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Impact of Obesity on Disease Activity and Patient Reported Outcomes Measurement Information System (PROMIS) in Inflammatory Bowel Diseases

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Abstract

Background and Aims: We conducted a cohort study on the impact of obesity on disease activity and patient reported outcomes measurement information system (PROMIS) measures in the IBD Partners cohort.

Methods: We performed a cross-sectional and longitudinal study within IBD Partners, an internet-based cohort of >15,000 patients living with Crohn's disease (CD) and ulcerative colitis (UC). We included adult patients with IBD, with recorded body mass index (BMI), with at least 6 months of follow-up, excluding patients with BMI<18.5kg/m^2. We evaluated the independent effect of World Health Organization classes of obesity on risk of clinical relapse or persistent

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disease activity (using validated disease activity indices) and PROMIS measures, using multivariate logistic regression and linear regression, respectively.

Results: We included 7296 patients with IBD (4748 patients with CD, 19.5% obese; 2548 patients with UC with intact colon, 20.3% obese). Obesity was independently, and in a dose-dependent fashion, associated with increased risk of persistent disease activity or relapse in both patients with CD (class II or III obesity vs. normal BMI: adjusted OR, 1.86; 95% CI, 1.30–2.68) and UC (aOR, 2.97; 95% CI, 1.75–5.17). Obesity was also independently associated with higher anxiety, depression, fatigue, pain and inferior social function scores in patients with CD and UC at baseline, and with worsening depression, fatigue, pain and social function in patients with CD on longitudinal assessment.

Conclusions: Obesity at baseline is independently associated with worsening disease activity and PROMIS measures in patients with IBD.

Keywords

patient-reported outcomes; body mass index; autoimmune diseases; disease activity

BACKGROUND

Incidence and prevalence of inflammatory bowel diseases (IBD) is rising in parallel with the global obesity epidemic. Approximately 15–40% of adult patients with IBD are obese (body mass index [BMI] ≥30 kg/m^2).(1) Obesity has been variably associated with IBD phenotype, with some studies suggesting milder disease and others suggesting lower prevalence of remission in cross-sectional studies.(1–4) There are conflicting data on how obesity may impact outcomes in patients with IBD, with some studies showing inferior quality of life and higher healthcare utilization, whereas others showing no significant difference in the risk of IBD-related surgery, hospitalization or emergency department use in obese vs. overweight vs. normal BMI adults.(4–8) Obesity has also been shown to negatively impact response to biologic therapy in patients with ulcerative colitis (UC) and other immune-mediated diseases, but this observation has been inconsistent.(9, 10)

However, most single-center studies have a small sample size, low event rate, and have relied on retrospective physician global assessment or non-validated indices, rather than patient-reported outcomes (PROs), to assess impact of obesity on clinical activity; none have systematically evaluated it’s impact on patient reported outcomes measurement information system (PROMIS) measures in IBD.

Hence, we performed secondary analysis of a prospectively maintained internet-based cohort of >15,000 patients with IBD, IBD Partners, to evaluate the association between obesity and clinical disease activity (risk of relapse in a subset of patients in remission at baseline, and risk of persistently active disease in patients with active disease at baseline) and PROMIS measures (at baseline, and follow-up).

METHODS

Study Population

We performed a cross-sectional and longitudinal study within the Crohn's and Colitis Foundation's IBD Partners cohort. The study cohort has been described in detail previously. (11, 12) Briefly, patients were recruited to enroll in this online cohort registry via a variety of means, including invitations via email, social media, and recruitment at the Crohn's and Colitis Foundation educational events. Over 15,000 patients with self-reported IBD have enrolled in the cohort since initiation in 2011, and cohort members are followed up at 6-month intervals. Baseline and follow up surveys include a core survey with information on disease phenotype, activity, medication use, and patient-reported outcomes.

From this cohort, we included (1) patients with IBD (CD or UC), (2) recorded data on body mass index (BMI) at baseline, and (3) at least 6 months of follow-up (i.e., filling a follow-up survey). When data was available at multiple time points, then outcomes at 12 months, 18 months or 6 months were used, in that order; if only one time point measure was available, then that time point was used for outcome assessment. We excluded patients who were underweight (BMI<18.5 kg/m^2) (due to potential confounding by disease severity impacting nutritional status), had end-ileostomy or ileoanal pouch (as disease activity indices are not validated in these specific sub-populations).

Exposure

The primary predictor variable was BMI, based on patient self-reported weight and height, categorized based on World Health Organization obesity classes as: normal BMI (BMI 18.5–24.9 kg/m^2, reference), overweight (BMI 25.0–29.9 kg/m^2), class I obesity (BMI 30.0–34.9 kg/m^2) and class II/III obesity (BMI 35.0–39.9 kg/m^2). In addition, BMI was also categorized as a continuous variable, evaluating the association between each 1 kg/m^2 increase in BMI and clinical outcomes.

Outcomes

There were two primary outcomes in the study: (1) clinical disease activity, measured using short Crohn's disease activity index (sCDAI) in patients with CD and simple clinical colitis activity index (SCCAI) in patients with UC,(13, 14) and (2) PROMIS measures, for anxiety, depression, fatigue, sleep disturbance, satisfaction with social role, and pain interference. Of note, sCDAI is based on abdominal pain, diarrhea frequency, and general well-being, and unlike full CDAI, does not include weight as a variable.

Clinical disease activity: In the cross-sectional analysis, presence of active disease was defined as sCDAI >150 (CD) or SCCAI >2 (UC). In the longitudinal analysis, active disease was defined as clinical relapse at follow-up survey (development of active disease, in the subset of patients in remission at baseline) or having persistent disease activity (in the subset of patients with active disease at baseline).

