Trends in Cannabis-Related Hospitalizations in Arizona From 2016 to 2021 and Associations With Mental Health-Related Hospitalizations

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ABSTRACT. Objective: The purpose of this study was to examine trends in cannabis-related hospital visits in Arizona from 2016 to 2021 and associations with hospital visits for a mental health condition. **Method:** Data were emergency department and inpatient hospital discharge records from all Arizona licensed hospitals from 2016 to 2021. Records comprised 18,758,614 hospital visits. Cannabis-related visits were defined by International Classification of Diseases (ICD) diagnostic codes for cannabis use (unspecified use, abuse, dependence) or poisoning. Mental health visits were defined by ICD diagnostic codes for mental health conditions. **Results:** The rate of cannabis-related hospital visits increased from 1,301.50 per 100,000 visits in 2016 to 1,565.54 per 100,000 visits in 2021, a 20% increase. The increase was larger for visits by adolescents and older adults ages 65+: 63.94% and 84.45%, respectively. Cannabis-related visits were 7.75 (95% CI [7.69, 7.81]) times as likely as visits unrelated to cannabis to have a mental health condition as the primary diagnosis from 2016 to 2021 and were 2.32 (95% CI [2.30, 2.34]) times as likely after adjustment for covariates, including alcohol and other substance-related diagnoses. The association between cannabis-related visits and mental health–related visits increased each year, particularly for older adults ages 65+. **Conclusions:** The rate of cannabis-related hospital visits is increasing, as is the cannabis-related risk of a hospital visit for a mental health condition. The increases are especially pronounced among hospital visits by older adults (ages 65+), highlighting the need for prevention and intervention in this underrecognized at-risk group. (*J. Stud. Alcohol Drugs, 86,* 000–000, 2025)

THE SOCIAL ACCEPTABILITY, availability, and use of cannabis are increasing in North America (Bahji et al., 2022; Hammond et al., 2021; Hasin & Walsh, 2021), where many U.S. states and Canada have legalized cannabis for medical use, nonmedical adult use, or both. Findings from the U.S. National Survey on Drug Use and Health show that the rate of daily or near-daily cannabis use increased 20 fold from 1992 to 2022, from 0.9 million to 17.7 million users (Caulkins, 2024). Globally, cannabis use disorder (CUD) and associated excess years lived with disability also generally increased (Shao et al., 2024). A key question is whether the health care burden of cannabis use has increased.

One approach to evaluating the cannabis-related health care burden involves monitoring trends in cannabis-related emergency department (ED) visits and inpatient hospitalizations. Not only are hospital visits costly, but they can also constitute a serious adverse outcome (Crocker et al., 2021). A number of studies have reported an increase in hospital visits for CUD and cannabis poisoning (Callaghan et al., 2023; Hall et al., 2018; Han et al., 2023; Kim et al., 2019; Roehler et al., 2022; Shen et al., 2019; Tolan et al., 2022; Wang et al., 2017, 2018; Zhu & Wu, 2017). This increase could occur as a consequence of increases in provider surveillance, increases in patient reporting associated with greater social acceptability of cannabis use (Chiu et al., 2022), and increases in cannabis use and cannabis potency (ElSohly et al., 2021; Hasin & Walsh, 2021). Importantly, however, increased provider surveillance and patient reporting alone are unlikely to fully account for the observed increase in cannabis-related hospital visits because the percentage of urine screens in the ED that are positive for cannabis has also increased (Fink et al., 2023).

