Racial and Economic Disparities in Pediatric Readmissions at Children's Hospitals and Clinics of Minnesota

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Abstract

Preventable pediatric readmissions have become a growing concern in Minnesota. Recurrent hospitalization increases the physical and emotional strain on patients and families. Additionally, continual hospitalizations negatively impact hospital resources. This health analytics project used GIS to map pediatric readmission rates, by census tract, in the 11-county Twin Cities Metro area. Pediatric patient data from Children's Hospitals of Minnesota was compared with demographic and economic data about the census tracts within the study area. The goals of this analysis were to (a) identify census tracts, within the study area, containing preventable pediatric readmissions, (b) compare pediatric patient demographic data with census tract demographic data to identify factors associated with pediatric readmission, (c) compare patient census tracts with census tracts from the entire study area to identify demographic and economic factors associated with pediatric readmission, and (d) provide recommendations to help Children's Hospitals of Minnesota reduce preventable pediatric readmission rates.

Introduction

Each year, U.S. hospitals treat approximately 26.9 million children, at a cost of more than $6 billion dollars (Tang, Maselli, and Gonzales, 2014). Total readmission costs in the U.S. are difficult to measure. However, one study estimates the cost at $1.7 billion dollars per year (Gay, Agrawal, Auger, Del Beccaro, Eghtesady, Fieldston, and Shah, 2015).

Increased health care costs have resulted in a budget crisis at both the federal and state levels of government. These financial crises have reduced the government funding given to Minnesota hospitals. Decreased funding has resulted in hospitals reducing their operating budgets (Johnson, Oliff, and Williams, 2011; Ross, 2017; Dickson, 2017). As a result, hospitals have looked for ways to lower costs but maintain a high standard of care.

In 2010, Congress enacted comprehensive health care reform in the form of the Affordable Care Act. Readmission rates were made the primary metric for determining whether a hospital was meeting the quality of care standard when treating patients (Affordable Care Act, 42 U.S.C. § 18001, 2010). This made readmission reductions the key for potential health care cost savings (Joynt and Jha, 2012).

Through the Affordable Care Act (2010), the Centers for Medicare and

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Medicaid Services were directed to penalize hospitals with 30-day readmission rates above expected rates (Readmissions Reduction Program (HRRP), 2012).

A hospital readmission is "an episode when a patient who had been discharged from a hospital is admitted again within a specified time interval" (Barrett, Raetzman, and Andrews, 2012). Congress chose 30-day readmission rates because the longer time indicates any subsequent readmission is less likely to result from hospital care and more likely to be related to an event occurring after discharge (Toomey, Peltz, Loren, Tracy, Williams, and Pengeroth, 2016).

Using readmissions as a quality metric for pediatric health has proven controversial. The definition of "readmission" is complex (Cohen, Kuo, Agrawal, Berry, Bhagat, Simon, and Srivastava, 2011). This complexity results from the lack of clarity defining the word "readmission."

Different studies have used different time frames for different illnesses. The Readmissions Reduction Program (42 CFR § 412.154) uses 30 days as the definition for readmission. Some studies also use 30 days as the readmission window (Christensen and Payne, 2016). However, the readmission time in other studies varied from 2-3 days (Edwards, Lucas, Stone, Boscardin, and Dudley, 2013) to 4 years (Knighton, Flood, Speedie, Harmon, Smith, Crosby, and Payne, 2013). These differing time frames have created confusion.

Numerous alternatives have been suggested to measure the quality of pediatric care. As of 2017, none have supplanted readmission rates as the standard for care quality.

Historically, most readmissions studies have focused on adult readmissions (Fontanarosa and McNutt, 2013). However, more recent studies have focused on pediatric readmissions. Because there are fewer cases involving children, pediatric readmissions are harder to measure, and pediatric readmissions studies have remained in the minority. (Bardach, Vittinghoff, Asteria-Peñaloza, Edwards, Yazdany, Lee, Boscardin, Cabana, and Dudley, 2013).

Studies have shown hospital readmissions can be divided into planned and unplanned (Knighton *et al.*, 2013). Unplanned readmissions can be further subdivided into non-preventable and preventable (Knighton *et al.*, 2013).

Reducing pediatric readmission rates may prove difficult. Many pediatric readmissions are not preventable. One study found that less than a fifth of urgent pediatric re-hospitalizations were preventable (Van Walraven, Bennett, Jennings, Austin, and Forster, 2011).

Another study found that, on average, just 27% of total pediatric readmissions were preventable (Jencks, Williams, and Coleman, 2009). Two other studies identified 60% of all pediatric readmissions as unpreventable (Christensen and Payne, 2016; Gay *et al*., 2015). Also, although the total number of readmissions varied substantially among hospitals, the rate of preventable readmissions did not vary (Van Walraven, Bennett *et al*., 2011; Van Walraven, Jennings, Taljaard, Dhalla, English, Mulpuru, Blecker, and Forster, 2011).

As a result, hospitals are focusing their efforts on potentially preventable readmissions (PPRs) to help reduce pediatric readmission rates (Gay *et al*., 2015; Hain, Gay, Berutti, Whitney, Wang, Saville, 2013). PPRs accounted for 27.3% of pediatric readmissions in 2015 (Gay *et al*., 2015). For 2015, the total cost of pediatric PPRs nationwide was $464.1

million (Gay *et al*., 2015).

