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Original Article

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COVID-19 Outcomes in Inflammatory Bowel Disease Hospitalized Patients: A Comprehensive Analysis Using the National Inpatient Sample

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Abstract

Background: There is no uniformity in the available literature concerning the effects of coronavirus disease 2019 (COVID-19) viral illness on people with inflammatory bowel disease (IBD).

Methods: We conducted an analysis using the 2020 National Inpatient Sample (NIS) database to compare the outcomes of COVID-19 hospitalized patients with and without IBD.

Results: Of 1,050,040 patients admitted with COVID-19, 5,750 (0.5%) also had IBD. The group with COVID-19 and IBD had higher percentages of females and White individuals and a greater prevalence of chronic lung disease, peripheral vascular disease, and liver disease. However, after accounting for confounding variables, there was no significant difference in mortality rates, length of hospital stays, or hospitalization costs between the two groups.

Conclusion: According to our findings, the presence of IBD does not appear to elevate the risk of COVID-19 complications.

Keywords: COVID-19; Gastrointestinal complications; Acute kidney injury; Inflammatory bowel disease

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Introduction

Coronavirus disease 2019 (COVID-19) viral illness has affected the entire global population, with a broad spectrum of clinical manifestations and variable outcomes. Patients diagnosed with inflammatory bowel disease (IBD) have been subject to speculation regarding their heightened susceptibility to COVID-19-related complications. This speculation stems from their underlying immune dysfunction and the potential utilization of immunomodulatory therapies [1]. Nevertheless, the complete extent of the impact of COVID-19 on patients with IBD remains unclear.

Recent studies have shown conflicting results on the severity of COVID-19 in IBD patients, with some studies reporting higher rates of hospitalization and mortality, while others reporting no differences [2, 3]. Furthermore, the literature also reports that patients with IBD have a comparable disease course as the overall population [4, 5]. These inconsistencies in the literature highlight the need for further investigation to better elucidate the relationship between IBD and COVID-19 viral illness.

The COVID-19 pandemic has significantly impacted the care of IBD patients, including disruptions in access to healthcare services, changes in treatment protocols, and delays in elective procedures [6]. While the effect of COVID-19 on IBD patients continues to be an area of active research, current literature does not associate IBD with severe COVID-19 viral illness [3, 7]. However, age, underlying health conditions, type of IBD, and use of immunomodulatory therapies might contribute to severe outcomes [3, 7]. The pandemic has also highlighted the need for continued efforts to ensure high-quality care for IBD patients during times of crisis.

The objective of this study was to analyze the National Inpatient Sample (NIS) database from 2020 and compare the outcomes of COVID-19 patients with and without IBD, including hospitalization, mortality, and complications. By analyzing hospitalized IBD patients with COVID-19 viral illness, this study sought to address the gaps in the existing literature and enhance the understanding of the association between COVID-19 and IBD, ultimately helping to guide clinical practice and patient care during the ongoing pandemic.

Materials and Methods

The NIS serves as the largest all-payer database for hospital

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inpatient stays in the United States. It comprises discharge data obtained from a 20% stratified sample of community hospitals across the country and is an integral component of the Healthcare Quality and Utilization Project (HCUP) [8]. The Agency for Healthcare Research and Quality sponsors the NIS. Within this database, each discharge record contains de-identified information pertaining to patients. Using the International Classification of Diseases, Tenth Revision, and Clinical Modification (ICD-10-CM), the NIS records 40 discharge diagnoses and 25 procedures for each patient. Utilizing the HCUP-NIS data from the year 2020, we conducted a retrospective cohort study focusing on admissions of patients aged 18 years or older, with the principal discharge diagnosis of COVID-19 (identified by ICD-10-CM codes U07.1). The first group had a co-existing secondary diagnosis of IBD (identified using ICD-10-CM codes K50xx and K51xx), while the second group did not have a co-existing secondary diagnosis.

Baseline demographic information, hospital characteristics, and clinically relevant comorbidities were determined for each hospitalization. Elixhauser comorbidities and ICD-10-CM codes were used to identify clinical comorbidities [9]. Descriptive statistics were used to summarize both continuous and categorical variables. For continuous data, the mean and standard error (SE) were calculated, while categorical variables were presented as percentages. Univariate analysis for between-group comparisons of categorical variables utilized the Rao-Scott Chi-square test, and weighted simple linear regression was employed for continuous variables.

