ORIGINAL RESEARCH

Associations Between Prescreening Dietary Patterns and Longitudinal Colonoscopy Outcomes in Veterans

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Background: Understanding associations between diet and long-term risk for colorectal cancer (CRC) among US veterans may provide insight for patient-clinician decisions about lifestyle recommendations as part of a CRC screening program.

Methods: Asymptomatic US veterans aged 50 to 75 years who received screening colonoscopy between 1994 and 1997 were followed through 2009. The most significant colonoscopy findings (MSCFs) across the study period were classified as no neoplasia, not advanced adenomas, or advanced neoplasia (AN). The food frequency questionnaire was used to calculate raw and percent scores for the Healthy Eating Index (HEI), Mediterranean diet (MD), and Dietary Approaches to Stop Hypertension (DASH) dietary patterns. In cross-sectional analyses, multinomial logistic regression models tested for associations between dietary pattern scores and MSCF, controlling for demographics.

Results: Among 3023 participants with complete data, 96.7% were male, and 83.8% were non-Hispanic White. Higher dietary patterns scores (ie, healthier diet) had similar or lower adjusted odds ratios (aORs) for AN vs no neoplasia (HEI: aOR, 1.00 [95% CI, 0.99-1.01]; MD: aOR, 0.95 [95% CI, 0.90-1.00]; DASH: aOR, 0.99 [95% CI, 0.98-1.00]). Higher grain category scores generally had lower aORs for AN for each dietary pattern (HEI: aOR, 0.96 [95% CI, 0.93-0.99]; MD: aOR, 0.29 [95% CI, 0.14-0.62]; DASH: aOR, 0.86 [95% CI, 0.78-0.95]).

Conclusions: Healthy dietary patterns were associated with lower aORs for colonic neoplasia among veterans enrolled in a CRC screening program. More research is needed to determine the role of dietary assessments for tailored CRC prevention and surveillance.

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Fed Pract. 2025;42(suppl 3). Published online August 15. doi:10.12788/fp.0609

Screening for colorectal cancer (CRC) with colonoscopy enables the identification and removal of CRC precursors (colonic adenomas) and has been associated with reduced risk of CRC incidence and mortality.[1-3] Furthermore, there is consensus that diet and lifestyle may be associated with forestalling CRC pathogenesis at the intermediate adenoma stages.[4-7] However, studies have shown that US veterans have poorer diet quality and a higher risk for neoplasia compared with nonveterans, reinforcing the need for tailored clinical approaches.[8,9] Combining screening with conversations about modifiable environmental and lifestyle risk factors, such as poor diet, is a highly relevant and possibly easily leveraged prevention for those at high risk. However, there is limited evidence for any particular dietary patterns or dietary features that are most important over time.[7]

Several dietary components have been shown to be associated with CRC risk,[10] either as potentially chemopreventive (fiber, fruits and vegetables,[11] dairy,[12] supplemental vitamin D,[13] calcium,[14] and multivitamins[15]) or carcinogenic (red meat[16] and alcohol[17]). Previous studies of veterans have similarly shown that higher intake of fiber and vitamin D reduced risk, and red meat is associated with an increased risk for finding CRC precursors during colonoscopy.[18] However, these dietary categories are often analyzed in isolation. Studying healthy dietary patterns in aggregate may be more clinically relevant and easier to implement for prevention of CRC and its precursors.[19-21] Healthy dietary patterns, such as the US Dietary Guidelines for Americans represented by the Healthy Eating Index (HEI), the Mediterranean diet (MD), and the Dietary Approaches to Stop Hypertension (DASH) diet, have been associated with lower risk for chronic disease.[22-24] Despite the extant literature, no known studies have compared these dietary patterns for associations with risk of CRC precursor or CRC development among US veterans undergoing long-term screening and follow-up after a baseline colonoscopy.

The objective of this study was to test for associations between baseline scores of healthy dietary patterns and the most severe colonoscopy findings (MSCFs) over ≥ 10 years following a baseline screening colonoscopy in veterans.

METHODS

Participants in the Cooperative Studies Program (CSP) #380 cohort study included 3121 asymptomatic veterans aged 50 to 75 years at baseline who had consented to initial screening colonoscopy between 1994 and 1997, with subsequent follow-up and surveillance.[25] Prior to their colonoscopy, all participants completed a baseline study survey that included questions about cancer risk factors including family history of CRC, diet, physical activity, and medication use.

