

Demographic Disparities amongst Patients Receiving Carpal Tunnel Release: A Retrospective Review of 92,921 Patients

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Background: Despite strong evidence supporting the efficacy of surgical release for carpal tunnel syndrome (CTS), previous studies have suggested that surgery is not performed equally amongst races and sex. The purpose of this study was to investigate potential socioeconomic disparities in the surgical treatment for CTS.

Methods: Adult patients (≥ 18) were identified in the New York Statewide Planning and Research Cooperative System database from 2011 to 2018 by diagnosis code for CTS. All carpal tunnel surgery procedures in the outpatient setting were identified using Current Procedural Terminology codes. Using a unique identifier for each patient, the diagnosis data were linked to procedure data. A multivariable logistic regression was performed to assess the impact of patient factors on the likelihood of receiving surgery.

Results: In total, 92,921 patients with CTS were included in the analysis and 30,043 (32.3%) went on to have surgery. Older age and workers compensation insurance had increased the odds of surgery. Feminine gender had lower odds of surgery. Asian, African American, and other races had decreased odds of surgery relative to the White race. Patients of Hispanic ethnicity had decreased odds of surgery compared with non-Hispanic ethnicity. Patients with Medicare, Medicaid, or self-pay insurance were all less likely to undergo surgery relative to private insurance. Higher social deprivation was also associated with decreased odds of surgery.

Conclusions: Surgical treatment of CTS is unequally distributed amongst gender, race, and socioeconomic status. Additional research is necessary to identify the cause of these disparities to improve equity in patient care. (*Plast Reconstr Surg Glob Open* 2021;9:e3959; doi: 10.1097/GOX.0000000000003959; Published online 24 November 2021.)

INTRODUCTION

Carpal tunnel syndrome (CTS) is one of the most common disorders of the hand and wrist in the United States, with a recent estimate of nearly 600,000 surgical interventions performed annually.¹ Several randomized controlled trials have demonstrated that carpal tunnel release (CTR) is an effective treatment with minimal recurrence or subsequent complications.² Despite strong evidence

supporting the efficacy of surgical release, several studies have shown disparities amongst population subgroups in regard to which patient population ultimately undergoes surgical intervention.³⁻⁶ Previous publications have demonstrated correlations between various demographic factors and the likelihood of undergoing CTR.³⁻⁵ However, these studies have had limited applicability, as they have involved relatively small populations or include populations outside the United States.

Using a comprehensive database of diagnosis and procedure codes utilized in New York State from 2011 to 2018, the present study seeks to determine whether socioeconomic status, insurance type, or other demographic factors are associated with the likelihood of undergoing surgical intervention for CTS. We hope to examine an association between these factors and rate of surgical intervention in New York and utilize our findings as a starting point to cue further exploration of underlying causes. In addition to helping direct further research into drivers

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of disparity, we expect that identification of differences in rates of surgical care can influence quality improvement and healthcare equity.

METHODS

Adult patients (≥ 18 years old) were identified in the New York Statewide Planning and Research Cooperative System (SPARCS) database from 2011 to 2018. SPARCS is a comprehensive all-payer database collecting all inpatient and outpatient (emergency department, ambulatory surgery, and hospital-based clinic visits) claims in New York. This includes all International Classification of Diseases (ICD) diagnosis codes and ICD/Current Procedural Terminology procedure codes associated with all visits.

Patients assessed in the outpatient setting were identified using the ICD-9-Clinical Modification and ICD-10-Clinical Modification diagnostic codes. The initial cohort of patients was first identified by diagnosis codes for CTS (ICD 9: 354.0; ICD-10: G56.00, G56.01, G56.02, G56.03). Only the patient's first CTS diagnosis was included and the first date of diagnosis for each patient was captured. Diagnoses after June 2018 were omitted to allow a minimum of 6 months follow up for all patients included in the analysis.

