

# Trends and Correlates of Cannabis-involved Emergency Department Visits: 2004 to 2011

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**Objectives:** To examine trends and correlates of cannabis-involved emergency department (ED) visits in the United States from 2004 to 2011.

**Methods:** Data were obtained from the 2004 to 2011 Drug Abuse Warning Network. We analyzed trend in cannabis-involved ED visits for persons aged  $\geq 12$  years and stratified by type of cannabis involvement (cannabis-only, cannabis-polydrug). We used logistic regressions to determine correlates of cannabis-involved hospitalization versus cannabis-involved ED visits only.

**Results:** Between 2004 and 2011, the ED visit rate increased from 51 to 73 visits per 100,000 population aged  $\geq 12$  years for cannabis-only use ( $P$  value for trend = 0.004) and from 63 to 100 for cannabis-polydrug use ( $P$  value for trend < 0.001). Adolescents aged 12–17 years showed the largest increase in the cannabis-only-involved ED visit rate (rate difference = 80 per 100,000 adolescents). Across racial/ethnic groups, the most prevalent ED visits were noted among non-Hispanic blacks. Among cannabis-involved visits, the odds of hospitalization (vs ED visits only) increased with age strata compared with age 12 to 17 years.

**Conclusions:** These findings suggest a notable increase in the ED visit numbers and rates for both the use of cannabis-only and cannabis-polydrug during the studied period, particularly among young people and non-Hispanic blacks.

**Key Words:** cannabis, emergency department, hospitalization, polydrug

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The continued spread of decriminalization or medical cannabis use laws in many states, and also a rising cannabis use prevalence noted from the population-based surveys have drawn growing concerns about the potential adverse effects of cannabis use on health (eg, addiction), which may trigger a wide range of unintended consequences (Volkow et al., 2014; Substance Abuse and Mental Health Services Administration [SAMHSA], 2015a). According to estimates from the 2014 National Survey on Drug Use and Health (NSDUH), 13.2% of persons aged  $\geq 12$  years (35 million) used cannabis in the past year, which increased by 2.6% (9.7 million) since 2004 (SAMHSA, 2015a). Nationally, an estimated 4 million of persons aged  $\geq 12$  years had a cannabis use disorder (CUD) in the past year (SAMHSA, 2015a). Among past-year cannabis users aged  $\geq 12$  years, 15% or more than 1 in 7 cannabis users were found to meet criteria for a CUD—an indicator of problem cannabis use or dependence that warrants intervention to reduce adverse effects (Wu et al., 2014). There has been an increased number of studies that examined cannabis use prevalence trends; however, the potential impact of cannabis use on healthcare utilization over time has not been adequately investigated (French et al., 2011; Hasin et al., 2015). This study used the national dataset to determine the national trend in cannabis-specific emergency department (ED) visits and hospitalization to better inform cannabis-involved healthcare utilization and to identify demographic groups disproportionately affected by cannabis-involved healthcare utilization.

Chronic or heavy cannabis use was associated with poor educational outcome and a wide range of health-related concerns, such as cognitive impairment, cannabis-impaired car accidents, addiction, symptoms of bronchitis, psychotic symptoms, depression, lung cancer, and reproductive health problems (Volkow et al., 2014; Hall, 2015). The latter may result in acute events or intensify existing medical conditions that are related to ED admissions. It was estimated that chronic drug use increased the probability of using ED for medical care by more than 30% (McGeary and French, 2000). Cannabis use may impair motor coordination and reaction times, and interfere with driving performance (Volkow et al., 2014). A meta-analysis found that driving under the influence of cannabis use was associated with increased odds of motor vehicle collisions compared with

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unimpaired driving (odds ratio [OR] 1.92, 95% confidence interval [CI] 1.35–2.73) (Asbridge et al., 2012).

Despite continued concerns about the adverse effects of cannabis use on health and their related impact on healthcare utilization (Volkow et al., 2014), there is very limited information about cannabis-specific ED admission and subsequent hospitalization. Previously, Perron et al. (2011) found that 1.7% of lifetime adult cannabis users reported an ED visit. In a study of a national sample, Wu et al. (2012) estimated that 12.1% of adults nationally who sought medical care in ED used cannabis in the past year compared with 9.7% of adults who received care in ED. However, these self-report drug use and ED treatment data from surveys provide inadequate information to inform cannabis-involved treatment visits to determine the potential effects of cannabis use on ED admissions. Therefore, national-level datasets that include cannabis-involved ED admissions are needed. The Drug Abuse Warning Network (DAWN) specifically collected data on drug-involved ED visits (either a direct cause or contributor for the visits); hence the DAWN data can improve the study of associations between problem cannabis use and cannabis-involved ED and hospitalization (Center for Behavioral Health Statistics and Quality [CBHSQ], 2013).

