Published in final edited form as:
Endoscopy. 2012 September ; 44(9): 813–818. doi:10.1055/s-0032-1309837.

A prospective study of obesity, weight change and the risk of adenoma recurrence

Adeyinka O. Laiyemo, MD, MPH[1,2], **Chyke Doubeni, MD, MPH**[3], **Dilhana S. Badurdeen, MD**[1], **Gwen Murphy, PhD, MPH**[4], **Pamela M. Marcus, PhD**[2], **Robert E. Schoen, MD, MPH**[5], **Elaine Lanza, PhD**[6], **Duane T. Smoot, MD**[1], and **Amanda J. Cross, PhD**[4]

[1]Department of Medicine, Howard University College of Medicine, Washington DC [2]Biometry Research Group, Division of Cancer Prevention, National Cancer Institute, National Institutes of Health, Bethesda, Maryland [3]Department of Family Medicine, University of Massachusetts, Worcester, Massachusetts [4]Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Bethesda, Maryland [5]Department of Medicine and Epidemiology, University of Pittsburgh, Pittsburgh, Pennsylvania [6]Laboratory of Cancer Prevention, Center for Cancer Research, National Cancer Institute, National Institutes of Health, Bethesda, Maryland

Abstract

Background and study aims—Obesity is a risk factor for colorectal neoplasia. Lifestyle modifications including weight loss have been advocated to reduce the risk. However, no prospective study has evaluated if weight loss actually affects adenoma recurrence. We examined whether weight change (loss or gain) over four years is associated with adenoma recurrence.

Patients and methods—1,826 participants with colorectal adenoma in the Polyp Prevention Trial had height and weight measured at baseline. Adenoma recurrence was determined by end of trial colonoscopy 4 years after study entry when participants' weights were re-measured. We used Poisson regression models to evaluate body mass index (BMI), weight change over 4 years and the risk of any adenoma and advanced adenoma recurrence.

Results—723 (39.6%) participants had adenoma recurrence, of whom 118 (6.5%) had advanced adenoma recurrence. Among those with baseline BMI < 25 kg/m^2 (n=466), BMI = 25–29 kg/m^2 (n=868), and BMI ≥ 30 kg/m^2 (n=492), the recurrence rate was 34.5%, 41% and 41.9%, respectively. Obesity was associated with an increased risk of adenoma (RR=1.19; 95%CI: 1.01–1.39) and advanced adenoma recurrence (RR=1.62; 95%CI: 1.01–2.57). However, when compared with those with relatively stable weight (< 5 pound weight change) over the 4-year trial, weight gain or loss was not associated with adenoma recurrence. This was consistent, regardless of the baseline BMI.

Conclusions—Weight loss or gain over 4 years does not affect adenoma recurrence. Our study does not support weight loss alone as an effective intervention for reducing adenoma recurrence.

Corresponding author (also for reprint requests): Adeyinka O. Laiyemo, M.D., M.P.H., Division of Gastroenterology, Department of Medicine, Howard University College of Medicine, 2041 Georgia Avenue, NW, Washington DC 20060. Phone: (202) 865 – 7186; Fax: (202) 865 – 6562; adeyinka.laiyemo@howard.edu.

Conflict of interest: No conflicts of interest exists

Disclosure: An abstract from this study was presented as an oral presentation at the Digestive Diseases Week in New Orleans in May 2010. Gastroenterology 2010; 138(5):S27

Financial disclosure: This study was sponsored by the National Cancer Institute.

Keywords

Adenomatous polyps; body mass index; colonoscopy; weight loss

INTRODUCTION

Higher body mass index (BMI) has been associated with an increased risk of colorectal adenoma [1 – 3] and colorectal cancer [4 – 7]. Obese patients have been reported to be at an increased risk of death from colorectal cancer [8 – 9]. Mechanisms related to insulin resistance and inflammation has been postulated to link body size to colorectal carcinogenesis [10 – 11]. Therefore, the current increasing prevalence of obesity in the US [12 – 14] has the potential to reverse the noted decreasing incidence of colorectal cancer [15].

Almendingen et al. [16] reported that the degree of body fatness from anthropometric measurement and BMI was associated with the growth of adenoma when left in situ during 3 years of follow-up. Following polypectomy, patients remain at a high risk for adenoma recurrence, which necessitates post-polypectomy surveillance. Three studies have examined the association between BMI and the risk of adenoma recurrence [17 – 19]. These studies suggested an increased risk of adenoma recurrence in association with high body mass index but two of the studies reported a differential association by sex with the increased risk only for men [17 – 18].