All carpal tunnel surgery—open and endoscopic—procedures in the outpatient setting were identified using Current Procedural Terminology codes 64721 and 29848, respectively. Using a unique identifier for each patient, the diagnosis data were linked to procedure data to determine which patients went on to have CTR after the initial diagnosis. Only residents of New York State were included in the analysis.

Statistical Analyses

Patients were divided into cohorts based on whether they underwent surgery or not. Patient demographics were compared between the surgery and nonoperative cohorts using chi-squared analysis. Mann-Whitney-U tests were used when appropriate when continuous data were found to be not normally distributed. A multivariable logistic regression was performed to assess the likelihood of receiving surgery after a diagnosis of CTS. The variables included patient age, gender, race, ethnicity, Social Deprivation Index (SDI), Charlson Comorbidity Index (CCI), and primary insurance type. Other race is defined as all other races excluding White, Asian, and African American but includes multiracial patients. Other primary insurance is defined as all other insurance excluding private, Medicare, Medicaid, self-pay, and workers' compensation.

SDI, as described by Butler et al, was linked to each patient based on ZIP code.⁷ SDI provides a comprehensive measure of social determinants of health not traditionally captured by healthcare administrative databases by converting the following categories to an index from 1 to 100: percent living in poverty, percent with less than 12 years of education, percent single parent household, percent living in rented housing unit, percent living in overcrowded housing unit, percent of households without a car, and

Takeaways

Question: Are socioeconomic status, insurance type, or patient demographic factors associated with the likelihood of undergoing surgical intervention for carpal tunnel syndrome?

Findings: In a New York statewide claims-based dataset, patients with carpal tunnel syndrome were identified and followed to determine whether they underwent surgical release. Using a multivariable logistic regression, feminine gender, Asian, African American, other races, Hispanic ethnicity, Medicare, Medicaid, self-pay, and those from areas with high social deprivation were found to have decreased odds of surgery.

Meaning: The disparity between operative and nonoperative management is significant with regard to racial and ethnic minorities and socioeconomic status.

percent nonemployed adults under 65 years of age. A higher SDI score equates to increased social deprivation. SDI data in this study was based on 2015 statistics.⁷ We felt this was a more accurate measure of socioeconomic status for our analysis. Recent upper extremity publications have used a similar deprivation index as a measure of socioeconomic status.^{8,9}

The CCI was calculated using the method described by Deyo et al and extended to ICD-10 Clinical Modification.¹⁰ CCI was dichotomized to a score of 0 versus a score of 1 or more. A *P* value less than 0.05 was considered significant across all statistical analyses. All analyses were performed using SAS 9.4 (SAS Inc, Cary, N.C.).

RESULTS

In total, 92,921 patients with a carpal tunnel syndrome diagnosis were included in the analysis, and 30,043 (32.3%) patients went on to have surgery. The number of surgeries captured stayed relatively constant ranging from 3,461 and 4,749 cases between 2009 and 2017, and 2231 cases were captured from the first half of 2018. Due to the SPARCS deidentification policy, the date of service is listed as the first day of the month; therefore if surgery occurred in the same month as the diagnosis, the time to surgery would be noted as 0. The average time to surgery after the initial diagnosis was 4.3 months with a median of 1 month.

On univariate analysis, several demographic differences were noted among the group that underwent surgery compared with the no surgery group. The no surgery group tended to be younger and from areas of higher social deprivation. The no surgery group had increased incidence of feminine gender, Hispanic ethnicity, Asian race, African American race, and other race. The no surgery group also had a higher incidence of private insurance, Medicaid, self-pay, and having one or more Charlson comorbidities. The surgery group had increased incidence of masculine gender, non-Hispanic ethnicity, White race, Medicare, and workers' compensation (Table 1).

