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ORIGINAL RESEARCH—CLINICAL

# Healthcare Utilization Patterns and Excessive Steroid Use in Late Adolescence Age and Young Adults With Crohn's Disease and Ulcerative Colitis

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**BACKGROUND AND AIMS:** Late adolescents and young adults (AYA) with inflammatory bowel disease (IBD) are a vulnerable population as they transition to adult healthcare. We aim to provide a real-world data on their healthcare utilization patterns and medication use through a large database. **METHODS:** We performed a retrospective cohort study from January 1, 2012, to June 30, 2020, using OneFlorida Data-Trust, an electronic health record-based data repository representing over half of the Florida population. Outcomes of interest included demographics, healthcare utilization, medications, and disease severity. Chi-square tests and logistic regression were used to compare the rates of medication use, healthcare utilization, and disease severity by age groups. **RESULTS:** The number of patients who met our inclusion criteria was 10,578 with 2731 (25.8%) in the 17–25-year-old group. AYA patients had fewer ambulatory visits vs children (90% vs 95%; *P* value <.05). AYA patients were admitted more frequently from emergency facilities vs children (22.3% vs 10.9%; *P* value <.05). AYA patients received steroids more often than adults and younger patients (48.9% vs 45.3 vs 44.3% *P* value <.05, respectively). AYA patients received more narcotic (41.1% vs 22.3 % *P* value <.05) and antidepressant prescriptions (15.9% vs 9.5%; *P* value <.05) compared with children. With advancing age, a decrease in biologic use was noted (51% vs 40% vs 25.4% *P* value <.05, respectively). **CONCLUSION:** AYA patients with IBD have higher rates of hospital admissions from emergency department, fewer ambulatory health visits and they receive more steroids compared to children. Our study demonstrates the need for age-specific IBD programs for AYA patients.

*Keywords:* College students; Access to healthcare; Biologics; Antidepressants; Narcotics

## Introduction

Crohn's disease (CD) and ulcerative colitis (UC) are chronic inflammatory diseases of the gastrointestinal tract affecting millions of people worldwide.[1] Approximately 25% of patients with inflammatory bowel disease (IBD) are diagnosed under the age of 20 with the peak onset in adolescence and young adulthood.[2–4] While adolescence is defined by the World Health Organization as individuals of ages 10–19 years,[5] many consequential, age-specific, life challenges begin in late adolescence and extend into the third decade of life, a timeframe we refer to as late adolescence and young adulthood (referred to here simply as late AYA or AYA). The disease burden for the late AYA population with IBD is not well established. In epidemiologic studies of patients with IBD, young adults are typically grouped with adult patients aged 18–40 or 18–60 years; thus, insight into AYA patients with IBD is limited.

Late AYA are often developing independence including moving away from their family for their education, employment, and/or to start their own family. For AYA patients with IBD, the transition from pediatric to adult health care includes the transition to self-management. The transition period can result in increased rates of nonadherence, a decline of self-management, and an increase in hospital admissions.[6,7] This age group represents a vulnerable population at risk of falling through the cracks in the healthcare system and having worse disease outcomes.[8]

Our prior work has shown that patients in this age group have difficulty adjusting to college and have disease-specific concerns that can affect academic performance, graduation rates, and future success.[9,10] AYA patients with IBD have been found to obtain their care more commonly in emergent or acute settings, with fewer outpatient encounters than patients with IBD of other ages.[11,12]

***Abbreviations used in this paper:*** **AYA, adolescents and young adults; CD, Crohn's disease; CRP, C-reactive protein; CT, computed tomography; CTE, computed tomography enterography; ED, emergency department; EGD, esophagogastroduodenoscopy; IBD, inflammatory bowel disease; MRI, magnetic resonance imaging; UC, ulcerative colitis.**

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The vulnerability of the AYA patient population along with the scarcity of real-world data on healthcare utilization specific to this age group form the basis of our study. We used a large, robust Data-Trust to determine the variables that affect disease severity, complications, and outcomes in AYA patients with IBD aged 17–25 years and compared them to younger vs older populations with IBD.