In clinical practice, anecdotal evidence suggests that clinicians do advocate lifestyle modifications including weight loss for obese patients to reduce their risk of adenoma recurrence. However, no prospective study has investigated the effect of short term weight gain or loss on adenoma recurrence. One retrospective study reported reduced odds of adenoma at 1 year follow-up among patients with a 5% reduction in their body weight [19]. The authors suggested that controlling body weight may decrease the risk of colorectal neoplasm. In this prospective study, we hypothesized that patients who lost weight during 4 years of follow- up would have a decreased risk while those who gained weight will have an increased risk of adenoma recurrence. We tested this hypothesis by examining the association between weight change and adenoma recurrence among the participants in the Polyp Prevention Trial (PPT) in this secondary data analysis.

METHODS

Study population

The rationale, design, and results of the PPT have been published previously [20 –22]. In brief, the PPT was a 4-year multicenter, randomized, controlled trial to assess the effect of a low-fat, high-fiber, fruit and vegetable diet on the risk of colorectal adenoma recurrence. A total of 2,079 participants who were at least 35 years old and had one or more histologically confirmed adenomatous polyps removed within 6 months were randomized. Exclusion criteria included history of surgical resection of adenomatous polyps, bowel resection, colorectal carcinoma, polyposis syndrome, inflammatory bowel disease, use of any lipid-lowering medications, and body weight above 150% of the ideal. The clinical trial was approved by the Institutional Review Boards of the National Cancer Institute, and each of the eight participating clinical centers in the United States (Kaiser Foundation Research Institute, California; University of Pittsburgh, Pennsylvania; Wake Forest University, North Carolina; State University of New York (SUNY) at Buffalo, New York; Memorial Sloan Kettering Cancer Center, New York; University of Utah School of Medicine, Utah; Edward

Hines Jr. VA Hospital, Illinois; and Walter Reed Army Medical Center, Washington DC). All participants gave written informed consent.

Exposure and outcome assessment

At baseline, information on the subjects' demographic characteristics, health-related lifestyle, dietary supplements intake and medication use were obtained from every participant through direct interview. The weight and height of the participants were measured by trained personnel. The participants underwent a clearing colonoscopy approximately one year after randomization (T1) to remove any lesion which may have been missed at qualifying colonoscopy (T0). They were followed for approximately four years after randomization, and had an end-of-trial (T4) colonoscopy to ascertain adenoma recurrence. Participants also had their weights re-measured at the end of the trial. The colonoscopy reports provided information on size, number, and location of polyps. The histology and degree of dysplasia were confirmed by two centrally located trial pathologists who were masked to the participants' randomization assignments. We defined an advanced adenoma as an adenoma with size ≥1 cm in diameter, or villous histology or high grade dysplasia.

A total of 1,905 (91.6%) participants completed the trial by undergoing the end of trial (T4) colonoscopy. The dietary intervention did not affect adenoma recurrence [22]. Our analytic cohort for this study comprises 1,826 participants who completed the trial and had complete information on their body weights at baseline and at the end of the trial.

Statistical analyses

We calculated BMI (the weight in kilograms divided by the square of the height in meters) and categorized BMI into 3 mutually exclusive categories: BMI < 25 kg/m^2 (normal); BMI = 25 – 29 kg/m^2 (overweight) and BMI ≥ 30 kg/m^2 (obese). We compared demographic and lifestyle factors at baseline by BMI categories. We used ANOVA to compare age (continuous) across BMI categories and compared categorical variables with chi squared statistics. We used Poisson regression models with robust standard error estimation to evaluate the association between baseline BMI and adenoma recurrence and advanced adenoma recurrence. Participants with BMI < 25 kg/m^2 served as the reference category. Assuming a recurrence rate of 30% among those with normal BMI, this study has 89.9% power to detect a 30% increased risk of adenoma recurrence among overweight (BMI 25 – 29 kg/m^2) and 81.8% among obese (BMI ≥ 30 kg/m^2) participants.