Cannabis use was associated with sex, age, and race/ethnicity (Wu et al., 2012, 2014). Males in general were more likely than females to use cannabis and have a CUD (Wu et al., 2014). Adolescence is in the critical stage of brain development, and early and frequent cannabis use was associated with altered brain development (eg, impairment in brain functional connectivity), which could increase adolescent users' vulnerability to long-term effects of cannabis on addiction, other psychiatric conditions, or cognitive impairment (Rubino et al., 2012; Volkow et al., 2014). Nationally, about 13% of adolescents used cannabis in the past year (Wu et al., 2014). Although past-year cannabis use was most common among adults aged 18 to 25 years (29%), adolescent cannabis users were more likely than adult cannabis users to meet criteria for a CUD in the past year (Wu et al., 2014). Among US high school seniors, the likelihood of unsafe driving was positively associated with substance use frequency, especially concurrent use of alcohol and cannabis (Terry-McElrath et al., 2014).

Nationally, approximately 13% of blacks aged  $\geq 12$  years used cannabis in the past year compared with 11% of whites and 9% of Hispanics (Wu et al., 2014). Recent data estimated that black adolescents were about 68% more likely than white adolescents to have used cannabis and 34% more likely to have a CUD in the past year (Wu et al., 2015). These findings point towards the need to determine whether the number of cannabis-involved ED admissions was associated with sex, age, and race/ethnicity (ie, increases among males, adolescents, or blacks). Besides demographic variables, polydrug use may intensify adverse effects of drug use and increase treatment admissions (Dean, 2006; CBHSQ, 2012). Based on prior DAWN data, 73% of ED visits involving cannabis also included other drug(s) in 2009 (CBHSQ, 2012). Because of the cost and challenges of conducting the study in ED settings to determine substance-specific ED admissions, this study capitalizes on existing datasets to examine cannabis-involved ED visits and hospitalization.

We compare use of cannabis only with use of cannabis and other drug(s) (cannabis-polydrug) to better understand the trend and patterns of cannabis-involved healthcare use (including subsequent hospitalization). We determine the national trends in cannabis-involved ED visits, stratified by cannabis and other drug use status (cannabis-only, cannabis-polydrug); quantify demographic patterns in cannabis-involved ED visits (age, sex, race/ethnicity); determine specific drugs commonly identified among cannabis-involved ED visits; and conduct adjusted analyses to identify correlates of cannabis-involved hospitalization versus cannabis-involved ED visit only. To our knowledge, this study is among the first to specifically examine the pattern of cannabis-involved ED visits and subsequent hospitalizations. Results will have timely clinical implications for informing demographic groups impacted by cannabis-involved hospitalizations.

