

2018-10-01

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Anna M Leszczynski, Kristin L MacArthur, Kerrie P Nelson, Samuel A Schueler, Paula A Quatromoni, Brian C Jacobson. 2018. "The association among diet, dietary fiber, and bowel preparation at colonoscopy." *GASTROINTESTINAL ENDOSCOPY*, Volume 88, Issue 4, pp. 685 - 694 (10). <https://doi.org/10.1016/j.gie.2018.06.034>

<https://hdl.handle.net/2144/40924>

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Published in final edited form as:

Gastrointest Endosc. 2018 October ; 88(4): 685–694. doi:10.1016/j.gie.2018.06.034.

The association among diet, dietary fiber, and bowel preparation at colonoscopy

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Abstract

Background and Aims—Pre-colonoscopy dietary restrictions vary widely and lack evidence-based guidance. We investigated whether fiber and various other foods/macronutrients consumed during the 3 days before colonoscopy are associated with bowel preparation quality.

Methods—This was a prospective observational study among patients scheduled for outpatient colonoscopy. Subjects received instructions including split-dose polyethylene glycol, avoidance of vegetables/beans two days before colonoscopy and clear liquid diet the day before colonoscopy. Two 24-hour dietary recall interviews and one patient recorded food log measured dietary intake on the 3 days before colonoscopy. The Nutrition Data System for Research was used to estimate dietary exposures. Our primary outcome was the quality of bowel preparation measured by the Boston Bowel Preparation Scale (BBPS).

Results—We enrolled 201 subjects from November 2015 to September 2016 with complete data for 168. The mean age was 59 (SD 7) and 90% of colonoscopies were conducted for screening/surveillance. Only 17% and 77% of subjects complied with diet restrictions 2 and 1 day(s) before

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Kerrie Nelson: study concept and design, analysis and interpretation of data, critical revision of manuscript for important intellectual content

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Brian Jacobson: study concept and design, analysis and interpretation of data, drafting of manuscript, critical revision of manuscript for important intellectual content, obtained funding, study supervision

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colonoscopy, respectively. We found no association between foods consumed 2 and 3 days before colonoscopy and BBPS scores. However, BPPS was positively associated with intake of gelatin, and inversely associated with intake of red meat, poultry, and vegetables on the day before colonoscopy.

Conclusions—Our findings support recent guidelines encouraging unrestricted diets >1 day before colonoscopy if using a split-dose bowel regimen. Furthermore, we found no evidence to restrict dietary fiber one day before colonoscopy. We also found evidence to promote consumption of gelatin and avoidance of red meat, poultry, and vegetables one day before colonoscopy.

Keywords

bowel preparation; diet; colonoscopy; Boston Bowel Preparation Scale

INTRODUCTION

Despite maximizing liquid purgatives (eg, use of “split-dose” regimens), inadequate bowel preparation has been reported in 10% to 25% of colonoscopies.^{1–4} This may hinder the identification of colonic lesions, result in longer procedure times and necessitate repeat examinations at foreshortened intervals.^{2,3,5–7} In addition to the liquid purgative, patients are also instructed to limit their diets in the days preceding colonoscopy. Although several studies have examined various types of laxative regimens, minimal data are available regarding specific food intake before colonoscopy and the effect diet has upon bowel preparation. The American Society for Gastrointestinal Endoscopy advises that patients should limit their diet to clear liquids at least one day before colonoscopy,⁸ whereas some experts have recommended liberalizing dietary restrictions before colonoscopy.^{9–13}

A survey of precolonoscopy patient instructions from 201 endoscopy units nationwide found that diet instructions varied greatly.¹⁴ Although 91% of endoscopy units requested a clear liquid diet (CLD) for the day before colonoscopy, 9% offered patients either low-residue or normal diets. Two-thirds of endoscopy units recommended avoidance of nuts, seeds, pulp, and fiber and 84% recommended avoidance of dairy products. The timing of when to cease consumption of specific foods was also not standardized. For example, instructions indicating when to avoid nuts, seeds, pulp, and fiber ranged from 1 to 10 days (median 3 days) before the colonoscopy. Yet it remains unknown exactly which dietary components affect bowel preparation in a clinically significant manner. These non-standardized dietary restrictions place inconsistent constraints on patients and may result in decreased patient satisfaction with the procedure and perhaps decreased compliance with the preparation.

