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Trends and Outcomes of Hip Fracture Hospitalization Among Medicare Beneficiaries with Inflammatory Bowel Disease, 2000–2017

Fang Xu[1], **Anne G. Wheaton**[1], **Kamil E. Barbour**[1], **Yong Liu**[1], **Kurt J. Greenlund**[1]

[1]Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 4770 Buford Highway NE, Atlanta, GA 30341, USA

Abstract

Background—Patients with inflammatory bowel disease (IBD) have a higher risk of hip fracture, but lower likelihood of having arthroplasties than non-IBD patients in Nationwide Inpatient Sample. Little is known about hip fracture-associated hospitalization outcomes.

Aims—We assessed the trends in hip fracture hospitalization rates from 2000 to 2017 and estimated 30-day readmission, 30-day mortality, and length of stay in 2016 and 2017.

Methods—We estimated trends of age-adjusted hospitalization rates using a piecewise linear regression. Medicare beneficiaries aged ≥ 66 years with Crohn's disease (CD, $n = 2014$) or ulcerative colitis (UC, $n = 2971$) hospitalized for hip fracture were identified. We performed propensity score matching to create 1:3 matched samples on age, race/ethnicity, sex, and chronic conditions and compared hospitalization outcomes between matched samples.

Results—In 2017, the age-adjusted hospitalization rates (per 100) were 1.15 [95% CI = (1.07–1.24)] for CD, 0.86 [95% CI = (0.82–0.89)] for UC, and 0.59 [95% CI = (0.59–0.59)] for no IBD. The hospitalization rates for CD and UC decreased from 2000 to 2012 and then increased from 2012 to 2017. Compared to matched cohorts, CD patients had longer hospital stays (5.55 days vs. 5.30 days, $p = 0.01$); UC patients were more likely to have 30-day readmissions (17.27% vs. 13.71%, $p < 0.001$), longer hospital stays (5.59 days vs. 5.40 days, $p = 0.02$), and less likely to have 30-day mortality (3.77% vs. 5.15%, $p = 0.003$).

Conclusions—Prevention of hip fracture is important for older adults with IBD, especially CD. Strategies that improve quality of inpatient care for IBD patients hospitalized for hip fracture should be considered.

Keywords

Hip fracture hospitalization; Trends of hospitalization rate; Inflammatory bowel disease; 30-day readmission; 30-day mortality; Length of stay

✉Fang Xu, vmf7@cdc.gov.

Compliance with Ethical Standards

Conflict of interest All authors have no conflicts of interest to disclose.

Introduction

Crohn's disease (CD) and ulcerative colitis (UC), collectively known as inflammatory bowel disease (IBD), involve chronic inflammation of the gastrointestinal tract. In 2015–2016, an estimated 3 million US adults had CD or UC [1]. The incidence of IBD peaks around one's 20 s and decreases with older age [2]. Although overall mortality in adults with IBD is similar to or lower than that of the general population [3], the incidence and prevalence of IBD are increasing globally [4]. The number of older adults living with IBD in the USA is also expected to increase with the aging population.

The systemic inflammatory process of IBD often leads to a higher likelihood of both gastrointestinal and extraintestinal comorbidities and complications in adults with the disease than those without [1, 5]. The extraintestinal manifestations involve nearly any other organ in the body [6]. Emerging evidence suggests that comorbidities are associated with increased IBD-related hospitalization rates, worse hospitalization outcomes among patients, and increased healthcare costs [7].

Hip fracture among older adults is associated with significantly lower functional status as well as morbidity and mortality [8]. Compared with other types of fractures, hip fracture is more likely to be associated with lower bone mineral density (BMD) among older adults and is the most likely fracture that requires a hospitalization with a procedure [9]. Multiple studies have shown that IBD is associated with an increased risk of fractures [10–12]. For instance, a Canadian study showed that the incidence of fracture among IBD patients was 40% higher than that in the general population [10]. Similarly, a Swedish nationwide cohort study showed that individuals with IBD had a 42% higher risk to develop fractures than their matched controls from the general population [11]. Given the increased risk of hip fracture among IBD patients [10–12], it is important to assess hospitalization outcomes associated with hip fracture as part of overall disease management for IBD. Furthermore, the last two decades represent the new era of biologics for IBD treatment. It is unknown whether hip fracture hospitalization rates differ between older adults with and without IBD during this period. To date, there is a paucity of data that assess fracture-related hospitalization outcomes and do not focus on older adults with IBD [13, 14], and no study has explored recent trends in hospitalizations for this population. The objective of this population-based study, therefore, was to assess hip fracture-associated hospitalization trends and outcomes among older adults with IBD in the USA in the last two decades.