## METHODS

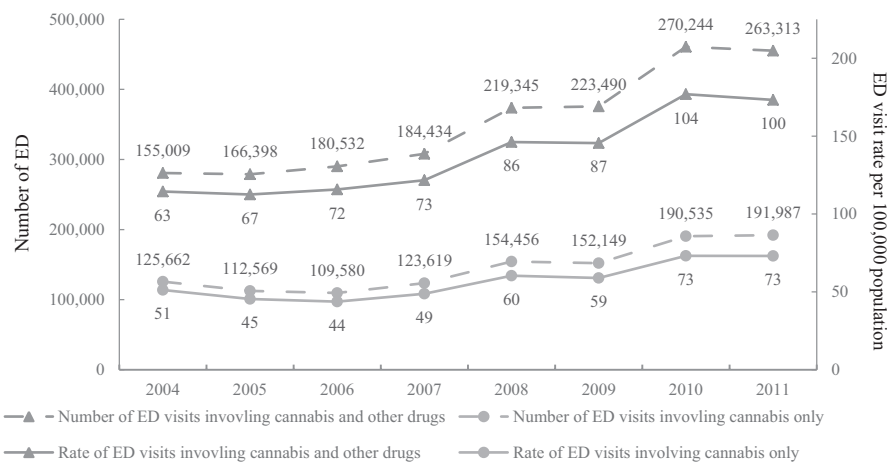
### Data Source

Data were obtained from public-use datasets of the 2004 to 2011 DAWN (CBHSQ, 2013; SAMHSA, 2015c). DAWN is the only national representative surveillance system designed to monitor the trends in drug abuse and misuse involved hospital ED visits and subsequent hospitalizations (CBHSQ, 2013). The 2004 to 2011 DAWN used a stratified simple random sample of the non-Federal, short-stay, general surgical and medical hospitals, with at least one 24-hour ED in the United States. DAWN provides a drug reference vocabulary (DRV), which can be used to identify specific illicit drug use and combinations among illicit drugs, nonmedical prescription drugs, and alcohol. The most recent data of DAWN was from 2004 to 2011 due to the redesigned survey methodology in 2003, and it can be used to estimate the trends in the specific drug for the nation and selected metropolitan areas (CBHSQ, 2013).

The observation unit of DAWN data is an ED visit involving recent drug use (or alcohol only for patients younger than 21 years), and drug use can be a direct cause or contributor for the visits (CBHSQ, 2013). These substance-involved ED visits were identified and collected by trained DAWN reporters through reviewing the medical records of patients, and 1 visit may report multiple substance use (up to 16). This study focused on a subsample of cannabis-involved ED visits for admitted patients aged  $\geq 12$  years. In the final sample, the weighted number of ED visits were 2,823,321 from 2004 to 2011, and 41.1% (1,160,556) of them were related to cannabis-only and 58.9% (1,662,765) related to a combination of cannabis and other drug(s). The use of DAWN dataset was determined to be exempt from review by the institutional review board of Duke University Health System.

### Study Variables

A cannabis-involved ED visit was defined as any ED visit involving cannabis use for all-listed drug reported, and 1 patient may have several visits recorded by a number of visits. Based on the presence of cannabis and other drug(s), we categorized cannabis involvement into 2 categories: cannabis-only (cannabis was the only drug identified); and cannabis-polydrug (cannabis plus 1 or more other illicit drugs or pharmaceuticals).



**FIGURE 1.** The estimated number and rate per 100,000 population aged  $\geq 12$  years of cannabis-involved ED visits, 2004 to 2011 DAWN: cannabis-only versus cannabis-polydrug admissions. All numbers are weighted estimates, and the rate was defined as a weighted estimate of the ED visit number divided by 100,000 population aged  $\geq 12$  years.

Other illicit drugs or pharmaceuticals included cocaine, heroin, stimulants (methamphetamine/amphetamine), hallucinogens (ecstasy, phencyclidine, d-lysergic acid diethylamide, and miscellaneous hallucinogens), opiates/opioids, and sedatives/benzodiazepines.

Demographic characteristics of patients in the DAWN dataset included age (12–17, 18–20, 21–24, 25–29, 30–34, 35–44, 45–64, and 65 or older), sex (male and female), and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic or Latino, and other races). Other races consisted of American Indian, Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or mixed race/ethnicities (CBHSQ, 2013).

The DAWN assigned a unique case type to each ED visit to analyze the similar admission reasons. The admission case types included seeking detoxification, suicide attempt, problem drug use (adverse reaction, overmedication, accidental ingestion, and malicious poisoning) and other admission reasons.

### Statistical Analysis

We first described the trends in the annual number and rate of cannabis-involved ED visits, stratified by type of cannabis involvement (cannabis-only and cannabis-polydrug) and demographics. The ED visit rate for each type of cannabis involvement was computed by the number of relevant ED visits divided by the total number of resident population aged  $\geq 12$  years from the US Census Bureau (CBHSQ, 2013). The ED visit rate for each demographic group was calculated by the number of relevant ED visits divided by the number of resident population for corresponding group. *P* value for trend was estimated from univariate linear regression between the variable of interest and year. Finally, multiple logistic regression analyses were used to estimate associations between demographic factors and type of cannabis involvement, and also to determine factors associated with hospitalization versus ED-only visits. All analyses took into account DAWN’s complex survey designs by using Stata 13.0 (Stata-Corp, 2013). All results are weighted figures.