A recent guideline on bowel cleansing released by the Multi-Society Task Force on Colorectal Cancer explicitly expressed concern with the paucity of data regarding the impact of diet on bowel preparation.¹ The guideline’s authors were reluctant to make specific dietary recommendations, stating: “Pending additional study, colonoscopists should carefully evaluate any compromise in efficacy if dietary flexibility is allowed.” Moreover, with an estimated 11 to 14 million colonoscopies performed annually in the United States^{15–17}, if specific dietary restrictions are indeed necessary to ensure maximizing the

endoscopist's ability to detect malignant or pre-malignant lesions, then identification of optimal instructions becomes an important public health endeavor.

We therefore conducted a study designed to provide data to scientifically inform "dietary flexibility" and determine whether fiber, in addition to other dietary components, consumed in the days leading up to colonoscopy are associated with bowel cleanliness during the procedure.

METHODS

This was a prospective observational study of patients scheduled for outpatient colonoscopy at Boston Medical Center, a safety-net academic medical center in Boston. The study was approved by our Institutional Review Board and funded by the National Institute of Diabetes, Digestive and Kidney Diseases.

Research team members called patients 50 and older scheduled for colonoscopy from November 2015 to September 2016. Exclusion criteria included non-English speakers, prior bowel surgery, inability to complete a food diary/conduct a dietary interview by telephone, inability to tolerate a regular diet, and participation in another colonoscopy-related research study. Patients who provided verbal consent were mailed an information packet including the hospital's standard preparation instructions, which include no dietary restrictions 3 days before colonoscopy (referred to herein as Day -3), avoidance of vegetables and beans 2 days before colonoscopy (Day -2), and use of 4L split dose polyethylene glycol with a CLD the day before colonoscopy (Day -1). No specific instructions were given for the volume of clear liquids to consume. The packet also included instructions for participants to keep a 24-hour food record of all foods and beverages consumed on Day -2, a sample completed food record, and a booklet picturing a variety of food-specific portions. A timeline depicting study components was also included in the precolonoscopy packet (Figure 1).

On the morning of Day -2, nutrition research staff conducted a scripted, 24-hour dietary recall interview by telephone. The multiple pass approach (i.e. collect list of consumed foods/beverages; probe for foods forgotten; collect time of consumption; probe for preparation details and portion sizes of food/beverages consumed; review for completeness) was used to elicit details on all foods and beverages consumed by patients on Day -3. Subjects were also instructed on how to complete the 1-day, prospective food record to self-report their intake on Day -2. Patients were enrolled into the study after successfully completing the phone interview. Subjects then independently completed the prospective detailed food diary for the remainder of Day -2. Upon presentation to our endoscopy unit on the day of their colonoscopy, the research assistant administered a structured 24-hour dietary recall interview to capture all foods and beverages consumed on Day -1, the intended clear liquid day. Next, the research assistant reviewed the Day -2 participant-recorded food log, probing for details where needed to increase the accuracy of the self-report. Demographics and other patient information were also collected in a preprocedure questionnaire and supplemented, when needed, via chart review. Subjects received a \$25 incentive if they completed all three dietary assessments.

Colonoscopies were observed by a study team physician who recorded procedure-related factors including amount of fluid used for lavage, amount of fluid suctioned from the colon, colonoscope insertion, and withdrawal times, and presence of polyps. The endoscopist was blinded to the dietary intake data. Our primary end point was the Boston Bowel Preparation Scale (BBPS) score as determined by the endoscopist, with bowel cleanliness determined for each segment of the colon after all washing was completed. With the BBPS, a higher score indicates a cleaner colon and the range of scores is 0–9.^{18,19} Secondary end points included BBPS segment scores for the right, transverse, and left side of colons (each segment score 0–3).

Dietary recalls and food records were coded using the Nutrition Data System for Research (NDSR, from the Nutrition Coordinating Center at the University of Minnesota), a research tool used to analyze dietary data, producing estimates of food and nutrient intake.²⁰ The NDSR database includes commodity and brand name foods commonly consumed in the United States; it is updated annually to reflect changes in the marketplace.²¹ The database contains over 18,000 foods and is widely used in research. Compliance with Day -2 restriction of vegetables and legumes and with Day -1 CLD guidelines was determined objectively based upon reported dietary data, not on subjects' self-assessment of compliance.

Statistical Methods

For power considerations, a sample size of 160 subjects was required to be able to detect a minimum linear slope of 0.15 between daily fiber intake in the days leading up to the colonoscopy and the BBPS score based upon a 2-sided hypothesis test at a 5% significance level and a minimum of 80% power. This means that if at least a mild positive linear slope exists between fiber and bowel cleanliness as measured by BBPS then our study would be sufficiently large to detect this association.

