ORIGINAL RESEARCH ARTICLE

Healthcare Utilization of Patients with Opioid Use Disorder in US Hospitals from 2016 to 2019: Focusing on Racial and Regional Variances

Sun Jung Kim[1,2,3] · Mar Medina[4] · Jongwha Chang[5]

Abstract

Background There is a lack of US population-based research on healthcare utilization differences caused by opioid misuse.
Objective The aim of this study was to explore disparities in healthcare utilization by type of opioid use disorder, race, region, and other patient factors for a more targeted prevention and treatment program.
Methods The National Inpatient Sample of the United States was used to identify patients with opioid use disorder ($n = 101,231$, weighted $n = 506,155$) from 2016 to 2019. Type of opioid use disorder was defined as opioid dependence/unspecified use, adverse effects of opioids, opioid misuse, and opioid poisoning (also known as overdose). We examined the sample characteristics and the association between type of disorder, racial and regional variables, and healthcare utilization, measured by hospital charges and length of stay. The multivariate survey linear regression model was used.
Results Among 506,155 patients, most were categorized as opioid dependence/unspecified use (56.3%) and opioid poisoning (42.7%). The number of opioid use disorder patients during the study decreased; however, overall total charges and length of stay continuously increased. Survey linear results showed that opioid poisoning, adverse effects, and abuse were associated with higher hospital charges than opioid dependence; however, length of stay was significantly lower for these groups. White patients compared with minorities, and West, Northeast, and South regions were associated with higher hospital charges and length of stay.
Conclusion Significant differences in healthcare utilization exist between type of disorder, race, and region. Such findings illustrate that tailored treatment regimens are required to bridge the gaps in care and combat the opioid crisis. Minorities with opioid use disorder utilize healthcare the least, possibly because of affordability, and need culturally sensitive and financially feasible treatment options.

Sun Jung Kim, and Mar Medina have contributed equally.

✉ Jongwha Chang
  jc2345@tamu.edu

1   Department of Health Administration and Management, College of Medical Science, Soonchunhyang University, Asan, Republic of Korea

2   Center for Healthcare Management Science, Soonchunhyang University, Asan, Republic of Korea

3   Department of Software Convergence, Soonchunhyang University, Asan, Republic of Korea

4   School of Pharmacy, University of Texas at El Paso, El Paso, TX, USA

5   Department of Pharmaceutical Sciences, Irma Lerma Rangel School of Pharmacy, Texas A&M University, College Station, TX, USA

Key Points

Previous research has demonstrated that ethnic minority patients struggle to access care equally. Our study highlights instances of high cost for short lengths of stay or increased health utilization that marginalizes specific demographics.

This study describes differences in care for opioid misuse patients in the Northeast, specifically the Middle Atlantic, and for Hispanic and Black patients.

By understanding where at-risk patients are and identifying over-burdened races, our research promotes targeted financial support and preventative programs in minority communities and high-risk areas.

1 Introduction

Pain management and the opioid crises are complex phenomena rooted in undertreatment and inequalities [1]. The opioid epidemic has been described as coming in three waves in the United States [1, 2]. With the first wave in the 2000s, prescription opioids were increasingly abused; in 2007, the second wave hit, bringing heroin abuse, and in 2016 the third wave landed with increased fentanyl and synthetic opioid misuse [1, 2]. Opioid use disorder can have widespread ramifications for individuals and society. Individuals suffering from opioid use disorder often have multiple comorbidities like asthma, chronic obstructive pulmonary disease, diabetes mellitus, HIV, cardiovascular disease, and cancer [3, 4]. Some risk factors for opioid use disorder include genetics, younger age, low education and income, male sex, mood disorders, and other substance use disorders [5]. Recently, with the COVID-19 pandemic, medications for opioid use disorder like naltrexone and opioid agonists increased the risk of hospitalization and length of stay [3]. Yet, those without medications and suffering from opioid use disorder had greater mortality risk and ventilator dependence [3].

Looking at the nationwide effects of the opioid crisis in the US, opioid illness between 2015 and 2018 cost the nation US$631 billion [6], and in 2018 cost US$93 billion to taxpayers [7]. Previous research has demonstrated the increased costs of an opioid use disorder, ranging from monetary to societal burdens like increased healthcare costs, criminal activity, and decreased productivity [7]. North America is considered a high consumption area for opioids and has grown in use with 1000 opioid use disorder cases per 100,000 people in 2016 [8]. Opioid poisoning, also known as overdose, is a national concern and caused 47,000 deaths in 2018 in the United States [3]. Further, patients with low income using state-funded insurance like Medicaid, who have been recently incarcerated, are homeless, and have low education or socioeconomic status have an increased risk of opioid poisoning [9]. Chronic opioid users also have higher medical and medication costs [10]. By comparison, targeted avoidance interventions to prevent opioid disorders appear to be cost effective and cost society US$2.2 million and the taxpayer US$325,125 [7].

