

# Evaluating the Impact of Patient Social Deprivation on the Level of Symptom Severity at Carpal Tunnel Syndrome Presentation

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## Abstract

**Background:** There is a paucity of research examining the impact of social deprivation on the level of symptom severity at presentation, including in common hand conditions like carpal tunnel syndrome. We aimed to determine whether patient deprivation is associated with worse Patient-Reported Outcomes Measurement Information System (PROMIS) Upper Extremity (UE), Physical Function (PF), Pain Interference (PI), and Depression scores. **Methods:** Patients presenting to an academic hand clinic from December 2016 to December 2018 for a new patient visit for carpal tunnel syndrome completed PROMIS UE, PF, PI, and Depression Computer Adaptive Tests. Bivariate analyses were done to compare patient variables between the least and most deprived thirds, as measured by Area Deprivation Index (ADI), at the state (New York) and national levels. Multivariable linear regression was used to determine whether there was an association between social deprivation and PROMIS UE, PF, PI, and Depression scores. **Results:** All PROMIS domain scores were significantly worse in the most deprived cohort at the national level ( $P < .05$ ) but not at the state level ( $P > .05$ ). In multivariable regression at the national level, ADI values were associated with PROMIS UE ( $\beta = -0.06, P < .01$ ) and PROMIS PI ( $\beta = .05, P < .01$ ) but not PROMIS PF or PROMIS Depression. In multivariable regression at the state level, ADI values were associated with PROMIS UE ( $\beta = -0.79, P = .03$ ) and PROMIS PI ( $\beta = 0.58, P < .05$ ) but not PROMIS PF or PROMIS Depression. **Conclusions:** Higher levels of social deprivation are associated with worse PROMIS UE and PROMIS PI scores on both the state and national levels when initially seeking care for carpal tunnel syndrome.

**Keywords:** carpal tunnel syndrome, patient-reported outcome measures, PROMs, PROMIS, social deprivation, Area Deprivation Index

## Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral nerve condition worldwide, with a prevalence of between 3% and 5%.<sup>1,2</sup> Carpal tunnel syndrome can cause hand numbness, pain, and weakness and negatively impact work productivity.<sup>3</sup> Carpal tunnel release (CTR) is an effective treatment that tends to meet expectations for reducing pain while improving numbness and weakness.<sup>4</sup> However, in cases of severe CTS, patients may not have complete resolution of numbness even with pain relief following CTR.<sup>5</sup>

Socioeconomic status (SES) and insurance status have been shown to impact health care and surgery access<sup>6-9</sup> and patient outcomes,<sup>10,11</sup> including patient-reported outcome measures (PROMs) following total knee arthroplasty.<sup>12</sup> Furthermore, social deprivation—a measure of SES disadvantage—has also been shown to impact the

prevalence of musculoskeletal pain<sup>13</sup> and self-reported symptom severity across orthopedic surgery.<sup>14</sup> Therefore, in accordance with the US Institute of Medicine's recommendation to consider social and mental health to further America's overall health<sup>15</sup> and the European Union's focus on improving its citizens' overall mental health and well-being,<sup>16</sup> physicians should consider social deprivation when providing care.

Overall, there is limited research on the impact of social deprivation on patients seeking hand care. However, a study by Wright et al<sup>17</sup> evaluated self-reported symptom severity

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using the Patient-Reported Outcomes Measurement Information System (PROMIS) in patients presenting for evaluation of CTS. The authors found those with greater social deprivation at a national level had worse self-reported mental and physical health symptoms.<sup>17</sup>

The frequency of CTS and costs associated with treatment make confirming or refuting these initial findings with an independent sample warranted. Furthermore, we sought to build upon this initial study by evaluating whether social deprivation when analyzed at the state level versus the national level leads to similar findings. This additional analysis is important to perform because patients who are considered socially deprived in a state where the average quality of life is high may not be considered nearly as socially deprived on a national scale where the average quality of life may be comparably lower. Our primary null hypothesis was that there would be no association between social deprivation at the national level and PROMIS Upper Extremity (UE), Physical Function (PF), Pain Interference (PI), and Depression scores. Our secondary null hypothesis was that there would be no association between social deprivation at the state level (New York State) and PROMIS UE, PF, PI, and Depression scores.

## Materials and Methods

This study was approved by the appropriate institutional review board.