Spearman correlation coefficients were used to measure the association between dietary variables and BBPS scores because BBPS scores are measured on an ordinal scale. Multivariate linear regressions were conducted in an exploratory manner to investigate the association between each dietary component and BBPS scores and adjust for possible confounders including age, gender, body mass index, and race/ethnicity. To assess whether participation in the study itself was independently associated with BBPS scores, we compared total BBPS scores from all patients who underwent outpatient colonoscopies in our endoscopy unit during the same time as our study cohort. All statistical analyses were conducted using the software package R.²²

RESULTS

We identified 1,889 patients aged 50 or older scheduled for outpatient colonoscopy between November 2015 and August 2016. We successfully engaged 711 patients by telephone and enrolled 204 subjects (see Figure 2 for the flow of potential subjects through the enrollment process, and their reasons for exclusion when applicable). Among those enrolled, 168 completed their colonoscopy, contributed all three days of dietary data, and constituted our final cohort for analysis. Subject demographics are shown in Table 1. The mean patient age

was 59.3 years ($SD \pm 6.8$ years); 60% were female, 53% were self-identified as Black, and 61% of the colonoscopies were performed for colorectal cancer screening. Of note, although our protocol excluded non-English speakers, 16% considered English to be their secondary language and nearly 8% of subjects had lived in the United States for 10 years or less. 27% of subjects had received a bachelor's or graduate degree and 58% had previously undergone at least one colonoscopy.

Despite receiving printed instructions and verbal reminders from our patient navigators, only 28 subjects (17%) complied with the dietary restriction to eliminate vegetables and beans 2 days before colonoscopy (Day -2). Higher, though not universal, compliance was achieved with the CLD on Day -1 (77%, $n=129$). In spite of objective evidence of noncompliance determined by our research team, 155 (92%) of our study subjects reported no difficulty with understanding bowel preparation instructions and 162 (96%) reported good understanding of the CLD instructions. Not surprisingly, 28% of patients reported at least some difficulty complying with the Day -2 restrictions, and 43% reported difficulty complying with a CLD. In addition, 64 patients (38%) reported having to purchase specific food items in order to comply with the pre-procedure dietary instructions. More than 90% of subjects drank at least three-quarters of the polyethylene glycol purgative.

Figure 3 shows the distribution of total BBPS scores among study participants. The median BBPS score was 9.0 (IQR = 2; mean BBPS = 7.9, $SD \pm 1.84$) and 96% of subjects had an adequate bowel preparation, defined as having all three BBPS segment scores ≥ 2 .²³ We calculated a median BBPS score of 7.0 (IQR =2; mean BBPS score of 7.03, $SD \pm 1.49$) among a comparison group of 2,663 patients who underwent outpatient colonoscopy at our medical center during the same time frame as our study (difference between mean BBPS scores of the 2 groups has a $P < .001$), suggesting that study participation itself was associated with bowel cleanliness.

Table 2 displays food and nutrient intake by study subjects during the 3 days before colonoscopy. Results are presented in terms of the numbers of serving sizes consumed. Most nutrient intake decreased appropriately from Day -3 (unrestricted diet) to Day -1 (CLD), except for gelatin and water as expected. There was only a small difference in consumption of insoluble fiber comparing Day -3 to Day -2, consistent with the relatively low compliance observed in our study subjects with vegetable/legume restriction for Day -2. We also found that Day -2 consumption of fruits, dairy, meat, poultry, fish, deli meats, nuts and seeds was comparable to Day -3 consumption, consistent with a lack of any self-imposed dietary restriction for those food groups. We also found no difference in compliance with a CLD depending on the time of colonoscopy (morning vs afternoon procedure).

Table 3 demonstrates the correlation between pre-colonoscopy dietary intake and both total and segmental BBPS scores. Total BBPS scores were compared with dietary data on all 3 days leading up to procedure, but segmental BBPS score were only examined in relation to Day -1 intake. We found no association between total BBPS scores and any food or nutrient consumed on either Day -3 or Day -2. We found a positive association between total BBPS scores and consumption of gelatin and animal protein (derived in this case from gelatin) on Day -1, with Spearman correlation coefficients of 0.228 ($P = .003$) and 0.115 ($P = .045$),

respectively. We found an inverse association between total BBPS scores and meat consumption on Day -1 with a Spearman correlation coefficient of -0.153 ($P = .048$) indicating that meat consumption may negatively impact bowel cleanliness (although only 4 participants (2.4%) consumed meat on day -1).

