

Original Article

## DIETARY FIBER CONSUMPTION AND COLORECTAL CANCER: A CASE-CONTROL STUDY

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### ABSTRACT

**Background:** Colorectal cancer (CRC) is an increasingly imperative cause of morbidity and mortality. This study aimed to determine the association between dietary fiber consumption and CRC.

**Methods:** This age- and sex-matched case-control study was conducted from July 2020 to June 2021 at the Combined Military Hospital (CMH) and the National Institute of Cancer Research and Hospital (NICRH) in Dhaka. A total of 102 cases and 102 controls were selected through purposive sampling. Cases were adult patients diagnosed with CRC, while controls were individuals without cancer. Data were collected using a pretested semi-structured questionnaire and checklist, which included information on socio-demographic characteristics, colorectal cancer attributes, and dietary fiber consumption. Face-to-face interviews were conducted to collect data from both cases and controls.

**Results:** The mean ( $\pm$ SD) age of the cases and controls were 44.7 $\pm$ 13.9 years and 45.6 $\pm$ 13.3 years, respectively, with a male-female ratio of 1:1.3 in both groups. A significantly higher proportion of cases (53.9%) lived in joint families compared to controls (39.2%) ( $p=0.035$ ). Type 2 diabetes mellitus (T2DM) was significantly more prevalent in cases (27.5%) than in controls (15.7%) ( $p=0.041$ ) among the comorbid conditions. Majority of the cases (72.5%) consumed low dietary fiber (<25 grams/day), while three-fifths of the controls (67.6%) consumed normal to high dietary fiber daily ( $p<0.001$ ). After adjusting for the type of family, residence, and presence of T2DM, participants who consumed low dietary fiber were found to be 7 times more likely to develop CRC than those who consumed normal or high dietary fiber (OR=7.003, 95% CI = 3.616-13.565,  $p<0.001$ ) based on binary logistic regression.

**Conclusion:** The findings of this study suggest that low dietary fiber consumption is associated with an increased risk of CRC. Specific measures that could be taken to promote a high-fiber diet include increasing awareness through public health campaigns, providing nutrition education, and ensuring that healthy food options are readily available and accessible to people from all socioeconomic backgrounds.

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**Keywords:** Colorectal cancer, Dietary fiber, Case-control study, Bangladesh

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### INTRODUCTION

Colorectal cancer (CRC) is a significant public health concern, being the third most commonly diagnosed malignant condition and the second leading cause of cancer-related deaths globally (1). A rising trend in incidence and mortality is observed in a number of developing countries (2). According to International Agency for Research on Cancer (IARC) database, CRC accounted for over 10% of all incidences of

cancer and caused approximately 935,000 deaths in 2020 (3). People in developing nations like Bangladesh are particularly vulnerable to this lethal disease due to significant barriers to accessing and utilizing healthcare services (4).

Approximately 70% of CRC cases are sporadic and influenced by environmental factors, such as dietary habits, physical activity, smoking, and alcohol consumption. About 25% of CRC cases have a

genetic predisposition, while 5% of CRC patients have inherited factors that increase their risk of developing the disease (5). Being physically active, consuming whole grains, dairy products, foods containing dietary fiber, and taking calcium supplements are protective factors against CRC risk (6). Conversely, factors that increase the risk of developing CRC include consuming red or processed meat, consuming alcoholic beverages, being overweight or obese, and being tall (7, 8).

Dietary fiber is an important nutritional component due to its various properties, such as bulk density, hydration capacity, binding ability, and fermentability. As a result, experts typically recommend increasing dietary fiber intake by consuming more grains, legumes, vegetables, and fruits, rather than relying on supplements (9). The pathogenesis of CRC is multifaceted, involving a series of progressive changes from the earliest dysplastic lesion called aberrant crypt focus to adenomatous polyp to invasive cancer. At the molecular level, the development of carcinogenesis depends on the gradual accumulation of alterations that promote tumor growth over time, ultimately resulting in an invasive malignancy. This process is commonly known as the adenoma-carcinoma sequence (10).

Consuming dietary fiber, which is abundant in various food items, particularly fruits and vegetables, has been found to offer significant health benefits. In particular, the consumption of vegetable fiber has been associated with a decreased risk of CRC (11). On the other hand, some studies have found no association between vegetable fiber intake and reduced CRC risk (12, 13). The intake of these soluble fibers increases fecal bulk, thus reducing transit time and potentially decreasing blood cholesterol levels (14).

