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Structural and Social Determinants of Opioid Abuse Among Florida-Based Hospitals

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STRUCTURAL AND SOCIAL DETERMINANTS OF OPIOID ABUSE AMONG FLORIDA-BASED HOSPITALS

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Background: With over two million people suffering from opioid abuse disorders, the Centers for Medicare and Medicaid Services has identified opioid abuse as a key priority. Florida is one of eight states labeled as a high-burden opioid abuse and is an “epicenter” for opioid use and misuse. **Purpose:** The purpose of this study was to discover potential predictors of opioid abuse in Florida by exploring specific healthcare delivery, geographic, and patient demographic factors. **Methods:** A retrospective longitudinal study design was used to examine four years (2014-2017) of Florida inpatient administrative discharge data across 173 hospitals of opioid abuse rate. Main measures included, opioid abuse counts (n=12,804) defined using both ICD-9-CM and ICD-10-CM systems. Negative binomial regression was used to estimate the association between hospital factors, county factor, and opioid abuse hospital rates. **Results:** We found a statistically significant association between hospital opioid abuse count and hospital size, location, teaching status, patients’ average age, gender, and race. The estimated probability of opioid abuse for a patient if treated in a large hospital is 0.23 (about 23%), significantly higher than small (8%) and medium (17%) size hospitals. The estimated probability of opioid abuse for a patient if treated in a rural hospital is 0.12 (about 12%), while in an urban hospital is higher at 0.17 (about 17%). The risk ratio is 0.71, which means the risk decreased by two-thirds when treated in rural hospitals. We also found that hospitals with a younger patient population, a higher percent of males and a higher proportion of Caucasian patients, are at a higher risk for an increase in opioid abuse counts. **Discussion:** These findings provide policymakers with crucial insight into Florida’s opioid crisis and the identification of predictive factors that contribute to opioid abuse.

Background | The Center for Medicare and Medicaid Services (CMS) identified opioid abuse as a critical priority for 2019 and is expected to continue as a priority over the next five years.¹ Opioid abuse is characterized as the “intentional, nontherapeutic use of a drug or substance for the purpose of achieving a psychological or physiological effect.”² Strong evidence shows that opioid abuse is causing a significant economic burden by directly impacting costs of care, utilization, and societal financial burden.³ Studies have attempted to identify risk factors that could predict opioid overdose, often for patients with specified morbidity or focused on specific high-risk populations.^{4,5} A medical claims data study of over 42,000 Colorado patients taking chronic opioid therapy, found that mental health diagnoses, substance use disorders, long-acting and extended-release opioid formulations, and tobacco use were significant opioid overdose predictors.⁴

However, there is very little research on hospital structural characteristics and their potential influence on opioid abuse. Most studies explore the impact of

hospital structure on opioid related adverse events, for example, one study was identified that researched hospitals in 32 states participating in the Healthcare Cost and Utilization Project (HCUP). This study found that preventable opioid related adverse events were higher in urban teaching hospitals as well as private, not-for-profit hospitals.⁶ However, since the community and its health system are connected,⁷ there may be an influence of hospital structural characteristics and opioid abuse. This influence should be further examined due to the absence of outpatient factors in consideration.

Florida is one of eight states that is labeled a high-burden opioid abuse. Florida suffers from one of the highest concentrations of fentanyl-related overdoses and is considered an “epicenter” for opioid use.^{8,9} In Florida, synthetic opioids are responsible for the sharp increase in abuse, characterized by high overdose deaths. In 2018, the overdose death rate in Florida was 15.8 per 100,000. This was higher than the national average of 14.6 per 100,000.¹⁰ In 2017, Fentanyl and Fentanyl analogs contributed to around 28,400 deaths,

the sharpest increase in overdose deaths.¹⁰ While Florida’s opioid-related emergency department visit rates have drastically increased by 32.3% from 2009 to 2014,¹¹ prescription rates have decreased by as much as 80%.¹² This decrease is possibly a result of Florida’s prescription drug monitoring programs and “pill mill” laws.⁹ However, despite the decrease, inpatient stays due to opioid utilization in Florida are far higher than the national average.¹³ Thus, this study explored the potential predictive relationship between patient characteristics, hospital structural characteristics and county characteristics and their predictive impact on opioid abuse.