To examine the relationship between IBD and various clinical outcomes in primary COVID-19 hospitalizations, we used weighted logistic and linear regression. The logistic regression results were reported as odds ratios (ORs) along with 95% confidence intervals (CIs). These regression models were adjusted for age, sex, race, comorbidities (Table 1), and hospital characteristics.

To estimate cost figures, hospital total charges were converted using hospital-specific cost-to-charge ratios provided by HCUP. All statistical analyses were performed using Stata 16.1 [10], considering the survey design complexity by incorporating sampling weights, primary sampling units, and strata. This approach enabled us to estimate population proportions, means, and regression coefficients using svy commands. SEs were computed using Taylor series linearization. Statistical significance was defined as a P value of < 0.05.

The NIS database comprises de-identified billing and diagnostic codes gathered from participating hospitals. As per federal regulations and guidance, the NIS dataset does not directly involve "human subjects", and therefore, it is exempt from requiring institutional review board approval. This study was conducted in accordance with the ethical standards of the responsible institution concerning human subjects, as well as in compliance with the principles outlined in the Helsinki Declaration.

Results

Baseline characteristics

Our sample included 1,050,040 patients hospitalized due to COVID-19 infection in 2020. Among them, 5,750 (0.5%) had co-existing IBD. Hospitalizations with primary COVID-19 and IBD had more women (53.6% vs. 47.2%, $P < 0.001$), a higher proportion of White adults (76.6% vs. 52.5%, $P < 0.001$), and a lower proportion of Black (11.3% vs. 18.5%, $P < 0.001$) and Hispanic adults (8.8% vs. 20.6%, $P < 0.001$) when compared to those with a primary diagnosis of COVID-19 without IBD. Patients with COVID-19 and IBD had a higher prevalence of chronic pulmonary disease (30.5% vs. 23.4%, $P < 0.001$), peripheral vascular disease (5.8% vs. 4.5%, $P = 0.039$), liver disease (6.5% vs. 4.5%, $P = 0.002$), deficiency anemias (5.2% vs. 3.4%, $P = 0.001$), hypothyroidism (17.7% vs. 13.9%, $P < 0.001$), valvular disease (5% vs. 3.9%, $P = 0.036$), tobacco use disorder (35.7% vs. 26.9%, $P < 0.001$), and drug abuse (2.9% vs. 1.8%, $P = 0.011$) when compared to patients with COVID-19 without IBD. Patients with COVID-19 and IBD had a lower prevalence of diabetes mellitus (29.3% vs. 40.83%, $P < 0.001$), hypertension (63.1% vs. 67.7%, $P = 0.001$), obesity (22.8% vs. 27.4%, $P = 0.001$), and prior cerebrovascular disease (6.4% vs. 8.4%, $P = 0.01$) when compared to patients with COVID-19 without IBD.

No significant differences were observed between the two cohorts concerning age or bed size of the hospital. In addition, the prevalence of atrial fibrillation, congestive heart failure, renal failure, neurological disorders, alcohol abuse, carotid artery disease, dyslipidemia, ischemic heart disease, and prior pacemaker or implantable cardioverter-defibrillator placement did not differ significantly among COVID-19 patients with or without IBD.

In-hospital mortality

Table 2 summarizes the adjusted odds ratio(aOR) of clinical outcomes. After adjustment of variables, the in-hospital mortality for COVID-19 patients with IBD did not differ significantly compared to those without IBD (10.4% vs. 11.2%, aOR: 1.00, 95% CI: 0.8-1.2, $P = 0.97$). This finding persisted when analyzing only patients aged 18 - 64 and those aged 65 and older (Table 3).

In-hospital complications

COVID-19 patients with IBD had a higher incidence of acute kidney injury (AKI, 27.0% vs. 25.3%, aOR: 1.29, 95% Cl: 1.1 - 1.5, $P = 0.001$) than those without IBD. However, there was no difference in invasive mechanical ventilation (10.3% vs. 9.9%, aOR: 1.18, 95% CI: 0.96 - 1.44, $P = 0.109$) or pressor use (1.3% vs. 1.8%, aOR: 0.80, 95% CI: 0.48 - 1.34, $P = 0.40$) between the two cohorts. These findings regarding invasive mechanical ventilation were consistent across age groups: 18 - 64 and 65 or older (Table 3). Additionally, there was no statistically significant difference between the two groups in the incidence of cardiogenic shock (0.35% vs. 0.38%, aOR: 0.97, 95% CI: 0.4 - 2.6, $P = 0.95$), AKI requiring dialysis (1.65% vs. 1.74%, aOR: 1.1, 95% CI: 0.7 - 1.8, $P = 0.72$), or cardiac arrest (1.9% vs. 2.8%, aOR: 0.8, 95%

