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Impact of Regional Food Insecurity and Social Vulnerability on Inflammatory Bowel Disease Severity: A Cross-Sectional Analysis

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Abstract

Inflammatory Bowel Disease (IBD) is an autoimmune disorder involving chronic inflammation of the gastrointestinal tract. While research has linked ultra-processed food consumption to its pathophysiology, the role of food access on the severity of IBD remains understudied. This cross-sectional study of Texas inpatient hospitalization data evaluated how county-level food access and social vulnerabilities affect IBD severity. Records of 2,000 patients hospitalized for IBD in 2016 and 2018 were merged with county-level data from the Feeding America and Centers for Disease Control's Social Vulnerability Index datasets. An ordinal logistic regression model assessed predictors of clinical severity using All-Patient Refined Diagnosis-Related Groups scores. The county-level food insecurity rate was a significant predictor of higher clinical severity (OR = 1.03, $p = 0.04$). Conversely, the county-level percentage of food-insecure individuals with incomes above Supplemental Nutrition Assistance Program (SNAP) eligibility but within range for other federal nutrition programs was associated with lower odds of severe illness (OR = 0.88, $p < 0.001$). Advanced age was also a strong predictor, while neither sex nor composite SVI markers reached statistical significance. Overall, these findings identify regional food insecurity as a social determinant of health strongly associated with increased clinical severity of IBD, demonstrating that food access affects clinical outcomes at admission.

Keywords: inflammatory bowel disease, food insecurity, social determinants of health, IBD severity, Texas, social vulnerability index, inpatient hospitalization, county-level health disparities

1. Introduction

Inflammatory Bowel Disease (IBD) encompasses Crohn's Disease and Ulcerative Colitis, two chronic, immune-mediated conditions characterized by relapsing inflammation of the gastrointestinal (GI) tract (Fakhoury et al., 2014; Reddavide et al., 2018). Since 2015, IBD prevalence in the United States has been increasing by 1.72%. With 0.7% of Americans having IBD, Coward et al. projected that total U.S. healthcare costs for IBD would reach $25,243,078,919 by 2025 (Coward et al., 2015).

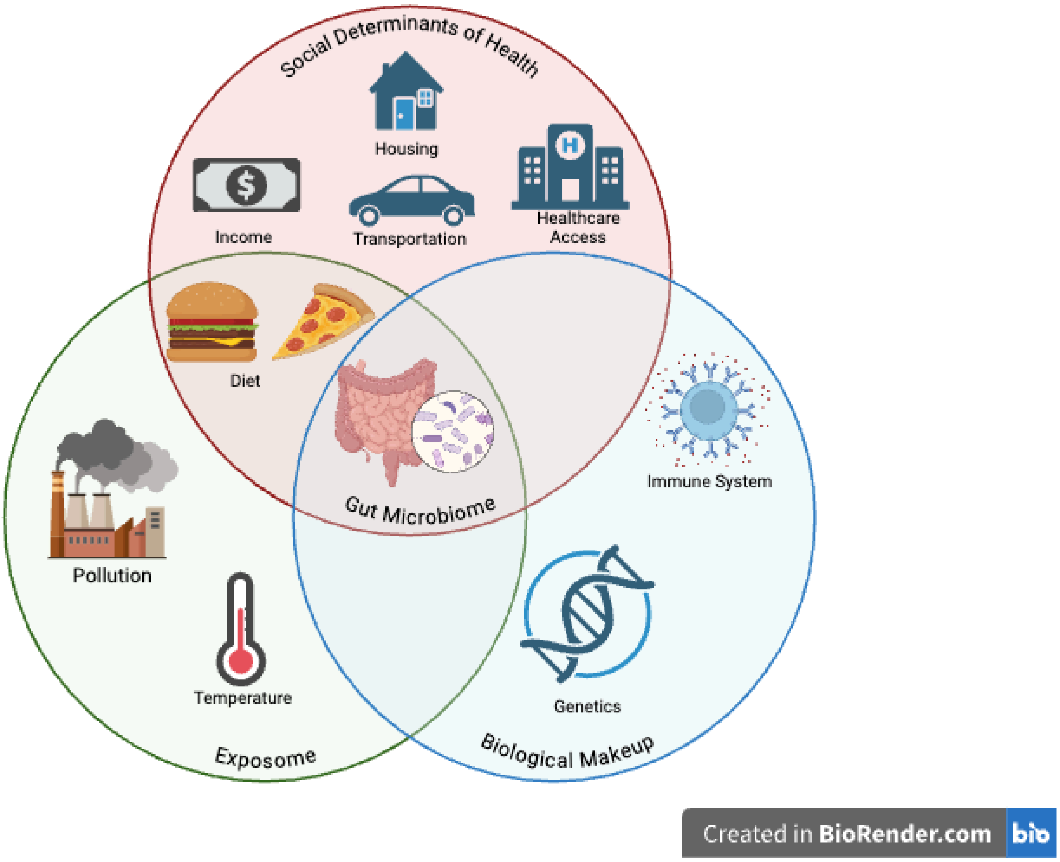

Figure 1: Contributing factors to IBD pathophysiology; created with BioRender.com; the various contributing factors to IBD pathophysiology are illustrated above.