Included in this cross-sectional analysis were data from a sample of veteran participants of the CSP #380 cohort with 1 baseline colonoscopy, follow-up surveillance through 2009, a cancer risk factor survey collected at baseline, and complete demographic and clinical indicator data. Excluded from the analysis were 67 participants with insufficient responses to the dietary food frequency questionnaire (FFQ) and 31 participants with missing body mass index (BMI), 3023 veterans.

Measures

MSCF. The outcome of interest in this study was the MSCF recorded across all participant colonoscopies during the study period. MSCF was categorized as either (1) no neoplasia; (2) ≤ 2 nonadvanced adenomas, including small adenomas (diameter < 10 mm) with tubular histology; or (3) advanced neoplasia (AN), which is characterized by adenomas ≥ 10 mm in diameter, with villous histology, with high-grade dysplasia, or CRC.

Dietary patterns. Dietary pattern scores representing dietary quality and calculated based on recommendations of the US Dietary Guidelines for Americans using the HEI, MD, and DASH diets were independent variables.[26-28] These 3 dietary patterns were chosen for their hypothesized relationship with CRC risk, but each weighs food categories differently (Appendix 1).[22-24,29] Dietary pattern scores were calculated using the CSP #380 self-reported responses to 129 baseline survey questions adapted from a well-established and previously validated semiquantitative FFQ.[30] The form was administered by mail twice to a sample of 127 participants at baseline and at 1 year. During this interval, men completed 1-week diet records twice, spaced about 6 months apart. Mean values for intake of most nutrients assessed by the 2 methods were similar. Intraclass correlation coefficients for the baseline and 1-year FFQ-assessed nutrient intakes that ranged from 0.47 for vitamin E (without supplements) to 0.80 for vitamin C (with supplements). Correlation coefficients between the energy-adjusted nutrient intakes were measured by diet records and the 1-year FFQ, which asked about diet during the year encompassing the diet records. Higher raw and percent scores indicated better alignment with recommendations from each respective dietary pattern. Percent scores were calculated as a standardizing method and used in analyses for ease of comparing the dietary patterns. Scoring can be found in Appendix 2.

Demographic characteristics and clinical indicators. Demographic characteristics included age categories, sex, and race/ethnicity. Clinical indicators included BMI, the number of comor-

TABLE 1. Demographics at Baseline and Most Significant Colonoscopy Findings Across Study Period

Variable	Results (N = 3023)
Age range, No. (%)	
50-59 y	1006 (33.3)
60-69 y	1436 (47.5)
≥ 70 y	581 (19.2)
Sex, No. (%)	
Male	2923 (96.7)
Female	100 (3.3)
Race/ethnicity, No. (%)	
Non-Hispanic White	2532 (83.8)
Non-Hispanic Black	279 (9.2)
Other race/ethnicities[a]	212 (7.0)
Body mass index, No. (%)	
< 25	488 (16.1)
25-29.9	1325 (43.8)
≥ 30	1210 (40.0)
Comorbidities, No. (%)[b]	
≤ 2	2024 (67.0)
3-4	867 (28.7)
≥ 5	132 (4.4)
Family history of colon cancer, No. (%)	
None	2602 (86.1)
≥ 1 First-degree relative	421 (13.9)
Screening or surveillance colonoscopies, No. (%)	
1	1683 (55.7)
2	909 (30.1)
≥ 3	431 (14.3)
Colonoscopy outcomes at baseline, No. (%)	
No neoplasia[b]	1885 (62.4)
Nonadvanced adenomas[d]	814 (26.9)
Advanced neoplasia[e]	324 (10.7)
Vitamin D, mean (SD), IU/day	427.8 (326.2)
Most significant colonoscopy findings (baseline through follow-up surveillance),[f] No. (%)	
No neoplasia[c]	1628 (53.9)
Nonadvanced adenomas[d]	966 (32.0)
Advanced neoplasia[e]	429 (14.2)
Time from baseline until most significant outcome, mean (SD), d	1214 (1555)

[a]Include Asian, American, Indian/Alaska Native, Native Hawaiian/other Pacific Islander, multiple races, and Hispanic.
[b]Count of conditions included in the Charlson Comorbidity Index list.
[c]No adenomas or polyps or small polyps of tubular (nonvillous) histology.
[d]< 3 adenomas with diameter < 10 mm and of nonvillous histology.
[e]≥ 3 adenomas with diameter ≥ 10 mm, villous histology, high-grade dysplasia, or colorectal cancer.
[f]Includes pooled findings from baseline and follow-up/surveillance colonoscopy over the study period.