## RESULTS

### Trend in Cannabis-involved ED Visits

Overall, both the annual number and rate of cannabis-involved ED visits showed a significantly increasing trend from 2004 to 2011. The rate of ED visits involving cannabis-only increased by 43% from 51 per 100,000 population aged  $\geq 12$  years in 2004 to 73 in 2011 (*P* value for trend = 0.004). The rate of ED visits involving cannabis-polydrug increased 59% from 63 per 100,000 population aged  $\geq 12$  years in 2004 to 100 per 100,000 population in 2011 (*P* value for trend < 0.001). Cannabis-polydrug had a higher number and rate of ED visits than cannabis-only each year. Among cannabis-involved ED visits, the presentation of alcohol has been stable over time (Table S1, Supplemental Digital Content 1, <http://links.lww.com/JAM/A46>) (Fig. 1).

### Demographic Trends in Cannabis-involved ED Visits

Between 2004 and 2011, the cannabis-only ED visit rate for adolescents increased from 79 to 159 per 100,000 aged 12 to 17 years (rate difference = 80; *P* value for trend = 0.004), and the cannabis-polydrug ED visit rate for young adults aged 21 to 24 years increased from 134 to 275 per 100,000 aged 21 to 24 years (rate difference = 141; *P* value for trend < 0.001). Both showed an increase among all age groups. Non-Hispanic blacks had the highest increase in the ED visit rate, an increase by 65 ED visits per 100,000 blacks for cannabis-only from 2004 to 2011 (*P* value for trend = 0.013) and 87 for cannabis-polydrug (*P* value for trend = 0.004), and the increases over doubled those of non-Hispanic whites (Table 1).

### Characteristics of Cannabis-involved ED Visits

Among age groups, 19.63% of cannabis-only-involved ED visits were adolescents aged 12 to 17 years, which were higher than other age groups. Compared with adolescent admissions, those aged 35 to 44 years were most likely to use cannabis and other drug(s) (adjusted OR [AOR] 3.02, 95%

**TABLE 1.** The Estimated Cannabis-involved ED Visit Rate\* By Demographic Characteristics and Type of Cannabis Involvement (2004–2011 DAWN)

	Cannabis-only Admissions					Cannabis-polydrug Admissions				
	2004	2011	Average Rate (2004–2011)	Rate Difference (2011 vs 2004)	P Value for Trend	2004	2011	Average Rate (2004–2011)	Rate Difference (2011 vs 2004)	P Value for Trend
ED visits	51	73	57	22	0.004	63	100	81	37	<0.001
Age, yrs										
12–17	79	159	111	80	0.004	75	81	75	6	0.109
18–20	164	226	190	63	0.009	130	218	205	87	0.007
21–24	123	172	135	49	0.009	134	275	196	141	<0.001
25–29	92	114	99	21	0.009	126	206	158	80	<0.001
30–34	75	95	68	20	0.111	107	160	130	53	0.011
35–44	43	55	44	12	0.079	77	111	94	35	<0.001
45–64	17	29	20	12	0.008	24	51	38	27	<0.001
65+	1	3	2	2	0.038	—	—	—	—	—
Sex										
Male	79	96	81	17	0.024	82	136	107	54	<0.001
Female	25	51	34	26	<0.001	45	66	57	21	<0.001
Race/ethnicity										
White, non-Hispanic	30	51	41	22	0.001	51	93	72	43	<0.001
Black, non-Hispanic	120	185	132	65	0.013	114	200	161	87	0.004
Hispanic or Latino	80	67	53	-13	0.786	43	57	50	13	0.019
Other races	15	23	12	8	0.133	—	16	11	—	—

Results are weighted estimates.

A dash (—) indicated an estimated with a relative standard error (RSE) greater than 50% or an estimated based on fewer than 30 visits.

\*The rate was the number of ED visits per 100,000 subgroup population, and it was calculated by a weighted estimate of the ED visit number divided by the number of the population in the corresponding group.

CI 2.39–3.81). Black admissions were less likely to involve cannabis-polydrug than white admissions (AOR 0.66, 95% CI 0.59–0.74). Over 26% of ED visits involving cannabis-polydrug and 19% of ED visits involving cannabis-only were admitted to inpatient care (Table 2).

### Patterns of Polydrug Use By Demographics

There were 1,662,765 ED visits involving cannabis and at least 1 other drug. Cocaine (44.1%), opiates/opioids (26.9%), and sedatives/benzodiazepines (29.1%) were the drug classes commonly identified among cannabis-polydrug admissions. Among cannabis-polydrug ED admissions, 67% of blacks and 55% of Hispanics used cocaine together with cannabis, whereas opiates/opioids (36.8%) and sedatives/benzodiazepines (38.3%) were the most common drugs among whites (Table 3).