Note: The exposome measures all environmental exposures an individual has experienced throughout their lifetime. Diet is a component of the external exposome that influences the internal exposome, namely the gut microbiome and the immune system. Genetic predisposition makes individuals more prone to developing IBD. The social determinants of health, such as housing, income level, access to transportation, and proximity to the hospital, all influence disease severity and patient outcomes.

While the exact etiology of IBD remains unknown, it is widely accepted to involve immunological, environmental, physiological, and psychosocial factors that trigger genetic predispositions and alter the gut microbiome (Figure 1). The exposome, the total lifetime burden of environmental exposures, is one such factor (Coward et al., 2015). These exposures trigger abnormal immune responses in the GI tract and cause chronic dysbiosis, an imbalance in the gut microbiome that disrupts normal digestion and creates a pro-inflammatory environment (Figure 1).

One major component of the exposome that influences IBD onset and prognosis is diet, as high consumption of ultra-processed foods (UPFs) is associated with increased IBD risk (Abegunde et al., 2016). Food insecurity (FI), defined as inconsistent and unreliable access to food necessary for an active, healthy life, is another component. Both contribute to the chronic nutritional deficiencies that perpetuate dysbiosis in IBD. This impairs the mucosal lining of the GI tract, increasing intestinal permeability to pathogens and amplifying the immune response that drives chronic inflammation in IBD patients (Nguyen & Bollegala, 2014; Nguyen et al., 2020).

The widespread prevalence of FI and consequent UPF consumption raises concerns about gastrointestinal health in the IBD population. Data from the Centers for Disease Control and Prevention's (CDC) 2023 National Health and Nutrition Examination Survey (NHANES) indicated that UPFs accounted for roughly 55.0% of the average American's total caloric intake (Williams et al., 2025). FI also affects 11-14% of the current population in the United States. In an analysis of the National Health Interview Survey carried out by the CDC, it was found that individuals with IBD face a higher risk of experiencing FI than the average US adult, with 14% of individuals with IBD in the US eligible for classification as food insecure (Gold et al., 2024; Baniqued et al., 2025).

Yet, FI is just one component of the Social Determinants of Health (SDoH) that influence IBD quality of care and health outcomes. The SDoH is defined as the conditions in which people grow, live, learn, and work. It is grouped into five categories: financial stability, access to quality education, quality healthcare, neighborhood environment, and community support (Chirayath et al., 2025; Figure 1). Of these factors, neighborhood socioeconomic disadvantage has been independently associated with 30-day mortality for patients with common gastrointestinal diseases, and lower socioeconomic status has also been linked to increased rates of outpatient visits in persons with IBD (Vrtikapa et al., 2025; Clark et al., 2025). Given the documented impacts of these structural inequalities on the health outcomes of IBD patients, recent research has focused on identifying their compounding effects alongside patient demographics and physiological symptoms to better track disease progression and healthcare utilization of IBD patients.

A study by Shah et al. (2022) used clinical charts and self-reported surveys from a major Texas hospital system to evaluate the effectiveness of incorporating SDoH, alongside disease extent and behavior, in IBD patients for predicting whether patients would need hospitalization or surgery (Shah et al., 2022). Although the model demonstrated that incorporating the SDoH improves the performance of predictive models, the fact that the majority of patients were insured and reported no financial, food security, or transportation concerns led to the conclusion that these factors have limited impact on the likelihood of adverse health outcomes.

Prior research relied on self-reported measures within a single institution, limiting generalizability. Publicly available, county-level indicators that capture structural food-access conditions and social vulnerabilities independent of individual recall allow for a more objective evaluation of their association with IBD severity. Accordingly, this study examines how food-access disparities and socioeconomic vulnerabilities affect the severity of inflammatory bowel disease across demographic groups in Texas.

2. Methods

The Texas Health Care Information Collection (THCIC) program was used to collect inpatient hospitalization records for the years 2016 and 2018. Since these are publicly available secondary data that are de-identified, no IRB approval was required. Patients were filtered based on the Major Diagnostic Category for digestive diseases and refined to include only Inflammatory Bowel Disease based on All-Patient Refined Diagnosis-Related Groups (APR-DRG); ICD-9 or ICD-10 diagnosis codes were not used. Records with unknown or missing county of residence were excluded, yielding a final cohort of 2,000 patients. As county-level food access metrics also vary by year, hospitalizations from 2016 and 2018 were treated as independent records despite the possibility that the same patient may have been admitted both years. Patients with an unknown recorded sex were retained as a separate category because they represented a substantial population of the cohort. Each patient's sex, age group, county of residence, and illness severity were compiled. The APR-DRG severity scale was used to quantify the patient's severity of illness, with 1 indicating Minor, 2 Moderate, 3 Major, and 4 Extreme.

Food insecurity data were obtained through a direct request to the Feeding America organization to acquire their Map the Meal Gap datasets. County-level food insecurity rates and average meal costs were compiled for each calendar year. The percentage of food-insecure individuals with incomes below the federal or state eligibility limit for nutrition programs (165% of the Federal Poverty Line for the state of Texas) was also collected. Additionally, the percentage of food-insecure individuals with incomes above SNAP eligibility but within the range for other federal nutrition programs (within 165-185% of the Federal Poverty Line for the state of Texas) was included.