Various factors affect pediatric readmission rates. These factors included length of stay (Edwards *et al*., 2013), age (Chung, Hathaway, and Lew, 2015), gender (Gay *et al*., 2015; Jan, Slap, Smith-Whitley, Dai, Keren, and Rubin, 2013), and race (Edwards *et al*., 2013).

Geographic factors (Kharbanda, Hall, Shah, Freedman, Mistry, Macias, Bonsu, Dayan, Alessandrini, and Neuman, 2013) and socioeconomic factors (Van Walraven, Bennett *et al*., 2011) have also been shown to play a role in pediatric readmissions.

Because they are quantifiable, readmissions are likely to remain a quality metric for the foreseeable future (Christensen and Payne, 2016). However, the medical community would benefit greatly by utilizing other metrics such as community outreach programs in conjunction with readmission rates to improve the quality of pediatric care (Christensen and Payne, 2016; Gay *et al*., 2015).

Methodology

Study Area

The study area was Minnesota's 11-county metro area (Figure 1). The metro area consists of Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Sherburne, Washington, and Wright counties.

Children's Hospitals and Clinics of Minnesota (CHC) operates two Minnesota hospitals. One hospital is in Minneapolis, in Hennepin County, and the other is in St. Paul, in Ramsey County.

Data Collection

Two sets of data were combined for this analysis. One data set was provided by CHC and contained health and demographic information for all 7-day pediatric readmissions to its hospitals. A hospital can create any measure of readmission because it has the admission discharge date and the readmission date. Seven-day readmissions were chosen because that is the measure CHC uses most frequently as its quality metric. A second data set was obtained from 2015 census records and contained economic and demographic information for the study area census tracts.

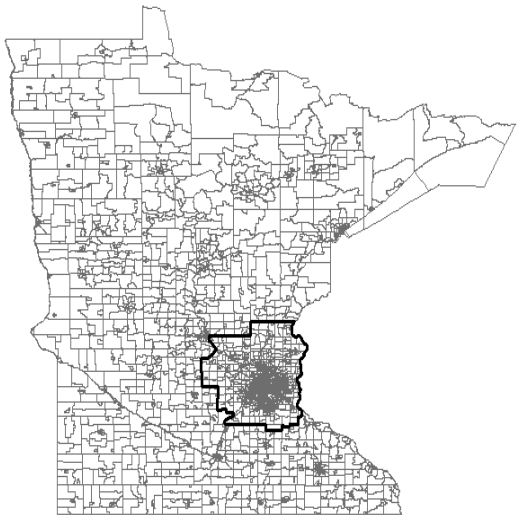

Figure 1. Eleven (11) County metro study area outlined in black.

Hospital Data

CHC provided a limited data set of health, demographic, and economic records for all 7-day pediatric readmissions between November 2011 and December 2015. This data set included a total of 1959 pediatric readmission records. Of those records, 1029 (52.5%) agreed to allow their medical records to be used in this study.

Data errors were found and corrected. The most common errors were duplicate patient records and patient addresses located in the wrong city and/or county. After correcting for these errors,

584 patients lived in the 11-county metro study area.

Attributes associated with the CHC data set included health information such as readmission dates, type and severity of illness, and hospital length of stay (LOS), as well as demographic data including patient addresses, age, race, and gender. The only type of economic data about CHC patients available was insurance type.

Census Data

An additional data set was created from 2015 Census records. Census.gov provided demographic and economic information about the population of Minnesota, reported by census tract. There are 767 census tracts in the 11-county study area.

Demographic attributes included total population, age, race, gender, married and unmarried households, households with at least one person under age 18, family or nonfamily households with 1-4 people, education, poverty status, number of families under the poverty level, households receiving public assistance income, and public and private health insurance. Although available, census data on language was not included in this study.

Study Design

Patient addresses were geocoded and corresponding points were placed within the 767 census tracts found in the study area. The total census tracts were divided into two groups. One group consisted of 374 tracts with at least one patient address (readmission tracts). The other group consisted of 393 tracts with no patients (non-readmission tracts).

Racial disparities in pediatric readmissions were investigated using patient demographic information found in the hospital dataset. Comparisons were also made between the racial composition of the hospital patients, the readmission census tracts, and the overall study area.

Economic disparities in pediatric readmissions were analyzed using census data for the 767 census tracts in the study area. Comparisons about economic conditions were made between the readmission census tracts and the non-readmission tracts.

Method of Calculation

To compare the presence of the economic variables in the readmission and non-readmission census tract groups, two percentages were calculated: Readmission Tracts Percentage and Non-Readmission Tracts Percentage using the following equations:

$$\text{Readmission \%} = X_R / X_{ALL}$$
$$\text{Non-Readmission \%} = X_N / X_{ALL}$$

Where:
X_R is the number of people or households with the economic indicator in the 374 readmission tracts,
X_N is the number of people or households with the economic indicator in the 393 tracts without a readmission patient, and
X_{ALL} is the number of people or households with the economic indicator in all 767 study area tracts ($X_R + X_N$).

Limitations of the Study

It should be noted the study results may have been impacted by several issues. First, the Health Insurance Portability and Accountability Act of 1996 (HIPPA) privacy rule requires researchers obtain permission when using patient health

records (HIPPA Privacy Rule, 2007). 52.5% of patients provided medical consent. Missing data from patients who declined to participate might have altered the study results.

Second, the sample size of the CHC data set is an issue. Small sample sizes often limit the usefulness of racial and ethnic studies (Hasnain-Wynia and Baker, 2006). In this study, only 584 patients lived in the study area. In the 374 readmission tracts, the total population of children, age 0-24, is 626,258.