We then calculated weight difference by subtracting the weight of participants at end of trial from the weight at baseline. At first, we modeled weight difference as a continuous variable. We examined any weight change, any weight loss, and any weight gain with any adenoma and advanced adenoma recurrence. Subsequently, we defined a weight difference that is less than 5 pounds (gain or loss) as stable weight to accommodate slight variations that occur in body weight with repeated measurements and designated these patients as our reference category. We also compared the baseline characteristics of participants by weight change. We categorized patients who have gained 5 – 9 pounds as a category and those who have gained 10 pounds or more as a separate category. Those who have lost weight were categorized similarly. We then evaluated the association between weight change categories and adenoma and advanced adenoma recurrence.

We performed stratified analyses by sex for both BMI and weight change since previous studies have reported differences by sex in the association between obesity and adenoma recurrence [17, 18]. We also investigated the effect of weight change on any adenoma recurrence by baseline BMI categories. The small number of participants with advanced

adenoma recurrence prevented us from analyzing the effect of weight change on advanced adenoma recurrence by baseline BMI. Although the dietary intervention in the original 4-year trial did not affect adenoma recurrence, we performed exploratory stratified analyses by dietary intervention assignment of the trial since dietary modification may affect weight change. Furthermore, we performed sensitivity analyses in which we added adenomas removed at T1 clearing colonoscopy to the end of trial colonoscopy (as recurrent lesions) and repeated our analyses. We used Stata® statistical software version 11.2 (College Station, Texas) for our analyses. We calculated incidence risk ratios (RR) and 95% confidence intervals (CI). All reported P-values correspond to two-sided tests.

RESULTS

Baseline characteristics

At baseline, 466 (25.5%) participants had BMI < 25 kg/m^2; 868 (47.5%) with BMI = 25 – 29 kg/m^2 and 492 (26.9%) had BMI ≥ 30 kg/m^2. Table 1 shows selected baseline characteristics of study participants by the baseline BMI categories (Table 1A) and by weight change at the end of the trial (Table 1B). The mean age of participants and the proportion with a first degree relative with colorectal cancer was comparable across the BMI categories. Women and current smokers were less likely, but blacks were more likely to be obese. Furthermore, obese patients were more likely to be taking non steroidal anti-inflammatory drugs (NSAIDs). Former smokers and those randomized to the dietary intervention group were more likely to lose weight at the end of the PPT.

Adenoma and advanced adenoma recurrence by baseline BMI

At end of trial (T4) colonoscopy, 723 (39.6%) participants had adenoma recurrence while 118 (6.5%) participants had advanced adenoma recurrence. Obese patients had a significant 19% increased risk of adenoma recurrence (Table 2). Although, the 12% increased risk among overweight participants (BMI = 25 – 29 kg/m^2) was not statistically significant, the trend analysis was consistent with an increasing risk of recurrence with increasing BMI (P_{value} for trend = 0.04). A similar pattern was observed with advanced adenoma recurrence. Obese participants had a significant 62% increased risk of advanced adenoma recurrence. In analysis stratified by sex, the increased risk of adenoma and advanced adenoma recurrence was seen in men but not in women.

Adenoma and advanced adenoma recurrence by weight change

There were 727 (39.8%) participants with relatively stable weight over the 4-year trial (i.e. weight change less than 5 pounds). The mean weight change was −0.33 pounds (range −48.5 to +83.5 pounds). Only 20 participants gained 30 pounds or more while 18 participants lost 30 pounds or more. Adenoma recurrence occurred among 293 (40.2%) participants while advanced adenoma recurrence occurred among 49 (6.7%) participants with stable weight (Table 3). As a continuous variable, weight change was not associated with adenoma recurrence (all weight changes, RR = 1.00; 95% CI: 1.00 – 1.01, P_{value} = 0.25; weight loss only, RR = 1.00; 95% CI: 0.99 – 1.01, P_{value} = 0.70; and weight gain only, RR = 1.00; 95% CI: 0.99 – 1.01, P_{value} = 0.67). Similar results were obtained with advanced adenoma recurrence (data not shown). When compared with participants with relatively stable weight category, weight loss or gain as categories were not associated with adenoma or advanced adenoma recurrence. This was independent of the sex of the participants. In stratified analysis by baseline BMI, weight change in each category of BMI was also not associated with adenoma recurrence (Table 4). In exploratory analyses in which we stratified weight change by dietary randomization assignment, the results were similar except that subjects who gained 10 or more pounds had a modest increased risk of adenoma recurrence in the control group (RR = 1.26; 95% CI: 1.01 – 1.57, P value = 0.043).