## Materials and Methods

### Cohort selection

We performed a retrospective cohort study from January 1, 2012, to June 30, 2020, using the OneFlorida Data-Trust (IRB201500466), an electronic health record-based data repository that includes over 22 million patients in over 22 hospitals and 1200 outpatient practices in Florida.[13] Patients diagnosed with CD and UC were identified using ICD +(International Classification of Diseases)-9-CM codes (555.* for CD and 556.* for UC) and ICD-10-CM codes (K50.* for CD and K51.* for UC). The inclusion criteria we formulated are to: 1) have 3 clinical encounters on different days with a diagnosis of CD or UC (2 of which must occur within the same calendar year) or 2) one encounter with a diagnosis of CD or UC and one IBD-specific medication. Medication prescribing data were identified by the National Drug Codes or Healthcare Common Procedure Coding System codes. Subjects included were in the age group cohorts of 6–16 years (children), 17–25 years (AYA), and 26–50 years (older adults), established at the first visit within the study time period. Those 2747 patients who were classified as having both disease phenotypes, CD and UC, were excluded from the main study but included in the sensitivity analysis using an expanded cohort. Patients were followed from study inclusion until the end of the observation period (June 30, 2020). This study was approved by the University of Florida Institutional Review Board with an exempt status for secondary research.

### Outcomes

Outcomes of interest included healthcare utilization (emergency department [ED] visits, hospitalizations, endoscopies, abdominal surgeries, imaging studies, and medications including steroids, narcotics, immunomodulators, and biologics). We also examined disease severity using established surrogates including white blood cell count, hemoglobin, C-reactive protein (CRP), and albumin.[14] Disease activity was determined by blood biomarkers consistent with worse disease activity defined as having any or a combination of the following: CRP >201 mg/L, hemoglobin <8 g/dL, albumin < 3.5 g/dL, and white blood cell count >$11 \times 10^3$ /mL.

### Statistical methods

We estimated (crude) utilization rates for each of the outcomes separately for patients within each age group. Utilization rates were calculated as the number of patients with at least 1 instance of the outcome per follow-up time. Data were examined by disease and age group and summarized by percentages for all categorical variables of interest. Chi-square tests compared rates of medications/healthcare utilization/lab severity categories by age groups, comparing the 6–16 years old group (children) and the 26–50 years old group (older adults) to the 17–25 years old group (AYA) separately. Logistic regression was performed to compare the odds of these outcomes by age groups overall, adjusted for disease type, sex, and race/ethnicity. We then fit further logistic models assessing for age x disease type interactions while continuing to adjust for sex and race/ethnicity. For those interactions observed to be statistically significant ($P < .05$), disease-specific adjusted odds ratios comparing the age groups were reported. All analyses were performed using SAS Version 9.4; statistical significance was defined as $P < .05$ throughout.

## Results

The total number of patients who met our inclusion criteria for IBD in all age groups was 10,578, with 64.6% CD and 35.4% UC (Table 1). The main cohort included 25.8% of patients who were 17–25 years of age, 14.9% of ages 6–16 years, and 59.2% of ages 26–50 years. There was a slightly higher number of female subjects (54%) compared to males (46%). The sample was predominantly non-Hispanic White (47%) followed by Hispanic (24%). The expanded cohort included 12,507 total patients with IBD (CD and/or UC).

Healthcare utilization rates differed between the 3 age groups (Table 2). AYA patients with IBD had fewer

**Table 1.** Total Numbers and Percentages of General Demographics in Relation to All IBD, Crohn's Disease, and Ulcerative Colitis

| Characteristics | All IBD (n = 10,578) | Crohn's disease (n = 6836) | Ulcerative colitis (n = 3742) |
|---|---|---|---|
| Gender | | | |
| Female | 5694 (54%) | 3695 (54%) | 1999 (53%) |
| Male | 4884 (46%) | 3141 (46%) | 1743 (47%) |
| Age group (years) | | | |
| 6–16 | 1584 (15%) | 1181 (17%) | 403 (11%) |
| 17–25 | 2731 (26%) | 1793 (26%) | 938 (25%) |
| 26–50 | 6263 (59%) | 3862 (56%) | 2401 (64%) |
| Hispanic/Race | | | |
| Non-Hispanic White | 4971 (47%) | 3344 (49%) | 1627 (43%) |
| Non-Hispanic Black | 1152 (11%) | 771 (11%) | 381 (10%) |
| Hispanic | 2501 (24%) | 1572 (23%) | 929 (25%) |
| Other | 1645 (16%) | 946 (14%) | 699 (19%) |
| Unknown/No information | 309 (3%) | 203 (3%) | 106 (3%) |