Several studies have suggested a significant relationship between the consumption of dietary fiber-rich foods and the low risk of CRC (13, 15, 16, 17). However, there is a lack of emphasis and documentation on this subject matter in Bangladesh. Therefore, this study aims to investigate dietary fiber consumption behavior and its association with CRC risk in Bangladesh. Thus, modifying cancer risk factors such as dietary fiber consumption habits may help reduce the incidence of colorectal cancer and related mortality.

## **MATERIALS AND METHODS**

This was a case-control study that matched

participants based on age and sex. It was conducted from July 1, 2020, to June 30, 2021, at the National Institute of Cancer Research & Hospital (NICRH) and Combined Military Hospital (CMH) in Dhaka. The questionnaire was pretested at Dhaka Medical College Hospital (DMCH). The study population included patients attending the inpatient (IPD) and outpatient (OPD) departments of the Oncology and Colorectal Surgery unit at NICRH and CMH.

Cases were patients previously diagnosed with CRC by Colorectal Surgeons and Oncologists/Specialist physicians, based on colonoscopy-directed biopsy and histopathology reports, who attended the hospitals for treatment. Controls were healthy individuals without CRC or any other diagnosed cancer who attended the hospitals. Male and female patients were matched with an age variation of  $\pm 5$  years for this study. Purposive sampling was used to select a total of 102 cases and 102 controls for enrollment in this study.

After proper greetings and informing the study subjects about the study purpose and objectives, informed written consent was obtained from them. The study instrument was a pretested semi-structured questionnaire comprising socio-demographic variables, attributes of colorectal cancer, and consumption of dietary fiber. Face-to-face interviews were conducted to collect the data. Before processing the data, it was checked for completeness and internal consistency following the norms of missing data. Data analysis was done using Statistical Package for the Social Sciences (SPSS) version 27.0. Descriptive and inferential statistics were performed to determine the association between dietary fiber consumption and the risk of developing CRC.

Before the study, ethical clearance was taken from the ethical review committee of the National Institute of Preventive and Social Medicine (NIPSOM), Dhaka.

## **RESULTS**

Table 1 presents the socioeconomic characteristics of cases and controls. The distribution of respondents according to their age, sex, education, occupation, marital status, monthly family income, and residence was not statistically significant ( $p > 0.05$ ). However, the family type was found to be statistically significant ( $p = 0.035$ ) as the majority of cases (53.9%) were from joint families compared to controls (39.2%) and 46.1% of cases were from nuclear families compared to 60.8% in controls.

**Table 1. Comparison of socio-demographic characteristics between cases and controls**

Socio-demographic characteristics		Type of participants		p-value
		Case n (%)	Control n (%)	
Age	20 – 29	14 (13.7)	14 (13.7)	0.982
	30 – 59	72 (70.6)	71 (69.6)	
	60 – 75	16 (15.7)	17 (16.7)	
	<b>Mean ± SD</b>	44.7 ± 13.9	45.6 ± 13.3	0.625
Sex	Male	44 (43.1)	44 (43.1)	1.000
	Female	58 (56.9)	58 (56.9)	
Education	Illiterate	16 (15.7)	8 (7.8)	0.460
	Primary/Informal education	22 (21.6)	24 (23.5)	
	SSC/ Equivalent	31 (30.4)	27 (26.5)	
	HSC / Equivalent	17 (16.7)	20 (19.6)	
	Graduation/Equivalent	11 (10.8)	17 (16.7)	
	Post-graduation/Equivalent	5 (4.9)	6 (5.9)	
Occupation	Unemployed	10 (9.8)	8 (7.8)	0.256
	Service	13 (12.7)	22 (21.6)	
	Business	23 (22.5)	20 (19.6)	
	Farmer	9 (8.8)	7 (6.9)	
	Retired	14 (13.7)	22 (21.6)	
	Home maker	33 (32.4)	23 (22.5)	
Marital status	Unmarried	9 (8.8)	4 (3.9)	0.132
	Married	80 (78.4)	80 (78.4)	
	Separated	2 (2.0)	0 (0.0)	
	Widow/widower	11 (10.8)	18 (17.6)	
Family type	Nuclear	47 (46.1)	62 (60.8)	0.035
	Joint	55 (53.9)	40 (39.2)	
Monthly family income (BDT)	5000-10000	42 (41.2)	30 (29.4)	0.055
	10001-20000	37 (36.3)	34 (33.3)	
	20001-50000	23 (22.5)	38 (37.3)	
	<b>Mean ± SD</b>	15884±10077	17751±8413	
Residence	Urban	75 (73.5)	62 (60.8)	0.053
	Rural	27 (26.5)	40 (39.2)	
<b>Total</b>		102 (100.0)	102 (100.0)	

BDT: Bangladeshi Taka

Table 2 illustrates the family history of CRC, tobacco use, alcohol consumption, and drug history between the cases and the controls, but there was no statistically significant relationship (p>0.05).