In the entire 767 census tract study area, the population of children increases to 1,110,780. Extrapolating demographic characteristics of 584 patients to a population of between 0.6 million children (374 census tracts) or 1.1 million children (767 tracts) may produce an inaccurate result.

Third, CHC is perceived, within the study area, as a specialty hospital. This perception may have influenced the decisions on seeking treatment.

Fourth, the lack of coordination between hospital systems could affect the severity of illness and LOS. A patient may be seen at multiple hospitals for the same illness. For example, a patient could be admitted to hospital A with an illness minor in severity, then be readmitted to hospital B after the same illness became more serious. This would affect the severity diagnosis and the length of a patient's hospital stay.

A final limitation concerns the comparison of the economic variables between the two data sets. Excluding insurance, no information on the economic condition of any patient was made available. For this reason, the economic conditions present in the census tracks cannot be applied to individual patients. A patient may live in a poor census tract, but this information alone does not prove the patient is poor.

Results

There are significant disparities in health care based on race. Many studies have shown minority children and adults have a higher risk of readmission (Joynt and Jha, 2012; Berry, Hall, Kuo, Cohen, Agrawal, Feudtner, Hall, Kueser, Kaplan, and Neff, 2011; Kenyon, Melvin, Chiang, Elliott, Schuster, and Berry, 2014).

Figure 2 shows the racial distribution of white and minority patients in the study. No census track had patients from more than one racial group. Minority patients, represented in black, tend to be concentrated in the three largest counties of the study area: Hennepin, Ramsey, and Dakota counties. In contrast, white patients, represented in gray, were more spread out within the study area.

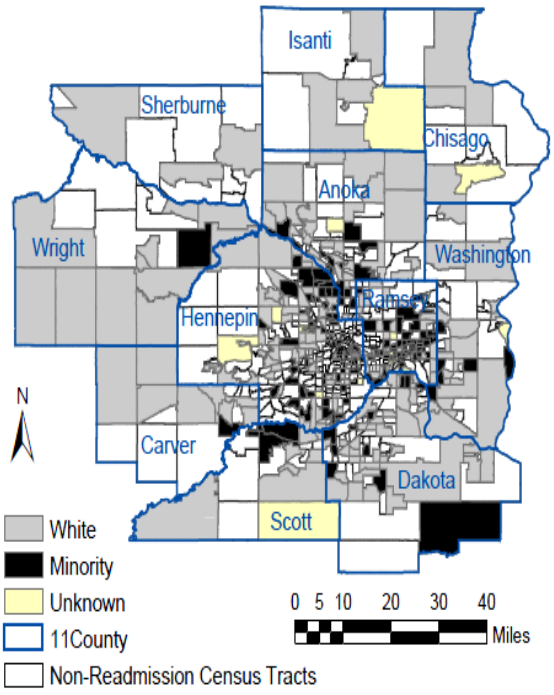

Figure 2. Racial distribution of whites and minority patients in the study group, ordered by largest to smallest. Non-readmission census tracts are in white.

Figure 3 also shows the racial distribution of white and minority patients in the study. No census tract had patients from more than one racial group. Minority patients are separated into the four largest racial groups. Again, with a few exceptions, the four minority racial groups tend to concentrate in the study area's three largest counties. White patients tended to be spread out over the entire study area.

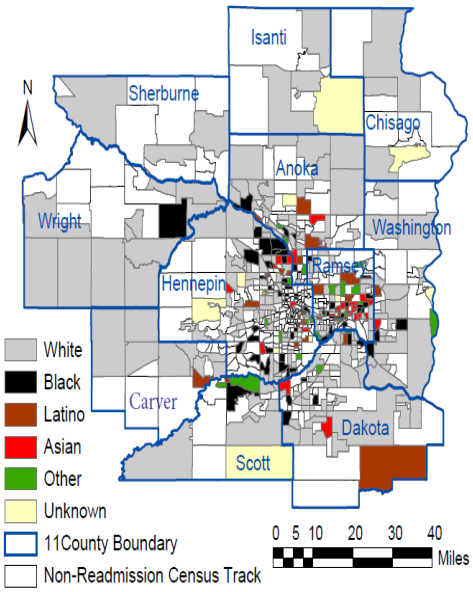

Figure 3. Racial distribution of the major ethnicities in the study group, ordered by largest to smallest.

Some studies have shown minorities receiving care at children's hospitals, specifically, have a higher risk of readmission (Berry *et al*., 2011). Even with medical advances resulting from modern technology, these gaps continue to exist (Blanchard, Haywood, and Scott, 2003).

Demographics of Patients in the Study

Race

As shown in Table 1, Whites, Blacks, Hispanics, and Asians were the only racial groups to have more than 5% of the patients. No other race or ethnicity accounted for more than 3.1% of the patients.

Table 1. Racial composition (percentage) and average age (years) of the readmission patients.

Group	Total	Male	Female	Avg. Age
White	54.5	54.7	54.1	6.2
Minority	41.2	41.1	41.4	5.7
Black	19.7	17.4	22.4	6.8
Hispanic	7.7	8.5	6.7	4.7
Asian	6.8	8.5	4.9	5.4
Other	7.0	6.6	7.5	3.9
Unknown	4.3	4.1	4.5	4.7

Pediatric readmission patients were from 7 racial groups. 54.5% of patients were White, 41.2% were minorities, and in 4.3% of the cases, race was declined/unknown. Additional analysis of the data set showed that males accounted for more than half of the study patients and were more prevalent among both Whites (54.7%) and minorities. Three out of four of the major racial groups, had more males than females. Blacks were the exception, having more females than males.