We also found positive associations between BBPS segment scores and consumption of gelatin (right and transverse colon segments) and animal protein (right colon only) on Day -1 (Table 3). We found significant inverse associations between BBPS segment scores and consumption of all vegetables (transverse colon), meats (transverse and left colon) and poultry (transverse colon) on Day -1. Although legume consumption on Day -1 also appears inversely associated with BBPS segment scores in the transverse and left colon, only one study subject consumed legumes on Day -1, making this result difficult to interpret. There was no association between volume of water consumed as a beverage and BBPS scores. We also examined whether there was an association between preparation adequacy (i.e. BBPS 6 vs BBPS <6) and dietary intake on Days -2 and -1, with all food groups showing no significant association. However, our study was not powered for this binary outcome and this was performed in a purely exploratory manner.

In multivariate analyses of individual foods adjusted for age, gender, body mass index and race/ethnicity, Day -1 consumption of meat and gelatin were each significantly associated with total BBPS scores (Table 4). However, in a secondary analysis that included both of those foods simultaneously, only Day -1 gelatin consumption remained significantly associated with total BBPS scores.

We also found that total BBPS scores were inversely associated with increasing volume of water used for intraprocedure colonic lavage and quantity of effluent fluid suctioned from the colon (Spearman correlation coefficients -0.205 , $P = .008$ and -0.249 , $P = .001$, respectively). However, we did not find an association between procedure time and BBPS score (Spearman correlation coefficient -0.033 , $P = .675$), nor between consumption of any food or nutrient group and total procedure time. We found that consumption of dairy and poultry were each positively associated with the amount of fluid suctioned from the colon (Spearman correlation coefficient 0.245 , $P = .001$ and Spearman correlation coefficient 0.162 , $P = .037$, respectively).

DISCUSSION

In this observational study, we explored the relationship between dietary intake during the three days before colonoscopy and subsequent bowel cleanliness during the procedure as measured by the BBPS. Our findings provide much needed support for current guidelines^{1,24} indicating no need to alter patients' diets except for the day before colonoscopy, as only dietary intake on that day correlated with BBPS scores. We found that in the 24 hours before colonoscopy, consumption of gelatin and animal protein (reflecting gelatin intake) were associated with improved bowel cleanliness, whereas consumption of meat, poultry, vegetables, and whole grains were associated with worse bowel cleanliness. We had insufficient evidence that dietary fiber was associated with bowel preparation quality based upon our sample size of enrolled patients.

Current guidelines suggest use of a full liquid to low-residue diet on the day before colonoscopy¹; however, it is noted that this is a “weak” recommendation, with “moderate-quality” evidence per the authors. Our findings therefore provide very important additional evidence to support the current, more liberalized dietary guidelines. We also found that although the majority of our patients reported a good understanding of dietary and purgative instructions, fewer than 20% fully adhered to our restrictions against vegetables and beans two days before colonoscopy and ~75% fully adhered to a CLD the day before colonoscopy. Significant percentages of patients indicated difficulty complying with dietary restrictions and many reported having to make food purchases to enable compliance.

Previous studies have examined the effects of pre-colonoscopy diet on bowel cleanliness. Stolpman and colleagues compared bowel preparation quality in patients allowed a low-residue diet for breakfast and lunch the day before colonoscopy vs those on a CLD.²⁵ They found that 96.5% of patients had BBPS scores ≥ 6 . Those patients on a low residue diet had noninferior bowel cleanliness compared to those on a CLD (mean BBPS scores 8 vs 8.2, respectively), with similar polyp detection rates. Interestingly, patient tolerance of their preparation process did not differ between the two groups. In another study, Soweid and colleagues evaluated the efficacy and tolerability of a polyethylene glycol based preparation in patients who were randomized to either a fiber-free diet or a CLD.²⁶ Both groups were given instructions indicating acceptable food options. The authors found that patients assigned to the fiber-free diet drank more preparation, had superior bowel cleanliness, and reported fewer side effects. However, the study’s 33% rate of “unsatisfactory” bowel preparations is high compared to guidelines, which suggest an inadequacy rate of no more than 15%, making the results difficult to generalize.¹ In addition, the authors did not determine whether subjects randomized to a fiber-free diet versus CLD actually adhered to these recommendations as no dietary recall was performed. Sipe and colleagues also examined the effects of a low residue diet on bowel preparation by providing subjects with a handout of low residue food options for breakfast, lunch and a snack the day before colonoscopy and comparing BBPS scores between these subjects and those adhering to a CLD.²⁷ They found mean preparation scores were not different in either segmental or total scores (total BBPS 8.03 vs 7.89 in low residue vs CLD groups, $P = .81$). Patient satisfaction with both bowel preparation and diet was significantly higher in the low residue diet group. However, dietary recall was limited, with subjects indicating the foods they ate off of a pre-printed list.

