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Racial Disparities in Readmission, Complications and Procedures in Children with Crohn's Disease

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Abstract

Background—Racial disparities in care and outcomes contribute to mortality and morbidity in children however the role in pediatric Crohn's disease (CD) is unclear. In this study, we compared cohorts of Black and White children with CD to determine the extent race is associated with differences in readmissions, complications, and procedures among hospitalizations in the United States.

Methods—Data were extracted from the Pediatric Health Information System (January 1, 2004–June 30, 2012) for patients <21 years of age hospitalized with a diagnosis of CD. White and Black cohorts were randomly selected in a 2:1 ratio by hospital. The primary outcome was time from index hospital discharge to readmission. The most frequent complications and procedures were evaluated by race.

Results—There were 4377 patients. Black children had a shorter time to first readmission and higher probability of readmission ($p=0.009$), and a 16% increase in risk of readmission compared to White children ($p=0.01$). Black children had longer length of stay and higher frequency of overall and late (30 days–12 months post discharge) readmissions ($p<0.001$). During index hospitalization, more Black children had perianal disease and anemia ($p<0.001$). During any hospitalization, Black children had higher incidence of perianal disease, anemia, and vitamin D deficiency, and greater number of perianal procedures, endoscopies, and blood product transfusion ($p<0.001$).

Conclusions—There are differences in hospital readmissions, complications, and procedures among hospitalized children related to race. It is unclear whether these differences are due to

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genetic differences, worse intrinsic disease, adherence, access to treatment, or treatment disparities.

Keywords

inflammatory bowel disease; disparities; race; pediatrics

INTRODUCTION

Inflammatory bowel disease (IBD), which includes Crohn's disease (CD) and ulcerative colitis (UC), is a chronic, relapsing, inflammatory disorder that primarily affects the digestive tract of approximately 1.4 million people in North America,^{1, 2} with 25% being diagnosed in childhood. IBD carries a significant burden of disease given its rising incidence,³⁻⁵ the significant associated morbidity, psychosocial effects⁶⁻⁸ and the healthcare related costs⁹⁻¹¹.

Disparities in care and outcomes contribute to mortality and morbidity in various conditions in children including asthma, congenital heart disease, diabetes, and ADHD.¹²⁻¹⁹ The Institute of Medicine defines a disparity as "racial or ethnic difference in the quality of healthcare that is not due to access-related factors or clinical needs, preference and appropriateness of intervention".²⁰

Health disparity research in adult IBD and other disease processes suggest that minority status, female gender and low socioeconomic status are related to poorer outcomes.^{21, 22} There are numerous differences between Black and White IBD patients in regards to health care utilization practices and disease impact upon daily activities,²³ as well as evidence of racial differences regarding characteristics of IBD, including more severe disease among minority patients.^{24, 25} Disproportionately high rates of IBD-related hospitalizations and mortality among non-Hispanic Blacks as compared to non-Hispanic Whites occur, even after taking into account differences in IBD prevalence across racial groups.²⁶ Bowel resection among hospitalized adult CD patients varies by race, health insurance status and gender.²⁷ A systematic review of 40 studies reported evidence for race and SES-based disparities in IBD care, especially with regard to surgical care and in-hospital mortality risk.²⁸

We suspect healthcare disparities also exist in pediatric IBD, which may contribute to variation in care, increased costs and poorer outcomes, however data in children is limited. The effects of race on hospital admissions in children with CD are unknown. Our study begins to address this gap by evaluating racial differences between Black children and White children with CD who are hospitalized. The main objectives of our study were to determine 1.) if Black children hospitalized for CD are more likely to be readmitted and have longer length of stay (LOS) compared to White children 2.) if corticosteroids, biologic agents and total parenteral nutrition (TPN) usage differs between races and 3.) if there are differences in CD related complications and procedures between races.

MATERIALS AND METHODS

Data Source

The Pediatric Health Information System (PHIS) database is a large, administrative database established in 2002 (with archived data since 1992) by Children's Hospital Association (formerly known as Child Health Corporation of America). PHIS contains comprehensive inpatient data from 44 not-for-profit children's hospitals in the United States, which represents about 25% of pediatric centers in the U.S. and the majority of the tertiary care centers.