The opioid crises' pervasive effects reach even the most vulnerable, as a study from the CDC found that between 1999 and 2014, opioid use disorder rates for pregnant women delivering in hospitals quadrupled [11]. One study found that concomitant opioid users, patients who used opioids and benzodiazepines together for over 30 days, were more likely to be hospitalized or have an emergency room visit than chronic users or those diagnosed with opioid use disorder [10]. Certain comorbidities like depression tend

to increase in prevalence in patients close to overdosing, and after overdosing, patients often enroll in Medicaid or leave their private insurance [4]. Previous research has also explored how emergency department visits tend to increase in the 6 months before overdosing by double compared with the 2 years before the event [4]. Furthermore, a study by Kilaru et al. found that patients who overdosed often did not receive follow-up treatment and were likely impeded by lack of private insurance [12]. Generally, patients with private insurance have fewer emergency department visits and more office visits than patients on Medicaid; however, it is more expensive, which can be a barrier for many patients [13].

Across the United States, opioid use disorder has been a historical and highly relevant health concern. The third wave of the opioid crisis, marked by an increase in fatal fentanyl overdoses, started in the East, but between 2017 and 2019 it has made its way across the Western United States [14]. Of further concern, Western and national fentanyl deaths continue to rise and may have been exacerbated by the COVID-19 pandemic [14, 15]. Heroin overdose is the highest in the Midwest and Northeast United States and has grown in both areas and East North Central [16]. Previous research has postulated that the patients may be switching from prescription opioids to heroin in the East South Central, and South Atlantic, which is increasingly being adulterated with fentanyl [1, 16, 17]. Indeed, there appears to be an overlap with high synthetic opioid overdoses in regions with increased heroin overdose, like New England, South Atlantic, and East North and South Central [16]. Rural and urban differences have also been found; one study focusing on veterans found that veterans in more rural areas had higher mortality rates, greater risk for abuse, and more high-risk prescribing [15]. Further, rural patients may have increased opioid use disorder treatment barriers because of increased distance and driving time to treatment centers [18].

Another study found that white patients had increased heroin overdose hospitalization compared with other ethnicities for most geographic regions; Black patients had increased heroin overdose hospitalizations in West North Central [16]. In contrast, Hispanics had the most significant increase in the New England region [16]. These findings align with a previous study that found that white patients are at an increased risk for opioid use disorder, followed by Native Americans, despite better pain management [19]. Minorities continue to be barred from seeking appropriate treatment for opioid use disorder [19]. Adolescent Hispanics have the highest opioid use disorder rates, and Black patients face more criminal justice problems for opioid use disorder [19].

Identifying differences between races and ethnicities in terms of consequences and treatment for opioid use disorder is critical to creating targeted treatment programs. Often ethnic minority patients, like Black and Hispanic patients, face tremendous obstacles to receiving treatment for opioid use

disorder, leading to worse results [20, 21]. One study found that during the COVID-19 pandemic, minority patients receiving treatment for opioid use disorder faced more significant barriers to naloxone and sterile syringes than non-Hispanic white patients [20]. Similar findings came from a study by Goedel et al., which explored the barriers to methadone and buprenorphine treatment for opioid use disorder in minorities [21]. Indeed, buprenorphine, one of the medications used for opioid use disorder, has low usage because of its high costs, limited prescribing capabilities, and insufficient identification of prospective patients [22]. Previous research has also identified various biases in prescribing and administering opioids [23]. First, Medicaid and uninsured patients are more likely to receive opioids than patients with private insurance [23, 24]. Second, racial disparities were found in prescribing for back and abdominal pain emergency department visits [23]. Non-Hispanic Blacks are more likely than non-Hispanic whites to be given and prescribed opioids for back pain [23]. All minorities, compared with white patients, are less likely to receive a prescription for opioids for abdominal pain [23].

With the profound effects of opioid use disorder and opioid poisoning, it is critical to characterize differences in care and how these barriers differ between race and region. Such information can promote awareness of treatment opportunities, health inequalities, and resource allocation. In addition, future healthcare providers are being called upon to address this crisis better [25], and there is a growing movement to promote safe opioid disposal and community programs to curb addiction rates [26]. This study examines the racial and regional differences in healthcare utilization, defined by hospital charges and length of stay, by type of opioid use disorder. Types of opioid use disorder include opioid misuse, adverse effects from opioids, opioid dependence or unspecified use, and opioid poisoning. Differences in health care utilization by opioid use disorder type, race, and region can identify differences in care and areas to improve to help combat the opioid epidemic.

2 Methods

2.1 Data Collection

The latest 2016–2019 United States' National Inpatient Sample (NIS) data was used to obtain a population-based estimate for patients with opioid use disorder. We conducted a serial, cross-sectional, retrospective data analysis utilizing a National Inpatient Sample (NIS) dataset. The NIS dataset is a product of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ). It is the largest publicly available all-payer inpatient database in the US. It contains data from nearly 8 million hospital inpatient stays, providing a weighted estimate for more than 35 million hospital stays per year. The NIS is a 20% sample of all nonfederal, short-term hospitals from 44 states in the US.

As shown in Fig. 1, we first identified the primary diagnosis of opioid use disorder (total $n = 107,244$) using the International Classification of Diseases, 10th Version (ICD-10) codes for opioid use disorder among all 2016–2019 NIS samples ($N = 28,484,087$). The primary diagnosis of opioid use disorder includes opioid misuse, adverse effects of opioids, opioid dependence/unspecified use, and opioid poisoning. Then, after patients with missing variables were excluded, we obtained a final sample of patients (total $n = 101,231$, National Estimates $= 506,155$). Sampling weights were applied in all statistical analyses to represent the entirety of patients without biased estimates. The survey weights and adjustments estimate the annual national population (Fig. 1).