PROMIS measures: The PROMIS® initiative of the National Institutes of Health was developed to advance the science and application of patient-reported outcomes among

patients with chronic diseases for use in research and clinical practice.(15) PROMIS instruments are general (not disease-specific) measures that are valid and responsive, allow comparisons within and between conditions, and are grouped into item banks based on symptoms, function, well-being, and general health. PROMIS items are calibrated using a T-score metric with the mean of the US general population equal to 50 and standard deviation (SD) in the general population equal to 10.(15) Minimal Important Differences (MIDs), the score that is large enough to have implications for a patient's treatment or care, was deemed to be 2.5.(16) Higher scores indicate more of the domain being measured, such that high scores for anxiety, depression, fatigue, sleep disturbance, and pain interference indicate poorer health, whereas high scores for satisfaction with social role indicate better health. In the cross-sectional analysis, difference in T-score of PROMIS measures was measured between different categories of BMI. In the longitudinal analysis, the association between obesity and change in PROMIS measure over time was measured.

Covariates

Covariates of interest included: disease duration, smoking status (stratified as never, past, and current smoking at the time of baseline questionnaire), ethnicity, education status, self-reported IBD-related hospitalization or surgery, as well as medications for treatment of IBD including 5-aminosalicylates (oral), corticosteroids (oral), immunomodulators, and biologic therapies (infliximab, adalimumab, certolizumab pegol, and natalizumab), and narcotic use. Post-hoc, we also included change in BMI class at follow-up as a covariate. We also evaluated interaction between BMI and age, sex, smoking, college education, race, prior surgery, prior hospitalization, disease duration, biologic therapy, immunomodulator therapy, corticosteroids, 5-aminosalicylate therapy and narcotic use, in both patients with Crohn's disease and ulcerative colitis.

Statistical Analysis

All analyses were stratified by CD and UC.

Clinical disease activity: In the cross-sectional analysis, we compared the unadjusted prevalence of remission across BMI categories using univariable logistic regression. In the longitudinal analysis, the association between BMI categories and risk of active disease was analyzed using multivariable logistic regression analysis. In this analysis, all key covariates were included in univariable analysis, and all baseline variables with a p-value<0.20 were included in the multivariable model, using backward model selection approach. In the longitudinal cohort, stratified analysis by patients in remission vs. active disease at baseline was performed. Dose-response relationship between BMI and clinical disease activity was analyzed using logistic regression analysis, for increase in BMI category.

PROMIS Measures: In the cross-sectional analysis, we compared the T-scores for each PROMIS item at baseline across BMI categories, both unadjusted using analysis of variance (ANOVA) and after adjustment for key covariates including baseline medication use, disease activity, etc., using linear regression with ANOVA F test to analyze for significant variability across categories. In the longitudinal analysis, we compared magnitude of change from baseline T-score for each item across BMI categories using multivariable linear regression,

after adjusting for key covariates, including baseline PROMIS score. As noted above, MID for PROMIS items was assigned as 2.5.

All hypothesis testing was performed using a two-sided p-value with a statistical significance threshold <0.05. All statistical analyses were performed with Stata MP (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP). IBD Partners' study protocol was approved by the Institutional Review Board at the University of North Carolina, Chapel Hill, North Carolina; this secondary analysis of previously collected data was deemed exempt by the University of California San Diego Institutional Review Board.

RESULTS

We included 7296 patients with IBD in our analysis. The number of patients with follow-up at 6, 12 and 18 months was 2074, 6056 and 7018, respectively. On follow-up at 12 months, across baseline BMI categories, 78.3%−91.2% remained in their respective BMI categories at 12 months (eTable 1). Among patients with change in BMI, most moved up or down one category; <0.5% moved up or down 2 categories (except 2% patients with baseline class II or III obesity, who had BMI at follow-up <30kg/m^2).

Crohn's Disease

We included 4748 patients with CD in our analysis, of whom 19.5% were classified as obese. Baseline demographics and clinical features of CD patients, stratified by BMI category are shown in Table 1. As compared to patients with normal BMI, obese patients were marginally older, more likely to be female, less likely to have college education, more likely to be current smokers, less likely to have had prior surgery, and were more likely to be on narcotics, in this cohort. The prevalence of use of 5-aminosalicylates, immunomodulators, biologic agents and corticosteroids was comparable across BMI categories; of note, <10% of the cohort was on corticosteroids at time of baseline evaluation.

Clinical disease activity: At baseline, the prevalence of clinical remission was lower in obese patients as compared to patients with normal BMI, with an exposure-response relationship (p<0.01) (Figure 1). On longitudinal analysis, obese patients were more likely to have active disease on follow-up, as compared to patients with normal BMI, with an exposure-response relationship (Figure 2). After adjustment for covariates, patients with overweight, class I and class II/III obesity had 39%, 50% and 86% higher odds of having active disease at follow-up as compared to patients with normal BMI, respectively (Table 2). Each 1 kg/m^2 increase in BMI was associated with a 3% higher odds of having active disease. When analysis was restricted to patients in clinical remission at baseline, higher risk of relapse was observed in obese patients vs. patients with normal BMI (obese vs. normal BMI: OR, 1.31; 95% CI, 1.00–1.73, p=0.049). Similar results were obtained when analysis was restricted to patients with active disease at baseline. No significant interactions were observed, except race and BMI in CD – African American patients with class I/II/III obesity had higher risk, as compared to Caucasians with class I/II/III obesity.

