Association between Nutrition Behavior and Colorectal Cancer Diet Recommendation

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The incidence of colorectal cancer has considerably increased worldwide, particularly among adults aged 50 and older. Despite numerous nutrition initiatives, colorectal cancer (CRC) remains a public health burden that affects younger adults in the United States. Understanding the potential factors contributing to non-adherence to nutrition recommendations can be helpful to develop effective nutrition initiatives to prevent CRC. This study aimed to determine differences in nutrition knowledge, attitudes, and beliefs (KAB); examine their associations on diet characteristics and weight status; and identify factors influencing eating patterns among ethnically diverse populations at risk for CRC and living in urban areas. The study used a quantitative descriptive and correlational research design in which data were collected through an online cross-sectional survey. A total of 377 participants responded to the survey. The study revealed a few significant differences in KAB levels between males and females. KAB levels were not associated with weight status but with meat recommendations among overweight or obese males. Ultimately, the study identified perceived barriers and facilitators as factors influencing participants' diets. Differences in KAB among males and females were inconsistent with the diet characteristics and weight status variables. This study suggests acknowledging these differences and inconsistencies when designing nutrition initiatives focusing on colorectal cancer prevention.

Key Words Diet, food, and nutrition, Colorectal neoplasm, Diet, Culture and replace diet with knowledge, Attitudes

INTRODUCTION

Globally, colorectal cancer (CRC) is the second most diagnosed cancer in women and the third most diagnosed cancer in men. Despite numerous health initiatives to reduce CRC incidence, it remains a public health burden. In the United States, although the incidence of CRC has been gradually decreasing among adults aged 50 years and older, it rapidly increases among young adults [1]. Though evidence has revealed poor diets represent 30% to 35% of tumor contributors [2], and poor lifestyle habits appear to be substantial risk factors for CRC [3], nutrition has often been ignored as a contributing factor [4].

Studies focusing on colorectal cancer prevention have identified dietary factors as mediators of CRC. Such factors include diets rich in red, processed, and grilled meats, and alcohol consumption [5]. Castelló et al. [6] explained approximately 50% of CRC cases could be prevented through lifestyle modifications, including following a healthful diet and maintaining a healthy body weight. To encourage healthier lifestyles and reduce the risk of CRC, some organizations have implemented preventive approaches. For example, the World Cancer Research Fund (WCRF) and the American Institute for Cancer Research (AICR) established recommendations to reduce CRC risk through diets and lifestyle modifications [7]. However, promoting healthy eating involves more than a change in diet. Factors preventing the adoption of healthy eating behaviors may influence individuals' diet characteristics. Such factors, including facilitators and barriers to healthy eating, were addressed in several studies [8,9].

Other factors, including nutrition knowledge, behavior, and beliefs, were identified in CRC studies through the health behavior model (HBM) and the theory of planned behavior model (TPB) [10,11]. The HBM focuses on individuals' beliefs regarding health. The main goal of the HBM is to identify and predict health behavior [12]. The model was developed to support research intended to understand why individuals often neglect preventive measures improving health [12]. The TPB posits most factors of behavior correspond to the intention of performing a behavior. Intention is defined as the effort

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employ to perform a behavior. Intentions are determined by attitudes, evaluation of the benefits or cost to perform the behavior, evaluation of the opinions of significant others regarding the behavior, and the analysis of perceived behavioral control [13]. The TPB is effective in studies addressing nutrition and healthy diets, as it can predict the behavior of individuals and their intentions.

Nutrition approaches to CRC prevention encompass prudent diets and weight status, yet they often omit individuals' perceived beliefs and behavior. Because poor nutrition remains a substantial factor enhancing the risk of CRC [6,12,14], individuals' perspectives regarding dietary behavioral changes should be considered during the development of effective interventions. When designing nutrition interventions focused on CRC prevention, assessments of unmet needs should be performed to identify the potential barriers, motivators, and facilitators that influence diets. A few studies focusing principally on CRC survivors have examined health behaviors toward nutrition and CRC [8,15]. Other studies have analyzed the perceptions of cancer patients regarding nutrition and the barriers and motivators influencing cancer patients' diets [16,17].

Populations at risk of developing CRC are often unaware of the function of nutrition as a tool to ameliorate their lifestyle. Understanding populations' perceived beliefs regarding diet and evaluating subjects' knowledge about the benefits of nutrition as a means of CRC prevention can enlighten health professionals to design effective health initiatives. Additionally, identifying whether sex differences exist in regard to dietary choices may help nutritionists and dietitians develop targeted interventions fostering changes in nutritional behavior. Although the previous studies that compared healthy males and females revealed differences in nutritional needs; they mainly focused on dietary characteristics. Therefore, studies identifying factors that may influence dietary choices in men and women at risk of CRC may be an asset in reducing CRC prevalence. The purpose of this quantitative descriptive correlational study is to determine differences in nutrition knowledge, attitudes and beliefs; examine their association on diet characteristics and weight status; and identify factors influencing eating patterns among ethnically diverse populations at risk for CRC and living in urban areas.

