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ORIGINAL ARTICLE

Association of Race and Postoperative Outcomes in Patients with Inflammatory Bowel Disease

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Abstract

Background Previous literature suggests that rates of postoperative complications following inflammatory bowel disease (IBD) surgery differ based on race.

Aims The purpose of this study was to examine the association between race and adverse events and wound complications in patients with IBD.

Methods This was a retrospective cohort study of the American College of Surgeons National Surgery Quality Improvement Program Inflammatory Bowel Disease Collaborative from 2017 to 2022. The data was collected from 15 high-volume IBD centers across the United States. The data was analyzed using crude and multivariable logistic regressions.

Results 4284 patients were included in the study. Overall rates of adverse events and wound complications were 20.3% and 11.3%, respectively, and did not differ based on race on bivariate analysis. Rates of adverse events were 20.0% vs 24.6% vs 22.1%, p = 0.13 for white, black and other minority subjects, respectively. The adjusted odds of adverse events were higher for black subjects (1.46 [95%CI 1.0–2.1], p = 0.03) compared to white subjects. No difference in adverse events was found between other minority subjects and either black or white subjects (1.29 [0.7–2.3], p = 0.58). Race was not associated with likelihood of wound complications in the final analysis.

Conclusions We found that a subset of black patients with IBD continue to experience more adverse events compared to white patients, primarily driven by a higher need for postoperative blood transfusion. Nonetheless, known risk factors, including comorbid conditions, decreased BMI, open surgery, and emergency surgery have a stronger association with postoperative complications than race alone.

Keywords Inflammatory bowel disease · Crohn's disease · Ulcerative colitis · Surgical complications · Race

Introduction

Inflammatory bowel disease (IBD) is a collection of diseases characterized by inflammation of the digestive tract and includes Crohn's disease (CD), ulcerative colitis (UC), and indeterminate colitis. Surgical intervention varies between IBD types and is often reserved for medically refractory patients and those in extremis [1–4]. Although more prominent in the white population, the incidence of IBD is rising in minority populations [5–8], with a doubling of the incidence rate in non-white patients since 1970 [9]. Race, socioeconomic status, and ethnicity often play a significant role in healthcare disparities [10, 11], particularly for postoperative outcomes [12–19]. Several national database studies evaluating postoperative outcomes based on race have demonstrated differences in postoperative morbidity

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[6, 12–15, 20, 21], mortality [10], and length of stay [12–15], often finding increased morbidity and mortality and longer lengths of stay in minority races compared to white patients. A study using the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) data from 2005 to 2017 found higher odds of renal and cardiac complications, death, and serious morbidity in black compared to white patients [12]. The NSQIP IBD data collaborative [22, 23], which was created in 2017, invited collaborators from high volume IBD centers to evaluate outcomes for patients with IBD using IBD-specific data (e.g. medication use within 60 days, ileostomy creation, ileoanal anastomotic technique, and presence of colonic dysplasia) in addition to standard NSQIP variables. These variables provide tailored insight into the pre- and post-operative care of patients with IBD. With the incidence of IBD increasing in non-white populations and previous data suggesting differences in postoperative outcomes based on race, it is imperative to elucidate the contemporary state of disparities in surgical outcomes in patients with IBD. The objective of this study was to assess whether rates of postoperative complications, specifically wound complications (WC) and adverse events (AE), in patients with IBD vary based on race.

Methods

Patient Selection

We conducted a retrospective cohort study using data from the American College of Surgeons NSQIP IBD database collaborative [22, 23], which collected patient information from 15 tertiary care medical centers across the United States from March 2017 to March 2022. Patients over 18 years old with a diagnosis of IBD who underwent surgery were included in this study. Subjects with missing data regarding outcomes (AE and WC), race, and covariates were excluded.

Exposures

The primary exposure variable was race, which was defined as "white", "black" or African American, and "other minorities" as self-reported in the patient chart. The "other minorities" racial category consisted of Asian Americans, Pacific Islanders, and all other races not otherwise defined as black or white.

Outcomes

The primary outcomes of the study were adverse events (AE) and wound complications (WC). AE was defined as the subject having any one of the following: death, pneumonia, unplanned reintubation, mechanical ventilation for ≥ 48 h, pulmonary embolism (PE), deep venous thrombosis (DVT), progressive renal insufficiency, acute kidney injury (AKI), stroke, urinary tract infections (UTI), cardiac arrest requiring cardiopulmonary resuscitation (CPR), myocardial infarction, postoperative transfusion requirement within 72 h of surgery, sepsis and septic shock, and unplanned reoperation. WC was defined as a subject having any surgical site infection, including superficial, deep, or organ space infection, or disruption of the wound.