### Factors Associated with Hospitalization Relative to ED Visits Only

In model 1, use of cannabis and other drug(s) (vs cannabis-only) increased the likelihood of hospitalization relative to ED visit only (AOR 1.31, 95% CI 1.15–1.50). In all models, young adult admissions (21–24 years) had higher odds of cannabis-involved hospitalization than adolescent admissions (12–17 years), and the odds increased with age strata (Table 4).

## DISCUSSION

This study used a national sample of drug-involved ED visits to inform the trends in cannabis-involved ED visits. Our results reveal an increased trend in ED utilization involving cannabis use from 2004 to 2011, and suggest cannabis use might potentially add burden to the healthcare system. We

found that, between 2004 and 2011, adolescents aged 12 to 17 years and non-Hispanic blacks showed the fastest increase in the cannabis-only-involved ED visit rate, and that young adults aged 21 to 24 years and non-Hispanic blacks had the highest increase in cannabis-polydrug-involved ED visit rate. The drug classes commonly identified among cannabis-polydrug ED visits were cocaine, opiates/opioids, and sedatives/benzodiazepines. Relative to ED visits only, the odds of hospitalization increased with older age strata compared with adolescent admissions, suggesting a heavier burden in cannabis-involved ED visits and hospitalization among older cannabis users.

Our study extends epidemiological data on cannabis use trends and cannabis-related health conditions. The possible effects of cannabis use on health over time not only depend on the prevalence of cannabis use, but also on the cannabis potency and dose, administration mode, and individual experiences with cannabis and other drugs (Hall, 2015). It is worrisome that cannabis potency in samples of seized cannabis had steadily increased from 5.3% in 2000 to 12.2% in 2014 (ONDCP, 2015), and that use of high-potency cannabis may enhance addiction or treatment demand (Freeman and Winstock, 2015). Our results of the increase in cannabis-involved ED visits are in line with other reports. In the Treatment Episode Data Set, the proportion of cannabis-involved admissions to addiction-related treatment facilities among persons aged ≥12 years increased from 15.8% in 2004 to 18.3% in 2011 (SAMHSA, 2015b). Colorado legalized medical cannabis in 2000 and recreational cannabis in 2014. A recent study of state-wide ED visit data (2011–2014) on International Classification of Diseases codes found an increasing trend in ED visits that were potentially related to CUD in Colorado (Kim et al., 2016). Given the continued

**TABLE 2.** Characteristics of Cannabis-involved ED Visits By Type of Cannabis Involvement (2004–2011 DAWN)

Characteristics	Cannabis-only Admission (n = 1,160,556)*	Cannabis-polydrug Admissions (n = 1,662,765)*	AOR of Cannabis-polydrug Versus Cannabis-only Admissions AOR (95% CI) <sup>†</sup>
	Column %	Column %	
Age, yrs			
12–17	19.63	9.22	Ref.
18–20	17.26	13.02	1.56 (1.33–1.83)
21–24	15.82	16.05	2.12 (1.75–2.58)
25–29	13.96	15.69	2.26 (1.85–2.76)
30–34	9.29	12.40	2.76 (2.25–3.38)
35–44	12.93	19.01	3.02 (2.39–3.81)
45–64	10.56	14.36	2.89 (2.48–3.36)
65+	0.55	0.25	0.99 (0.60–1.65)
Sex			
Male	69.51	64.04	Ref.
Female	30.49	35.96	1.23 (1.11–1.36)
Race/ethnicity			
White, non-Hispanic	53.22	64.01	Ref.
Black, non-Hispanic	30.55	25.60	0.66 (0.59–0.74)
Hispanic or Latino	14.61	9.39	0.65 (0.55–0.77)
Other races	1.63	0.99	0.56 (0.44–0.71)
Case type			
Seeking detox	3.28	12.52	Ref.
Suicide attempt	1.16	6.14	1.41 (1.08–1.83)
Problem drug use	0.41	0.46	0.34 (0.21–0.56)
Other cases	95.16	80.88	0.26 (0.21–0.31)
Disposition			
Treated and released	68.12	56.05	Ref.
Admitted to same hospital	19.02	26.22	1.32 (1.15–1.51)
Other dispositions	12.86	17.74	1.41 (1.24–1.60)
Alcohol			
Alcohol involvement	36.76	34.18	Ref.
Non-alcohol	63.24	65.82	0.80 (0.71–0.89)

Boldface: the estimate in a group differed from the estimate in the reference group ( $P < 0.05$ ).