MATERIALS AND METHODS

Survey development

A quantitative descriptive and correlational research design was applied to perform the study, and an online cross-sectional survey method was used to collect data. The survey consisted of a food frequency questionnaire (FFQ) of 12 questions evaluating diet characteristics for red meat and processed chicken, fish, sugar-sweetened drinks, alcohol, fibers, and high-calorie foods. The FFQ was created from the recommendations of the WCRF and AICR (limit consumption of red and processed meat; sugar-sweetened drinks; fast foods and other processed food high in fat, starches, or sugar; limit alcohol consumption; eat a diet rich in whole grains, vegetables, fruit, and beans) as well as the recommendation for fish consumption of the World Health Organization (WHO). The FFQ asked participants to recall how often they eat specific foods per month or per week following these options: never, once a month, 2-3 times per month, once a week, 2-3 times per week, 4-6 times per week, and daily consumption. Additionally, the survey included questions addressing nutrition knowledge created from the recommendations of the WCRF and AICR. The use of an FFQ to assess nutrition for colorectal cancer prevention and the WCRF and AICR recommendations were validated and tested in previous studies in that the reproducibility and validity of the FFQ were assessed by comparing FFQ1 against FFQ2, and FFQ1 against a 3-day diary method, respectively. The validity test revealed a reproducibility of more than 85% of the CRC-related food groups and a significant difference for eight CRC- related food groups. The authors suggested the FFQ could be satisfactory for estimating food and nutrient intakes and ranking subjects according to high and low intake categories [7,18].

Ultimately, the survey consisted of questions focusing on beliefs, attitudes, and perceptions regarding nutrition. The questions were adapted from the open-ended questionnaire created by Hardcastle and from the dietary habits and colon cancer beliefs survey created by Smith to create a health belief model and theory of health behavior-based structured questionnaire [10,15]. The questionnaire consisted of 17 questions scored on a 5-point Likert scale and based on four constructs of the HBM (perceived severity, susceptibility, barriers, and cues to action) and two constructs of the TBP (attitudes and behavioral intentions). Perceived severity and susceptibility were categorized as motivators (potential factors that induce motivation to adopt a new behavior) and cues to action represented facilitators (potential factors that facilitate or trigger a behavior change). The HBM and TPB have been tested in previous studies [10,19]. and the questionnaires developed by Hardcastle and Smith were both peer-reviewed for validity.

Study participants

Participants were recruited online through convenience sampling. Digital flyers were disseminated on online platforms and were provided to organizations fostering cancer prevention. The inclusion criteria included English-speaking adults living in the United States between 30 and 75 years of age. Participants who had a current or past cancer diagnosis of any type were excluded. A total of 547 participants responded to the survey resulting in a response rate of 69%. Seventy respondents were disqualified because they had a history of cancer, they were under 30 years old, or they did not live in the United States, and 100 responses had to be excluded because the participants only partially completed the survey.

The final sample consisted of 377 respondents, of whom 289 were females, and 88 were males. The A.T. Still University Institutional Review Board (IRB) committee approved the study (no. IRB #2019-175).

Statistical analyses

Statistical analyses were conducted for all variables using IBM SPSS Statistics 26.0 (IBM Co., Armonk, NY, USA). Descriptive statistics were used to describe participants' demographic characteristics, including age, ethnicity, highest level of education, household income, and weight status. Participants' weight status was represented by the body mass index (BMI), which was categorized into underweight, normal weight, overweight, and obese using the cut-off points of the Centers for Disease Control and Prevention [20]. All demographic data were represented in frequency and percentage. Scales and scores were calculated for the variables of diet characteristics, diet recommendations, knowledge, attitudes, and beliefs.

Composite scales and scores

For each food category of the FFQ, a score of 1 was attributed if the recommendations were met, and a score of 0 was given if the recommendations were not met. Cut-offs for each food group, as established in the study of Hastert and White [7], were used to calculate the scores. Cut-offs for fish followed the WHO suggestions [21].

Scores obtained from each diet recommendation were added to obtain a total diet recommendation score that was used as a continuous variable for inferential statistics. Additionally, factors including perceived barriers, facilitators, and motivators comprised a 5-point Likert-scale questionnaire ranging from strongly disagree, disagree, neutral, agree, to strongly agree, and scored as 1, 2, 3, 4, and 5, respectively. Scores for each perceived factor were added to obtain total scores that were used as continuous variables for inferential statistics.