Covariates

All subjects had a diagnosis of IBD based on the International Classification of Diseases 10th revision (ICD-10) coding: K50- for Crohn's disease, K51- for ulcerative colitis, and K53.3 for indeterminate colitis. Perioperative information collected included operative type (open surgery, minimally invasive surgery (MIS) [robotic, laparoscopic, or hybrid], or MIS converted to open), emergency surgery, age, number of comorbidities, medication (i.e. steroids, immunologic, biologic therapy) use within 60 days prior to surgery, sex assigned at birth (male or female), ethnicity (Hispanic or non-Hispanic) and body mass index (BMI). Number of comorbidities was defined as patients having 0, 1–2, or ≥ 3 of any of the following: diabetes, chronic obstructive pulmonary disease, dyspnea, hemodialysis, AKI, disseminated cancer, bleeding disorder, pre-sepsis, smoking history, hypertension, or congestive heart failure. BMI was categorized into underweight (< 18.5 kg/m^2), normal to overweight (18.5–30 kg/m^2), and obese (> 30 kg/m^2). Immunologic therapy was defined as using any one of the following within 60 days of surgery: 6-meraptopurine, Azathioprine, or Methotrexate. Biologic agent use was defined as using any one of the following: Infliximab, Adalimumab, Certolizumab, Golimumab, Vedolizumab, Natalizumab, Ustekinumab, or Tofactinib. Ileostomy was defined as having an ileostomy present at the time of surgery, creating a new one, or revising a previously created one. Surgery type was defined using Current Procedural Terminology (CPT) coding and a user input variable included in the NSQIP IBD collaborative. Data, which is aggregated yearly and disseminated to participating institution, was collected on an iterative basis and entered into the database by a trained member of each institution's research team.

Statistical Analysis

Continuous variables were analyzed with univariate analysis (means and standard deviations) and then compared between each exposure group using a student's t-test and ANOVA. For nominal and categorical variables, frequencies were

calculated for each group and the groups were compared using Mantel–Haenszel chi-squared tests.

We computed odds ratios (OR) and 95% confidence intervals (95% CI) for the association between race and AE and WC using logistic regression. A crude model was created including all possible covariates of the relationship between race and postoperative outcomes, and the p-value was determined for each covariate. A final adjusted model was then created, which included all statistically significant covariates ($p < 0.10$) from the crude analysis. To assess for potential confounding, effect measure modification (EMM) analyses were performed for variables with a greater than 10% change in OR from crude analysis to the final model. For variables with statistically significant findings on EMM, an adjusted logistic regression was performed using the variables from the final model. A second logistic regression analysis investigated race's relationship with each component AE and WC. A p-value less than 0.05 was considered statistically significant.

The data analysis for this paper was generated using SAS, Version 8.3 of the SAS System for Academics. Copyright © 2021 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Results

Cohort Characteristics

The NSQIP IBD database collaborative included 5,603 patients. After applying inclusion and exclusion criteria, 4,284 subjects were included in the study (Table 1). Of these, 3,899 (91%) were white, 276 (6.4%) were black, and 113 (2.6%) were other minority subjects. Notably, there were baseline cohort differences in IBD diagnoses, BMI, age, biologic agent and steroid use, and ileostomy presence based on race. While not statistically significant,

Table 1 Cohort characteristics and post-operative outcomes

	Race							
	White		Black		AAPI/Other			
	N = 3899	(%)	N = 272	(%)	N = 113	(%)	*p-value*	
Diagnosis								
Crohn's disease	2137	54.8	170	62.5	52	46.0	*0.36*	*
Ulcerative colitis	1445	37.1	71	26.1	48	42.5		
Indeterminate colitis	317	8.1	31	11.4	13	11.5		
Gender								
Female	1980	50.8	126	46.3	72	63.7	*0.19*	*
Male	1919	49.2	146	53.7	41	36.3		
Age (Mean, SD)	44.31	16.9	40.41	14.9	41.55	16.8	*< 0.01*	**
BMI (kg/m^2)								
BMI ≤ 18.5	302	7.7	36	13.2	27	23.9	*< 0.01*	*
BMI 18.5–30	2827	72.5	170	62.5	77	68.1		
BMI > 30	770	19.7	66	24.3	9	8.0		
Comorbidities (0)	2487	63.8	156	57.4	73	64.6	*0.45*	**
1–2	1327	34.0	113	41.5	38	33.6		
≥ 3	85	2.2	3	1.1	2	1.8		
Operative Type (Open)	1267	32.5	96	35.3	33	29.2	*0.66*	**
MIS converted to Open	200	5.1	15	5.5	0	0.0		
MIS	2432	62.4	161	59.2	80	70.8		
Emergency Surgery (Yes)	85	2.2	7	2.6	3	2.7	*0.61*	**
Presence of Ileostomy (Yes)	1966	50.4	101	37.1	47	41.6	*< 0.01*	**
Medication use within 60 days of surgery								
Steroid (Yes)	1767	45.3	95	34.9	50	44.2	*0.03*	**
Immunologic (Yes)	512	13.1	28	10.3	16	14.2	*0.59*	**
Biologic (Yes)	1766	45.3	93	34.2	41	36.3	*< 0.01*	**
Post-Operative Outcomes								
Adverse Event	778	20.0	67	24.6	25	22.1	*0.13*	**
Wound Complication	441	11.3	27	9.9	14	12.4	*0.90*	**

55% of white subjects had CD and 37% had UC, while 46% of other minority and 63% of black subjects had CD, and 43% of other minority and 26% of black subjects had UC respectively (p = 0.36). BMI differed between groups with 20% of white subjects having a BMI > 30 and 7.7% having a BMI < 18.5 compared to black subjects with 24% having a BMI > 30 and 13.2% having a BMI < 18.5 and other minority subjects having 8% with a BMI > 30 and 24% having a BMI < 18.5 (p < 0.05). The average age of white subjects was higher than that of black and other minority subjects with an average age of 44.3 years old compared to 40.4 and 41.6 years old respectively (p < 0.05). Use of biologic agents also differed with 45% of white subjects being on a biologic agent pre-operatively compared to 34% and 36% of black and other minority subjects (p < 0.05). Other minority and white subjects had higher pre-operative rates of steroid use as well (44% and 45% respectively) compared to black subjects (34.9%) (p < 0.05). 50% of white subjects had an ileostomy compared to 37% of black and 42% of other minority subjects (p < 0.05). There were no statistically significant differences between number of comorbidities, operative type, need for emergency surgery, and immunologic medication use when stratified by race.