\*Results are weighted estimates.

†Logistic regressions were adjusted for complex survey design and the admission year.

Ref. indicates reference group.

wave of cannabis legalization and reports of increased availability of higher-potency cannabis, our findings reinforce the need for research to identify subgroups at risk for CUD and related healthcare utilization.

### Increase in ED Use Among Adolescents

We found that the cannabis-only-involved ED visit rate in adolescents aged 12 to 17 years grew faster than that of other age groups between 2004 and 2011. This finding implies that the prevalence of problem cannabis use among adolescents may have risen. On the other hand, because the DAWN data represent treatment admissions, the admission rate may also be influenced by a subset of severe adolescents who had frequent cannabis-involved admissions. National surveys found that the overall prevalence of any current cannabis use among adolescents remained stable between 2004 and 2011 (Johnson et al., 2015; SAMHSA, 2015a). However, it is imperative to conduct in-depth analysis of problem cannabis use to better inform targeted intervention for adolescents who need timely help, as a crude indicator of any cannabis use may overlook high-risk groups of cannabis users. For example, the prevalence of past-year CUD was lower among adolescents aged 12 to 17 years (3.4%) than young adults aged 18 to 25 years (5.7%), but adjusted analysis controlling for

demographics and other substance use found that young adults were about 20% less likely than adolescents to have a CUD (Wu et al., 2014). Among adolescent past-year cannabis users, as many as 25.6% met criteria for a CUD compared with 19.4% of adult past-year cannabis users aged 18 to 25 years (Wu et al., 2014). Adolescents are vulnerable to cannabis exposure. Short-term consequences of cannabis use may include impaired short-term memory, decreased concentration or problem solving, and altered judgment, which could interfere with learning or increase unprotected sexual behaviors and medical conditions (Dougherty et al., 2013; Volkow et al., 2014). Adolescent-onset and long-term cannabis use increase the risk for altered brain development, declined IQ, and psychiatric disorder (Meier et al., 2012; Volkow et al., 2014; Lubman et al., 2015).

### Increase in ED Use Among Blacks

We found that non-Hispanic blacks had the highest increase in the cannabis-involved ED visit rate across racial/ethnic groups from 2004 to 2011. This finding and other reports suggest the need to monitor cannabis-related health events and develop intervention for black cannabis users. Hasin et al. (2015) found that past-year cannabis use (4.7% vs 12.7%) and CUD (1.8% vs 4.6%) among black adults increased between 2001 to 2002 and 2012 to 2013. Blow et al. (2011) used latent class analyses to study drug-related ED admissions and found that blacks were most likely to be in the primary cannabis use group. In a sample of adults with alcohol/drug use disorders, Pacek et al. (2012) found that a greater proportion of blacks (22%) had a CUD than whites (11%) or Hispanics (10%). Several factors may be related to the elevated rate of cannabis-involved ED admissions among blacks. First, perceived regular cannabis use as great risk among blacks has significantly declined by 10% between 2004 and 2012, which may be related to cannabis legalization (Pacek et al., 2015). Second, blunt use was found to be comparatively prevalent among blacks that may be related to the elevated prevalence of cannabis use problems (Golub et al., 2006; Timberlake, 2013). For example, Montgomery (2015) found that blunt use among blacks was related to a pattern of an earlier age of onset of cigarette, and cigar and cannabis use than no use of blunt (tobacco use only). Recent studies showed that blunt use was associated with increased odds of CUD among blacks (Fairman, 2015; Cohn et al., 2016). Lastly, blacks have faced more barriers to mental health care than whites, and a delay to access timely health care may be related to excess use of ED care (Cook et al., 2010). The DAWN data are based on encounters. Future research is needed to clarify further the severity of cannabis use and healthcare use patterns, including moderating effects (eg, access to addiction care) for blacks and young adults.