**Table 2. Comparison of selected risk factors of colorectal cancer between cases and controls**

Characteristics			Type of participants		p-value
			Case n (%)	Control n (%)	
Family history	Colorectal cancer	Yes	6 (5.9)	1 (1.0)	0.054
		No	96 (94.1)	101 (99.0)	
	Other cancers	Yes	11 (10.8)	6 (5.9)	0.205
		No	91 (89.2)	96 (94.1)	
Tobacco use	Tobacco use	Yes	49 (48.0)	37 (36.3)	0.089
		No	53 (52.0)	65 (63.7)	
		<b>Total</b>	102 (100.0)	102 (100.0)	
	Tobacco form	Smoking	33 (67.3)	25 (67.6)	0.983

	Smokeless tobacco	Smokeless tobacco	16 (32.7)	12 (32.4)	0.107	
		<b>Total</b>	49 (100.0)	37 (100.0)		
	Smoked tobacco	Bidi	2 (6.1)	5 (20.0)		
		Cigarette	31 (93.9)	20 (80.0)		
		<b>Total</b>	33 (100.0)	25 (100.0)		
	Smokeless tobacco	Zarda	16 (100.0)	10 (83.3)		0.175
		Sadapata	0 (0.0)	2 (16.7)		
		<b>Total</b>	16 (100.0)	12 (100.0)		
	<b>History of alcohol/liquor consumption</b>	Yes		3 (2.9)		1 (1.0)
No		99 (97.1)	101 (99.0)			
<b>Drugs</b>	Aspirin	Yes	8 (7.8)	2 (2.0)	0.052	
		No	94 (92.2)	100 (98.0)		
	Statins	Yes	7 (6.9)	2 (2.0)	0.170	
		No	95 (93.1)	100 (98.0)		
<b>Total</b>			102 (100.0)	102 (100.0)		

Table 3 shows a comparison of comorbidities between cases and controls, revealing that Type 2 diabetes mellitus (T2DM) was more prevalent among

cases (27.5%) than controls (15.7%), with a statistically significant difference (p=0.041).

**Table 3. Comparison of comorbidities between cases and controls**

Comorbidities	Characteristics	Type of participants		p-value
		Case n (%)	Control n (%)	
<b>Dyslipidemia</b>	Present	4 (3.9)	6 (5.9)	0.517
	Absent	98 (96.1)	96 (94.1)	
<b>Hypertension</b>	Present	28 (27.5)	21 (20.6)	0.251
	Absent	74 (72.5)	81 (79.4)	
<b>Type 2 DM</b>	Present	28 (27.5)	16 (15.7)	0.041
	Absent	74 (72.5)	86 (84.3)	
<b>Coronary artery disease</b>	Present	10 (9.8)	10 (9.8)	1.000
	Absent	92 (90.2)	92 (90.2)	
<b>H. Pylori infection</b>	Present	11 (10.8)	6 (5.9)	0.205
	Absent	91 (89.2)	96 (94.1)	
<b>Inflammatory bowel disease</b>	Present	6 (5.9)	1 (1.0)	0.119
	Absent	96 (94.1)	101 (99.0)	
<b>Intestinal polyps</b>	Present	6 (5.9)	3 (2.9)	0.498
	Absent	96 (94.1)	99 (97.1)	
<b>Diverticulitis</b>	Present	0 (0.0)	1 (1.0)	1.000
	Absent	102 (100.0)	101 (99.0)	

Table 4 shows that 72.5% of the cases consumed less than 25 grams of dietary fiber per day compared to 32.4% of controls, while 27.5% of cases consumed normal or high amounts of dietary fiber compared to 67.6% of controls, with a statistically significant

difference in distribution (p<0.001); the participants who consumed low dietary fiber (<25 grams/day) were 5.5 times more likely to develop CRC than the reference category of normal or high fiber consumption (OR=5.526, 95% CI 3.030-10.079).

**Table 4. Comparison of level of dietary fiber consumption between cases and controls**

Level of daily dietary fiber consumption	Case n (%)	Control n (%)	p-value*	OR (95% CI)
Low fiber intake (< 25 gram)	74 (72.5)	33 (32.4)	<0.001	5.526 (3.030-10.079)
Normal or high fiber intake (≥ 25 gram)	28 (27.5)	69 (67.6)		
<b>Total</b>	<b>102 (100.0)</b>	<b>102 (100.0)</b>		

\* $\chi^2$  test

Binary logistic regression was used to identify factors associated with CRC, and Table 5 shows that only three independent variables made a unique and statistically significant contribution to the model (residence, T2DM, and level of daily dietary fiber

consumption). The odds ratio analysis indicated that participants who consumed less than 25 grams of dietary fiber per day were approximately seven times more likely to develop colorectal cancer (adjusted OR = 7.003, 95% CI: 3.616-13.565).