Table 1. Patient Demographics and Characteristics by Treatment Group

	Nonoperative (n = 62,878)	Surgery (n = 30,043)	P
Age, median (mean, SD)	54 (53.7, 14.9)	57 (58, 14.2)	<0.0001
Gender, n (%)			
Women	45,703 (72.7)	19,692 (65.6)	<0.0001
Men	17,175 (27.3)	10,351 (34.5)	—
Ethnicity, n (%)			
Non-Hispanic	48,617 (77.3)	26,370 (87.8)	<0.0001
Hispanic	14,261 (22.7)	3673 (12.2)	—
Race, n (%)			
White	27,150 (43.2)	21,389 (71.2)	<0.0001
Asian	1838 (2.9)	388 (1.3)	<0.0001
African American	14,590 (23.2)	3434 (11.4)	<0.0001
Other	19,300 (30.7)	4832 (16.1)	<0.0001
Primary insurance, n (%)			
Private	30,467 (48.5)	14,319 (47.7)	0.0237
Medicare	15,370 (24.4)	9295 (30.9)	<0.0001
Medicaid	9115 (14.5)	2936 (9.8)	<0.0001
Workers' compensation	1564 (2.5)	2237 (7.5)	<0.0001
Self-pay	6165 (9.8)	1113 (3.7)	<0.0001
Other	197 (0.3)	143 (0.5)	0.0001
Charlson score, n (%)			
0	55,779 (88.7)	28,056 (93.4)	<0.0001
≥1	7099 (11.3)	1987 (6.6)	—
SDI, median (mean, SD)	82 (70, 30)	55 (53.9, 30.7)	<0.0001

Bold P values are <0.05.

White patients had a 44.1% surgical management rate, which was more than twice the rate among African American patients at 19.1%. Asian patients underwent surgery at a rate of 17.4% and other races had a surgical rate of 20%. Similarly, the non-Hispanic surgical rate was 35.2%, almost twice the Hispanic surgical rate at 20.5%. The group with the highest surgical rate at 58.9% was patients with workers' compensation as the primary insurer. In contrast, the group with the lowest surgical rate was patients who were self-pay, at 15.3%.

The logistic regression showed older age and workers' compensation insurance relative to private had increased odds of surgery. Women had decreased odds relative to men. Asian, African American, and other races had decreased odds of surgery relative to White race. Patients of Hispanic ethnicity also had decreased odds of surgery compared with non-Hispanic ethnicity. Patients with Medicaid or self-pay insurance were less likely to undergo surgery relative to private insurance. Despite a higher surgical rate for patients with Medicare compared with private insurance, after controlling for the variables in the model, those with Medicare had decreased odds of surgery. Lastly, a higher SDI was also associated with decreased odds of surgery (Table 2).

Figure 1 illustrates how the SDI varies across New York ZIP codes, with darker areas representing higher social deprivation. Figure 2 illustrates the rate of CTR by ZIP code. As an example, western Long Island, which encompasses New York City and surrounding boroughs, represents higher SDI scores in Figure 1 and lower rates of CTR in Figure 2.

DISCUSSION

This study utilized the SPARCS database to evaluate differences between patients who underwent surgical treatment for CTS and those who did not undergo surgical treatment for CTS. Our findings were consistent with the

previous literature that noted significant disparities in the management of patients in regard to social deprivation, race, ethnicity, and insurance status.³⁻⁵ We found patients from areas with higher levels of social deprivation were less likely to undergo CTR. Additionally, patients who did not undergo surgical management tended to be younger and women. In terms of racial disparities, those who identified as Hispanic ethnicity, Asian race, African American