PHIS provides direct access to the data and viewers can select which hospitals and networks to compare. Encrypted medical record numbers (MRN) allow longitudinal tracking of patients over time within an institution. Standardized data is collected on demographics, diagnoses, procedures, interventions, outcomes and resource utilization for all pediatric patients admitted to participating hospitals. Data elements are abstracted and coded using PHIS data quality guidelines (de-identified at submission and reliability/validity checks are performed before database inclusion).

Study Cohort

The study population included pediatric patients (age ≥ 21 years) who were admitted to a PHIS affiliated hospital between January 1, 2004 and June 30, 2012. Patients entered the study cohort on the day of admission of their index hospitalization (first hospitalization in the study period) and were followed through subsequent admissions during the entire study period. Patients were included in the study population if they had a primary or secondary diagnosis of CD (555.x) and if both race and gender were reported. A hospitalization was excluded if a patient was admitted and discharged on the same day, or if a patient was admitted for an ostomy take down (CPT 44625, ICD 9 procedure code 46.5x) as this procedure was considered an elective, planned admission. Other exclusion criteria included: missing race, multiple races, Hispanic ethnicity, missing gender, or gender mismatch among two or more encounters. A subset of eligible patients was randomly selected at the hospital level to achieve a 2:1 ratio of Whites to Blacks which increased the number of patients in the study (relative to parity). Whereas some hospital sites had more Whites than Blacks, a few sites had a disproportionately higher number of Blacks due to their local population demographics. In order to maintain this ratio at each hospital site, the number of Blacks was reduced using random selection at a given site where the number of Whites was less than twice the number of Blacks. No matching based on potentially confounding variables was performed; rather, the influence of potential confounds was controlled for statistically.

Variables

Basic demographics included: gender, age, race, ethnicity, payor, median neighborhood income, and hospital location. We included only patients who reported a single race for analysis. Payor status was assigned to 1 of 3 groups: commercial insurance, Medicaid, or other (APPENDIX A). Additional variables collected included admission and discharge dates, discharge ID, MRN (encrypted), LOS, and number of readmissions.

Secondary predictors included payor status, and median neighborhood income. Regional divisions (Northeast, South, Midwest, and West) were derived from the state in which the hospital resided and then assigned to a region based on the 2010 Census Regions and Divisions of the United States (www.census.gov). The median neighborhood incomes were based upon patients' actual zip code at initial hospitalization.

Treatment variables included *corticosteroids*, *biologic agents* and *TPN use*. We collected the number of IBD-related complications and abdominal surgical procedures during the index hospitalization by generating a list of the top 200 procedural codes and complications in the study cohort and grouped them along clinical grounds. (APPENDIX B)

Outcomes

The primary outcome was the time from index hospital discharge to readmission as it was more indicative of poor post-hospitalization care and/or poor self-management. We also felt an admitted population would increase the likelihood of similar disease severity between groups at study entry (i.e. both cohorts demonstrated significant enough disease to warrant hospitalization) and assure that the patient had established care within a pediatric medical center, although admission criteria vary and several factors could potentially affect the decision to admit a patient, (e.g., access to care, reliability of follow-up, etc.). Readmissions were divided into 2 categories: early (< 30 days from initial discharge) and late (30 days to 1 year after initial discharge). Secondary outcomes included median LOS and the number of readmissions. Secondary predictors included payor status and the median neighborhood income associated with zip code.

Study Design

This is a retrospective review of patients who were hospitalized with a diagnosis of CD. To assess the validity of the data extracted from PHIS, a subset of the main cohort was created, consisting of 113 CD patients (37 Black and 76 White) from Nationwide Children's Hospital (NCH). Chart reviews were conducted for this group, and the results were compared to the data extracted from PHIS. Variables examined included: race, CD diagnosis, payor status, and corticosteroids, biologic agents (infliximab, adalimumab, and certolizumab), and TPN.