Methods | Data Sources The 2014-2017 Florida Inpatient Discharge (FID) data was obtained from the Agency for Health Care Administration’s Center for Health Information and Transparency and linked to the 2017 American Hospital Association (AHA) annual survey using Medicare Provider Numbers. Also, we used the 2014-2017 US Census Bureau Current Population Survey (CPS) and linked it using county Federal Information Processing Standards (FIPS). The

FID data contained over 13 million discharges for all hospitals in Florida and recorded information regarding the patients, diagnoses, procedures, costs and attending physicians. Specifically, the data recorded 30 diagnosis codes and procedure codes, making it a comprehensive dataset for diagnosis selection. The AHA annual survey collects information about all U.S. hospitals regarding organizational structure, financial well-being, workforce, and services. The CPS collects information on household adults 18 years of age or older and provides 1- and 5-year estimates of population characteristics.

Variables and Measures *Outcome variable.* Our primary outcome variable was a hospital’s total number of opioid abuse related stays during our study period (2014 to 2017). Opioid abuse stays were identified using principle and secondary ICD-9-CM and ICD-10-CM codes presented in Table 1. The codes were extracted from prior research and the Healthcare Cost and Utilization Project (HCUP).^{14,15}

Table 1: ICD-9-CM and ICD-10-CM Opioid-Abuse Diagnosis Codes

ICD-9-CM Code	ICD-10-CM Code	Description
305.50		Opioid abuse, unspecified
305.51		Opioid abuse, continuous
305.52		Opioid abuse, episodic
	F11.10	Opioid abuse, uncomplicated
	F11.120	Opioid abuse with intoxication, uncomplicated
	F11.121	Opioid abuse with intoxication delirium
	F11.122	Opioid abuse with intoxication with perceptual disturbance
	F11.129	Opioid abuse with intoxication, unspecified
	F11.14	Opioid abuse with opioid-induced mood disorder
	F11.150	Opioid abuse with opioid-induced psychotic disorder with delusions
	F11.151	Opioid abuse with opioid-induced psychotic disorder with hallucinations
	F11.159	Opioid abuse with opioid-induced psychotic disorder, unspecified
	F11.181	Opioid abuse with opioid-induced sexual dysfunction
	F11.182	Opioid abuse with opioid-induced sleep disorder
	F11.188	Opioid abuse with other opioid-induced disorder
	F11.19	Opioid abuse with unspecified opioid-induced disorder

Demographics of Patient Population. We identified key factors that have previously been identified as critical to determining opioid use, which included patient age, gender, patient priority level, and ethnicity.¹⁶⁻¹⁸ Patient age was reported as a hospital’s median patient age for the study year. Gender was reported as the percent of female patients at the hospital. Insurance status was reported as the percent of patients with commercial health insurance. Patient priority level was reported as hospitals’ percent of non-elective admissions. Non-elective admissions included emergency, urgent, and trauma admissions. Lastly, we included patient ethnicity, and it was

reported as hospitals’ percent of patients who identify as African Americans or Blacks and hospitals’ percent of patients who identify as Latino/Hispanic.