**Table 2.** Percentages of Healthcare Utilization, Medication Use, Procedures, and Disease Severity Indices in All IBD, Crohn's, and Ulcerative Colitis Divided by Age Groups (6–16 y, 17–25 y, 26–50 y)

| | All IBD | | | CD | | | UC | | |
|---|---|---|---|---|---|---|---|---|---|
| % Usage | 6–16 y (n = 1584) | 17–25 y (n = 2731) | 26–50 y (n = 6263) | 6–16 y (n = 1181) | 17–25 y (n = 1793) | 26–50 y (n = 3862) | 6–16 y (n = 403) | 17–25 y (n = 938) | 26–50 y (n = 2401) |
| Ambulatory visits | **94.9** | 90.2 | 90.0 | **95.9** | 90.1 | 88.9 | 92.1 | 90.3 | 91.8 |
| ED visits | 33.0 | 33.7 | 35.3 | 34.3 | 36.6 | **40.5** | 29.3 | 28.0 | 27.0 |
| ED to inpatient admissions | **10.9** | 22.3 | **25.4** | **10.8** | 23.0 | **28.3** | **10.9** | 20.8 | 20.8 |
| Inpatient admissions | **40.1** | 27.9 | 27.6 | **40.2** | 29.9 | 31.1 | **39.7** | 24.0 | **21.8** |
| Narcotics | **22.3** | 41.1 | **55.0** | **22.8** | 44.6 | **61.4** | **21.1** | 34.3 | **44.8** |
| Steroids | **44.3** | 48.9 | **45.3** | **42.4** | 47.1 | 45.9 | **49.9** | 52.3 | **44.3** |
| Antidepressants | **9.5** | 15.9 | **24.9** | **9.6** | 16.6 | **26.9** | **9.2** | 14.6 | **21.7** |
| At least one biologic | **50.6** | 40.0 | **25.4** | **55.2** | 45.8 | 30.5 | **37.0** | 28.8 | **17.2** |
| EGD | **31.0** | 13.5 | 13.9 | **33.8** | 15.7 | 15.7 | **22.8** | 9.2 | 11.1 |
| Colonoscopy | **34.3** | 25.4 | 24.5 | **36.3** | 25.6 | 24.3 | 28.5 | 25.2 | 24.7 |
| MRI abdomen pelvis | **36.4** | 21.0 | **16.2** | **41.4** | 26.7 | **21.7** | **21.8** | 10.2 | **7.3** |
| CT abdomen pelvis | **2.5** | 4.5 | **9.5** | **2.6** | 4.9 | **10.5** | **2.2** | 3.6 | **7.8** |
| CTE | **14.5** | 21.3 | 22.7 | **16.3** | 23.5 | 26.7 | **9.2** | 17.2 | 16.3 |
| Surgeries | 1.9 | 2.2 | **2.9** | 2.1 | 2.8 | 3.4 | 1.2 | 1.0 | **2.2** |
| Severely elevated CRP | **0.9** | 2.5 | 2.4 | **0.9** | 2.8 | 2.7 | 0.7 | 1.8 | 1.8 |
| Severe anemia | 8.0 | 9.4 | **14.7** | 6.5 | 7.8 | **15.0** | 12.2 | 12.7 | 14.2 |
| Hypoalbuminemia | **18.3** | 22.3 | **25.2** | **18.5** | 22.9 | **27.2** | 17.9 | 21.2 | 21.9 |
| Elevated WBC | 32.6 | 31.2 | 30.9 | 32.6 | 32.7 | 34.5 | 32.8 | 28.1 | 25.1 |

Reference group: 17–25 y.
Bold indicates a statistical significance with *P* value < .05.
WBC, white blood cell; EGD, esophagogastroduodenoscopy; CT, computed tomography; CTE, computed tomography enterography.

ambulatory visits compared to children (90% vs 95%; *P* value <.05). AYA patients were more likely to be admitted from ED compared to children (22.3% vs 10.9%; *P* value <.05). Consistent with prior literature,[11,12] when the expanded IBD cohort was analyzed, AYA patients with IBD were more likely to be seen in the ED compared to children with IBD (odds ratio [OR] comparing children to AYA patients = 0.88, 95% confidence interval [CI] = [0.78–0.99]). When CD and UC were considered separately, AYA patients with CD had a greater number of ED visits compared to children (OR comparing children to AYA patients = 0.85, 95% CI = [0.72–0.99]).