CUD and poisoning represent only a portion of the cannabis-related health care burden. Frequent cannabis use is associated with an increased risk of mental health problems, including psychosis, depression, and suicide (Gobbi et al., 2019; Lev-Ran et al., 2014; Robinson et al., 2023). Several studies have documented an association between cannabis-related hospital visits and mental health–related hospital visits (Hall et al., 2018; Kim et al., 2019; Salas-Wright et al., 2019; Shen et al., 2019; Wang et al., 2017; Zhu & Wu, 2017). For example, two studies from Colorado reported that the prevalence of mental health conditions was five times higher among cannabis-related hospital visits than among cannabis-unrelated hospital visits (Hall et al., 2018; Wang et al., 2017). Likewise, a study using a U.S. nationwide inpatient sample reported that the prevalence of mental health conditions was nearly six times higher among cannabis-re-

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lated hospital visits than among cannabis-unrelated hospital visits (Zhu & Wu, 2017). Further, a recent Danish registry study found that CUD-related risk of incident schizophrenia increased over time from 1972 to 2021, particularly for young-adult males (Hjorthøj et al., 2023). The authors speculated that this may have occurred as a consequence of increases in the prevalence of CUD and increases in cannabis potency (Hjorthøj et al., 2023). However, few studies have leveraged health records to examine trends in cannabis–mental health associations over time and how they vary by sex and age—two of the most striking user characteristics associated with vulnerability to cannabis-related problems (Cooper & Craft, 2018; Meier et al., 2024).

To fill this gap, we used hospital discharge data from the state of Arizona to examine trends in cannabis-related hospital visits and associations with hospital visits for a mental health condition from 2016 to 2021. Arizona legalized medical cannabis use in 2012 and legalized nonmedical adult-use cannabis in late 2020, with adult-use sales beginning in 2021. Therefore, the data largely represent hospital visits during a time when medical cannabis use was legal but nonmedical adult use was not. We first investigated time trends in cannabis-related hospital visits and, separately, mental health–related hospital visits because understanding these trends aids in interpretation of trends in cannabis–mental health associations. We next investigated time trends in associations between cannabis-related hospital visits and mental health–related hospital visits to determine whether associations had increased over time. We also tested whether there were age and sex differences in these trends because it is useful to know, for prevention and intervention, if particular demographic subgroups have shown larger increases than others.

Method

Data

The institutional review boards of the Arizona Department of Health Services and Arizona State University approved this study. We used ED and inpatient hospital discharge records from 2016 to 2021 from all Arizona licensed hospitals. Federal, military, and Department of Veterans Affairs hospitals, as well as hospitals located on tribal lands, are excluded. ED visits that resulted in inpatient admission were coded as inpatient visits and not as ED visits except in a small percentage of visits where the billing was split (0.15% of visits). The records include patient demographics and International Classification of Diseases (ICD) diagnostic codes. The unit of analysis is visits and not patients, as the data lack unique patient identifiers, and some patients could be represented multiple times in the data. Arizona residents and nonresidents were included in analyses.

There were 18,769,352 ED and inpatient hospital admissions from 2016 to 2021. A small number of visits were excluded because they lacked a primary diagnosis (n = 129) or because there was an invalid primary diagnosis code (n = 25). A further 10,584 visits were excluded because the primary diagnosis was a cannabis-related diagnosis, and the primary diagnostic field was used to determine the outcome (i.e., mental health–related visits). This left a total of 18,758,614 visits. Patient characteristics for visits are shown in Table 1.

Measures

Cannabis-related visits. Cannabis-related visits were defined by *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM; National Center for Health Statistics and Centers for Medicare and Medicaid Services, 2015) diagnostic codes for cannabis use (F12: unspecified use, abuse, dependence) or poisoning (T40.7) in any of 25 diagnostic fields, except the first diagnostic field, because the first diagnostic field was used to determine the outcome variable—a primary diagnosis of a mental health condition (Hall et al., 2018; Wang et al., 2017; Zhu & Wu, 2017). Table S1 lists the ICD-10-CM cannabis-related diagnostic codes used to define the exposure—a dichotomous variable indicating the presence or absence of a cannabis diagnosis. (Supplemental material appears as an online-only addendum to this article on the journal's website.)