Our study differed from those of previous authors in several important ways. First, we did not assign our patients specific food recommendations. They were given dietary restrictions for the 48 hours before colonoscopy, but were free to eat whatever they liked within those restrictions. Therefore, their dietary habits more closely resembled real world experiences, enabling us to study the impact of patients’ personal choices on bowel preparation. We also applied a rigorous methodology for collecting, coding and processing food intake data using standardized interview and coding protocols administered by trained research assistants using the NDSR database. We also examined patients’ perception of compliance with pre-colonoscopy guidelines but then compared this to their food records to assess for objective evidence of compliance. We found a discordance between patients’ stated compliance rates and their actual food intake. This may be related to low health literacy or the way we

communicate with our patients, which typically consists of listing excluded food groups but giving few examples of acceptable choices.

In subgroup analysis of bowel segments (transverse, right, and left) we found certain foods were correlated with total BBPS scores, but other foods and nutrients were correlated with bowel cleanliness only for particular segments of the colon. It is likely this represents limited power for specific foods and bowel segments, as it seems implausible that certain foods only impact bowel cleanliness in some segments. Moreover, on multivariate analysis controlling for age, gender, BMI, race and ethnicity, and total meat intake on the day before colonoscopy was associated with worse bowel preparation, whereas gelatin's association with better preparations persisted. We postulate that gelatin's association with improved bowel cleanliness reflects simply that it is a marker of compliance with a CLD. Likewise, the positive association of animal protein with improved bowel cleanliness (whereas meat consumption had an inverse association) likely reflects the large quantity of animal protein present in gelatin products.

Our study had several strengths, including racial and ethnic diversity among our study subjects making our results generalizable to a broad range of patients; use of a standardized dietary data collection protocol that minimized exposure measurement error; use of a standardized, reliable bowel preparation rating scale (BBPS), which minimized outcome measurement errors; and use of a robust nutritional data analysis program. Nonetheless, we acknowledge certain limitations. We did not specifically inquire of the 23% of study subjects why they failed to comply with the CLD. More than 40% of our subjects reported that complying with a CLD was "difficult" or "very difficult," although almost all reported no difficulty understanding the instructions for a CLD. Nearly 40% also reported having to buy food specifically to follow our dietary restrictions which may have been a factor in noncompliance. Although we had sufficient power to detect differences in BBPS scores based on typical dietary variation between patients, our subgroup analyses should be taken as exploratory. In addition, our nearly 96% bowel preparation adequacy rate exceeds those reported in many studies.²⁸ However, we found a similar rate of adequate preparation among non-study patients at our institution undergoing colonoscopy during the same time as our study. In addition, previously published data from our institution showed similar historical rates of adequate bowel preparation.²⁹ Our comparison group's mean BBPS scores were lower than those of study subjects (7.0 vs 7.9, $P < .001$), yet both of these values indicate adequate bowel preparations and therefore likely has minimal clinical significance. However, the difference between groups does suggest that participation in the study was independently associated with bowel preparation. This may reflect selection bias, but does not invalidate the correlations observed between diet and bowel cleanliness. Moreover, the high adequacy rate despite large numbers of subjects who failed to comply with dietary instructions provides further evidence that restrictive diets are not required to achieve adequate bowel preparation. We had very small numbers of subjects with comorbidities/medications that may impact bowel preparation, limiting our ability to explore interactions between diet and these conditions. Finally, although we found statistically significant correlations between specific foods and BBPS scores, these were generally weak correlations. However, we consider this an important message about our findings; namely that restrictive diets in the days leading to colonoscopy are not supported by strong

associations between what people eat and their bowel cleanliness. We recognize that diet restrictions will likely persist and therefore consider our results to be a much-needed addition to the literature to provide at least some evidence-based rationale if one does want to impose dietary restrictions.

In summary, our study supports current guidelines to only restrict diet one day before colonoscopy, to avoid high-residue foods and to freely include the use of gelatin and other clear liquids on the day before colonoscopy. We found no evidence that dietary fiber was associated with bowel preparation quality. Restrictive, multi-day dietary instructions appear confusing and inconvenient to patients without providing significant impact on bowel preparation quality or procedure time.