AYA patients with IBD received significantly more steroid prescriptions than either older adults or children (48.9% vs 45.3% and 44.3%; *P* value < .05, respectively). There were significant age-related differences in biologic use (Table 2). AYA patients with IBD had higher rates of elevated CRP and low albumin levels when compared to children (2.5% vs 0.9%; *P*-value <.05) and (22.3% vs 18.3%; *P* value <.05, respectively; Table 2). Despite data suggesting more severe disease in our AYA patient cohort, AYA patients had lower utilization of biologics compared to children (Table 3).

AYA patients with IBD received narcotic prescriptions at almost twice the rate as children (41.1% vs 22.3 %; *P* value <.05). They also received more antidepressant prescriptions (15.9% vs 9.5%; *P* value <.05) compared to children.

With regard to advanced radiographic imaging, AYA patients with CD underwent fewer magnetic resonance imaging (MRI) abdomen/pelvis exams (21.0% vs 36.4%; *P* value <.05) and more computed tomography enterography (CTE) exams compared to children (21.3% vs 14.5%; *P* value <.05, Table 2). AYA patients with IBD underwent fewer esophagogastroduodenoscopies (13.5% vs 31.0%; *P* value <.05) and colonoscopies (25.4% vs 34.3%; *P* value <.05) compared to children.

Regression models for healthcare utilization showed similar findings as the univariate analysis results indicating fewer ambulatory visits and greater rates of ED admissions to inpatient hospital stays in AYA patients with IBD compared to children.

Also noted were higher rates of steroids, narcotics, and antidepressants prescriptions and lower biologics utilization, as reported in univariate analysis. Logistic regression analysis revealed significant differences in the odds of some healthcare utilization outcomes when CD and UC were considered separately (Table 4).

For patients with diagnosis codes for both CD and UC who were excluded from the main analysis, a sensitivity analysis was performed. Among the 2747 patients, 767 patients aged greater than 50 years and 51 patients aged less than 6 years were excluded. The overall sample size of our expanded IBD cohort was 12,507. After analysis, there were no significant changes compared to our main analysis.

**Table 3.** Percentages of IBD Medication Prescription Rates in All IBD, Crohn's, and Ulcerative Colitis Based on Age Groups (6–16 y, 17–25 y, 26–50 y)

| | All IBD | | | CD | | | UC | | |
|---|---|---|---|---|---|---|---|---|---|
| % prescribed | 6–16 y (n = 1584) | 17–25 y (n = 2731) | 26–50 y (n = 6263) | 6–16 y (n = 1181) | 17–25 y (n = 1793) | 26–50 y (n = 3862) | 6–16 y (n = 403) | 17–25 y (n = 938) | 26–50 y (n = 2401) |
| Adalimumab | 17.0 | 15.4 | **10.0** | 19.2 | 19.0 | **13.1** | 10.7 | 8.4 | **5.1** |
| Infliximab | **38.1** | 23.0 | **10.6** | **42.3** | 25.7 | **11.9** | **26.1** | 17.8 | **8.6** |
| Vedolizumab | **4.4** | 5.9 | 5.3 | 3.6 | 5.1 | 5.4 | 6.7 | 7.4 | **5.2** |
| Certolizumab | **1.0** | 2.1 | 1.8 | **1.4** | 3.1 | 2.7 | 0.0 | 0.1 | 0.2 |
| Ustekinumab | **2.2** | 3.3 | 3.5 | **2.8** | 4.6 | 5.3 | 0.5 | 1 .0 | 0.5 |
| Etanercept | 0.1 | 0.0 | **0.2** | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.2 |
| Golimumab | 0.5 | 0.4 | 0.5 | 0.3 | 0.1 | 0.2 | 1.0 | 0.9 | 0.9 |
| Natalizumab | 0.1 | 0.2 | 0.3 | 0.1 | 0.2 | 0.5 | 0.0 | 0.1 | 0.0 |
| Cyclosporine | 0.3 | 0.5 | 0.9 | 0.2 | 0.4 | 0.6 | 0.5 | 0.7 | 1.4 |
| Tacrolimus | 3.1 | 3.7 | 3.6 | 2.7 | 3.7 | 3.7 | 4.2 | 3.5 | 3.5 |
| Methotrexate | **24.6** | 9.7 | **4.9** | **28.6** | 12.5 | **6.4** | **12.7** | 4.4 | **2.5** |
| Azathioprine | **6.6** | 13.2 | 12.1 | **5.9** | 13.6 | 13.6 | **8.4** | 12.5 | **9.5** |
| Mesalamine | **32.0** | 36.4 | **34.1** | 27.1 | 24.9 | **22.1** | **46.4** | 58.4 | **53.4** |
| Sulfasalazine | 4.4 | 3.3 | **4.4** | 2.9 | 2.4 | **3.6** | **8.9** | 5.0 | 5.6 |
| Mercaptopurine | **10.9** | 9.0 | **6.3** | **11.5** | 9.1 | **7.2** | 8.9 | 8.7 | **4.8** |
| Biologic[a] | **50.6** | 40.0 | **25.4** | **55.2** | 45.8 | **30.5** | **37.0** | 28.8 | **17.2** |
| Immunomodulator[b] | **37.1** | 27.8 | **20.7** | **40.2** | 30.4 | **24.1** | **28.0** | 22.8 | **15.1** |
| MBS[c] | **34.5** | 38.0 | 36.4 | 28.7 | 26.3 | 24.5 | **51.4** | 60.3 | **55.6** |