Methods

Data Sources

We used the Medicare Master Beneficiary Summary File (MBSF) and part A (Medicare Provider Analysis and Review [MedPAR]) and part B (Outpatient and Carrier) files obtained from the Centers for Medicare and Medicaid Services (CMS). The MBSF includes beneficiary demographic characteristics such as age, race/ethnicity, sex, and chronic conditions. The MedPAR file contains records of inpatient and skilled nursing facility stays. The Outpatient file contains claim records from institutional outpatient providers. The Carrier file contains claim records from providers including physicians, physician assistants,

clinical social workers, and nurse practitioners. Medicare part A and part B data contain information about diagnosis and procedure codes, admission and discharge dates, discharge destination, and date of service that were used in the study. Details of the Medicare data are described elsewhere [15]. Data were accessed under a Data User Agreement with CMS through the Centers for Disease Control and Prevention (CDC).

Identification of Hip Fracture Hospitalization and IBD Status

Hip fracture was determined from MedPAR using the *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) principal diagnosis codes, S720-S722, S790, S324, M80, or M84 for hospitalizations occurring after October 1, 2015, and using ICD-9-CM principal diagnosis codes, 820, 808.1, 733.14, 733.15, 733.81, 733.82, 733.96 for hospitalizations that occurred prior to that date [16]. Patients with CD (ICD-10-CM diagnosis code: K50; ICD-9-CM diagnosis code: 555) or UC (ICD-10-CM diagnosis code: K51; ICD-9-CM diagnosis code: 556) were identified from part A and part B files by searching the diagnosis codes with a 2-year look back: at least 1 stay from MedPAR or at least 2 claims of different dates from the Outpatient and Carrier files during the study period and one year prior. Patients were considered to have no IBD if the diagnosis codes were not found during the time period.

Trends of Age-Adjusted Hospitalization Rate for Hip Fracture

Medicare Fee-for-Service beneficiaries aged ≥ 66 years, who had continuous enrollment in part A and part B and did not enroll in a Health Maintenance Organization (HMO) during a calendar year, were identified. For hospitalization rates, the numerator was the number of admissions (short stay only) for hip fracture as the principal diagnosis. The denominator was the number of Medicare enrollees from MBSF during the calendar year who were identified to have CD or UC or had no IBD. The age-adjusted hospitalization rates for hip fracture were calculated from 2000 to 2017 using the age categories: 66–74, 75–84, and ≥ 85 years [17].

Hospitalization Outcomes Following Hip Fracture

The study population included beneficiaries aged ≥ 66 years who had continuous enrollment in part A and part B and did not enroll in an HMO in 2016 and 2017 and had a hospital admission (index admission) for hip fracture. For patients who had multiple hospitalizations for hip fracture, the first hospitalization was captured. A total of 6% IBD patients with both CD and UC codes were excluded.

Three hip fracture-associated hospitalization outcomes were estimated: 30-day readmission, 30-day mortality, and length of stay. Thirty-day readmission was defined as all-cause readmission that was emergency or urgent and occurred within 30 days from the discharge date of the index admission for hip fracture as the principal diagnosis. Records were excluded if the readmission was to a federal hospital or was not acute or urgent, or patients were transferred to another short-term hospital, deceased, discharged against medical advice, or discharged in December 2017, as the 30-day window could not be ensured to capture readmission. Thirty-day mortality was defined as all-cause death that occurred within 30 days from the discharge date of the index admission for hip fracture. To use the same

analytic sample for both 30-day readmission and 30-day mortality, we excluded in-hospital mortality as it was one of the exclusion criteria to define 30-day readmission. Length of stay was defined as the number of days in hospital for the hip fracture-associated admission.

Covariates

Covariates included age group (66–69, 70–74, 75–79, 80–84, and ≥ 85 years), sex, race/ethnicity (non-Hispanic white, non-Hispanic black, and others including Hispanic, Asian, Native American, and others or unknown races), and selected chronic diseases that were common conditions for older adults and were relevant to IBD, including heart disease (acute myocardial infarction, congestive heart failure, or ischemic heart disease), stroke, chronic obstructive pulmonary disease, asthma, diabetes, cancer (of the lungs, colon/rectum, prostate, breast, or endometrium), obesity, anemia, chronic kidney disease, osteoporosis, rheumatoid arthritis, depression, anxiety disorders, liver disease or cirrhosis, viral hepatitis, opioids use disorder, and tobacco use disorder. These chronic conditions were defined by the Chronic Disease Warehouse and described elsewhere [18]. The surgery variable was defined according to whether or not a hip fracture-related procedure [19] was performed during the hospitalization. Hospital volume was created based on the counts of hip fracture-related procedures performed at the hospital level and then categorized in tertiles.