TABLE 2. Quintile Distribution of Scores Derived From Baseline Food Frequency Questionnaire Responses by Most Significant Finding

Quintile	HEI, mean (SD)[a]			MD, mean (SD)[b]			DASH, mean (SD)[c]		
	NN[d]	NAA[e]	AN[f]	NN	NAA	AN	NN	NAA	AN
1									
Score	42.7 (4.6)	42.6 (4.6)	43.0 (4.6)	3.5 (0.8)	3.6 (0.7)	3.5 (0.8)	36.1 (4.4)	36.6 (3.7)	35.2 (4.8)
Score %	42.7 (4.6)	42.6 (4.6)	43.0 (4.6)	20.8 (4.4)	21.3 (4.0)	20.8 (4.5)	45.1 (5.6)	45.7 (4.6)	44.0 (6.0)
2									
Score	52.3 (1.9)	52.3 (2.0)	52.3 (2.0)	5.3 (0.4)	5.3 (0.4)	5.2 (0.4)	45.1 (1.8)	45.1 (1.7)	45.0 (1.5)
Score %	52.3 (1.9)	52.3 (2.0)	52.3 (2.0)	31.0 (2.2)	30.9 (2.2)	30.7 (2.2)	56.3 (2.3)	56.4 (2.1)	56.3 (1.9)
3									
Score	58.5 (1.6)	58.5 (1.7)	58.6 (1.6)	6.5 (0.4)	6.5 (0.4)	6.5 (0.3)	50.6 (1.4)	50.5 (1.4)	50.5 (1.5)
Score %	58.5 (1.6)	58.5 (1.7)	58.6 (1.6)	37.9 (2.0)	38.2 (2.1)	38.0 (2.0)	63.1 (1.7)	63.1 (1.8)	63.1 (1.8)
4									
Score	64.5 (2.1)	64.7 (2.0)	64.4 (2.0)	7.6 (0.4)	7.7 (0.4)	7.6 (0.3)	56.0 (1.8)	55.9 (1.8)	56.1 (1.8)
Score %	64.5 (2.1)	64.7 (2.0)	64.4 (2.0)	44.8 (2.1)	45.1 (2.1)	44.9 (2.0)	70.0 (2.3)	69.8 (2.2)	70.1 (2.3)
5									
Score	74.6 (4.9)	74.5 (5.0)	74.1 (4.8)	9.6 (1.1)	9.5 (1.1)	9.5 (1.0)	64.8 (4.4)	64.4 (3.9)	64.5 (4.1)
Score %	74.6 (4.9)	74.5 (5.0)	74.1 (4.8)	56.6 (6.3)	55.7 (6.3)	56.0 (6.1)	81.0 (5.5)	80.5 (4.8)	80.6 (5.1)

Abbreviations: AN, advanced neoplasia; DASH, Dietary Approaches to Stop Hypertension; HEI, Health Eating Index; MD, Mediterranean diet; NAA, non-advanced adenoma; NN, no neoplasia.
[a]Scale: 0-100.
[b]Scale: 0-17.
[c]Scale: 0-80.

bid conditions used to calculate the Charlson Comorbidity Index, family history of CRC in first-degree relatives, number of follow-up colonoscopies across the study period, and food-based vitamin D intake.[31] These variables were chosen for their applicability found in previous CSP #380 cohort studies.[18,32,33] Self-reported race and ethnicity were collapsed due to small numbers in some groups. The authors acknowledge these are distinct concepts and the variable has limited utility other than for controlling for systemic racism in the model.

Statistical Analyses

Descriptive statistics were used to describe distributional assumptions for all variables, including demographics, clinical indicators, colonoscopy results, and dietary patterns. Pairwise correlations between the total dietary pattern scores and food category scores were calculated with Pearson correlation (*r*).