The KAB score represented the sum of the total score obtained from knowledge, attitude, and belief questions. The knowledge section was comprised of five dichotomous questions, with a score of 1 provided for the correct answer and a score of 0 for incorrect and "I don't know" answers. The attitude and belief sections were comprised of a 5-point Likert-scale questionnaire ranging from strongly disagree, disagree, neutral, agree, to strongly agree, and scored 1, 2, 3, 4, and 5, respectively. The maximum possible total score for the KAB score was 30, and the minimum was 5. The scores were categorized into three groups: poor (scores between 5 and 10), fair (scores between 11 and 20), and good (scores between 21 and 30).

Normality

Normality was assessed through the Kolmogorov–Smirnov test and a normal Q-Q plot for the KAB score, diet rec-

ommendation score, and perceived factor scores. For all variables, the Kolmogorov–Smirnov test provided a non-significant alpha of $P < 0.05$, yet the normal Q-Q plot for each variable showed data approximately normally distributed. Ultimately, the central limit theorem was used to assume normality.

Analysis of the research question

Chi-square and Mann–Whitney U-tests were used to compare weight status, diet characteristics, knowledge, attitudes, beliefs, perceived barriers, facilitators, and motivators between males and females. Spearman correlation and point biserial parametric tests were used to analyze the relationship between KAB score, weight status, and diet characteristics. Multiple regression analysis was used to analyze the influence of perceived barriers, facilitators, and motivators on dietary characteristics for female and male participants. Statistical significance was denoted by a P-value < 0.05, and the tests were two-tailed.

RESULTS

Table 1 illustrates the participants' demographic characteristics. Nearly half of the participants were aged between 30 and 34 years (55.2%), and the other half was mainly comprised of participants aged between 35 and 44 years (27.9%). Additionally, most participants were Caucasian (60.7%), had a master's degree (36.1%), earned an annual income greater than USD 100,000 (49.3%), and had a normal BMI (43.2%). A large proportion of males had a master's degree (28.4%) and a high school diploma (21.6%), while most females had a master's degree (38.4%) and a bachelor's degree (23.9%).

Compared with female participants, a larger proportion of males were overweight or obese, (42.0%) and (39.8%), respectively. Only 28.0% of females were overweight, and 19.0% were obese. To determine whether the difference in male and female participants' BMI was significant, a Mann–Whitney U-test was conducted. As shown in Table 1, male participants had a statistically significantly higher BMI (median = 3) than female participants (median = 2), Mann–Whitney U = 7,932.5, $P < 0.001$.

Chi-square analyses were conducted to assess the differences in CRC diet recommendation scores between males (n = 88) and females (n = 289). As illustrated in Table 2, a larger proportion of females (65.1%) had significantly met the recommendation for sugary drinks as compared to males (35.2%), χ^2 (1, n = 377) = 24.647, $P < 0.001$. Similarly, more females (16.3%) had met the recommendation for high-calorie food as compared to males (6.8%), χ^2 (1, n = 377) = 4.981, $P = 0.026$. There were no statistically significant differences in processed chicken and red meat recommendation scores between males (64.8%) and females (58.8%), χ^2 (1, n = 377) = 0.997, $P = 0.318$. Likewise, as presented in Table 2, no statistically significant differences in recommendation

Table 1. Demographic characteristics of participants

Characteristics	Total participants (n = 377)	Male (n = 88)	Female (n = 289)	P-value
Age (yr)				
30-34	208 (55.2)	53 (60.2)	155 (53.6)	
35-44	105 (27.9)	21 (23.9)	84 (29.1)	
45-54	45 (11.9)	11 (12.5)	34 (11.8)	
55-64	19 (5.0)	3 (3.4)	16 (5.5)	
65-70	-	-	-	
Ethnicity				
African American/Black	59 (15.6)	22 (25.0)	37 (12.8)	
Caucasian/White	229 (60.7)	47 (53.3)	182 (63.0)	
Hispanic/Latino	10 (2.7)	5 (5.7)	5 (1.7)	
Asian/Pacific Islander	2 (0.5)	1 (1.1)	1 (0.3)	
American Indian/Native American	49 (13.0)	6 (6.8)	43 (14.9)	
Other	28 (7.4)	7 (8.0)	21 (7.3)	
Education level				
No formal education	3 (0.8)	3 (3.4)	0	
High school diploma	54 (14.3)	19 (21.6)	35 (12.1)	
College degree	46 (12.2)	10 (11.4)	36 (12.5)	
Bachelor's degree	85 (22.5)	16 (18.2)	69 (23.9)	
Master's degree	136 (36.1)	25 (28.4)	111 (38.4)	
Doctorate degree	53 (14.1)	15 (17.0)	38 (13.1)	
Household income (USD/yr)				
Under 20,000	19 (5.0)	4 (4.5)	15 (5.2)	
20,001-40,000	42 (11.1)	13 (14.8)	29 (10.0)	
40,001-60,000	36 (9.5)	12 (13.6)	24 (8.3)	
60,001-80,000	36 (9.5)	5 (5.7)	31 (10.7)	
80,001-100,000	58 (15.4)	15 (17.0)	43 (14.9)	
> 100,000	186 (49.3)	39 (44.3)	147 (50.9)	
BMI (kg/m^2)				
Underweight: BMI < 18	6 (1.6)	1 (1.1)	5 (1.7)	
Normal weight: 18.5 < BMI < 24.9	163 (43.2)	15 (17.0)	148 (51.2)	
Overweight: 25.0 < BMI < 29.9	118 (31.3)	37 (42.0)	81 (28.0)	
Obese: BMI > 30	90 (23.9)	35 (39.8)	55 (19.0)	
Median BMI		3	2	< 0.001
Minimum-Maximum BMI		1-4	1-4	

