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A Healthy Lifestyle Index Is Associated With Reduced Risk of Colorectal Adenomatous Polyps Among Non-Users of Non-Steroidal Anti-Inflammatory Drugs

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Abstract

In a Columbia, South Carolina-based case-control study, we developed a healthy lifestyle index from five modifiable lifestyle factors (smoking, alcohol intake, physical activity, diet, and body mass index), and examined the association between this lifestyle index and the risk of colorectal adenomatous polyps (adenoma). Participants were recruited from a local endoscopy center and completed questionnaires related to lifestyle behaviors prior to colonoscopy. We scored responses on each of five lifestyle factors as unhealthy (0 point) or healthy (1 point) based on current evidence and recommendations. We added the five scores to produce a combined lifestyle index for each participant ranging from 0 (least healthy) to 5 (healthiest), which was dichotomized into unhealthy (0–2) and healthy (3–5) lifestyle scores. We used logistic regression to calculate odds ratios (*OR*) and 95% confidence intervals (CI) for adenoma with adjustment for multiple covariates. We identified 47 adenoma cases and 91 controls. In the main analyses, there was a statistically nonsignificant inverse association between the dichotomous (*OR* 0.54; 95% CI 0.22, 1.29) and continuous (*OR* 0.75; 95%CI 0.51, 1.10) lifestyle index and adenoma. Odds of adenoma

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CONFLICT OF INTEREST

The authors declare no conflict of interest

were significantly modified by the use of non-steroidal anti-inflammatory drugs (NSAIDs) ($p_{interaction}$=0.04). For participants who reported no use of NSAIDs, those in the healthy lifestyle category had a 72% reduction in odds of adenoma as compared to those in the unhealthy category (*OR* 0.28; 95%CI 0.08, 0.98), whereas a one-unit increase in the index significantly reduced odds of adenoma by 53% (*OR* 0.47; 95% CI 0.26, 0.88). Although these findings should be interpreted cautiously given our small sample size, our results suggest that higher scores from this index are associated with reduced odds of adenomas, especially in nonusers of NSAIDs. Lifestyle interventions are required to test this approach as a strategy to prevent colorectal adenomatous polyps.

Keywords

Colorectal adenomatous polyps; Healthy lifestyle index; NSAIDs

INTRODUCTION

Colorectal cancer is the third most common cancer and second leading cause of cancer mortality among men and women in the United States (Siegel et al., 2013). Adenomatous polyps (adenomas) are precursor lesions to colorectal cancer (Burnett-Hartman et al., 2012; Sillars-Hardebol et al., 2012; Winawer, 1999). The adenoma-carcinoma sequence is a series of well characterized steps leading to colorectal cancer (Rouillier et al., 2005; Triantafillidis et al., 2009; Vogelstein & Kinzler, 1993). Although, several modifiable risk factors have been implicated in causing colorectal cancer, they are typically studied independently (Wei et al., 2009). Cigarette or tobacco smoking has consistently been associated with incident colorectal adenomas (Zisman, 2006) and colorectal cancer (Anderson et al., 2011; Botteri et al., 2008). Several studies have supported a positive association between alcohol intake and colorectal cancer risk (Bagnardi et al., 2001; Cho et al., 2004; Moskal et al., 2007). Expert panels have found sufficient evidence to link overweight, obesity and lack of physical activity to increased colon cancer incidence (Howard et al., 2008; IARC, 2002; WCRF/AICR, 2011). Red and processed meat have been consistently linked to increased risk for colorectal cancer (Ryan-Harshman & Aldoori, 2007; Santarelli et al., 2008), although the association with fat intake is less consistent (Flood et al., 2003; Lin et al., 2004). Results from studies examining the effect of fruit and vegetable intake on colorectal cancer risk have been mixed (Koushik et al., 2007; Riboli & Norat, 2003). Dietary advice for cancer prevention often includes a reduction of red meat and total dietary fat consumption and an increase in the intake of vegetables, fruit and fiber from various sources (USDA & DHHS, 2010).