Investigation of the data showed that the average overall age of patients in the study group was 5.8 years. Whites had an average age of 6.2 years, and minorities 5.7 years. The average ages for the four primary racial categories were Blacks (6.8), Whites (6.2), Asians (5.4), and Hispanics (4.7). 0-6 months was the most common age across all racial categories. The most common ranges of ages across the study group were 0-6 years old and 12-16 years old.

Insurance Type

Table 2 shows which type of insurance patients in the study used to pay for medical services. Patients were separated into primary racial group.

Table 2. Insurance type by race.

Group	Private	Government
White	78.1	25.2
Minority	17.9	70.1
Black	5.2	37.6
Hispanic	1.9	15.1
Asian	5.2	8.9
Other	5.6	8.5
Unknown	4.0	4.7

Within the primary racial groups, it was more likely that a patient with private insurance is white (78.1%) than minority (17.9%). In fact, when the minority category was subcategorized, it was four times more likely that a patient with private insurance is white than minority; fifteen times more likely that a patient with private insurance was white than Black or Asian; and, forty-five times more likely that a patient with private insurance was white than Hispanic. However, it should be noted that these differences may be due in part to the underlying racial composition of the patients in the study group.

Multiple studies have shown a correlation between readmission and insurance status (Jiang and Wier, 2007; Berry *et al*., 2011; Gay *et al*., 2015). Additional studies indicate an increased likelihood of pediatric readmission associated with public insurance (Jiang and Wier, 2007; Coller, Klitzner, Lerner, and Chung, 2013).

The gap between Whites vs. minorities in private insurance may be related to minorities having less access to higher paying jobs or jobs with better health coverage (The Henry J. Kaiser Family Foundation, 2013). Private or supplemental health insurance is expensive and often depends on employer coverage (Flynn, 2013).

Medical tests and medications often require out-of-pocket co-pays. One study found Whites were almost two times more likely than Hispanics and three times more likely than Blacks to have supplemental insurance (Pourat and Rice, 2000). This expense may help explain the racial discrepancies in insurance type.

Service Line Illness

The Service Line Illness designation combines similar illnesses into broader categories, allowing for a more accurate measure of patient care. Table 3 shows the racial percentages associated with the most common service line illnesses at CHC.

Table 3. Racial composition of patients in the most common Service Line categories.

Group	Digestive	Cancer	Respiratory	Neuroscience	Neonatal
White	66.7	45.5	49.5	70.5	48.6
Minority	27.8	49.5	48.4	26.2	45.9
Black	14.4	30.7	23.7	16.4	12.2
Hispanic	4.4	7.9	11.8	4.9	8.1
Asian	2.2	6.9	8.6	-	8.1
Other	6.7	4.0	4.3	4.9	17.6
Unknown	5.6	5.0	2.2	3.3	5.4

In this study, additional investigation of the data showed Cancer Care, Digestive Disease, Neuroscience, Neonatal Care, and Respiratory Disease were the 5 most common Service Lines. In varying patterns, this was true for all four primary ethnicities, as well as minorities.

The additional analysis also found that within the top five Service Line categories, Cancer Care was the most common category for Minorities and Blacks, yet it was the least common for Whites. This may result from the inclusion of Sickle Cell Anemia (SCA) in Cancer Care. SCA is normally not found in White patients.

All Patients Refined Diagnosis Related Illness Groups (APR-DRG)

The APR-DRG code is a diagnosis classification for illness used by Medicare/Medicaid for cost reimbursement and to monitor

readmissions. The APR-DRG code is based on diagnosis and narrower in scope than the Service Line designation. Table 4 shows the five most common APR illnesses, separated by race.

Chemotherapy and Pneumonia/ Bronchiolitis were the most common APR illnesses found in the study. Seizure was also a common condition. Seizure was found among the top five illnesses for Whites, Blacks, and Minorities.

Table 4. Most common APR-DRG illnesses by race.

Group and DRG Illness	
White	
Chemotherapy	24
Pneumonia & Bronchiolitis	23
Nonbacterial	15
Seizure	12
Ventricular shunt procedures	10
Minority	
Pneumonia & Bronchiolitis	22
Sickle cell anemia crisis	18
Chemotherapy	14
Seizure	10
Neonatal	8
Black	
SCA crisis	18
Pneumonia & Bronchiolitis	10
Seizure	8
Chemotherapy	5
Neonate, transferred <5 days	4
Hispanic	
Pneumonia & Bronchiolitis	5
Acute leukemia	4
Neonate birthweight >2499g	3
Chemotherapy	2
Respiratory system diagnosis	2
Asian	
Chemotherapy	4
Pneumonia & Bronchiolitis	4
Circulatory system	2
Kidney/urinary tract procedures	2
Major respiratory infections	2

Illness Severity and Hospital LOS

Table 5 shows the severity of illness and the LOS for white, minority, and the four largest categories of minority patients. Major and moderate were the two most common severity types across all racial categories. Whites, Hispanics, and Asians all had the same high to low pattern of severity instances: major, moderate, extreme, and then minor. Blacks followed a similar severity pattern: moderate, major, extreme, and minor.

Table 5. Severity type and LOS by race.

