Risk Factors for Colorectal Cancer: A Case-control Study in Egypt, 2022

Original Article

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ABSTRACT

Background: In the literature, it has been pointed out that lifestyle and environmental factors might contribute substantially to the etiology of colorectal cancer (CRC). Identifying modifiable risk factors would be crucial for prevention. This study was conducted to determine the risk factors for CRC.

Patients and Methods: A case-control study was conducted at the Maadi Armed Forces Medical Complex in Egypt in 2022, including 101 cases and 101 controls. All participants underwent face-to-face interviews with a structured questionnaire to gather information about sociodemographic characteristics, lifestyle, dietary and gastrointestinal habits, family, medical, and reproductive history, and occupational data. Regression analysis was done to model CRC as a function of the potential risk factors.

Results: In univariate analysis, CRC was significantly associated with positive family history for CRC, not attaining higher education, not having a spouse, infrequent fruit and vegetable consumption, frequent consumption of processed meat, sedentary behavior, and bowel movements more than once per day. According to the multivariate regression analysis, four independent predictors of CRC were identified, namely: positive family history of CRC [OR = 8.70, 95% CI = 1.60,48.8], sedentary behavior more than 6 hours per day [OR = 3.54, 95% CI = 1.60,8.1], bowel movements more than once per day [OR = 2.07, 95% CI = 1.1,4.1], and not attaining higher education [OR = 2.47, 95% CI = 1.3,4.8].

Conclusion: The study highlighted predictors of CRC. Awareness campaigns and screening of high-risk groups are recommended. Moreover, longitudinal multicentric studies with objective evaluations of physical activity and dietary consumption are required.

Key Words: Colorectal cancer; Egypt, predictors, risk factors.

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INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer worldwide and the second cause of cancer-related mortality[1]. In Egypt, CRC is the seventh most common cancer, accounting for three and a half percent of all male cancers and three percent of all female cancers[2]. Egypt has experienced distinctive patterns of young-onset, decreased prevalence of colorectal adenomas, and/or a high percentage of rectal cancer compared to CRC in developed countries[3].

Though the individual risk of CRC is basically dependent on non-modifiable factors like age, sex, and family history[4], the great majority of CRCs have unknown exact etiology, which may be based on multiple genetic and environmental alterations. Although CRC can originate from inherited cancer syndromes, sporadic CRC accounts for around 70% of all cases, meaning that no clear hereditary or familial predisposition exists[5]. This denotes that environmental or lifestyle factors play a significant role in the etiology of CRC[6,7].

For example, developing countries historically had a low rate of CRC; however, diet westernization has been associated with higher rates of the disease[8,9]. In addition, studies reported factors that might be implicated in the development of CRC (risk factors) and others that might reduce the risk (protective factors). High consumption of alcohol, red and processed meat, calorie-dense food, low consumption of fruit and vegetables, physical inactivity, and smoking were found to raise the risk of developing CRC[9.10]. Moreover, medical conditions including obesity and diabetes are suggested risk factors for CRC[11]. On the other hand, dietary fiber intake[12], prolonged lactation, and increased parity were associated with a lower risk of CRC [13].

A large portion of primary cancer prevention focuses on maintaining a healthy lifestyle and avoiding exposures

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that can cause it. Even though CRC screening has proven benefits, substantial research supports the effectiveness of primary prevention efforts, particularly those that focus on changing one's lifestyle. Strong evidence suggests that avoiding smoking and excessive alcohol consumption, maintaining weight control, and physical exercise are all modifiable protective factors for CRC[6]. Lifestyle, environmental, and occupational factors vary among different populations. Identifying modifiable risk factors of CRC among the Egyptian population would be a crucial step for the primary prevention of the disease in Egypt. Thus, this study was conducted to determine the risk factors for CRC in a tertiary hospital in Egypt.

PATIENTS AND METHODS:

Research design and setting:

A case-control study was conducted from March through July 2022 at the Medical Oncology Department at the Oncology and Hematology Hospital of the Maadi Armed Forces Medical Complex (MAFMC) in Cairo, Egypt. The MAFMC is the largest military medical complex in Egypt, with multiple tertiary and specialized hospitals. The study population comprised CRC cases and matched controls.