A few studies (Chan & Giovannucci, 2010; Driver et al., 2007; Kirkegaard et al., 2010) have examined the combined effects of some of these risk factors in relation to colorectal adenoma or colorectal cancer, with the suggestion that a multi-factor lifestyle approach may be more informative in the design of preventive strategies for the disease. Kirkegaard and colleagues, suggested that a lifestyle index based on achievable national and international, public health recommendations would be a practical tool for counselling people on the effect

of living in accordance with the recommendations to reduce the risk of certain diseases (Kirkegaard et al., 2010).

In order to study the relationship between colorectal adenomas and healthy lifestyles we created a scoring system consisting of five potentially modifiable lifestyle factors including cigarette smoking, alcohol intake, physical activity, diet (fruit/vegetable and fat intakes), and body mass index (BMI). We ranked study participants in a South Carolina-based pilot study according to their adherence to this scoring system, and examined associations of the combined lifestyle index with colorectal adenomatous polyp occurrence to test the hypothesis that a healthier lifestyle index score would be associated with lower odds of adenoma.

METHODS

Study population

From October 2008 to April 2010, we recruited 143 individuals from a local endoscopy clinic in Columbia, South Carolina. Of 256 participants who expressed interest in the study, a total of 143 (56.0%) completed and returned questionnaire data and agreed to participate. We implemented a pre-consent process in the clinic, where we contacted interested individuals by phone to screen for eligibility. Eligibility criteria included upcoming scheduled colonoscopy, being 30 to 80 years of age, ability to provide a written informed consent, ability to complete the interview in English, and self-identification as either African American or European American (regardless of ethnicity). Participants completed questionnaires related to demographics, dietary intake, dietary supplement use, physical activity, and medication use. We excluded seven participants with missing information on most of the covariates. Forty-three (31.0%) of the study participants were undergoing routine screening while 95 (69.0%) were undergoing surveillance colonoscopies. The study was approved by the Institutional Review Board of the University of South Carolina.

Assessment of modifiable lifestyle factors

Prior to their clinic visit for colonoscopy, participants completed two dietary screeners and a physical activity questionnaire and brought those to the clinic visit at which time study staff checked them for completeness. Participants completed two dietary screeners to determine fruit and vegetable intake (Greene et al., 2008) and percent energy from fat (Thompson et al., 2008). Physical activity that included leisure activity, along with whether the activity took place outdoors or indoors, was assessed using a modified version of the Lifetime Total Physical Activity Questionnaire developed by Friedenreich and coworkers (Friedenreich et al., 1998), which documents the frequency, duration, and length of participation in the reported activity. We summed total duration (minutes/week) for each activity across all activities for each individual to provide an estimate of total physical activity per participant. During the on-site interview, lasting approximately 10–15 minutes, we collected information on demographic characteristics and other colorectal cancer risk factors (i.e., socioeconomic status, smoking status, and family history of cancer).

Case ascertainment

We conducted medical record abstraction to obtain clinical data, including information on the presence and number of colorectal polyps and related histological features (e.g., adenomatous, hyperplastic, or no polyp). We selected cases and controls from the same population of patients attending the endoscopy facility; and obtained information blinded as to the case status of the participant, thus avoiding one of the pitfalls of disease-differential recall in case-control studies. Cases were individuals with at least one incident; non-hereditary (sporadic) adenoma that was histologically confirmed by a pathologist. Controls were subjects who had a biopsy and were histologically confirmed as having hyperplastic polyps, or had no polyps detected during colonoscopy.