Statistical Analysis

All analyses were conducted separately for CD and UC. For the trend analysis, age-adjusted hospitalization rates for hip fracture (per 100 eligible Medicare enrollees, hereafter referred to hospitalization rates) were calculated from 2000 to 2017. A restricted cubic spline was first used to assess the linearity of the model. Based on the results, a piecewise linear regression was constructed, and years 2008 and 2012 were determined to be the cutoffs. A general linear model using the inversed standard errors as the weight was used to estimate the slopes. For the analysis of hospitalization outcomes, descriptive statistics included percentage or mean. To compare groups by IBD status, T tests and the Wilcoxon Mann–Whitney tests were used for continuous variables, and the χ^2 test was used for categorical variables. To remove bias caused by demographic characteristics and chronic conditions, a propensity score analysis with a greedy (nearest-neighbor) matching technique was performed to generate 1 case (IBD) to 3 controls (no IBD). To assess the balance diagnostics of covariates, the distributions of characteristics were compared using standardized differences of mean and prevalence between the patients with and without IBD before and after matching. The standardized difference, which is the ratio of the difference of two proportions to the square root of the average of two variances, is not affected by the sample size [20]. The assessment of good balance between matched samples was determined by a standardized difference less than 0.1. Differences of rates and mean were calculated and compared between cases and controls. In addition, a log binomial regression was used to estimate relative risks for 30-day readmission and 30-day mortality, and a general linear model with a gamma distribution was used to estimate ratio of length of stay by IBD status. Generalized estimating equations (GEE) with a compound symmetry correlation structure were used to estimate the associations between IBD groups and the hospitalization outcomes, taking into account the correlations between the matched samples.

Analyses were performed using SAS Enterprise Guide 7.1 (SAS Institute, Cary, North Carolina) on the Chronic Condition Warehouse Virtual Research Data Center (VRDC) platform and R 3.4.2 software. Analyses conducted on CMS data in the VRDC are not considered as human subjects research.

Results

In 2017, the hip fracture hospitalization rates (per 100 eligible Medicare enrollees) were 1.15 [95% CI = (1.07–1.24)] for CD, 0.86 [95% CI = (0.82–0.89)] for UC, and 0.59 [95% CI = (0.59–0.59)] for no IBD. From 2000 to 2008, for every year increment, the hospitalization rate decreased by 0.04 per 100 beneficiaries with CD [95% CI = (− 0.06 to − 0.02); $p < 0.001$]; decreased by 0.04 for UC [95% CI = (− 0.06 to − 0.04); $p < 0.001$]; and decreased by 0.03 for those without IBD [95% CI = (− 0.03 to − 0.02); $p < 0.001$] (Fig. 1). From 2008 to 2012, with every year increment, the hospitalization rate decreased by 0.04 for CD [95% CI = (− 0.07 to − 0.02); $p = 0.002$]; decreased by 0.03 for UC [95% CI = (− 0.04 to − 0.02); $p < 0.001$]; and decreased by 0.01 for no IBD [95% CI = (− 0.02 to − 0.01); $p < 0.001$]. From 2012 to 2017, with every year increment, the hospitalization rate increased by 0.04 for CD [95% CI = (0.01–0.06); $p = 0.01$]; increased by 0.02 for UC [95% CI = (0.01–0.03); $p = 0.004$]; and increased by 0.01 for no IBD [95% CI = (0.01–0.02); $p < 0.001$].

In 2016 and 2017, a total of 2014 CD patients, 2971 UC patients, and 312,196 patients without IBD were hospitalized for hip fracture (Table 1). The average age was about 80–83 years, and 71–73% were women. The prevalence of hip fracture-associated surgery was similar (89%) among the three groups. Compared with patients without IBD, IBD patients were younger, more likely to be non-Hispanic white, and have almost all the selected chronic conditions. IBD was also associated with an increasing number of chronic conditions, higher hospital volumes related to hip fracture procedures, higher 30-day readmission rate, longer hospital stays, but lower 30-day mortality rate.

After matching, 2014 CD patients and their 6042 controls, and 2971 UC patients and their 8913 controls were hospitalized for hip fracture. The distributions of age, sex, race/ethnicity, and chronic conditions were similar by the IBD status in the two matched samples (Table 2). The distributions between the matched samples were comparable for both CD and its controls as well as UC and its controls, whereas the distributions were not balanced prior to the matching (Fig. 2a, b). After matching, the following associations remained statistically significant: CD patients had a longer hospital stay than their controls by 0.24 day; UC patients had 3.56% 30-day readmission rate higher, 0.19 day’s hospital stay longer, but 1.38% 30-day mortality rate lower than their controls (Table 3). In the GEE model, CD patients had 5% longer hospital stays than their controls; UC patients had 26% higher risk of 30-day readmissions, 27% lower risk of 30-day mortality, and 4% longer hospital stays than their controls (Table 4). Inclusion of surgery and hospital volumes did not change the estimates appreciably (Model 2).

