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Trends and Associated Factors of Use of Opioid, Heroin, and Cannabis Among Patients for Emergency Department Visits in Nevada: 2009–2017

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Trends and associated factors of use of opioid, heroin, and cannabis among patients for emergency department visits in Nevada: 2009–2017

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Abstract

To examine trends and contributing factors of opioid, heroin, and cannabis-associated emergency department (ED) visits in Nevada.

The 2009 to 2017 Nevada State ED database (n = 7,950,554 ED visits) were used. Use of opioid, heroin, and cannabis, respectively, was identified by the International Classification of Diseases, 9th & 10th Revisions. Three multivariable models, one for each of the 3 dependent variables, were conducted. Independent variables included year, insurance status, race/ethnicity, use of other substance, and mental health conditions.

The number of individuals with opioid, heroin, cannabis-associated ED visits increased 3%, 10%, and 23% annually from 2009 to 2015, particularly among 21 to 29 age group, females, and African Americans. Use of other substance (odds ratio [OR] = 3.91; 95% confidence interval [CI] = 3.84, 3.99; reference - no use of other substance), mental health conditions (OR = 2.48; 95% CI = 2.43, 2.53; reference – without mental health conditions), Medicaid (OR = 1.41; 95% CI = 1.38, 1.44; reference – non-Medicaid), Medicare (OR = 1.44; 95% CI = 1.39, 1.49; reference – non-Medicare) and uninsured patients (OR = 1.52; 95% CI = 1.49, 1.56; reference - insured) were predictors of all three substance-associated ED visits.

With a steady increase in trends of opioid, heroin, and cannabis-associated ED visits in recent years, the main contributing factors include patient sociodemographic factors, mental health conditions, and use of other substances.

Abbreviations: ACA = Affordable Care Act, ED = emergency department, ICD-10 = International Classification of Diseases 10h Edition, ICD-9 = International Classification of Diseases 9th Edition, OR = odds ratio, PDMP = prescription drug monitoring program, SEDDN = State Emergency Department Databases of Nevada, U.S. = United States.

Keywords: cannabis, emergency department, heroin, opioid, substance use

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1. Introduction

The epidemic of opioid abuse and dependency over the past 2 decades creates an urgent health policy and public health concern in the United States (U.S).[1] The volume of opioids prescribed plateaued in 2010 but has modestly declined since then.[2] In 2016, nearly 64,000 people died from drug overdoses in the U.S.[3] Based on current data and projections, death from opioids will continue to increase further still in the upcoming dates.[3] The opioid epidemic has manifested in many ways. For example, high rates of intravenous drug use among individuals with opioid use disorders have led to local outbreaks of hepatitis C.[4] According to the Centers for Disease Control and Prevention, heroin-associated deaths increased more than 4-fold increase in the U.S. over the last 5 years.[5] The epidemic is so far-reaching that it has been cited as a contributing factor to the declining life expectancy of the nation.[6] While more diseases and deaths are occurring from opioids than ever before, more states have eased regulations on medical and recreational cannabis use. Research into the health effects of recent state cannabis policies has shown mixed results. Legalization of recreational cannabis in Colorado was associated with short-term reduction in opioid-associated deaths and medical legalization was associated with reduction in opioid-associated hospitalizations in the U.S.[7,8] However, the

cannabis-associated emergency department (ED) visits increased annually by 7% in the U.S.[9] In Nevada, opioid-associated overdose deaths have increased since 1999 and reached a rate of 13.3 deaths per 100,000 persons in 2016 which is equal to the national rate.[10] While decrease in overdose deaths from 2011 to 2014 were detected, the number of heroin-associated deaths has doubled from 2011 to 2016 in Nevada.[10] Nevada legalized cannabis for medical and recreational use in 2001 and 2016. Legal consumption of medical cannabis went into effect in 2013 and recreational consumption of cannabis went into effect in 2017. A recent study provided insight into trends of opioid and heroin-associated inpatient and ED discharges in U.S.[11] A decline of opioid-associated inpatient and ED discharges was observed beginning in 2010, yet heroin-associated discharges started a sharp increase began in 2008.[11]

A decrease of opioid-associated deaths and hospital utilizations starting in 2010 mirrored federal initiatives urging more judicious opioid prescribing in 2010, accompanied by an increase trend of heroin-associated deaths and hospital utilizations. We may speculate use of other illicit drugs such as heroin in lieu of opioid use increases as a result of national and local polices on opioid prescription reduction. Therefore, studying health impact of other substance use in relation to trends of opioid in a state that largely increase cannabis accessibility by legalizing cannabis for medical and recreational use is important. The purpose of this study, therefore, was 2-fold:

(1) to examine the temporal trends of opioid, heroin, and cannabis -associated ED visits among 12 years of age or older in the Nevada from 2009 through 2017 and
(2) to identify potential sociodemographic and other factors associated with increased risk for those ED visits over the same time period.