Results of sensitivity analyses

In analyses in which we considered adenoma removed during the year 1 (T1) clearing colonoscopy as recurrent and added them to the end of trial (T4) findings, 997 (54.6%) participants had adenoma recurrence and 191 (10.5%) had advanced adenoma recurrence. When compared to participants with baseline BMI < 25 kg/m^2, overweight (RR = 1.12; 95% CI: 1.00 – 1.25) and obese (RR = 1.16; 95% CI: 1.03 – 1.31) participants had increased risk of adenoma recurrence as observed in our main analysis, but the association with advanced adenoma recurrence was weaker for both overweight (RR = 1.03; 95% CI: 0.74 – 1.43) and obese (RR = 1.32; 95% CI: 0.94 – 1.87) participants. Nonetheless, the overall inference remains unchanged. There was no association between weight change (loss or gain) and adenoma or advanced adenoma recurrence (data not shown).

DISCUSSION

We evaluated the association between baseline BMI and weight change over a 4 year period with the risk of adenoma recurrence. Our study suggests an increased risk of adenoma recurrence with increasing body size, but short-term weight change (loss or gain) over a 4 year period did not affect adenoma recurrence. We observed that baseline BMI had more of an impact on adenoma recurrence than weight change. Although the maintenance of healthy weight should continue to be recommended for its overall health benefits, this may not have the desired effect of reducing the risk of metachronous colorectal neoplasia, at least in the short-term.

The majority of studies reporting the association of body size with colorectal neoplasia reported the prevalence of adenoma [1 – 3] and incidence of cancer [4 – 7]. Few studies have evaluated the association of body size with adenoma recurrence [17 – 19]. Jacobs et al. [18] reported an increased odds of adenoma recurrence with overweight (OR = 1.13; 95% CI: 1.01 – 1.26) and obesity (OR = 1.29; 95% CI: 1.14 – 1.45) over a median follow-up of 47.2 months among 8,213 patients. These positive associations were only found in men. Yamaji et al. [19] also reported an increased risk of adenoma recurrence in association with BMI among 2,568 Japanese over 1 year of follow-up. These reports are comparable to our findings.

We are not aware of any prospective study that has evaluated weight change with adenoma recurrence. In their retrospective cohort analysis, Yamaji et al. [19] reported that loss of 5% or more of body weight among Japanese patients over 1 year was associated with reduction in adenoma recurrence (OR = 0.47; 95% CI: 0.26 – 0.83), but there was no increased risk of recurrence among those who gained 5% or more of their body weight over the same period. This finding is at a variance with our study and may be due to differences in study design and population. The study by Yamaji et al. [19] only had 1 year of follow-up of patients with and without adenoma at baseline examinations, BMI was classified at baseline by quartiles with the highest quartile being participants with BMI ≥ 25.1 kg/m^2, weight change was defined as 5% change in body weight, and only Japanese were studied. Asians have been reported to develop ill-effects of body adiposity at lower BMI than what is observed in the Western Hemisphere [23, 24]. Furthermore, the authors acknowledged that the reported incident adenomas at 1 year may represent missed adenoma from the baseline colonoscopy. In our study however, we aligned our BMI classification to clinically useful categories and defined weight change by a commonly used unit of measurement. Our study population also underwent clearing colonoscopy one year after the baseline colonoscopy to remove potentially missed lesions from the baseline examination. However, our study does not have many Asians for a race specific analysis to compare with the findings of Yamaji et al. [19]

Other studies have reported the association of weight change with colorectal cancer. Rapp et al. [25] evaluated weight change over a mean of 6.9 years among 65,649 Austrians over 8 years of follow-up in relation to incident cancer in many sites. The authors reported that weight loss was associated with a reduced risk of incident colorectal cancer among men (HR = 0.50; 95% CI: 0.29–0.87), but not in women. Using the Melbourne Collaborative Cohort Study, Bassett et al. [26] reported that adult weight gain was positively associated with colon cancer risk for men (HR = 1.11 per 5-kg increment; 95% CI: 1.03–1.20), but not for women (HR = 1.00; 95% CI: 0.94–1.07).