Values are presented as number (%). Median BMI: underweight = 1, normal weight = 2, overweight = 3, obese = 4. Mann–Whitney U = 7,932.5, $P < 0.001$.

scores for fish, alcoholic drinks, and fibers existed between male and female participants, χ^2 (1, n = 377) = 2.027, P = 0.155; χ^2 (1, n = 377) = 1.543, P = 0.214; and χ^2 (1, n = 377) = 0.092, P = 0.761, respectively.

To determine whether differences in nutrition knowledge scores exist between males (n = 88) and females (n = 289), Chi-square analyses were performed for each nutrition knowledge variable. As illustrated in Table 3, a large proportion of males (58%) and females (62.3%) were unaware of CRC frequent age occurrence. However, more than half of male and female participants responded correctly to all other nutrition knowledge questions. The Chi-square tests revealed no statistically significant differences in nutrition knowledge scores between males and females, $P > 0.5$. Overall, participants had good nutrition knowledge.

As illustrated in Figure 1, more than half of the participants

(66.8%) believed a healthy diet was necessary to prevent CRC, and 79.3% of participants did not perceive diet as a futile solution to prevent CRC. In terms of behavioral beliefs, most participants agreed maintaining a healthy weight (86.2%), eating healthy (82.0%), and knowing CRC prevention guidelines (89.9%) were important. Similarly, a large proportion of participants (93.1%) acknowledged the severity of CRC regarding quality of life and death. Yet, 52.8% remained neutral regarding their perceived risk of developing CRC, and 30.8% believed they were not at risk of developing CRC.

Regarding perceived barriers, approximately 60% of participants did not perceive a need to quotidianly eat red meat (59.2%) and processed chicken (68.7%). Most participants (81.4%) disagreed that the taste of healthy foods was a hindrance, and 68.7% did not perceive time as a constraint to cooking. However, only 48.6% of the participants did not

Table 2. Diet characteristics by sex

Diet Characteristics	Sex	Unmet	Met	χ^2	P-value
Chicken and red meat	Male (n = 88)	57 (64.8)	31 (35.2)	0.997	0.318
	Female (n = 289)	170 (58.8)	119 (41.2)		
Fish	Male (n = 88)	58 (65.9)	30 (34.1)	2.027	0.155
	Female (n = 289)	213 (73.7)	76 (26.3)		
Sugary drinks	Male (n = 88)	57 (64.8)	31 (35.2)	24.647	< 0.001
	Female (n = 289)	101 (34.9)	188 (65.1)		
Alcoholic drinks	Male (n = 88)	0	88 (100)	1.543	0.214
	Female (n = 289)	5 (1.7)	284 (98.3)		
Fibers	Male (n = 88)	82 (93.2)	6 (6.8)	0.092	0.761
	Female (n = 289)	272 (94.1)	17 (5.9)	0.103	0.748
High calorie food	Male (n = 88)	82 (93.2)	6 (6.8)	4.981	0.026
	Female (n = 289)	242 (83.7)	47 (16.3)		

Values are presented as number (%). P < 0.005.