Reference group: 17–25 y.
Bold indicates a statistical significance with *P* value <.05.
[a]Biologic = At least one biologic (adalimumab, infiximab, vedolizumab, certolizumab, ustekinumab, golimumab, natalizumab).
[b]Immunomodulator = At least one immunomodulator (methotrexate, azathioprine, mercaptopurine).
[c]MBS, At least one (mesalamine, balsalazide, sulfasalazine).

Using the expanded cohort, we found that AYA patients with IBD had more ED visits compared to children. In addition, AYA patients had lower Hb levels compared to children with IBD (OR comparing children to AYA = 0.79, 95% CI = [0.65–0.96]) consistent with other study findings suggesting more severe disease in the AYA patients.

## Discussion

Our study demonstrates unique patterns of access to healthcare and medication use in AYA patients with IBD. At the transitioning juncture of their life, the challenges AYA patients face are not only shaped by the usual challenges experienced by healthy peers but also the added burden of their chronic disease. The modern concepts of transition readiness from pediatric to adult care include patient self-management behaviors and self-efficacy factors including disease knowledge and medical regimen adherence.[15] Several studies have shown that, compared to adult patients with IBD, adolescents have increased rates of non-adherence, hospital admissions, anxiety, depression, inadequate self-efficacy, insufficient knowledge of the disease, and developmental immaturity.[16–19] While our study results concur with the previous findings demonstrating the different patterns of healthcare utilization among AYA patients with IBD, it also captures real-world data on healthcare utilization based on age groups.

Our data are consistent with prior studies[11,12] demonstrating that AYA patients with IBD access healthcare in acute settings through emergency rooms rather than utilizing ambulatory visits. Our study shows that AYA patients have worse disease activity markers, receive more steroid and narcotic prescriptions, and are more likely to be admitted to the hospital from the ED. These actions could result in, or be the result of, poor disease knowledge and lack of self-management skills among the AYA patients.[18,19]

Poignantly, AYA patients with IBD were more likely to receive steroids and less likely to receive biologics compared to the pediatric IBD population. In their cohort study, Bottema et al demonstrated lower utilization of steroids in adolescents while under the pediatric care compared to adult care.[20] The study group suggested the need for improving clinical care for adolescents during the transitioning period. Oral corticosteroids are highly effective in inducing remission in IBD. However, judicious prescribing is essential to avoid potential side effects.[21] It is possible that the increased steroid prescriptions in the AYA patients are due to the pattern of healthcare utilization seen in this age group and compounded by a lack of stable follow-up in