Table 2. Multivariable Logistic Regression Model for the Likelihood of CTR

	Rate of Surgery (32.3%)	Odds Ratio (95% CI)	P
Age	—	1.017 (1.015–1.018)	<0.0001
Gender			
Men	37.6	—	—
Women*	30.1	0.966 (0.936–0.997)	0.0334
Race			
White race	44.1	—	—
Asian race†	17.4	0.378 (0.337–0.424)	<0.0001
African American race†	19.1	0.434 (0.414–0.454)	<0.0001
Other race‡	20	0.5 (0.479–0.523)	<0.0001
Ethnicity			
Non-Hispanic ethnicity	35.2	—	—
Hispanic ethnicity‡	20.5	0.85 (0.811–0.891)	<0.0001
Primary insurance			
Private	32	—	—
Medicare§	37.7	0.897 (0.862–0.934)	<0.0001
Medicaid§	24.4	0.816 (0.777–0.856)	<0.0001
Workers' compensation§	58.9	2.431 (2.266–2.608)	<0.0001
Self-Pay§	15.3	0.499 (0.465–0.534)	<0.0001
Other§	42.1	1.113 (0.89–1.392)	0.3482
Charlson score			
CCI = 0	33.5	—	—
CCI ≥ 1¶	21.9	0.568 (0.538–0.6)	<0.0001
SDI	—	0.993 (0.992–0.993)	<0.0001

*Compared with men.

†Compared with White race.

‡Compared with non-Hispanic ethnicity.

§Compared with private insurance.

¶Compared with CCI = 0.

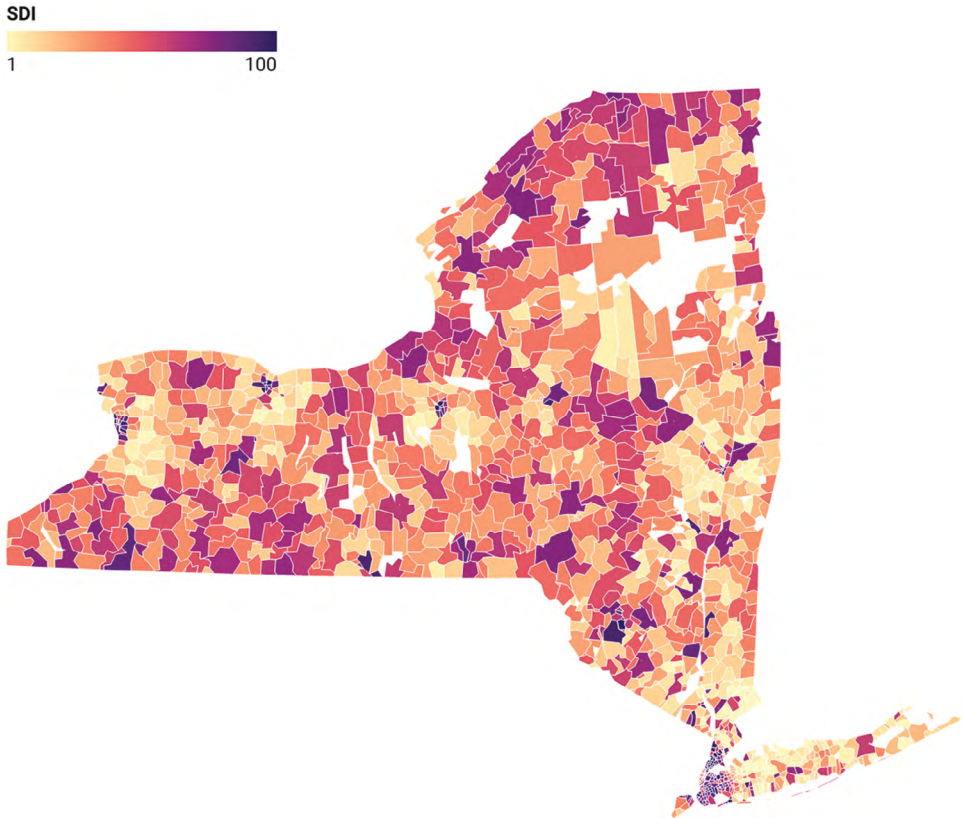


Fig. 1. SDI by New York ZIP code. White ZIP codes had no CTS cases included in the analysis.