Hospital Characteristics. We identified vital hospital factors that have previously been found to impact patient utilization and community health. Hospital ownership was reported as a categorical variable (not-for-profit, for-profit, and government-owned). An indication of the health of the community and services available are indicative of hospital ownership status.¹⁹ Hospital location was reported as a categorical variable (rural and urban) and indicates hospital

resources, and state or federal funding support as urban hospitals have been found to be better funded and more efficient than rural hospitals.²⁰ Hospital size was reported as a categorical variable of the number of staffed hospital beds (small <100, medium <400, and large 400+) and is an indication of hospital quality and market power.²¹ Teaching status was reported as a categorical variable (major, minor, non-teaching) and is an indication of hospital safety and quality.²² Finally, we estimated an average hospitals' market competition using the Herfindahl-Hirschman Index (HHI). A hospital HHI is a ratio of the total inpatient days and county's total inpatient days (all hospitals in the county). A HHI of 0 is an indication of a competitive market, while an HHI of 1 is an indication of a monopolistic market.^{23,24}

County Characteristics. At the county level, we examined community diversity and poverty for the study period. These two variables provide insight into the county's health disparity and health.²⁵ We used an inequality index score that examines the amount of diversity and population evenness within a county,²⁶ which we estimated by calculating the sum of the log proportions of each of the six racial/ethnic groups present in the US. These groups are African Americans, American Indians or Alaskan Natives, Asians, Native Hawaiians or other Pacific Islanders, Latino/Hispanics, and non-Latino/Hispanic Whites. The closer the score to 1.79, the more diverse (i.e., even) the population.²⁷ County poverty was reported as the percent of the population below the federal poverty. These characteristics are necessary to evaluate the potential relationship between demographic factors and opioid misuse and abuse.

Approach We chose to analyze the counts for opioid abuse counts at the hospital level due to the extremely low incidence at the individual patient level (0.56% overall). A retrospective longitudinal study design was used to examine four years (2014-2017) of Florida inpatient medical discharge data across 173 unique hospitals (a total of 12,804 opioid abuse incidents). The opioid abuse counts were analyzed using a generalized linear mixed model with a negative binomial distribution and a log-link function. The

model included the hospital characteristics (ownership type, location, size, teaching affiliation), patient demographics at hospital level (average age, percent of female patients, percent of African American patients, percent of Latino/Hispanic patients, and percent of cases admitted through emergency/urgent care/trauma) and county-level characteristics (diversity index, HHI index and poverty percent) as fixed covariates. A random intercept was added for each provider to account for the random variation. The year was also included as another fixed covariate to examine the trend over time. The model also accounted for the difference in hospital sizes by using an offset variable (log of the total number of patients for each year); therefore, a fair comparison on the negative binomial rate (the probability of having an opioid abuse case for an individual patient) can be made. Generalized Chi-Square over degrees of freedom and residual plots were used to assess the goodness of fit of the model. The Kenward, Roger²⁸ method was used for the calculation of the denominator degrees of freedom.²⁹ All analyses were performed using SAS software, version 9.4.³⁰ In accordance with the policy of the University, the Institutional Review Board (IRB) categorized the research as exempt since the study analyzed secondary data that is publicly available.

Results | Figure 1 shows the distribution of opioid abuse counts in Florida hospitals for each year from 2014 to 2017. The general patterns are similar from year to year, with a gradual increase in the right tails, which indicates the number of hospitals with a relatively high number of opioid abuse counts has increased.

Table 2 displays the descriptive statistics of the opioid abuse counts at the hospital level from 2014 to 2017 in Florida. The mean and median number of opioid abuse reports steadily increased from 2014 to 2017. In addition, more hospitals reported a higher number of opioid abuse events during 2014 to 2017. For example, 2 hospitals reported more than 100 opioid abuse events in 2014 and 2015, compared with 7 hospitals in 2016 and 2017. The standard deviations from table 2 also confirm the spread of distribution from 2014 to 2017.