Our study has a number of notable strengths. Our study population is from a large randomized controlled trial with participants recruited from eight geographically dispersed areas in the United States. Information on candidate risk factors was prospectively gathered, all patients had planned colonoscopic assessment for recurrence after an adequate follow up period, and dedicated trial pathologists with expertise in gastrointestinal tumors examined the adenomas, thereby ensuring consistency. Furthermore, height and weight were measured by trained staff from which we calculated BMI. However, our study is limited by the fact that the design of the PPT limited the degree of obesity of participants such that participants could weigh no more than 150% of their ideal body weight at baseline to be eligible for the trial, so the highest BMI in our study was 38.8 kg/m^2. Therefore, we could not evaluate the risk of adenoma recurrence in association with morbid obesity. We also assessed weight at two time points within a 4 year period and we could not evaluate the actual duration of the observed weight change and fluctuations in weight of the participants.

In conclusion, we observed an increased risk of adenoma recurrence with high BMI at baseline, while short-term weight change did not affect adenoma recurrence regardless of the initial BMI. Further studies are needed to elucidate whether long-term sustained weight loss will reduce the risk of adenoma recurrence.

Acknowledgments

Grant support

Dr Laiyemo is supported by the National Cancer Institute's new faculty recruitment supplement to the Comprehensive Minority Institution/Cancer Center Partnership between Howard University Cancer Center and Sidney Kimmel Comprehensive Cancer Center of Johns Hopkins University (5U54CA091431-09 S1).

Dr. Doubeni is supported by a mentored career development award (5K01CA127118-03) from the National Cancer Institute

Financial support

The study was funded by Intramural Research Program of the Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health; and the Division of Cancer Prevention, National Cancer Institute, National Institutes of Health. The funding agency had a role in the design and reporting of the study and in the decision to submit the manuscript for publication and approved the final version of the manuscript.

References

1. Terry MB, Neugut AI, Bostick RM, et al. Risk factors for advanced colorectal adenomas: a pooled analysis. Cancer Epidemiol Biomarkers Prev. 2002 Jul; 11(7):622–9. [PubMed: 12101109]
2. Giovannucci E, Colditz GA, Stampfer MJ, et al. Physical activity, obesity, and risk of colorectal adenoma in women (United States). Cancer Causes Control. 1996; 7(2):253–63. [PubMed: 8740738]
3. Boutron-Ruault MC, Senesse P, Méance S, et al. Energy intake, body mass index, physical activity, and the colorectal adenoma-carcinoma sequence. Nutr Cancer. 2001; 39(1):50–7. [PubMed: 11588902]