**Table 4.** Comparison of Odds of Healthcare Utilization Outcomes, Medication Prescriptions, and Disease Severity by Age Group

| | Overall adjusted OR (95% CI) (reference group: 17–25 y) | | Disease-specific adjusted OR (95% CI)[a] (reference group: 17–25 y) | | | |
|---|---|---|---|---|---|---|
| | | | UC | | CD | |
| Outcome | 6–16 y | 26–50 y | 6–16 y | 26–50 y | 6–16 y | 26–50 y |
| Ambulatory visit | **2.18 (1.68, 2.82)** | 0.95 (0.82, 1.11) | 1.30 (0.85, 1.98) | 1.17 (0.90, 1.52) | **2.74 (1.97, 3.81)** | 0.85 (0.70, 1.02) |
| ED visit | 0.88 (0.77, 1.01) | 1.08 (0.97, 1.19) | 1.01 (0.77, 1.32) | 0.97 (0.82, 1.16) | **0.85 (0.72, 0.99)** | **1.14 (1.00, 1.28)** |
| ED admit to inpatient hospital stay | **0.39 (0.33, 0.47)** | **1.18 (1.06, 1.32)** | No significant age × disease interaction | | | |
| Inpatient hospital stay | **1.63 (1.42, 1.86)** | 0.99 (0.89, 1.09) | **2.04 (1.58, 2.63)** | 0.91 (0.76, 1.09) | **1.51 (1.29, 1.76)** | 1.03 (0.91, 1.17) |
| Narcotics | **0.38 (0.33, 0.44)** | **1.77 (1.61, 1.95)** | **0.49 (0.37, 0.65)** | **1.60 (1.36, 1.87)** | **0.36 (0.30, 0.42)** | **1.86 (1.66, 2.10)** |
| Antidepressants | **0.56 (0.46, 0.69)** | **1.63 (1.44, 1.83)** | No significant age × disease interaction | | | |
| Steroids | **0.84 (0.74, 0.95)** | **0.86 (0.78, 0.94)** | 0.91 (0.72, 1.15) | **0.72 (0.62, 0.84)** | **0.83 (0.71, 0.96)** | 0.93 (0.83, 1.04) |
| Biologics | **1.48 (1.30, 1.68)** | **0.52 (0.47, 0.57)** | No significant age × disease interaction | | | |
| Severe CRP | **0.33 (0.19, 0.60)** | 0.96 (0.72, 1.29) | No significant age × disease interaction | | | |
| Severe Hb | 0.88 (0.70, 1.10) | **1.56 (1.34, 1.81)** | 0.95 (0.66, 1.36) | 1.13 (0.90, 1.42) | 0.89 (0.67, 1.20) | **1.93 (1.58, 2.35)** |
| Severe albumin | **0.76 (0.65, 0.89)** | **1.15 (1.04, 1.29)** | No significant age × disease interaction | | | |
| Severe WBC | 1.01 (0.88, 1.15) | 0.96 (0.87, 1.06) | No significant age × disease interaction | | | |
| Abdominal surgery | 0.85 (0.54, 1.32) | 1.33 (0.99, 1.80) | No significant age × disease interaction | | | |

Adjusted odds ratios (95% CIs) comparing 6-16-year-old and 26-50-year-old groups to the AYA group (17–25 y) presented, adjusting for disease type, gender, and race/ethnicity. Overall adjusted odds ratios are presented, unless a significant interaction ($P < .05$) was observed between age and disease type, in which case odds ratios (adjusted for gender and race) for age are presented by disease type.
Adjusted OR's statistically significantly different than 1 are bold indicates.
WBC, white blood cell.
[a]Presented only if a statistically significant ($P < .05$) age × disease type interaction.

an ambulatory setting. Furthermore, nonadherence to IBD medications poses a significant impact on disease outcomes.

Although the association between medication nonadherence and IBD flare symptoms has not been studied extensively in adolescent patients, our data are consistent with a link between receiving less biologics and more steroids to increased ED visits and admissions to the hospital for flares.

While healthier students do better at college,[22] IBD in college students could impact their mental health and well-being at a critical stage in social and emotional development. Almadani et al determined that CD patients adjusted less well to college life than their healthy peers.[10] Our current data suggest increased narcotic and antidepressant prescriptions in the AYA group compared to children with IBD. This is likely compounded by the changes in their relationships with parents and peers as well as the lack of a stable ambulatory healthcare team.