Table 3. Nutrition knowledge by sex

Nutrition knowledge	Sex	Incorrect	Correct	χ^2	P-value
Colorectal cancer occurs around 50 years old.	Male (n = 88)	51 (58.0)	37 (42.0)	0.997	0.318
	Female (n = 289)	180 (62.3)	109 (37.7)		
Eating red meat frequently can increase the risk of developing colorectal cancer overtime.	Male (n = 88)	36 (40.9)	52 (59.1)	0.533	0.465
	Female (n = 289)	106 (36.7)	183 (63.3)		
Eating more vegetables and fruits can decrease the risk of developing colorectal cancer.	Male (n = 88)	20 (27.3)	64 (72.7)	0.510	0.473
	Female (n = 289)	54 (18.7)	235 (81.3)		
Eating fried food influences the risk of developing colorectal cancer.	Male (n = 88)	29 (33.0)	59 (67.0)	3.032	0.844
	Female (n = 289)	92 (31.8)	197 (68.2)		
Being overweight or obese increases the risk of having colorectal cancer.	Male (n = 88)	28 (31.8)	60 (68.2)	0.233	0.629
	Female (n = 289)	100 (34.6)	189 (65.4)		

Values are presented as number (%). P < 0.005.
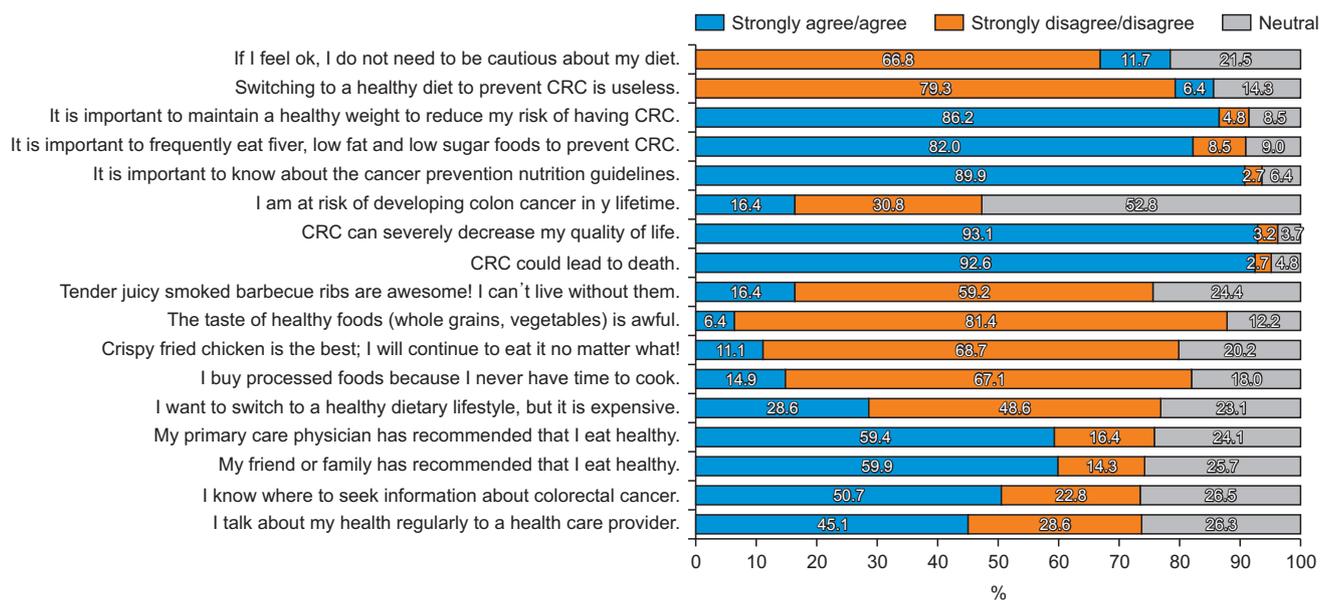
Figure 1. Perceived belief responses of participants. Values are presented as number (%). n = 377. CRC, colorectal cancer.

perceive healthy foods as costly. Nearly 60% of participants received recommendations from physicians (59.4%), friends, or family members (59.9%) about CRC, and 50.7% believed to know where to seek information about CRC. Finally, 45.1% agreed to regularly talk about their health to a health care provider. To determine differences in scores among males and females, Mann–Whitney U analyses were conducted. The results of the analyses are represented in Table 4. Males were significantly less cautious about their diet and the risk of developing CRC (mean rank = 168.12), as compared to females (mean rank = 195.36), U = 10,878.5, P = 0.030. However, there were no significant differences in attitude scores regarding a healthy diet as a means of CRC prevention between males (mean rank = 186.10) and females (mean rank = 189.88), U = 12,460.0, P = 0.759. No significant differences in behavior scores existed between males (mean ranks = 181.60) and females (mean rank = 190.58) regarding the importance of maintaining a healthy weight, U = 11,971.5, P = 0.461.

Similarly, there were no differences between males (mean rank = 183.30) and females (mean rank = 188.75) regarding the variables addressing frequent intake of fiber, low fat, and low sugar, U = 12,023.0, P = 0.646. However, compared with males (mean rank = 166.11), the importance of knowing CRC nutrition guidelines was a significant component for females (mean rank = 193.98), U = 10,624.0, P = 0.022. Compared

with males (mean rank = 172.80), the perceived severity regarding the quality of life was a more significant motivator for females (mean rank = 193.93), U = 11,290.0, P = 0.044. No significant differences in perceived susceptibility scores existed between males (mean rank = 182.82) and females (mean rank = 190.88), U = 12,172.5, P = 0.502. Similarly, no significant differences in scores for the perceived severity of CRC regarding death existed between males (mean rank = 174.77) and females (mean rank = 193.33), U = 11,463.5, P = 0.098.