PROMIS Measures: Mean baseline PROMIS scores for anxiety, depression, fatigue, sleep disturbance, satisfaction with social role, and pain interference, by BMI categories are shown in Table 1. Across all items, except sleep disturbance, overall scores were inferior in obese patients as compared to patients with normal BMI ($p<0.001$), though we did not specifically evaluate differences in PROMIS measures across pre-defined individual categories of obesity. After adjustment for covariates including baseline disease activity, these differences were higher than the MIDs for all items (except sleep disturbance) in patients with class II/III obesity vs. normal BMI (MIDs ranging from 2.14 to 5.02) (eTables 2–7). On longitudinal analysis, after adjustment for covariates including baseline item scores, obese patients had a significantly greater magnitude of decline in PROMIS item scores for depression (change in T-score, class II/III obesity vs. normal BMI: 1.15), fatigue (1.52), pain interference (1.33) and satisfaction with social role (−1.62); however, these did not meet thresholds for MID.

Ulcerative Colitis

We included 2548 patients with UC in our analysis, of whom 20.3% were classified as obese. Baseline demographics and clinical features of UC patients, stratified by BMI category are shown in Table 3. As compared to patients with normal BMI, obese patients were marginally older, less likely to have college education and were more likely to be on narcotics; there was no difference in the prevalence of use of 5-aminosalicylates, immunomodulators, biologic agents and corticosteroids across BMI categories.

Clinical disease activity: At baseline, the prevalence of clinical remission was lower in obese patients as compared to patients with normal BMI, with an exposure-response relationship ($p<0.01$) (Figure 1). On longitudinal analysis, obese patients were more likely to have active disease on follow-up, as compared to patients with normal BMI, with an exposure-response relationship (Figure 3). After adjustment for covariates, patients with class I and class II/III obesity had 65% and 197% higher odds of having active disease at follow-up as compared to patients with normal BMI, respectively (Table 4). Each 1 kg/m^2 increase in BMI was associated with a 5% higher odds of having active disease. When analysis was restricted to patients in clinical remission at baseline, 40.3% and 27.3% patients with class II/III and class I obesity experienced relapse, respectively, as compared to 21.7% patients with normal BMI ($p<0.01$). After adjustment for covariates, patients with class II/III obesity had 2.4 times higher odds of relapse as compared to patients with normal BMI (adjusted OR, 2.41; 95% CI, 1.40–4.17). Similar results were obtained when analysis was restricted to patients with active disease at baseline. No significant interactions between BMI and covariates were observed.

PROMIS Measures: Mean baseline PROMIS scores for anxiety, depression, fatigue, sleep disturbance, satisfaction with social role, and pain interference, by BMI categories are shown in Table 3. As noted for CD, across all items, except sleep disturbance, overall scores were inferior in obese patients with UC as compared to patients with normal BMI ($p<0.001$), though we did not specifically evaluate differences in PROMIS measures across pre-defined individual categories of obesity. After adjustment for covariates including baseline disease activity, these differences were higher than the MIDs for all items (except fatigue, MID

1.74) in patients with class II/III obesity vs. normal BMI (MIDs ranging from −3.20 to 4.01) (eTables 8–13). On longitudinal analysis, after adjustment for covariates including baseline item score, obese patients had a significantly greater magnitude of decline in PROMIS item scores for pain interference (change in T-score, class II/III obesity vs. normal BMI: 2.97), though they experienced a marginal improvement in sleep disturbance (−0.74).

DISCUSSION

In this secondary analysis of prospectively collected data on >7000 patients with IBD from an internet-based cohort, ~20% of whom were obese, we made several key observations. First, both patients with CD and UC with obesity at baseline had significantly lower prevalence of clinical remission, and inferior scores on multiple PROMIS domains including anxiety, depression, fatigue, satisfaction with social role, and pain interference, as compared to patients with normal BMI, with an exposure-response relationship. Second, on longitudinal analysis over the course of 12 months, obese patients with CD and UC had higher risk of having active disease, including higher risk of relapse (among patients in remission at baseline) and persistently active disease (among patients with active disease at baseline), as compared to patients with normal BMI. The magnitude of this effect appears stronger in patients with UC, as compared to patients with CD. Third, obese patients, particularly those with CD, experienced worsening across multiple PROMIS domains on longitudinal analysis, as compared to patients with normal BMI. However, these differences did not meet thresholds of MID, and clinical significance of these findings is unclear. Overall, these findings suggest that obesity significantly impacts disease-specific patient-reported clinical activity and disease-agnostic patient-reported outcomes, both at baseline and on longitudinal follow-up over the course of 12 months. In conjunction with evolving findings on the impact of obesity on increased healthcare utilization, and higher risk of hospitalization, surgery and biologic treatment failure, especially in patients with UC, these findings firmly identify obesity as a negative prognostic factor in patients with IBD.(5, 9, 10) This has important potential clinical implications. Physicians should be cognizant of this association between obesity and adverse IBD outcomes, and should closely monitor these patients and consider early optimization of therapy.

Obesity is recognized as a perpetual state of chronic low-grade inflammation, through systemic and paracrine increase in levels of cytokines, chemokines and adipokines, and is also associated with dysbiosis.(1) Obesity increases leptin secretion from adipocytes and resistin secretion from macrophages and leukocytes that increase levels of pro-inflammatory cytokines such as tumor necrosis factor, interleukin-1 and −6.(17) In addition to its direct impact on inflammation, obesity can also modify pharmacokinetics of biologic agents, resulting in rapid drug clearance.(18) Hence, obesity could adversely affect both inflammatory burden in IBD, as well as response to medical therapy.