2.2 Variables

The primary outcome of this research was to investigate the association between type of opioid disorder, racial and regional variables, and healthcare utilization as measured by hospital charges and length of stay in the NIS sample dataset. Due to the skewing of distribution for hospital charges and length of visit, we conducted a natural log of those variables. In addition, we adjusted various patient- and hospital-level confounders. Patient characteristics included age, race, annual median household income, primary payer (Medicare, Medicaid, Self-Pay/No Charge, Other, Private insurance), and the severity of illness. Hospital characteristics include size (no. of beds), ownership, location, teaching status, and region where patients were treated.
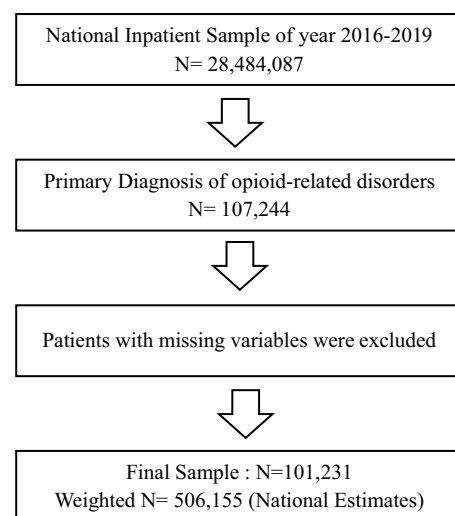

National Inpatient Sample of year 2016-2019
N= 28,484,087

↓

Primary Diagnosis of opioid-related disorders
N= 107,244

↓

Patients with missing variables were excluded

↓

Final Sample : N=101,231
Weighted N= 506,155 (National Estimates)

Fig. 1 Flow chart of patient sample selection

2.3 Statistical Analysis

Sampling weights were used for all statistical analyses to represent nationwide opioid use disorder patients. First, we examined the characteristics of the final dataset. The patient characteristics were presented as weighted frequency (percentage) or means (SD). Then we investigated the temporal trend of hospital charges and length of stay among opioid use disorder patients. Next, we investigated how the type of opioid use disorder and other characteristics (region, race, etc.) are associated with hospital charges and length of stay using the multivariate survey linear regression analysis.

Additionally, we ran the models with census division variables to figure out more specific regional variance. Finally, subgroup analyses were conducted by race. All studies were conducted using SAS statistical software (version 9.4; SAS Institute Inc., Cary, NC, USA). All statistical tests were two-sided and statistical significance was determined at a *p*-value <0.05.

3 Results

3.1 Patient Characteristics

A total of 107,244 patients with opioid use disorder were identified in the 2016–2019 NIS data (weighted *n* = 506,155, Table 1). Most opioid use disorder patients had opioid dependence/unspecified use (56.3%) and opioid poisoning (42.7%). The race variable generally reflects the US population; most of our patients were white (71%), with 15.6% Black and 8.6% Hispanic. In addition, most opioid use disorder patients used Medicaid and had low income. More detailed characteristics of the patients are shown in Table 1.

3.2 Temporal Patterns of Hospital Charges and Length of Stay

Table 2 shows the temporal healthcare utilization trends among hospitalized patients with opioid use disorder between 2016 and 2019. The number of patients with opioid use disorder during the study periods continuously decreased. However, overall hospital charges and length of stay were somewhat increased.

3.3 Association of Type of Opioid Use Disorder and Other Characteristics with Hospital Charges and Length of Stay

Table 3 shows the associations of opioid use disorder and other characteristics with hospital charges and length of stay. Opioid poisoning, adverse effect, and abuse were associated with higher hospital charges than opioid

Table 1 General characteristics of the study sample

Variables	Value[a]
Number of patients with OUD	101,231
Weighted *N* [national estimates]	506,155
Type of opioid use disorder	
Opioid misuse	3975 (0.8%)
Adverse effects of opioids	1315 (0.3%)
Opioid dependence/unspecified use	284,765 (56.3%)
Opioid poisoning	216,100 (42.7%)
Age[b]	43.31 (15.97)
Sex	
Male	293,780 (58.0%)
Female	212,375 (42.0%)
Race	
White	359,230 (71.0%)
Black	78,910 (15.6%)
Hispanic	43,515 (8.6%)
Asian or Pacific Islander	3340 (0.7%)
Native American	4330 (0.9%)
Other	16,830 (3.3%)
Median household income	
0–25th percentile	182,665 (36.1%)
26th to 50th percentile	122,600 (24.2%)
51st to 75th percentile	108,465 (21.4%)
76th to 100th percentile	92,425 (18.3%)
Primary payer	
Medicare	116,215 (23.0%)
Medicaid	230,765 (45.6%)
Private insurance	98,655 (19.5%)
Self-pay	39,070 (7.7%)
No charge	6850 (1.4%)
Other	14,600 (2.9%)
Severity of illness[c]	
No/minor comorbidity or complications	144,260 (28.5%)
Moderate comorbidity or complications	182,270 (36.0%)
Major comorbidity or complications	94,640 (18.7%)
Extreme comorbidity or complications	84,985 (16.8%)
Bed-size of hospital	
Small	147,550 (29.2%)
Medium	149,670 (29.6%)
Large	208,935 (41.3%)
Ownership of hospital	
Government, nonfederal	70,785 (14.0%)
Private, non-profit	370,260 (73.2%)
Private, investor-own	65,110 (12.9%)
Location/teaching status of the hospital	
Rural	44,070 (8.7%)
Urban nonteaching	122,830 (24.3%)
Urban teaching	339,255 (67.0%)
Region of hospital	
Northeast	158,025 (31.2%)