Definition of the five lifestyle factors and the combined lifestyle index

We developed a combined healthy lifestyle index for each participant based on the current epidemiological evidence on the risk factors for colorectal cancer and on current national [2008 Physical Activity Guidelines for Americans (DHHS, 2008) and 2010 Dietary Guidelines for Americans (USDA & DHHS, 2010)] and international (World Health Organization) public health guidelines. Each participant received a score of one for each of the risk factors if they were never smokers; drank ≤2 drinks/day for males and ≤1 drink/day for females; were regularly active, i.e. performing ≥150 minutes/week of moderate intensity physical activity or ≥60 minutes/week of vigorous intensity physical activity; had a "normal" BMI of <25kg/m^2, [there were no underweight participants (i.e., BMI <18kg/m^2)]; otherwise participants received a score of zero for each of these factors (Table 1). The diet quality score was built from two components - combined fruit and vegetable intake and percent energy from fat. Participants received a score of one if they reported ≥2.5 cups of fruits and ≥2.5 cups of vegetables per day (≥5 servings per day) for the first component and if their percent energy from fat was ≤30 for the second component; otherwise they received a score of zero. The two diet scores were combined into a diet quality score, where participants with both low fruit and vegetable and high percent energy from fat intake received a diet quality score of zero, while those with either high fruit/vegetable intake and/or low fat intake received a diet quality score of one.

We then generated the combined healthy lifestyle index by summing the binary score for each of the five components (smoking, alcohol, physical activity, diet quality, and BMI). We dichotomized the healthy lifestyle index, which ranged from 0 (least healthy) to 5 (healthiest), into unhealthy (0–2) and healthy (3–5) categories.

Statistical analyses

We described participant characteristics using frequencies of lifestyle and demographic variables by adenoma status, and used logistic regression to calculate adjusted odds ratios (*OR*) and 95% confidence intervals (CI) for the presence or absence of adenomatous polyps. To identify the best model in terms of model likelihood and complexity, we applied a backward elimination procedure. We used a *p*-value of 0.2 to eliminate covariates from the model and removed covariates having a *p*-value greater than 0.2 to create "reduced models". The "reduced model" was then compared with the preceding or "full" model that contained the deleted variable, using the log-likelihood ratio test. We assessed the following covariates

for confounding: age (<54, 55–64, ≥65 years), race (African American, European American), sex (male/female), educational level (up to high school, some college, college graduate or higher), family history of colorectal cancer (yes/no), marital status (yes/no), reason for colonoscopy (screening/surveillance), and regular (i.e., at least weekly) use of non-steroidal anti-inflammatory drugs (NSAIDs) (yes/no). We determined potential effect modification by family history of colorectal cancer and use of NSAIDs by generating interaction terms in the multivariable model.

We created four separate healthy lifestyle index variables representing four models. In the first model, we investigated the association of each binary lifestyle index factor with adenomatous polyps, adjusting for the other four factors (smoking, alcohol use, physical activity, diet quality, and BMI), with participants in the 0 category as the referent group. In the second and third models, we examined the association of the dichotomous and continuous healthy lifestyle index, respectively, with adenomatous polyps adjusting for covariates. In the fourth model, we investigated how the odds of adenomas changed with each additional level of the index by calculating *OR*s for the association of each level of the index (1 through 5) compared to the lowest level (0). We combined the two highest levels because there were only two participants in the highest level (meeting all 5 healthy lifestyle recommendations). We adjusted all four models for age, race, educational status and sex, and stratified the second and third models by NSAIDs use and additionally adjusted for NSAIDs use in the unstratified models. We considered two-sided *p*-values lower than 0.05 to be statistically significant and used SAS® statistical software version 9.3 (SAS Institute, Cary, NC, USA) for all analyses.

RESULTS

Among the 138 participants retained in the final analyses, 47 were diagnosed with colorectal adenomatous polyps. Participant characteristics (except age groups) did not differ significantly between adenoma cases and non-cases (Table 2). About half (49.3%) of the participants were male, 18.8% had a family history of colorectal cancer, 43.5% used NSAIDs, while 66% were classified by the lifestyle index as having an unhealthy lifestyle (overall score ≤2). Among cases, 30.0% had one adenoma while 17.0% had two or more adenomas. Table 1 shows the proportions of participants in the two categories of each of the five factors that constitute the lifestyle index: 46.4% of participants were never smokers, 82.6% had alcohol intake within the recommended limits, 21.7% followed the recommendation for regular physical activity, 47.1% followed the recommendation for fruit and vegetable intake, while 18.1% were in the normal weight category.

