RESEARCH ARTICLE

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Association between Dietary and Lifestyle Indices and Colorectal Cancer in Oman: A Case-Control Study

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Abstract

Background: Colorectal cancer (CRC) represents a heterogeneous group of diseases characterized by uncontrolled growth and spread of abnormal cells in the body. CRC vary on the basis of both the biologic features of the disease and its associated lifestyle characteristics. The risk of CRC increases with several modifiable factors including obesity, physical inactivity, a diet high in red or processed meat, heavy alcohol consumption, and possibly inadequate intake of fruits and vegetables. We aimed to establish a baseline data for dietary and lifestyle characteristics of Omani adults diagnosed with CRC. **Methods:** A Case control study conducted at Sultan Qaboos University Hospital, a referral hospital for CRC patients in Oman, and included 279 subjects (109 diagnosed CRC cases and 170 matched controls). All study subjects were recruited on volunteer basis and personally interviewed for preset questions related to sociodemographic data, anthropometric assessment, dietary intake and physical activity. **Results:** There was no significant difference between cases and controls regarding smoking, alcohol intake, physical activity and dietary fiber intake. However the enrolled cases were more overweight (OR =3.27. 95% CI: 1.91, 7.27), and, had a higher caloric (p =0.001) and macronutrient intake (carbohydrate: p = 0.001; protein: p = 0.017; saturated fat: P = 0.034) than the controls. In addition, the dietary pattern of the cases was characterized by a trend towards low vegetables and fruits intake. **Conclusion:** CRC maybe prevented through dietary management of high risk groups. This primary prevention approach will ultimately reduce the burden of CRC in Oman.

Keywords: Colorectal cancer- diet- lifestyle- Oman

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Introduction

Colorectal cancer (CRC) is the third most common cancer in the world and the fourth in cancer-related deaths after lung and breast cancers respectively (Fitzmaurice et al., 2015). It is predicted that about 2.4 million cases will be diagnosed annually worldwide by 2035 (Torre et al., 2015). In 2013, CRC accounted for 1.6 million of the 14.9 million global incident cancer cases. Within the same period, CRC was responsible for more than 700,000 of the total 8.2 million cancer- related deaths (Fitzmaurice et al., 2015). According to literature, incidence rates for CRC are generally higher in more developed countries of the West (Fitzmaurice et al., 2015). However, the Middle Eastern countries such as Oman, previously considered as low-risk regions for CRC, are witnessing a rising trend (Hakulinen, 2007; Fitzmaurice et al., 2015). The 2006 Oman cancer registry report on the ten most common cancers in Oman indicated that CRC was the 7th most common in Omani men and 10th among women respectively in that year (Oman National Cancer Registry, 2006). However, by 2012, CRC had become the most frequent cancer among Omani men and the third most common in Omani women with incidence rates of 10.2 and 8.5 per 100,000 cases for men and women respectively (Oman National Cancer Registry, 2012). Within the same period, CRC accounted for 9.0% of all-cause mortality in adult Omani males and 8.3% in females (Oman National Cancer Registry, 2012; World Health Organization, 2014).

CRC is an important public health problem. About one in three people diagnosed with CRC die of the disease within 5 years after diagnosis (American Cancer Society, 2016). In addition to the human cost, the tangible and intangible costs of treating CRC are enormous. The direct medical costs for CRC treatment in the U.S. in 2011 was $88.7 billion (American Cancer Society, 2016). These figures do not include the indirect costs such as patient- time involved with receiving medical care and productivity losses among patients and caregivers (Yabroff et al., 2013;

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American Cancer Society, 2016). Although there has been a marked reduction in CRC incidence and death rates across developed countries due to improved screening services and specialized care (American Cancer Society, 2016), screening and early detection services for CRC are lacking in Oman. As a result of this, many CRC cases are detected in the late stages where the only option of treatment is palliative. Furthermore, apart from a small number of CRC cases related to genetic disposition and advanced age, up to 90% of CRC cases are non-hereditary, and have been linked to modifiable behavioral practices related to diet, physical inactivity, obesity, heavy alcohol consumption and tobacco use (MacFarlane et al., 2007; Kirkegaard et al., 2010; Spring et al., 2012; Jones-McLean et al., 2015).