Participants:

CRC cases were recruited from outpatient clinics, inpatient wards, and ambulatory treatment units affiliated with the Medical Oncology Department at MAFMC. The inclusion criteria set for enrollment in this study were pathologically confirmed CRC cases older than 18 years, of any gender, of any pathological type, at any stage of cancer, and receiving any treatment modality. CRC cases were excluded if they had second cancer, organ failure (heart, kidney, or liver), inflammatory bowel disease, acute complications, had a chemotherapy or radiation session on the day of the interview, or were immediately post-operative.

In this study, 101 eligible CRC cases agreed to participate. An equal number of age- and sex-frequency-matched controls (n = 101) were chosen from patients' accompanying persons at MAFMC.

Sampling and Sample size:

A convenient sampling method was applied for this study. The sample size was calculated using the Open-Epi online calculator (**version 3.3a, Open-Epi, Atlanta, GA, USA**). In order to detect the minimum CRC risk of 3 among those having a positive family history of CRC, considering the previously reported frequency of a positive family history of CRC in the population of 10%[14], at a power of 80%, a confidence level of 0.95 ($P = 0.05$), and a ratio of controls to cases of 1, the minimum required sample size in this study was 202 (101 CRC cases and 101 controls)[15].

Data collection tools:

All participants were subjected to a face-to-face interview using a predesigned, structured questionnaire to collect the following:

- Sociodemographic characteristics: gender, age, residence, level of education, and marital status

- Smoking history: a current smoker was defined as an adult who has smoked 100 cigarettes in his lifetime and who currently smokes cigarettes. An ex-smoker is an adult who has smoked at least 100 cigarettes in his lifetime but who quit smoking on the day of the interview. “Never smoker” refers to an adult who has never smoked or who has smoked less than 100 cigarettes in his lifetime[16].

- Diet and gastrointestinal habits: cases were asked to report their habits prior to the onset of the disease.

- Physical activity and sedentary behavior: cases were asked to report their habits prior to the onset of the disease. Moderate-intensity physical activity was defined as any activity (at work or leisure time) that causes a small increase in breathing or heart rate with a duration of at least 10 minutes continuously; examples include walking very briskly and cleaning heavy (washing windows, vacuuming, and mopping)[17]. The duration of sedentary behavior was defined as time spent sitting or lying with low energy expenditure, excluding sleeping time.

- Family history of CRC: A positive family history was considered if the participant had one or more first-degree relatives (an individual’s parents, siblings, and offspring) and/or second-degree relatives (an individual’s aunts, uncles, grandparents, grandchildren, nieces, and nephews).

- Medical history: comorbidities, cholecystectomy, use of aspirin and non-steroidal anti-inflammatory drugs.

- Occupational information: the status and duration of employment and exposure to fumes, chemicals, or dust at work.

- Female reproductive history: oral contraceptive pill (OCP) use was defined as any type of OCP use for at least one year.

Statistical analysis:

Data were entered in a Microsoft Excel spread sheet for Windows and analysed using SPSS version 26 (**IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp**). Categorical variables were presented as frequency (n) and percentage (%) and analysed using the chi-square test. Whereas as quantitative variables were presented as mean,

standard deviation (SD), median and interquartile range (IQR). Nonparametric data were analysed with the Mann-Whitney U test. All statistical analyses were judged at level of significance of 5% ($\alpha = 0.05$).

Multivariate regression analysis was done among all participants (n = 202) to model CRC (the dependent variable) as a function of 8 independent variables that were significant in the univariate analysis, namely, a positive family history for CRC, not attaining higher education, not having a spouse, infrequent vegetable consumption, infrequent fruit consumption, frequent consumption of processed meat, sedentary behavior more than 6 hours per day, and bowel movements more than once per day. The model was significant (X2 = 59.96, $p < 0.001$) and correctly classified 72.3% of CRC cases and controls in this study.

Ethical considerations

The study proposal was approved by the Armed Forces College of Medicine Ethical Review Committee (IRB: 37; meeting: September 25, 2021; serial number: 70). Verbal informed consent was obtained from all participants before enrollment in the study. The study conformed to the requirements of the Revised Helsinki Declaration of Biomedical Ethics. The policy of data confidentiality was strictly followed.