Multinomial logistic regression models were created using SAS procedure LOGISTIC with the outcome of the categorical MSCF (no neoplasia, nonadvanced adenoma, or AN).[34] A model was created for each independent predictor variable of interest (ie, the HEI, MD, or DASH percentage-standardized dietary pattern score and each food category comprising each dietary pattern score). All models were adjusted for age, sex, race/ethnicity, BMI, number of comorbidities, family history of CRC, number of follow-up colonoscopies, and estimated daily food-derived vitamin D intake. The demographic and clinical indicators were included in the models as they are known to be associated with CRC risk.[18] The number of colonoscopies was included to control for surveillance intensity presuming risk for AN is reduced as polyps are removed. Because colonoscopy findings from an initial screening have unique clinical implications compared with follow-up and surveillance, MSCF was observed in 2 ways in sensitivity analyses: (1) baseline and (2) aggregate follow-up and surveillance only, excluding baseline findings.

Adjusted odds ratios (aORs) and 95% CIs for each of the MSCF outcomes with a reference finding of no neoplasia for the models are presented. We chose not to adjust for multiple comparisons across the different dietary patterns given the correlation between dietary pattern total and category scores but did adjust for multiple comparisons for dietary categories within each dietary pattern. Tests for statistical significance used α = .05 for the dietary pattern total scores and *P* values for the dietary category scores for each dietary pattern controlled for false discovery rate using the MULTTEST SAS procedure.[35] All data manipulations and analyses were performed using SAS version 9.4.

RESULTS

The study included 3023 patients. All were aged 50 to 75 years, 2923 (96.7%) were male and 2532 (83.8%) were non-Hispanic White (Table 1). Most participants were overweight or obese (n = 2535 [83.8%]), 2024 (67.0%) had ≤ 2 comorbidities, and 2602 (86.1%) had no family history of CRC. The MSCF for 1628 patients (53.9%) was no neoplasia, 966 patients (32.0%) was nonadvanced adenoma, and 429 participants (14.2%) had AN.

Mean percent scores were 58.5% for HEI, 38.2% for MD, and 63.1% for the DASH diet, with higher percentages indicating greater alignment with the recommendations for each diet (Table 2). All 3 dietary patterns scores standardized to percentages were strongly and significantly correlated in pairwise comparisons: HEI:MD, $r = 0.62$ ($P < .001$); HEI:DASH, $r = 0.60$ ($P < .001$); and MD:DASH, $r = 0.72$ ($P < .001$). Likewise, food category scores were significantly correlated across dietary patterns. For example, whole grain and fiber values from each dietary score were strongly correlated in pairwise comparisons: HEI Whole Grain:MD Grain, $r = 0.64$ ($P < .001$); HEI Whole Grain:DASH Fiber, $r = 0.71$ ($P < .001$); and MD Grain:DASH Fiber, $r = 0.70$ ($P < .001$).

Associations between individual participants' dietary pattern scores and the outcome of their pooled MSCF from baseline screening and ≥ 10 years of surveillance are presented in Table 3. For each single-point increases in dietary pattern scores (reflecting better dietary quality), aORs for nonadvanced adenoma vs no neoplasia were slightly lower but not statistically significantly: HEI, aOR, 1.00 (95% CI, 0.99-1.01); MD, aOR, 0.98 (95% CI, 0.94-1.02); and DASH, aOR, 0.99 (95% CI, 0.99-1.00). aORs for AN vs no neoplasia were slightly lower for each dietary pattern assessed, and only the MD and DASH scores were significantly different from 1.00: HEI, aOR, 1.00 (95% CI, 0.99-1.01); MD, aOR, 0.95 (95% CI, 0.90-1.00); and DASH, aOR, 0.99 (95% CI, 0.98-1.00).

We observed lower odds for nonadvanced adenoma and AN among all these dietary patterns when there was greater alignment with the recommended intake of whole grains and fiber. In separate models conducted using food categories comprising the dietary patterns as independent variables and after correcting for multiple tests, higher scores for the HEI Refined Grain category were associated with higher odds for nonadvanced adenoma (aOR, 1.03 [95% CI, 1.01-1.05]; $P = .01$) and AN (aOR, 1.05 [95% CI, 1.02-1.08]; $P < .001$). Higher scores for the HEI Whole Grain category were associated with lower odds for nonadvanced adenoma (aOR, 0.97 [95% CI, 0.95-0.99]; $P = .01$) and AN (aOR, 0.96 [95% CI, 0.93-0.99]; $P = .01$). Higher scores for the MD Grain category were significantly associated with lower odds for nonadvanced adenoma (aOR, 0.44 [95% CI, 0.26-0.75]; $P = .002$) and AN (aOR, 0.29 [95% CI, 0.14-0.62]; $P = .001$). The DASH Grains category also was significantly associated with lower odds for AN (aOR, 0.86 [95% CI, 0.78-0.95]; $P = .002$).