Table 1 (continued)

Variables	Valueª
Midwest	132,240 (26.1%)
South	152,640 (30.2%)
West	63,250 (12.5%)

OUD opioid use disorder

ªValues are expressed as *n* (%) unless specified otherwise

ᵇContinuous variable, the result is mean and SD

ᶜAll Patient Refined DRG (APRDRG) with the severity of illness subclass. No/minor/moderate/major/extreme loss of function

dependence/unspecified use; however, length of stay was significantly lower for those groups. Hospital charges and length of stay were mostly higher in white patients with statistical significance than in other races. Compared with the Midwest, the West, South, and Northeast were associated with higher hospital charges and length of stays.

3.4 Models with Specific Region Variable and Sub-Group Analysis by Race

Table 4 presents the results of the model we ran where we replaced the region variable with census division. Compared with the South Atlantic, the New England, East North Central, and West North Central regions were associated with lower hospital charges. Conversely, the East South-Central Middle Atlantic, West South Central, Mountain, and Pacific were associated with higher hospital charges.

Table 5 contains the results of the sub-group analysis by race. Like the complete model analysis, the race subgroup analysis also showed differences in cost and length of stay by race and ethnicity. Black patients were consistently charged more than white patients for opioid misuse, adverse effects of opioids, and opioid poisoning. White patients also had the lowest charge for the adverse effects of opioids. All minority races and ethnicities were charged more for opioid poisoning than white patients. Black and Hispanic patients were hospitalized longer for opioid poisoning than the other groups. White patients had longer stays for opioid misuse than Black and Hispanic patients.

4 Discussion

This research aimed to discuss how the type of opioid use disorder impacts healthcare utilization, defined by hospital charges and length of stay. Our study further explored how opioid use disorder patient factors like race, region, health insurance, and illness severity also impact healthcare utilization. Opioid misuse, adverse effects of opioids, and opioid poisoning were associated with longer hospital charges compared with opioid dependence/unspecified use. Opioid poisoning had the highest hospital charges of the groups, with 21.2% greater cost than opioid dependence/unspecified use. However, these same groups had lower lengths of stay than opioid dependence/unspecified use, and patients with opioid poisoning spent the least amount of time hospitalized.

Opioid use disorder is a multifactorial disease that can be affected by health status and insurance type. We found that as comorbidities and complications increase, the length of

Table 2 Temporal trend of hospital charges and length of stay

Variables	2016	2017	2018	2019
Number of patients with OUD	28,719	27,553	23,904	21,055
Weighted *N* [national estimates]	143,595	137,765	119,520	105,275
Average hospital charges total [USD]	25,721	28,613	30,784	34,533
Average hospital charges by type use disorder [USD]				
Opioid misuse	19,447	19,152	20,926	22,109
Adverse effects of opioids	32,387	34,418	41,730	46,962
Opioid dependence/unspecified use	15,145	16,465	17,953	19,078
Opioid poisoning	41,329	44,998	47,685	52,730
Average LOS total [days]	4.25	4.34	4.47	4.53
Average LOS by type of opioid utilization [days]				
Opioid misuse	4.11	3.60	3.82	3.79
Adverse effects of opioids	3.97	3.64	3.00	3.89
Opioid dependence/unspecified use	4.55	4.67	4.88	4.86
Opioid poisoning	3.81	3.91	3.96	4.15

LOS length of stay, *OUD* opioid use disorder

Table 3 Results of survey linear regression: how opioid misuse was associated with healthcare utilization