Acknowledgments

Grant Support: The National Institute of Diabetes, Digestive and Kidney Diseases of the National Institutes of Health

Acronyms

BBPS	Boston Bowel Preparation Scale
BMI	body mass index
CLD	clear liquid diet
NDSR	Nutrition Data System for Research

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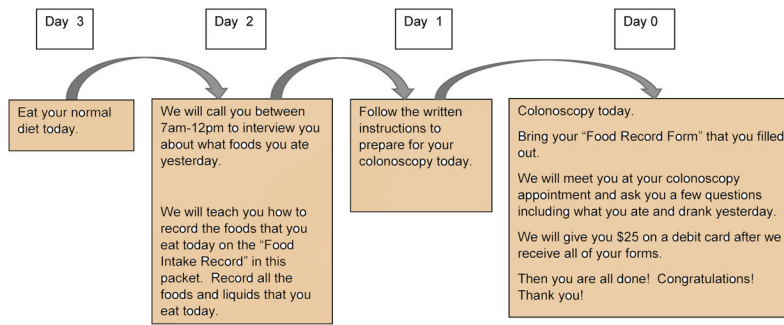


Figure 1. Study design flow chart
Instructions provided to subjects outlining study details and timeline.

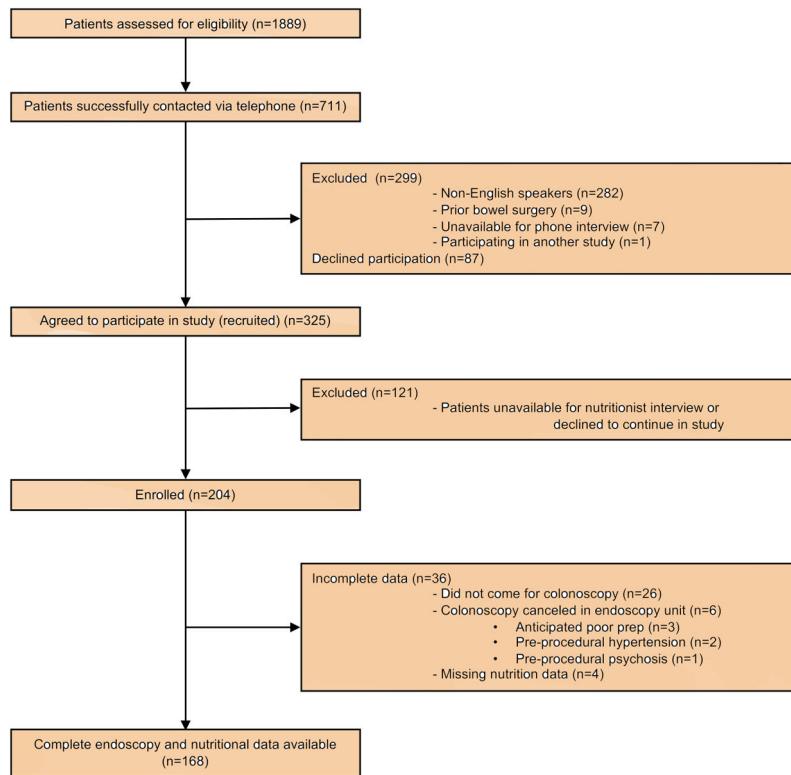


Figure 2. Subject enrollment process
CONSORT diagram of study subject selection, recruitment, enrollment and reasons for ineligibility.

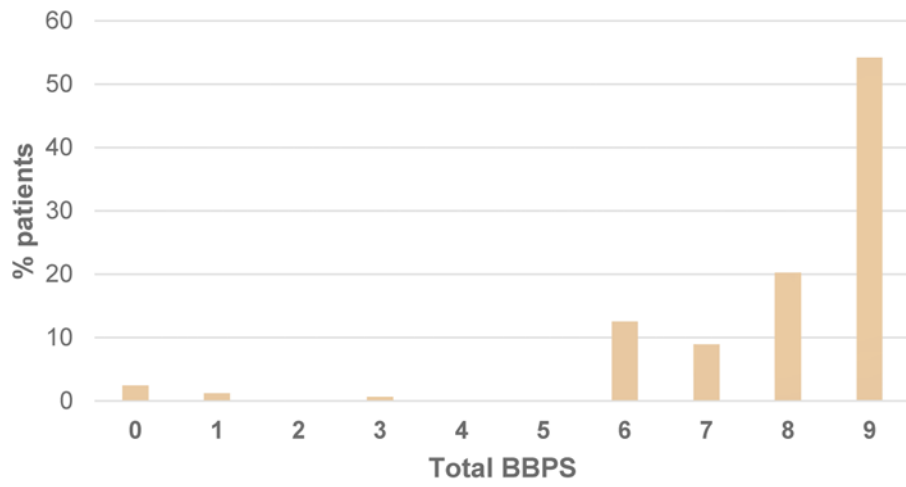


Figure 3. Distribution of Boston Bowel Preparation Scale scores
Frequency of observed total BBPS scores among study subjects.