DISCUSSION

In this study of 3023 veterans undergoing first-time screening colonoscopy and ≥ 10 years of surveillance, we found that healthy dietary patterns, as assessed by the MD and DASH diet, were significantly associated with lower risk of AN. Additionally, we identified lower odds for AN and nonadvanced adenoma compared with no neoplasia for higher grain scores for all the dietary patterns studied. Other food categories that comprise the dietary pattern scores had mixed associations with the MSCF outcomes. Several other studies have examined associations between dietary patterns and risk for CRC but to our knowledge, no studies have explored these associations among US veterans.

These results also indicate study participants had better than average (based on a 50% threshold) dietary quality according to the HEI and DASH diet scoring methods we used, but poor dietary quality according to the MD scoring method. The mean HEI scores for the present study were higher than a US Department of Agriculture study by Dong et al that compared dietary quality between veterans and nonveterans using the HEI, for which veterans' expected HEI score was 45.6 of 100.[8] This could be explained by the fact that the participants needed to be healthy to be eligible and those with healthier behaviors overall may have self-selected into the study due to motivation for screening during a time when screening was not yet commonplace.[36] Similarly, participants of the present study had higher adherence to the DASH diet (63.1%) than adolescents with diabetes in a study by Günther et al. Conversely, firefighters who were coached to use a Mediterranean-style dietary pattern and dietary had higher adherence to MD than did participants in this study.[27]

A closer examination of specific food category component scores that comprise the 3 distinct dietary patterns revealed mixed results from the multinomial modeling, which may have to do with the guideline thresholds used to calculate the dietary scores. When analyzed separately in the logistic regression models for their associations with nonadvanced adenomas and AN compared with no neoplasia, higher MD and DASH

TABLE 3. aORs for Most Significant Colonoscopy Findings vs No Neoplasia for Percentage

	Nonadvanced adenoma vs no neoplasia		Advanced neoplasia vs no neoplasia	
Diet	**aOR (95% CI)**	***P* value**	**aOR (95% CI)**	***P* value**
Healthy Eating Index				
Total	1.00 (0.99-1.01)	.90	1.00 (0.99-1.01)	.50
Fish	1.08 (0.98-1.20)	.12	0.98 (0.87-1.11)	.81
Fruit	0.97 (0.92-1.02)	.20	0.95 (0.89-1.02)	.15
Whole fruit	0.99 (0.94-1.04)	.71	0.98 (0.92-1.04)	.49
Vegetable	1.04 (0.98-1.10)	.24	1.00 (0.92-1.08)	.98
Greens	1.03 (0.98-1.09)	.20	0.98 (0.91-1.05)	.51
Dairy	0.98 (0.96-1.02)	.35	0.98 (0.94-1.03)	.44
Protein	1.07 (0.94-1.21)	.32	1.03 (0.87-1.21)	.75
Refined grain	1.03 (1.01-1.05)	.01[b]	1.05 (1.02-1.08)	< .001[b]
Whole grain	0.97 (0.95-0.99)	.01[b]	0.96 (0.93-0.99)	.01[b]
Fat ratio	1.01 (0.97-1.04)	.75	0.97 (0.93-1.02)	.19
Saturated fat	0.99 (0.96-1.01)	.32	0.97 (0.94-1.01)	.12
Sodium	0.97 (0.94-1.01)	.19	1.04 (0.98-1.10)	.18
Sugar	1.02 (0.99-1.04)	.14	1.00 (0.97-1.03)	.95
Mediterranean				
Total	0.98 (0.94-1.02)	.35	0.95 (0.90-1.00)	.05
Fruit	0.92 (0.84-1.00)	.04[b]	0.89 (0.80-1.00)	.05
Vegetable	1.05 (0.96-1.16)	.28	1.01 (0.88-1.14)	.93
Grain	0.44 (0.26-0.75)	.002[b]	0.29 (0.14-0.62)	.001[b]
Dairy	1.00 (0.70-1.42)	.99	0.91 (0.56-1.46)	.68

Abbreviation: aOR, adjusted odds ratio.
[a]Multinomial logistic models controlled for age, sex, race/ethnicity, body mass index, comorbidities, family history of colon cancer, daily vitamin D intake, and number of colonoscopies.
[b]aORs are significant, where α = .05 and *P* values of food category models have been adjusted for multiple comparisons by controlling for false discovery rate.