Between December 2016 and December 2018, all patients presenting for a new patient visit to a single, academic hand clinic were asked to complete PROMIS UE, PF, PI and Depression Computer Adaptive Tests as part of routine clinical care.<sup>18</sup> Patient-Reported Outcomes Measurement Information System is a validated, general PROM funded through the US National Institutes of Health designed to follow a normal distribution with a mean *t* score of 50 and a standard deviation of 10.<sup>19-22</sup> Higher PROMIS PF scores indicate better physical function, whereas lower PROMIS PI and Depression scores indicate better pain coping and decreased depression symptoms, respectively. In addition, changes in PROMIS UE, PF, and PI domains that are considered clinically relevant range from 4.2 to 8.0, 1.8 to 2.8, and 4.1 to 9.7, respectively.<sup>23</sup>

Patient-Reported Outcomes Measurement Information System data were stored in a longitudinally maintained database by our institution. The database was queried for new patient visits in which CTS was diagnosed by a fellowship-trained hand surgeon, identified using International Classification of Diseases, Tenth revision codes (G56.0X). A total of 475 patients were identified. We removed the 75 patients (16% of 475) who did not complete all 4 PROMIS domains, leaving a final sample of 400 patients (84% of 475) for our study.

The following continuous variables were recorded: PROMIS scores and age (years). In addition, the following categorical variables were recorded: CTS side (bilateral, right, left, unspecified); sex (women or men); self-reported race (white, black, or other); marital status (married, single, or other). In addition, census block groups were used to determine the level of social deprivation by calculating the validated Area Deprivation Index (ADI).<sup>24</sup> Area Deprivation Indices were determined at both the state (1-10, 10 = lowest SES/highest social deprivation) and national (1-100, 100 = lowest SES/highest social deprivation) levels. For state values, each unit of the state ADI represents social deprivation deciles and is determined without regard to national ADIs.<sup>24</sup>

Bivariate analysis was conducted between the least and most deprived thirds across all patient characteristics and PROMIS scores. The  $\chi^2$  analysis was used to compare categorical variables, whereas *t* tests were used to compare continuous variables. Multivariable linear regression including all patient characteristics noted above was used to determine whether there was an association between social deprivation and presenting patient-reported health status (ie, PROMIS UE, PF, PI, and Depression scores) at both the state and national levels (separate analyses). For multivariable linear regression analyses, state and national ADI values were left as continuous variables to remove bias created by arbitrary cutoff values.

For all analyses, significance was set a priori at  $P < .05$ .

## Results

The average state and national ADIs were 7 (range, 3-10) and 53 (range, 9-100), respectively (Table 1). Most patients were women (62%) and white (88%) (Table 1). The average PROMIS UE, PF, PI, and Depression scores were 40.22 (range, 17.95-60.99), 44.97 (range, 23.21-68.78), 57.38 (range, 38.67-80.07), and 48.64 (range, 34.17-78.05), respectively (Table 1).

In bivariate analysis comparing the least and most deprived third of patients at the *national level*, the most deprived third was significantly younger (51 [20-82] vs 58 [19-89],  $P < .01$ ) and were less commonly married (46% vs 73%,  $P < .01$ ) (Table 2). Furthermore, all PROMIS scores were significantly worse in the most deprived third than the least deprived third: PROMIS UE (37.40 [17.95-60.99] vs 42.38 [22.29-60.99],  $P < 0.01$ ); PROMIS PF (43.34 [23.21-64.93] vs 46.31 [23.71-66.49],  $P = .02$ ); PROMIS PI (59.85 [38.67-80.07] vs 55.93 [38.67-74.11],  $P < .01$ ); and PROMIS Depression (50.59 [34.17-78.05] vs 47.01 [34.17-73.55],  $P = .01$ ) (Table 2).

In bivariate analysis comparing the least and most deprived third of patients at the *state level*, the most deprived third was significantly younger (54 [19-92] vs 61 [19-88],  $P < .01$ ) and had more bilateral CTS noted (65% vs 43%,

**Table 1.** Patient Characteristics (N = 400).

Patient characteristic	No. (%) or Mean (Range)
Age, years	56 (19-92)
Carpal tunnel side	
Bilateral	262 (66)
Right	90 (23)
Left	41 (10)
Unspecified	7 (2)
Sex	
Women	249 (62)
Men	151 (38)
Race	
White	352 (88)
Black	27 (7)
Other	21 (5)
Marital status	
Married	253 (63)
Single	85 (21)
Other	62 (16)
State ADI	7 (3-10)
First third (lowest ADI)	35 (9)
Second third	187 (47)
Last third (highest ADI)	178 (45)
National ADI, mean (range)	53 (9-100)
First third (lowest ADI)	113 (28)
Second third	187 (47)
Last third (highest ADI)	100 (25)
PROMIS scores	
UE	40.22 (17.95-60.99)
PF	44.97 (23.21-68.78)
PI	57.38 (38.67-80.07)
Depression	48.64 (34.17-78.05)

Note. ADI = Area Deprivation Index; PROMIS = Patient-Reported Outcomes Measurement Information System; UE = Upper Extremity; PF = Physical Function; PI = Pain Interference.