Group	Major	Moderate	Extreme	Minor	Avg. LOS
White	58.3	52.7	49.5	55.4	10.4
Minority	36.8	44.1	44.4	41.9	12.1
Black	15.7	23.7	18.2	23.0	8.9
Hispanic	8.1	8.6	7.1	5.4	8.1
Asian	8.1	5.4	7.1	6.8	10.2
Other	4.9	6.5	12.1	6.8	15.1
Unknown	4.9	3.2	6.1	2.7	22.5

Additional data showed the average length of stay in the hospital (LOS) for patients was 14.2 days. White patients (10.4) had a slightly lower LOS than minority patients (12.1). Across the primary racial groups, within the four primary ethnicities, Whites had the highest LOS, followed by Asians, Blacks, and Hispanics.

The “Other” category includes Multi-Racial, Bi-Racial, and American Indian ethnicities. All the “other” ethnicities had substantially higher LOS numbers than average. This is likely the result of these ethnicities having fewer patients than other groups. The smaller number of patients in the “Other” category could skew their results towards a higher average LOS.

The difficulty in showing links between severity, LOS, and race may be related to the nature of illness itself. Illnesses and severity levels are different for each patient. Also, each instance of illness varies in severity, even in the same patient. It may be that LOS is tied more to illness and severity than to race.

Language and Campus

Language and Campus were two variables having no correlation with race. In terms of language, Table 6 shows that an overwhelming 87.7% of the study patients spoke English as their primary language. The next highest language spoken was Spanish (5.0%). No other language was spoken by more than 2.9% of the study patients.

CHC operates two hospitals in Minnesota. One is in Minneapolis and the other is in St. Paul. There seems to be no relation between campus choice and race. The study data showed the Minneapolis campus (66.4%) had two times as many patients as St. Paul (33.6%).

All racial groups were seen more often at the Minneapolis campus. Where race was identified, Minneapolis patients were 54.1% White compared with 41.2% minority. St. Paul patients were 55.1% White compared to 41.3% minority. Choice of campus was probably more related to distance from home or choice of doctor.

Table 6. Languages spoken in the readmission census tracts.

Language	% of Patients
English	87.7
Spanish	5.0
Somali	2.9
Hmong	1.5
Oromo	0.9
9 other languages combined	2.1

Racial Comparison of Readmission Patients, 374 Readmission Census Tracts, and 767 Total Census Tract Study Area

Numerous studies have shown a racial disparity in the quality of health care (Hasnain-Wynia and Baker, 2006). Studying patient demographics is an increasingly common strategy for reducing health care disparities (Hasnain-Wynia and Baker, 2006). To improve minority care, hospitals need to be responsive to the entire community.

Creating programs aimed at improving health care for minorities requires an understanding of cultural differences between ethnicities. Collection of patient information can help hospitals to understand these differences (Hasnain-Wynia and Baker, 2006).

CHC documents certain demographic characteristics as part of a patient's record. For some demographic variables, a comparison could be made between the patients and the overall population living in the same census tracts. These comparisons could help determine whether a demographic characteristic was unique to a patient or common throughout the census tract.

The study area contained 767 total census tracts. 374 census tracts contained at least one readmission patient address (readmission tracts). Race was one of the variables that could be compared between patient data and census tract data.

Table 7 shows that white patients were the most prevalent, followed by minorities, and unknown. Within the three major minority ethnicities, Blacks had the highest number of patients, followed by Hispanics, and Asians. In the 374 readmission tracts, the White population remained the largest racial group, followed by minorities, Blacks, Asians, Hispanics, and the "other" category.

Comparison of the racial percentages between the study group and the readmission census tracts yielded an interesting result. Minority study group patients (41.2%) were 11 percentage points higher than the corresponding pediatric minority population in the readmission tracts (30.2%). Blacks accounted for 8.4 percentage points of this 11-point difference. This shows a racial

disparity between the study group patients and the population within the readmission tracts; however, the racial disparity seemed to be limited to primarily the Black subgroup.

Table 7. Percent of racial composition under 24 years of age of the study group, readmission census tracts, and the total census tracts.

	% of Population < Age 24		
Group	**Hospital Patients**	**Readmission Tracts**	**Total Tracts**
White	54.5	69.8	71.3
Minority	41.2	30.2	28.7
Black	19.7	11.3	10.7
Hispanic	7.7	8.4	8.6
Asian	6.8	9.3	8.0
Other	7.0	1.2	1.4
Unknown	4.3	-	-

Relative to the readmission tracts, Whites were underrepresented among study patients, while minorities were overrepresented. Within the three primary minority groups, Blacks were overrepresented, while Hispanics and Asians were underrepresented.

Comparing the composition of the study group patients with the larger 767 census tract area, the racial discrepancy became slightly higher. This may be due to the population in the total study area being larger than the population in the readmission tracts. In the 767 census tracts, Whites were still the largest racial group, followed by minorities, Blacks, Hispanics, Asians, and the other category.

The same pattern of racial discrepancy was observed at the study area level. Minorities were 41.2% of the patients in the study group but only 28.7% of the population in the 767 tracts, a difference of 12.5 percentage. Again, Blacks accounted for 9 percentage points of the difference. This shows that minorities, or at least Blacks, had a higher rate of readmission relative to the population.

Lack of insurance, differential access to health care, inability to pay for expensive tests, inadequate patient follow-up after initial visit, and lack of doctor-patient communication are all factors that may help explain the racial differences in demographics.

Readmission and Socioeconomic Status

Neighborhood characteristics can influence the health of its residents (Bell, Wilson, Bissonnette, and Shah, 2013). Community-level geographic factors can affect individual-level factors. Research has shown community-level factors may have more impact on individual health than individual-level factors (Diez-Roux, Nieto, Muntaner, Tyroler, Comstock, Shahar, Cooper, Watson, and Szklo, 1997).