fruit scores (but not HEI fruit scores) were found to be significant. Other studies have had mixed findings when attempting to test for associations of fruit intake with adenoma recurrence.[10,37]

This study had some unexpected findings. Vegetable intake was not associated with nonadvanced adenomas or AN risk. Studies of food categories have consistently found vegetable (specifically cruciferous ones) intake to be linked with lower odds for cancers.[38] Likewise, the red meat category, which was only a unique food category in the MD score, was not associated with nonadvanced adenomas or AN. Despite consistent literature suggesting higher intake of red meat and processed meats increases CRC risk, in 2019 the Nutritional Recommendations Consortium indicated that the evidence was weak.[39,40] This study showed higher DASH diet scores for low-fat dairy, which were maximized when participants reported at least 50% of their dairy servings per day as being low-fat, had lower odds for AN. Yet, the MD scores for low-fat dairy had no association with either outcome; their calculation was based on total number of servings per week. This difference in findings suggests the fat intake ratio may be more relevant to CRC risk than intake quantity.

The literature is mixed regarding fatty acid

Standardized Dietary Pattern Scores and Component Score Categories[a]

	Nonadvanced adenoma vs no neoplasia		Advanced neoplasia vs no neoplasia	
Diet	aOR (95% CI)	*P* value	aOR (95% CI)	*P* value
Mediterranean (continued)				
Low-fat dairy	1.80 (0.75-4.30)	.19	1.44 (0.43-4.79)	.55
Beans	1.09 (0.90-1.32)	.40	1.14 (0.89-1.48)	.30
Nuts	0.88 (0.78-1.00)	.04	0.83 (0.70-0.98)	.03[b]
Fish	1.15 (1.01-1.32)	.04	1.01 (0.84-1.21)	.90
Poultry	0.89 (0.74-1.06)	.18	0.88 (0.70-1.12)	.31
Red meat	0.87 (0.66-1.16)	.36	0.77 (0.51-1.16)	.21
Sweet	0.94 (0.60-1.44)	.77	0.99 (0.56-1.77)	.98
Oil	1.10 (0.78-1.51)	.61	1.06 (0.68-1.64)	.81
Dietary Approaches to Stop Hypertension				
Total	0.99 (0.99-1.00)	.12	0.99 (0.98-1.00)	.03[b]
Dairy	0.97 (0.90-1.03)	.31	1.01 (0.92-1.10)	.90
Fruit	0.97 (0.94-1.00)	.02[b]	0.97 (0.93-1.00)	.07
Grains	0.94 (0.87-1.01)	.08	0.86 (0.78-0.95)	.002[b]
Fiber	0.96 (0.91-1.00)	.05	0.94 (0.89-1.00)	.049[b]
Low-fat dairy	0.97 (0.92-1.02)	.24	0.94 (0.87-1.00)	.049[b]
Nut and bean	1.00 (0.98-1.02)	.96	0.98 (0.95-1.00)	.10
Oils	1.00 (0.94-1.07)	.90	1.05 (0.96-1.16)	.28
Protein	0.97 (0.94-1.00)	.049	0.97 (0.94-1.01)	.18
Sweets	1.00 (0.97-1.02)	.60	1.01 (0.98-1.03)	.55
Vegetable score	1.02 (0.99-1.05)	.27	1.00 (0.96-1.04)	.94

intake and CRC risk, which may be relevant to both dairy and meat intake. One systematic review and meta-analysis found dietary fat and types of fatty acid intake had no association with CRC risk.[41] However, a more recent meta-analysis that assessed both dietary intake and plasma levels of fatty acids did find some statistically significant differences for various types of fatty acids and CRC risk.[42]

The findings in the present study that grain intake is associated with lower odds for more severe colonoscopy findings among veterans are notable.[43] Lieberman et al, using the CSP #380 data, found that cereal fiber intake was associated with a lower odds for AN compared with hyperplastic polyps (OR, 0.98 [95% CI, 0.96-1.00]).[18] Similarly, Hullings et al determined that older adults in the highest quintile of cereal fiber intake had significantly lower odds of CRC than those in lower odds for CRC when compared with lowest quintile (OR, 0.89 [95% CI, 0.83-0.96]; $P < .001$).[44] These findings support existing guidance that prioritizes whole grains as a key source of dietary fiber for CRC prevention.