Mental health–related visits. Mental health–related visits were defined by mental health–related ICD-10-CM diagnostic codes in the first (primary) diagnostic field. The first diagnostic field indicates the diagnosis established to be chiefly responsible for the visit. To classify mental health conditions, we used the Healthcare Cost and Utilization Project (HCUP) Clinical Classifications Software Refined (CCSR) for ICD-10-CM Diagnoses, v2023.1. The software groups ICD codes for "Mental, Behavioral, and Neurodevelopmental Disorders" into 32 categories, 14 of which were considered here: schizophrenia spectrum and other psychotic disorders; depressive disorders; bipolar and related disorders; other specified and unspecified mood disorders; anxiety and fear-related disorders; obsessive-compulsive and related disorders; trauma- and stressor-related disorders; disruptive, impulse-control, and conduct disorders; personality disorders; feeding and eating disorders; somatic disorders; suicidal ideation/attempt/intentional self-harm; miscellaneous mental and behavioral disorders; and neurodevelopmental disorders. (The remaining HCUP mental disorder categories were mostly substance-use-related conditions, which we considered as covariates.) Analyses report on risk of specific mental health categories as well as risk of any of the 14 HCUP mental health categories, each coded as a dichotomous variable.

Covariates. We considered the following covariates, selected because of their established associations with can-

Table 1. Patient demographic characteristics for inpatient hospital and emergency department visits in Arizona from 2016 to 2021

Variable	2016	2017	2018	2019	2020	2021
Overall, *n*	3,240,036	3,288,467	3,202,562	3,271,416	2,730,213	3,025,920
Sex, *n* (%)						
Female	1,812,522 (55.94)	1,830,090 (55.66)	1,775,467 (55.44)	1,804,190 (55.15)	1,473,962 (53.99)	1,641,234 (54.24)
Male	1,427,389 (44.06)	1,458,173 (44.34)	1,426,925 (44.56)	1,467,075 (44.85)	1,256,070 (46.01)	1,384,403 (45.76)
Age group, *n* (%)						
<10 years	14.02 (454,128)	13.56 (445,963)	13.18 (421,923)	13.29 (434,749)	10.36 (282,855)	11.13 (336,801)
10–17 years	5.88 (190,396)	5.92 (194,808)	5.82 (186,249)	5.90 (193,009)	4.99 (136,299)	5.37 (162,539)
18–20 years	3.87 (125,341)	3.77 (123,917)	3.69 (118,307)	3.64 (119,107)	3.66 (99,910)	3.61 (109,096)
21–24 years	5.90 (191,239)	5.68 (186,843)	5.48 (175,577)	5.28 (172,855)	5.48 (149,576)	5.37 (162,532)
25–34 years	14.89 (482,312)	14.69 (483,154)	14.44 (462,417)	14.26 (466,641)	14.97 (408,578)	14.62 (442,221)
35–44 years	11.77 (381,373)	11.69 (384,551)	11.64 (372,760)	11.52 (376,882)	12.32 (336,357)	12.28 (371,419)
45–54 years	11.47 (371,729)	11.28 (370,835)	11.06 (354,228)	10.82 (353,805)	11.45 (312,502)	11.20 (338,966)
55–64 years	10.90 (353,010)	11.12 (365,827)	11.45 (366,645)	11.50 (376,218)	12.27 (334,930)	12.06 (364,898)
≥65 years	21.31 (690,432)	22.27 (732,486)	23.24 (744,338)	23.78 (778,001)	24.51 (669,044)	24.36 (737,175)
Race/ethnicity, *n* (%)						
White	59.18 (1,898,067)	59.13 (1,921,168)	58.96 (1,864,347)	59.26 (1,914,658)	60.80 (1,637,930)	60.68 (1,808,852)
Hispanic	27.88 (894,089)	27.79 (903,032)	27.83 (880,104)	27.45 (886,750)	25.91 (697,843)	26.14 (779,180)
Black	7.05 (226,197)	7.21 (234,109)	7.38 (233,339)	7.59 (245,327)	7.37 (198,547)	7.55 (225,061)
Native American	4.20 (134,662)	4.14 (134,489)	3.98 (125,744)	3.86 (124,792)	4.12 (110,922)	3.79 (112,947)
Asian/Pacific Islander	1.58 (50,653)	1.61 (52,235)	1.72 (54,279)	1.70 (55,073)	1.67 (44,905)	1.70 (50,744)
Multiracial	0.10 (3,343)	0.12 (3,933)	0.13 (4,231)	0.13 (4,291)	0.13 (3,636)	0.14 (4,250)
Payer status, *n* (%)						
Medicaid	40.43 (1,309,791)	39.77 (1,307,790)	38.11 (1,220,374)	37.78 (1,235,854)	36.58 (998,757)	37.56 (1,136,365)
Private	24.74 (801,699)	24.48 (805,114)	24.37 (780,506)	24.53 (802,364)	26.30 (717,917)	27.05 (818,362)
Medicare	19.07 (617,915)	19.45 (639,591)	19.99 (640,212)	20.22 (661,485)	20.38 (556,371)	19.52 (590,549)
Other	9.80 (317,540)	10.10 (331,964)	10.84 (347,099)	10.94 (357,834)	10.72 (292,652)	10.64 (321,816)
Self-pay	5.96 (193,051)	6.20 (203,898)	6.69 (214,316)	6.54 (213,785)	6.02 (164,422)	5.24 (158,667)
Homeless, *n* (%)	0.31 (9,920)	0.38 (12,618)	0.47 (14,951)	0.52 (17,071)	0.78 (21,371)	0.71 (21,541)