$P = .04$ ) (Table 3). There was no difference in PROMIS UE, PF, PI, or Depression scores between the least and most deprived thirds at the state level (Table 3).

In multivariable linear regression at the national level, ADI values were associated with PROMIS UE ( $\beta = -0.06$ ,  $P < .01$ ) and PROMIS PI ( $\beta = 0.05$ ,  $P < .01$ ) but not PROMIS PF or PROMIS Depression (Table 4). In multivariable linear regression at the state level, ADI values were associated with PROMIS UE ( $\beta = -0.79$ ,  $P = .03$ ) and PROMIS PI ( $\beta = 0.58$ ,  $P < .05$ ) but not PROMIS PF or PROMIS Depression (Table 5).

## Discussion

Using an independent patient sample, we sought to confirm prior findings by Wright et al<sup>17</sup> that high levels of social deprivation are associated with worse physical and mental

health in patients with CTS. In addition, we aimed to build upon this previous study by determining whether the same impact of social deprivation on self-reported health status was present when analyzing data at the state level. In bivariate analysis, we confirmed that when using the national ADI scores, more socially deprived patients demonstrated worse PROMIS UE, PF, PI, and Depression scores when presenting to the clinic with CTS. However, no such difference in self-reported health status was appreciated when comparing the third least and most socially deprived patients at the state level. Interestingly, the level of social deprivation was only associated with PROMIS UE and PROMIS PI; however, there was no such association with PROMIS PF or PROMIS Depression. These findings were consistent at both the national and state levels.

The difference in PROMIS scores based on being in the least or most socially deprived thirds appreciated at the national level but absent at the state level provides the basis for an interesting discussion. This is especially true in relation to the differences observed in PROMIS PF scores at the national level, which may represent true clinical differences between the 2 patient populations.<sup>23</sup> One hypothesis is that the difference in self-reported health status in patients with CTS at the national level exists because we are truly analyzing data across the entire spectrum of social deprivation. In contrast, when evaluating the impact of social deprivation on self-reported CTS symptom severity at the state level, one must consider the state of the current study—New York. New York is considered a wealthier state with a higher median annual household income than many other states<sup>25</sup>; furthermore, New York has a high number of surgeons and also expanded Medicaid, a government health insurance for the poor and underserved, which has been shown to increase access to orthopedic surgery care.<sup>26,27</sup> Therefore, it is plausible that self-reported symptom severity is a function of health care access. Across the country, there remains a much wider variation in health care access than within a wealthier state that expanded Medicaid (eg, New York). Future research is warranted to determine whether our state-level findings are consistent across other states that expanded Medicaid and to determine whether states that did not expand Medicaid do have differences in self-reported health status in patients with CTS based on social deprivation levels.

At both the state and national levels, social deprivation was associated with presenting PROMIS UE and PI scores in patients with CTS. In each case, higher levels of social deprivation were associated with worse presenting upper extremity function and pain interference. Prior research has demonstrated that greater upper extremity functional limitation preoperatively is an important prognostic factor for poorer overall work-related and functional outcomes postoperatively.<sup>28-30</sup> Thus, similar to a previous study,<sup>17</sup> we believe that it is crucial for hand surgeons to appreciate the impact of social deprivation on self-reported symptom

**Table 2.** A Comparison of Patient Characteristics by the Least and Most Deprived Thirds Nationally.

Patient characteristic	Least deprived (n = 113) No. (%) or Mean (range)	Most deprived (n = 100) No. (%) or Mean (range)	P value
Age, years	58 (19-89)	51 (20-82)	<.01
Carpal tunnel side			.60
Bilateral	69 (61)	70 (70)	
Right	28 (25)	19 (19)	
Left	14 (12)	10 (10)	
Unspecified	2 (1.8)	1 (1)	
Sex			.73
Women	72 (64)	66 (66)	
Men	41 (36)	34 (34)	
Race			.41
White	101 (89)	85 (85)	
Black	5 (4.4)	9 (9)	
Other	7 (6.2)	6 (6)	
Marital status			<.01
Married	83 (73)	46 (46)	
Single	19 (17)	35 (35)	
Other	11 (9.7)	19 (19)	
PROMIS scores			
UE	42.38 (22.29-60.99)	37.40 (17.95-60.99)	<.01
PF	46.31 (23.71-66.49)	43.34 (23.21-64.93)	.02
PI	55.93 (38.67-74.11)	59.85 (38.67-80.07)	<.01
Depression	47.01 (34.17-73.55)	50.59 (34.17-78.05)	.01