Variables	Hospital charges			Length of stay		
	Coefficients	SE	p value	Coefficients	SE	p value
Type of opioid use disorder						
Opioid misuse	0.070	0.027	0.011	−0.168	0.022	<0.0001
Adverse effects of opioids	0.165	0.046	0.000	−0.405	0.031	<0.0001
Opioid dependence/unspecified use	Reference					
Opioid poisoning	0.212	0.007	<0.0001	−0.512	0.005	<0.0001
Age	0.004	0.0002	<0.0001	0.003	0.0002	<0.0001
Sex						
Male	−0.064	0.005	<0.0001	−0.034	0.004	<0.0001
Female	Reference					
Race						
White	Reference					
Black	−0.084	0.007	<0.0001	−0.038	0.005	<0.0001
Hispanic	−0.021	0.009	0.021	−0.038	0.007	<0.0001
Asian or Pacific Islander	0.018	0.029	0.522	0.005	0.024	0.844
Native American	−0.146	0.026	<0.0001	0.102	0.022	<0.0001
Other	0.042	0.016	0.007	0.017	0.012	0.133
Median household income						
0–25th percentile	Reference					
26th to 50th percentile	0.018	0.006	0.006	0.012	0.005	0.020
51st to 75th percentile	0.045	0.007	<0.0001	0.005	0.005	0.401
76th to 100th percentile	0.110	0.008	<0.0001	−0.003	0.006	0.602
Primary payer						
Medicare	0.037	0.008	<0.0001	0.018	0.007	0.007
Medicaid	0.002	0.007	0.761	−0.022	0.005	<0.0001
Private insurance	Reference					
Self-pay	−0.022	0.010	0.030	−0.164	0.008	<0.0001
No charge	−0.802	0.031	<0.0001	−0.180	0.014	<0.0001
Other	−0.001	0.015	0.939	0.016	0.012	0.163
Severity of illness						
No/minor comorbidity or complications	Reference					
Moderate comorbidity or complications	0.276	0.006	<0.0001	0.167	0.005	<0.0001
Major comorbidity or complications	0.639	0.008	<0.0001	0.282	0.007	<0.0001
Extreme comorbidity or complications	1.295	0.010	<0.0001	0.686	0.008	<0.0001
Bed-size of hospital						
Small	Reference					
Medium	0.071	0.007	<0.0001	−0.017	0.005	0.001
Large	0.162	0.006	<0.0001	0.019	0.005	<0.0001
Ownership of hospital						
Government, nonfederal	Reference					
Private, non-profit	0.087	0.007	<0.0001	0.039	0.006	<0.0001
Private, investor-own	0.615	0.010	<0.0001	0.013	0.007	0.085
Location/teaching status of the hospital						
Rural	Reference					
Urban nonteaching	0.275	0.009	<0.0001	0.013	0.007	0.093
Urban teaching	0.371	0.009	<0.0001	0.023	0.007	0.001
Region of hospital						
Northeast	0.359	0.007	<0.0001	0.180	0.005	<0.0001
Midwest	Reference					

Table 3 (continued)

Variables	Hospital charges			Length of stay		
	Coefficients	SE	*p* value	Coefficients	SE	*p* value
South	0.123	0.007	<0.0001	0.078	0.005	<0.0001
West	0.448	0.009	<0.0001	0.102	0.007	<0.0001
Year	0.046	0.002	<0.0001	−0.001	0.002	0.442

Table 4 Results of survey linear regression: replace region variable by census division

Variables	Hospital charges[a]			Length of stay[a]		
	Coefficients	SE	*p* value	Coefficients	SE	*p* value
Census division of hospital						
New England	−0.195	0.013	<0.0001	−0.012	0.010	0.217
Middle Atlantic	0.393	0.009	<0.0001	0.134	0.007	<0.0001
East North Central	−0.071	0.008	<0.0001	−0.083	0.006	<0.0001
West North Central	−0.026	0.012	0.030	−0.010	0.010	0.333
South Atlantic	Reference					
East South Central	0.120	0.010	<0.0001	0.024	0.008	0.004
West South Central	0.085	0.011	<0.0001	0.000	0.008	0.981
Mountain	0.227	0.013	<0.0001	0.012	0.011	0.262
Pacific	0.453	0.011	<0.0001	0.041	0.009	<0.0001

[a]All other variables were adjusted

Table 5 Results of survey linear regression: sub-group analysis by race

Race	Opioid misuse	Adverse effects of opioids	Opioid poisoning
Coefficients for hospital charges			
White	0.032	*0.117*	*0.199*
Black	*0.198*	*0.288*	*0.316*
Hispanic	0.147	0.416	*0.323*
Asian or Pacific Islander	0.248	0.734	*0.254*
Native American	0.524	0.325	*0.232*
Other	0.036	−0.179	*0.128*
Coefficients for length of stay			
White	*−0.154*	*−0.433*	*−0.519*
Black	*−0.189*	*−0.268*	*−0.419*
Hispanic	*−0.172*	−0.357	*−0.495*
Asian or Pacific Islander	−0.012	−0.224	*−0.551*
Native American	−0.174	−0.074	*−0.589*
Other	*−0.405*	*−0.495*	*−0.622*

Reference: opioid dependence/unspecified use

Bold indicates statistically significant results

stay and cost increase. Previous research found that patients with opioid use disorder have multiple comorbidities like HIV, diabetes, and cancer [3, 4]. Therefore, increased healthcare utilization may be related to their increased comorbidities. As a result, these factors may identify at-risk patients requiring greater treatment access and increased monitoring or prevention. To mitigate these high costs and prolonged hospitalizations, opioid misuse patients with comorbidities or at risk for complications should have overdose antidote

access and greater counseling on managing their chronic diseases.

Medicare had the highest length of stay and hospital charges, thus greater healthcare utilization, demonstrating a receipt of care for opioid use disorders. Past research revealed that Medicaid patients had greater access to opioids [23, 24]. Our study indicates that they are not presenting for care for opioid use disorder, perhaps due to affordability concerns [23, 24]. Private hospitals had higher hospital charges than government hospitals, and private not-for-profit hospitals had longer lengths of stay. Consequently, despite having health insurance or accessing hospital care, patients are not receiving equal care, illustrating the need for standardized costs and treatment programs.

Critical trends emerged when exploring opioid misuse and healthcare utilization between races. Black and Hispanic patients had lower hospital charges and lengths of stay than white patients; Black and Hispanic patients had equally short lengths of stay, with Hispanics paying slightly more. Our results are like previous research, which found that white patients have a higher risk of opioid use disorder than minorities but that minorities face tremendous obstacles to treatment [19–21]. The decreased healthcare utilization identified in this study signals that Black and Hispanic patients may not be receiving adequate treatment for opioid use disorder. These findings are concerning because Black and Hispanic patients have higher rates of opioid overdose than white patients [27, 28].