nabis use and mental health: age, sex, race/ethnicity, payer status, and homelessness (Azofeifa et al., 2023; Roehler et al., 2022; Yang et al., 2019). We also considered alcohol and other (noncannabis) substance use and poisoning diagnoses as covariates because they could confound cannabis–mental health associations.

All covariates were dummy coded. Sex was coded *female* (0) or *male* (1). Age groups were: <10, 10–17, 18–20, 21–24, 25–34, 35–44 (reference), 45–54, 55–64, and 65+ years. Race and ethnicity, which were initially two separate variables, were combined as follows: Hispanic, non-Hispanic White (reference), Black, Asian/Pacific Islander, American Indian, and multiracial. Payer status was coded as self-pay, private (reference), Medicare, Medicaid, and other. Homelessness was coded *homeless* (1) or *otherwise* (0). Alcohol and other substance-related diagnoses (sedative, cocaine, other stimulants, hallucinogens, inhalants, other psychoactive substances) were coded as two dichotomous variables based on relevant substance use (unspecified use, abuse, and dependence) and poisoning ICD-10-CM diagnostic codes.

Statistical analyses

First, we pooled the data from 2016 to 2021 and obtained the prevalence of mental health conditions among cannabis-related visits and among cannabis-unrelated visits. Results are shown for a primary diagnosis of any mental health condition from 2016 to 2021 and for each of 14 specific mental health categories. Estimates of the association between cannabis-related visits and mental health–related visits are shown unadjusted for covariates (Model 1), adjusted for sociodemographic factors and admission year (Model 2), and adjusted for all aforementioned covariates plus alcohol and other substance-related diagnoses (Model 3). We used a sequential covariate adjustment approach because it is interesting to know the extent to which the cannabis association is attenuated by adjustment for other substance-related diagnoses as opposed to demographic factors.

Next, we examined time trends in the rate of cannabis-related hospital visits and, separately, mental health–related hospital visits, with time represented by a variable ranging from 1 (*admission year 2016*) to 6 (*admission year 2021*). To examine sex and age differences in these trends, we tested two-way interactions of time with sex and age. Results of statistical tests are shown unadjusted and then adjusted for sociodemographic factors.