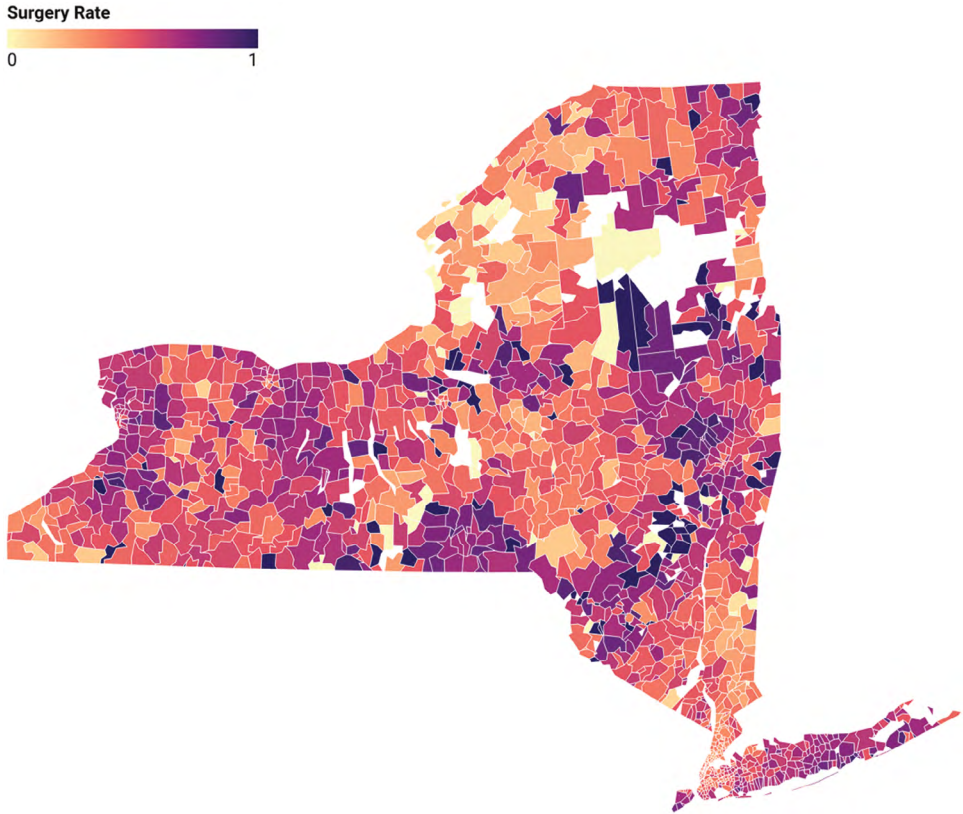


Fig. 2. Rate of CTR by ZIP code. White ZIP codes had no CTS cases included in the analysis.

race, and other race were less likely to receive surgery than those of non-Hispanic ethnicity and White race. Those who had Medicare, Medicaid, or self-pay insurance status were less likely to receive surgery as well.

With regard to patient age, we found that patients in the surgery group had a higher median age (57 years) than those in the nonoperative group (54 years). These results are consistent with previous research, which found increased age to be a prognostic factor for surgical management of carpal tunnel syndrome.³ Although, it is unclear why older patients tend to undergo surgery at a higher rate, we hypothesize that older patients have suffered from CTS symptoms for a longer duration of time, may have decreased opportunity cost if they are retired, and are perhaps more willing to undergo CTR as a first line option. Additionally, Table 1 shows that the Medicare patients make up a higher proportion of surgical patients than nonsurgical patients, which further supports the older population undergoing surgery at increased rates.

Our study found that female patients comprise a majority of patients diagnosed with CTS but are less likely to undergo surgery compared with men. Day et al performed a retrospective analysis of demographic trends on disease management in CTS patients from 2005 to 2007, and found that male patients were more likely to receive surgery than female patients.³ In 2017, Zhang et al also found that a CTS diagnosis was associated with feminine gender and increased age, consistent with our results. In their study, the authors found that female patients comprised 65.9% of patients with CTS.⁴ It is unclear why female patients undergo nonoperative treatment more frequently. Gong et al. noted several factors related to the willingness of female patients to forgo surgery, mostly related to postoperative weakness, pain, and financial burden.¹¹ Mitake et al also found a lower rate of women undergoing CTR compared with men. They noted that female patients had a higher rate of thenar atrophy, suggesting more severe disease at the time of evaluation.¹²