Statistical Analyses

To examine the validity of data extracted from PHIS, percent agreement was calculated between PHI data and the corresponding data obtained via medical record review at NCH. Baseline and demographic characteristics were summarized using standard descriptive statistics. Effect sizes were calculated using Cohen's *d* to describe the magnitude of the difference between races. Categorical data were compared between races using either the Chi-Square test of independence (for 2×2 comparisons) or the exact binomial test (for comparing White to Black frequencies to the expected 2:1 distribution). Continuous data (e.g., LOS) were compared using nonparametric Wilcoxon two-sample tests. A Cox proportional hazards model was constructed to assess the risk of readmission over time between Black and White children. The proportionality assumption of the Cox model was examined and validated with a Kaplan-Meier survival curve. The Kaplan-Meier survival analysis with a log-rank test was then used to compare the probability of readmission in the

first year after index hospitalization by race. Multivariate logistic regression models were constructed to assess the influence of the following predictors on readmission status (yes versus no): age at first admission, gender, geographical region (West, Midwest, South, and Northeast), corticosteroid use, biologic agent use, TPN use, insurance payor (Medicaid, commercial, and other), and income. This was calculated for the total number of readmissions, readmission within 1 year, readmission after 1 year, and LOS. Similar multivariate logistic regression models were constructed to assess the IBD-related complications and procedures which occurred during the index hospitalization, and for any hospitalization.

For each set of analyses, we assumed a critical alpha of 0.05 and made Bonferroni corrections for multiple testing where appropriate. We expected that small effects would be magnified by our large study population and considered an effect size of >0.15 to be clinically meaningful. All statistical analyses were conducted using SAS 9.3 (by SAS Institute Inc., Cary, NC, USA). This study was approved by the NCH institutional review board.

RESULTS

PHIS validation/NCH cohort

Overall, agreement between data extracted from PHIS and data from NCH documentation was high. For race, corticosteroid usage, and TPN usage, the PHIS and NCH records agreed for over 99% and payor status percent agreement was about 94%.

Descriptive Statistics

The initial query included 26,381 total encounters and 11,190 distinct patients, with a final cohort of 1456 Black children and 2921 White children (Figure 1). We found no significant differences in either gender or geographical region between the Black and White cohorts. Compared with White children, Black children were slightly older at the first admission, were more likely to have Medicaid as their primary payor, and had a lower median neighborhood income. (Table 1)

LOS

Black children had slightly longer LOS (6.8 ± 7.1 days, median=5 days) than White children (6.3 ± 8.9 days, median=4 days) ($p < 0.001$, $d = 0.07$) although the effect size was small.

Percent of Early and Late Readmissions

Using the exactly binomial test, there was no significant difference in the percentage of Black vs. White children who had an early readmission (154 (11%) vs. 327 (11%), ns), however a larger percentage of Black children had a late readmission (410 (28%) vs. 677 (23%), $p = 0.002$). During the overall study period, Black children had a higher frequency of readmissions (1.4 ± 2.6 , median=0) than White children (0.9 ± 1.9 , median=0) ($p < 0.001$, $d = 0.19$). Black children also had a higher number of readmissions after 1 year compared to White children (3.1 ± 3.2 vs. 2.4 ± 2.4 , < 0.001 , $d = 0.22$).

Time to readmission

A Kaplan-Meier survival analysis with a log-rank test shows that the probability of being readmitted was essentially identical for Blacks and Whites during the first 100 days, and after 100 days White patients had a statistically lower probability of readmission ($p=0.009$). A Cox proportional hazards model shows that in the first year after index admission, Black children had a 16% increase in risk of readmission compared to White children ($p=0.01$). (Figure 2)

Medication Use

Regarding the inpatient medical treatment, we found that more Blacks received biologic agents during *any* hospitalization, during the *index* hospitalization and also during *late* readmissions. More Blacks received corticosteroids during late readmissions. (Table 2)