Discussion

The current study demonstrated that hospitalization rates for hip fracture were significantly higher among Medicare beneficiaries with IBD than those without IBD. Although this secondary study measured hospitalization rates rather than incidence rate, the findings were consistent with previous studies that showed IBD patients had a higher risk of fractures [10–12]. Specifically, a Swedish cohort study following over 83,000 patients with IBD for 50 years showed that a high dose of corticosteroids was associated with increased risk of fractures among IBD patients aged 60 years or older [11]. It further showed that the risk of hip fracture was significantly higher in CD than UC, which could be due to the increased exposure to corticosteroids among CD patients than UC patients [11]. The current study confirmed that hospitalization rates for hip fracture were significantly higher in CD than UC across 18 years.

Overall, the findings were consistent with a previous study by Lewiecki et al. based on a Medicare female population that the hip fracture incidence decreased from 2002 to 2012 and plateaued at 2012 until 2015 [21]. As the study explained, one of the possible contributors to the decline may have been increased BMD testing recommended by CMS and subsequent treatment [21]. The same study showed that the proportion of women having dual-energy X-ray absorptiometry (DXA) testing and osteoporosis diagnoses increased from 2001 to 2008 and decreased from 2008 to 2014. Another study found that prevalence of oral bisphosphonate use, the osteoporosis medication, paralleled the trends in DXA testing and osteoporosis diagnosis in the study of Lewiecki et al. increasing from 1996 to 2008 and declining until 2012 [22]. The decline in bisphosphonate use might be due to a concern of the adverse effects of the medicine [22]. In the current study, the similar trends in IBD patients as in those without IBD imply that new medications of immunomodulators and biologics during the study period had little impact on hip fracture hospitalization among older adults with IBD, as shown in the Swedish cohort study [11]. In addition, IBD patients aged 60 years or older were found to be more likely to have corticosteroids and less likely to have anti-TNF agents than younger patients during the biologic era [23]. The increasing trends of hospitalization rates after 2012 may warrant continuous follow-up and investigation.

Regardless of IBD status, approximately 89% patients hospitalized for hip fracture had surgery in the current study. Ehrenpreis et al. using the Nationwide Inpatient Sample (NIS) found that hip arthroplasty was less prevalent among IBD patients compared with non-IBD patients among all age groups [13]. As the study explained, the NIS data included only inpatients, and IBD patients overall might receive intensive screenings and outpatient treatment [13]. The current study included 100% Medicare beneficiaries aged 66 years or older who had IBD-related diagnosis from inpatient, outpatient, and noninstitutional claims. As hip fracture-associated hospitalization rate was higher among IBD patients and the prevalence of surgery among hospitalized patients was similar regardless of IBD status, the prevalence of surgery, therefore, was higher among overall IBD patients than non-IBD patients. The average age of the cohort was 80–83 years, and a vast majority of the patients hospitalized for hip fracture required an invasive procedure in the current study. The same previous study also showed that IBD patients had increased length of stay but similar costs

compared with the controls [13]. While this current study did not assess costs, it confirmed that IBD patients had increased length of stay by 0.2 days compared with their controls. Although such a small magnitude may not be clinically meaningful, lowering length of stay might minimize hospital-acquired infections such as *Clostridium difficile* that IBD patients are vulnerable to [24].

The 30-day readmission rate was 11.0% in patients without IBD, similar to 11.9% from a previous study [25]. The matched analyses indicated that age and the selected chronic conditions were associated with readmission. Surgery and hospital volume, however, were not significant predictors. A previous study found that readmission following hip fracture hospitalization was caused more likely by medical reasons, including pneumonia, cardiovascular diseases, renal failure, and deep vein thrombosis [26], than surgical reasons [27]. Although hospital volume has been shown to be associated with 30-day readmission and mortality in previous studies evaluating other procedures [28, 29], numerous studies investigating patients following hip fracture confirmed that 30-day readmission or mortality did not differ by hospital volume [30–32], which was consistent with our findings. It is likely that other conditions or indicators associated with IBD not included or not able to be assessed in the current study are the underlying causes for readmission. For instance, postoperative venous thromboembolism and hospital-acquired infection have been found to be common among hospitalized IBD patients, while the latter was more prevalent among UC than CD patients [24, 33]. In addition, IBD patients might be more likely to have pain problems, indicated by higher prevalence of opioid use disorder in the current study. Lack of pain control at discharge has been found to be associated with readmission [34].

The 30-day mortality rate was 5.6% for patients without IBD. If in-hospital mortality had been included, the result would be close to the 8.0% from the 2013 National Hip Fracture Database [35]. The current study showed that the IBD patients, however, had lower 30-day mortality than those without IBD and that UC patients had lower 30-day mortality than their matched controls. Noteworthy, Ehrenpreis et al. reported a decreased mortality among IBD patients following acute myocardial infarction and pneumonia hospitalizations [36]. As the previous study explained, IBD medications and/or the biological mechanism of the disease might play a role in decreased mortality following hip fracture [36]. The mechanism of IBD medications on postoperative outcomes is not understood. Very few studies have explored the role of medications on postoperative outcomes, and the results were mixed due to different study measures and settings [37, 38]. One study showed that preoperative use of steroids reduced 30-day mortality following colectomy among IBD patients [37]. Another study, however, found that 30-day mortality did not differ by use of steroids [38]. Well-designed studies are needed to understand the mechanism of IBD medications on 30-day mortality, 30-day readmission, and postoperative complications among older IBD patients.