RESULTS:

Sociodemographic characteristics

As regards sociodemographic characteristics, no statistically significant difference was found between CRC cases and controls regarding age, gender, residence, and employment status. On the other hand, a significantly higher percentage of CRC cases did not attain higher education (62.4%) and were not living with a spouse (divorced, widowed, or never married) (24.8%) compared with controls (37.6%, and 11.9%, respectively) ($P < 0.001$ and $P = 0.018$, respectively). CRC cases were less likely to have attained higher education than controls [OR = 0.36, 95% CI = 0.21, 0.64] and to have been married [OR = 0.41, 95% CI = 0.19, 0.87]. (Table 1)

Dietary factors and bowel movement

A CRC case was 3.27 times more likely to report infrequent consumption of vegetables and 3.19 times more likely to report infrequent consumption of fruits than controls [OR = 3.27, 95% CI = 1.80, 5.97; OR = 3.19, 95% CI = 1.18, 4.76, respectively]. In addition, a CRC case was 1.97 times more likely to report frequent consumption of processed meat than a control [OR = 1.97, 95% CI = 1.03, 3.74]. On the other hand, no significant difference was found between cases and controls regarding consumption of tea, coffee, and red meat. A CRC case was 2.72 times more likely to have had bowel movements more than once per day than a control [OR = 2.72, 95% CI = 1.50, 4.92]. (Table 2)

Physical activity, sedentary behavior and smoking habit

A CRC case was 4.1 times more likely to have sedentary behavior of more than six hours per day, compared with controls [OR = 4.10, 95% CI = 2.01, 8.29]. There was no statistically significant difference between cases and controls in regard to physical activity ($P = 0.572$) or smoking status ($P = 0.124$). An ever-smoker CRC case, on the other hand, was 12.5 times more likely to start smoking at a young age than an ever-smoker control [OR = 12.5, 95% CI = 1.5, 104.2]. (Table 3)

Family and medical history

A CRC case was 6.7 times more likely to have a positive family history of CRC than a control [OR = 6.7, 95% CI = 1.5, 30.6]. As for medical history, there were no statistically significant differences between cases and controls in terms of using aspirin or non-steroidal anti-inflammatory drugs, a history of cholecystectomy, or comorbidities ($P = 0.365$, $P = 0.071$, and $P = 0.561$, respectively). (Table 4)

Occupational characteristics

There was no statistically significant difference between the ever-employed cases (n = 75) and controls (n = 86) in regard to employment duration. ($P = 0.174$). However, an ever-employed CRC case was 3.3 times more likely to have been exposed to chemicals compared with an ever-employed control [OR = 3.3, 95% CI = 1.3, 8.5]. Similarly, an ever-employed CRC case was 3.6 times more likely to have been exposed to dust or fumes than an ever-employed control [OR = 3.6, 95% CI = 1.4, 9.1]. (Table 5)

Female reproductive history

Among women participants (n = 96), CRC cases were less likely to have used OCPs than controls [OR = 0.2, 95% CI = 0.1, 0.6]. Moreover, post-menopausal controls reported a significantly higher median age of menopause (50 years) compared with post-menopausal cases (49 years). ($P = 0.033$). (Table 6)

Independent predictors of CRC

According to the analysis, positive family history of CRC, sedentary behavior of more than six hours per day, bowel movements more than once per day, and low educational level were found to be independent predictors of CRC ($P = 0.014$, $P = 0.003$, $P = 0.036$, and $P = 0.008$, respectively). A person with a positive family history of CRC was 8.7 times more likely to have CRC than a person without a positive family history of CRC [OR = 8.70,

95% CI = 1.60, 48.8]. In addition, sedentary behavior of more than six hours per day increases the risk of CRC by 3.54 times [OR = 3.54, 95% CI = 1.60, 8.1], while bowel movements more than once per day increase the risk of CRC by 2.07 times [OR = 2.07, 95% CI = 1.1, 4.1]. CRC cases were less likely to have attained higher education by 2.47 times than controls [OR = 2.47, 95% CI = 1.3, 4.8]. (Table 7).