Predictors of Readmission

In a multivariate model, race was a significant predictor of readmission (OR=1.28 95% CI [1.09, 1.50], $p=0.009$). Predictive factors of overall readmission included corticosteroid usage (OR=1.53, 95% CI [1.32, 1.78], $p<0.001$) and TPN usage (OR=1.32, 95% CI [1.10, 1.59], $p=0.009$) during the index hospitalization, and patients with “Other” insurance status (OR=1.62, 95% CI [1.38, 1.91], $p<0.001$). Predictive factors of early readmission included older age (OR=1.05 per year older, 95% CI [1.02–1.09], $p=0.01$) and TPN usage (OR=1.54, 95% CI [1.18, 2.00], $p=0.004$) during index hospitalization. The predictive factors of late readmission are corticosteroids given during the index hospitalization (OR=1.38, 95% CI [1.16, 1.64], $p=0.0009$).

IBD-related Complications and Procedures

During the *index* hospitalization, there was no significant difference between Black and White children for procedures, however more Black patients had perianal disease (8.6% vs. 5.8%, $p=0.011$) and anemia (34.2% vs. 25.4%, $p<0.002$). Among the most prevalent diagnosis and procedure groups during *any* hospitalization, there was a higher percentage of Black patients with perianal disease (14.6 vs. 8.3%, $p<0.002$), anemia (42.6% vs. 31.1%, $p<0.002$), vitamin D deficiency (2.3% vs. 0.9%, $p=0.002$), and who underwent perianal/perineal procedures (8.5% vs. 5.0%, $p<0.001$), endoscopies (52.1% vs. 46.4%, $p=0.004$), and received blood product transfusions (14.2% vs. 10.9%, $p=0.023$) than Whites. (Tables 3 and 4). Even after controlling for gender, income, and type of insurance in multivariate regression models, race remained as a significant predictor of the above complications and procedures.

DISCUSSION

To date, few studies have investigated healthcare disparities in CD, and most existing studies have focused on adult populations.^{27, 29–31} Of the few studies investigating racial disparities in pediatric CD, most have either utilized smaller sample sizes,³² discussed disparities in IBD without distinction between CD and UC,³³ focused only on UC,³⁴ or examined sociodemographic factors other than race that might be associated with disparities.^{35, 36}

Using a large and diverse cohort extracted from the PHIS database, our study investigated evidence of racial disparities in the treatment and outcomes of hospitalized White and Black pediatric patients with CD. Our findings support that racial disparities exist among children and adolescents with CD, but to what degree this represents a healthcare disparity or a disparity due to genetic and/or environmentally determined differences in disease is still unknown. We found several statistically significant differences between races, including important outcomes such as hospital readmissions; however the effect sizes were small. This suggests that although one may not readily identify these racial differences at a practice level due to the small effect size, they may be important at the population level. The etiology of these racial differences must be understood in order to design practice level interventions that can reduce population level disparities. In our study, Black children had a 1.5 times higher frequency of readmissions compared to White children.

Our large, regionally diverse cohort also allowed for the detection of other less common events and adds valuable information to the sparse literature on pediatric IBD race disparities. Our study supports the findings noted by Schaefer et al, that race did not influence the risk of bowel surgery.³⁷ However, we found that Black children were more likely to have anemia, vitamin D deficiency, endoscopic procedures, blood product transfusions and treatment with corticosteroids and biologic agents compared to White children.

Some of the observed differences in our study are likely attributable to intrinsic differences in disease between Blacks and Whites. For example, the increase in perianal procedures is likely secondary to the increased rate of perianal disease in Blacks.^{24, 38, 39} However, other differences may reflect disparities in care, although biologic differences can't be excluded. For instance, while the increased usage of corticosteroids and biologic agents among Black children could suggest a more severe disease course that may be attributable to worse intrinsic disease in Black children, it is equally possible that Black patients were more ill at the time of hospital admissions secondary to delays in seeking care or impaired access to care, thus requiring more intensive therapy. This point may also be strengthened by the fact that Black children were slightly older at the first admission than White children, which could represent a subtle marker of diminished access to medical care or a delay in disease recognition from a community health level. Unfortunately, there are no validated measures in PHIS to address disease severity as a potential explanatory factor.