Finally, to examine if the cannabis–mental health association had increased over time, we tested the two-way interaction between cannabis-related visits and time in predicting the risk of a visit for which the primary diagnosis was a mental health condition. Sex and age differences were examined by testing three-way interactions between cannabis, time, and either sex or age. Results of statistical tests are shown unadjusted and then adjusted for sociodemographic factors and alcohol and other substance-related diagnoses. Analyses used Poisson regression with a log link.

Results

Overall, 3.56% (n = 667,741) of visits from 2016 to 2021 had a primary diagnosis of a mental health condition, and 1.47% (n = 276,290) of visits had a cannabis-related diagnosis as a co-occurring (not primary) diagnosis. The prevalence of a primary diagnosis of a mental health condition was 25.09% among cannabis-related visits versus 3.24% among cannabis-unrelated visits (Table 2). Thus, cannabis-related visits had 7.75 times the risk of a primary diagnosis of a mental health condition compared with cannabis-unrelated visits (Table 2, Model 1). This association was attenuated after adjusting for sociodemographic factors and admission year (Table 2, Model 2: relative risk [RR] = 4.80, 95% CI [4.76, 4.84], $p < .001$) and was further attenuated, but still statistically significant, after additionally adjusting for alcohol and other substance-related diagnoses (Table 2, Model 3: RR = 2.32, 95% CI [2.30, 2.34], $p < .001$). In terms of cannabis-related risk for specific mental health conditions, risk was highest for bipolar disorders (fully adjusted RR = 4.05), personality disorders (fully adjusted RR = 3.63), other (nondepressive) mood disorders (fully adjusted RR = 3.60), and psychotic disorders (fully adjusted RR = 2.79; Table 2, Model 3).

The rate of cannabis-related visits and the rate of visits with a primary diagnosis of a mental health condition increased from 2016 to 2021 (Table 3). The rate of cannabis-related visits increased by 2.3%, on average, per year, from 1,301.50 per 100,000 visits in 2016 to 1,565.54 per 100,000 visits in 2021 (unadjusted RR = 1.023, 95% CI [1.021, 1.025], $p <$ .001; adjusted for sociodemographic factors RR = 1.019, 95% CI [1.017, 1.022], $p < .001$). The rate of visits with a primary diagnosis of a mental health condition increased by 4.0%, on average, per year, from 3,153.89 per 100,000 in 2016 to 3,782.65 per 100,000 in 2021 (unadjusted RR = 1.040, 95% CI [1.039, 1.041], $p < .001$; adjusted for sociodemographic factors RR = 1.040, 95% CI [1.038, 1.041], $p < .001$). Moreover, the association between cannabis-related visits and mental health–related visits increased over time, from a crude RR of 7.63 in 2016 to 8.12 in 2021 (Table 4) (cannabis-time interaction est. [unadjusted] = 0.024, 95% CI [0.020, 0.028], $p < .001$; cannabis-time interaction est. [adjusted for sociodemographic factors and alcohol and other substance-related diagnoses] = 0.025, 95% CI [0.020, 0.030], $p < .001$). Stated differently, the increase in the rate of visits with a primary diagnosis of a mental health condition from 2016 to 2021 was larger for visits with a cannabis-related diagnosis (6.0% per year; crude RR = 1.060, 95% CI [1.056, 1.065], $p < .001$) than for visits without a cannabis-related diagnosis (3.5% per year; crude RR = 1.035, 95% CI [1.034, 1.037], $p < .001$).