This was the first population-based study that assessed the trends of hip fracture among IBD patients during the recent two decades. However, there are a few limitations in the study. First, Medicare data are collected for insurance reimbursement purposes. The data do not capture information about health-risk behaviors such as smoking, additional demographic variables, and other chronic conditions that were likely correlated with the hospitalization

outcomes. Second, diagnoses or procedures might be subject to coding errors. Third, the study population is limited to Medicare Fee-for-Service beneficiaries; therefore, the findings might not be generalizable to all adults aged ≥ 66 years in the USA.

Our studying findings could inform clinical practice in several ways. First, optimized disease management is essential to prevent IBD- and non-IBD-related hospitalizations. Osteoporosis is one of the main risk factors for fractures that is caused by decreased BMD and is more prevalent among patients with IBD than those without IBD [39]. The American College of Gastroenterology recommends that "Patients with conventional risk factors for abnormal BMD with UC and CD should undergo screening for osteoporosis with BMD testing at the time of diagnosis and periodically after diagnosis" [40]. The current study showed that IBD patients tended to be younger for hip fracture, possibly due to the impact of the natural history of the disease or glucocorticoids use on earlier occurrence of fractures [11, 12], which underscores the importance of early screening and timely treatment to prevent hip fracture hospitalization. Second, CD patients were more likely to have tobacco use disorder in the current study. Smoking, which can be prevented, is associated with reduced BMD and fractures [12]. The US Preventive Services Task Force (USPSTF) recommends all adults being asked about tobacco use and being advised to stop using tobacco [41]. Third, the USPSTF recommends exercise intervention to prevent falls, the primary cause of hip fractures [42], which may be important for IBD patients. Last, once admitted to hospital, IBD patients may require comprehensive inpatient care and focused monitoring during hospitalization. As the current study indicated, underlying conditions such as depression, anxiety, and opioid use disorder were prevalent among older adults with IBD which may need assessment and treatment at the time of discharge, as these conditions have been found to be correlated with readmission and longer hospital stay [43]. Appropriate patient placement and multidisciplinary hospital care coordination may reduce length of stay. In addition, clear discharge instructions including pain management, proper discharge destination, and compliant outpatient follow-up have also been found to be important to reduce the risk of readmission [34].

In conclusion, the Medicare study showed an elevated hip fracture hospitalization rate among IBD patients, especially among CD patients, and a similar trend in hospitalization rate as the general Medicare population. IBD patients had increased 30-day readmissions and longer hospital stay. Future studies are warranted to assess the direct impact of timing, duration, and dose of anti-TNF biologic therapy and corticosteroids on hospitalization outcomes and complications among IBD patients.

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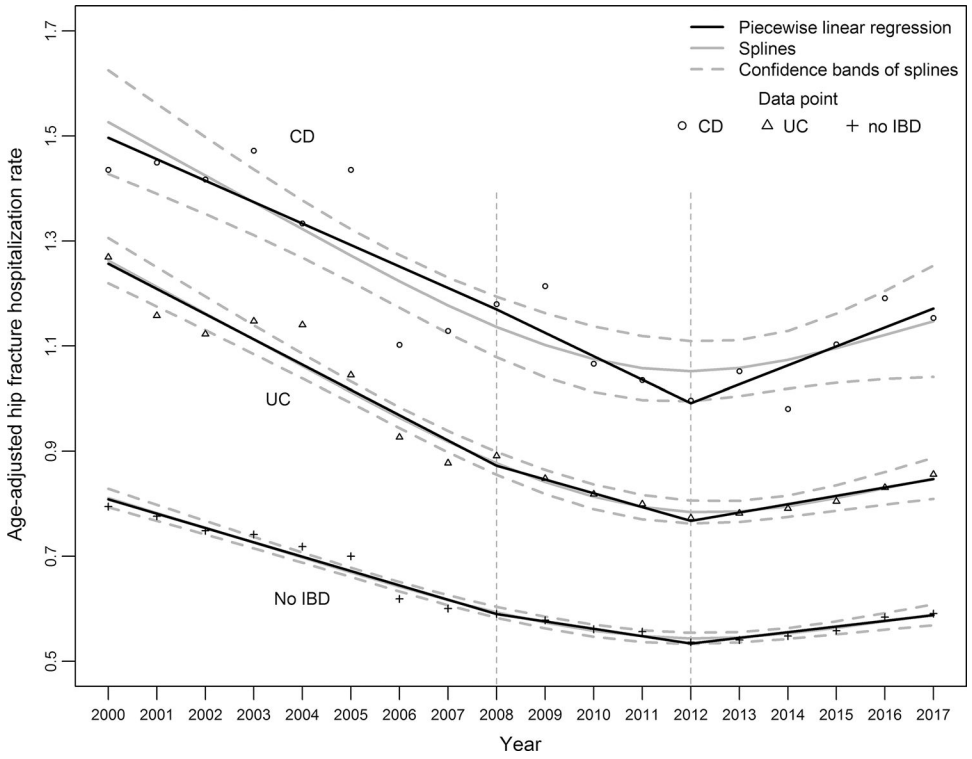

Fig. 1.