Table 3 presents the main effect of each lifestyle index factor on the odds of adenoma after adjusting for the other four index factors and for age, race, sex, NSAIDs use and education. Never smoking, limited alcohol intake, regular physical activity, high intake of fruits/vegetables and low fat intake, and normal BMI all showed nonsignificant inverse associations with colorectal adenomatous polyps. *OR* for the associations between the healthy lifestyle index and the odds of adenoma are presented in Table 4 for all participants and stratified by NSAIDs use. When all participants were considered, there was a statistically nonsignificant inverse association between the dichotomous lifestyle index and

adenoma (*OR* 0.54; 95% CI 0.22, 1.29), comparing participants in the unhealthy versus healthy categories, and with the continuous lifestyle index and odds of adenoma (*OR* 0.75; 95%CI 0.51, 1.10).

The association between the index and odds of adenoma varied significantly by NSAIDs use (*p* value for interaction, $p_{interaction}$=0.04), but not by family history of colorectal cancer ($p_{interaction}$=0.30). When models for the dichotomous and continuous healthy lifestyle indices were stratified by NSAIDs use, we found that among participants who reported no use of NSAIDs, those in the healthy lifestyle index category (3–5) had a 72% reduced odds of adenoma compared to those in the unhealthy lifestyle category (0–2) (*OR* 0.28; 95% CI 0.08, 0.98), whereas a one-unit increase in the index (continuous) significantly reduced odds of adenoma by 53% (*OR* 0.47; 95% CI 0.26, 0.88). For participants who reported using NSAIDs, there was no association of the healthy lifestyle index with adenomas (see Table 4).

There was no association between the lifestyle index and adenoma when each category of the healthy lifestyle index was compared to the referent of 0 (unhealthy): *OR* and 95%CI were as follows for each level of the healthy lifestyle index compared to 0: index=1: *OR* 1.43; 95%CI 0.24, 8.65; index=2: *OR* 0.71; 95%CI 0.14, 3.53; index=3: *OR* 0.43; 95%CI 0.08, 2.38; index=4/5: *OR* 0.63; 95%CI 0.08, 4.98.

DISCUSSION

In this case-control study we found that having a higher score on the healthy lifestyle index compared with a lower score was associated with reduced odds of colorectal adenomatous polyps only in non-users of NSAIDs, whereas no association was observed among those who reported using NSAIDs regularly. Findings from the main analysis, though suggestive of inverse associations between a healthy lifestyle index and odds of colorectal adenoma, were not statistically significant.

While the overall association between the healthy lifestyle index and colorectal adenomatous polyps was not statistically significant, the statistically significant association among non-users of NSAIDs was consistent with findings from previous studies (Driver et al., 2007; Fu et al., 2012; Hartman et al., 2005; Kirkegaard et al., 2010; Odegaard et al., 2013; Platz et al., 2000; Wei et al., 2009). The comparability of these studies is, however, limited due to the adoption of different combinations, cut-points and weighting of lifestyle factors. Odegaard and coworkers combined six factors (including all five factors in the present study plus sleep habits) and examined their association with colorectal cancer in a Chinese population. They found that higher index scores were associated with a decreased risk of developing colon (but not rectal) cancer in Chinese men and women (Odegaard et al., 2013). The difference by anatomic subsite is similar to results of other studies we have conducted on risk of colorectal cancer (Cavicchia et al., 2013). In a systematic comparison of six risk factors (cigarette smoking, obesity, no regular use of NSAIDs, high intake of red meat, low intake of fiber, and low intake of calcium) by type of colorectal polyp in the Tennessee Colorectal Polyp Study, Fu and colleagues found that the risk of polyps increased progressively with an increasing number of adverse lifestyle factors. Polyps considered in

three separate groups were adenoma only, hyperplastic polyps and synchronous hyperplastic & adenoma (Fu et al., 2012). In a Danish study, Kirkegaard and colleagues investigated the associations of a 5-factor lifestyle index (based on smoking, alcohol intake, physical activity, diet [dietary fiber, energy percentage from fat, red and processed meat, and fruits and vegetables] and waist circumference) and the risk of colorectal cancer. After adjustment for potential confounders, they found that each additional point achieved on the lifestyle index was associated with a lower risk of colorectal cancer (Kirkegaard et al., 2010). Another study generated a combined lifestyle index using the same five factors as in our study, but examined the association of the lifestyle index with risk of pancreatic cancer. The study found that participants with the highest score (5 points), compared to those with the lowest score (0 point), had a 58% reduced risk of pancreatic cancer (Jiao et al., 2009).