We found that Black children had a lower median income and were more likely to have Medicaid. Financial barriers to outpatient care and self-management, such as transportation, medication and nutrition needs, may have influenced the disparities seen in our study. In support of this hypothesis, a recently published study found that Black children with asthma were twice as likely to be readmitted as White children and this difference was partially explained by financial and social hardship.⁴⁰

It has been noted in other chronic diseases that the role of biology in health disparities is often modest and there are many other factors which contribute to disparities in care.^{14-16, 40-42} Some of these factors include SES status, access to care, payor status, health

care system inefficiencies, health literacy, adherence, and provider biases. We suspect that this is also true in pediatric IBD.

The limitations of our study include that the results may not be generalizable to all pediatric centers, the PHIS database is not weighted for extrapolation to national estimates and misclassification errors can also occur since the data were obtained from an administrative database. The strengths of this study include that it is a large, regionally diverse population and we minimized confounding by severity by focusing on a hospitalized cohort which restricted the study population to patients with moderate/severe disease.

There are significant differences in hospital readmissions, medication usage and both medical and surgical complications of children with CD which are related to race. It is unclear whether this is due to disparities in care, or phenotypic variation in disease between racial groups, although both likely play a role. We propose that non-biologic factors are likely contributors to these differences and may include factors such as differences in adherence, access or treatment, and may be influenced by financial considerations. Thus, future investigations should examine frequency of follow up care, adherence, access to care, disease severity and distribution, medication treatment differences and provider bias. Further primary research endeavors and standardization of care are needed to ultimately improve healthcare delivery and minimize healthcare disparities among minorities.^{42, 43} Minimizing complications and cost of care would have a profound effect on quality of life and healthcare expenditures.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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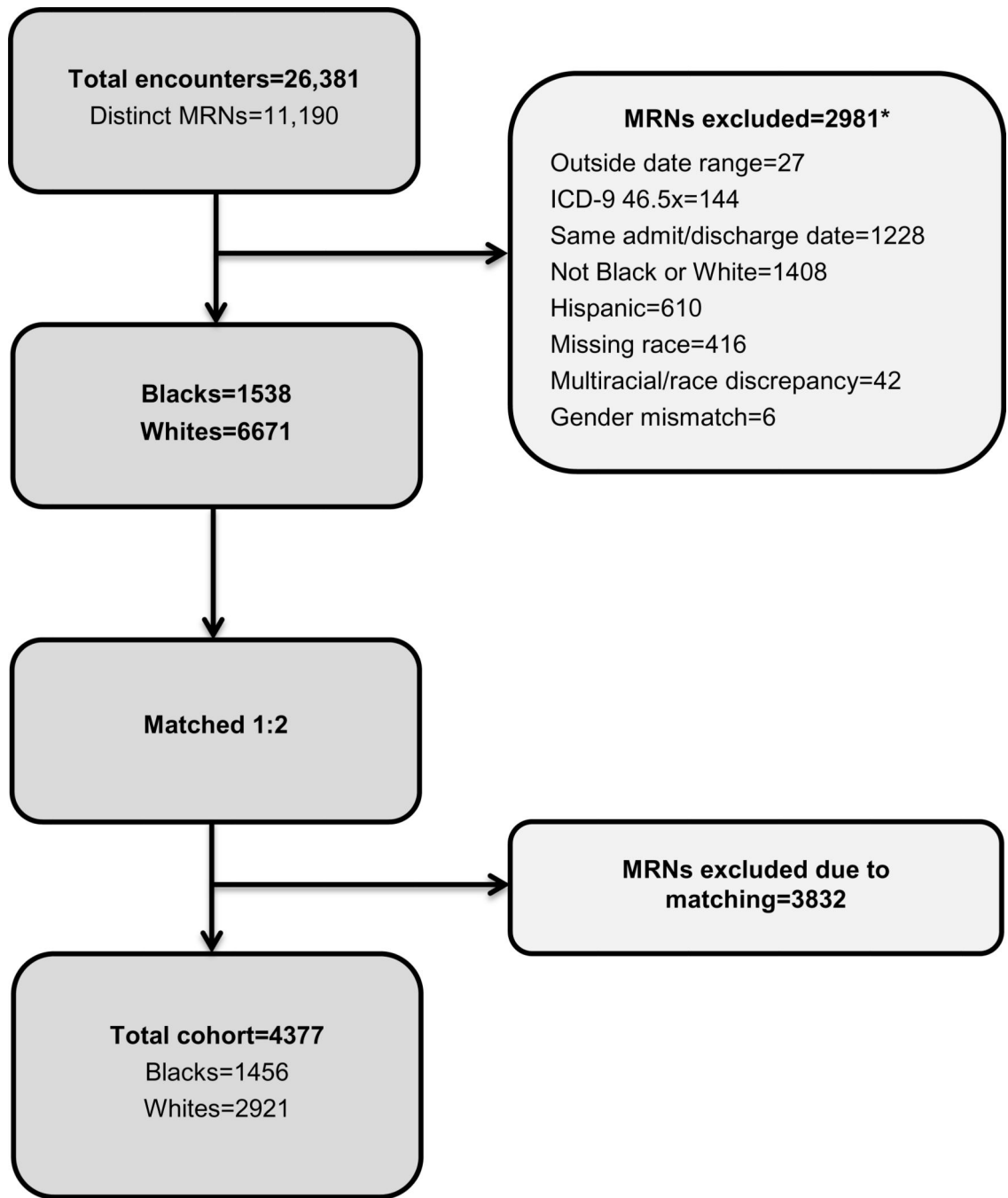