While obesity has been consistently shown to negatively impact clinical disease activity and treatment response to biologic agents in immune-mediated inflammatory diseases, this evidence has been inconsistent in patients with IBD to date.(9) There have been a limited number of conflicting longitudinal studies on the impact of obesity on disease course in IBD. Seminerio and colleagues observed inferior IBD-related quality of life and higher

frequency of elevated levels of serum C-reactive protein in patients with obesity (particularly class II or III obesity) compared with normal weight patients; however, there was no statistically significant difference in the risk of IBD-related surgery, hospitalization or emergency department use between patients who were obese, overweight or a normal BMI.(4) In contrast, Flores and colleagues observed a lower risk of IBD-related surgery (41% versus 52% versus 61% for patients who were obese, overweight, or normal or underweight, respectively), hospitalization (42% versus 44% versus 66%) and initiation of anti-TNF therapy (25% versus 26% versus 43%), both in patients with CD and UC.(2) How obesity impacts clinical disease activity and patient-reported outcomes in patients with IBD has not been well studied. To understand the impact of obesity on the natural history of IBD in a controlled setting, we had previously conducted a post-hoc analysis of 4 placebo-controlled trials of infliximab in adults with moderate-severe IBD. In 575 placebo-treated patients in these trials, we did not observed any association between BMI and odds of achieving clinical remission or mucosal healing, measured using validated clinical disease activity indices.(8) However, in these trials, follow-up was short, and proportion of patients with class II/III obesity was small, which limited meaningful inferences on the impact of morbid obesity on clinical activity in IBD. Moreover, this study did not evaluate the impact of obesity on PROMIS measures. This void was filled by the current study, where by using a large internet-based cohort of patients with IBD, with follow-up over 12 months, using validated patient-reported disease-related activity indices as well as disease-agnostic PROMIS measures, we observed a clear negative association between obesity and patient-reported outcomes across multiple domains.

Our findings provide potential directions for future research. While small RCTs and cohort studies in patients with psoriasis, psoriatic arthritis and rheumatoid arthritis have suggested a beneficial effect of intentional weight loss on treatment response to anti-TNF agents, it is unclear whether such a therapeutic intentional weight loss may improve outcomes in patients with IBD, and merits evaluation.(19–21). Additionally, future clinical trials should consider obesity as a potential effect modifier, and consistently report stratified analyses.

There are several strengths to the current study. This is the largest study to date investigating impact of obesity on patient-reported outcomes in patients with IBD. The IBD Partners cohort includes patients cared for in a variety of settings including academic and community centers. We believe this real-world cohort, in which 20% of participants were obese (including 8% patients with class II/III obesity), is more representative, than evidence from post-hoc analyses of clinical trials on the natural history of disease. This diverse distribution of BMI in the cohort also helped confirm presence of an exposure-response relationship. Additionally, we used validated self-reported clinical disease activity indices and PROMIS measures, which makes the study more rigorous. Observing consistent findings across both disease-specific and disease-agnostic measures, after adjusting for key relevant variables, and the presence of an exposure-response relationship, make these findings more biologically plausible.

Nonetheless, there are some key limitations. First, we relied on patient self-report of weight and height to estimate BMI. Given the simplicity of these measurements and the large sample size of the current study, systematic errors in reporting BMI is less likely;

nonetheless, future studies should evaluate should involve systematic objective assessment of both overall obesity and central adiposity in patients with IBD.(22) Second, while IBD Partners has notable strengths in recruitment and retention, the dataset may not be truly representative of a population of IBD patients, including a higher percentage of female patients (>70%), Caucasian race (>90%) and higher rates of college education than national averages. Third, the IBD Partners cohort does not include physician notes, laboratory, radiology or endoscopy data. Hence, we were unable to corroborate our findings with simultaneous assessment of impact of obesity on biochemical and/or endoscopic remission. Fourth, we also do not have validated data on disease phenotype, disease location or extent in this cohort, limiting detailed analyses of how obesity may impact disease activity across these strata. Finally, we were unable to evaluate stability of BMI at baseline assessment; however, as noted, on follow-up, proportion of patients with significant change in BMI was small. Likewise, prior medication exposure or change in medication exposure on follow-up could not be systematically analyzed.

In conclusion, based on a large internet-based cohort study of >7000 patients with IBD, we observed a strong and consistent association between obesity and lower rates of clinical remission and inferior PROMIS measures on cross-sectional and longitudinal analyses, in both patients with CD and UC. Among patients in remission at baseline, obesity was associated with increased risk of relapse, with stronger associations in patients with UC. Prospective cohort studies, including objective measures of overall obesity and central adiposity and disease activity, are warranted to confirm this association.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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WHAT IS CURRENT KNOWLEDGE?

- Approximately 15–40% patients with IBD are obese
- Obesity has been variably associated with IBD phenotype, with some cross-sectional studies suggesting milder disease and others suggesting lower prevalence of remission
- There are conflicting data on how obesity may impact outcomes in patients with IBD

WHAT IS NEW HERE?

- In a large internet-based cohort of patients with IBD, obesity was independently associated with persistent disease activity (in patients with active disease at baseline) and relapse (in patients in clinical remission at baseline) in patients with ulcerative colitis and Crohn's disease, in a dose-dependent manner
- Obesity was also independently associated with higher anxiety, depression, fatigue, pain and inferior social function scores in patients with Crohn's disease and ulcerative colitis