Socioeconomic Factors

Socioeconomic status (SES) is a significant determinant of health and mortality (Isaacs and Schroeder, 2004). The link between socioeconomic status and SES and health care, in general, has been documented since the early 20th century (Schereschewsky, Warren, and Sydenstricker, 1916). Recent studies have shown an increase in the connection between SES and illness (Drever, Whitehead, and Rodin, 1996 as cited in Gallo and Matthews, 2003).

Most studies have focused on either adult illness (Singh, Lin, Kuo, Nattinger, and Goodwin, 2014) or neighborhood effects on illness (O'Lenick, Chang, Kramer, Winquist, Mulholland, Friberg, and Sarnat, 2017). However, there are studies that have shown a connection between socio-economic status (SES) and pediatric illness. Low SES in childhood has been linked with poor health outcomes in adulthood (Ye and Waite, 2005).

Social and economic conditions of a family may influence their child's risk for readmission (Chung, Lui, Cowgill, Hoffman, Elijah, and Schuster, 2012). Multiple variables at the patient, family, and community level all may influence readmission risk (Nakamura, Toomey, Zaslavsky, Berry, Lorch, Jha, and Schuster, 2014).

Identifying which specific economic factors affect pediatric readmission is a more difficult question. Numerous SES factors have been shown to influence health disparities (Gallo and Matthews, 2003). Larger families can influence pediatric illness (Moncrief, Beck, Simmons, Huang, and Kahn, 2014). Children in households with only one parent were more likely to return to the ER (Moncrief *et al.*, 2014).

Children from low income families are more likely to use urgent care (Clark, Lachance, Benedict, Little, Leo, Awad, and Wilkin, 2015). Families on food stamps (Watt, Appel, Roberts, Flores, and Morris, 2013) or with children enrolled in public assistance programs (Wise, Wampler, Chavkin, and Romero, 2002) have a higher incidence of pediatric readmission.

A correlation exists between parental education level and pediatric illness (Lindeboom, Llena-Nozal, and Van der Klaauw, 2009). In Lindeboom (2009), investigators found the less educated the parent, the more likely their child was to experience a hospital readmission. Investigators theorized that parents with lower education levels might be more likely to wait until their child's illness become more severe before seeking medical intervention. Finally, the choice of private or public health insurance influences the quality of pediatric care (Bethell, Kogan, Strickland, Schor, Robertson, and Newacheck, 2011).

Socioeconomic Comparison of 374 Readmission Census Tracts vs. 393 Non-Readmission Census Tracts

Excluding insurance type, patient records contained in the CHC data set contained no economic information on patients. However, a general comparison can be made between census tracts containing readmitted patients and census tracts with no readmission patients. Comparing census tracts containing patient records with census tracts containing no patient records allows for a discussion of the economic differences between the living areas of the study patients and the study area. The study area contained 767 total census tracts. 374 census tracts contained at least one readmission patient address (readmission tracts). 393 census tracts had no readmission patients (non-readmission tracts). Figure 4 shows the distribution of the 374 readmission census tracts and the 393 non-admission tracts. Readmission patients are found throughout the study area. However, patients are especially concentrated in Hennepin, Ramsey, and Dakota counties.

To determine if the economic characteristics of a neighborhood influenced pediatric readmissions, the total study area (767 census tracts) was divided into two groups. One group was composed of 374 tracts containing at least one patient record (readmission tracts). The other group contained the remaining 393 census tracts containing no patient records (non-readmission tracts).

Readmission tracts were compared to the non-readmission tracts using 7 economic variables often found in the literature as associated with pediatric illness and readmissions. Variables included households with children, household size, poverty status, total

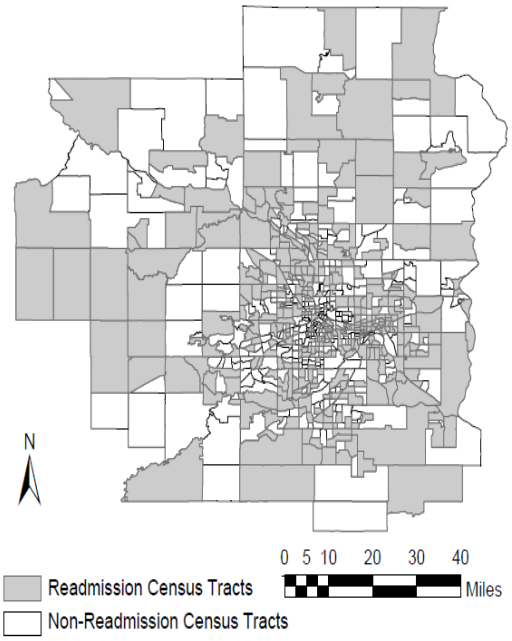

Figure 4. 374 readmissions census tracts and 393 non-readmission census tracts in the 11-county metro study area.

household earnings, public assistance, educational attainment, and insurance type. Two percentages were calculated for each variable: Readmission Tracts Percentage and Non-Readmission Tracts Percentage using the equation found in the methods section.

The hypothesis was that the 7 economic characteristics associated with pediatric illness would be more evident in the readmission tracts than in the non-readmission tracts. And, in fact, the hypothesis was supported in 6 of 7 variables.