FIGURE 1. Cohort Section Procedures and Exclusion Criteria (*not mutually exclusive categories).

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Probability of not being readmitted

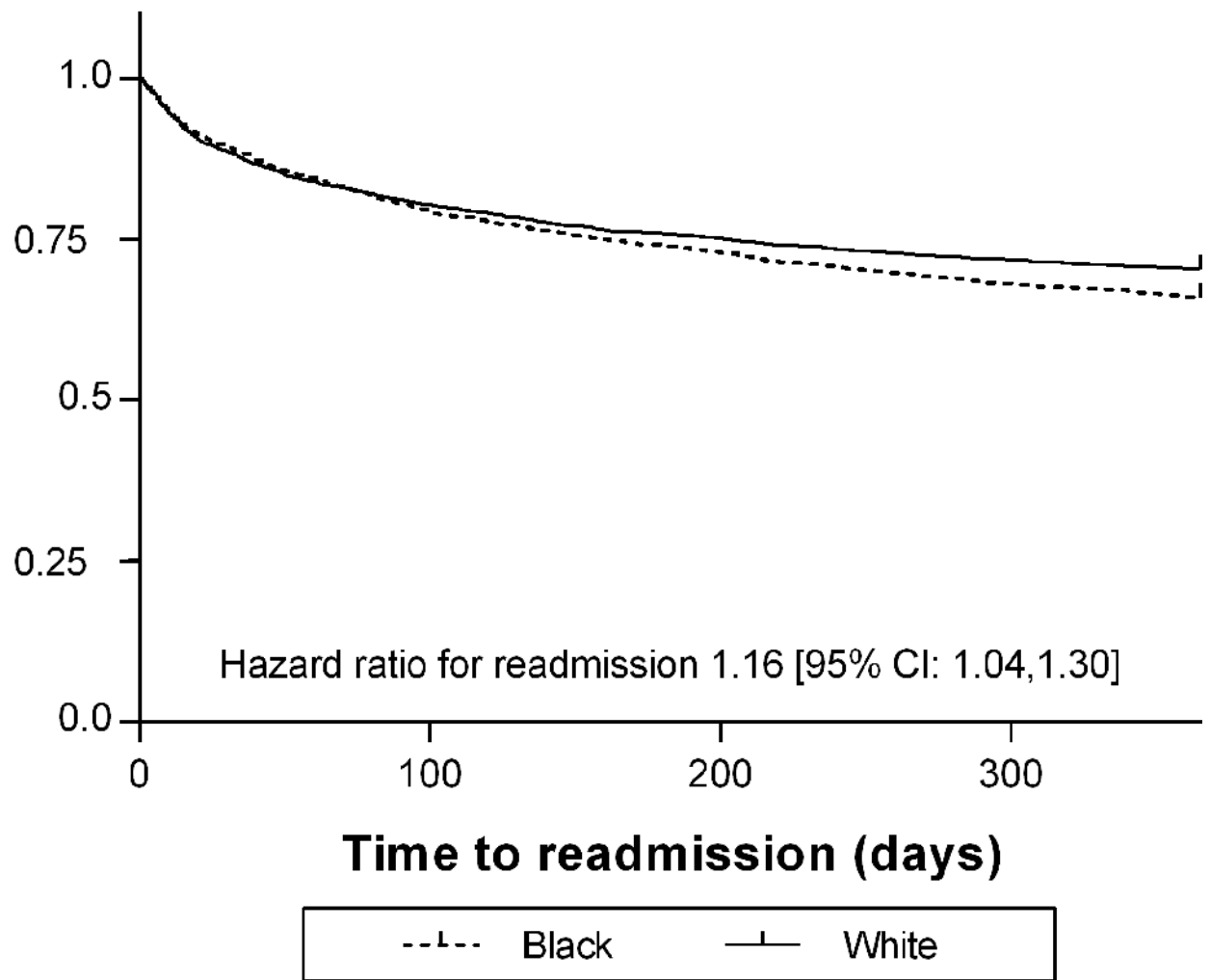


FIGURE 2.

Time to first readmission, according to race, in children hospitalized with Crohn's disease. The graph depicts the curves are very close together in time period [0, 100], after 100 days, it appears that White patients had slightly less probability of readmission (Kaplan-Meier analysis with Log-Rank test, $p=0.009$; Cox proportional hazards $p=0.01$).

TABLE 1

Demographic Characteristics by Race

Variable	Black n (%)	White n (%)	p value ¹
Total	1456 (33)	2921 (67)	
Gender			
Male	781 (54)	1545 (53)	1
Female	673 (46)	1373 (47)	
Age at 1st admission (years)	14.6±3.4 (median: 15.1)	14.1±3.7 (median: 14.7)	<0.001
Region			
Midwest	381 (26)	765 (26)	NA
Northeast	267 (18)	536 (18)	
South	731 (50)	1465 (50)	