As per Table 4, the need to eat red meat was a more significant barrier for males (mean rank = 231.45) as compared to females (mean rank = 176.07), U = 8,980.5, P < 0.001. Likewise, as compared to females (mean rank = 209.75), the taste of healthy food was a more significant barrier for males (mean rank = 182.68), U = 10,890.0, P = 0.025. Additionally, the reluctance to reduce fried chicken intake was a more significant barrier among males (mean rank = 217.73) as compared to females (mean rank = 180.25), U = 10,188.0, P = 0.003. However, no statistically significant differences in barrier scores for time existed between males (mean rank = 190.44) and females (mean rank = 188.56), U = 12,589.5, P = 0.882, and there were no significant differences in barrier scores for cost between males (mean rank = 199.81) and females (mean rank = 185.71), U = 11,765.0, P = 0.274. Recommendations from friends and family were more significant

Table 4. Perceived beliefs and KAB level by sex

| | Perceived beliefs | Mean rank | | U | P-value |
		Male (n = 88)	Female (n = 289)		
Attitudes	If I feel ok, I do not need to be cautious about my diet because I have a low risk of having colorectal cancer.	168.12	195.36	10,878.5	0.030
	Switching to a healthy diet to prevent colorectal cancer is useless; if this is meant to be, there is nothing I can do to avoid it.	186.10	189.88	12,460.5	0.759
Behaviors	It is important to maintain a healthy weight to reduce my risk of having colorectal cancer.	181.60	190.58	11,971.5	0.461
	It is important to frequently eat fiber, low fat, and low sugar foods to prevent colorectal cancer.	183.30	188.75	12,023.0	0.646
	It is important to know about the cancer prevention nutrition guidelines.	166.11	193.98	10,624.0	0.022
Motivators	I am at risk of developing colon cancer in my lifetime.	182.82	190.88	12,172.5	0.502
	Colon cancer can severely decrease my quality of life.	172.80	193.93	11,290.0	0.044
	Colon cancer could lead to death.	174.87	193.33	11,463.5	0.098
Barriers	Tender juicy smoked barbecue ribs are awesome! I can't live without them.	231.45	176.07	8,980.5	< 0.001
	The taste of healthy foods (whole grains, vegetables) is awful.	209.75	182.68	10,890.0	0.025
	Crispy fried chicken is the best; I will continue to eat it no matter what!	217.73	180.25	10,188.0	0.003
	I buy processed foods because I never have time to cook.	190.44	188.56	12,589.5	0.882
	I want to switch to a healthy dietary lifestyle, but it is expensive.	199.81	185.71	11,765.0	0.274
Facilitators	My primary care physician has recommended that I eat healthy.	204.97	184.14	11,311.0	> 0.990
	My friend or family has recommended that I eat healthy.	208.45	183.08	11,004.0	0.043
	I know where to seek information about colorectal cancer.	185.77	189.98	12,432.0	0.742
	I talk about my health regularly to a health care provider.	160.78	197.59	10,233.0	0.004
KAB Level	Fair	23 (26.1)	45 (15.6)		
	Good	62 (70.5)	242 (83.3)		

Values are presented as number (%). KAB, knowledge, attitudes, and beliefs. P < 0.005.

facilitators among males (mean rank = 208.45) as compared to females (mean rank = 183.08), U = 11,004.0, P = 0.043. Yet, discussions of healthful diets with physicians were more significant facilitators for females (mean rank = 160.78) than males (mean rank = 197.59), U = 10,233.0, P = 0.004. No significant differences in scores existed between males (mean rank = 204.97) and females (mean rank = 184.14) for facilitators encouraging healthy eating by primary care physicians, U = 11,311.0, P > 0.990. Similarly, there were no differences in scores between males (mean rank = 185.77) and females (mean rank = 189.98) for knowledge regarding where to seek information on CRC, U = 12,432.0, P = 0.742. As presented in Table 4, no participants had a poor KAB level. Compared to males (70.5%), females (83.3%) had a higher KAB level. Nonetheless, both males and females had an overall good KAB level.