Households with Children and One Parent Families

It was hypothesized that readmission census tracts would have more households with children than non-readmission tracts. Table 8 shows this to be the case. There was a 7.8 percentage point difference. The 374 readmission census tracts had more family households (53.9%) than the non-readmission census tracts (46.1%).

Table 8. Percent of family households with children under 18 years of age in census tracts with readmissions and in census tracts with no readmissions.

% of Family Households	Readmission Tracts	Non Readmissior Tracts
All family households	53.9	46.1
With children <18	57.1	42.9
With children < 18, married	57.0	43.0
With children < 18, other	57.5	42.5

Additionally, as predicted, the readmission census tracts (57.1%) had more families with children under 18 than the non-readmission tracts (42.9%). Finally, it was believed where single parent families were more prevalent, there would be a corresponding increase in the incidence of pediatric readmissions. This assumption was also proven correct. A 15.0 percentage point difference was found. Readmission tracts had more single parent families (57.5 %) than non-readmission tracts (42.5 %).

Poverty Status

Table 9 shows the percentage of families with children meeting federal poverty guidelines. Since the literature associated pediatric readmissions with poverty, readmission tracts should have more families meeting the federal poverty guidelines than the healthy tracts.

Table 9. Percent of family households meeting the Federal poverty guidelines in census tracts with readmissions and in census tracts with no readmissions.

% of Family Households Meeting Federal Poverty Guidelines	Readmission Tracts	Non Readmission Tracts
All families	55.6	44.4
With children <18	55.8	44.2
With children < 18, married	59.5	40.5
With children < 18, other	54.0	46.0

This was found to be true. There

was an 11.6 percentage point difference. Readmission tracts (55.8%) had more families within federal poverty guidelines than in the non-readmission tracts (44.2%).

Household Earnings

Financial hardship often translates to less money available for nutrition and for preventative medical care. Therefore, it was believed families with less total household earnings would have more illness. Table 10 shows the differences in percentage of household earnings between the readmission census tracts and the non-readmission tracts.

Table 10. Percent of family households in census tracts with readmissions and in census tracts with no readmissions: total households, with earnings, and with no earnings.

Household Earnings in the Past 12 months	Readmission Tracts	Non Readmission Tracts
All families	53.9	46.1
With earnings	54.3	45.7
Without earnings	52.1	47.9

Comparison of the two groups indicates this was not the case. The readmission tracts (52.1%) did have a higher number of households with no earnings than the non-readmission tracts (47.9%). However, the readmission tracts also had more households than the non-readmission tracts.

Public Assistance

Table 11 shows the percentage of families receiving public assistance in the two comparison groups. Government support is more likely rendered to poor families. Therefore, those families receiving public assistance or food stamps were thought likely to have more readmissions. This was true. The data shows a 10.6 percentage point difference. Readmission tracts had more families receiving public assistance.

This was true for both families receiving and not receiving cash assistance. Although the gap was larger for those readmission tract families receiving public assistance with cash benefits, as opposed to those not receiving the additional financial benefits. However, it is also possible that this gap may have resulted from the fact that the readmissions census tracts contained more households than the non-readmission tracts.

Table 11. Percent of households in the past 12 months in census tracts with readmissions and in census tracts with no readmissions: all households, households receiving public assistance (PAI) or food stamps (FS), and households not receiving public assistance or food stamps.

Households and Public Assistance or Food Stamps	Readmission Tracts	Non Readmission Tracts
All households	53.9	46.1
With PAI or FS	55.3	44.7
Without PAI or FS	53.8	46.2

Parent Educational Level

Table 12 shows the difference in educational levels between the readmission and the non-readmission tracts. Since only 12% of the U.S. population has an advanced degree (Ryan and Bauman, 2016), only education up to Bachelor's Degree level is included in this table.

It was believed lower parental education was more likely to result in more readmissions among their children. Results were contradictory. On the one hand, the readmission tracts had more people greater than 25 years old with no high school diploma. On the other hand, the readmission tracts had more people over the age of 25 years old with high school diplomas or a four-year degree. More information on the individual census

tracts is needed to determine what, if any, role parental education played on pediatric readmissions.

Table 12. Percent of education levels in census tracts with readmissions and in census tracts with no readmissions for population over 25 years old. Table includes up to Bachelor's Degree. Table does not include advanced degrees.

Education Level of Population	Readmission Tracts	Non Readmission Tracts
12th grade, no diploma	56.4	43.6
High school diploma	55.3	44.7
GED or alternative credentials	53.4	46.6
Some college, < 1 year	55.4	44.6
1 or more years college, no degree	55.3	44.7
Associate Degree	56.7	43.3
Bachelor Degree	55.3	46.7

Family Size

There were differences in family size between the readmission census tracts and the non-readmission tracts. It was assumed the readmission tracts would have larger families than the healthy tracts. Table 13 shows this was true. Readmission tracts had more 2-person, 3-person, and 4-person families than the non-readmission tracts. The percentage point difference varied depending on the size of the household.

Table 13. Percent of households of various sizes in census tracts with readmissions and in census tracts with no readmissions.

% of Number of People in in the Household	Readmission Tracts	Non Readmission Tracts
All households	53.9	46.1
All family households	55.6	44.4
2 person family households	54.0	46.0
3 person family households	55.6	44.4
4 person family households	56.7	43.3
All non family households	50.7	49.3
2 person non family households	51.1	48.9
3 person non family households	49.2	50.8
4 person non family households	47.1	52.9

Health Insurance

Table 14 shows the distribution of insurance, by type, between the two census tract groups.

Table 14. Percent of insurance type for population under age 24 years old in census tracts with readmissions and in census tracts with no readmissions.