Figure 1: Florida Hospital Opioid Abuse Counts Distribution by Year

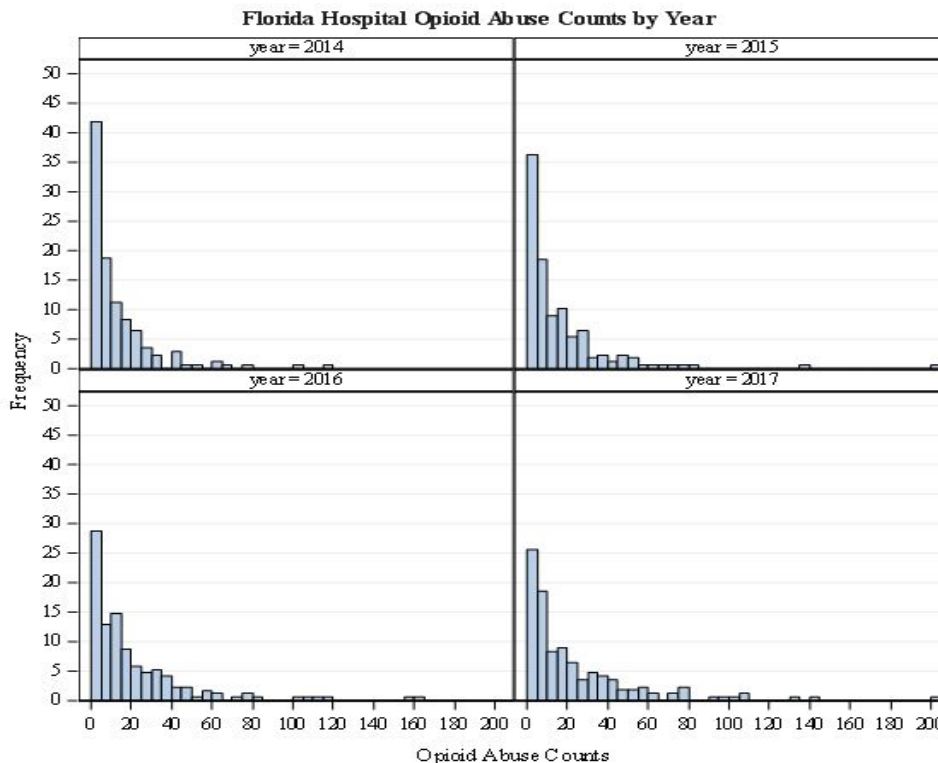


Table 2: Summary of Florida Hospital Opioid Abuse Counts by Year

	2014	2015	2016	2017
Hospital, <i>N</i>	170	168	170	168
Opioid Abuse				
Mean	12.5	16.2	22.2	24.9
STD	17.4	23.9	31.4	33.6
Median	6.0	8.0	12.0	13.5
Min	0	0	0	0
Max	117	203	230	220

Note: N: number of hospitals with records; STD: standard deviation

Table 3 displays the parameter estimate results for all key variables in the model, except for the ownership type, which was not significant; all the other variables of hospital characteristics were statistically significant. All variables of patient demographics were statistically significant. The diversity index was the only variable that was statistically significant at the county level. Compared with 2014, the opioid abuse rate was significantly increased in 2016 and 2017 (2015 was not statistically significantly different from in 2014). Furthermore, we may estimate the relationship between each of the variables with the risk (probability) of a patient encountering opioid abuse at a hospital. For example, hospitals with a younger patient mix, a higher percent of male patients, and a

higher proportion of Caucasian patients more likely to report a higher incidence of opioid abuse. Patients treated in hospitals located in a county with a higher diversity index tend to have a higher risk of opioid abuse. The estimated coefficients also show the magnitude of impact for each variable. For example, the variable ‘Mean Age’ has a coefficient of -0.053, which means that for each one-year increase on average age in the patient population, the expected log of the negative binomial rate decreases by 0.05. On the other hand, the variable ‘Diversity Index’ has a coefficient of 1.01, which means that for each one-unit increase on the diversity index score, the expected log of the negative binomial rate increases by 1.01.