No difference in AE or WC was found between racial groups on univariate analysis (AE: 20% white, 25% black, 22% other minority, p = 0.13 and WC: 11.3% white, 9.9% black, 12.4% other minority, p = 0.899; Table 1). Differences in rates of AE were present in open surgery and MIS converted to open compared to MIS (27% vs 29% vs 16.2% respectively, p < 0.01); emergency surgery compared to non-emergency surgery (52% vs 19.6%, p < 0.01); 1–2 and ≥ 3 comorbidities versus no comorbidities (26% vs 44% vs 16.6%, respectively, p < 0.01); BMI < 18.5 (27%) compared to BMI > 18.5 (< 20%); pre-operative steroid use (23%) compared to not using steroids (18.2%, p < 0.01); and in subjects with an ileostomy as compared to without (22% vs 18.4%, p < 0.01). Rate of WC was higher in open surgery compared to MIS and MIS converted to open surgery (16% vs 8.7% vs 9.8%, respectively, p < 0.01); ≥ 3 comorbidities (22%) compared to 1–2 (13.4%) and no comorbidities (22% vs 13.4% vs 9.7%, p < 0.01); and in patients with as compared to without an ileostomy (13.1% vs 9.5%, p < 0.01).

Multivariable Analysis

The odds of AE or WC did not differ based on race on unadjusted logistic regression analysis (Table 2). However, in the final multivariable analysis, black patients were found to have a 40% increase in odds of AE compared to white patients (OR 1.40 [95% CI 1.04–1.88] p = 0.03). We observed a 22% increase in odds of AE in UC subjects compared to CD (OR 1.22 [1.02–1.46], p = 0.03). Subjects who underwent open or MIS converted to open surgery had a > 85% increase in odds of AE compared to MIS. A BMI < 18.5 was associated with a nearly 1.5 times increase in AE compared to BMIs 18.5–30 (OR 1.48 [1.14–1.92], p < 0.01). Pre-operative steroid use increased the odds of AE by 1.36 compared to not using steroids (OR 1.36 [1.16–1.60], p < 0.01). In the multivariable analysis for WC, no difference in WC was observed based on race. An increasing number of comorbidities was associated with a 28% (1–2 comorbidities) and 96% (≥ 3 comorbidities) increase in odds of WC compared to having no comorbidities (p = 0.02). There was a nearly doubling in the odds of WC for subjects who underwent open surgery compared to MIS (OR 1.93 [1.58–2.35], p < 0.01).

Effect Measure Modification Analysis

To assess for confounding, EMM was performed using the variables included in the final multivariable model for AE in which statistically significant changes were noted in the odds of AE when stratified by IBD diagnosis, gender, and steroid use (Table 3). Black subjects with CD (OR 1.88 [1.31–2.72], p < 0.01), black males (OR 1.79 [1.21–2.64], p < 0.01), and black subjects on steroids (OR 2.14 [1.35–3.39], p < 0.01) had higher odds of AE compared to their white counterparts. No EMM was seen in the WC cohort.

Postoperative Complication Analysis

When we evaluated the relationship between race and each component of the composite postoperative outcomes independently, we saw few significant differences between racial groups (Table 4). Black subjects had a higher incidence of blood transfusions within 72 h of surgery (14%) compared to white (8.7%) and other subjects (8.0%) (p = 0.13). Other minority and black subjects also had higher rates of sepsis compared to white subjects (6.2%, 6.2% vs 3.4% p = 0.01). None of the non-white subjects experienced myocardial infarctions, cardiac arrest requiring CPR, or AKI, and no other minority subjects experienced PE, progressive renal insufficiency, reintubation or pneumonia. In the entire subject pool, no one suffered from a stroke. On logistic regression, there were increased odds of black subjects requiring a blood transfusion compared to white subjects (OR 1.71 [1.19–2.45], p < 0.01; Table 4), as well as increased odds of sepsis for black (OR 1.90 [1.12–3.18], p = 0.02) and other minority subjects (1.87 [0.85–4.10], p = 0.12).