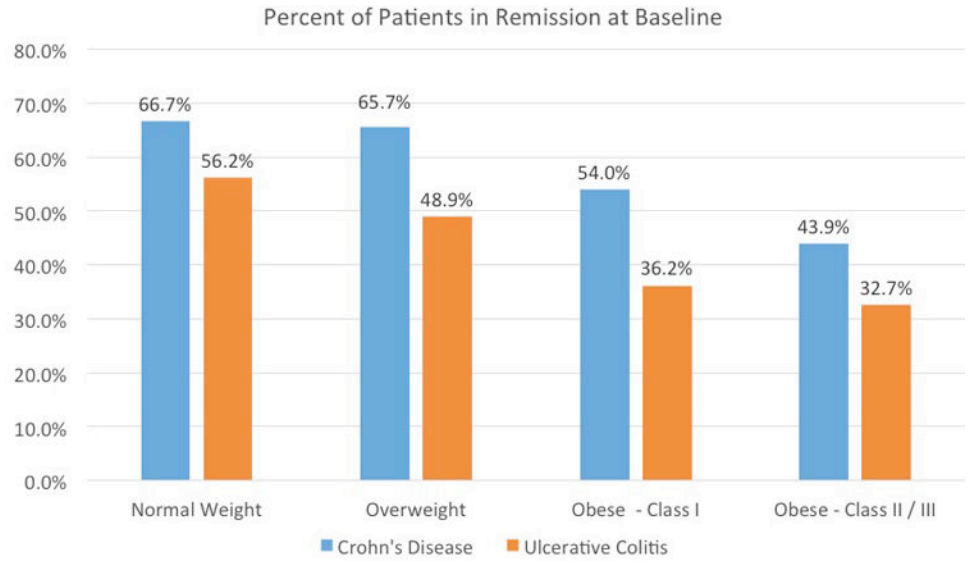
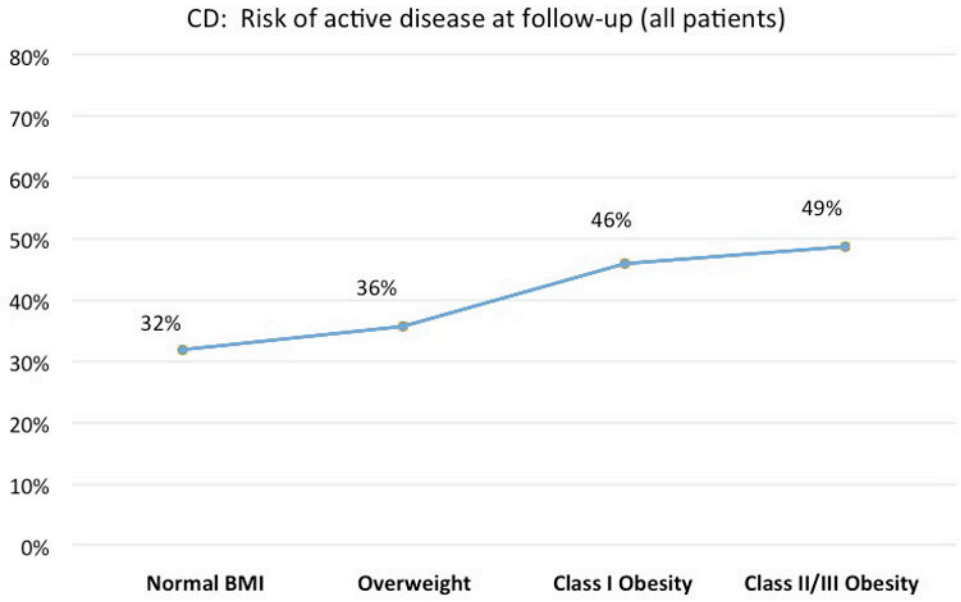
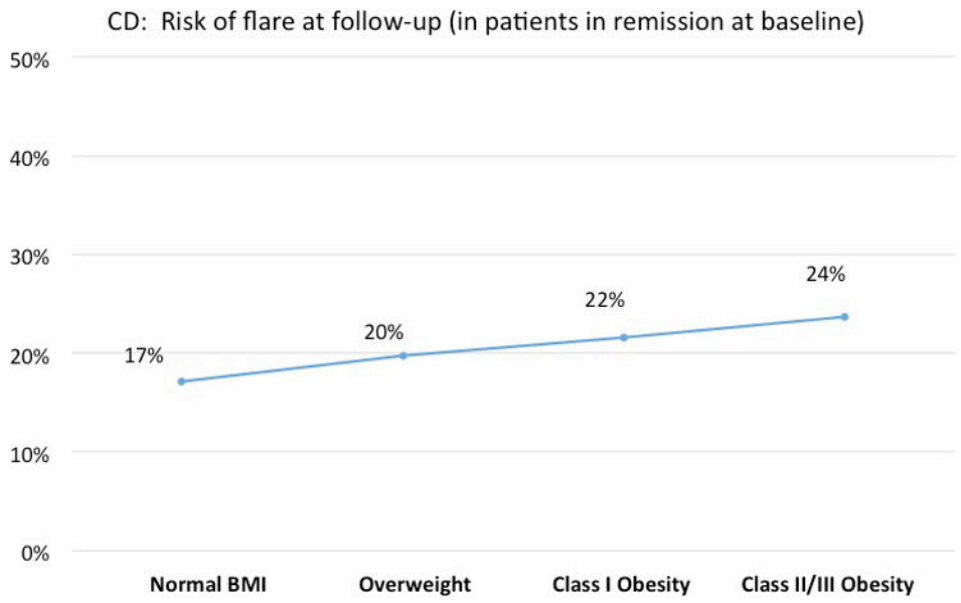


Figure 1.
Proportion of patients in clinical remission at baseline, based on body mass index