Many studies on Western populations have looked into the association between diet and lifestyle factors and CRC (Levi et al., 2002; Boyle et al., 2013; Johnson et al., 2013; Baroudi et al., 2014). Of the few such studies conducted in the Arab countries of the Middle East (Arafa et al., 2011; Alamri et al., 2014; Azzeh et al., 2017), none has examined the association between dietary and lifestyle indices and CRC in the Omani population despite the documented rise in CRC incidence in Oman over the past decade. Therefore, the overall aim of this study was to examine the association between dietary and lifestyle indices, and CRC among Omani cases and controls attending a tertiary hospital in Oman. The specific objectives were: 1- To compare the lifestyle characteristics of cases and controls, 2- Determine if there was any difference in daily macronutrient intake between cases and controls, 3- Explore the sociodemographic and lifestyle indices that predicted CRC while controlling for potential confounding variables.

Materials and Methods

Study Population

This case- control study was conducted from February to November 2016, among participants attending Sultan Qaboos University Hospital (SQUH), a tertiary hospital in Muscat, Oman. The study was approved by the Medical Research and Ethics Committee of SQUH (MREC #1232).

Sample size &power calculation

Allowing an error rate of 2.5%, a level of significance (type 1 error) of 5% and 95% confidence interval and with a priori estimate of 10% prevalence of CRC in controls and a least odds ratio of 2.5, the OpenEpi sample size calculator indicated that a sample size of 228 (114 participants in each group) was required to achieve a power of 80 % in this study.

Study Participants

The study participants included 279 adults aged 18 years and above (109 cases and 179 controls) of similar ethnicity, culture, and quality of care. The cases were selected by convenience sampling and the controls by simple random sampling.

Selection of Cases

Cases were selected from among Omani patients aged 18 years or above with histologically proven CRC (ICD-10: 18.0, 18.2 to 18.9, 19 and 20) who attended the outpatient oncology clinic or, were admitted into the oncology wards within the period of the study. One hundred and twenty cases were approached out of which 109 cases consented to participate in the study yielding a response rate of 91%.

Selection of Controls

The controls were randomly selected from among patients admitted in the ENT, ophthalmology and surgical wards with a wide range of acute non-malignant conditions that ranged from cataract, slipped discs, low back pain, simple fractures, sprains, minor traumas, hernia repair, gall bladder stones and osteoarthritis Two hundred and forty controls were approached out of which 170 consented to participate in the study to yield a response rate of 75%.

Potential participants were approached by trained research assistants who explained the purpose of the study and the details of the methodology to them. All potential participants received an information sheet that covered all aspects of the study. Participants who agreed to participate in the study were asked to sign an informed consent form, and were provided with contacts of the investigators for any further inquiries. Therefore, a total of 279 participants were included in the analysis.

Study tools and data collection

A structured questionnaire that has been tested for validity, reproducibility and reliability (Arafa et al, 2011) was used to collect the data during personal interviews. The questionnaire included sections on dietary characteristics, socio-demographic variables, relevant co-morbidities, lifestyle characteristics, and anthropometric measurements. Participants were asked to report the frequency and portion sizes for each of 33 food items in 8 food groups commonly eaten in Oman, prior to CRC diagnosis for cases, or, prior to their admission, for controls. Participants were also asked whether or not they used tobacco, consumed alcohol, and took part in selected physical activity aimed at achieving at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity throughout the week, according to the World Health Organization recommendation for adults (Hamer et al., 2013; WHO, 2016). Demographic variables included gender, age, education and marital status. All interviews were conducted in the hospital during admission or outpatient consultation.

Statistical Analysis

Prior to conducting the statistical analysis, physical activity, was recoded and dichotomized as active/not active. The "not active" category comprised participants who reported less than the WHO recommended standard physical activity whereas the "active" category was made up of participants who engaged in moderate or vigorous physical activity according to the standard recommendation of the World Health Organization, (WHO, 2016). Body mass index (BMI) was categorized

into three levels according to the WHO criteria as 18.5 - 24.99 kg/m^2, 25 - 29.99 kg/m^2, ≥30 kg/m^2 representing normal weight, overweight and obese respectively (WHO, 2015).