Table 1. Baseline Characteristics of Patients With COVID-19 With IBD and COVID-19 Without IBD

Baseline characteristics	No IBD (weighted n = 1,044,290)	IBD (weighted n = 5,750)	Total (weighted n = 1,050,040)	P value
Age (mean (SE)), years	64.74 (0.08)	64.30 (0.47)	64.74 (0.08)	0.333
Gender (%)				
Male	52.84	46.63	52.8	< 0.001
Female	47.16	53.57	47.2	< 0.001
Race (%)				< 0.001
White	52.52	76.61	52.66	
Black	18.51	11.29	18.47	
Hispanics	20.59	8.78	20.53	
Others	8.38	3.32	8.35	
Comorbidities (%)				
Chronic pulmonary disease	23.44	30.52	23.48	< 0.001
Atrial fibrillation	11.55	12.09	11.55	0.578
Diabetes mellitus	40.83	29.3	40.76	< 0.001
Hypertension	67.7	63.13	67.68	0.001
Congestive heart failure	16.76	16.61	16.76	0.889
Obesity	27.39	22.78	27.37	0.001
Peripheral vascular disease	4.53	5.83	4.53	0.039
Renal failure	20.16	18.35	20.15	0.124
Liver disease	4.51	6.52	4.52	0.002
Neurological disorders	14.22	15.65	14.23	0.154
Deficiency anemias	3.42	5.22	3.43	0.001
Hypothyroidism	13.93	17.65	13.95	< 0.001
Valvular disease	3.87	5.04	3.88	0.036
Smoking	26.94	35.65	26.99	< 0.001
Alcohol abuse	1.88	2.52	1.88	0.106
Drug abuse	1.82	2.87	1.83	0.011
Carotid artery disease	0.49	0.26	0.49	0.272
Dyslipidemia	42.36	41.39	42.36	0.511
Ischemic heart disease	22.24	22.96	22.24	0.556
Prior cerebrovascular disease	8.41	6.35	8.4	0.013
Prior PPM or ICD		3.39	3.56	0.768
Hospital location (%)	3.56			0.353
Rural	11.75	10.52	11.74	
Urban non-teaching	19.31	18.61	19.3	
Urban teaching			68.95	
Bed size of the hospital (%)	68.94	70.87		0.299
Small	25.7	24.78	25.7	
Medium	28.92	27.48	28.91	
Large	45.38	47.74	45.39	
Region (%)				< 0.001
Northeast	17.66	20.43	17.68	
Midwest	23.25	30.35	23.29	
South	41.88	35.04	41.84	
West		14.17	17.19	
Primary expected payor (%)	17.21			< 0.001
Medicare	52.32	56.97	52.34	
Medicaid	11.63	8.28	11.61	
Private insurance	27.7	30.66	27.72	
Self-pay, no charge, or other			8.33	
Elixhauser comorbidity index (%)	8.35	4.09		0.052
0 - 4	68.31	66.17	68.3	
5 - 8	29.77	31.04	29.78	
≥ 9	1.92	2.78	1.92	

IBD: inflammatory bowel disease; PPM: permanent pacemaker; ICD: implantable cardioverter-defibrillator; SE: standard error.

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Table 2. Clinical Outcomes of Patients With COVID-19 With IBD and COVID-19 Without IBD