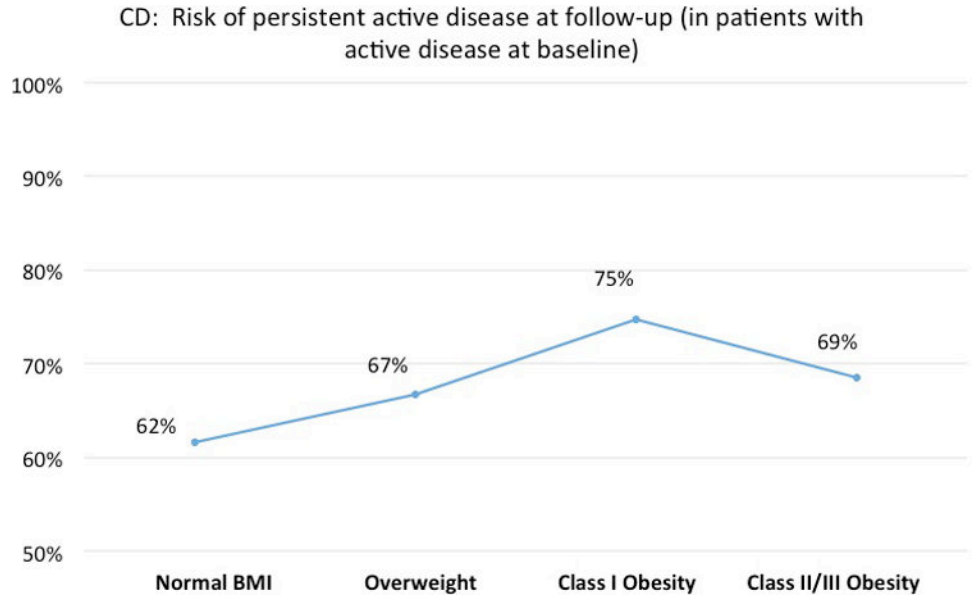
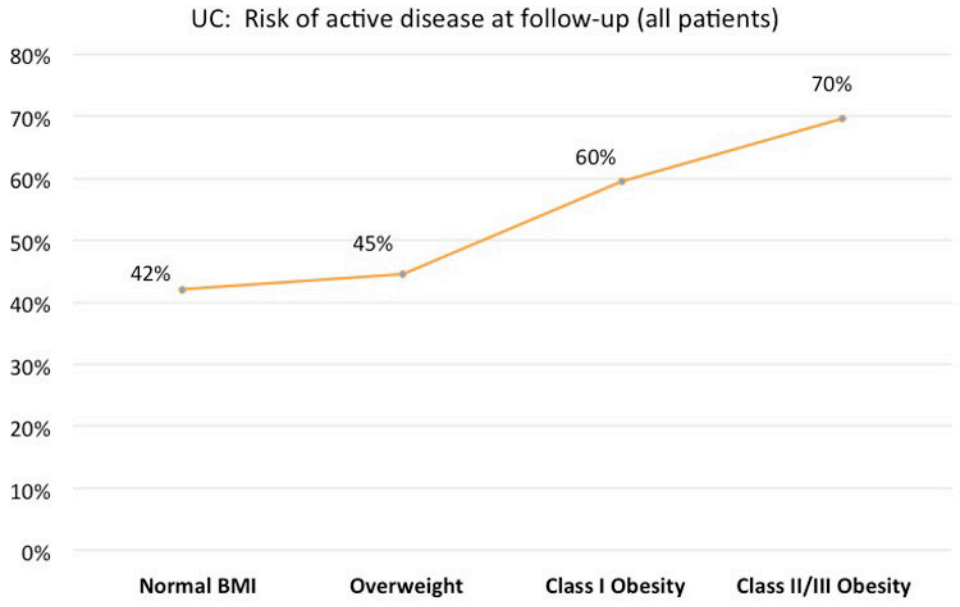
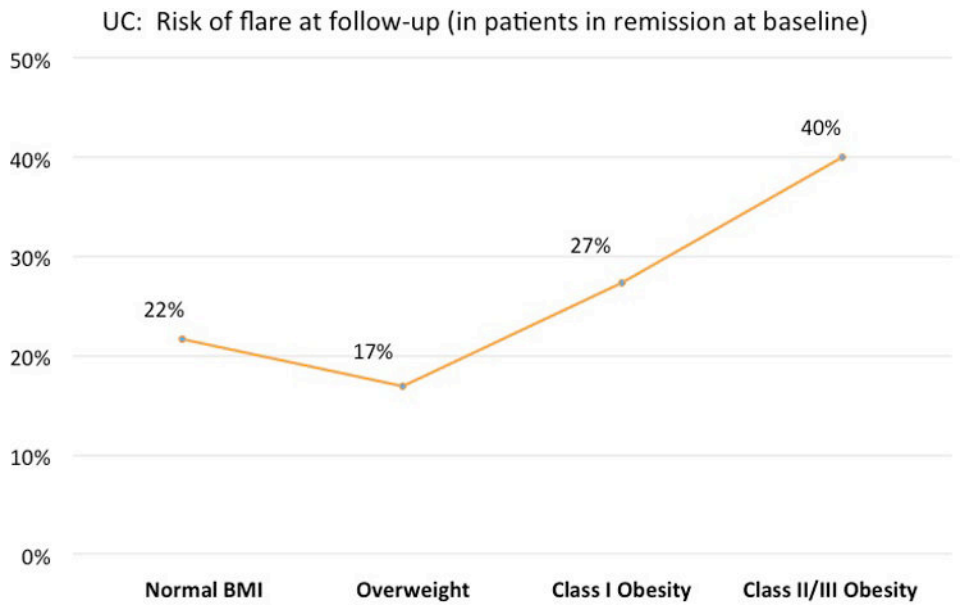


Figure 2.