To evaluate the statistical significance of differences among proportions of categorical data, Chi-square analyses were used. The non-parametric Fisher's exact test (two-tailed) replaced the Chi-square test in cases of small sample size, where the expected frequency was less than 5 in any of the cells in the 2 x 2 tables. Dietary data was analyzed based on the Food Guide Pyramid from US Department of Agriculture according to the number of daily servings and the frequency of consumption (Willett and Ludwig, 2011). Dietary data were expressed as mean ± standard deviation. The student unpaired t-test and correlation coefficients were used for mean comparisons. The odds ratios (OR) and 95% confidence intervals (CI) obtained from multivariable logistic regression models were taken as the measures of predictors of CRC. All statistical analyses were conducted using Statistical Package for Social Sciences (SPSS 21.0) and statistical significance was set at p-value of ≤ 0.05.

Table 1. Socio-Demographic and Lifestyle Characteristics of Study Participants, Oman, 2016.

Variable	Cases (N = 109) N (%)	Controls (N = 170) N (%)	P-value
Age (years)			
≤ 40	15 (13.8)	36 (21.2)	0.07
41-60	44 (40.4)	78 (45.9)	
>61	50 (45.9)	56 (32.9)	
Gender			
Male	65 (59.6)	76 (53.9)	
Female	44 (40.4)	94 (55.3)	0.02
Occupation			
Unemployed	40 (36.7)	52 (30.7)	
Unskilled Worker	31 (25.7)	66 (38.8)	
Self employed	28 (25.7)	66 (38.8)	0.005
Skilled worker	10 (9.2)	25 (14.7)	
Education			
No/some schooling	52 (47.7)	54 (31.8)	
High School	28 (25.7)	55 (32.4)	0.03
University/Technical	29 (26.6)	54 (35.9)	
Marital Status			
Single	6 (5.5)	13 (7.6)	
Married	84 (77.1)	127 (74.7)	
Divorced/Widow	19 (17.4)	30 (17.6)	0.78
Family History			
No	97 (89)	161 (94.7)	0.08
Yes	12 (11.0)	9 (5.3)	
Smoking			
Never	81 (74.3)	131 (77.1)	
Former/Current	28 (25.7)	39 (22.9)	0.35
Alcohol Intake			
Never	98 (89.9)	149 (87.6)	
Former/Current	11 (10.1)	21 (12.4)	0.35
Physical Activity			
Sedentary	58 (53.2)	96 (56.5)	
Active	51 (46.8)	74 (43.5)	0.34
Body Mass Index			
Normal weight	39 (38.2)	39 (23.2)	
Overweight	33 (32.4)	84 (43.3)	
Obese	30 (29.4)	45 (26.8)	< .001

Results

A total 270 participants were included in this study of which 109 (39.9%) were cases and 170 (60.1%) were controls. The sociodemographic characteristics of CRC cases and controls are as shown in Table 1.The mean age for cases and controls was 53.69±14.22, and 57.35±14.08 respectively. There were more participants of younger age, 36 (21.2%) in controls compared to cases 15 (13.8%). Compared to cases, controls had significantly higher educational qualification and were more in the skilled and professional occupations (P< 0.05). There were no statistically significant differences between cases and controls with regards to smoking, alcohol intake and physical activity. However, the control group was significantly more overweight (43.3%) than the CRC cases (32.4%, P< 0.0001).