Studies have shown that long-term use of low-dose aspirin or non-aspirin NSAIDs prevents the occurrence of colorectal adenomas (Baron et al., 2003; Bertagnolli et al., 2006; García-Rodríguez & Huerta-Alvarez, 2000; Sandler et al., 1998). In the present study we observed a significant interaction between our healthy lifestyle index and NSAIDs use, where an inverse association between the lifestyle index and colorectal adenomas was observed among nonusers of NSAIDs only. None of the studies cited previously on the combination of lifestyle factors and risk of colorectal cancer or colorectal adenomas stratified models by NSAIDs use. Some studies investigating the effect of diet or physical activity (components of the lifestyle index) on the risk of colorectal adenoma have observed significant effect modification by regular NSAIDs use (Hartman et al., 2005; Hauret et al., 2004). Hartman and colleagues (2005) found that a low-fat, high-fiber diet rich in fruits and vegetables reduced the risk of colorectal adenoma recurrence among nonusers of NSAIDs, while Hauret and coworkers (2004) observed that NSAIDs modified the effect of physical activity on incident sporadic colorectal adenoma, with inverse effects restricted to nonusers of NSAIDs. Our results are consistent with the two studies discussed above.

It is possible that the beneficial effect of NSAIDs is so high as to mask any potential beneficial effect of healthy lifestyle factors, which would explain our findings. Another interpretation suggested by Hauret et al (2004) is that the anti-inflammatory effect of NSAIDs on the colonic epithelium is so strong as to render inconsequential the relative contribution of physical activity, and thus a physical activity-adenoma association would not be observed among NSAID users, yet would be strong among nonusers of NSAIDs (Hauret et al., (2004). This would mean that the potential for protective effects of lifestyle modification on the risk of colorectal adenoma is limited overall, and once that level was achieved, no further protective effects would be observed (Hartman et al., 2005). In any event, it is important to remain mindful that an important advantage of lifestyle modification over regular NSAIDs use is that prudent dietary modification does not have the potential side effects associated with the regular use of NSAIDs (Rennie et al., 2003) and is associated with numerous other benefits beyond preventing colorectal cancer (Hebert et al., 1999).

The selection of the five factors used to generate the healthy lifestyle index was based on public health recommendations and current epidemiological evidence. We used BMI (kg/m^2) to estimate overweight and obesity but other studies have used waist circumference

(WC) with the argument that it captures abdominal fat better than BMI (Kirkegaard et al., 2010). Though WC and BMI are not interchangeable they are usually highly correlated (Vazquez et al., 2007). For example, a meta-analysis of nine prospective British studies revealed no major differences in the discriminatory capabilities of models with BMI, WC or waist-to-hip ratio (WHR) for cardiovascular or total mortality outcomes (Czernichow et al., 2011). Another meta-analysis of 32 studies used random effects models to examine the association of BMI, WC and WHR with risk of diabetes, and found that the three obesity indicators have similar associations with incident diabetes (Vazquez et al., 2007).

We defined diet quality based only on fruit and vegetable intake and fat intake because these were the dietary data that were collected in our study. These two dietary factors may be surrogate markers for specific dietary patterns. A previous study generated a modified lifestyle index with the dietary factor represented by only fruit and vegetable intake, as compared to the original lifestyle index with the diet factor composed of red and processed meat, fruit and vegetables, and percent energy from fat (Kirkegaard et al., 2010). The results in regards to the modified lifestyle index were not materially different from those of the original lifestyle index, which indicates the potential to use the index without a comprehensive diet assessment (Kirkegaard et al., 2010). However, a more comprehensive dietary assessment (such as by multiple 24-hour recalls or food frequency questionnaire) would have allowed for the addition of other variables in the diet quality score, such as red or cooked meat intake, which have been associated with colorectal cancer in other studies (WCRF/AICR, 2011). For the smoking factor, we combined former and current smokers in one category due to the current evidence that risk for smoking-related conditions may persist for up to 25 years after quitting smoking (Gong et al., 2012).