Discussion

Over the last several decades, race has been shown to be a determinant of health [24, 25]. In this study, we demonstrated that racial differences in postoperative

Table 2 Unadjusted and multivariable logistic regression analysis evaluating the odds of a post-operative adverse event (AE) and wound complications (WC). IBD—Inflammatory bowel disease; BMI—Body mass index; MIS—Minimally invasive surgery

	Adverse event						Wound complication					
	Unadjusted analysis			Multivariable analysis			Unadjusted analysis			Multivariable analysis		
	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*
Race												
White	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
Black	1.31	(0.98–1.75)	*0.06*	1.40	(1.04–1.88)	*0.03*	0.86	(0.57–1.30)	*0.48*	0.89	(0.59–1.35)	*0.59*
Other	1.14	(0.73–1.79)	*0.57*	1.14	(0.71–1.83)	*0.58*	1.11	(0.63–1.96)	*0.72*	1.24	(0.69–2.22)	*0.47*
IBD Diagnosis												
Crohn's Disease	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
Ulcerative Colitis	1.13	(0.97–1.32)	*0.12*	1.22	(1.02–1.46)	*0.03*	0.94	(0.77–1.15)	*0.57*	0.86	(0.68–1.07)	*0.17*
Indeterminate Colitis/ Other	0.89	(0.67–1.19)	*0.45*	0.91	(0.67–1.23)	*0.68*	0.79	(0.54–1.15)	*0.21*	0.72	(0.49–1.05)	*0.09*
Gender												
Male	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
Female	1.02	(0.88–1.19)	*0.78*	0.97	(0.83–1.13)	*0.68*	0.96	(0.80–1.16)	*0.70*	0.96	(0.79–1.16)	*0.64*
Comorbidities												
0	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
1 to 2	1.72	(1.48–2.02)	*<0.01*	1.55	(1.31–1.83)	*<0.01*	1.44	(1.18–1.75)	*<0.01*	1.28	(1.03–1.58)	*0.02*
≥3	4.02	(2.62–6.16)	*<0.01*	2.83	(1.77–4.53)	*<0.01*	2.65	(1.59–4.43)	*<0.01*	1.94	(1.12–3.35)	*0.02*
BMI (kg/m^2)												
18.5—30	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
< 18.5	1.47	(1.15–1.89)	*<0.01*	1.48	(1.14–1.92)	*<0.01*	1.17	(0.84–1.64)	*0.36*	1.15	(0.82–1.62)	*0.42*
> 30	1.00	(0.83–1.22)	*0.97*	0.87	(0.71–1.06)	*0.17*	1.36	(1.08–1.71)	*0.01*	1.25	(0.99–1.59)	*0.06*
Operative Approach												
MIS	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
Open	1.91	(1.64–2.37)	*<0.01*	1.85	(1.57–2.18)	*<0.01*	2.07	(1.70–2.51)	*<0.01*	1.93	(1.58–2.35)	*<0.01*
MIS converted to Open	2.10	(1.54–2.87)	*<0.01*	1.91	(1.37–2.64)	*<0.01*	1.14	(0.71–1.82)	*0.59*	0.99	(0.61–1.59)	*0.96*

Table 2 (continued)

	Adverse event						Wound complication					
	Unadjusted analysis			Multivariable analysis			Unadjusted analysis			Multivariable analysis		
	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*	OR	95% CI	*p*
Emergency Surgery												
No	1.00	Ref		1.00	Ref		1.00	Ref				
Yes	4.37	(2.90–6.58)	*<0.01*	2.99	(1.94–4.59)	*<0.01*	1.62	(0.94–2.79)	*0.08*			
Biologic Use												
No	1.00	Ref					1.00	Ref				
Yes	1.03	(0.88–1.19)	*0.75*				0.93	(0.77–1.13)	*0.45*			
Immunologic Use												
No	1.00	Ref					1.00	Ref				
Yes	1.12	(0.90–1.39)	*0.30*				1.03	(0.78–1.36)	*0.83*			
Preoperative Steroid Use												
No	1.00	Ref		1.00	Ref		1.00	Ref				
Yes	1.34	(1.16–1.56)	*<0.01*	1.36	(1.16–1.60)	*<0.01*	0.94	(0.78–1.14)	*0.55*			
Presence of an Ileostomy												
No	1.00	Ref		1.00	Ref		1.00	Ref		1.00	Ref	
Yes	1.27	(1.10–1.48)	*<0.01*	1.15	(0.97–1.36)	*0.11*	1.43	(1.18–1.73)	*<0.01*	1.50	(1.22–1.86)	*<0.01*
Age	1.013	(1.008–1.017)	*<0.01*	1.008	(1.003–1.013)	*<0.01*	1.011	(1.005–1.017)	*<0.01*	1.007	(1.000–1.013)	*0.04*

Table 3 Effect measure modification analysis. AE – Adverse Event; *Adjusted OR controls for age, race, gender, comorbidities, BMI, operative intervention type, emergency surgery, steroid use, and ileostomy creation or formation