The food consumption frequency among the study

Table 2. Food Consumption Frequency of Study Participants, Oman, 2016

Food group (servings/ day)	Cases (N = 109) N (%)	Controls (N = 170) N (%)	P-value
Bread, Cereal, Rice and Pasta			P >0.05
<6	32 (29.4)	43 (25.3)	
6-11	35 (32.1)	67 (38.8)	
≥11	42 (38.5)	61 (35.9)	
Vegetables			P < 0.05*
<3	57 (52.2)	16 (9.4.)	
3-5	27 (24.6)	56 (32.9)	
≥5	25 (23.2)	98 (57.7)	
Fruits			P < 0.05*
<2	41 (37.6)	55 (32.4)	
2-4	47 (43.1)	76 (44.7)	
>4	21 (19.3)	29 (22.9)	
Milk, Yogurt and Cheese			P >0.05
<2	83 (76.1)	141 (82.9)	
2-3	20 (18.1)	25 (14.7)	
≥3	6 (5.8)	4 (2.3	
Meat, Poultry, Fish			P > 0.05
<2	11 (10.1)	22 (13)	
2-3	13 (11.8)	32 (18.8)	
≥3	85 (78.1)	116 (68.2)	

*Significant difference

Table 3. Logistic Regression Analysis of Potential Predictors of CRC among Study Groups Oman, 2016

	Crude		*Adjusted	
Variable	OR (95%CI)	P-value	OR (95% CI)	P-value
Age (years)				
≤ 40	1		1	
41-60	0.51 (0.25, 1.03	0.06	0.86 (0.40, 1.88)	0.71
≥ 61	0.65 (0.38, 1.22)	0.12	0.42 (0.29, 1.55)	0.35
Gender				
Female	1		1	
Male	3.30 (1.52, 7.19)		2.38 (1.28, 4.35)	0.006
Family History of CRC				
No	1		1	
Yes	3.07 (1.04, 2.35)	0.04	3.23 (1.18, 8.33)	0.02
Body Mass Index				
≤ 24.99	1		1	
25-29.99	2.36 (1.19, 4.47)	0.02	3.27 (1.91,7.27)	0.00
≥ 30	0.55 (0.30, 1.02	0.06	1.58 (0.78, 3.18)	
Alcohol Consumption				
No	1		1	
Yes	0.67 (0.23, 1.93		0.91 (0.32,2.58)	0.86
Smoking				
No	1		1	
Yes	1.13 (0.63, 2.06)		1.62 (0.93, 2.84)	0.12
Physical Activity				
Not Active	1		1	
Active	1.36 (0.80,2.33	0.26	1.25 (0.76, 2.06)	0.37

*Adjusted for age

participants is as listed in Table 2. The enrolled cases consumed significantly lower amounts of vegetables and fruits ($p< 0.05$). There were no statistically significant differences in the consumption of breads, milk/milk products, and meat between the CRC cases and controls. The average daily consumption for proteins, total fat, and carbohydrates were significantly higher among CRC cases compared to controls ($p< 0.05$).

Table 3 shows the crude and adjusted logistic analysis of selected confounding variables. The crude odds ratio indicated that gender, family history of CRC and BMI were associated with CRC ($p< 0.05$). This effect remained and was increased after adjusting for age (gender: OR =2.38, 95% CI: 1.28, 4.35), (family history of CRC: OR =3.23, 95% CI: 1.18, 8.33), and (BMI: OR =3.27. 95% CI: 1.91, 7.27).

Discussion

To our knowledge, this study is the first study to examine the association between diet and lifestyle indices, and CRC among the Omani population. In our study, the dietary pattern of CRC cases had a statistically significant trend towards low vegetables and fruits intake which is similar to the finding by other authors from Saudi Arabia (Alamri et al., 2014; Azzeh et al., 2017). These authors examined the dietary habits of CRC cases and matched controls among a sample of Saudi participants and found that participants in the control group consumed more fruits and vegetables than the CRC cases. Furthermore, our study showed that the total caloric intake was significantly higher in CRC cases than in controls. This is consistent with the finding of other authors who reported that CRC cases consumed higher daily and total calories than controls (Alamri et al., 2014). Major health organizations such as the WHO, World Cancer Research Fund (WCRF), and, the American Institute for Cancer Research (AICR), have emphasized the important role that diet plays in the risk of CRC. These organizations recommend that diets rich in whole grains, fruits, vegetables, monounsaturated fats, dietary fibers and nuts are essential to reduce the burden of CRC and should be consumed in preference to processed and energy-rich foods and sugar sweetened beverages (WHO, 2010; AICR, 2016; WCRF, 2017). In our study, CRC cases consumed fewer vegetables and fruits than controls. Total caloric intake was also more in cases than in controls. These findings from our study provide insight into the dietary habits of Omani CRC patients which can form the basis for public awareness/ education interventions to reduce the burden of CRC in the Omani population.