With such disparities in treatment for minority patients compared with white patients, the discussion on culturally sensitive and tailored community programs becomes especially significant. The lower costs and lengths of stay show that Hispanic and Black opioid misuse patients do not utilize healthcare the same as white patients—possibly because they cannot afford it. Medications for opioid use disorder can be costly [22], and in 2019, the median income for Hispanic households was US$56,113, and for Black homes it was US$45,438 [29]. By comparison, the white non-Hispanic median income for 2019 was US$76,057 [29]. Improving medication costs and offering financial assistance programs for minority patients may help overcome this financial hurdle.

Differences in healthcare utilization by the type of disorder and race also appeared. Of note, Black patients were charged more for opioid misuse, adverse effects of opioids, and opioid poisoning, and those charges were higher than for white patients. All minorities were charged more for all other disorders than white patients. Only for opioid poisoning were costs and lengths of stay relatively equal between ethnicities; still, minorities were charged more than white patients, with Black and Hispanic patients charged the most for the most prolonged hospitalizations. Price differences are significant when considering that

lengths of stay were decreased for all patients compared with opioid dependence/unspecified use. Black patients had longer lengths of stay and increased costs for adverse effects of opioids than white patients. In opioid misuse, Black patients were again charged more and had the shortest lengths of stay next to Hispanic patients.

The increased healthcare utilization from Black and Hispanic patients compared with white patients reflects the higher opioid poisoning rates found in previous literature [16] and identifies a discrepancy in opioid misuse. Black and Hispanic patients had longer stays and higher costs for opioid poisoning, demonstrating an incongruency in care when there is an available overdose antidote. Further research is required to pinpoint factors leading to this mismatch which may be related to differences in comorbidities or complications. Looking at opioid misuse, Black patients paid more for one of the shortest lengths of stay, illuminating possible bias, differences in treatment, and the need for further research. Previous research has demonstrated racial and socioeconomic disparities in opioid use disorder treatment [30]. Therefore, differences in care may need to be addressed to ensure equal access to treatment and improve the opioid epidemic.

Differences can also be found by region and these are vital to explore to alter treatment plans across the United States. Research has shown that substance use disorders are undertreated and underdiagnosed in rural areas [31]. Such findings may be translated to our results where we found higher healthcare utilization for opioid use disorder patients in urban teaching and nonteaching hospitals compared with rural. Notably, the decreased healthcare utilization in rural regions compared with urban areas could be because of physical distance to treatment options [18].

Our study found that charges and lengths of stay were increased for all other regions compared with the Midwest. The most extended lengths of stay were in the Northeast, and the most significant hospital charges were in the West. The Northeast had the highest length of stay and second-highest hospital charges. Previous research found that the fentanyl wave of the opioid pandemic has now covered the United States [14], but overdose is the highest in the Midwest and Northeast [16]. The prevalence of opioid misuse across the United States is reflected in the increased healthcare utilization identified here.

We also examined regional differences by census division to find more targeted differences. Only the East North Central had significantly lower healthcare utilization for the length of stay and hospital charges. East North Central is part of the Midwest and has increasing heroin overdose cases, contradicting some previous literature [16]. However, East North Central and parts of the South, like East South Central, have high concentrations of rural areas [32]. Rural areas have increased physical barriers to treatment

[18] despite increased risk [15, 31]. Therefore, the decreased healthcare utilization in East North Central and moderate utilization in the South compared with other areas may be due to barriers to care.

The highest hospital charges were in the Pacific, part of the Western US, and the most increased length of stay was in the Middle Atlantic, in the Northeast. The increased healthcare utilization in the West, specifically the Pacific, coincides with previous literature describing the opioid crises reaching the West [14]. With this understanding of the prevalence of opioid use disorder and increased healthcare utilization in the Northeast, treatment and programs should focus on increasing access to medications for opioid use disorder. Past studies had found that increased access to those medications in the Northeast and amongst minorities was enough to improve medication use [33].

This study has explored differences in healthcare utilization and cost by race, region, and insurance type, illustrating significant healthcare inequality for opioid use disorder patients. However, there are some limitations to this research. For example, the National Inpatient Sample dataset used ICD-10 codes for opioid misuse, limiting patient selection. Also, the dataset does not include clinical information or disease severity, which is associated with increased cost and length of stay, limiting real-life interpretation, and weakening the study results. The dataset also did not include detailed ethnicity information, limiting our analysis to the races and ethnicities used. Finally, the dataset does not differentiate between inpatient and outpatient care or the views that patients and physicians have towards opioid misuse. Further research is required to determine how different perspectives on opioid misuse affect care delivery and how that is associated with differences in cost or utilization. Despite these limitations, our study remains generalizable to most opioid misuse patients in the US because of our well sampled dataset over multiple study periods. Therefore, our study has found significant racial and regional health disparities that warrant further research and action by policymakers to promote equality in cost and care for opioid use disorder.