	AE		No AE		Crude		*p*	Adjusted*		*p*
	N	(%)	N	(%)	OR	95% CI		OR	95% CI	
Crohn's Disease										
White	405	19.0	1732	81.0	1.00	Ref		1.00	Ref	
Black	49	28.8	121	71.2	1.73	(1.22–2.46)	*< 0.01*	1.88	(1.31–2.72)	*< 0.01*
Other	11	21.2	41	78.8	1.15	(0.59–2.25)	*0.69*	1.33	(0.66–2.71)	*0.43*
Ulcerative Colitis										
White	316	21.9	1129	78.1	1.00	Ref		1.00	Ref	
Black	14	19.7	57	80.3	0.88	(0.48–1.60)	*0.67*	0.88	(0.48–1.63)	*0.68*
Other	10	20.8	38	79.2	0.94	(0.46–1.91)	*0.86*	0.83	(0.39–1.74)	*0.61*
Indeterminate Colitis/Other										
White	57	18.0	260	82.0	1.00	Ref		1.00	Ref	
Black	4	12.9	27	87.1	0.68	(0.23–2.01)	*0.48*	0.80	(0.25–2.60)	*0.71*
Other	4	30.8	9	69.2	2.03	(0.60–6.81)	*0.25*	2.38	(0.63–9.02)	*0.20*
Male										
White	370	19.3	1549	80.7	1.00	Ref		1.00	Ref	
Black	43	29.5	103	70.5	1.75	(1.20–2.54)	*< 0.01*	1.79	(1.21–2.64)	*< 0.01*
Other	11	26.8	30	73.2	1.54	(0.76–3.09)	*0.23*	1.98	(0.95–4.11)	*0.07*
Female										
White	408	20.6	1572	79.4	1.00	Ref		1.00	Ref	
Black	24	19.0	102	81.0	0.91	(0.57–1.43)	*0.67*	0.99	(0.61–1.60)	*0.97*
Other	14	19.4	58	80.6	0.93	(0.51–1.68)	*0.81*	0.76	(0.41–1.44)	*0.40*
Pre-operative Steroid Use										
White	390	22.1	1377	77.9	1.00	Ref		1.00	Ref	
Black	33	34.7	62	65.3	1.88	(1.21–2.91)	*< 0.01*	2.14	(1.35–3.39)	*< 0.01*
Other	16	32.0	34	68.0	1.66	(0.91–3.04)	*0.10*	1.66	(0.87–3.17)	*0.12*
No pre-operative steroid use										
White	388	18.2	1744	81.8	1.00	Ref		1.00	Ref	
Black	34	19.2	143	80.8	1.07	(0.72–1.58)	*0.74*	1.06	(0.71–1.58)	*0.77*
Other	9	14.3	54	85.7	0.75	(0.37–1.53)	*0.43*	0.79	(0.38–1.64)	*0.52*

complications for patients undergoing IBD surgery have decreased [12–16]. We found no difference in WC based on race. However, we did demonstrate increased odds of AE in black subjects. In our EMM analysis, only black patients who were male, had CD, or received preoperative steroids had increased odds of AE. The rate of post-operative blood transfusions was higher for black subjects compared to white subjects as were the rates of post-operative sepsis for black and other minority subjects. Similar to previous reports, a diagnosis of UC [26, 27], presence of comorbidities [27, 28], decreased BMI [29], increased age [28], open versus minimally invasive surgery [30], and emergency surgery [31] were associated with increased odds of postoperative complications. In particular, an increased number of comorbidities, open surgery, and emergency surgery had the highest odds of AE and WC for all groups suggesting that medical optimization and pursuing elective surgery are the best measures to reduce postoperative complications.

In a previous study, Dos Santos Marques et al. used NSQIP data from 2005 to 2017 to demonstrate that black subjects with IBD had higher odds of postoperative AE, primarily due to higher rates of renal insufficiency, blood transfusions, and sepsis compared to white subjects [12, 14, 16]. In another study using NSQIP data from prior to 2008, which evaluated postoperative complications following emergency surgery, Esnaola et al. found that odds of postoperative cardiac arrest and renal insufficiency and/or failure were higher in black subjects compared to white [16]. Compared to the previous literature, our study had similar distributions of races (white patients 91 vs 89%, black 6.4 vs 7.6, other 2.6 vs 3.8%) and demonstrated lower rates of AE and WC for all populations [1]. Our secondary analysis of AE showed a decrease in cardiac and renal complications compared to the existing literature. Yet, we showed the continued increased need

Table 4 Secondary analysis of individual post-operative outcomes. CPR—cardiopulmonary resuscitation, SSI—surgical site infection