A potential limitation to our study was that all lifestyle index factors as well as data on all other covariates were self-reported. Self-reported measurements are likely to have some degree of misclassification. In this case, the misclassification would likely be non-differential leading to potential attenuation of odds ratios, because all study participants completed questionnaires prior to colonoscopy and knowledge of their adenoma status. We dichotomized covariates, including the healthy lifestyle index, which could have led to loss of information or statistical power and the potential introduction of residual confounding, but results from models constructed with the index as continuous or dichotomized were all statistically significant. Categorizing the healthy lifestyle index also provided an opportunity to directly compare participants who would be considered exposed/not exposed to healthy lifestyle behaviors. Our small sample size limited both the power of the study in most of the models and our ability to stratify by NSAIDs use in the model with the lifestyle index treated as a categorical variable with five categories. The effect estimates in our study also had wide confidence intervals and we cannot rule out that our statistically significant findings may be attributed to chance. Lastly, our study design was cross-sectional and included a large proportion of surveillance (69%) compared with screening (31%) colonoscopies. It is possible that some surveillance colonoscopy participants may have recently changed their lifestyle behaviors as a result of previous adenoma diagnosis. A change in lifestyle behaviors towards more healthy behaviors such as engaging in more physical activity, eating healthier diets, reducing alcohol intake, or losing weight among those who were more likely to have an adenoma (e.g., surveillance colonoscopy patients)

would decrease the odds of a protective lifestyle association (i.e., drive the association towards the null). Indeed, adjusting for reason for colonoscopy further strengthened the protective association of the healthy lifestyle index with adenoma, especially in non-users of NSAIDs, suggesting that the potential for a recent change in diet due to symptoms is not a likely explanation for our findings.

Strengths of the present study include our detailed assessment of exposure. Compared to studies that have investigated single lifestyle factors in relation to risk of colorectal adenoma, our study takes the next step by examining the effect of a combined healthy lifestyle index, which captures the influence of multiple health behaviors, on the occurrence of adenomatous polyps. Another strength is that all data were collected before study participants knew of their polyp status, thus obviating the problem of diet-related reporting and information bias.

In conclusion, our findings suggest that a higher score on the combined healthy lifestyle index generated on the basis of recommendations for five lifestyle factors (smoking, alcohol intake, physical activity, diet quality, and BMI) is associated with reduced odds for colorectal adenomas in nonusers of NSAIDs. This study supports the evidence that lifestyle modification is important for the prevention of colorectal adenomas which are precursors of colorectal cancer, and adds to the body of evidence on the beneficial effects of combined lifestyle factors on risk of colorectal adenomatous polyps. Lifestyle interventions are required to test this as a strategy to prevent colorectal adenomatous polyps.

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Table 1

Factors of the combined lifestyle score

Healthy lifestyle score factor	Score	Description	Percentage
Smoking	0	Former or Current smoker	53.6
	1	Never smoker	46.4
Alcohol use	0	High alcohol use: not conforming to recommended daily alcohol intake for the United States (>2 drinks/day for males and >1 drink/day for females)	17.4
	1	Limited alcohol use: Conforming to recommended intake levels (=<2 drinks/day for males and =<1 drink/day for females)	82.6
Physical activity (PA)	0	Not active/less active: <150 minutes/week of moderate intensity PA or <60 minutes/ week of vigorous intensity PA	78.3
	1	Regularly active: >=150 minutes/week of moderate intensity PA or >=60 minutes/ week of vigorous intensity PA	21.7
Diet quality≠	0	Unhealthy diet quality: low FV¥ intake and high fat intake	52.9
	1	Healthy diet quality: high FV intake or low fat intake, or both	47.1
Body mass index	0	Overweight or obese: BMI>=25	81.9
	1	Normal weight: BMI 18 – <25	18.1

≠For fruits/vegetables, ≥2.5 cups (≈ 5 servings) per day was considered adequate intake, while <30% of energy from fat was considered healthy intake,