% of the Population < age 24	Readmission Tracts	Non Readmission Tracts
Total population	55.1	44.9
With public health insurance	58.0	42.0
Without public health insurance	56.1	43.9

Public health insurance recipients tend to be poor or unable to afford health insurance. Additionally, public health insurance does not cover all the tests and treatments. As a result, poor and underinsured people often delay medical treatment which exacerbates illness and increases the likelihood of readmission. It was assumed children of public insurance recipients would be more likely to suffer readmissions. This was true. Of the population with public health insurance, more live in readmission tracts (58%) than in tracts with no readmissions (42%).

However, there is one important caveat regarding the comparison of economic characteristics of the readmission tracts and non-readmission tracts. This comparison involved the relationship of variables between two groups of census tracts. It did not involve a comparison between any individual patients in the study with populations of either census tract group.

Due to patient privacy concerns, CHC does not collect any economic data other than insurance type. This study can only say a patient lives in a tract defined as a "readmission tract." It cannot determine whether any individual patient has any specific economic characteristic.

Conclusion

Race and poverty, as they relate to illness, has been systematically studied for at least a century. Passage of the Affordable Care Act (2010) led to an increased

investigation of the factors associated with hospital readmissions. Although most studies have focused on adults, there have been studies linking various demographic and socioeconomic characteristics of race and poverty with pediatric readmissions.

This study examined pediatric readmissions between November 2011 and December 2015 at Children's Hospitals and Clinics of Minnesota. The study showed both a racial and economic disparity in health care between patients in the study group and the population of the study area.

Minority patients in the study group outnumbered the corresponding pediatric minority population within 374 readmission tracts by 11 percentage points. This difference increased to 12.5 percentage points when study patients were compared to the 767 census tracts in the total study area. In both instances, Blacks made up almost two thirds of the difference.

This gap showed minorities, or at least Blacks, had a higher rate of readmission. However, it is unknown whether the rate of initial admissions leads to the higher rate of minority readmissions or if the initial minority admissions are proportionate to minority percentages within population and the readmissions are the cause of the higher rate. More study is needed on this topic.

Additionally, 5 of 7 economic indicators of poverty were also more prevalent in the readmission tracts than in the healthy tracts.

Within the readmission tracts, families were more likely to have children, more likely to have larger households, more likely to fall within the federal poverty guidelines, more likely to be on public assistance, and more likely to use some form of public insurance to pay for services than those living in the tracts without readmissions. The effect of parental education was ambiguous. Lower household earnings, more present in the families of readmissions tracts, may have been due to a larger number of families in those tracts.

Parental education and household earnings did not correlate with an increase in pediatric readmissions. The increased presence of poverty indicators associated with pediatric readmissions shows there is an economic disparity between areas with pediatric readmission patients and areas without readmission patients.

An important limitation of the economic indicators was the comparison groups. Census tract populations, not patient populations, were compared. This was because other than insurance type, no information on the economics of the study group patients was available.

Recommendations for Reducing Pediatric Readmissions

The following are 6 recommendations for reducing pediatric readmissions.

(1) Establish a nationwide standard definition of "readmission." Despite passage of the Affordable Care Act (2010), there is no clear readmission time frame. Medicare/Medicaid reimbursement is based on 30-day readmissions. However, hospitals are not bound by this period. CHC uses a 7-day readmission window. Other hospitals use different time frames. If readmissions are going to be a successful metric for quality care, a standard readmission time frame is necessary.

(2) Better communication between patients and their care team members. Improving discharge programs, increasing inter-hospital coordination, and increasing hospital-patient communication would help reduce pediatric readmissions

(Knighton *et al.*, 2013; Kenyon *et al*., 2014).

(3) Community outreach programs to educate children and parents on the importance of preventative medicine. Health care literacy positively influences health care results (Sanders, Federico, Klass, Abrams, and Dreyer, 2009). Community involvement would help hospitals monitor any health problems in the population. Hospital personnel might provide information on preventative health care. Outreach programs would build a relationship between the hospital and the community. This is especially true in minority communities where there may be a mistrust of state agencies. Teaching preventative care would help reduce pediatric readmissions.

(4) Free aftercare visits upon release from the hospital. Health insurance is expensive. Many poor people cannot afford out of pocket copays for follow-up doctor visits. Delayed medical attention only increases the possibility of hospital readmission. Providing free aftercare would reduce the economic burden on patients. Reducing the economic burden might lead patients to meet more often with their care teams. Care teams could monitor and help patients manage aftercare to prevent conditions from becoming severe enough to require readmission to the hospital. Improving patient self-care after discharge would help reduce readmissions (Knighton *et al.*, 2013; Kenyon *et al*., 2014).

(5) Follow-up phone call from a triage nurse, 4-7 days after release from the hospital. Post discharge phone calls from nurses were effective in reducing readmissions (Kirsch, Wilson, Harkins, Albin, and Del Beccaro, 2015). Hospital patients are less focused on aftercare instructions and more focused more on leaving the hospital. These phone calls could give patients and care teams an additional chance to ask questions or to schedule follow-up visits. These calls would also provide reassurance that additional help is only a phone call away (Kirsch *et al*., 2015).

(6) More studies on how sociodemographic and economic factors affect pediatric illness. Demographics and economics affect illness. And, illness also affects demographics and economics. Understanding SES-based disparities could help guide future decisions about how to assess readmission rates as a metric for quality of care (Nakamura *et al.*, 2014).

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