Impact of obesity on clinical disease activity in patients with Crohn's disease on longitudinal follow-up: (A) proportion of patients with active disease, regardless of baseline disease activity, (B) proportion of patients with relapse in subset of patients in remission at baseline, (C) proportion of patients with persistent disease activity in subset of patients with active disease at baseline





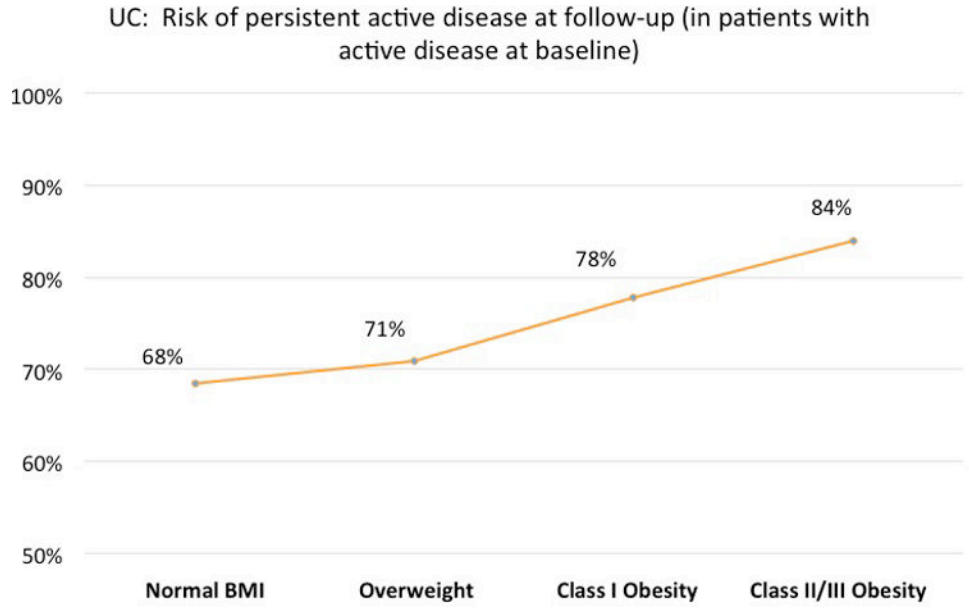


Figure 3.

Impact of obesity on clinical disease activity in patients with ulcerative colitis on longitudinal follow-up: (A) proportion of patients with active disease, regardless of baseline disease activity, (B) proportion of patients with relapse in subset of patients in remission at baseline, (C) proportion of patients with persistent disease activity in subset of patients with active disease at baseline

Table 1.

Baseline characteristics of patients with Crohn's disease, by body mass index

Characteristic	Normal BMI (18.5–24.9kg/m^2) (n = 2284)	Overweight (25.0–29.9 kg/m^2) (n = 1331)	Class I Obesity (30–34.9 kg/m^2) (n = 541)	Class II or III Obesity (≥35.0 kg/m^2) (n = 385)	P-value
Age, mean (SD)	41.5 ± 15.5	45.8 ± 14.6	45.4 ± 13.6	44.7 ± 12.4	**<0.01**
Disease duration, median in years (range)	11 (4 – 22.5)	12 (5 – 23)	11 (4 – 20)	10 (4 – 18)	**<0.01**
Gender (% female)	74.3%	62.6%	80.4%	85.2%	**<0.01**
Education (% with college degree)	72.3%	70.5%	69.4%	61.5%	**<0.01**
Race					
Caucasian	95.5%	95.1%	94.2%	92.1%	**0.003**
African American	1.0%	1.8%	2.1%	3.8%	
Asian	0.7%	0.6%	0.2%	0%	
Other	2.8%	2.5%	3.5%	4.1%	
Prior abdominal surgery (%)	51.0%	49.3%	44.0%	46.0%	**0.02**
Prior hospitalization	74.7%	73.2%	71.5%	72.2%	0.36
Smoking (current, % yes)	7.4%	7.2%	8.7%	11.4%	**0.03**
Baseline Medications					
5-aminosalicylates	18.1%	19.8%	20.5%	19.2%	0.44
Steroids	7.5%	6.9%	7.2%	9.1%	0.55
Immunomodulator	20.6%	20.5%	17.4%	22.3%	0.26
Biologics	33.5%	34.2%	33.5%	35.1%	0.92
Narcotics	5.0%	6.1%	9.4%	9.1%	**<0.01**
Baseline PROMIS Measures					
Anxiety	51.59 (9.50)	51.57 (9.47)	52.72 (9.78)	54.65 (10.33)	**<0.01**
Depression	49.60 (9.11)	50.04 (9.23)	51.81 (9.27)	53.93 (10.34)	**<0.01**
Fatigue	53.74 (10.84)	54.73 (10.92)	58.11 (10.70)	60.40 (10.35)	**<0.01**
Pain	50.52 (9.43)	51.12 (9.72)	54.08 (9.96)	56.39 (10.35)	**<0.01**
Sleep	52.04 (3.27)	51.86 (3.43)	51.89 (3.57)	52.22 (3.40)	0.20
Social satisfaction	50.34 (9.89)	49.60 (9.70)	46.85 (9.66)	44.54 (9.44)	**<0.01**

Table 2.