2. Methods

2.1. Data

The 2009 to 2017 State Emergency Department Databases of Nevada (SEDDN) was used to obtain a population-based estimate of trends. The earliest year data available are the 2009 SEDDN. The SEDDN, a de-identified dataset, contains complete information on ED visits from all nonfederal acute community hospitals in Nevada. All ED visits associated with use of opioid, heroin, cannabis, other substance use, and mental health conditions were identified by using the International Classification of Diseases, either the 9th Edition (ICD-9) codes (2009 – the 3rd Quarter of 2015) or the 10th Edition (ICD-10) (the 4th Quarter of 2015 – 2017). The specific ICD codes are listed in the Supplemental Table, http://links.lww.com/MD/D335. The Institutional Review Board waiver was granted by the University of Nevada Las Vegas institutional review board for this study. A total of 7,950,554 ED visits over the 9-year period were included for data analysis. Since the SEDDN database provides administrative data after a complete de-identification, an institutional review board approval was waived from University of Nevada Las Vegas.

2.2. Measures and data analysis

Our 3 dependent variables were ED visits associated with use of opioid, heroin, and cannabis, respectively. Specifically, 3 dummy variables were respectively created, with the value of "1" indicating "the patient associated with use of opioid, heroin, or cannabis was treated at ED" and the value of "0" indicating "the patient without use of opioid, heroin, or cannabis was treated at ED" for each patient.

We formed three multivariable models, one for each of the dependent variables. Our first independent variable was time (an ordinal variable with a value ranging from 1 to 9 representing the years from 2009 to 2017, respectively). The other independent variables included a dummy variable indicating use of other substance(s), a dummy variable indicating the patient having a mental health condition(s), 7 dummy variables indicating patient's age groups (< 12, 12 – 17, 18 – 24, 25 – 34, 35 – 44 (reference), 45 – 54, 55 – 64, and $>=65$), sex (a dummy variable indicating female), health insurance status (4 dummy variables were created to represent Medicare, Medicaid, uninsured, and other insurance; while private insurance served as the reference), and race/ethnicity (4 dummy variables were created to represent African American, Hispanic/Latino, Asian and Pacific Islander, and others; while white served as the reference). In the models for use of opioid and heroin, respectively, use of cannabis was included as an independent variable. In the model for use of cannabis, use of opioid was included as an independent variable. Since use of opioid and use of heroin were highly correlated, they were not included in each other's models.

We used a pooled, cross-sectional design, given that we were unable to track individual patients. The unit of analysis was ED visit, and multiple visits from the same patients were assumed independent. We used the mixed model for multivariable analysis and treated hospital as the random effect, to account for the within hospital variations due to the clustering effect, while estimated the fixed effect of the independent variables. The multivariable models were adjusted for hospital-level characteristics, such as bed size, ownership type, teaching affiliation, and rural or urban location. In addition, we also adjusted potential effects of ICD coding change from the 9th Edition to the 10th Edition by using a dummy variable to indicate the ICD-10 coding.

3. Results

The number of opioid, heroin, and cannabis -associated ED visits increased dramatically from 73,262 in 2009 to 1,070,747 in 2017 (Table 1). Patients from 21 to 29 years old remained relatively constant, among all age groups, as the highest risk for opioid (37.8% in 2017), heroin (65.75% in 2017), and cannabis (52.9% in 2017) associated ED visits. The percentage growth rate across all 9 years varied among race/ethnicity. Findings indicated that White patients were the most likely go to an ED for all three substances (53.62% in 2017) while African Americans showed the sharp increase of ED visits specially for opioid (50% increase: 8.38% in 2009 to 12.04% in 2017). Our study showed opposite trends in associated ED visits among the uninsured and Medicaid patients. Table 1 indicates a steep decline in opioid, heroin, and cannabis-associated ED visits among the uninsured patients while the annual temporal trend of Medicaid patients in associated ED visits increased sharply. Patient characteristics of opioid, heroin, and cannabis -associated ED visits from 2009 to 2017 are listed in Table 1.

Figure 1 displays the annual temporal trends of the number of ED visits and rates of with use of opioid, heroin, and cannabis per 100,000 ED visits, respectively, from 2009 to 2017. All 6 curves

Table 1

Patient characteristics of opioid, heroin, and cannabis associated emergency department visits in Nevada, 2009, 2013, 2017.