Sex differences

The rate of cannabis-related visits was larger for male visits than for female visits each calendar year, but this dif-

TABLE 2. The risk of a primary diagnosis of a mental health condition for cannabis-related versus cannabis-unrelated hospital visits from 2016 to 2021 in Arizona

Primary diagnosis	Cannabis unrelated (n = 18,482,324) % (n)	Cannabis related (n = 276,290) % (n)	Model 1: Unadjusted			Model 2: Adjusted for age, sex, race/ethnicity, homelessness, payer status, admission year			Model 3: +Adjustment for alcohol and other substances		
			RR	[95% CI]	p	RR	[95% CI]	p	RR	[95% CI]	p
Any mental health condition[a]	3.24 (598,416)	25.09 (69,325)	**7.75**	**[7.69, 7.81]**	**<.001**	**4.80**	**[4.76, 4.84]**	**<.001**	**2.32**	**[2.30, 2.34]**	**<.001**
Other mood	0.08 (13,956)	1.18 (3,266)	**15.65**	**[15.07, 16.26]**	**<.001**	**10.21**	**[9.82, 10.63]**	**<.001**	**3.60**	**[3.43, 3.77]**	**<.001**
Bipolar	0.38 (71,154)	5.92 (16,344)	**15.37**	**[15.11, 15.63]**	**<.001**	**9.58**	**[9.41, 9.75]**	**<.001**	**4.05**	**[3.97, 4.13]**	**<.001**
Personality	0.01 (2,664)	0.18 (494)	**12.40**	**[11.27, 13.65]**	**<.001**	**7.15**	**[6.47, 7.90]**	**<.001**	**3.63**	**[3.25, 4.05]**	**<.001**
Psychotic	0.49 (89,739)	5.55 (15,336)	**11.43**	**[11.24, 11.63]**	**<.001**	**5.67**	**[5.57, 5.77]**	**<.001**	**2.79**	**[2.74, 2.84]**	**<.001**
Depressive	0.83 (153,255)	7.77 (21,462)	**9.37**	**[9.24, 9.50]**	**<.001**	**6.01**	**[5.92, 6.10]**	**<.001**	**2.02**	**[1.99, 2.06]**	**<.001**
Trauma and stressor	0.12 (22,367)	0.67 (1,841)	**5.51**	**[5.25, 5.77]**	**<.001**	**3.92**	**[3.73, 4.11]**	**<.001**	**2.71**	**[2.57, 2.86]**	**<.001**
Self-harm and suicide	0.59 (108,165)	2.20 (6,082)	**3.76**	**[3.67, 3.86]**	**<.001**	**2.19**	**[2.13, 2.24]**	**<.001**	**1.14**	**[1.11, 1.17]**	**<.001**
Disruptive and conduct	0.03 (5,913)	0.11 (304)	**3.44**	**[3.06, 3.86]**	**<.001**	**2.93**	**[2.60, 3.30]**	**<.001**	**2.38**	**[2.09, 2.71]**	**<.001**
Obsessive compulsive	0.00 (574)	0.01 (29)	**3.38**	**[2.33, 4.91]**	**<.001**	**1.96**	**[1.34, 2.85]**	**<.001**	1.16	[0.79, 1.72]	.45
Eating and feeding	0.01 (970)	0.01 (36)	**2.48**	**[1.78, 3.46]**	**<.001**	**2.17**	**[1.55, 3.04]**	**<.001**	1.14	[0.79, 1.63]	.48
Anxiety and fear	0.64 (117,572)	1.39 (3,844)	**2.19**	**[2.12, 2.26]**	**<.001**	**1.55**	**[1.50, 1.60]**	**<.001**	**1.41**	**[1.37, 1.46]**	**<.001**
Miscellaneous	0.03 (4,670)	0.04 (119)	**1.70**	**[1.42, 2.04]**	**<.001**	1.10	[0.92, 1.32]	.31	0.87	[0.72, 1.05]	.15
Somatic	0.01 (2,538)	0.02 (60)	**1.58**	**[1.22, 2.04]**	**<.001**	1.22	[0.94, 1.58]	.13	1.14	[0.88, 1.49]	.32
Neurodevelopmental	0.03 (4,879)	0.04 (108)	**1.48**	**[1.22, 1.79]**	**<.001**	1.10	[0.91, 1.33]	.34	1.16	[0.95, 1.42]	.15

Notes: RR = Relative risk; CI = confidence interval. **Bold** indicates statistically significant at $p < .05$. [a]Any mental health condition = a primary diagnosis of any of the mental health conditions listed below. N for unadjusted models = 18,758,614; n for adjusted models = 18,521,585 due to missing covariate data.