Table 3: Negative Binomial Regression Parameter Estimates

Variable	Coefficient
Year (referent: 2014)	
2015	0.11*
2016	0.42**
2017	0.54**
Hospital Characteristics	
Ownership Status (Referent: Not-for-profit)	
For-profit	-0.05
Government	-0.004
Location (Referent: Urban)	
Rural	-0.37
Size (Referent: Small)	
Large	1.09**
Medium	0.77**
Teaching Status (Referent: Non-Teaching)	
Major	0.15
Minor	0.24**
Patient Characteristics	
Mean Age	-0.05**
Percent Female	-0.05**
Percent Emergency, Urgent and Trauma Admissions	0.02**
Percent African American	-0.01*
Percent Latino/Hispanic	-0.02**
County Characteristics	
Diversity Index	1.01**
Herfindahl-Hirschman Index	0.23
Percent Poverty	0.01

Note: * significant at 0.05; ** significant at 0.01

Table 4 displays the estimate of the opioid abuse rate (risk/probability of a patient being opioid abused) for all the categorical variables in the model. The risk ratios were calculated from the estimates. The risk ratio in this context is the risk of opioid abuse when a patient is treated in each condition versus the reference level. Using hospital location, for example, the estimated probability of opioid abuse for a patient if treated in a rural hospital is 0.12 (about 12%), while in an urban hospital is 0.17 (about 17%). The risk ratio is 0.71, which means the risk of opioid abuse is decreased by 30% when a patient is treated in rural hospitals. No significant difference is discovered in the hospital ownership type, with the risk at 14%. For

hospital size, the risks of a patient to be opioid abused is 22%, 17%, and 8% when treated in large, medium, and small hospitals, respectively. The risk ratios are 2.96 (large vs. small) and 2.16 (medium vs. small), which indicates the risk is significantly higher at large or medium hospitals compared with small hospitals. There is no significant difference in the risk between major and minor teaching hospitals. However, the risk at both major and minor teaching hospitals is higher than the non-teaching hospitals. Lastly, the increasing trend of opioid abuse rates is observed starting from 2016. The increase in the risk of opioid abuse over time may need more attention from the policymakers in Florida.

Table 4: Negative Binomial Regression Opioid Abuse Rate Estimates

Main Effect	LS Mean	Lower CL	Upper CL	Risk Ratio
Location				
Rural	0.12	0.07	0.19	0.71
Urban	0.17	0.14	0.20	
Ownership status				
For-profit	0.14	0.1	0.18	0.95
Government	0.14	0.10	0.21	0.95
Not-for-profit	0.14	0.11	0.19	
Size				
Large	0.23	0.16	0.31	2.96
Medium	0.17	0.12	0.22	2.16
Small	0.08	0.05	0.11	
Teaching status				
Major	0.15	0.10	0.21	1.16
Minor	0.16	0.12	0.21	1.27
Non-Teaching	0.12	0.10	0.16	
Year				
2015	0.12	0.09	0.16	1.03
2016	0.17	0.13	0.22	1.40
2017	0.19	0.14	0.25	1.47
2014	0.11	0.08	0.14	

Note: LS: least squares; CL: confident level

Discussion | This study examined potential predictors of opioid abuse in Florida through specific healthcare delivery, geographic, and patient demographic factors. The results from this study suggest that hospitals in Florida are continuously reporting higher counts of opioid abuse over the years. Our binomial regression analysis indicated a statistically significant increase in opioid abuse in Florida. A probable explanation for these results is a decrease in the uninsured population and an increase in the awareness of opioid misuse leading to more accurate reporting.

For example, the passing of the 2010 Patient Protection and Affordable Care Act (ACA) provided a reduction of financial barriers for the treatment of opioid use disorders.³¹ Changes under the ACA increased access to hospitals by removing the administrative barriers that impeded the timely payment for clinician reimbursement allowing hospitals to be more prone to addressing this issue³². This change allowed for an increase in treatment access and utilization, which may explain the increased reporting. In addition, in 2015 the US began using the ICD-10-CM, which increased codes from 14,000 to 68,000 codes, which may have contributed to more accurate documentation of patients with opioid abuse disorders and a 14.1% increase of inpatient stays with opioid-related diagnoses.¹⁴

Furthermore, our study found a significant relationship between hospital size and volume increase of opioid

abuse. Large and medium-sized hospitals were found to experience higher counts of patients with opioid abuse disorders compared to small-sized hospitals even when we adjust for other factors. This may be attributed to any number of factors, including the possibility of larger hospitals to have more resources compared to their small and medium counterparts. Our results showed that out of a total of 183 hospitals, 170 reported they had encountered patients with opioid abuse disorder with 3% from the total sample that did not report. Perhaps larger hospitals have the resources to better identify patients with opioid abuse disorder.