	Opioid-associated ED visits			Heroin-associated ED visits			Cannabis-associated ED visits			Total ED visits		
	2009	2013	2017	2009	2013	2017	2009	2013	2017	2009	2013	2017
N	2901	4588	8212	148	201	403	1981	5383	14,270	73,262	859,820	1,070,747
Age groups												
12-17	0.97	0.78	0.38	0	0	0	0.05	0.06	0.17	18.47	16.84	15.17
18-20	3.52	2.07	0.65	4.05	1.00	0	13.53	7.56	3.73	6.09	5.29	4.85
21-24	19.06	16.94	10.25	31.76	28.36	19.35	27.66	26.16	21.28	12.34	11.96	10.64
25-29	21.13	26.79	27.57	29.05	40.30	46.40	25.29	29.15	31.62	16.47	17.15	17.52
30-34	19.65	16.46	18.64	16.22	9.95	16.38	16.71	16.98	18.18	13.87	13.28	13.56
35-44	20.89	17.44	16.39	16.89	15.42	10.92	12.67	13.06	13.07	13.15	13.28	13.56
45-64	9.89	12.05	15.43	2.03	2.99	4.96	3.58	5.57	8.37	8.54	9.56	10.81
65 and older	4.89	7.48	10.69	0	1.99	1.99	0.50	1.47	3.59	11.07	13.02	14.79
Gender												
Male	53.09	50.00	50.32	72.97	74.13	69.23	64.31	61.14	58.89	46.14	45.19	45.23
Female	46.91	50.00	49.68	27.03	25.87	30.77	35.69	38.86	41.11	53.86	54.81	54.77
Race / ethnicity												
White	75.18	75.92	72.99	79.73	77.61	78.16	60.58	59.19	57.13	57.87	55.04	53.62
African American	8.38	9.39	12.04	2.70	2.99	1.74	20.19	22.09	23.24	14.43	15.41	17.81
Hispanic	7.24	7.93	8.13	8.11	11.44	9.93	11.46	9.75	11.51	16.65	16.37	17.08
Asian and Pacific Islander	2.38	2.66	1.25	2.03	2.99	0.99	3.03	3.23	1.58	4.38	5.00	3.58
Insurance status												
Medicare	11.34	18.72	21.44	2.03	3.98	4.47	4.34	8.86	9.36	12.57	16.47	17.28
Medicaid	9.24	14.63	46.36	5.41	13.43	55.58	12.92	17.65	42.56	16.03	21.27	39.47
Private insurance	25.37	21.88	20.41	16.89	16.42	14.89	22.36	22.85	30.64	38.43	32.20	31.20
Uninsured	50.60	39.39	10.59	73.65	61.19	23.33	58.46	44.94	15.63	29.67	25.76	10.08
Comorbidity												
Other substance use	25.23	26.26	71.21	26.35	36.32	45.91	42.91	35.02	39.44	4.18	5.20	13.35
Mental health disorders	9.48	17.22	26.50	5.41	7.46	11.41	19.74	19.78	26.79	3.67	5.74	9.34

Notes. Results of 2010, 2011, 2012, 2014, 2015, and 2016 are not displayed for the sake of reducing the width of the table; All numbers are expressed as a percentage except being noted; Percentages may not add to 100 because of rounding; ED, emergency department.
Source. State Emergency Department Databases of Nevada, 2009 to 2017.

showed a trend of steady increase with a "big jump" for use of cannabis from 428 per 100,000 ED visits in 2012 to 731 per 100,000 ED visits in 2013. From 2016 to 2017, conversely, a decline in both opioid and cannabis- associated ED visits were observed. In addition, similar 9-year trends were observed for the rates of use of other substance and mental health conditions, respectively (not shown in the figure).

We also found some significant trends of sociodemographic factors related disparities in ED visits associated with use of opioid and heroin (Fig. 2). Trends of racial/ethnic disparities were found in opioid-associated ED visits. There was a continuing upward trend among Whites as the highest risk group with a dramatic increase of African Americans during the same period of time (180% increase; 33 per 100,000 ED visits in 2009, 92.4 per 100,000 ED visits in 2017). Health insurance related disparity trends were depicted among heroin-associated ED visitors. The rate of heroin uses among Medicaid patients jumped significantly during the 9-year period while uninsured patients started decreasing in 2013 (Fig. 2).

We found an important trend in odds of ED visits associated with use of different substances. On average, the likelihood of visiting ED with opioid, heroin, and cannabis use increased about 3%, 10%, and 23% annually, respectively, from 2009 to 2017 in Nevada (Table 2). Furthermore, patients using cannabis were more likely to seek for opioid-associated ED treatment than their non- cannabis use counterparts (OR = 2.78; 95% CI = 2.67, 2.90), in other ways, patients using opioid were more likely to visit ED with the use of cannabis than non-opioid use counterparts (OR = 2.68; 95% CI = 2.57, 2.80). Using other substances was a strong predictor of opioid (OR = 6.68; 95% CI = 6.54, 6.82), heroin (OR = 3.81; 95% CI = 2.87, 5.06), and cannabis -associated ED visits (OR = 3.91; 95% CI = 3.84, 3.99). Finally, patients with mental health conditions were 1 to 2 times more likely to seek ED treatment for opioid (OR = 1.73; 95% CI = 1.69, 1.77) and cannabis (OR = 2.48; 95% CI = 2.43, 2.53) than patients without mental health conditions (Table 2).