The analysis focused on the 2016 and 2018 retrospective cohorts to correspond to the CDC and Agency for Toxic Substances and Disease Registry's Social Vulnerability Index (SVI) dataset, which is released biennially and publicly accessible. The composite social vulnerability score and its four principal theme scores (Socioeconomic Status, Household Characteristics, Racial and Ethnic Minority Status, and Housing Type and Transportation) were compiled for all 254 counties in Texas. Socioeconomic Status (Theme 1) measures individuals in a county who are below the poverty level, unemployed, classified as low income, or without a high school diploma. Household Composition and Disability (Theme 2) captured household composition by accounting for residents aged 65 or older, those aged 17 or younger, civilians living with a disability, and single-parent households. Minority Status and Language (Theme 3) evaluated the proportion of the population identifying as a minority, as well as the proportion of individuals who speak English "less than well." Finally, Housing Type and Transportation (Theme 4) assessed infrastructural vulnerabilities, including residents living in multi-unit structures, mobile homes, crowded housing, group quarters, or households without access to a vehicle.

Restricting the study period to 2016 and 2018 also excluded the 2020 dataset to avoid the potential clinical and healthcare utilization confounders introduced by the COVID-19 pandemic.

For each record acquired from the THCIC dataset, the patient's county of residence and data year were used to assign their county-level food insecurity and SDoH metrics. This data was used to run an ordinal logistic regression model in R version 4.5.2 (R Core Team, 2025). The *clm*() function from the ordinal package was used to evaluate the effects of these multi-level demographic and socioeconomic factors on IBD disease severity. Model fit was assessed using a likelihood ratio test against the null model and Nagelkerke's pseudo R^2, found with the *nagelkerke*() function from the *rcompanion* package. The proportional odds assumption was tested using the Brant test, through the *brant*() function from the *brant* package. To do so, the model was refitted with *polr*() from the MASS package. A pairwise correlation check was conducted for all continuous predictors. Finally, the p-value and odds ratio of the independent variables were evaluated using the *coeftest()* function from the *AER* package.

All food insecurity, demographic, and social vulnerability variables were selected based on their established relevance to IBD severity in existing research, rather than chosen after seeing the results. They were entered simultaneously into a single model, and interaction terms between variables were not tested.

3. Results

A total of 2,000 patients who were hospitalized for IBD in the state of Texas in 2016 and 2018 were identified. Within this cohort, females represented 49.95% of the sample (n = 999), males represented 41.40% (n = 828), and 8.65% (n = 173) had an unidentified or unknown sex (Table 1a). Pediatric patients (ages 0-17) comprised 11.05% (n = 221) of the cohort. The primary age demographic of the sample was 18-44 years, at 34.45% (n = 689), while the middle-aged 45-64 years age group represented 27.50% of the sample (n = 550). Older demographics comprised 292 individuals aged 65 to 74 and 248 aged 75 and older, representing 14.60% and 12.40% of the population, respectively (Table 1a).

Table 1a: Patient demographics and severity of illness (n = 2000)

Demographic category	Patient count (n)	Percentage (%)
Sex		
Female	999	49.95%
Male	828	41.40%
Unknown	173	8.65%
Age		
0-17	221	11.05%

18-44	689	34.45%
45-64	550	27.50%
65-74	292	14.60%
75+	248	12.40%
APR-DRG illness severity		
Minor	501	25.05%
Moderate	795	39.75%
Major	551	27.55%
Extreme	153	7.65%

When evaluating baseline clinical severity using the APR-DRG scale described above, the majority of patients had moderate illness severity, accounting for 39.75% (n = 795). Extreme severity of illness was the least prevalent manifestation, accounting for 7.65% of the total cohort (n = 153). Additionally, 501 individuals (25.05%) presented with minor severity of illness, and 551 individuals (27.55%) with major severity of illness.

At the county level, the median percentage of food-insecure individuals with household incomes at or below their state's Supplemental Nutrition Assistance Program (SNAP) gross income limit was 35.40% (Table 1b). The median percentage of food-insecure individuals with household incomes above the SNAP gross income limit but within the federal gross income limit for other federal nutrition programs, such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), was 2.93%. Across all 254 counties over two years, the median cost per meal was $2.87.

Table 1b: County-level environmental and socioeconomic medians

Metric	Value
% FI ≤ low threshold	Median: 35.40%
% FI between thresholds	Median: 2.93%
Cost per meal ($)	Median: $2.87
RPL Theme 1 (socioeconomic status)	Median: 0.43
RPL Theme 2 (household characteristics)	Median: 0.34
RPL Theme 3 (racial & ethnic minority status)	Median: 0.55
RPL Theme 4 (housing type & transportation)	Median: 0.58
RPL themes overall	Median: 0.52

Note: Ranked Percentile (RPL) values range from 0 to 1, with higher values signifying greater vulnerability. % FI ≤ Low Threshold: percentage of food insecure individuals at or below SNAP income level. % FI Between Thresholds: percentage of food insecure individuals with incomes above SNAP eligibility but below WIC/other program levels.

For overall county-level social vulnerability metrics, the overall median social vulnerability score across all categories was 0.52, where higher values indicate greater vulnerability (Table 1b). When examining the stratified subgroups, the median score was 0.43 for socioeconomic status (Theme 1), 0.34 for household characteristics (Theme 2), 0.55 for Racial and Ethnic Minority Status (Theme 3), and 0.58 for Housing Type and Transportation (Theme 4). Patient demographics and county-level socioeconomic summary statistics are shown in Table 1a and Table 1b.