Our findings also indicated that the majority of Florida hospitals with a higher risk for opioid abuse are located in urban areas. A possible explanation for this finding would be that urban populations are more susceptible to abuse due to better access to prescription opioids. While one study³³ showed that residents living in rural counties are more likely to take opioids for pain relief compared to those living in urban areas, another study³⁴ showed that individuals in urban areas are more likely to engage in misuse because of their higher exposure to other substances and access to care. A study by Sears, Edmonds, & Fulton-Kehoe³⁵ found a higher prevalence of prescribing physicians and pharmacists in urban areas. Trends in studies show that abundant supplies of opioids are positively correlated to abuse in urban areas with individuals in urban counties having

increased access to pain management physicians and pharmacies.^{33,36,37}

Another study from Cerdá et al.³⁸ supports this sentiment by finding a correlation between changes in pharmacy density and opioid abuse discharge rates in urban areas, particularly prescription-opioid poisoning rates. As prescription opioids are more readily available in urban settings, the risk of abuse in such areas increases consequently. Individuals in rural areas would have less access to treatment programs and would likely have to travel to urban areas in order to get access to treatment.³⁹ Another study found that treatment services are more readily available to urban residents than their rural counterparts.⁴⁰ In addition, one study found a correlation between concentrated homelessness in urban settings and higher risks of opioid abuse with homeless individuals having a disproportionately higher risk of opioid abuse disorders compared to individuals of lower-income households.⁴¹

Regarding the characteristics of patients who are of higher risk, our study found that among the 2014-2017 Florida patient population, those who were younger, male, and Caucasian were found to be more at risk of being identified with an opioid abuse disorder. This is an important finding because it supports other research that as a person ages, they have a decreased risk of opioid abuse.^{42,43} Furthermore, our findings support studies that males are more likely to abuse opioids compared to females.^{43,44} This is also consistent with literature related to risk factors for opioid abuse among veterans and younger adult males having a higher prevalence of opioid abuse disorder.⁴⁴ This study uses data from multiple databases to provide valuable insight into our understanding of potential predictors for opioid abuse disorder. However, the data is focused on Florida hospitals and the patient population within Florida. Therefore, the results are not generalizable to other states.

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Policy Implications | Despite its limitations, this study provides important insight into Florida's opioid crisis and the identification of predictive factors that contribute to opioid abuse. The results of our study indicate that there is a statistically significant association between opioid abuse rate and hospital size, location, and teaching status. These are important findings because it provides valuable insight for policymakers to direct limited resources in an effort to reduce the prevalence of opioid misuse and abuse. To more effectively utilize the limited resources associated to combat opioid abuse, our research indicates that policymakers should target policies at larger hospitals, in urban locations, and those designated as teaching hospitals. It is important for policymakers to understand these predictive patient characteristics because this type of demographic data is readily available. The understanding of patient characteristics and their association to opioid misuse and abuse can help policymakers more effectively and more efficiently target limited resources, like opioid cessation education programs, to specific populations. Finally, the findings presented in our study are especially important to providers and hospital administrators who are increasingly experiencing legislative interventions to reduce unnecessary and excessive opioid prescribing patterns. Therefore, it is important for hospital administrators and other providers to use this data to proactively identify solutions to improve population health by measurably reducing practices that contribute to the misuse and abuse of opioids.

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Conflicts of Interest | The authors declare that they do not have a conflict of interest.

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