**Table 5. Association of risk factors with occurrence of colorectal cancer (Binary logistic regression)**

Attribute	Co-efficient (B)	S.E.	Adjusted OR	95% CI for OR		p-value
				Upper	Lower	
<b>Type of family</b>						
Nuclear*						
Joint	0.558	0.321	0.572	0.305	1.074	0.082
<b>Residence</b>						
Rural*						
Urban	0.888	0.347	2.431	1.231	4.802	0.011
<b>Type 2 Diabetes Mellitus</b>						
No*						
Yes	1.056	0.408	2.875	1.292	6.401	0.010
<b>Dietary fiber consumption (per day)</b>						
Normal or high fiber intake (≥ 25 gram) *						
Low fiber intake (< 25 gram)	1.946	0.475	7.003	3.616	13.565	<0.001

\*Reference category

**DISCUSSION**

In Bangladesh, there is an increasing burden of non-communicable diseases including colorectal cancer because of the influence of globalization on consumption patterns and the aging of populations. In this context, this study was conducted to determine the association between dietary fiber consumption and CRC.

The study results revealed a strong association between low dietary fiber consumption and CRC, with the majority of cases (72.5%) consuming less than 25 grams of daily dietary fiber, compared to controls (32.4%). After adjusting for potential confounding factors, the risk of developing CRC among those with low dietary fiber consumption was

found to be seven times higher than those with normal or high levels of dietary fiber. These findings are consistent with previous studies that suggest a protective effect of vegetable fiber and total fiber intake against colorectal, colon, and rectal cancer. (17). A similar case-control study in Saudi Arabia showed the same result (18). Additionally, a cohort study by Slattery (2003) reported a reduction in the risk of colorectal cancer associated with increased grain fiber intake (19). The similarity in these findings underscores the importance of adequate dietary fiber consumption for the prevention of colorectal cancer, particularly given the increasing burden of non-communicable diseases like CRC in populations undergoing demographic and epidemiologic transitions.

The results of the bivariate logistic regression model indicated that, in addition to low dietary fiber consumption, urban residence and the presence of T2DM were important risk factors for CRC. The study found that urban residents accounted for a higher percentage of cases (73.5%) compared to controls (60.8%), while rural residents were slightly more among the controls (39.2%) than cases (26.5%). A population-based study exhibited that rural men experienced lower CRC survival compared with urban counterparts (20). However, this finding contradicts the results of the present study, which only involved patients from a tertiary-level hospital located in Dhaka city. Thus, the residential status and housing conditions of patients from other areas of the country may be different and not accurately represented in this study.

While the current study identified an association between diabetes and CRC, previous research has shown inconsistent results in this regard. For instance, a study conducted by He et al. found a positive association between T2DM and CRC (21), whereas another study by Nilsen and Vatten did not find a significant association (22). The inconsistency in findings across studies could be due to differences in study design, sample size, and other factors such as confounding variables. However, a meta-analysis by Larsson et al. strongly supports the relationship between T2DM and the increased risk of CRC in both women and men (23).

The findings of this study highlight the importance of promoting dietary fiber intake as a preventative measure against CRC. Policies and interventions should focus on increasing awareness of the benefits of a high-fiber diet, as well as promoting access to high-fiber foods, particularly in areas where access is limited. Additionally, strategies should be developed to encourage individuals to adopt healthy dietary habits from a young age, as dietary patterns established in childhood may persist into adulthood. Finally, further research is needed to investigate the efficacy of dietary interventions for reducing the incidence of CRC, as well as to identify specific types of fiber that may be most beneficial.

This study had a few limitations that need to be considered. The retrospective design and self-reported dietary fiber consumption data left room for recall bias. Additionally, there was potential for selection bias, as the cases were CRC patients and the controls were individuals without any cancers who were selected purposively for this study. Despite the potential underestimation of the association due to such bias, this study found a significant association

between low dietary fiber consumption and the risk of CRC.

## CONCLUSIONS

This study highlights that low dietary fiber consumption is a significant risk factor for colorectal cancer, a growing public health concern in Bangladesh. Urban residents were found to be at higher risk than rural residents, and those living in joint families tended to consume less fiber. The presence of comorbidities like T2DM also increased the risk of colorectal cancer. Therefore, targeted interventions and government policies are needed to increase awareness and promote the consumption of dietary fiber.

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