Our study revealed that gender, overweight and family history were independent risk factors for CRC. Epidemiological evidence suggests that men are at

a slightly higher risk for cancers than females with a higher lifetime probability of being diagnosed with an invasive cancer compared to women (Siegel et al., 2012). In our study, males were two times more likely to develop CRC than women. Similar to our findings, other authors found a higher risk of CRC in men compared to women (Campbell et al., 2010). However, contrary to our findings, some other authors found that women were more likely to develop CRC than men (He et al., 2010). Given these inconsistencies, further studies are necessary to further elucidate the association between gender and the risk of CRC in the Omani population.

Our study revealed that having a family history of CRC was associated with almost 3times higher risk of developing CRC in Omani adults. Similarly, findings from a meta-analysis showed that individuals with a family history of CRC in a first degree relative were almost two times more likely to develop CRC (Johnson et al., 2010). In another study, the authors found that among 12 non-screening risk factors of CRC, having a family history of CRC in a first degree relative was associated with a higher risk of CRC than other factors such as increased BMI and red meat consumption (Powell et al., 2013).

In our study, being overweight was associated with more than 3 times higher risk of CRC compared to having normal weight. Similarly, recent systematic review and meta-analyses of more than 1000 observational studies showed sufficient evidence that high Body Mass Index (BMI), a marker of overweight and obesity was significantly associated with the risk of CRC (WHO, 2015; Lauby-Secretan et al., 2016). The causal link between obesity and CRC has been attributed to metabolic and endocrine abnormalities involving sex hormone metabolism, insulin and insulin-like growth factor signaling, and, oxidative stress arising from release of inflammatory cytokines and reactive oxygen and nitrogen species (Wong et al., 2012; Ma et al., 2013). Studies have shown that obesity prevalence is on the rise in Oman. In 2010, about 20% of the Omani population was obese (Al-Riyami, 2010). By 2014, the figures had risen to 25% (ALNohair, 2014). Current WHO estimates indicate that as much as 27.2% adult Omani males and 37.7% females are obese (WHO, 2015).

The results of this study did not reveal an evidence for significant association between smoking and CRC or between alcohol consumption and CRC which is consistent with the findings from other studies McCleary et al., 2010; Rueda et al., 2012; Nordenvall et al., 2014).

This case control study may have been hampered by some limitations. First, this was a hospital based case-control study where both cases and controls were selected from the same hospital. Therefore, hospital-patient selection bias may have resulted in an underestimated odds ratio. However, controls were chosen from among patients who were admitted to the hospital for reasons unrelated to CRC, therefore, the potential for hospital-patient selection bias in this study was minimized. Secondly this study was limited to patients who attended one of two centers that treat CRC in Oman; hence, the findings from this research may not be representative of the general population in Oman.

Thirdly, information exposure misclassification and recall bias arising from the inability of participants to correctly recall their dietary habits during the interviewer-administered food frequency questionnaire may have hampered our result. Moreover, information bias would have also occurred if participants were not honest in their responses to questions on alcohol consumption given that Oman is a Muslim country where alcohol consumption is prohibited.. Finally, being an observational study design, other unknown confounders could have influenced our results plus, cause and effect could not be determined.

In conclusion, our study results have provided baseline diet and lifestyle indices that may influence CRC in Oman. The enrolled CRC cases consumed lower fruits and vegetables than healthy controls. Moreover, higher overall caloric intake was observed among enrolled cases compared to the controls. Our results also showed that male gender, having a family history of CRC and being overweight increased the risk of CRC. Given that overweight and obesity result from an imbalance between energy intake and expenditure, and are risk factors for many chronic diseases, primary prevention targeted towards reducing excess body weight has the potential to reduce the burden of CRC in Oman.

Disclosure

The authors report no conflicts of interest in this work.

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