Two highest risk groups of using opioid, heroin, and cannabis among all age groups were those groups between the ages of 18 to 24 and 25 to 34. In regard to patients' insurance status, patients with Medicaid, Medical, and uninsured are more likely to go to the ED for opioid, heroin, and cannabis than patients with private insurance Medicare patients, as compared with non-Medicare patients (OR = 2.26; 95% CI = 2.19, 3.14), Medicaid patients, compared with non-Medicaid patients (OR = 1.68, 95% CI = 1.64, 1.73), and uninsured patients, compared with insured patients (OR = 1.46; 95% CI = 1.42, 1.50), were 126%, 68%, and 46% more likely to visit ED for opioid use, respectively (Table 2). While African American patients were 45% more likely to seek ED treatment for cannabis (OR = 1.45; 95% CI = 1.42, 1.48) than White patients, White patients were more likely to go to ED than other minority groups in use of opioid, heroin, and cannabis (Table 2).

4. Discussion

It is important to consider the potential impact of higher ED visits in Nevada given the recent changes in laws pertaining to legal medical and recreational cannabis use when considering the

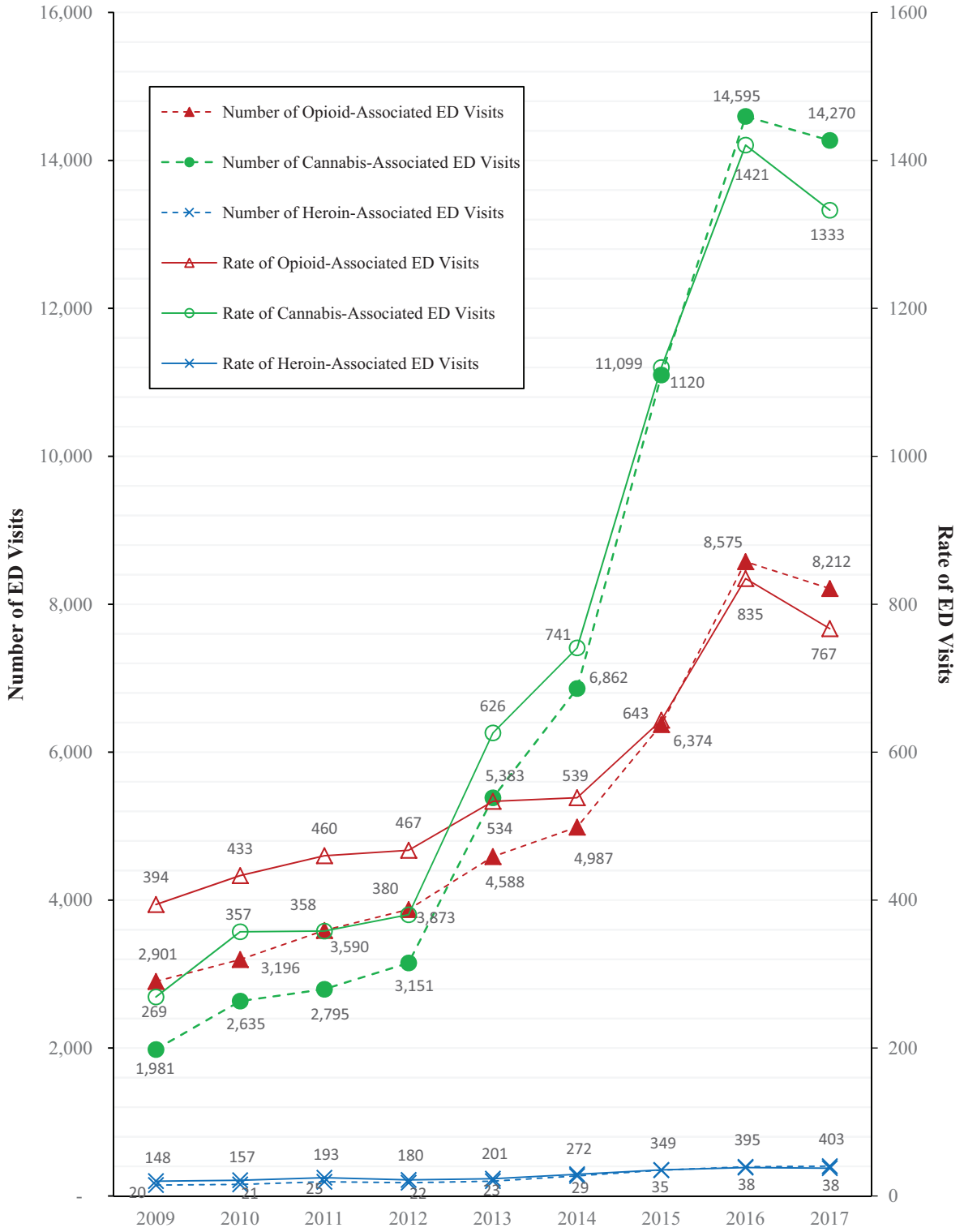

Figure 1. This graph shows trends of opioid, heroin, and cannabis associated emergency department visits. "Rate" refers to the number of emergency department visits per 100,000 emergency department visits. ED = emergency department, HR = heroin, OP = opioid.

trends of substantial increase in cannabis -associated hospital use based on the national data sample. This "big jump (a.k.a., level and slope change pattern)" pattern of cannabis -associated hospitalization was also observed from the 2 decades longitudinal analysis of National Inpatient Sample (1993–2014).[12]

The impact of Medicaid expansion under the Affordable Care Act (ACA) in 2010 showed many uninsured patients had been covered by Medicaid.[13] A changes in payer mix between Medicaid and uninsured patients were found in a study of cannabis-associated ED visits in U.S. based on 2006 to 2014