Somewhat disturbingly, AYA patients with IBD underwent fewer abdominal MRI studies and more abdominal CTEs. Though the radiation exposure resulting from CT scans has markedly decreased, the effect of cumulative, low-level exposure on developing tissues is still largely unknown. This underlies the multi-society recommendations favoring MRI technology over CT for routine imaging in patients with IBD.[23] The increased ED visits in the AYA patient population and lower biologic use could account for this increase in CT use.

## Strengths

The paucity of studies on this age group is, in part, due to the difficulty in accessing and engaging this population. Our study lends unique, real-world insights into age-dependent differences in healthcare resource utilization trends in IBD-affected populations.[24] OneFlorida is a large, real-world Data-Trust that includes 22 million lives in the state of Florida.[12] This Data-Trust provides real-world data as it includes the laboratory values and other valuable clinical information that are not routinely found in health care claims data. Additionally, the diverse representation of race and ethnicity in Florida is reflected in the OneFlorida Data-Trust and makes it a useful resource for health-related studies where racial and ethnic disparities exist. OneFlorida has a particularly high representation of Hispanic patients including 24% of our cohort compared to 18.4% representation of Hispanics nationally.[25] Another key feature of the OneFlorida Data-Trust is the linkage between electronic health records data to Medicaid claims data that serves some of the most vulnerable populations.

### Limitations

A limitation of this observational study is that we cannot establish causality between disease severity and healthcare utilization. Nonetheless, these inferences merit further in-depth study. Medication use in this study is based on medication prescribing records and not directly based on mediation adherence. The visits to the ED, hospitalizations, and imaging studies were not specific to IBD though all patients included had an IBD diagnosis. Also, AYA who move out of state for college could limit the number of patients in the AYA group. However, we have demonstrated in a prior study that college students with IBD tend to attend college closer to home[9] which may limit the out-of-state factor. Finally, the generalizability of our data from the state of Florida to the national patient population has not been confirmed and future studies are needed to cover larger geographic locations.

## Conclusion

Our study using a large electronic health record-based database shows that, despite laboratory markers of more severe disease, late AYA with IBD have fewer ambulatory visits, are more likely to be prescribed steroids, and utilize emergency facilities than younger patients. Our data demonstrated biologic use, endoscopic evaluation, disease severity, and cross-sectional imaging in this age group are all consistent with our hypothesis that AYA patients are less likely to receive modern IBD care than other age groups. This study adds real-world data to similar, previously reported work. Organizational initiatives have been shown to play an important role in limiting steroid use and improving patient outcomes.[26]

Patients with IBD aged 17–25 years represent a vulnerable population at risk of falling through the cracks in the healthcare system. AYA with IBD should receive modern, age-specific care. This population would benefit from streamlined pathways for proper healthcare utilization which in turn will improve outcomes. This may include introducing transitioning process and planning at an earlier age at earlier adolescence age and including parents in planning. Our team supports starting online educational programs to connect patients to their healthcare providers in hometown and college town as well as providing the expert support through educational series held online with patients and their families.

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Fatima S. Hussain: Contributed to the data collection, analysis, interpretation, and writing of the whole manuscript and review. Aniruddh Setya: Contributed equally to Fatima Hussain by data collection, analysis, interpretation, and writing of the whole manuscript and review. Isaac Molina: Contributed to the data collection and interpretation. Naueen A. Chaudhry: Contributed to the data analysis, interpretation, and review of the manuscript. Xiaofei Chi: Contributed to the data collection and data analysis. Matthew J. Gurka: Contributed to the data analysis, interpretation, and review of the manuscript. Stephanie L. Filipp: Contributed to the data collection and data analysis. Angela Pham: Contributed to the data analysis, interpretation, and review of the manuscript. David Kerman: Contributed to the data analysis, interpretation, and review of the manuscript. Maria T. Abreu: Contributed as a senior researcher to the data analysis, interpretation, and review of the manuscript. Ellen M. Zimmermann: Contributed as the main senior researcher on the research study in data collection, analysis, interpretation, writing the manuscript and reviewing it.

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**Ethical Statement:**
The corresponding author, on behalf of all authors, jointly and severally, certifies that their institution has approved the protocol for any investigation involving humans or animals and that all experimentation was conducted in conformity with ethical and humane principles of research.

**Data Transparency Statement:**
Data, analytic methods, and study material will not be available to other researchers.

**Reporting Guidelines:**
STROBE.