4. Dai Z, Xu YC, Niu L. Obesity and colorectal cancer risk: a meta-analysis of cohort studies. World J Gastroenterol. 2007 Aug 21; 13(31):4199–206. [PubMed: 17696248]
5. Giovannucci E, Ascherio A, Rimm EB, et al. Physical activity, obesity, and risk for colon cancer and adenoma in men. Ann Intern Med. 1995; 122(5):327–34. [PubMed: 7847643]
6. Renehan AG, Tyson M, Egger M, et al. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. Lancet. 2008; 371(9612):569–78. [PubMed: 18280327]
7. Moghaddam AA, Woodward M, Huxley R. Obesity and risk of colorectal cancer: a meta-analysis of 31 studies with 70,000 events. Cancer Epidemiol Biomarkers Prev. 2007; 16(12):2533–47. [PubMed: 18086756]
8. Calle EE, Rodriguez C, Walker-Thurmond K, et al. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med. 2003; 348(17):1625–38. [PubMed: 12711737]
9. Parr CL, Batty GD, Lam TH, et al. Body-mass index and cancer mortality in the Asia-Pacific Cohort Studies Collaboration: pooled analyses of 424,519 participants. Asia-Pacific Cohort Studies Collaboration. Lancet Oncol. 2010; 11(8):741–52. Erratum in: Lancet Oncol 2010, 11(8), 721. [PubMed: 20594911]
10. Frezza EE, Wachtel MS, Chiriva-Internati M. Influence of obesity on the risk of developing colon cancer. Gut. 2006; 55(2):285–91. [PubMed: 16239255]
11. Gunter MJ, Leitzmann MF. Obesity and colorectal cancer: epidemiology, mechanisms and candidate genes. J Nutr Biochem. 2006; 17(3):145–56. [PubMed: 16426829]
12. Selassie M, Sinha AC. The epidemiology and aetiology of obesity: a global challenge. Best Pract Res Clin Anaesthesiol. 2011; 25(1):1–9. [PubMed: 21516909]
13. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA. 2006; 295:1549–1555. [PubMed: 16595758]
14. Han JC, Lawlor DA, Kimm SY. Childhood obesity. Lancet. 2010; 15;375(9727):1737–48.
15. Edwards BK, Ward E, Kohler BA, et al. Annual report to the nation on the status of cancer, 1975–2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates. Cancer. 2010; 116(3):544–73. [PubMed: 19998273]
16. Almendingen K, Hofstad B, Vatn MH. Does high body fatness increase the risk of presence and growth of colorectal adenomas followed up in situ for 3 years? Am J Gastroenterol. 2001; 96(7): 2238–46. [PubMed: 11467659]
17. Jacobs ET, Martínez ME, Alberts DS, et al. Association between body size and colorectal adenoma recurrence. Clin Gastroenterol Hepatol. 2007; 5(8):982–90. [PubMed: 17553754]
18. Jacobs ET, Ahnen DJ, Ashbeck EL, et al. Association between body mass index and colorectal neoplasia at follow-up colonoscopy: a pooling study. Am J Epidemiol. 2009; 169(6):657–66. [PubMed: 19147743]
19. Yamaji Y, Okamoto M, Yoshida H, et al. The effect of body weight reduction on the incidence of colorectal adenoma. Am J Gastroenterol. 2008; 103(8):2061–7. [PubMed: 18796100]
20. Schatzkin A, Lanza E, Freedman LS, et al. The polyp prevention trial I: rationale, design, recruitment, and baseline participant characteristics. Cancer Epidemiol Biomarkers Prev. 1996; 5(5):375–83. [PubMed: 9162304]
21. Lanza E, Schatzkin A, Ballard-Barbash R, et al. The polyp prevention trial II: dietary intervention program and participant baseline dietary characteristics. Cancer Epidemiol Biomarkers Prev. 1996; 5(5):385–92. Erratum in: Cancer Epidemiol Biomarkers Prev 1996;5(7):584. [PubMed: 9162305]
22. Schatzkin A, Lanza E, Corle D, et al. Polyp Prevention Trial Study Group. Lack of effect of a low-fat, high-fiber diet on the recurrence of colorectal adenomas. N Engl J Med. 2000; 342(16):1149–55. [PubMed: 10770979]
23. Kanazawa M, Yoshiike N, Osaka T, et al. Criteria and classification of obesity in Japan and Asia-Oceania. Asia Pac J Clin Nutr. 2002 Dec; 11(Suppl 8):S732–S737. [PubMed: 12534701]
24. Bei-Fan Z. Cooperative Meta-Analysis Group of Working Group on Obesity in China. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults: study on optimal cut-off points of body mass index and waist circumference in Chinese adults. Asia Pac J Clin Nutr. 2002; 11 (Suppl 8):S685–93. [PubMed: 12534691]

25. Rapp K, Klenk J, Ulmer H, et al. Weight change and cancer risk in a cohort of more than 65,000 adults in Austria. Ann Oncol. 2008; 19(4):641–8. [PubMed: 18056917]

26. Bassett JK, Severi G, English DR, et al. Body size, weight change, and risk of colon cancer. Cancer Epidemiol Biomarkers Prev. 2010; 19(11):2978–86. [PubMed: 20870733]

Table 1

Baseline characteristics of participants

A. By body mass index (BMI)

Baseline characteristics	BMI < 25kg/m^2 (N = 466)	BMI 25 – 29 kg/m^2 (N = 868)	BMI ≥ 30kg/m^2 (N = 492)	P value
Mean age (SD)	61.1 (10.5)	61.1 (9.5)	60.8 (9.7)	0.81
Randomization assignment				
Control	236 (50.6)	434 (50.0)	237 (48.2)	0.72
Intervention	230 (49.4)	434 (50.0)	255 (51.8)	
Male	226 (48.5)	623 (71.8)	331 (67.3)	<0.001
Female	240(51.5)	245(28.2)	161(32.7)	
Race				
Whites	424 (91.0)	781 (90.0)	428 (87.0)	
Blacks	25 (5.4)	70 (8.1)	55 (11.2)	0.005
Others*	17 (3.7)	17 (2.0)	9 (1.8)	
Smoking status				
Never	192 (41.2)	322 (37.1)	201 (40.9)	
Former	183 (39.3)	447 (51.5)	243 (49.4)	<0.001
Current	91 (19.5)	99 (11.4)	48 (9.8)	
Positive family history of colorectal cancer	116 (24.9)	251 (28.9)	122 (24.8)	0.15
Uses non-steroidal anti-inflammatory drugs at least once/month	160 (34.3)	268 (30.9)	196 (39.8)	0.004