Factors associated with active disease at follow-up in patients with Crohn's Disease, regardless of baseline disease activity, on multivariable logistic regression analysis

Predictor Variables	Odds Ratio (95% Confidence Interval)	p-value
BMI		
• Normal	**1.0**	
• Overweight (25–29.9)	**1.39 (1.08 – 1.78)**	**0.01**
• Class I obesity	**1.50 (1.07 – 2.09)**	**0.02**
• Class II or III obesity	**1.86 (1.30 – 2.68)**	**<0.01**
Female gender (vs. male)	**1.71 (1.34 – 2.21)**	**<0.01**
College education	**0.72 (0.57 – 0.90)**	**<0.01**
African American versus Caucasian	1.29 (0.61 – 2.68)	0.50
Other ethnicities versus Caucasian	1.59 (0.92 – 2.70)	0.09
History of prior surgeries	**1.73 (1.35 – 2.22)**	**<0.01**
History of prior hospitalization	1.11 (0.84 – 1.48)	0.47
Current smoking status	**2.21 (1.54 – 3.20)**	**<0.01**
Immunologic therapy at baseline	0.94 (0.73 – 1.23)	0.67
Narcotic use at baseline	**2.56 (1.73 – 3.83)**	**<0.01**
5-ASA therapy at baseline	**0.75 (0.57 – 0.99)**	**0.04**
Steroid use at baseline	1.35 (0.88 – 2.05)	0.16
Biologic use at baseline	0.87 (0.69 – 1.09)	0.23
Age (per 1 y increase)	1.00 (0.99 – 1.01)	0.70
Disease duration (per 1y increase)	1.00 (0.99 – 1.01)	0.83
Change in BMI category		
• 1 category increase	0.90 (0.59 – 1.35)	0.60
• 1 category decrease	0.76 (0.48 – 1.18)	0.23

Table 3.

Baseline characteristics of patients with ulcerative colitis, by body mass index

Characteristic	Normal BMI (18.5–24.9kg/m^2) (n = 1279)	Overweight (25.0–29.9 kg/m^2) (n = 752)	Class I Obesity (30–34.9 kg/m^2) (n = 304)	Class II or III Obesity (≥35.0 kg/m^2) (n = 213)	P-value
Age, mean (SD)	41.3 ± 14.7	46.4 ± 14.7	47.4 ± 14.3	47.3 ± 12.9	**<0.01**
Disease duration, median in years (range)	7 (3 – 14)	9 (3 – 18)	7 (3 – 15)	8 (3 – 17)	**0.01**
Gender (% female)	74.1%	60.5%	69.4%	84.1%	**<0.01**
Education (% with college degree)	79.3%	74.8%	65.4%	64.1%	**<0.01**
Race					
Caucasian	92.4%	93.8%	91.7%	93.7%	0.13
African American	1.2%	1.3%	2.4%	2.9%	
Asian	2.6%	1.3%	2.1%	0%	
Other	3.8%	3.8%	3.8%	3.4%	
Prior hospitalization	41.8%	39.9%	38.8%	44.9%	0.45
Smoking (current, % yes)	4.1%	2.9%	5.3%	2.8%	0.24
Baseline Medications					
5-aminosalicylates	43.4%	46.7%	44.9%	46.7%	0.47
Steroids	6.6%	6.5%	7.6%	9.8%	0.34
Immunomodulator	16.0%	16.8%	19.8%	14.5%	0.36
Biologics	21.6%	18.5%	19.5%	17.3%	0.25
Narcotics	1.8%	2.5%	4.6%	6.5%	**<0.01**
Baseline PROMIS Measures					
Anxiety	51.54 (9.16)	50.58 (9.16)	52.74 (9.88)	54.05 (9.55)	**<0.01**
Depression	49.07 (8.66)	49.24 (8.67)	51.57 (9.98)	53.58 (9.82)	**<0.01**
Fatigue	51.75 (11.02)	52.28 (10.75)	55.48 (10.65)	57.97 (10.78)	**<0.01**
Pain	49.03 (9.11)	50.37 (9.46)	52.30 (10.07)	55.36 (10.07)	**<0.01**
Sleep	52.01 (3.30)	51.90 (3.53)	52.28 (3.58)	52.33 (3.60)	0.24
Social satisfaction	51.23 (9.92)	50.63 (10.14)	48.12 (9.64)	46.03 (10.07)	**<0.01**

Table 4.

Factors associated with active disease at follow-up in patients with ulcerative colitis, regardless of baseline disease activity, on multivariable logistic regression analysis

Predictor Variables	Odds Ratio (95% Confidence Interval)	p-value
BMI		
• **Normal**	1.0	
• **Overweight (25–29.9)**	1.03 (0.75 – 1.42)	0.84
• **Class I obesity**	**1.65 (1.05 – 2.61)**	**0.03**
• **Class II or III obesity**	**2.97 (1.75– 5.17)**	**<0.01**
Female gender	1.14 (0.84 – 1.54)	0.41
College education	0.73 (0.53 – 1.00)	0.05
African American vs. Caucasian	0.88 (0.28 – 2.64)	0.82
Other ethnicities vs. Caucasian	1.65 (0.92 – 2.99)	0.09
History of prior hospitalization	**1.55 (1.16 – 2.07)**	**<0.01**
Current smoking status	1.62 (0.76 – 3.57)	0.22
Immunologic therapy at baseline	**0.56 (0.37 – 0.83)**	**<0.01**
5-ASA therapy at baseline	0.81 (0.61 – 1.08)	0.15
Narcotic use at baseline	1.67 (0.75 – 3.95)	0.22
Steroid use at baseline	**2.26 (1.30 – 4.01)**	**<0.01**
Biologic use at baseline	1.12 (0.79 – 1.60)	0.53
Age (per 1y increase)	1.00 (0.99 – 1.01)	0.64
Disease duration (per 1y increase)	1.00 (0.98 – 1.01)	0.67
Change in BMI category		
• 1 category increase	0.63 (0.36 – 1.09)	0.10
• 1 category decrease	0.75 (0.43 – 1.29)	0.30

*Additionally adjusted for age, disease duration, African American versus Caucasian, Other ethnicities versus Caucasian, and biologic therapy at baseline.