Table 1: Sociodemographic characteristics of CRC cases (n=101) and controls (n=101) at MAFMC, 2022

Characteristics	CRC Cases (n=101)		Controls (n=101)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Gender						
Male	53	52.5	53	52.5	1 (0.57, 1.74)	*1.000*[a]
Female^	48	47.5	48	47.5		
Residence						
Rural	26	25.7	32	31.7	0.75 (0.41, 1.38)	*0.351*[a]
Urban^	75	74.3	69	68.3		
Higher education						
Yes	38	37.6	63	62.4	0.36 (0.21, 0.64)	*0.001*<[a*]
No^	63	62.4	38	37.6		
Currently married						
Yes	76	75.2	89	88.1	0.41 (0.19, 0.87)	*0.018*[a*]
No^	25	24.8	12	11.9		
Employment status						
Never employed	26	25.7	15	14.9	1.99 (0.98, 4.03)	*0.054*[a]
Ever employed^	75	74.3	86	85.1		
Age (years)						
Min- Max	20 - 84		27 - 81			
Mean ± SD	61.89 ± 12.93		61.27 ± 12.02			
Median (IQR)	66.00 (17)		64.00 (18)			*0.549*[u]

Abbreviations: CRC, Colorectal cancer; MAFMC, Maadi Armed Forces Medical Complex; SD, standard deviation; IQR, Interquartile range; OR, odds ratio; CI, confidence interval
^ Reference category
a Chi square test
u Mann Whitney U Test
* $p < 0.05$

Table 2: Dietary factors and bowel habit among CRC cases (n=101) and controls (n=101) at MAFMC, 2022

Factors	CRC Cases (n=101)		Controls (n=101)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Dietary consumption						
Tea (cups/day)						
≥ 3	49	48.5	49	48.5	1 (0.58, 1.74)	*1.000*[a]
< 3^	52	51.5	52	51.5		
Coffee (cup/week)						
≥ 3^	28	27.7	30	29.7	1.10 (0.60, 2.03)	*0.756*[a]
< 3	73	72.3	71	70.3		
Vegetables (days/week)						
<5	51	50.5	24	23.8	3.27 (1.80, 5.97)	*<0.001*[a**]
≥5^	50	49.5	77	76.2		
Fruit (days/week)						
<5	53	52.5	26	25.7	3.19 (1.18, 5.76)	*<0.001*[a**]
≥5^	48	47.5	75	74.3		

Red meat (days/week)						
≤2	54	53.5	62	61.4	0.72 (0.41, 1.27)	*0.255*[a]
>2^	47	46.5	39	38.6		
Processed meat (days/month)						
<4^	68	67.3	81	80.2	1.97 (1.03, 3.74)	*0.038*[a*]
≥4	33	32.7	20	19.8		
Bowel movement (times/day)						
≤1^	52	51.5	75	74.3	2.72 (1.50, 4.92)	*0.001*[a*]
>1	49	48.5	26	25.7		

Abbreviations: CRC, Colorectal cancer; MAFMC, Maadi Armed Forces Medical Complex; SD, standard deviation; IQR, Interquartile range; OR, odds ratio; CI, confidence interval
^ Reference category
a Chi square test
* *p<0.05;* ** *p<0.001*

Table 3: Physical activity, sedentary behavior, and smoking habit among CRC cases (n = 101) and controls (n = 101) at MAFMC, 2022

Factors	CRC Cases (n=101)		Controls (n=101)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Physical activity						
Regular practice of MIPA[$]						
Yes^	45	44.6	48	47.5	1.13 (0.65,1.96)	*0.672*[a]
No	56	55.4	53	52.5		
Duration of MIPA[k] (minutes/week)	(n=45)		(n=48)			
<150	22	48.9	19	39.6	1.37 (0.64,3.32)	*0.366*[a]
≥150^	23	51.1	29	60.4		
Sedentary behavior[&]						
Duration[&] (hours/day)						
≤ 6^	63	62.4	88	87.1	4.10 (2.01,8.29)	*<0.001*[a**]
> 6	38	37.6	13	12.9		
Smoking habits						
Smoking Status						
Non-smoker	66	65.3	76	75.2	0.62 (0.34,1.14)	*0.124*[a]
Ever-smoker^	35	34.7	25	24.8		
Age at smoking initiation (Years)	(n=35)		(n=25)			
< 18	12	34.3	1	4.0	12.5 (1.5, 104.2)	*0.005*[a*]
≥ 18^	23	65.7	24	96.0		
Smoking intensity[#]	(n=35)		(n=25)			
Light^	14	40.0	10	40.0	1.0 (0.351,2.85)	*1.000*[a]
Moderate/heavy	21	60.0	15	60.0		