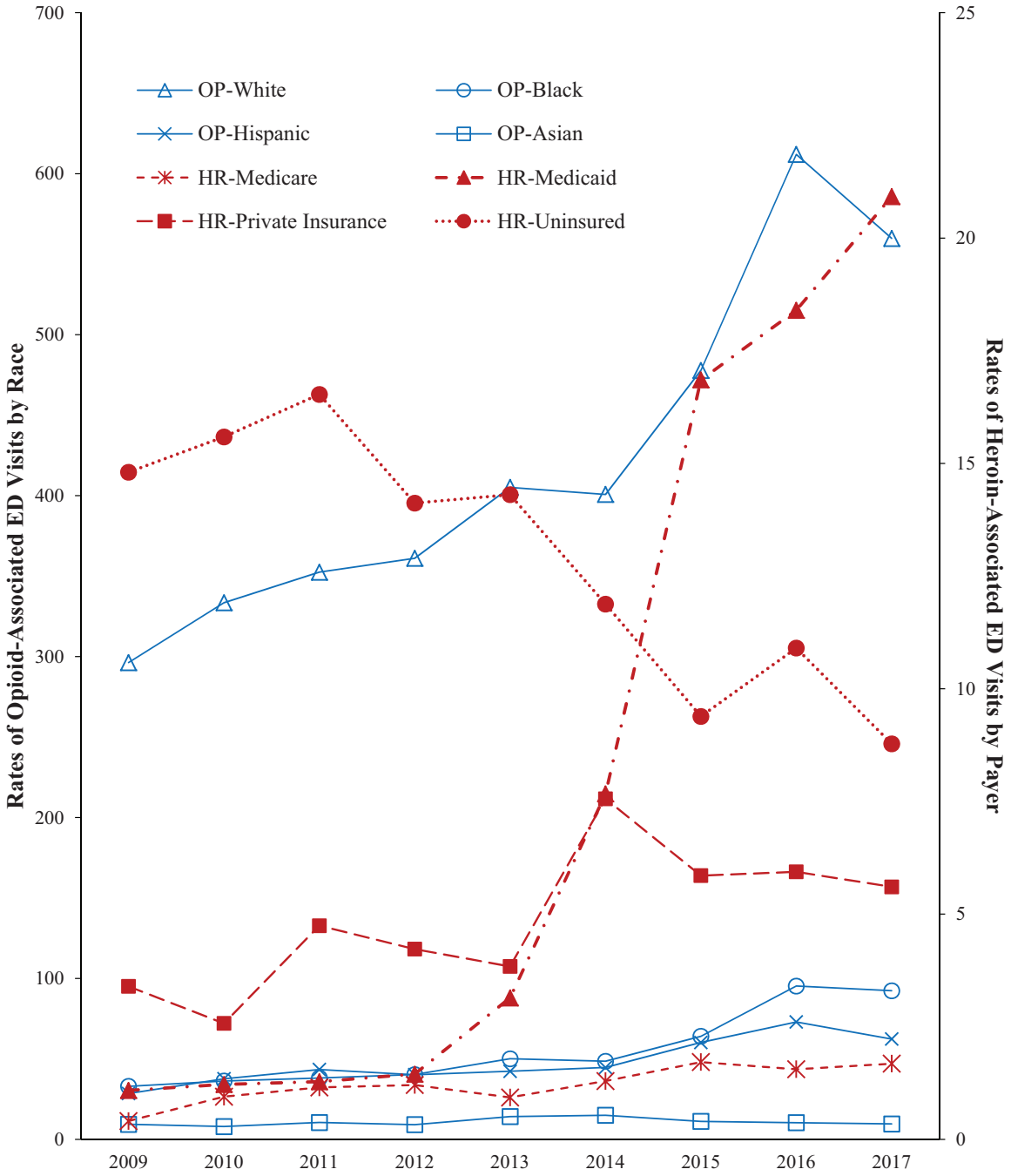

Figure 2. This graph illustrates significant trends of sociodemographic factors related disparities in emergency department visits associated with use of opioid and heroin. Rates of opioid-associated emergency department visits by race and rates of heroin-associated emergency department visits by payer are shown. ED = emergency department, OP = opioid; HR = heroin; rate, number of ED visits per 100,000 ED visits.

National Emergency Department Sample data.[9] A study on complete inpatient discharge data from all nonfederal acute care hospitals in Nevada reported the postexpansion trends increased rapidly among Medicaid patients at the beginning of 2014.[14] Our study also observed a sharp increase among Medicaid patients and decrease among uninsured patients in opioid, heroin, and cannabis associated ED visits between 2013 and 2017. It is important to note that Medicaid expansion under provisions of the ACA was implemented in 2014 in Nevada.

Nevada residents have shown an acceptance of legalized cannabis consumption, first with the passage of medical cannabis use in 2001, followed by the passage of legalized recreational consumption affirmed in 2016. While it took the state nearly 15 years to establish state-certified medical cannabis dispensaries, much less time was needed to license and regulate recreational cannabis dispensaries which become operational in July 2017. Moreover, the tacit acceptance of legalization of cannabis in some form since 2001 when medical cannabis was legalized may have contributed to a macroscopic social diffusion, in expanding

Table 2

Factors associated with use of opioid, heroin, and cannabis among emergency department visits in Nevada, 2009 to 2017.

	Opioid			Heroin			Cannabis		