Note. PROMIS = Patient-Reported Outcomes Measurement Information System; UE = Upper Extremity; PF = Physical Function; PI = Pain Interference.

**Table 3.** A Comparison of Patient Characteristics by the Least and Most Deprived Thirds Statewide.

Patient characteristic	Least deprived (n = 35) No. (%) or Mean (range)	Most deprived (n = 178) No. (%) or Mean (range)	P value
Age, years	61 (19-88)	54 (19-92)	<.01
Carpal tunnel side			.04
Bilateral	15 (43)	116 (65)	
Right	13 (37)	41 (23)	
Left	7 (20)	17 (10)	
Unspecified	—	4 (2.3)	
Sex			.41
Women	19 (54)	110 (62)	
Men	16 (46)	68 (38)	
Race			.85
White	30 (86)	152 (85)	
Black	2 (6)	15 (8.4)	
Other	3 (9)	11 (6.2)	
Marital status			.11
Married	25 (71)	93 (52)	
Single	5 (14)	48 (27)	
Other	5 (14)	37 (21)	
PROMIS scores			
UE	40.28 (22.29-60.99)	38.85 (17.95-60.99)	.53
PF	44.45 (23.85-64.51)	44.35 (23.21-68.78)	.97
PI	55.68 (38.67-73.70)	58.34 (38.67-80.07)	.13
Depression	46.78 (34.17-64.37)	49.80 (34.17-78.05)	.13

Note. PROMIS = Patient-Reported Outcomes Measurement Information System; UE = Upper Extremity; PF = Physical Function; PI = Pain Interference.

**Table 4.** Multivariable Logistic Regression Analyses by PROMIS Domain Using National ADI.

Variable	Coefficient (95% CI)	P value
PROMIS UE: Significant ( $P < .05$ ) covariates only		
National ADI	-0.06 (-0.11 to -0.02)	< .01
Men	5.41 (3.47 to 7.34)	< .01
Single relationship status	-4.12 (-6.62 to -1.63)	< .01
PROMIS PF: Significant ( $P < .05$ ) covariates only		
Age	-0.11 (-0.18 to -0.05)	< .01
Men	2.57 (0.77 to 4.37)	< .01
Single relationship status	-4.10 (-6.43 to -1.78)	< .01
Other relationship status	-2.56 (-5.07 to -0.05)	< .05
PROMIS PI: Significant ( $P < .05$ ) covariates only		
National ADI	0.05 (0.01 to 0.09)	< .01
Single relationship status	3.04 (1.03 to 5.04)	< .01
PROMIS Depression: Significant ( $P < .05$ ) covariates only		
Unspecified carpal tunnel side	11.11 (4.25 to 17.96)	< .01
Men	-2.75 (-4.63 to -0.87)	< .01
Other race	4.29 (0.25 to 8.33)	.04
Single relationship status	3.70 (1.27 to 6.13)	< .01
Other relationship status	4.59 (1.96 to 7.21)	< .01

Note. PROMIS = Patient-Reported Outcomes Measurement Information System; ADI = Area Deprivation Index; CI = confidence interval; UE = Upper Extremity; PF = Physical Function; PI = Pain Interference.