A recent literature review on fiber, fat, and CRC risk suggested a consensus regarding one protective mechanism: dietary fiber from grains modulates the gut microbiota by promoting butyrate synthesis.[45] Butyrate is a short-chain fatty acid that supports energy production in colonocytes and has tumor-suppressing properties.[46] Our findings suggest there could be more to learn about the relationship between butyrate production and reduction of CRC risk through metabolomic studies that use measurements of plasma butyrate. These studies may examine associations between not just a singular food or food category, but rather food patterns that include fruits, vegetables, nuts and seeds, and whole grains known to promote butyrate production and plasma butyrate.[47]

Improved understanding of mechanisms and risk-modifying lifestyle factors such as dietary patterns may enhance prevention strategies. Identifying the collective chemopreventive characteristics of a specific dietary pattern (eg, MD) will be helpful to clinicians and health care staff to promote healthy eating to reduce cancer risk. More studies are needed to understand whether such promotion is more clinically applicable and effective for patients, as compared with eating more or less of specific foods (eg, more whole grains, less red meat). Furthermore, considering important environmental factors collectively beyond dietary patterns may offer a way to better tailor screening and implement a variety of lifestyle interventions. In the literature, this is often referred to as a teachable moment when patients' attentions are captured and may position them to be more receptive to guidance.[48]

Limitations

This study has several important limitations and leaves opportunities for future studies that explore the role of dietary patterns and AN or CRC risk. First, the FFQ data used to calculate dietary pattern scores used in analysis were only captured at baseline, and there are nearly 3 decades across the study period. However, it is widely assumed that the diets of older adults, like those included in this study, remain stable over time which is appropriate given our sample population was aged 50 to 75 years when the baseline FFQ data were collected.[49-51] Additionally, while the HEI is a well-documented, standard scoring method for dietary quality, there are multitudes of dietary pattern scoring approaches for MD and DASH.[23,52,53] Finally, findings from this study using the sample of veterans may not be generalizable to a broader population. Future longitudinal studies that test for a clinically significant change threshold are warranted.

CONCLUSIONS

Results of this study suggest future research should further explore the effects of dietary patterns, particularly intake of specific food groups in combination, as opposed to individual nutrients or food items, on AN and CRC risk. Possible studies might explore these dietary patterns for their mechanistic role in altering the microbiome metabolism, which may influence CRC outcomes or include diet in a more comprehensive, holistic risk score that could be used to predict colonic neoplasia risk or in intervention studies that assess the effects of dietary changes on long-term CRC prevention. We suggest there are differences in people's dietary intake patterns that might be important to consider when implementing tailored approaches to CRC risk mitigation.

Acknowledgments

The authors thank the participants of CSP #380 for their generosity in contributing to this ongoing, longitudinal cohort study. This work is dedicated to Dawn Provenzale, MD, MS, former director of Cooperative Studies Program Epidemiological Center (CSPEC) investigator of CSP #380, for her dedication and contributions to cancer research at the US Department of Veterans Affairs and beyond.

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The authors report no actual or potential conflicts of interest with regard to this article.

Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner*, Frontline Medical Communications Inc., the US Government, or any of its agencies.

Ethics and consent

All methods were carried out in accordance with relevant guidelines and regulations. The Durham Veterans Affairs (VA) medical center institutional review board approved this secondary analysis under CSP #380 la: longitudinal analysis of VA CSP #380 screening colonoscopy (MIRB # 1872). A waiver of informed consent has been granted by the Durham VA medical center institutional review board for work performed under this protocol, including this secondary analysis.

Funding

This work was supported by The Cooperative Studies Program, Office of Research and Development, US Department of Veterans Affairs (CSP 380), the US Department of Veterans Affairs Office of Academic Affiliations Advanced Fellowship: The Big Data Scientist Training Enhancement Program, and the Biomedical Laboratory Research and Development (BLRD) Grant #1 I01 BX005718-01. BAS is supported by the AGA Research Foundation's AGA Research Scholar Award – AGA2021-13-03.