Age-adjusted (age adjustment to 2000 US census population according to age 66–74, 75–84, and ≥ 85 years. More details are available at https://www.census.gov/census2000/states/us.html) hip fracture-associated hospitalization rate (per 100) among Medicare Fee-for-Service beneficiaries aged ≥ 66 years by inflammatory bowel disease status

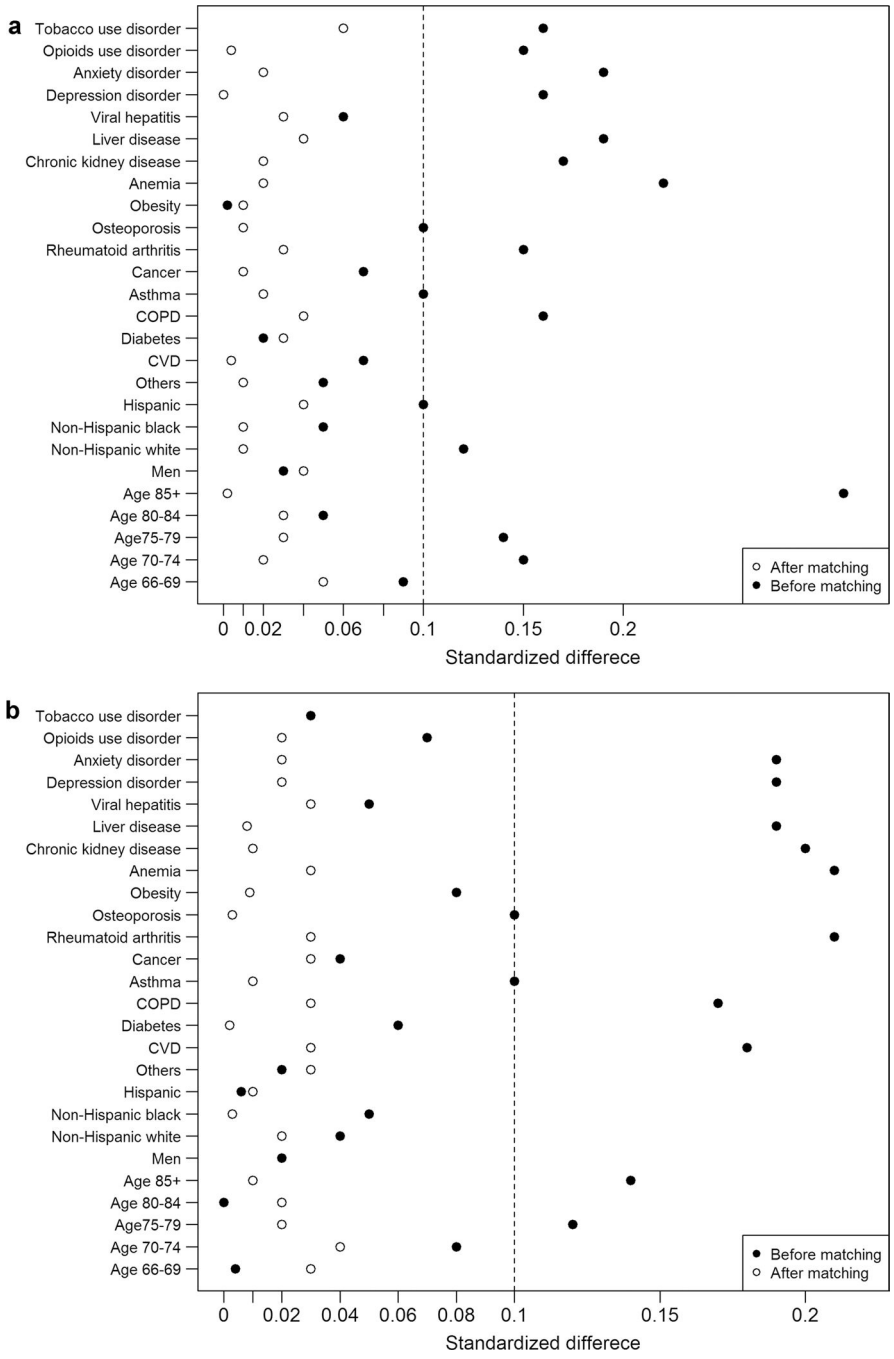

Fig. 2.