Abbreviations: CRC, Colorectal cancer; MAFMC, Maadi Armed Forces Medical Complex; MIPA, Moderate intensity physical activity; OR, odds ratio; CI, confidence interval
$ Physical activity, at least 10 minutes continuously, that brings about increase in heart and respiratory rates with preserved ability to talk without pausing for a breath
k among subjects reported moderate intensity physical activity
Among ever smokers smoking index (pack year) was calculated light (≤20) moderate (20-≤40) and heavy (>40)
& Any waking behavior characterized by an energy expenditure of 1.5 METS or lower while sitting, reclining, or lying
^ Reference category
a Chi square test
* *p<0.05;* ** *p<0.001*

Table 4: Family and medical history among CRC cases (n=101) and controls (n=101) at MAFMC, 2022

Factors	CRC Cases (n=101)		Controls (n=101)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Family history of CRC[&]						
Yes	12	11.9	2	02.0	6.7 (1.5, 30.6)	*0.006[a*]*
No^	89	88.1	99	98.0		
Family history of cancer[%]						
Yes	30	29.7	35	34.7	0.8 (0.4, 1.4)	*0.451[a]*
No^	71	70.3	66	67.8		
Use of Aspirin/NSAID[#]						
Yes^	23	22.8	31	30.7	1.5 (0.8, 2.8)	*0.203[a]*
No	78	77.2	70	69.3		
History of Cholecystectomy						
Yes	15	14.9	7	6.9	2.3 (0.9, 6.0)	*0.071[a]*
No^	86	85.1	94	93.1		
Comorbidities						
Yes	65	64.4	61	60.4	1.2 (0.7, 2.1)	*0.561[a]*
No^	36	35.6	40	39.6		
Multiple comorbidities[$]	(n=65)		(n=61)			
Yes	37	56.9	29	47.5	1.5 (0.7, 2.9)	*0.292[a]*
No^	28	43.1	32	52.5		

Abbreviations: MAFMC, Maadi Armed Forces Medical Complex; CRC, colorectal cancer; NSAID, non-steroidal anti-inflammatory drugs; SD: standard deviation; IQR, interquartile range; OR, odds ratio; CI, confidence interval
& First degree relative and/ or second degree relative
% Other than CRC
# Regular use for at least 1 year
$ among participants with comorbidities
^ Reference category interval
a Chi square test
* *p<0.05*

Table 5: Occupational factors associated with CRC among ever employed participants (n=161) at MAFMC, 2022.

Factors	CRC Cases (n=75)		Controls (n=86)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Exposure to chemicals						
Yes	17	22.7	7	8.1	3.3 (1.3,8.5)	*0.010[a*]*
No^	58	77.3	79	91.1		
Exposure to fumes/dust						
Yes	18	24.0	7	8.1	3.6 (1.4,9.1)	*0.006[a*]*
No^	57	77.3	79	93.0		
Duration employment (years)						
Min - Max	2 - 50		3 - 50			
Mean ± SD	26.88 ± 11.84		29.86 ± 9.99			
Median (IQR)	30.00 (48)		30.00 (47)			*0.174[u]*

Abbreviations: CRC, Colorectal cancer; MAFMC, Maadi Armed Forces Medical Complex; SD, standard deviation; IQR, Interquartile range; OR, odds ratio; CI, confidence interval
^ Reference category
a Chi square test
u Mann Whitney u test
* *p<0.05*

Table 6: Reproductive factors associated with CRC among women participants (n=96) at MAFMC, 2022