To assess whether a relationship existed between KAB scores and weight status among males and females, a Spearman analysis was conducted. As presented in Table 5, no relationship existed between BMI and KAB among males, $r_s(85)$ = –0.062, P = 0.570, and females, $r_s(287)$ = –0.043, P = 0.466. A point-biserial correlation analysis computing diet and KAB variables was conducted to assess if a relationship existed among underweight and normal weight and overweight/obese male and female participants. As presented in Table 5, a positive statistically significant relationship existed only among overweight and obese male participants. As the score of KAB increased, overweight and obese males met the recommendation for processed chicken and red meat, $r_{pb}(71)$ = 0.410, P < 0.001. A multiple linear regression analysis was performed to explore associations between perceived factors, including barriers, facilitators, motivators, and CRC diet recommendations. As indicated in Table 6, a statistically significant influence was observed for barrier and facilitator variables. An increase in scores of barriers and facilitators was associated with a decrease in CRC diet recommendation scores, F(3,372) = 12.056, P < 0.001, R^2 = 0.089.

DISCUSSION

This study evaluated the differences in diet characteristics, weight status, nutrition knowledge, attitudes, and perceived beliefs among males and females to assess whether an association existed. The investigation revealed an overall good KAB level among participants despite poor diet recommendation adherence. Furthermore, the study reported significant differences between males and females regarding CRC diet recommendations, weight status, and perceived beliefs. These differences implied that males are exposed to higher CRC risk factors than females, yet females are not spared from the risks of developing CRC. These findings are important to develop nutrition initiatives focused on CRC prevention and behavioral changes among young and older adults. While nutrition education is fundamental, it may be ineffective

Table 5. Correlations between KAB and BMI by sex and KAB and diet by weight and sex

KAB score	BMI		High-calorie food		Fish		Sugary drinks		Alcoholic drinks		Fibers		Red meat and processed chicken		
	r_s	P-value	r_{pb}	P-value	r_{pb}	P-value	r_{pb}	P-value	r_{pb}	P-value	r_{pb}	P-value	n	r_{pb}	P-value
Male (n = 85)															
Under/normal weight (n = 14)	–0.062	0.570			–0.315	0.273	0.028	0.923			0.343	0.231	14	–0.054	0.855
Overweight/Obese (n = 72)			0.065	0.588	0.073	0.545	0.081	0.504			–0.188	0.117	71	0.410	< 0.001
Female (n = 287)															
Under/normal weight (n = 153)	–0.043	0.466	–0.147	0.072	0.093	0.257	0.210	0.770	–0.056	0.491	–0.005	0.949	152	0.020	0.805
Overweight/Obese (n =136)			–0.005	0.952	0.015	0.859	0.064	0.459	–0.075	0.385	0.104	0.230	135	–0.021	0.812

KAB, knowledge, attitudes, and beliefs; BMI, body mass index. r_s, Spearman coefficient; r_{pb}, Point-biserial coefficient. P < 0.05.

Table 6. Multiple linear regression of CRC diet recommendation and perceived factors

Variable	B	95% CI	P-value
Intercept	3.379	(2.62, 4.14)	< 0.001
Barriers	−0.067	(−0.09, −0.04)	< 0.001
Motivators	0.018	(−0.03, 0.07)	0.491
Facilitators	−0.040	(−0.07, −0.01)	0.009

B, unstandardized coefficient; CI, confidence interval; CRC, colorectal cancer. Models adjusted for motivators, barriers, and facilitators. $P < 0.05$.

for educated populations as discrepancies between nutrition knowledge, beliefs, and dietary recommendations existed among participants. Thus, the study suggests nutrition interventions designed to prevent CRC should acknowledge the differences in perceived beliefs among males and females. Nutrition interventions should also consider the factors influencing dietary behavior to improve health outcomes, especially among males.

A few studies that evaluated adherence to diet recommendations toward CRC have reported lower CRC risks among females [7] but higher risks among males [22]. These findings are consistent with the results reported in this present study. Except for the alcoholic drink recommendation, most males did not meet the diet recommendations for preventing CRC. Whereas when compared with males, in addition to the alcoholic recommendation, females met the recommendations for sugary drinks and high caloric food. Interestingly, these results reflected participants' weight status as males were more likely to be overweight or obese as compared to females. The adherence to the alcoholic drink recommendation was also observed in a previous study, but the study targeted CRC survivors [8].

Despite poor diet recommendation scores, results reported high levels of nutrition knowledge among participants. Though most participants were not aware of age as a risk factor for CRC, and most participants were indifferent in perceiving CRC as a susceptible risk during their lifetime. Studies that evaluated populations' awareness regarding CRC explained such indifference by a need for improvement in medical awareness and population information about CRC risk factors [23,24]. Furthermore, modifiable risk factors of CRC, including poor diet and increased weight, were strongly associated with non-modifiable factors of CRC, such as age [25]. Such modifiable risk factors must be altered to reduce CRC risk, especially among the populations with higher risk due to non-modifiable factors. In addition to age, sex was seen to be a potential risk factor for CRC, and males were deemed to be at higher risks due to high consumptions of meat and increased body weight [25]. In consistency with these findings, this present study identified a higher BMI and meat consumption among males as compared with females.