5 Conclusion

To overcome the opioid crisis, greater access to care and financial assistance or more cost-effective options are required and should be promoted in predominantly minority communities. Targeted prevention and cost-effective treatment plans must be implemented for racial minorities and focus on high-risk areas. While opioid agonist treatments like methadone and buprenorphine are gold standard [34], their associated cost may limit patient acceptance

and lessen their effectiveness in combating this crisis. Cost-effective options like adjunct digital therapeutics [35] and treatment cascades [36] have proven effective and should be adapted to minority populations. Our research has identified gaps in care in the Northeast, specifically the Middle Atlantic, and for Hispanic and Black patients. For example, there are inconsistencies in care for Black and Hispanic patients with opioid poisoning; they utilize healthcare the least, have more significant barriers to opioid use disorder treatment, and earn the least. Without a greater focus on racial and regional healthcare variances, the opioid crisis will continue to rage.

References

1. Volkow ND, Blanco C. The changing opioid crisis: development, challenges and opportunities. Mol Psychiatry. 2021;26(1):218. https://doi.org/10.1038/S41380-020-0661-4.
2. Ciccarone D. The triple wave epidemic: supply and demand drivers of the US opioid overdose crisis. Int J Drug Policy. 2019;71:183–8. https://doi.org/10.1016/J.DRUGPO.2019.01.010.
3. Qeadan F, Tingey B, Bern R, et al. Opioid use disorder and health service utilization among COVID-19 patients in the US: a nationwide cohort from the Cerner Real-World Data. eClinicalMedicine. 2021;37: 100938. https://doi.org/10.1016/J.ECLINM.2021.100938.
4. Maeng DD, Han JJ, Fitzpatrick MH, Boscarino JA. Patterns of health care utilization and cost before and after opioid overdose:

findings from 10-year longitudinal health plan claims data. Subst Abuse Rehabil. 2017;8:57. https://doi.org/10.2147/SAR.S135884.

5. Blanco C, Volkow ND. Management of opioid use disorder in the USA: present status and future directions. Lancet. 2019;393(10182):1760–72. https://doi.org/10.1016/S0140-6736(18)33078-2.

6. Beaulieu E, DiGennaro C, Stringfellow E, et al. Economic evaluation in opioids modeling: systematic review. Value Health. 2021;24(2):158. https://doi.org/10.1016/J.JVAL.2020.07.013.

7. Murphy SM. The cost of opioid use disorder and the value of aversion. Drug Alcohol Depend. 2020;217: 108382. https://doi.org/10.1016/J.DRUGALCDEP.2020.108382.

8. Ju C, Wei L, Man KKC, et al. Global, regional, and national trends in opioid analgesic consumption from 2015 to 2019: a longitudinal study. Lancet Public Health. 2022;7(4):e335–46. https://doi.org/10.1016/S2468-2667(22)00013-5.

9. van Draanen J, Tsang C, Mitra S, Karamouzian M, Richardson L. Socioeconomic marginalization and opioid-related overdose: a systematic review. Drug Alcohol Depend. 2020;214: 108127. https://doi.org/10.1016/J.DRUGALCDEP.2020.108127.

10. Chang HY, Kharrazi H, Bodycombe D, Weiner JP, Alexander GC. Healthcare costs and utilization associated with high-risk prescription opioid use: a retrospective cohort study. BMC Med. 2018;16(1):1–11. https://doi.org/10.1186/S12916-018-1058-Y/TABLES/4.

11. Haight SC, Ko JY, Tong VT, Bohm MK, Callaghan WM. opioid use disorder documented at delivery hospitalization—United States, 1999–2014. Morb Mortal Wkly Rep. 2018;67(31):845. https://doi.org/10.15585/MMWR.MM6731A1.

12. Kilaru AS, Kilaru AS, Xiong A, et al. Incidence of treatment for opioid use disorder following nonfatal overdose in commercially insured patients. JAMA Netw Open. 2020;3(5):e205852–e205852. https://doi.org/10.1001/JAMANETWORKOPEN.2020.5852.

13. Allen H, Gordon SH, Lee D, Bhanja A, Sommers BD. Comparison of utilization, costs, and quality of medicaid vs subsidized private health insurance for low-income adults. JAMA Netw Open. 2021;4(1):e2032669–e2032669. https://doi.org/10.1001/JAMANETWORKOPEN.2020.32669.

14. Shover CL, Falasinnu TO, Dwyer CL, et al. Steep increases in fentanyl-related mortality west of the Mississippi River: recent evidence from county and state surveillance. Drug Alcohol Depend. 2020;216: 108314. https://doi.org/10.1016/J.DRUGALCDEP.2020.108314.

15. Lund BC, Ohl ME, Hadlandsmyth K, Mosher HJ. Regional and rural-urban variation in opioid prescribing in the veterans health administration. Mil Med. 2019;184(11–12):894–900. https://doi.org/10.1093/MILMED/USZ104.

16. Unick GJ, Ciccarone D. US regional and demographic differences in prescription opioid and heroin-related overdose hospitalizations. Int J Drug Policy. 2017;46:112–9. https://doi.org/10.1016/J.DRUGPO.2017.06.003.

17. Pergolizzi J, LeQuang JA, Taylor R, Raffa RB. Going beyond prescription pain relievers to understand the opioid epidemic: the role of illicit fentanyl, new psychoactive substances, and street heroin. Postgrad Med. 2017;130(1):1–8. https://doi.org/10.1080/00325481.2018.1407618.