Analysis of IBD severity (2016 and 2018)

The associations between county-level food insecurity, demographic factors, and IBD severity are summarized in Table 2. All predictors were entered simultaneously into a single ordinal logistic regression. There was a significantly improved fit over the null model (likelihood ratio $\chi^2 = 76.50$, df = 15, $p < 0.001$), though Nagelkerke's pseudo R^2 was 0.041.

Table 2: Odds ratios for predictors of increased IBD severity (2016 and 2018)

Predictor	Odds ratios (95% CI)	p-value
Food insecurity rate	1.03 (1.00, 1.07)	0.040*
% FI between thresholds	0.88 (0.82, 0.95)	<0.001*
% FI low threshold	1.00 (0.99, 1.00)	0.43
Cost per meal	1.16 (0.66, 2.03)	0.61
Age 18-44	0.84 (0.63, 1.13)	0.24
Age 45-64	1.07 (0.79, 1.43)	0.67
Age 65-74	1.46 (1.06, 2.02)	0.02*
Age 75+	2.09 (1.49, 2.92)	<0.001*
Sex M	1.00 (0.85, 1.19)	0.98

Sex F	1.00 (0.84, 1.18)	0.98
Sex unknown	1.18 (0.87, 1.61)	0.28

Note. *Statistically significant value with the p-value < 0.05. Odds ratios are rounded to two decimal places. The unrounded food insecurity rate coefficient (OR = 1.0336) is used in the Analysis and Discussion sections.

For 2016 and 2018, county-level food insecurity emerged as a statistically significant predictor of more severe manifestations of IBD, with a 3.36% increase in odds per 1% increase in food insecurity (unrounded OR = 1.0336, noted as 1.03 in Table 2; p = 0.04). The percentage of food-insecure individuals at or below the state's SNAP gross income limit (165% of the Federal Poverty Level) showed a negligible, non-significant association with IBD severity (p = 0.43). In contrast, the percentage of food-insecure individuals with household incomes above the SNAP gross income limit but below the upper gross income threshold for alternative federal nutrition programs was significantly associated with lower odds of IBD severity (OR = 0.88, p < 0.001). Despite the slight increase in odds of greater illness severity, the average cost per meal demonstrated no significant impact (OR = 1.16, p = 0.61).

Beyond food insecurity metrics, age also appeared as a statistically significant predictor of patient severity of illness, with older age groups having a strong positive association with increased IBD severity compared to younger patients, meaning the odds of severe illness rose as age increased (Table 2). The geriatric cohort aged 75 years and above exhibited more than double the odds of experiencing increased IBD severity (OR = 2.09, p < 0.001). The 65 to 74-year age group exhibited a similarly significant positive association, although to a lesser extent, with an estimated 46% increase in the odds of heightened clinical severity (OR = 1.46, p = 0.02). The 45 to 64-year age group showed slightly higher odds of IBD severity (OR = 1.07, p = 0.67), while the 18-44-year age group showed lower odds of IBD severity (OR = 0.84, p = 0.24).

Neither the composite social vulnerability score nor the four social vulnerability themes were statistically significant predictors of increased IBD severity (Figure 1). Measures of economic hardship and financial resilience, as represented by Theme 1 (Socioeconomic Status), were inversely associated with the severity of IBD, meaning higher socioeconomic vulnerability corresponded to lower odds of severe illness in this sample (OR = 0.59, p = 0.30). Similarly, Theme 2, involving care dependency and household income sources, showed lower odds of severity; this was not statistically significant (OR = 0.57, p = 0.09). The association between severity of illness and county-level racial and ethnic minority distributions (Theme 3) was close to an OR of 1 (p = 0.83). Neighborhood structural dynamics, such as housing density and transportation infrastructure (Theme 4), were associated with lower odds of extreme IBD presentation but were not statistically significant (OR = 0.47, p = 0.09). The aggregation of these themes yielded a county's composite SVI score, which was associated with three times higher odds of experiencing a more severe manifestation of disease; however, this was not statistically significant (OR = 3.66, p = 0.18) (Figure 1).

Finally, the association between clinical disease severity and patients' recorded sex was evaluated. Sex F was the model's reference category, so only the Sex M and Sex Unknown coefficients were directly estimated. To also report Sex F's odds ratio relative to the Sex M category, the Sex F row in Table 2 shows the reciprocal of the Sex M odds ratio (1/OR). The 95%

confidence interval bounds were also inverted and swapped. Male patients had marginally higher odds of more severe IBD than female patients, though the difference was negligible and not statistically significant. Individuals whose sex was classified as "unknown" experienced somewhat greater odds of more severe IBD (OR = 1.18), though this finding was not statistically significant either (Table 2).