Factors	CRC Cases (n=48)		Controls (n=48)		OR (95% CI)	*P-value*
	No.	%	No.	%		
Use of OCP[#]						
Yes	21	43.8	37	77.1	0.2 (0.1, 0.6)	*0.001*[a*]
No[^]	27	56.3	11	22.9		
Duration of use of OCP[@] (years)	(n=21)		(n=37)			
Min- Max	01-10		2-20			
Mean ± SD	4.19 ± 2.82		6.16 ± 4.34			
Median (IQR)	3.00 (3)		5.00 (5)			*0.072*[u]
Age at giving birth to first child (years)	(n=44)		(n=43)			
Min- Max	14-30		16-28			
Mean ±SD	22.39 ± 4.18		22.23 ± 3.46			
Median (IQR)	22.00 (05)		22.00 (06)			*0.983*[u]
Number of live births	(n=48)		(n=48)			
Min- Max	0-7		0-6			
Median (IQR)	3.00 (1)		3.00 (1)			*0.983*[u]
Menopausal status						
Yes	41	85.4	35	72.9	2.2 (0.8, 6.1)	*0.132*[a]
No[^]	7	14.6	13	27.1		
Age of menopause[&] (years)	(n=41)		(n=35)			
Min- Max	26-57		45-58			
Mean ±SD	46.78 ± 7.36		50.49 ± 3.00			
Median (IQR)	49.00 (9)		50.00 (4)			*0.033*[u*]

Abbreviations: MAFMC, Maadi Armed Forces Medical Complex; CRC, colorectal cancer; OCPs, oral contraceptive pills
@: Among users of oral contraceptive pills; SD, standard deviation; IQR, Interquartile range; OR, odds ratio; CI, confidence interval
Regular use for at least 1 year
& Among post-menopausal women
^ Reference category;
u Mann Whitney U Test
a Chi square test
* *p<0.05*

Table 7: Multivariate logistic regression analysis of independent predictors of CRC among all participants (n=202), at MAFMC, 2022

Variables	Coefficient	Adj. OR[†]	95% CI	*P-value*
Positive family history for CRC	2.16	8.70	(1.6, 48.8)	*0.014*[*]
Not attaining higher education	0.90	2.47	(1.3, 4.8)	*0.008*[**]
Not having a spouse	0.72	2.05	(0.9, 4.8)	*0.101*
Infrequent veg. consumption[^]	0.76	2.14	(0.9, 4.6)	*0.051*
Infrequent fruit consumption[^]	0.60	1.82	(0.9, 3.9)	*0.120*
Frequent consumption of processed meat[#]	0.57	1.76	(0.8, 3.8)	*0.147*
Sedentary behavior [$]	1.26	3.54	(1.6, 8.1)	*0.003*[*]
Bowel movement [&]	0.73	2.07	(1.1, 4.1)	*0.036*[*]
Model X^2 =59.96 (*p<0.001*); Nagelkerke's R^2=0.34; Cox & Snell R^2=0.26; Hosmer and Lemeshow X^2=8.37 (*P=0.39*)				

Abbreviations: MAFMC, Maadi Armed Forces Medical Complex; CRC, colorectal cancer; OR, odds ratio; CI, confidence interval
† OR adjusted for all independent variables in the above table.
^ Less than 5 days per week;
# More than 4 days per week
$ More than 6 hours per day
& More than 1 time per day
* *p<0.05;* ** *p<0.001*

DISCUSSION

Recognizing modifiable risk factors for CRC among the Egyptian population is essential for the primary prevention of the disease in Egypt. A positive family history of CRC, sedentary behavior of more than six hours per day, frequent bowel movements, and a low educational level were found to be independent predictors of CRC in the current study.

The current study suggests a positive family history of CRC would be an important risk factor for the development of CRC; this finding is consistent with the observations reported in other studies[18,19,20], which support a genetic contribution to CRC risk. A recent meta-analysis of 46 studies revealed that cases with a positive family history of CRC in first-degree relatives have a 1.87-fold increased chance of developing the disease compared with those without a family history[21]. In the current study, however, the odds of a CRC case having a positive family history were 8.7 times higher than those of a control. The much higher risk in the current study could be attributed to two reasons: first, unlike Mehraban *et al*. meta-analysis, risk estimation in the current study included first- and second-degree relatives, second, a relatively smaller sample size in the current study has resulted in a wide, less precise confidence interval CI [OR = 8.70, 95% CI = 1.60, 48.8].