West	77 (5)	155 (5)	
Payor ²			
Commercial	378 (26)	1305 (45)	<0.001
Medicaid	626 (43)	462 (16)	
Other	406 (28)	1056 (36)	
Missing	46 (3)	98 (3)	
Median neighborhood income (at 1st admission) ³	\$39,855±\$15,764 (median: \$36,423)	\$53,599±\$21,155 (median: \$49,763)	<0.001

¹ Bonferroni corrected p value;

² See Appendix A;

³ Based on 2010 United States Census Data compared to reported zip code

TABLE 2

Medications Received by Race

Variable	Black n (%)	White n (%)	p value ^I
Any			
Corticosteroid	1025 (70)	1977 (68)	0.81
Biologic agent	473 (33)	642 (22)	0.001
TPN	399 (27)	719 (25)	0.56
Index			
Corticosteroid	943 (65)	1786 (61)	0.23
Biologic agent	278 (19)	405 (14)	0.001
TPN	262 (18)	508 (17)	1
Early (<30 days)			
Corticosteroid	103 (7)	234 (8)	1
Biologic agent	34 (2)	74 (3)	1
TPN	36 (3)	95 (3)	1
Late (30 days-1yr)			
Corticosteroid	287 (20)	416 (14)	0.001
Biologic agent	130 (9)	169 (6)	0.001
TPN	89 (6)	149 (5)	1