Those of Hispanic ethnicity were nearly half as likely to undergo surgery compared with non-Hispanic patients. Additionally, patients in the surgery group were significantly less likely to be of Asian or African American race. Disparities in undergoing surgical release for CTS are substantial and may highlight pervasive differences of care based on race and ethnicity. Similar to our findings, Shoefeld et al noted a significant difference in the rate that ethnic minorities underwent surgery. Among a Medicare population, they found that those who identified as African American, Hispanic, and Asian underwent surgical intervention at lower rates.¹³ Furthermore, when investigating patients specifically undergoing orthopedic surgery, a systematic review found minorities had a higher rate of complications and mortality in spine and joint arthroplasty surgery.¹⁴ Cultural differences may play a factor in the lower rates of operative intervention. A recent study found online educational materials related to carpal tunnel syndrome that was translated into Spanish were direct translations and not adapted to the education level of users.¹⁵ The ethnic disparities found in our study are similar to those in other published studies. These results

are likely due to multiple factors that lead to lower rates of CTR in racial and ethnic minorities.

Socioeconomic factors have been demonstrated to have a substantial impact on access to medical care. We found that patients in the no surgery group had a median SDI that was nearly 35% higher than that of those in the surgery group. Furthermore, previous studies have found a higher incidence of CTS in those with higher levels of socioeconomic deprivation.⁵ It has also been reported that specialist hand surgeons are unevenly distributed away from areas with lower socioeconomic status,¹⁶ which may correlate directly with SDI. Additionally, our data showed that patients who were self-pay had the lowest surgical rate (15.4%). Odom et al investigated the reimbursement rate as a proportion of price billed of common hand surgical procedures (the majority of which were CTRs). The study found that for CTR, workers' compensation reimbursed 65% of the billed price, whereas Medicaid reimbursed 25.8% of the billed price on average.⁶ While the study did not specifically include patients who were self-pay, their findings of financial disincentives for physicians to accept federal health insurance are also reflected in the present study. The surgical group was comprised of a higher percentage of privately insured and workers' compensation patients than the nonsurgical group, which had a higher percentage of patients with federal insurance and self-pay. Our results of a lower rate of surgical management associated with increased SDI adds to the established trends that those of lower socioeconomic status undergo surgical treatment at lower rates.

This study is not without limitations. Given the retrospective nature of the study, our results rely on the accuracy of medical coding. In addition, we were not able to control for more detailed demographic factors that can be considered to be social determinants of health (ie, occupational demands, cultural or language barriers etc.). Due to the limitations of the database, we could not account for injury specific factors such as pain level or severity of symptoms, which would be expected to influence outpatient surgical decisions. The data did not allow us to distinguish those who presented early in the disease course versus those who presented late, as those who present early are candidates for, and more likely to have success with conservative treatment measures. Additionally, we were not able to account for the variability in treatment guidelines and criteria for surgery that is used by each practitioner; however, the large sample allows an opportunity for this variability to have a smaller effect on the presented results. These same database limitations also included more detailed diagnostic and treatment information like disease severity quantity electromyography/nerve conduction studies (EMG/NCS), response to conservative management, and steroid injection rate. Our study only considered patients who are residents of New York State, thus national or global trends cannot be directly inferred. However, New York contains a very heterogeneous population with high demographic variability among patients, providers, and facilities.¹⁷

Our results invite a more detailed review of the root causes of apparent disparities in management of CTS. The

disparity between operative and nonoperative management is significant with regard to racial and ethnic minorities compared with non-Hispanic and White patients. Additionally, those from areas with a higher SDI, self-pay patients, and federally funded insurance are less likely to receive surgery. Our findings can be used to increase awareness of systemic biases within healthcare and provide the basis for policy interventions to improve access to equitable upper extremity care.

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