	Cohort data									Unadjusted logistic regression						
	Total		White		Black		Other			White	Black			Other		
Adverse event	*N*	%	*N*	%	*N*	%	*N*	%	*p*	*Ref*	*OR*	*95% CI*	*p-value*	*OR*	*95% CI*	*p*
Death	136	3.17	128	3.28	3	1.09	5	4.42	*0.53*		0.33	(0.10–1.04)	*0.06*	1.36	(0.55–3.40)	*0.51*
Mechanical ventilation > 48 h	35	0.82	32	0.82	2	0.72	1	0.88	*0.98*		0.90	(0.21–3.76)	*0.88*	1.08	(0.15–7.97)	*0.94*
Reintubation	28	0.65	26	0.67	2	0.72	0	0.00	*0.55*		1.10	(0.26–4.67)	*0.89*	–	–	–
Myocardial infarction	6	0.14	6	0.15	0	0.00	0	0.00	*0.47*		–	–	–	–	–	–
Cardiac arrest requiring CPR	3	0.07	3	0.08	0	0.00	0	0.00	*0.61*		–	–	–	–	–	–
Blood transfusion	385	8.99	338	8.67	38	13.77	9	7.96	*0.13*		1.71	(1.19–2.45)	*0.00*	0.91	(0.46–1.82)	*0.79*
Pneumonia	54	1.26	51	1.31	3	1.09	0	0.00	*0.26*		0.84	(0.26–2.71)	*0.77*	–	–	–
Urinary tract infection	57	1.33	53	1.36	2	0.72	2	1.77	*0.83*		0.54	(0.13–2.22)	*0.39*	1.31	(0.32–5.43)	*0.71*
Sepsis	157	3.66	133	3.41	17	6.16	7	6.19	*0.01*		1.89	(1.12–3.18)	*0.02*	1.87	(0.85–4.10)	*0.12*
Septic shock	51	1.19	44	1.13	6	2.17	1	0.88	*0.46*		1.98	(0.84–4.68)	*0.12*	0.78	(0.11–5.73)	*0.81*
Acute kidney injury	8	0.19	8	0.21	0	0.00	0	0.00	*0.40*		–	–	–	–	–	–
Progressive renal insufficiency	17	0.40	15	0.38	2	0.72	0	0.00	*0.99*		1.92	(0.47–8.43)	*0.39*	–	–	–
Stroke	0	0.00	0	0.00	0	0.00	0	0.00	–		–	–	–	–	–	–
Pulmonary embolism	24	0.56	21	0.54	3	1.09	0	0.00	*0.91*		2.06	(0.61–6.95)	*0.24*	–	–	–
Deep venous thrombosis	74	1.73	67	1.72	5	1.81	2	1.77	*0.91*		1.07	(0.43–2.68)	*0.88*	1.03	(0.25–4.26)	*0.97*
Re-operation	217	5.07	197	5.05	14	5.07	6	5.31	*0.89*		1.02	(0.59–1.78)	*0.94*	1.06	(0.46–2.43)	*0.90*
Superficial SSI	168	3.92	159	4.08	5	1.81	4	3.54	*0.19*		0.44	(0.18–1.08)	*0.07*	0.86	(0.31–2.37)	*0.78*
Deep SSI	23	0.54	19	0.49	2	0.72	2	1.77	*0.08*		1.51	(0.35–6.53)	*0.58*	3.68	(0.85–15.99)	*0.08*
Organ Space SSI	296	6.91	267	6.85	19	6.88	10	8.85	*0.48*		1.02	(0.63–1.66)	*0.93*	1.32	(0.68–2.56)	*0.41*
Wound dehiscence	19	0.44	16	0.41	3	1.09	0	0.00	*0.64*		2.71	(0.78–9.35)	*0.12*	–	–	–

for post-operative blood transfusions for black subjects, and higher rates of sepsis in both black and other minority subjects.

Since the odds of AE increased for black subjects on multivariable analysis, we assessed for confounding using EMM. When stratified by IBD diagnosis, gender, and steroid use, the analyses showed that black subjects who were male, had CD, and who used pre-operative steroids had increased odds of AE. Separately, we found that subjects with UC had higher odds of AE compared to those with CD [32]. For subjects with UC, race did not influence odds of AE in contrast to a NSQIP study from 2016 to 2019 [33].

Of the medications recorded in the dataset, only preoperative steroid use was associated with increased odds of AE, while both biologic and immunologic agents were not associated with either of AE or WC, consistent with previous literature [34–37]. In particular, the EMM analysis revealed that black subjects using pre-operative steroids had increased odds of AE compared to white subjects. We also found that black subjects used biologics the least. Considering that biologic medications cost significantly more than steroids and immunologic agents, financial status and access to care may also influence racial differences in surgical morbidity [38, 39].Other factors, such as socioeconomic status and cultural differences can contribute to disparities in surgical outcomes as shown by Akinyemiju et al. who demonstrated that patients with Medicare or Medicaid experience more post-surgical complications than privately insured patients [11].

This study has several strengths. First, this data includes typical NSQIP variables as well as IBD specific ones (e.g. medication use, ileostomy formation) allowing us to have a more detailed assessment of the effect these variables have on the IBD patient population. Next, the dataset is a large national dataset utilizing data from high volume tertiary IBD centers, which are at often the forefront of surgical and medical care. Lastly, the effect of medication usage and ileostomy creation and revision as predictors of postoperative outcomes based on race has rarely been incorporated into larger national studies until now.

This study also has several limitations. First, our definition of AE included multiple postoperative complications of varying severity. To account for this heterogeneity and increased sensitivity, we analyzed each outcome independently and its association with race. Next, this study is retrospective in nature and is therefore limited by the data quality entered into the database. Third, given that the data collected was exclusively from tertiary care centers, this study's results are less generalizable to non-academic or academic-affiliated centers. For this same reason, our study population likely underrepresents black and other minority races with UC as well as other minority races with CD [1, 5]. Finally, this study follows subjects for 30-days post-operatively. However, IBD is a chronic disease and 30-day follow up may not suffice in determining the long-term outcomes for these patients.

Despite improvements in care for patients with IBD, race was associated with increased odds of AE for black patients with IBD who underwent surgery. On further analysis, black subjects who were male, had CD, or who were using steroids had increased odds of AE compared to their white counterparts. Blood transfusions continue to be the primary AE associated with black race, while other AE have decreased in frequency compared to the previous literature. Importantly when using this IBD specific database, typical predictors of postoperative complications, including comorbidities, BMI, open surgery, and emergency surgery played a stronger role than race alone.