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APPENDIX 1. Food Categories Used in Dietary Pattern Scores

US Dietary Guidelines for Americans (HEI)	Mediterranean diet	DASH diet
Total vegetables	Vegetables	Vegetables
Greens and beans		
Total fruits	Fruits	Fruits
Whole fruits		
Whole grains	Whole grains and potatoes	Total grains
Refined grains		High-fiber grains
Dairy	Regular, low fat, and nonfat	Total and low fat
Total protein foods	Fish	Meat, poultry, fish, and eggs
Seafood, plant proteins	Poultry, red meat, and beans	
Fatty acids	Nuts and healthy oils	Nuts, seeds, and legumes
Saturated fats	Other fats	Fats and oils
Sodium		
Added sugars	Sweets and processed foods	Sweets

Abbreviations: DASH, Dietary Approaches to Stop Hypertension; HEI, Healthy Eating Index.

APPENDIX 2. Diet Scoring[a]

Diet	Minimum score threshold	Maximum score threshold	Score range
Healthy Eating Index[54,b]			
Total fruits[c]	0 cup	≥ 0.8 cup	0-5
Whole fruits[d]	0 cup	≥ 0.4 cup	0-5
Total vegetables	0 cup	≥ 1.1 cup	0-5
Greens and beans[e]	0 cup	≥ 0.2 cup	0-5
Whole grains	0 oz	≥ 1.5 oz	0-10
Dairy[f]	0 cup	≥ 1.3 cup	0-10
Total protein foods[e]	0 oz	≥ 2.5 oz	0-5
Seafood and plant proteins[g]	0 oz	≥ 0.8 oz	0-5
Fatty acids[h]	Fatty acid ratio ≤ 1.2	Fatty acid ratio ≥ 2.5	0-10
Refined grains	≥ 4.3 oz	≤ 1.8 oz	0-10
Sodium	≥ 2.0 g	≤ 1.1 g	0-10
Added sugars[i]	≥ 26% of daily kcal	≤ 6.5% of daily kcal	0-10
Saturated fats	≥ 16% of daily kcal	≤ 8% of daily kcal	0-10
Mediterranean, servings/wk[27,j]			
Vegetables	0	≥ 28	0-3
Fruits	0	≥ 21	0-3
Low-fat or non-fat dairy	0	14-18	0-0.5
Regular dairy	0	≤ 6	0-0.5
Fish	0	≥ 4	0-2
Poultry	0	≤ 3	0-1
Red meat	0	≤ 2	0-1
Beans	0	≥ 3	0-1.5
Nuts and healthy oils	0	≥ 5	0-2
Other fats	> 7	≤ 7	0-0.5
Sweets and processed foods	> 3	≤ 3	0-1
Whole grains and potatoes	0	≥ 49	0-1
Dietary Approaches to Stop Hypertension[28,k]			
Total grains	0 servings/d	≥ 6 servings/d	0-5
High-fiber grains	0% of daily servings	≥ 50% of daily servings	0-5
Total vegetables	0 servings/d	≥ 4 servings/d	0-10
Fruits	0 servings/d	≥ 4 servings/d	0-10
Total dairy	0 servings/d	≥ 2 servings/d	0-5
Low-fat dairy	0% of daily servings	≥ 50% of daily servings	0-5
Meat, poultry, fish, and eggs	≥ 4 servings/d	≤ 2 servings/d	0-10
Nuts, seeds, and legumes	0 servings/wk	≥ 4 servings/wk	0-10
Fats and oils	≥ 6 servings/d	≤ 3 servings/d	0-10
Sweets	≥ 10 servings/wk	≤ 5 servings/wk	0-10

[a]Scores for each category are calculated proportionately between minimum and maximum thresholds of relevant food items from participants' intake reported in the study's food frequency questionnaire.
[b]Total scores are the sum of each category score with a maximum of 100. Thresholds for score calculations are based on stated units per 1000 kcal/d.
[c]Includes 100% fruit juice items.
[d]Includes all fruit items except juice.
[e]Includes peanuts, beans, and peas.
[f]Includes all milk product items including yogurt, cheese, and soy beverages.
[g]Includes seafood, nuts, seeds, soy food products, peanuts, beans, and peas.
[h]Ratio of polyunsaturated + monounsaturated fatty acids to saturated fatty acids.
[i]Added sugars for items were calculated using data from US Department of Agriculture database for the added sugars content of selected foods.[55]
[j]Total scores are the sum of each category score with a maximum of 17. Thresholds for score calculations are based on stated units per 2000 kcal/day.
[k]Total scores are the sum of each category score with a maximum of 80. Thresholds for score calculations are based on stated units per 2000 kcal/day