Clinical outcomes	No IBD (weighted n = 1,044,290)	IBD (weighted n = 5,750)	Total (weighted n = 1,050,040)	Unadjusted OR	95% CI			Adjusted OR	95% CI		
					Lower	Upper	P value		Lower	Upper	P value
Pressor use	1.77	1.3	1.77	0.73	0.45	1.21	0.223	0.80	0.48	1.34	0.401
Invasive mechanical ventilation	9.86	10.26	9.86	1.04	0.86	1.26	0.65	1.18	0.96	1.44	0.109
Cardiogenic shock	0.38	0.35	0.38	0.91	0.34	2.40	0.842	0.97	0.35	2.63	0.946
Disposition to SNF, ICF or other facility	19.77	19.9	19.77	1.01	0.87	1.17	0.914	0.96	0.80	1.15	0.635
Acute kidney injury	25.26	27.04	25.27	1.10	0.96	1.26	0.189	1.29	1.11	1.51	0.001
Acute kidney injury requiring dialysis	1.74	1.65	1.74	0.95	0.61	1.49	0.825	1.09	0.68	1.76	0.719
Gastrostomy	1.27	0.87	1.26	0.68	0.37	1.26	0.225	0.74	0.40	1.37	0.331
Tracheostomy	0.87	0.78	0.87	0.90	0.47	1.73	0.758	0.96	0.49	1.85	0.894
Cardiac arrest	2.78	1.83	2.77	0.65	0.42	1.02	0.062	0.81	0.51	1.28	0.371
In-hospital mortality	11.18	10.35	11.17	0.92	0.76	1.11	0.377	1.00	0.81	1.22	0.973
LOS (mean (SE)), days	7.48 (0.03)	7.7 (0.26)	7.48 (0.03)	0.22	-0.27	0.71	0.383	0.47	-0.02	0.96	0.059
Cost, US$ (mean (SE))	19,085.64 (215.7)	19,160.75 (985.42)	19,086.05 (217.02)	75.11	-1,705.72	1,855.94	0.934	1,272.53	-486.38	3,031.44	0.156

COVID-19 patients with IBD had a higher incidence of acute kidney injury (27.0% vs. 25.3%, aOR: 1.29, 95% CI: 1.1 - 1.5, P = 0.001) than those without IBD. IBD: inflammatory bowel disease; CI: confidence interval; aOR: adjusted odds ratio; LOS: length of stay; SNF: skilled nursing facility; ICF: intermediate care facility; SE: standard error.

Table 3. Subgroup Analysis by Age Groups

	No IBD (n = 483,485)	IBD (n = 2,695)	Total (n = 486,180)	Unadjusted OR	95% CI			Adjusted OR	95% CI		
					Lower	Upper	P value		Lower	Upper	P value
Clinical outcomes for ages 18 - 64											
Invasive mechanical ventilation	9.47	8.91	9.47	0.93	0.70	1.25	0.648	0.99	0.72	1.37	0.964
In-hospital mortality	5.48	4.45	5.47	0.80	0.54	1.20	0.289	0.89	0.58	1.37	0.598
Clinical outcomes for ages 65+	n = 560,805	n = 3,055	n = 563,860								
Invasive mechanical ventilation	10.2	11.46	10.21	1.14	0.89	1.46	0.304	1.27	0.98	1.64	0.07
In-hospital mortality	16.09	15.55	16.09	0.96	0.77	1.20	0.72	01.02	0.81	1.29	0.85

No statistically significant findings were seen after subgroup analysis by age groups. IBD: inflammatory bowel disease; CI: confidence interval; OR: odds ratio.

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CI: 0.5 - 1.3, P = 0.37) in either group. Similarly, there was no statistically significant difference in the likelihood of requiring gastrostomy (0.9% vs. 01.3%, aOR: 0.7, 95% CI: 0.4 - 1.4, P = 0.3) or tracheostomy (0.8% vs. 0.9%, aOR: 0.96, 95% CI: 0.5 - 1.9, P = 0.9) placement between the two cohorts (Table 2).

In-hospital quality measures and disposition

There was no statistically significant difference in the mean length of stay (7.7 days vs. 7.5 days, aOR: 0.47, 95% CI: -0.02 - 0.96, P = 0.06) among the two cohorts. In addition, there was no statistically significant difference in the higher adjusted mean cost of hospitalization (19,160.75 USD vs. 19,085.64 USD, aOR: 1,272.53, 95% CI: -486.38 - 3,031.44, P = 0.16) compared to those without IBD. There was also no difference in the disposition to the facility (skilled nursing facility, intermediate care facility, or other facilities) between the two cohorts (19.9% vs. 19.8%, aOR: 0.96, 95% CI: 0.80 - 1.15, P = 0.64) (Table 2).