**Table 5.** Multivariable Logistic Regression Analyses by PROMIS Domain Using State ADI.

Variable	Coefficient (95% CI)	P value
PROMIS UE: Significant ( $P < .05$ ) covariates only		
State ADI	-0.79 (-1.48 to -0.10)	.03
Men	5.35 (3.41 to 7.29)	< .01
Single relationship status	-4.25 (-6.76 to -1.75)	< .01
PROMIS PF: Significant ( $P < .05$ ) covariates only		
Age	-0.11 (-0.18 to -0.04)	< .01
Men	2.53 (0.73 to 4.33)	< .01
Single relationship status	-4.19 (-6.51 to -1.86)	< .01
Other relationship status	-2.64 (-5.16 to -0.13)	< .05
PROMIS PI: Significant ( $P < .05$ ) covariates only		
State ADI	0.58 (0.02 to 1.13)	< .05
Single relationship status	3.15 (1.14 to 5.17)	< .01
Other relationship status	2.29 (0.11 to 4.46)	< .05
PROMIS Depression: Significant ( $P < .05$ ) covariates only		
Unspecified carpal tunnel side	11.10 (4.24 to 17.97)	< .01
Men	-2.72 (-4.60 to -0.84)	< .01
Other race	4.28 (0.24 to 8.32)	.04
Single relationship status	3.74 (1.31 to 6.17)	< .01
Other relationship status	4.62 (2.00 to 7.25)	< .01

Note. PROMIS = Patient-Reported Outcomes Measurement Information System; ADI = Area Deprivation Index; CI = confidence interval; UE = Upper Extremity; PF = Physical Function; PI = Pain Interference.

severity because it can impact many of our CTS patients' outcomes and well-being. Through a team-based approach that incorporates additional support services for the most socially deprived patients, it may be possible to improve patient outcomes. Future research is warranted to determine

whether this type of approach is of value to CTS patient care.

Our study should be evaluated keeping the limitations of our work in mind. First, this study uses patient data from a single academic medical center hand clinic; thus, our find-

ings may not be generalizable to all settings. While our national analyses are consistent with those of Wright et al,<sup>17</sup> future work using patient data from other countries, including European Union members, would add value to the literature and confirm or refute the importance of understanding social deprivation and its relation to hand care regardless of patient location. Second, the determination of a diagnosis of CTS was based on clinical examination and supplemented with electrodiagnostic studies, 6-item CTS (CTS-6) score, or both. Of note, access to electrodiagnostic studies or the use of CTS-6 scores did not differ by patient social deprivation levels. While some surgeons may seek electrodiagnostic testing to guide surgical intervention, others do not.<sup>31</sup> In addition, prior research has shown that the addition of electrodiagnostic testing to the workup for CTS does not change the probability of diagnosing the condition in a clinically meaningful way.<sup>32</sup> Nonetheless, it is possible that some of the patients included in this study do not have CTS using electrodiagnostic criteria but clinically demonstrate signs of CTS and were thus included in our study cohort. In addition, we have only looked at 1 diagnosis (CTS), and it is possible that other diagnoses would have different results. Third, our state-level findings may not be generalizable to other dissimilar states. For example, as noted earlier, some states are wealthier than others or have a greater number of hand surgeons per capita. Therefore, additional research is needed to confirm or refute our state-level findings more broadly. Similar important analyses can also be done at the national level of a European Union member state and within states and/or regions. Finally, ADI values are calculated using census block groups and are not necessarily representative of each individual patient's true SES. However, ADI has been validated and used as an acceptable estimate.<sup>33,34</sup>

Overall, our study demonstrated that the most socially deprived patients measured on the national level have lower self-reported functional status and higher pain and depressive symptoms than the least socially deprived patients. In contrast, such a finding was not present on the state level. However, at both the state and national levels, social deprivation was associated with worse upper extremity function and pain interference at presentation for CTS. As health care systems globally continue to transition further toward a focus on value—defined as health outcomes achieved per dollar spent over the entire care cycle<sup>35</sup>—a biopsychosocial team-based approach to patient care for those less fortunate (ie, more socially deprived) with CTS may lead to higher value care. However, future research is warranted to determine the impact of social deprivation and PROMIS severity on overall CTS treatment cost. In addition, we believe further study is warranted to better understand why social deprivation levels may be associated with some PROMIS domains in patients with CTS at the national level but not others. Finally, confirmatory studies in other countries are

needed, and global approach to ensuring high-quality access to hand surgery care is of utmost importance.

### Ethical Approval

The Institutional Review Board of the University of Rochester Medical Center approved this study.

### Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

### Statement of Informed Consent

This is a database review. We have institutional review board approval for review of the data in the hand repository, but individual patient consent is not required.

### Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: D.N.B. received personal fees from the Institute for Strategy and Competitiveness at Harvard Business School and Horizon Therapeutics. All other authors (E.K., K.F., W.C.H.) certify that they have no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements) that might pose a conflict of interest in connection with the submitted article.

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### Statement on Research Location

The work was performed at the Department of Orthopaedics and Rehabilitation, University of Rochester Medical Center, Rochester, New York.

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