### Increase in ED and Hospitalization Use Among Cannabis-polydrug Users

This study also identified important finding regarding elevated odds of cannabis-involved ED admission plus subsequent hospitalizations among adult cannabis-polydrug users aged  $\geq 30$  years. This finding is consistent with epidemiologic

**TABLE 3.** Patterns of Other Substance Use Among Cannabis-polydrug ED Visits (2004–2011 DAWN)

Cannabis-involved Admissions	Other Substances Identified							Sedatives/ Benzodiazepines <sup>§</sup>
	n	Cocaine Row % <sup>¶</sup>	Heroin Row % <sup>¶</sup>	Stimulants <sup>†</sup> Row % <sup>¶</sup>	Hallucinogens <sup>‡</sup> Row % <sup>¶</sup>	Inhalants Row % <sup>¶</sup>	Opiates/Opioids <sup>‡</sup> Row % <sup>¶</sup>	
ED visits	1,662,765	44.1	7.9	15.4	9.9	0.5	26.9	29.1
Age, yrs								
12–17	153,313	22.4	3.6	14.6	14.7	1.7	21.4	27.2
18–20	216,432	28.8	7.9	14.1	16.7	1.0	28.2	28.6
21–24	266,909	34.6	10.2	15.8	12.1	0.4	32.1	31.9
25–29	260,922	41.3	9.1	15.8	10.8	0.3	30.6	32.1
30–34	206,232	47.7	7.6	16.3	10.1	0.2	28.8	32.9
35–44	316,012	61.4	8.6	12.0	5.5	0.2	23.4	26.4
45–64	238,742	59.8	6.6	9.3	2.9	0.2	22.9	24.7
65+	4203	47.1	2.7	4.5	—	—	20.5	23.2
Sex								
Male	1,064,700	45.3	8.7	12.9	10.7	0.6	26.1	26.8
Female	597,730	42.2	6.6	15.5	8.5	0.3	28.4	33.2
Race/ethnicity								
White, non-Hispanic	982,772	33.2	8.6	15.8	6.9	0.5	36.8	38.3
Black, non-Hispanic	393,061	67.2	5.4	4.0	16.8	0.4	12.7	14.1
Hispanic or Latino	144,201	54.8	9.4	19.4	10.1	0.8	9.6	15.0
Other races	15,210	42.2	6.1	24.5	13.2	0.3	12.0	18.2

A dash (—) indicated an estimated with a relative standard error (RSE) greater than 50% or an estimated based on fewer than 30 visits.

Results are weighted estimates.

<sup>†</sup>Stimulants: methamphetamine and amphetamine.

<sup>‡</sup>Hallucinogens: MDMA (Ecstasy), phencyclidine (PCP), d-lysergic acid diethylamide (LSD), miscellaneous hallucinogens.

<sup>‡</sup>Opiates/opioids: narcotic pain relievers (buprenorphine, codeine, fentanyl, hydrocodone, hydromorphone, morphine, oxycodone, proxyphene products and methadone, and unspecified opiates/opioids).

<sup>§</sup>Sedatives/benzodiazepines: barbiturates, benzodiazepines (alprazolam, clonazepam, diazepam, lorazepam), diphenhydramine, hydroxyzine and zolpidem.

<sup>¶</sup>Row % was calculated by the number of other specific substance combined with cannabis divided number of any other substance identified for each demographic groups.

**TABLE 4.** Adjusted Logistic Regression Analysis of Factors Associated With Hospitalizations (Relative to Treated and Released From ED), Stratified By Type of Cannabis Involvement (2004–2011 DAWN)