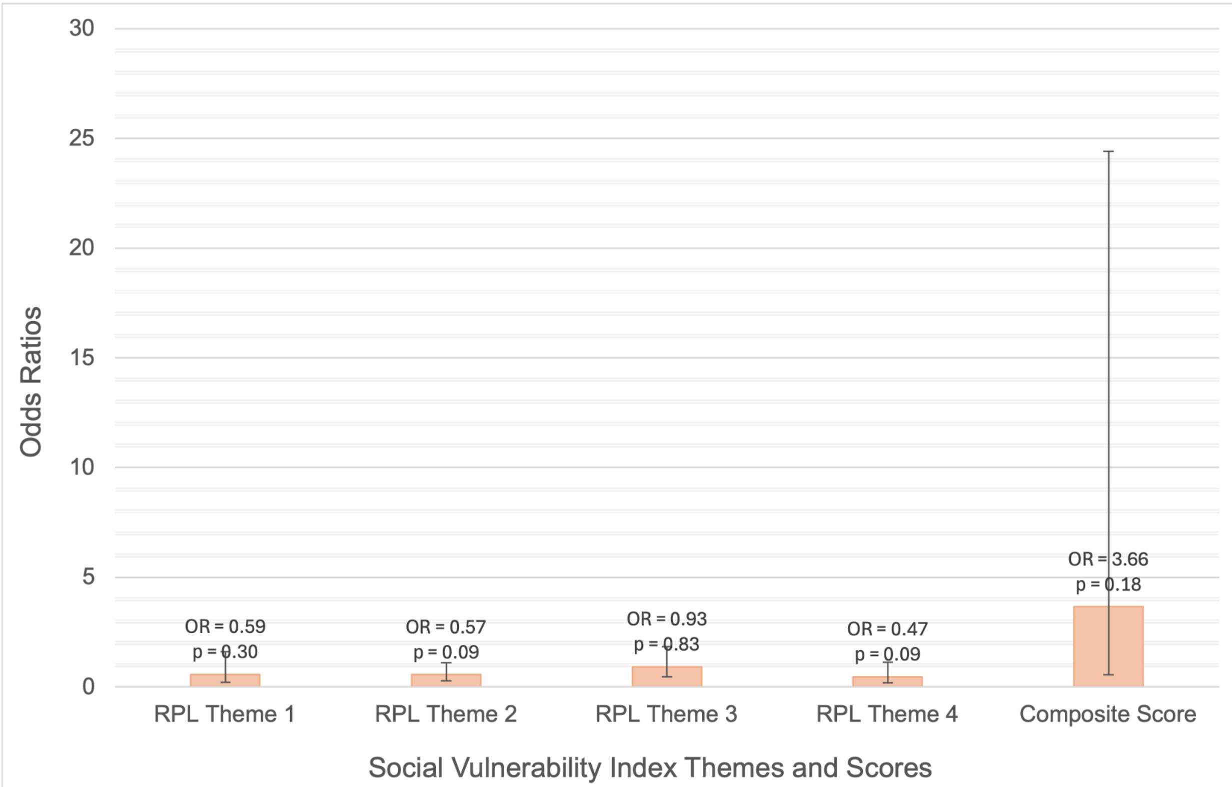

Figure 1: Association of SVI RPL Themes and the SVI Composite Score of a County with IBD Severity.

The proportional odds assumption was tested using the Brant test and required each predictor's effect on IBD severity to be consistent across all severity thresholds: Minor and Moderate, between Moderate and Major, and between Major and Extreme. The omnibus test indicated an overall violation of this assumption ($\chi^2 = 68.93$, df = 30, $p < 0.001$). The specific variables that contributed to this violation at the $p < 0.05$ level were Socioeconomic Status (Theme 1), the composite SVI score, Age 75+, and the percentage of food-insecure individuals between thresholds.

4. Discussion

In this cross-sectional study of patients hospitalized for IBD in Texas in 2016 and 2018, the association between food insecurity, income level, social vulnerability, and disease severity was analyzed. Individuals with IBD have 3.36% higher odds of experiencing more severe illness for each percentage-point increase in county-level food insecurity rates. On its own, this increased likelihood appears to be small. However, because odds ratios compound multiplicatively, this effect grows substantially across counties. The range of food insecurity rates observed in Texas counties spanned from 4.90% to 24.00% in this dataset, a difference of roughly 19.10 percentage points. This corresponds to a maximum compounded odds ratio of 1.89, or nearly 89.40% higher odds of severe IBD, when comparing a county with a low food insecurity rate to a county with a high food insecurity rate. Because county-level indicators do not depend on individual patients accurately recalling or disclosing their own food security status, they can be applied uniformly across an entire hospitalized population, including patients whose individual social history was incompletely documented, offering a scalable screening signal that patient-level, self-reported data alone cannot provide.

As this study measured food insecurity at the county level rather than for individual patients, the following mechanistic explanations from individual-level literature offer a plausible explanation for the findings of this study. Food-insecure IBD patients are 27% more likely to consume ultra-processed foods and 29% less likely to consume unprocessed foods compared to those who are food-secure (Nguyen et al., 2020). Furthermore, cross-sectional analyses of the NHANES show that food insecurity is associated with 21% higher odds of elevated C-reactive protein (an inflammatory marker) and 36% higher odds of high white blood cell counts, consistent with an association between the dietary patterns of food-insecure patients and inflammation and immune activation (Gowda et al., 2012). An additional explanation is that UPFs are also nutritionally deficient and may delay healing (Lobionda et al., 2019; Scaldaferri et al., 2017). The mucosal lining of the gastrointestinal tract becomes impaired due to nutritional inadequacy, increasing intestinal permeability and the immune response that causes IBD flares. Further consequences include prolonged hospitalization, infection, venous thromboembolism, and increased postoperative mortality (Kane et al., 2014; Michielan & D'Incà, 2015; Men et al., 2019). Malnutrition affects 65-75% of patients with Crohn's disease and 18-62% of patients with ulcerative colitis, making it a major concern for this population (Scaldaferri et al., 2017). Taken together, these findings suggest that county-level food access metrics may help identify geographic regions where hospitalized IBD patients face elevated risk of severe illness, warranting further individual-level investigation to confirm the mechanisms proposed above.