Discussion

To our knowledge, this study is the most extensive analysis to evaluate the impact of IBD as a comorbidity among hospitalized COVID-19 patients. According to our analysis, the in-hospital mortality for COVID-19 patients with IBD did not significantly differ as compared to those without IBD. COVID-19 patients with IBD had a significantly higher incidence of developing AKI. However, there was no difference in AKI requiring dialysis, invasive mechanical ventilation or pressor use between the two cohorts. The differences in the incidence of cardiogenic shock and cardiac arrest among the two cohorts were also statistically insignificant. Moreover, there was no statistically significant difference in the mean length of stay or mean cost of hospitalization among those with and without IBD.

One analysis of the Cerner Real World Data (CRWD) COVID-19 database involving 100,902 patients had a 0.30% prevalence of IBD amongst COVID-19 hospitalized patients, which is similar to ours (0.54%) [11]. The same study also concluded that IBD was not associated with increased mortality or mechanical ventilation in COVID-19 patients. However, it revealed a higher prevalence of chronic liver disease and chronic pulmonary disease, consistent with our analysis. The exact pathophysiology behind the higher prevalence of these comorbidities in IBD is not entirely understood; however, it is likely due to the presence of chronic systemic inflammation and has been noted in multiple studies [12-15].

One meta-analysis found the mortality rate among IBD patients who contracted COVID-19 to be 2.5%. Among IBD patients diagnosed with COVID-19, 4% required intensive care unit (ICU) admissions, and one-third required hospitalization [3]. Although the two study populations differ, it does support our own study's findings that a pre-existing diagnosis of IBD is not associated with worsened clinical outcomes in patients with COVID-19 infection. It is seen that altered intestinal angiotensin-converting enzyme 2 (ACE2) levels are associated with disease severity in IBD, and anti-cytokine therapy in IBD patients restores the balance of intestinal ACE2 levels, leading to improved morbidity and mortality [7].

One crucial component of the pathophysiology of COVID-19 infection is the emergence of the cytokine storm. The entry of the SARS-COV-2 virus into the respiratory epithelial cell triggers a pathway resulting in the infiltration of macrophages and neutrophils into the lung tissue. This results in a systemic pro-inflammatory state causing end-organ damage and subsequent multi-organ failure [16, 17]. The exact mechanism by which SARS-COV-2 causes gastrointestinal symptoms like diarrhea is still poorly understood, though it likely involves malabsorption, increased permeability of the luminal mucosa, and gut dysbiosis [18-20]. In theory, IBD patients should have an overall worse clinical outcome; however, our findings could be explained by the fact that IBD patients are usually on immunomodulators that may help suppress the hyperactivation of T cells and subsequently prevent the cytokine storm from developing. Additionally, some studies have suggested cytokine blockers to have potential benefits in the setting of sepsis. JAK inhibitors have been suggested to block viral entry and the TH17 part of the cytokine storm syndrome [21]. In their meta-analysis, Abdullah et al reported the risk of COVID-related hospitalization to be significantly higher in patients with ulcerative colitis (UC) than those with Chron's disease (CD). They attributed this difference to the severe nature of disease, higher level of immunosuppression and higher level of hospitalization in patients with UC. Factors such as advanced age, unvaccinated status, use of oral steroids and proton pump inhibitors, female gender and obesity, as well as other co-morbid conditions like diabetes, hypertension and asthma were also associated with a higher risk of severe COVID-19 infection [4]. In terms of therapies, chronic use of mesalamine resulted in increased hospitalizations, ICU admissions, and mortality in COVID-19 patients [3]. This is likely due to the mechanism of mesalamine as it acts on the peroxisome proliferator-activated receptor-gamma receptor to mitigate a systemic anti-inflammatory response. Similarly, systemic corticosteroids as chronic maintenance therapy for IBD have also been associated with increased mortality and hospitalizations in multiple studies, likely because chronic steroids negatively impact multiple organ systems [3, 22-24]. On the contrary, the continuation of biologic maintenance therapy decreased the prevalence of adverse clinical outcomes in acute COVID-19 infection [3, 7].