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Author's contribution J.J.N., K.W.B., and M.H.S. drafted the text for the main manuscript. R.V. and J.J.N. performed the statistical analysis. All authors were involved in the interpretation of the data analysis. A.C.B. and S.E. were involved in the acquisition the data set to be used for the analysis. A.C.B., J.J.N., and M.H.S. were involved in the conception of the research project as well as its design. All authors critically reviewed and edited the final draft of the manuscript to be published.

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Data availability The raw data that support the findings of this study are not openly available but are available from the corresponding author upon reasonable request. These data are securely stored by the NSQIP-IBD data collaborative at the University of California, San Diego.

Declarations

Conflict of interest The authors declare no competing interests.

References

1. Dahlhamer JM, Zammitti EP, Ward BW, Wheaton AG, Croft JB. Prevalence of inflammatory bowel disease among adults aged ≥18 years - United States, 2015. *MMWR Morb Mortal Wkly Rep.* 2016;65:1166–1169.
2. Harbord M, Eliakim R, Bettenworth D, Karmiris K, Katsanos K, Kopylov U et al. Third european evidence-based consensus on diagnosis and management of ulcerative colitis. Part 2: current management. *J Crohns Colitis.* 2017;11:769–84.
3. Lamb CA, Kennedy NA, Raine T, Hendy PA, Smith PJ, Limdi JK et al. British society of gastroenterology consensus guidelines on the management of inflammatory bowel disease in adults. *Gut.* 2019;68:s1-106.
4. Fakhoury M, Negrulj R, Mooranian A, Al-Salami H. Inflammatory bowel disease: clinical aspects and treatments. *J Inflamm Res.* 2014;7:113–120.
5. Barnes EL, Nowell WB, Venkatachalam S, Dobes A, Kappelman MD. Racial and ethnic distribution of inflammatory bowel disease in the United States. *Inflamm Bowel Dis.* 2022;28:983–987.
6. Veluswamy H, Suryawala K, Sheth A, Wells S, Salvatierra E, Cromer W et al. African-American inflammatory bowel disease in a Southern U.S. health center. *BMC Gastroenterol.* 2010;10:104.
7. Misra R, Faiz O, Munkholm P, Burisch J, Arebi N. Epidemiology of inflammatory bowel disease in racial and ethnic migrant groups. *World J Gastroenterol.* 2018;24:424–437.
8. Mahid SS, Mulhall AM, Gholson RD, Eichenberger MR, Galandiuk S. Inflammatory bowel disease and African Americans: a systematic review. *Inflamm Bowel Dis.* 2008;14:960–967.
9. Aniwan S, Harmsen WS, Tremaine WJ, Loftus EV. Incidence of inflammatory bowel disease by race and ethnicity in a population-based inception cohort from 1970 through 2010. *Ther Adv Gastroenterol.* 2019;12:1756284819827692.
10. Peterson K, Anderson J, Boundy E, Ferguson L, McCleery E, Waldrip K. Mortality disparities in racial/ethnic minority groups in the veterans health administration: an evidence review and map. *Am J Public Health.* 2018;108:e1-11.
11. Akinyemiju T, Meng Q, Vin-Raviv N. Race/ethnicity and socio-economic differences in colorectal cancer surgery outcomes: analysis of the nationwide inpatient sample. *BMC Cancer* 2016;16:715.
12. Dos Santos Marques IC, Theiss LM, Wood LN, Gunnells DJ, Hollis RH, Hardiman KM et al. Racial disparities exist in surgical outcomes for patients with inflammatory bowel disease. *Am J Surg.* 2021;221:668–674.
13. Gunnells DJ, Morris MS, DeRussy A, Gullick AA, Malik TA, Cannon JA et al. Racial Disparities in readmissions for patients with inflammatory bowel disease (IBD) after colorectal surgery. *J Gastrointest Surg Off J Soc Surg Aliment Tract.* 2016;20:985–993.
14. Montgomery SR, Butler PD, Wirtalla CJ, Collier KT, Hoffman RL, Aarons CB et al. Racial disparities in surgical outcomes of patients with inflammatory bowel disease. *Am J Surg.* 2018;215:1046–1050.
15. Holleran TJ, Napolitano MA, LaPiano JB, Arnott S, Amdur RL, Brody FJ et al. Racial disparities in 30-day outcomes after colorectal surgery in an integrated healthcare system. *J Gastrointest Surg Off J Soc Surg Aliment Tract.* 2022;26:433–443.
16. Esnaola NF, Hall BL, Hosokawa PW, Ayanian JZ, Henderson WG, Khuri SF et al. Race and surgical outcomes: it is not all black and white. *Ann Surg.* 2008;248:647–655.
17. Khan IS, Huang E, Maeder-York W, Yen RW, Simmons NE, Ball PA et al. Racial disparities in outcomes after spine surgery: a systematic review and meta-analysis. *World Neurosurg.* 2022;157:e232–e244.
18. Causey MW, McVay D, Hatch Q, Johnson E, Maykel JA, Champagne B et al. The impact of race on outcomes following emergency surgery: an American college of surgeons national surgical quality improvement program assessment. *Am J Surg.* 2013;206:172–179.
19. Best MJ, McFarland EG, Thakkar SC, Srikumaran U. Racial disparities in the use of surgical procedures in the US. *JAMA Surg.* 2021;156:274–281.
20. Sewell JL, Velayos FS. Systematic review: The role of race and socioeconomic factors on IBD healthcare delivery and effectiveness. *Inflamm Bowel Dis.* 2013;19:627–643.
21. Yarur AJ, Abreu MT, Salem MS, Deshpande AR, Sussman DA. The impact of hispanic ethnicity and race on post-surgical complications in patients with inflammatory bowel disease. *Dig Dis Sci.* 2014;59:126–134.https://doi.org/10.1007/s10620-013-2603-3
22. Eisenstein S, Stringfield S, Holubar SD. Using the national surgical quality improvement project (NSQIP) to perform clinical research in colon and rectal surgery. *Clin Colon Rectal Surg.* 2019;32:41–53.
23. Eisenstein S, Holubar SD, Hilbert N, Bordeianou L, Crawford LA, Hall B et al. The ACS national surgical quality improvement program - inflammatory bowel disease collaborative: design, implementation, and validation of a disease-specific module. *Inflamm Bowel Dis.* 2019;25:1731–1739.
24. Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A et al. Racism as a determinant of health: a systematic review and meta-analysis. *PLoS ONE.* 2015;10:e0138511.
25. Manuel JI. Racial/ethnic and gender disparities in health care use and access. *Health Serv Res.* 2018;53:1407–1429.
26. Sundel MH, Newland JJ, Blackburn KW, Vesselinov RM, Eisenstein S, Bafford AC et al. Sex-based differences in inflammatory bowel disease surgical outcomes. *Dis Colon Rectum.* 2023. https://doi.org/10.1097/DCR.0000000000002984.
27. Hill SS, Ottaviano KE, Palange DC, Chismark AD, Valerian BT, Canete JJ et al. Impact of preoperative factors in patients with IBD on postoperative length of stay: A national surgical quality improvement program-inflammatory bowel disease collaborative analysis. *Dis Colon Rectum.* 2024;67:97–106.