B. By weight change in 4 years

Baseline characteristics	No weight change (N = 727)	Lost weight (N = 557)	Gained weight (N = 542)	P value
Mean age (SD)	61.3 (9.4)	63.6 (9.3)	58.0 (10.1)	0.141
Randomization assignment				
Control	366 (40.4)	233 (25.7)	308 (34.0)	<0.001
Intervention	361 (39.3)	324 (35.3)	234 (25.5)	
Male	454 (38.5)	382 (32.4)	344 (29.2)	0.06
Female	273 (42.3)	175 (27.1)	198 (30.7)	
Race				
Whites	647 (39.6)	502 (30.7)	484 (29.6)	
Blacks	60 (40.0)	45 (30.0)	45 (30.0)	0.862
Others*	20 (46.5)	10 (23.3)	13 (30.2)	
Smoking status				
Never	299 (41.8)	204 (28.5)	212 (29.7)	
Former	331 (37.9)	295 (33.8)	247 (28.3)	0.024
Current	97 (40.8)	58 (24.4)	83 (34.9)	
Positive family history of colorectal cancer	194 (39.7)	139 (28.4)	156 (31.9)	0.357
Uses non-steroidal anti-inflammatory drugs at least once/month	237 (38.0)	191 (30.6)	196 (31.4)	0.415

*Others = Hispanics, Asians, Native Americans

Table 2

The risk of adenoma recurrence by baseline body mass index

Group	Body mass index, kg/m^2 N=1826		No recurrence N=1103 n (%)	Any adenoma recurrence N=723 n (%)	Any adenoma recurrence versus no recurrence RR (95% CI)	Advanced adenoma recurrence N=118 n (%)	Advanced adenoma recurrence versus no recurrence RR (95% CI)
Overall*	< 25	(n=466)	305(65.5)	161(34.5)	Ref	27 (22.9)	Ref
	25–29	(n=868)	512(59.0)	356(41.0)	1.12(0.96–1.30)	51 (43.2)	1.05(0.67–1.65)
	≥30	(n=492)	286(58.1)	206(41.9)	1.19(1.01–1.39)	40 (33.9)	1.62(1.01–2.57)
P $_{trend}$					0.04		0.04
Male†	< 25	(n=226)	133(58.8)	93(41.2)	Ref	16 (13.6)	Ref
	25–29	(n=623)	353(56.7)	270(43.3)	1.08(0.90–1.29)	36 (30.5)	0.93(0.53–1.64)
	≥30	(n=331)	172(52.0)	159(48.0)	1.22(1.01–1.48)	32 (27.1)	1.75(0.99–3.08)
P $_{trend}$					0.03		0.04
Female†	< 25	(n=240)	172(71.7)	68(28.3)	Ref	11 (9.3)	Ref
	25–29	(n=245)	159(64.9)	86(35.1)	1.21(0.93–1.58)	15 (12.7)	1.32(0.62–2.80)
	≥30	(n=161)	114(70.8)	47(29.2)	1.05(0.77–1.44)	8 (6.8)	1.12(0.45–2.77)
P $_{trend}$					0.63		0.73

*Models adjusted for age, sex, non steroidal anti inflammatory drugs, smoking and family history of colorectal cancer

†Models adjusted for age, non steroidal anti inflammatory drugs, smoking and family history of colorectal cancer