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Table 1

Demographics and baseline characteristics of study subjects

Characteristic	Mean \pm SD or n (%)
Subjects who completed study with all data available	168
Female	100 (59.5%)
Age, years	59.3 \pm 6.8
Height, inches	65.8 \pm 3.7
Weight, kg	85.4 \pm 20.7
BMI	30.7 \pm 7.4
Race	
White	62 (36.9%)
Black	89 (53%)
Asian	4 (2.4%)
Native Hawaiian/Pacific Islander	1 (0.6%)
American Indian	2 (1.2%)
More than one race	4 (2.4%)
Other	6 (3.6%)
Ethnicity	
White Hispanic	8 (4.8%)
Non-white Hispanic	9 (5.4%)
Indication	
Screening	103 (61.3%)
Surveillance	49 (29.1%)
Diagnostic	16 (9.5%)
Primary Language	
English	142 (84.5%)
Spanish	6 (3.6%)
Haitian Creole	3 (1.8%)
Portuguese Creole	1 (0.60%)
Other	16 (9.5%)
How Long in the US	
<5 years	10 (5.9%)
5–10 years	3 (1.8%)
>10 years	155 (92.3%)
Highest Level of Education	
High school or less	68 (40.5%)
Some College/ Trade School	55 (32.7%)
Bachelor's degree	24 (14.3%)
Graduate degree	21 (12.5%)
Number of Previous Colonoscopies	1.5 \pm 3.8

Characteristic	Mean \pm SD or n (%)
Compliant with restricted diet Day -2 (no vegetables, no beans)	28 (17%)
Compliant with clear liquid diet Day -1	129 (77%)

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Table 2Food and nutrient intake levels (mean \pm SD) on days leading up to colonoscopy (n=168)

Foods (servings)	Day -3 Unrestricted Diet	Day -2 Restricted Diet¹	Day -1 Clear Liquid Diet²
All vegetables	2.12 \pm 2.17	1.45 \pm 1.60	0.09 \pm 0.57
Green vegetables	0.53 \pm 1.27	0.19 \pm 0.58	0.01 \pm 0.06
Legumes	0.18 \pm 0.71	0.045 \pm 0.19	0.003 \pm 0.04
Citrus fruits	0.49 \pm 1.53	0.39 \pm 1.35	0.08 \pm 0.45
Other fruits ³	1.13 \pm 1.96	1.51 \pm 2.56	1.43 \pm 3.24
Dairy foods	1.37 \pm 1.68	1.38 \pm 1.59	0.05 \pm 0.23
Meats	1.26 \pm 2.29	1.11 \pm 2.00	0.02 \pm 0.15
Poultry	2.17 \pm 3.26	2.21 \pm 3.32	0.12 \pm 0.86
Fish	0.66 \pm 1.80	0.75 \pm 1.78	0.06 \pm 0.51
Deli Meats	0.76 \pm 1.99	0.56 \pm 1.03	0.04 \pm 0.36
Whole grain foods	1.06 \pm 2.15	1.07 \pm 1.77	0.082 \pm 0.48
Nuts and seeds	0.90 \pm 3.11	0.67 \pm 2.04	0.01 \pm 0.18
Popcorn	0.05 \pm 0.38	0.02 \pm 0.21	0.00 \pm 0.00
Water as a beverage	4.19 \pm 4.60	4.72 \pm 6.06	12.96 \pm 5.96
Gelatin	0.03 \pm 0.31	0.06 \pm 0.45	1.27 \pm 2.66
Nutrients (grams)	Day -3	Day -2	Day -1
Soluble fiber	5.07 \pm 3.58	5.02 \pm 3.83	0.87 \pm 1.64
Insoluble fiber	10.85 \pm 9.94	9.56 \pm 6.95	1.01 \pm 2.57
Total fat	64.21 \pm 45.03	57.96 \pm 38.66	4.12 \pm 8.75
Solid fat	28.15 \pm 24.36	26.50 \pm 22.70	2.04 \pm 5.53
Total carbohydrate	185.00 \pm 110.40	193.60 \pm 105.87	91.17 \pm 87.11
Animal protein	47.37 \pm 32.67	47.81 \pm 36.05	4.85 \pm 9.80

¹ Participants were instructed to “stop eating vegetables and beans” and to drink at least 8 glasses of water two days before the procedure

² Participants were instructed to “follow a strict clear liquid diet; to not eat any food or thick liquids”