28. Guasch M, Vela E, Mañosa M, Clèries M, Cañete F, Parés D et al. Postoperative mortality after surgery for inflammatory bowel disease in the era of biological agents: a population-based study in Southern Europe. *Dig Liver Dis Off J Ital Soc Gastroenterol Ital Assoc Study Liver.* 2021;53:54–60.
29. Jiang K, Chen B, Lou D, Zhang M, Shi Y, Dai W et al. Systematic review and meta-analysis: association between obesity/overweight and surgical complications in IBD. *Int J Colorectal Dis.* 2022;37:1485–1496.
30. Sampietro GM, Colombo F, Corsi F. Sequential approach for a critical-view COlectomy (SACCO): a laparoscopic technique to reduce operative time and complications in IBD acute severe colitis. *J Clin Med.* 2020;9:3382.
31. Sakurai Kimura CM, Scanavini Neto A, Queiroz NSF, Horvat N, Camargo MGM, Borba MR et al. Abdominal surgery in crohn's disease: risk factors for complications. *Inflamm Intest Dis.* 2021;6:18–24.
32. Arsoniadis EG, Ho Y-Y, Melton GB, Madoff RD, Le C, Kwaan MR. African Americans and short-term outcomes after surgery for crohn's disease: an ACS-NSQIP analysis. *J Crohns Colitis.* 2017;11:468–473.
33. Ore AS, Vigna C, Fabrizio A, Messaris E. Evaluation of racial/ethnic disparities in the surgical management of inflammatory bowel disease. *J Gastrointest Surg.* 2022;26:2559–2568.
34. Lau C, Dubinsky M, Melmed G, Vasiliauskas E, Berel D, McGovern D et al. The Impact of preoperative serum anti-TNFα therapy levels on early postoperative outcomes in inflammatory bowel disease surgery. *Ann Surg.* 2015;261:487–496.
35. Law CC, Bell C, Koh D, Bao Y, Jairath V, Narula N. Risk of postoperative infectious complications from medical therapies in inflammatory bowel disease. *Cochrane Database Syst Rev.* 2020;2020:CD013256.
36. Yu CS, Jung SW, Lee JL, Lim S-B, Park IJ, Yoon YS et al. The influence of preoperative medications on postoperative complications in patients after intestinal surgery for Crohn's disease. *Inflamm Bowel Dis.* 2019;25:1559–1568.
37. Visser A, Geboers B, Gouma DJ, Goslings JC, Ubbink DT. Predictors of surgical complications: a systematic review. *Surgery.* 2015;158:58–65.
38. Yu H, MacIsaac D, Wong JJ, Sellers ZM, Wren AA, Bensen R et al. Market share and costs of biologic therapies for inflammatory bowel disease in the United States. *Aliment Pharmacol Ther.* 2018;47:364–370.
39. Park KT, Ehrlich OG, Allen JI, Meadows P, Szigethy EM, Henrichsen K et al. The cost of inflammatory bowel disease: an initiative from the Crohn's & colitis foundation. *Inflamm Bowel Dis.* 2020;26:1–10.