TABLE 3. Trends in rates of cannabis-related hospital visits and rates of hospital visits with a primary diagnosis of a mental health condition in Arizona from 2016 to 2021

Variable	Rate per 100,000 hospital visits[a]						Average annual change in rate[b]		Change from 2016 to 2021	
	2016 (*n* = 3,240,036)	2017 (*n* = 3,288,467)	2018 (*n* = 3,202,562)	2019 (*n* = 3,271,416)	2020 (*n* = 2,730,213)	2021 (*n* = 3,025,920)	RR	[95% CI]	Absolute % change	Relative change
Cannabis visits										
Overall	1,301.50	1,525.88	1,556.88	1,355.90	1,551.31	1,565.54	1.023	[1.021, 1.025]	264.04	20.29
Sex										
Male	1,864.03	2,129.03	2,135.78	1,827.38	2,016.61	1,974.28	0.998	[0.996, 1.001]	110.25	5.91
Female	858.58	1,045.41	1,091.54	972.46	1,154.91	1,220.91	1.056	[1.052, 1.060]	362.33	42.20
Age group										
<10 years	1.32	1.35	2.61	2.76	4.24	6.83	1.417	[1.224, 1.641]	5.51	417.42
10–17 years	1,474.82	1,599.01	1,888.33	1,847.06	2,669.13	2,417.88	1.119	[1.110, 1.128]	943.06	63.94
18–20 years	2,972.69	3,529.78	3,510.36	2,996.47	3,554.20	3,386.01	1.014	[1.006, 1.022]	413.32	13.90
21–24 years	2,788.13	3,297.96	3,347.25	2,991.53	3,303.34	3,399.95	1.025	[1.019, 1.032]	611.82	21.94
25–34 years	2,356.77	2,931.78	2,921.61	2,472.57	2,731.91	2,747.72	1.010	[1.006, 1.014]	390.95	16.59
35–44 years	1,919.13	2,255.36	2,334.48	2,049.45	2,197.67	2,282.87	1.018	[1.013, 1.024]	363.74	18.95
45–54 years	1,555.97	1,770.87	1,781.34	1,577.14	1,595.83	1,645.59	0.996	[0.990, 1.002]	89.62	5.76
55–64 years	1,188.07	1,337.79	1,398.36	1,205.68	1,255.79	1,309.96	1.004	[0.997, 1.011]	121.89	10.26
≥65 years	235.94	302.94	356.16	341.90	367.69	435.18	1.104	[1.094, 1.115]	199.24	84.45
Mental health visits										
Overall	3,153.89	3,371.24	3,583.82	3,579.61	3,968.70	3,782.65	1.040	[1.039, 1.041]	628.76	19.94
Sex										
Men	3,357.77	3,631.33	3,947.16	3,981.87	4,410.26	4,109.71	1.046	[1.044, 1.048]	751.94	22.39
Women	2,993.62	3,164.33	3,291.92	3,252.15	3,592.09	3,506.51	1.033	[1.031, 1.035]	512.89	17.13
Age group										
<10 years	218.88	263.03	315.22	302.47	325.96	280.28	1.054	[1.039, 1.069]	61.40	28.05
10–17 years	7,454.46	8,342.57	9,896.97	9,587.64	12,799.80	12,704.46	1.117	[1.113, 1.121]	5,250.00	70.43
18–20 years	5,133.99	5,802.27	6,102.77	6,166.72	6,794.12	6,778.43	1.054	[1.048, 1.060]	1,644.44	32.03
21–24 years	4,562.88	5,005.81	5,398.20	5,610.48	6,198.19	5,808.70	1.055	[1.050, 1.060]	1,245.82	27.30
25–34 years	4,507.04	4,967.15	5,275.76	5,440.80	6,010.36	5,642.88	1.050	[1.046, 1.053]	1,135.84	25.20
35–44 years	4,502.15	4,749.96	5,019.05	5,256.82	5,493.27	5,226.17	1.035	[1.031, 1.039]	724.02	16.08
45–54 years	4,111.87	4,236.12	4,323.20	4,429.28	4,410.21	4,080.65	1.003	[0.999, 1.007]	-31.22	-0.76
55–64 years	2,940.99	3,007.71	3,199.55	3,045.84	2,996.15	2,769.27	0.989	[0.985, 0.994]	-171.72	-5.84
≥65 years	1,051.23	1,080.16	1,096.28	1,016.32	1,056.88	1,046.02	0.995	[0.989, 1.000]	-5.21	-0.50