The percentage of food-insecure individuals whose incomes fell above the SNAP gross income limit but within the upper threshold for alternate federal nutrition programs was significantly associated with lower odds of IBD severity. These individuals are within the "SNAP gap," where household income exceeds the SNAP eligibility threshold yet food insecurity rates remain elevated at approximately 25% (Wentworth et al., 2018). However, they still qualify for other federal nutrition assistance programs like WIC. Despite being food insecure, these households have somewhat greater financial resources than those at or below the SNAP threshold, and their continued eligibility for other federal nutrition programs may help buffer severe nutritional deprivation. By contrast, the percentage of food-insecure individuals at or below the SNAP income threshold did not reach statistical significance. This finding should not be interpreted as evidence that SNAP participation is ineffective, since this study measured county-level income eligibility for SNAP, not whether individual patients were actually enrolled in or received SNAP benefits. Prior individual-level research has shown that SNAP enrollment reduces the likelihood of food insecurity by approximately 30% among enrolled households (Ratcliffe et al., 2011; Geanacopoulos et al., 2025); the null finding here is more likely to reflect the limits of using an eligibility threshold as a proxy for program participation than any conclusion about SNAP's effectiveness.

Beyond food access, age emerged as one of the most significant predictors of IBD severity in the cohort. Patients aged 75 years and older had more than double the odds of severe illness relative to the pediatric age group. The 65 to 74-year cohort showed a similarly significant, though smaller, increase in odds. The results are consistent with the recorded

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growing global burden of IBD in older adults. The absolute number of elderly IBD cases more than doubled globally between 1990 and 2021, increasing from 573,500 to 1,278,190. Projections indicate that elderly IBD prevalence may reach 2,316,000 by 2051. Deaths and disability-adjusted life years were also estimated to increase to 75,000 and 1,401,000, respectively, by 2051 (Liu et al., 2024). This pattern could be explained by elderly patients' immunosenescence, the gradual decline of the immune system that occurs with age, which results in the impaired function of dendritic cells, phagocytes, and natural killer cells (Berrut & de Decker, 2015). Dysfunction of these innate immune cells results in the gut microbiome secreting pro-inflammatory cytokines and mediators, which destroy tissue and create excessive fibrosis in the GI tract (Saez et al., 2023; Steinbach & Plevy, 2014). While this study cannot confirm that immunosenescence drives the age-related severity pattern observed here, it remains a biologically plausible explanation consistent with the broader literature.

In contrast to age and food insecurity, neither sex nor county-level social vulnerability achieved statistical significance as a predictor of IBD severity. This study found that male patients had marginally higher odds of more severe illness than female patients despite the lack of significance, a direction consistent with prior findings that male IBD patients are 42% more likely to require surgery than female patients (Rasmussen et al., 2024). Similarly, despite comparatively high odds ratios for several social vulnerability measures, none reached statistical significance. One possible contributor is variation in healthcare utilization patterns across socioeconomic groups. Publicly insured patients have been shown to have 2.82 times higher odds of high inpatient costs and 2.50 times higher odds of high emergency spending, while low-income IBD patients are 62% less likely to use outpatient services (Park et al., 2014). This pattern could distort severity scores recorded in administrative datasets like the one used here. As such, the role of insurance and income in social vulnerability should be treated as a hypothesis for future research rather than an established cause of the null findings.

4.1. Limitations

The paper assumes that individuals included in the THCIC dataset are consistent across all datasets used in the study. Because food insecurity and social vulnerability were measured at the county level and assigned to individual patients based on county of residence, this study is subject to the ecological fallacy. It is the risk that relationships observed at the group level do not necessarily hold for individuals within that group (Robinson, 1950/2009). County-level food insecurity does not necessarily reflect whether any given hospitalized patient was personally food insecure, and this limitation should be kept in mind when interpreting all food insecurity and social vulnerability findings reported here.

No formal statistical model was used to account for missing data in this study. Records with missing county of residence were excluded from the analysis, and patients with unknown recorded sex were retained as their own category since they represented a substantial part of the cohort. As no formal missing-data model, such as multiple imputations, was applied, the extent to which excluded or unknown records differ systematically from the analyzed cohort cannot be ruled out.

Several important variables were not available in this dataset and could not be adjusted for, including whether patients had Crohn's disease or ulcerative colitis, comorbidities, insurance status, disease duration, race/ethnicity, hospital characteristics, and urban versus rural residence. The absence of these variables limits the ability to isolate the independent effect of food insecurity and social vulnerability from other factors that plausibly influence IBD severity.