¥FV=fruits/vegetables

Table 2

Characteristics of study participants by polyp status

	Adenomatous polyp (*n*=47) *n*(%)	No adenomatous polyp (*n*=91) *n*(%)	Difference testing; *p* value
Combined healthy lifestyle score			
Unhealthy lifestyle score	34(72.3)	57(62.6)	0.25
Healthy lifestyle score	13(27.7)	37(37.4)	
Age category (years)			
<54	9(19.1)	29(31.8)	0.04
55–64	17(36.2)	40(44.0)	
≥65	21(44.7)	22(24.2)	
Race			
European Americans	37(78.7)	59(64.8)	0.09
African Americans	10(21.3)	32(35.2)	
Sex			
Female	20(42.6)	50(54.9)	0.17
Male	27(57.4)	41(45.1)	
Years of education			
Up to High School	13(27.6)	30(33.0)	0.41
some college	17(36.2)	23(25.3)	
College graduate or higher	17(36.2)	38(41.7)	
Family history of colorectal cancer			
No	38(80.8)	74(81.3)	0.95
Yes	9(19.2)	17(18.7)	
Reason for colonoscopy			0.0002
Screening	5 (10.4)	38 (41.8)	
Surveillance	42 (89.6)	53 (58.2)	
NSAID use			
No	29(61.7)	49(53.8)	0.38
Yes	18(38.3)	42(46.2)	
Marital status			
No	8(17.0)	24(26.4)	0.22
Yes	39(83.0)	67(73.6)	

Note. The continuous healthy lifestyle score (0–5) was dichotomized by combining 0–2 in one category and 3–5 in the second category.

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Table 3

Age-adjusted and fully-adjusted odds ratios (95% confidence intervals) for each factor of the combined lifestyle score

Lifestyle index Factor	cases / controls	Factor category	Age- adjusted *OR*	95%CI	Fully- adjusted *OR*[§]	95%CI
Smoking score	31/43	Current/former smoker	1.00	referent	1.00	referent
	16/48	Never smoker	0.48	0.23–1.02	0.65	0.28–1.47
Alcohol score	10/24	High intake	1.00	referent	1.00	referent
	37/77	Limited intake	0.54	0.21–1.39	0.74	0.26–2.14
Physical activity score	37/71	No/less activity	1.00	referent	1.00	referent
	10/20	Regular activity	0.86	0.35–2.09	0.81	0.29–2.26
Diet score	25/48	Low FV[¥] intake and high fat intake	1.00	referent	1.00	referent
	22/43	High FV intake or low fat intake or both	0.93	0.45–1.93	0.90	0.39–2.05
BMI[¥] score	39/74	Overweight/obese	1.00	referent	1.00	referent
	8/17	Normal weight	0.79	0.31–2.07	0.64	0.22–1.86

[§]In the model, each factor was adjusted for the other four factors and additionally for age, sex, educational status, NSAID use, and race.

[¥]FV=fruits/vegetables; BMI = Body Mass Index

Table 4

Odds ratios (95% confidence intervals) for categorical and continuous healthy lifestyle index stratified by NSAIDs use

		All participants		No NSAIDs use		NSAIDs use	
		OR [*]	**95%CI**	***OR***	**95%CI**	***OR***	**95%CI**
Dichotomous healthy lifestyle index	Unhealthy lifestyle score	1.00	referent	1.00	referent	1.00	referent
	Healthy lifestyle score	0.54	0.22–1.29	0.28	0.08–0.98	1.30	0.35–4.91
Continuous healthy lifestyle index[¥]		0.75	0.52–1.10	0.47	0.26–0.88	1.14	0.64–2.05

Note. All models were adjusted for age, sex, educational status, race and reason for colonoscopy. NSAIDs-unstratified model was additionally adjusted for NSAIDs use.

[¥]The continuous healthy lifestyle score (0–5) was dichotomized by combining 0–2 in one category and 3–5 in the second category.

[*]*OR*=odds ratio (95% confidence interval) of having an adenoma vs. no, normal or hyperplastic polyps.