	Model 1: Any Cannabis-involved Admissions	Model 2: Cannabis-only Admissions	Model 3: Cannabis-polydrug Admissions
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Categories of cannabis use (vs cannabis-only)			
Cannabis-polydrug	<b>1.31 (1.15–1.50)</b>		
Age, yrs (vs 12–17)			
18–20	<b>1.65 (1.34–2.04)</b>	<b>1.80 (1.40–2.32)</b>	1.44 (1.00–2.08)
21–24	<b>1.86 (1.54–2.24)</b>	<b>2.11 (1.62–2.75)</b>	<b>1.57 (1.09–2.27)</b>
25–29	<b>2.36 (1.83–3.06)</b>	<b>2.64 (1.99–3.49)</b>	<b>2.04 (1.37–3.03)</b>
30–34	<b>2.94 (2.25–3.84)</b>	<b>3.46 (2.55–4.68)</b>	<b>2.45 (1.63–3.67)</b>
35–44	<b>3.19 (2.48–4.10)</b>	<b>3.35 (2.47–4.54)</b>	<b>2.84 (1.96–4.12)</b>
45–64	<b>3.80 (3.01–4.80)</b>	<b>3.94 (2.92–5.30)</b>	<b>3.44 (2.47–4.79)</b>
65+	<b>7.73 (4.59–13.01)</b>	<b>7.77 (4.10–14.73)</b>	<b>7.95 (3.11–20.30)</b>
Sex (vs male)			
Female	1.01 (0.91–1.12)	0.86 (0.73–1.02)	1.10 (0.96–1.26)
Race/ethnicity (vs white, non-Hispanic)			
Black, non-Hispanic	0.95 (0.81–1.11)	1.01 (0.81–1.27)	0.91 (0.77–1.07)
Hispanic or Latino	1.07 (0.78–1.46)	1.24 (0.93–1.67)	0.93 (0.68–1.25)
Other races	1.29 (0.86–1.94)	1.35 (0.93–1.97)	1.29 (0.65–2.54)
Alcohol use (vs non-alcohol)			
Alcohol	0.94 (0.85–1.04)	0.98 (0.81–1.19)	0.91 (0.79–1.04)
Case type (vs seeking detox)			
Suicide attempt	<b>2.54 (1.72–3.76)</b>	1.78 (0.88–3.62)	<b>2.64 (1.76–3.96)</b>
Problem drug use	<b>0.11 (0.05–0.23)</b>	<b>0.02 (0.01–0.05)</b>	<b>0.16 (0.07–0.36)</b>
Others	<b>0.53 (0.42–0.68)</b>	<b>0.52 (0.35–0.78)</b>	<b>0.53 (0.41–0.69)</b>

Bold faced: *P* < 0.05.

Logistic regressions were adjusted for complex survey design and the admission year.

data, showing that active older drug users tend to have to a pervasive pattern of medical comorbidities and an elevated rate of treatment admissions, especially among persons aged 50 to 64 years (Wu and Blazer, 2011). The long-term effect of cannabis use among middle-aged or older adults may be related to manifestations of multiple health conditions, such as addiction, memory impairment, or cardiovascular disease that require more treatment (Thomas et al., 2014; Hall, 2015; Auer et al., 2016).

## Implications

Infrequent screening of problem drug use and under-treatment of drug use disorders at general healthcare settings may contribute to ED admissions (Rockett et al., 2003; Tai et al., 2012). Cannabis-related health risks may be overlooked by adolescents and their parents, or healthcare providers (Chung et al., 2003). During ED visits, toxicology questions or testing as a screening method may improve the identification of problem cannabis use, in particular, for adolescents (Bernstein et al., 2009). These data also show the importance of taking into account racial/ethnic variations (cannabis and cocaine use among blacks; cannabis and sedative/opiate use among whites) in the screening, assessment, and intervention for cannabis-related drug use problems and other healthcare needs. Cannabis-related intervention research should be expanded to target adolescents and blacks (Woolard et al., 2013; Pitts and Shrier, 2014). There is a need for research to develop risk-stratified screening and targeted interventions for high-risk groups (eg, adolescents, blacks, middle-aged active drug users), especially at ED settings where drug-involved events may be more common than other settings.

## Limitation

The results should be interpreted within the following limitations. First, although cannabis-involved ED visit reflected recent or active cannabis use and it was considered either a direct cause or a contributor to the visits (CBHSQ, 2013), the causality between cannabis use and ED visits cannot be determined. Regarding the reason for ED admission, most of the reasons were coded as unknown, which constrain our analysis for this variable. Second, the DAWN data do not include the information about the frequency and dose of cannabis use. Third, about 8% of ED visits did not document the race/ethnicity in DAWN between 2004 and 2011 (SAMHSA, 2015a), and the missing data may result in the underestimates. Finally, when polydrug use was reported by DAWN, the principle cause of the ED visits cannot be definitely determined.

## CONCLUSIONS

This study provides the national-level findings specifically for cannabis-involved healthcare utilization. By using the only national-level drug-related ED admission dataset available, we were able to examine the national trends in the ED visits for cannabis-only and cannabis-polydrug. These findings indicated a notable increase in cannabis-involved utilization of ED during the studied period. There is a continuous need to monitor cannabis-related healthcare utilization, especially among young people and blacks,

and also states permitting recreational cannabis use. Research is needed to identify and develop feasible screening and intervention approaches in general medical settings to prevent or reduce problem cannabis use and related health concerns.

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