18. Kiang M, Barnett ML, Wakeman SE, Humphreys K, Tsai AC. Robustness of estimated access to opioid use disorder treatment providers in rural vs. urban areas of the United States. Drug Alcohol Depend. 2021. https://doi.org/10.1016/J.DRUGALCDEP.2021.109081.

19. Siddiqui N, Urman RD. Opioid use disorder and racial/ethnic health disparities: prevention and management. Curr Pain Headache Rep. 2022;26(2):129–37. https://doi.org/10.1007/S11916-022-01010-4/TABLES/1.

20. Rosales R, Janssen T, Yermash J, et al. Persons from racial and ethnic minority groups receiving medication for opioid use disorder experienced increased difficulty accessing harm reduction services during COVID-19. J Subst Abuse Treat. 2022;132: 108648. https://doi.org/10.1016/J.JSAT.2021.108648.

21. Goedel WC, Shapiro A, Cerdá M, Tsai JW, Hadland SE, Marshall BDL. Association of racial/ethnic segregation with treatment capacity for opioid use disorder in counties in the United States. JAMA Netw Open. 2020;3(4):e203711–e203711. https://doi.org/10.1001/JAMANETWORKOPEN.2020.3711.

22. Molfenter T, McCarty D, Jacobson N, Kim JS, Starr S, Zehner M. The payer's role in addressing the opioid epidemic: it's more than money. J Subst Abuse Treat. 2019;101:72–8. https://doi.org/10.1016/J.JSAT.2019.04.001.

23. Singhal A, Tien YY, Hsia RY. Racial-ethnic disparities in opioid prescriptions at emergency department visits for conditions commonly associated with prescription drug abuse. PLoS ONE. 2016;11(8): e0159224. https://doi.org/10.1371/JOURNAL.PONE.0159224.

24. Abraham AJ, Andrews CM, Yingling ME, Shannon J. Geographic disparities in availability of opioid use disorder treatment for medicaid enrollees. Health Serv Res. 2018;53(1):389. https://doi.org/10.1111/1475-6773.12686.

25. Aronowitz S, Compton P, Schmidt HD. Innovative approaches to educating future clinicians about opioids, pain, addiction and health policy. Pain Manag Nurs. 2021;22(1):11–4. https://doi.org/10.1016/J.PMN.2020.07.001.

26. Humphreys K, Shover CL, Andrews CM, et al. Responding to the opioid crisis in North America and beyond: recommendations of the Stanford-Lancet Commission. Lancet. 2022;399(10324):555–604. https://doi.org/10.1016/S0140-6736(21)02252-2.

27. Lippold KM, Jones CM, Olsen EO, Giroir BP. Racial/ethnic and age group differences in opioid and synthetic opioid-involved overdose deaths among adults aged ≥ 18 years in metropolitan areas—United States, 2015–2017. MMWR Morb Mortal Wkly Rep. 2019;68(43):967–73. https://doi.org/10.15585/MMWR.MM6843A3.

28. Larochelle MR, Slavova S, Root ED, et al. Disparities in opioid overdose death trends by race/ethnicity, 2018–2019, from the HEALing Communities Study. Am J Public Health. 2021;111(10):1851–4. https://doi.org/10.2105/AJPH.2021.306431.

29. US Census Bureau. Median Household Income and Percent Change by Selected Characteristics. Census.gov. https://www.census.gov/content/dam/Census/library/visualizations/2020/demo/p60-270/figure1.pdf. Accessed 29 May 2022.

30. Nguemeni Tiako MJ. Addressing racial & socioeconomic disparities in access to medications for opioid use disorder amid COVID-19. J Subst Abuse Treat. 2021;122: 108214. https://doi.org/10.1016/J.JSAT.2020.108214.

31. Hallgren KA, Witwer E, West I, et al. Prevalence of documented alcohol and opioid use disorder diagnoses and treatments in a regional primary care practice-based research network. J Subst Abuse Treat. 2020;110:18–27. https://doi.org/10.1016/J.JSAT.2019.11.008.

32. US Census Bureau. Rural America. Census.gov. Published 2010. https://mtgis-portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=49cd4bc9c8eb444ab51218c1d5001ef6. Accessed 31 May 2022.

33. Solomon KT, Bandara S, Reynolds IS, et al. Association between availability of medications for opioid use disorder in specialty treatment and use of medications among patients: a state-level trends analysis. J Subst Abuse Treat. 2022;132: 108424. https://doi.org/10.1016/J.JSAT.2021.108424.

34. Wakeman SE, Larochelle MR, Ameli O, et al. Comparative effectiveness of different treatment pathways for opioid use disorder.

JAMA Netw Open. 2020;3(2):e1920622–e1920622. https://doi.org/10.1001/JAMANETWORKOPEN.2019.20622.

35. Velez FF, Luderer HF, Gerwien R, Parcher B, Mezzio D, Malone DC. Evaluation of the cost-utility of a prescription digital therapeutic for the treatment of opioid use disorder. Postgrad Med. 2021;133(4):421–7. https://doi.org/10.1080/00325481.2021.1884471.

36. Williams AR, Nunes E, Bisaga A, et al. Developing an opioid use disorder treatment cascade: a review of quality measures. J Subst Abuse Treat. 2018;91:57–68. https://doi.org/10.1016/J.JSAT.2018.06.001.