Our study concluded that patients with IBD are more susceptible to developing AKI. While AKI is a known extra-intestinal manifestation of IBD, there is a lack of consensus with regards to its etiology with possible causes ranging from drugs and genetics to disease-induced nephrotoxity [25]. Hence, it is safe to say that a complex relationship exists between the incidences of AKI in a patient with IBD, which can easily be complicated even further in the presence of an active COVID-19 infection. A meta-analysis calculated the prevalence of digestive symptoms (nausea or vomiting, diarrhea, and loss of appetite) at 15% in COVID-19 patients [26]. Patients with IBD are generally more susceptible to these

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symptoms; consequently, they develop higher rates of prerenal AKI secondary to dehydration, supporting our study findings. Additionally, we did not see any significant difference in AKI requiring dialysis. This shows that AKI in IBD is usually self-limited and likely due to volume depletion, as seen in the general population [27]. Therefore, timely volume resuscitation is vital in preserving renal function, especially in IBD patients. In our analysis, apart from kidneys, we did not appreciate the increased risk of other organ involvement, likely because IBD patients have a similar hospital course to those without IBD.

These findings agree with prior reviews, which suggest that the standard of care for patients with IBD who are hospitalized for COVID-19 infection is similar to COVID-19 patients without IBD. Recent reviews also suggest that most IBD medications are safe to continue if positive for the SARS-Cov-2 virus, depending on the clinical context [28]. Furthermore, the use of biologics or steroids in IBD patients with COVID-19 has not shown any difference in morbidity and mortality compared to conditions using immunosuppressants without IBD in COVID-19 [29]. Experts also find that other non-steroidal therapies like methotrexate, thiopurine therapy, tumor necrosis factor antagonists, interleukin inhibitors, and JAK inhibitors should be held during symptomatic COVID-19 infection until return to baseline [30].

Limitations

Our study has limitations. First, the database relies on administrative codes, which may be subject to coding errors and may not accurately reflect the true prevalence of certain conditions.

Moreover, it is essential to acknowledge the retrospective nature of the NIS database, which may present certain limitations in understanding the complete picture of COVID-19 patients with IBD. Additionally, the database's focus solely on inpatient hospitalizations might result in a partial representation of the overall impact of COVID-19 on individuals with IBD. The absence of outpatient data is also a limitation that may have affected our ability to assess the association between IBD and COVID-19 outcomes fully. Furthermore, the NIS database did not provide medication information, which limits our ability to establish a causal link based on these variables.

Furthermore, our database lacked the capacity to account for crucial laboratory values, such as complete blood count, inflammatory markers, liver function tests, or indicators of severity, which have been strongly linked to COVID-19-related morbidity and mortality. The absence of such data may impact the comprehensive assessment of the relationship between IBD and COVID-19 outcomes in our study. Overall, while our study provides valuable insights into the impact of IBD on COVID-19 outcomes, the limitations of the NIS database and our study design need to be considered when interpreting the results. Further studies that account for these limitations and include a more detailed assessment of IBD, disease severity, and laboratory values are required to confirm our results. Further research should also take into account the various modalities of IBD treatment and patient compliance to treatment. Looking into whether COVID-19 affects patients with UC and CD differently may also fill the gap in current literature.

Conclusion

Our study sheds valuable light on the relationship between IBD and COVID-19, particularly focusing on clinical outcomes. The findings indicate that, except for a higher incidence of AKI, IBD does not seem to be associated with worsened clinical outcomes in COVID-19. These results align with previous research, adding to the growing body of evidence suggesting that IBD may not significantly increase the risk of adverse outcomes in COVID-19.

However, it is important to note that our study has its limitations, and larger, multicenter studies with more comprehensive data collection are necessary to validate our findings and gain a more in-depth understanding of the impact of IBD on COVID-19 outcomes. Despite these limitations, our research offers valuable insights to clinicians treating COVID-19 patients with IBD. By enhancing our comprehension of the impact of IBD on COVID-19 outcomes, we can optimize treatment approaches and enhance the care provided to this vulnerable population.

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Conflict of Interest

The authors have no conflict of interest to report.

Informed Consent

Not applicable.

Author Contributions

JJ: finalization of manuscript, AA: writing up, RA: writing up and referencing, SA: data gathering, MR: data analysis, AF: data analysis, KG: editing and revision, EE: data analysis and tables, AS: senior author, concept and editing.

Data Availability

The data utilized in this study were sourced from the Health-

care Cost and Utilization Project's National (Nationwide) Inpatient Sample for the year 2020. The NIS is a publicly accessible database, and researchers interested in obtaining the data can directly access it from the HCUP website (https://www.hcup-us.ahrq.gov/ (accessed on 2023)).

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