³ Includes 100% fruit juice

Table 3

Correlation between pre-colonoscopy dietary intake and total/segmental BBPS scores

n=168	Total BBPS			Right BBPS		Transverse BBPS		Left BBPS	
	Day -3	Day -2	Day -1	Day -1	Day -1	Day -1	Day -1	Day -1	
	Spearman (P value)	Spearman (P value)	Spearman (P value)	Spearman (P value)	Spearman (P value)	Spearman (P value)	Spearman (P value)	Spearman (P value)	
Foods (servings)									
All vegetables	0.111 (.154)	0.04 (.607)	-0.102 (.187)	-0.08 (.302)	-0.161 (.038)	-0.086 (.266)			
Green vegetables	0.09 (.247)	-0.113 (.143)	-0.112 (.148)	-0.124 (.11)	-0.053 (.493)	-0.068 (.385)			
Legumes	0.061 (.434)	0.034 (.665)	NA*	NA*	NA*	NA*			
Citrus fruit	0.034 (.658)	-0.009 (.905)	-0.04 (.609)	-0.016 (.838)	-0.048 (.536)	-0.08 (.306)			
Other fruit	0.003 (.973)	0.041 (.601)	-0.082 (.289)	-0.097 (.212)	-0.071 (.358)	-0.058 (.452)			
Dairy	-0.013 (.866)	0.042 (.589)	0.019 (.809)	-0.005 (.944)	-0.025 (.746)	0.035 (.65)			
Meat	0.004 (.959)	-0.066 (.395)	-0.153 (.048)	-0.13 (.092)	-0.182 (.018)	-0.206 (.007)			
Poultry	0.000 (.996)	-0.006 (.941)	-0.108 (.164)	-0.109 (.16)	-0.168 (.029)	-0.129 (.096)			
Fish	-0.047 (.547)	0.132 (.088)	-0.01 (.893)	0.022 (.781)	-0.019 (.81)	0.071 (.358)			
Delic meat	0.049 (.531)	0.028 (.723)	0.096 (.218)	0.088 (.255)	0.065 (.403)	0.058 (.455)			
Whole grain foods	0.031 (.686)	0.001 (.957)	-0.166 (.031)	-0.166 (.031)	-0.233 (.002)	-0.125 (.106)			
Nuts / seeds	0.028 (.719)	0.045 (.559)	-0.042 (.589)	0.062 (.423)	-0.122 (.116)	0.041 (.598)			
Popcorn	-0.031 (.694)	0.018 (.821)	NA [†]	NA [†]	NA [†]	NA [†]			
Water as a beverage	0.041 (.595)	-0.072 (.355)	-0.073 (.345)	-0.028 (.719)	-0.066 (.394)	-0.084 (.281)			
Gelatin	0.067 (.385)	0.028 (.715)	0.228 (.003)	0.252 (.001)	0.194 (.012)	0.148 (.056)			
Nutrients (grams)									
Soluble fiber	0.049 (.532)	-0.009 (.905)	-0.043 (.583)	0.005 (.948)	-0.093 (.23)	-0.101 (.193)			
Insoluble fiber	0.077 (.318)	0.012 (.878)	-0.056 (.472)	-0.038 (.622)	-0.104 (.178)	-0.045 (.567)			
Total fat	-0.011 (.89)	0.101 (.194)	0.01 (.895)	-0.029 (.71)	-0.035 (.655)	0.055 (.475)			
Solid fat	-0.025 (.745)	-0.032 (.681)	0.093 (.232)	0.101 (.193)	0.03 (.704)	0.065 (.402)			
Total carbohydrates	0.034 (.658)	0.002 (.98)	0.033 (.668)	0.069 (.375)	0.015 (.843)	0.034 (.661)			
Animal protein	-0.029 (.714)	0.003 (.967)	0.115 (.045)	0.189 (.014)	0.078 (.314)	0.098 (.208)			

† Insufficient data owing to a single subject consuming legumes

Table 4

Multivariate linear regression analysis of food intake on Day -1 and resulting BBPS

Dietary Component (n=168)	Estimate	Std. Error	T value	P value
Total animal protein (g) ¹	-0.009307	0.015295	-0.608	.544
Total meat ¹	-0.07830	0.03352	-2.336	.0207
Total poultry ¹	-0.009898	0.005941	-1.666	.0977
Gelatin ¹	0.002553	0.001166	2.189	.0301
Gelatin ²	0.002377	0.001155	2.058	.0412

¹Controlled for age, gender, BMI, race and ethnicity²Controlled for age, gender, BMI, race, ethnicity, and meat intake