In the present study, sedentary behavior lasting more than six hours per day was found to increase the risk of CRC by 3.54 times. In the literature, emerging evidence suggests that sedentary behavior, independent of physical activity, may be a risk factor for CRC (22-25). A meta-analysis found that colon cancer risk was increased by 54%, 24%, and 24% depending on how much time was spent watching TV, sitting at work, and overall sitting, respectively (23). In a more recent prospective analysis in the UK Biobank, longer television watching time, but not time spent on a computer, was linked to higher colon cancer risk, with no associations found for rectal cancer risk[26]. On the contrary, the current study was unable to assess how domain-specific activities were associated with CRC risk, since sedentary behavior was defined as the time spent during a typical day sitting or reclining. Moreover, the risk, in the current study, was not assessed for colon or rectal cancer separately. Substantial challenges remain in translating the current understanding of the impact of sedentary behavior on CRC risk into interventions with a possible clinical impact.

Bowel movements more than once per day was found to increase the risk of CRC by 2.07 times, in the current study. Similarly, a large meta-analysis that included more than one million participants provided strong evidence supporting the association between the frequency of bowel movement and CRC risk[27]. Moreover, a cohort study found that the frequency of bowel movements was associated with an increased risk of rectal cancer but not CRC, and constipation was associated with decreased risks of both CRC and rectal cancer[28]. On the contrary, in the European Prospective Investigation into Cancer and Nutrition (EPIC) Norfolk study, the frequency of bowel movements was not associated with overall CRC risk; however, it revealed that loose stools could be an indicator of CRC ris[29]. Variable results were reported in terms of the impact of the consistency of the stool on CRC risk. For example, unlike the EPIC-Norfolk study, in a meta-analysis based on case-control studies, the prevalence of constipation in CRC patients was higher than that in controls[30]. In the present study, participants were asked to report a specific index, namely, bowel movement frequency (not constipation), as a predictor factor of CRC.

In the current study, CRC cases were less likely to have attained higher education 2.47 times than controls. In agreement with current research, a case-control study of 50 CRC patients matched with 50 controls conducted in Saudi Arabia reported a significantly greater percentage of controls attained higher education levels compared to patients with CRC[31]. Moreover, in another case-control study in China, educational level was inversely associated with CRC risk with an adjusted odds ratio of 0.42[32]. Furthermore, lower socio-economic status was associated with a higher risk of digestive cancers in Japan[33]. These findings suggest that higher education might protect individuals from developing CRC. However, opposite findings were reported in studies conducted in European countries. For example, in the EPIC study, a lower educational level was associated with a lower CRC risk compared to a higher educational level, especially in the proximal colon. Furthermore, the results of a large case-control study in Italy revealed an increased colon cancer risk for participants with more educational years, whereas such an association was not found in the rectum[34]. In addition, people with a lower education were more likely to present with a more advanced CRC stage compared to people with a higher education. It has been explained by lead time bias, delayed diagnosis, or dietary consumption as a confounding factor among people with lower education living in rural residence in Europe[35].

Although smoking is a well-established risk factor for CRC[36], in the current study, smoking status was not found to be a predictor of CRC. Similar findings were reported in other studies[37,38]. Among smokers in the current study, smoking intensity was not a risk factor

for CRC. A large meta-analysis revealed a pooled risk estimate of 1.25 for ever-vs.-never smokers[39]. Age of smoking initiation was significantly associated with CRC among smokers in the current study, contradicting findings in an earlier study[40]. In the current study, passive smoking and other types of smoked tobacco were not assessed, which might explain the variability in findings compared with other studies.

Limitations of the study

The case-control design could have exposed the results to recall, response, and/or personal bias. In addition, risk factors were assessed using a subjective tool; it would have been better to conduct a more comprehensive, objective assessment of physical activity and dietary habits.

CONCLUSION

The study highlighted four independent predictors of CRC risk among CRC cases: having a positive family history of CRC, sedentary behavior of more than six hours per day, bowel movements more than once per day, and not attaining a higher education. Campaigns to raise awareness and screen high-risk groups are strongly advised for the prevention of the disease. Moreover, longitudinal multicentric studies with objective evaluations of physical activity and dietary consumption are required.

LIST OF ABBREVIATIONS

EPIC: European Prospective Investigation into Cancer and Nutrition

CRC: Colorectal Cancer

MAFMC: Maadi Armed Forces Medical Complex

OCP: Oral Contraceptive Pill

CONFLICT OF INTEREST

There are no conflicts of interest.

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