A pairwise correlation check identified substantial collinearity between the composite SVI score and two of its component themes, Socioeconomic Status and Housing Type and Transportation. This is likely because the composite score is mathematically derived from its component themes. Since the composite score and its individual themes were included in the same regression model, collinearity may have inflated standard errors and reduced the ability to detect true associations for these variables. It may also explain why none of the social vulnerability measures reached statistical significance despite several large odds ratios. Additionally, the proportional odds assumption was violated overall and for four individual predictors: Socioeconomic Status (Theme 1), the composite SVI score, Age 75+, and the percentage of food-insecure individuals between thresholds. Socioeconomic Status (Theme 1) and the composite SVI score were also the two variables flagged for collinearity in the pairwise correlation check; both the collinearity and the proportional odds violation were observed for these predictors and may affect interpretation. For Age 75+ and the percentage of food-insecure individuals between thresholds, the violation is not explained by collinearity and instead suggests these variables' true effects on IBD severity differ across thresholds. For example, these variables may have a stronger influence on the transition from major to extreme illness than on the transition from minor to moderate illness. In both cases, the single odds ratio reported in Table 2 should be understood as an average effect across thresholds rather than a uniform one.

5. Conclusion

This study contributes a novel population-level perspective on the determinants of IBD severity in Texas, a state defined by geographic and demographic heterogeneity in food access and socioeconomic vulnerability. The study revealed that county-level food insecurity and advanced age were significantly associated with increased odds of severe IBD presentation in our sampled population. Conversely, neither sex nor county-level social vulnerability measures were significant predictors of clinical severity in this sample. These findings suggest a potential role for incorporating food-access screening into IBD patient care. Pairing such screening with targeted nutritional interventions and assistance navigating federal food assistance programs may represent a meaningful, actionable strategy for lessening the disparate burden of this severe chronic disease among vulnerable patient populations, potentially reducing severe, resource-intensive hospitalizations.

6. References

Abegunde, A. T., Muhammad, B. H., Bhatti, O., & Ali, T. (2016). Environmental risk factors for inflammatory bowel diseases: Evidence based literature review. World Journal of Gastroenterology, 22(27), 6296. https://doi.org/10.3748/wjg.v22.i27.6296

Baniqued, M. R., Greb, A. C., Shah, N. D., Parian, A. A., Li, Z., Limketkai, B. N. (2025). Nationwide analysis of food insecurity among individuals with inflammatory bowel disease in the United States. Inflammatory Bowel Diseases, 32(4), 695-701. https://doi.org/10.1093/ibd/izaf289

Berrut, G., & de Decker, L. (2015). Immunosénescence : une revue [Immunosenescence: a review]. Geriatrie et psychologie neuropsychiatrie du vieillissement, 13 Suppl 2, 7–14. https://doi.org/10.1684/pnv.2015.0548

Chirayath, S., Bahirwani, J., Pandey, A., Memel, Z., Park, S., & Schneider, Y. (2025). Inpatient nutritional considerations in inflammatory bowel disease. Current Gastroenterology Reports, 27(1). https://doi.org/10.1007/s11894-024-00958-0

Clark, A. G., Bae, J., Townsend, M. J., Patel, A., Muir, A. J., & Hammill, B. G. (2025). Neighborhood socioeconomic deprivation and 30-day outcomes after admission for common gastrointestinal conditions: A large nationwide study. Gastro Hep Advances, 4(5), 100614. https://doi.org/10.1016/j.gastha.2025.100614

Coward, S., Clement, F., Williamson, T., Hazlewood, G., Ng, S., Heitman, S., Seow, C., Panaccione, R., Ghosh, S., & Kaplan, G. G. (2015). The Rising Burden of Inflammatory Bowel Disease in North America from 2015 to 2025: A Predictive Model: 1959. Official Journal of the American College of Gastroenterology | ACG, 110, S829. https://journals.lww.com/ajg/fulltext/2015/10001/The_Rising_Burden_of_Inflammatory_Bowel_Disease_in.1959.aspx

Fakhoury, M., Al-Salami, H., Negrulj, R., & Mooranian, A. (2014). Inflammatory bowel disease: Clinical aspects and treatments. Journal of Inflammation Research, 7(7), 113-120. https://doi.org/10.2147/jir.s65979

Geanacopoulos, A. T., Branley, C. E., Garg, A., Samuels-Kalow, M. E., Gabbay, J. M., & Peltz, A. (2025). Missed opportunities to address SNAP for nonenrolled children. Pediatrics, 155(3). https://doi.org/10.1542/peds.2024-066652

Gold, S., Kohler, D., Freid, H., Haskey, N., & Raman, M. (2024). Food insecurity is common in patients with inflammatory bowel disease and is associated with increased ultra-processed food intake. Nutrients, 16(21), 3736. https://doi.org/10.3390/nu16213736

Gowda, C., Hadley, C., & Aiello, A. E. (2012). The association between food insecurity and inflammation in the US adult population. American Journal of Public Health, 102(8), 1579-1586. https://doi.org/10.2105/AJPH.2011.300551

Kane, A. V., Dinh, D. M., & Ward, H. D. (2014). Childhood malnutrition and the intestinal microbiome. Pediatric Research, 77(1-2), 256-262. https://doi.org/10.1038/pr.2014.179

Liu, Y., Li, J., Yang, G., Meng, D., Long, X., & Wang, K. (2024). Global burden of inflammatory bowel disease in the elderly: Trends from 1990 to 2021 and projections to 2051. Frontiers in Aging, 1, 1479928. https://doi.org/10.3389/fragi.2024.1479928

Lobionda, S., Sittipo, P., Kwon, H. Y., & Lee, Y. K. (2019). The role of gut microbiota in intestinal inflammation with respect to diet and extrinsic stressors. Microorganisms, 7(8), 271. https://doi.org/10.3390/microorganisms7080271