Independent Variable	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**
Year, increment	1.03	[1.027, 1.039]	<.001	1.10	[1.01, 1.20]	.026	1.23	[1.22, 1.24]	<.001
Opioid							2.68	[2.57, 2.80]	<.001
Cannabis	2.78	[2.67, 2.90]	<.001	1.07	[0.50, 2.32]	<.001			
Age groups									
35–44 (Reference)									
12-17	0.15	[0.14, 0.17]	<.001	0.05	[0.00, 27.58]	.350	0.05	[0.04, 0.07]	<.001
18-20	0.80	[0.73, 0.87]	<.001	2.87	[0.35, 23.40]	.326	8.57	[6.59, 11.16]	<.001
21-24	2.77	[2.64, 2.91]	<.001	35.37	[7.34, 170.34]	<.001	12.45	[11.74, 13.21]	<.001
25-29	2.83	[2.71, 2.96]	<.001	28.53	[5.98, 136.07]	<.001	9.07	[8.55, 9.63]	<.001
30-34	2.23	[2.13, 2.34]	<.001	12.82	[2.64, 62.22]	.002	6.65	[6.26, 7.05]	<.001
45-64	2.21	[2.31, 2.31]	<.001	9.66	[1.99, 46.98]	.005	4.89	[4.61, 5.19]	<.001
65 and older	2.30	[2.20, 2.41]	<.001	6.39	[1.26, 32.3]	.025	3.62	[3.40, 3.85]	<.001
Sex									
Male (Reference)									
female	0.91	[0.90, 0.93]	<.001	0.33	[0.25, 0.44]	<.001	0.51	[0.51, 0.51]	<.001
Race / Ethnicity									
White (Reference)									
African American	0.45	[0.44, 0.47]	<.001	0.15	[0.08, 0.29]	<.001	1.45	[1.42, 1.48]	<.001
Hispanic	0.50	[0.48, 0.51]	<.001	0.39	[0.25, 0.60]	<.001	0.72	[0.71, 0.74]	<.001
Asian and Pacific Islander	0.42	[0.39, 0.45]	<.001	0.31	[0.11, 0.86]	.025	0.66	[0.62, 0.70]	<.001
Insurance Status									
Private insurance (Reference)									
Medicare	2.26	[2.19, 2.34]	<.001	1.47	[0.70, 3.07]	.306	1.44	[1.39, 1.49]	<.001
Medicaid	1.68	[1.64, 1.73]	<.001	2.39	[1.61, 3.55]	<.001	1.41	[1.38, 1.44]	<.001
Uninsured	1.46	[1.42, 1.50]	<.001	3.07	[2.11, 4.46]	<.001	1.52	[1.49, 1.56]	<.001
Comorbidity									
Other substance use	6.68	[6.54, 6.82]	<.001	3.81	[2.87, 5.06]	<.001	3.91	[3.84, 3.99]	<.001
Mental health disorders	1.73	[1.69, 1.77]	<.001	0.82	[0.52, 1.28]	.376	2.48	[2.43, 2.53]	<.001