Although a few differences in motivator and attitude scores existed, both males and females strongly acknowledged the

implications of CRC regarding a decrease in quality of life and the importance of diet in CRC prevention. Paradoxically, the taste of healthy foods and the need to consume red meat and processed chicken were significant barriers for males. These findings are in line with those of a previous study in that males found healthful diets less appealing and were more tempted to eat processed foods [26]. Love and Sulikowski [27] explained this paradox by revealing that males value meat more highly than women and perceive meat as healthy and delicious. These results indicate the potential existence of misconceptions among males regarding healthy eating. In contrast, females were more likely to be cautious about their diet and strongly considered the importance of acquiring nutrition knowledge to prevent CRC. Females perceived CRC severity as a motivator to improve their quality of life and were more likely to discuss healthful diets with their primary care physicians. Pool et al. [28] explained females are tempted to visit their physicians more frequently than males; such behavior may foster more opportunities to discuss diet.

As opposed to previous studies [29,30], in this study, most participants did not perceive the cost of healthy food products and time for cooking as barriers. This finding reiterates the notion of diet misconception and implies participants' perceived beliefs may interfere with their food choices. Regardless of the differences between sex found in this study, participants had a good KAB level in that they had good nutrition knowledge, attitudes, and behavior. Surprisingly, no significant associations were observed between KAB and BMI. However, a significant association was found between KAB and meat recommendations only among overweight and obese males. These findings were consistent with the study of Acheampong and Haldeman [31], which did not report an association between KAB, BMI, and diet. As most participants met only one or two diet recommendations to prevent CRC, the results suggest that a good level of KAB may not be sufficient to influence healthy nutritional choices. Nonetheless, specific nutrition recommendations may foster dietary behavior improvements among overweight and obese individuals.

Acheampong and Haldeman [31] reported that overweight and obese participants had higher KAB scores and suggested that participants' knowledge should be applied during their food selection process. The authors also recommended that health professionals develop nutrition initiatives based on populations' beliefs [31]. While education and beliefs are important elements, it is fundamental to consider all aspects of beliefs, including perceived barriers and facilitators. This study revealed that an increase in participants' perceived barrier scores was significantly associated with a decrease in diet recommendations. Strangely, diet recommendation scores also decreased as facilitators increased. These findings suggest that further factors related to knowledge, beliefs, and attitudes may influence the use of facilitators. Individuals with good KAB levels, for instance, may not perceive a need

for facilitators; consequently, they might unconsciously ignore their physicians' recommendations or reject their friends' and families' advice regarding healthful diets. In studies exploring eating behaviors, facilitators including social support were positively associated with diet [8,16]. However, these studies focused on CRC survivors and only identified participants' perceived facilitators. Consequently, it is unknown how populations follow and apply facilitators in the improvement of diet behavior.

The study presented several limitations. First, participants were not randomly selected because a convenience sampling method was used for their recruitment. Although such a method may be adequate, it is subject to sampling bias and can limit the generalization of the study. Additionally, the sample was homogeneous, consisting mostly of high-income Caucasian women. Therefore, the study is not generalizable to other populations, especially those living in low-income communities with more diverse ethnicities. Furthermore, as the study used a cross-sectional design, it cannot provide information regarding potential changes in dietary characteristics or attitudes over time. Finally, because participants self-reported their responses, accuracy might have been affected, and potential recall bias might have influenced data from the FFQ.

The differences in perceived beliefs between males and females indicate a need to design nutrition and health initiatives based on gender perceptions and specific unmet needs. The study suggests that health professionals should acknowledge the existence of misconceptions regarding healthy food to design population-centered nutrition initiatives for preventing CRC. Ultimately, perceived beliefs and dietary behavior may differ among more diverse populations living in different geographical areas. Thus, further studies using a randomized sample design should be conducted to assess the influence of socioeconomic and cultural factors on populations' nutrition knowledge, weight status, and perceived beliefs.

This study revealed important points regarding nutrition and CRC prevention in that nutrition knowledge and KAB levels may not always reflect diet characteristics or weight status. Such inconsistencies may have emerged from misconceptions about healthy eating and may have influenced populations' food choices. Further studies analyzing healthy eating misperceptions and food choices could help better understand the source of such misconceptions. Nonetheless, considering the differences between genders regarding nutritional beliefs and attitudes, the existence of misperceptions should be acknowledged in nutrition interventions focusing on CRC prevention. The present findings will provide health professionals with supplemental insights to design nutrition initiatives more centered on populations' characteristics to reduce CRC prevalence.

CONFLICTS OF INTEREST

No potential conflicts of interest were disclosed.

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