, writing-original draft, writing-reviewing, and editing, and data curation; Reza Malekpour Afshar: writing-reviewing, and editing, Azam Bazrafshan: conceptualization, data curation, writing-reviewing, and editing, Ashraf Yazdizadeh: conceptualization, data curation, writing-reviewing, and editing.

### Ethical Considerations

The protocol for this study was approved by the Medical Ethics Committee of Kerman University of Medical Sciences, Kerman, Iran with the ethics code IR.KMU.REC.1401.277.

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### Conflict of Interests

The authors declare that they have no competing interests.

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