Notes. The multivariable analyses were adjusted for the International Classification of Diseases systems and hospital characteristics; CI = confidence interval, OR = odds ratio.
Source. State Emergency Department Databases of Nevada.

cannabis consumption, licitly or illicitly.[15] Medical cannabis laws appear to have advanced social contagion of substance use in general, contributing to a collective trend toward the passage of recreational cannabis legalization laws, according to the three different nationally representing U.S. adult surveys.[16] Whether a *fait accompli* regarding cannabis legalization has influenced an increase in cannabis consumption along with in combination with opioids is unclear. It is also worth noting that states that have not legalized cannabis in any form or beyond medical use also have shown an increase in opioid and heroin use and hospital admissions. Moreover, the development, marketing, prescribing and ultimate abuse of prescription opioid also grew during this period. Since both influencing social factors coexisted during this period the relationship of social acceptance cannabis and the coinciding increase in prescription opioids merits further study. This social contagion of substance use may obviously extend to the population of previously underuse population such as middle age, female, Medicaid and Medicare patients in our analysis. These populations are compatible with substantially increased volume of degenerative orthopedic conditions/operations as well as opioid prescription across the U.S.[17] Even so, our findings documenting a higher use of cannabis in combination with opiates among 18 to 24 year old and 25 to 24 year old does not support the use of substances for degenerative orthopedic conditions.

In order to enforce and regulate the prescribing and dispensing of prescription drugs, prescription drug monitoring programs (PDMP) were designed in the early 1900.[18] However, implementation of PDMP was low until recent years. With continuous increase in opioid mortality and scientifically proven effectiveness of PDMP, states began to participate into enforcing PDMP. In Nevada, PDMP was included in Senate Bill (SB) 459, which was passed in 2015.[19] A sudden decrease in opioid-associated ED visits at 2016 might have been an early impact of PDMP implementation in Nevada.

In Nevada, recreational cannabis use was legalized in 2016. Decrease in cannabis-associated ED visits from 2016 and 2017 from our study supports earlier study on cannabis-associated ED visits in U.S.[9] Shen & collogues speculated that increase in prevalence of cannabis-associated ED visits was not associated with legalization of recreational cannabis use.[9] Hence, we may suspect that a decrease in cannabis-associated ED visits from 2016 and 2017 might be related to recreational legalization in 2016. However, more studies need to be done to find out impact of recreational cannabis legalization on healthcare outcomes associated with cannabis use and other substance use.

According to the recent national poll on older adults' experiences, half of responders reported that they reserved leftover opioid medications for future use.[20] Opioid medications that fall into the wrong hands may place family members, particularly adolescents and young adults, and communities at risk. Moreover, older adults often need changes to their medications, and the use of leftover medications even occasionally and without medical supervision could lead to possible adverse drug effects. Among retirement-age adults, the poor as well as Medicaid enrollees were disproportionate users of opioids

(both prescribed and illicit) out of perceived necessity rather than out of choice according to the nationally representing Health and Retirement Study.[21]

Social contagion of substance use expands its impact from single substance to polysubstance use that might have occurred from gateway or corner stone drug (for example, cannabis) to hard drug such as heroin.[15] In our analysis, individuals with mental health conditions are more likely to have both opioid and cannabis -associated ED visits. Individuals with mental health conditions are more vulnerable to these dynamics of advancing to polysubstance use.[22] Thus, approximately 7.9 million adults had co-occurring mental health conditions and substance use disorders in 2014.[23] These populations remain at risk of serious adverse health outcomes by either or both mental health or substance use disorders. An estimated 1.6 million patient with substance use disorder have gained access to health care in Medicaid expansion states.[24] Considerable gaps remain in health care access among substance use disorder patients, especially, with mental health conditions based on the decision of some states to forgo Medicaid expansion.

In conclusion, Nevada residents have shown an acceptance of legalized cannabis consumption during the last 16 years. The tacit acceptance of legalization of cannabis in some form since 2001 when medical cannabis was first legalized may have contributed to a macroscopic social diffusion, in expanding cannabis consumption, licitly or illicitly.

We must also advise that poly-substance abuse is not a new problem. Research going back decades has documented poly-substance abuse among drug and alcohol abusers and individuals with mental illness.[25] Previous research shows that while cannabis may lead to use and abuse of other legal and illegal substances other substances such as alcohol and nicotine have led to similar results.[26] Whether these factors may have a biological association, other factors including one's social environment and interacting with others who use drugs increases their risk of furthering their drug abuse. What may be further compounding the relationship of opioids and cannabis use is the availability of prescription opiates drugs which has created a new market of drugs that can be abused. Increase in the prescription of amphetamines and barbiturates led to abuse among individuals for whom those drugs were not intended. The bigger challenge for medical professionals, public health providers and policy makers is understanding early on the potential pharmaceuticals intended for providing relief from medical disorders and the unintended consequences of abuse of these drugs, the development of a new black market for these drugs and the manufacture of illicit, more dangerous, substances that provide similar effects.