Standardized score difference before and after matching. **a** Crohn's disease versus matched control. **b** Ulcerative colitis versus matched control. Standardized difference is the ratio of the difference of two proportions to the square root of the average of two variances

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Table 1

Characteristics by inflammatory bowel disease status among Medicare Fee-for-Service beneficiaries with principal diagnosis of hip fracture-associated hospitalizations, 2016–2017

Characteristics	No Crohn's disease or ulcerative colitis (*n* = 312,196)	Crohn's disease (*n* = 2014)		Ulcerative colitis (*n* = 2971)	
	Mean (std) %	Mean (std) %	*p* value[a]	Mean (std) %	*p* value[a]
Age (continuous, years)	83.3 (8.2)	80.7 (7.8)	< 0.001	82.0 (7.9)	< 0.001
Age groups (years)			< 0.001		< 0.001
66–69	6.6	9.1		6.6	
70–74	10.8	15.8		13.3	
75–79	14.5	19.9		18.8	
80–84	19.4	21.4		19.4	
85 +	48.7	33.8		41.9	
Sex			0.15		0.19
Male	28.6	27.1		27.5	
Female	71.4	72.9		72.5	
Race			< 0.001		0.04
Non-Hispanic white	90.2	93.5		91.3	
Non-Hispanic black	3.4	2.6		2.5	
Hispanic	3.6	1.9		3.7	
Others or unknown	2.8	2.0		2.5	
Chronic conditions[b]					
Heart disease[c] or stroke	63.3	66.8	0.001	71.7	< 0.001
Diabetes	31.6	30.5	0.31	34.6	< 0.001
Chronic obstructive pulmonary disease	28.8	36.4	< 0.001	37.1	< 0.001
Asthma	8.1	11.0	< 0.001	11.1	< 0.001
Cancer[d]	17.1	19.8	0.002	18.6	0.03
Rheumatoid arthritis or osteoarthritis	60.7	67.8	< 0.001	70.6	< 0.001
Osteoporosis	32.8	37.4	< 0.001	37.6	< 0.001
Obesity	11.6	11.7	0.91	14.3	< 0.001
Anemia	80.8	88.8	< 0.001	88.3	< 0.001

Characteristics	No Crohn's disease or ulcerative colitis (*n* = 312,196)	Crohn's disease (*n* = 2014)		Ulcerative colitis (*n* = 2971)	
	Mean (std) %	Mean (std) %	*p* value[a]	Mean (std) %	*p* value[a]
Chronic kidney disease	48.5	57.1	< 0.001	58.5	< 0.001
Liver disease	5.7	11.0	< 0.001	10.9	< 0.001
Viral hepatitis	1.1	1.9	0.001	1.7	0.002
Depression	39.7	47.6	< 0.001	48.9	< 0.001
Anxiety disorder	35.7	44.7	< 0.001	44.8	< 0.001
Opioids use disorder	5.9	10.1	< 0.001	7.8	< 0.001
Tobacco use disorder	12.3	18.0	< 0.001	13.4	0.07
Number of chronic conditions	4.8 (2.2)	5.6 (2.2)	< 0.001	5.7 (2.2)	< 0.001
Categories of chronic conditions			< 0.001		< 0.001
0–4	45.9	32.1		29.6	
5–6	32.5	34.6		35.9	
≥7	21.6	33.3		34.5	
Hospital volume specific to hip fracture[e]			0.01		0.004
1st tertile	33.1	29.8		30.5	
2nd tertile	33.0	34.5		33.3	
3rd tertile	33.9	35.7		36.2	
Hip fracture-associated surgery	89.1	88.9	0.80	89.4	0.65
Hospitalization outcomes					
30-day readmission	11.0	14.0	< 0.001	17.3	< 0.001
30-day mortality	5.6	4.5	0.03	3.8	< 0.001
Length of stay (days)	5.2 (3.3)	5.5 (4.1)	0.002	5.6 (4.1)	< 0.001

std standard deviation

[a] For group comparison, *t* test was used for continuous variables that are lognormal; χ^2 test was used for categorical variables

[b] Definition of chronic conditions was available at https://www2.ccwdata.org/web/guest/condition-categories

[c] Heart diseases include acute myocardial infarction, congestive heart failure, and ischemic heart disease

[d] Conditions include colorectal cancer, lung cancer, prostate cancer among men, and breast cancer among women

[e] Based on tertile cutoffs at 358 and 726

Table 2

Distribution of characteristics of the matched sample between Medicare Fee-for-Service beneficiaries with inflammatory bowel disease and matched controls, 2016–2017