^I Bonferroni corrected p value; TPN=total parenteral nutrition

TPN=total parenteral nutrition

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TABLE 3

Diagnoses at Index Hospitalization and Any Hospitalization

	Index Hospitalization			Any Hospitalization		
	Black n (%)	White n (%)	p value ¹	Black n (%)	White n (%)	p value
Anemia	498 (34.2)	742 (25.4)	<0.002	620 (42.6)	908 (31.1)	<0.002
Nutrition complications ²	252 (17.3)	474 (16.2)	1	344 (23.6)	596 (20.4)	0.24
Dehydration/hypovolemia	139 (9.5)	295 (10.1)	1	243 (16.7)	458 (15.7)	1
Infection (others)	140 (9.6)	263 (9.0)	1	278 (19.1)	481 (16.5)	0.51
Obstruction	107 (7.3)	253 (8.7)	1	223 (15.3)	406 (13.9)	1
Perianal disease	125 (8.6)	170 (5.8)	0.011	213 (14.6)	243 (8.3)	<0.002
Other	68 (4.7)	185 (6.3)	0.38	130 (8.9)	291 (10)	1
Electrolyte anomalies	66 (4.5)	138 (4.7)	1	118 (8.1)	223 (7.6)	1
Intra-abdominal abscess	37 (2.5)	110 (3.8)	0.48	86 (5.9)	187 (6.4)	1
<i>C. difficile</i> infection	33 (2.3)	103 (3.5)	0.32	70 (4.8)	179 (6.1)	1
Fistula	50 (3.4)	77 (2.6)	1	105 (7.2)	156 (5.3)	0.24
Perforation/peritonitis	21 (1.4)	57 (2.0)	1	36 (2.5)	91 (3.1)	1
Bacteremia/sepsis	21 (1.4)	44 (1.5)	1	50 (3.4)	88 (3.0)	1
Short stature	7 (0.5)	31 (1.1)	0.64	14 (1.0)	54 (1.8)	0.32
Vitamin D deficiency	17 (1.2)	12 (0.4)	0.08	34 (2.3)	25 (0.9)	0.002
Venous Thromboembolism	7 (0.5)	8 (0.3)	1	17 (1.2)	20 (0.7)	1

n=4377 (Black n=1456; White n=2921);

¹ Bonferroni corrected p values were adjusted within outcome group (index and any hospitalization);

² Including malnutrition, failure to thrive, weight loss

TABLE 4

Procedures at Index Hospitalization and Any Hospitalization

	Index Hospitalization			Any Hospitalization		
	Black n (%)	White n (%)	p value ¹	Black n (%)	White n (%)	p value
Endoscopies	626 (43.0)	1135 (38.9)	0.10	759 (52.1)	1355 (46.4)	0.004
Blood product transfusion	134 (9.2)	200 (6.8)	0.08	207 (14.2)	319 (10.9)	0.023
Colectomy ²	84 (5.8)	195 (6.7)	1	244 (16.8)	447 (15.3)	1
Perianal/perineal procedures	59 (4.1)	92 (3.1)	1	124 (8.5)	146 (5.0)	<0.001
Resection/anastomosis	37 (2.5)	109 (3.7)	0.41	113 (7.8)	234 (8.0)	1
Abdominal surgery ³	40 (2.7)	96 (3.3)	1	116 (8.0)	230 (7.9)	1
Appendectomy	28 (1.9)	70 (2.4)	1	51 (3.5)	114 (3.9)	1
Wound/lesion related	28 (1.9)	59 (2.0)	1	78 (5.4)	136 (4.7)	1
Ostomy ⁴	18 (1.2)	61 (2.1)	0.47	66 (4.5)	136 (4.7)	1
Central access	22 (1.5)	45 (1.5)	1	42 (2.9)	86 (2.9)	1
Intra-abdominal fistula repair	4 (0.3)	19 (0.7)	1	24 (1.6)	51 (1.7)	1
Cholecystectomy	2 (0.1)	7 (0.2)	1	6 (0.4)	15 (0.5)	1

n=4377 (Black n=1456; White n=2921);

¹ Bonferroni corrected p values were adjusted within outcome group (index and any hospitalization);

² Partial, subtotal, total;

³ General or lysis of adhesions;

⁴ Small and/or large intestine