Men, F., Gundersen, C., Urquia, M. L., & Tarasuk, V. (2019). Prescription medication nonadherence associated with food insecurity: A population-based cross-sectional study. CMAJ Open, 7(3), E590-E597. https://doi.org/10.9778/cmajo.20190075

Michielan, A., & D'Incà, R. (2015). Intestinal permeability in inflammatory bowel disease: Pathogenesis, clinical evaluation, and therapy of leaky gut. Mediators of Inflammation, 2015(1), 1-10. https://doi.org/10.1155/2015/628157

Nguyen, G. C., & Bollegala, N. (2014). Factors associated with readmissions and outcomes of patients hospitalized for inflammatory bowel disease. Clinical Gastroenterology and Hepatology, 12(11), 1897-1904.e1. https://doi.org/10.1016/j.cgh.2014.02.042

Nguyen, N. H., Khera, R., Ohno-Machado, L., Sandborn, W. J., & Singh, S. (2020). Prevalence and Effects of Food Insecurity and Social Support on Financial Toxicity in and Healthcare Use by Patients With Inflammatory Bowel Diseases. Clinical Gastroenterology and Hepatology, 19(7). https://doi.org/10.1016/j.cgh.2020.05.056

Park, M. D., Bhattacharya, J., & Park, K. (2014). Differences in healthcare expenditures for inflammatory bowel disease by insurance status, income, and clinical care setting. PeerJ, 2(e587), e587. https://doi.org/10.7717/peerj.587

R Core Team. (2025). R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/

Rasmussen, N. F., Moos, C., Helene, L., Hikmat, Z., Andersen, V., Green, A., Jess, T., Madsen, G. I., Pedersen, A. K., Petersen, S. R., & Kjeldsen, L. J. (2024). Impact of sex and socioeconomic status on the likelihood of surgery, hospitalization, and use of medications in inflammatory bowel disease: A systematic review and meta-analysis. Systematic Reviews, 13(1). https://doi.org/10.1186/s13643-024-02584-3

Ratcliffe, C., McKernan, S.-M., & Zhang, S. (2011). How much does the Supplemental Nutrition Assistance Program reduce food insecurity? American Journal of Agricultural Economics, 93(4), 1082-1098. https://doi.org/10.1093/ajae/aar026

Reddavide, R., Rotolo, O., Caruso, M. G., Stasi, E., Notarnicola, M., Miraglia, C., Nouvenne, A., Meschi, T., deAngelis, G. L., Di Mario, F., & Leandro, G. (2018). The role of diet in the prevention and treatment of inflammatory bowel diseases. Acta Biomedica, 89(9-S), 60-75. https://doi.org/10.23750/abm.v89i9-S.7952

Robinson, W. S. (2009). Ecological correlations and the behavior of individuals. *International Journal of Epidemiology*, 38(2), 337–341. https://doi.org/10.1093/ije/dyn357 (Original work published 1950)

Saez, A., Herrero-Fernandez, B., Gomez-Bris, R., Sánchez-Martinez, H., Gonzalez-Granado, J. M. (2023). Pathophysiology of inflammatory bowel disease: Innate immune system. International Journal of Molecular Sciences, 24(2), 1526. https://doi.org/10.3390/ijms24021526

Scaldaferri, F., Pizzoferrato, M., Lopetuso, L. R., Musca, T., Ingravalle, F., Sicignano, L. L., Mentella, M., Miggiano, G., Mele, M. C., Gaetani, E., Graziani, C., Petito, V., Cammarota, G., Marzetti, E., Martone, A., Landi, F., & Gasbarrini, A. (2017). Nutrition and IBD: Malnutrition and/or sarcopenia? A practical guide. Gastroenterology Research and Practice, 2017(1), 1-11. https://doi.org/10.1155/2017/8646495

Shah, R., Kelley, J., Amundsen, T., Coggins, K., Edwards, A., & Johnson, C. M. (2022). Medical and social determinants of health as predictors of adverse outcomes in patients with inflammatory bowel disease. Baylor University Medical Center Proceedings, 36(2), 1-6. https://doi.org/10.1080/08998280.2022.2156025

Steinbach, E. C., & Plevy, S. E. (2014). The role of macrophages and dendritic cells in the initiation of inflammation in IBD. Inflammatory Bowel Diseases, 20(1), 166-175. https://doi.org/10.1097/mib.0b013e3182a69dca

Vrtikapa, K., Hoque Urmy, F., & Hoque, F. (2025). Social determinants of health: The impact of this overlooked vital sign. Journal of Brown Hospital Medicine, 4(3). https://doi.org/10.56305/001c.138072

Williams, A. M., Couch, C. A., Emmerich, S. D., & Ogburn, D. F. (2025). *Ultra-processed food consumption in youth and adults: United States, August 2021–August 2023* (NCHS Data Brief No. 536). National Center for Health Statistics. https://doi.org/10.15620/cdc/174612

Wentworth, B. J., Buerlein, R. C. D., Tuskey, A. G., Overby, M. A., Smolkin, M. E., & Behm, B. W. (2018). Nonadherence to biologic therapies in inflammatory bowel disease. Inflammatory Bowel Diseases, 24(9), 2053-2061. https://doi.org/10.1093/ibd/izy102

Data & Code Availability Statement

The dataset and R code used in this study are made available from the author and can be accessed at the following repository.

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Mentor Contribution Statement

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