Characteristics	Controls for Crohn's disease (*n* = 6042) mean %	Crohn's Disease (*n* = 2014) mean %	Controls for ulcerative colitis (*n* = 8913) mean %	Ulcerative colitis (*n* = 2971) mean %
Age (continuous, years)	80.5	80.7	82.0	82.0
Age group (years)				
66–69	10.5	9.1	7.9	6.6
70–74	16.4	15.8	13.0	13.3
75–79	18.9	19.9	16.9	18.8
80–84	20.3	21.4	20.3	19.4
85 +	33.9	33.8	41.9	41.9
Men	28.9	27.1	28.3	27.5
Race/ethnicity				
Non-Hispanic white	93.2	93.5	91.2	91.3
Non-Hispanic black	2.4	2.6	2.5	2.5
Hispanic	2.5	1.9	3.7	3.7
Other or unknown	1.9	2.0	2.6	2.5
Chronic conditions				
Heart disease[a] or stroke	67.0	66.8	72.5	71.7
Diabetes	31.9	30.5	34.8	34.7
Chronic obstructive pulmonary disease	38.5	36.4	38.3	37.1
Asthma	10.5	11.0	10.8	11.1
Cancer[b]	20.2	19.8	19.6	18.6
Rheumatoid arthritis or osteoarthritis	69.5	67.8	72.1	70.6
Osteoporosis	36.8	37.4	36.9	37.6
Obesity	12.0	11.7	14.5	14.3
Anemia	88.2	88.8	88.3	88.3
Chronic kidney disease	58.2	57.1	58.4	58.5
Liver disease	9.9	11.0	9.9	10.9
Viral hepatitis	1.5	1.9	1.6	1.7

Characteristics	Controls for Crohn's disease (*n* = 6042) mean %	Crohn's Disease (*n* = 2014) mean %	Controls for ulcerative colitis (*n* = 8913) mean %	Ulcerative colitis (*n* = 2971) mean %
Depression	47.6	47.6	48.4	48.9
Anxiety disorder	43.8	44.7	44.3	44.8
Opioids use disorder	10.0	10.1	7.3	7.8
Tobacco use disorder	20.4	18.0	13.6	13.4

[a]Conditions include acute myocardial infarction, stroke, congestive heart failure, and ischemic heart disease

[b]Conditions include colorectal cancer, lung cancer, prostate cancer among men, and breast cancer among women

Table 3

Hip fracture-associated hospitalization outcomes between Medicare Fee-for-Service beneficiaries with inflammatory bowel disease and the matched controls, 2016–2017

Hospitalization outcomes	Cases	Controls	Difference[a] (95% CI)	*p* value
Crohn's disease (n)	2014	6042	–	–
30-day readmission rate (%)	14.00	13.01	0.99 (−0.75–2.73)	0.25
30-day mortality rate (%)	4.52	4.93	−0.41 (−1.47–0.65)	0.46
Length of stay (mean, days)	5.55	5.30	0.24 (0.07–0.42)	0.01
Ulcerative colitis (n)	2971	8913	–	–
30-day readmission rate (%)	17.27	13.71	3.56 (2.02–5.09)	< 0.001
30-day mortality rate (%)	3.77	5.15	−1.38 (−2.20 to −0.56)	0.003
Length of stay (mean, days)	5.59	5.40	0.19 (0.03–0.35)	0.02

CI confidence interval

[a]The difference of 30-day readmission rate, 30-day mortality rate, and mean of length of stay between cases and controls

Table 4

Model-based associations between inflammatory bowel disease and hip fracture-associated hospitalization outcomes among Medicare Fee-for-Service beneficiaries, 2016–2017

Inflammatory bowel disease status	30-day readmission Relative risk (95% CI)	*p* value	30-day mortality Relative risk (95% CI)	*p* value	Length of stay Ratio (95% CI)	*p* value
Crohn's disease						
Unmatched						
Model 1	1.28 (1.15–1.43)	< 0.001	0.80 (0.66–0.98)	0.03	1.08 (1.05–1.10)	< 0.001
Matched[a]						
Model 1[b]	1.08 (0.95–1.23)	0.25	0.92 (0.73–1.15)	0.46	1.05 (1.01–1.08)	0.01
Model 2[c]	1.07 (0.94–1.21)	0.31	0.91 (0.73–1.15)	0.45	1.05 (1.01–1.08)	0.01
Ulcerative colitis						
Unmatched						
Model 1	1.58 (1.46–1.71)	< 0.001	0.67 (0.56–0.80)	< 0.001	1.08 (1.07–1.10)	< 0.001
Matched[a]						
Model 1[b]	1.26 (1.15–1.38)	< 0.001	0.73 (0.60–0.90)	0.003	1.04 (1.01–1.07)	0.02
Model 2[c]	1.26 (1.15–1.38)	< 0.001	0.73 (0.59–0.89)	0.002	1.04 (1.01–1.07)	0.02

CI confidence interval

[a]GEE models taking into account the matched samples

[b]Model 1: Crohn's disease or ulcerative colitis

[c]Model 2: Model 1 + hospital volume specific to hip fracture + surgery + length of stay (not for models when length of stay is an outcome)