At the same time, it is important to recognize the social determinants for substance abuse and how these affect the health care delivery and the need for improved access for substance abuse treatment beyond the hospital ED.

5. Limitations

Several limitations should be considered in the interpretation of this study. First, data received was de-identified and therefore data were assumed as cross-sectional. If patients could be tracked over time, potential for additional patterns to emerge. Second, the coding accuracy of opioid-associated conditions as well as transition stability from the ICD-9 to ICD-10 systems remains relatively low.[27,28] The jump from 2014 to 2015 might be partially due to the change from the ICD-9 to the ICD-10 systems because the ICD-9 coding system may have missing cases of opioid-associated conditions than new ICD-10 coding system.[28] However, we did adjust the potential coding effect of using the ICD-10 in the multivariable analyses. Third, the state of Nevada may not perfectly represent the west or southwest region where most of these states adopted cannabis legalization but may have different political, social, and economic atmospheres. Despite these potential limitations, we believe this is the first study to report several new insights to the current. To the best of our knowledge, there was no previous study that examined the trends of opioid, heroin, and cannabis simultaneously and examined associated factors of health outcomes.

6. Public health implications

Our study observed significant changes in payer mix for all 3 drugs-associated ED visits as other studies on ED visits reported, that is, uninsured patients shifted toward Medicaid, which might be related to the implementation of ACA in 2010 and the Medicaid expansion in 2014.[9,13] This pattern was more notable in heroin-associated ED visit. This can be speculated by:

(1) the heroin's hard (or advanced) drug characteristics that might lead heroin user to easily depleting or already depleted in socioeconomic status;
(2) Nevada's unemployment rate soared and sustained higher than the national average unemployment rate since the Great Recession in 2008.[29]

Our study noted that African American group was the fasted growing race/ethnicity group of opioid-associated ED visit and was the highest probable race/ethnicity group of cannabis -associated ED visit. These findings were in line with African American population's treatment and healthcare use demand in the nationally representing databases from the Treatment Episode Data Set, substance-involved admissions to treatment facilities, the National Survey on Drug Use and Health, and National Inpatient Sample.[30–32] Black race was studied to have an increased prevalence of blunt smoking, and blunt smoking was known to be positively associated with cannabis use and its disorders.[31] In-depth research efforts for African American population are warranted to inform the development of evidence-based and culturally appropriate addiction prevention and treatment approaches.

Considering the nation's opioid epidemic, to reduce misuse and abuse of prescribed opioids, more than 30 states have implemented PDMP during the past 2 decades. Yet, PDMPs have not been effective in reducing drug overdose mortality rates.[33] As such, PDMPs may not be effective to comprehensively address prescription diversions, doctor shopping, or other abusive behaviors of other than prescribed opioids.[33] At-risk districts as well as states were concentrated in the Southeastern states with clear rural versus urban variation.[34] Further research has to focus on why certain states or districts are more successful in achieving more appropriate opioid prescription rates.

Heroin injection is known to be a major route of hepatitis C transmission, and young adults are increasingly shifting from other opiates to heroin use due to its lower price and easier accessibility as prescription opioids become more difficult to acquire amid concern for an epidemic of opiate addiction.[35,36] In a nationally representing survey, 20% of 12th grades reported that they could easily get heroin if they wanted to. In the experience from state of Maryland, heroin-associated deaths

could be identified more by additional sources of information, such as toxicology results and scene investigation reports.[23,37] In our analysis, both opioid and heroin at risk population shares the same demographic characteristics, white and male population. These vulnerable populations overlap at risk group of opioid-associated in-hospital mortality analysis using the National Inpatient Sample 1993 to 2014.[32] Given ED visit is often a precursor of hospitalization, enhancive preventive efforts for these populations are warranted such as hepatitis C screening that is now limited to baby boomer cohort born between 1945 and 1964 because hepatitis C is now curative condition by direct-acting antiviral therapy.[35,38] Another aspect of further research is the intersection between substance use associated health outcomes and crimes specifically, among adolescents and young adults. The relationship between medical cannabis legalization and fatal driving accidents under opioid influence was empirically assessed earlier, but this assessment was too early to assess the policy effects of medical legalization.[39] Further research is urgently warranted to examine the effects of recreational cannabis legalization on health outcomes as well as the varieties of crimes and misdemeanors.

Author contributions

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