Table 3

Risk of adenoma and advanced adenoma recurrence by weight change

Weight change N=1826			No recurrence N=1103 n (%)	Any adenoma recurrence N=723 n (%)	Any adenoma recurrence versus no recurrence RR (95%CI)	Advanced adenoma recurrence N=118 n (%)	Advanced adenoma recurrence versus no recurrence RR (95%CI)
Overall*	No change	(n=727)	434(59.7)	293(40.2)	Ref	49(6.7)	Ref
	Lost 5–9 lbs	(n=250)	154(61.6)	96(38.4)	0.90(0.76–1.07)	17(6.8)	0.90(0.55–1.50)
	Lost ≥ 10 lbs	(n=307)	182(59.3)	125(40.7)	0.91(0.77–1.07)	23(7.5)	0.87(0.53–1.41)
	Gained 5–9 lbs	(n=278)	170(61.1)	108(38.9)	0.97(0.82–1.16)	15(5.4)	0.77(0.45–1.33)
	Gained ≥ 10 lbs	(n=264)	163(61.7)	101(38.3)	1.03(0.87–1.23)	14(5.3)	1.04(0.59–1.84)
Males†	No change	(n=454)	253(55.7)	201(44.3)	Ref	32(7.0)	Ref
	Lost 5–9 lbs	(n=168)	90(53.6)	78(46.4)	1.01(0.84–1.22)	14(8.3)	1.12(0.64–1.95)
	Lost ≥ 10 lbs	(n=214)	122(57)	92(43)	0.89(0.74–1.08)	16(7.5)	0.77(0.43–1.40)
	Gained 5–9 lbs	(n=190)	109(57.4)	81(42.6)	0.96(0.79– 1.17)	13(6.8)	0.85(0.46–1.57)
	Gained ≥ 10 lbs	(n=154)	84(54.5)	70(45.5)	1.07(0.87–1.30)	9(5.8)	1.03(0.51–2.06)
Females†	No change	(n=273)	181(66.3)	92(33.7)	Ref	17(6.2)	Ref
	Lost 5–9 lbs	(n=82)	64(78)	18(22)	0.63(0.41–0.98)	3(3.7)	0.50(0.15–1.71)
	Lost ≥ 10 lbs	(n=93)	60(64.5)	33(35.5)	0.96(0.70–1.32)	7(2.3)	1.13(0.49–2.59)
	Gained 5–9 lbs	(n=88)	61(69.3)	27(30.7)	1.05(0.73–1.50)	2(3.3)	0.52(0.13–2.12)
	Gained ≥ 10 lbs	(n=110)	79(71.8)	31(28.2)	0.97(0.69–1.32)	5(4.5)	1.07(0.39–2.90)

*Models adjusted for age, sex, non steroidal anti inflammatory drugs, smoking, baseline weight, dietary randomization assignment and family history of colorectal cancer

†Models adjusted for age, non steroidal anti inflammatory drugs, smoking, baseline weight, dietary randomization assignment and family history of colorectal cancer

Table 4

The risk of adenoma recurrence by weight change stratified by baseline body mass index*

Baseline Body mass index	Weight change in 4 years	Any adenoma recurrence n (%)	Any adenoma recurrence versus no recurrence RR (95%CI)
	No change (n=226)	80 (35.4)	Reference
	Lost 5–9 lbs (n=52)	15 (28.8)	0.78 (0.50–1.22)
< 25 kg/m^2	Lost ≥ 10 lbs (n=49)	22 (44.9)	1.30 (0.89–1.89)
	Gained 5–9 lbs (n=73)	25 (34.2)	0.99 (0.69–1.41)
	Gained ≥ 10 lbs (n=60)	19 (31.7)	0.87 (0.58–1.31)
	No change (n=358)	148 (41.3)	Reference
	Lost 5–9 lbs (n=138)	54 (39.1)	0.89 (0.70–1.13)
25 – 29 kg/m^2	Lost ≥ 10 lbs (n=139)	55 (39.6)	0.89 (0.71–1.13)
	Gained 5–9 lbs (n=120)	53 (44.2)	1.10 (0.87–1.39)
	Gained ≥ 10 lbs (n=113)	46 (40.7)	1.09 (0.84–1.40)
	No change (n=143)	65 (45.5)	Reference
	Lost 5–9 lbs (n=60)	27 (45.0)	1.00 (0.73–1.37)
≥ 30 kg/m^2	Lost ≥ 10 lbs (n=119)	48 (40.3)	0.83 (0.63–1.10)
	Gained 5–9 lbs (n=85)	30 (35.3)	0.81 (0.58–1.14)
	Gained ≥ 10 lbs (n=85)	36 (42.4)	1.10 (0.82–1.49)

* Models adjusted for age, sex, non steroidal anti inflammatory drugs, smoking and family history of colorectal cancer.