Notes: RR = relative risk; CI = confidence interval. [a]*N*s for each calendar year represent the total number of hospital visits that year; rates of cannabis and mental health visits represent the number of visits per 100,000 visits. [b]Estimates are unadjusted for covariates. The percentage increase = (RR − 1) × 100. The percentage decrease = (1 − RR) × 100.

ference narrowed over time (sex-time interaction est. [unadjusted] = -0.054, 95% CI [-0.061, -0.052], $p < .001$; sex-time interaction est. [adjusted for sociodemographic factors] = -0.064, 95% CI [-0.069, -0.060], $p < .001$) (Table 3). For example, in unadjusted analyses, male visits were 2.17 times as likely as female visits to be cannabis-related visits in 2016 and were 1.62 times as likely in 2021. The rate of cannabis-related visits increased by 5.6% per year, on average, for female visits (crude RR = 1.056, 95% CI [1.052, 1.060], $p < .001$) but was stable over time for male visits (crude RR = 0.998, 95% CI [0.996, 1.001], $p = .24$).

The rate of visits with a primary diagnosis of a mental health condition was larger for male visits than for female visits each calendar year, and this sex difference widened slightly over time (sex-time interaction est. [unadjusted] = 0.012, 95% CI [0.009, 0.015], $p < .001$; sex-time interaction est. [adjusted for sociodemographic factors] = 0.007, 95% CI [0.004, 0.010], $p < .001$; Table 3). For example, in unadjusted analyses, male visits were 1.12 times as likely as female visits to have a primary diagnosis of a mental health condition in 2016 and were 1.17 times as likely in 2021. The rate of visits with a primary diagnosis of a mental health condition increased by 3.3% per year, on average, for female visits (crude RR = 1.033, 95% CI [1.031, 1.035], $p < .001$) and 4.6% per year, on average, for male visits (crude RR = 1.046, 95% CI [1.044, 1.048], $p < .001$).

The cannabis-related risk of a primary diagnosis of a mental health condition was larger for female visits than for male visits, and this sex difference was stable over time (i.e., there was no three-way interaction between cannabis, time, and sex: unadjusted est. = 0.004, 95% CI [-0.006, 0.013], $p = .41$; Table 4). From 2016 to 2021, the crude cannabis-related risk of a primary diagnosis of a mental health condition was 8.50 for female visits and 7.08 for male visits (cannabis-sex interaction est. [unadjusted] = -0.183, 95% CI [-0.199, -0.167], $p < .001$; cannabis-sex interaction est. [adjusted for sociodemographic factors and alcohol and other substance-related diagnoses] = -0.270, 95% CI [-0.287, -0.254], $p < .001$).

Age differences

Relative to other age groups, the young-adult age group (ages 18–24 years) showed the highest rate of cannabis-

TABLE 4. The risk of a primary diagnosis of a mental health condition, given a cannabis-related hospital visit in Arizona from 2016 to 2021

	2016		2017		2018		2019		2020		2021	
Variable	RR	[95% CI]	RR	[95% CI]	RR	[95% CI]	RR	[95% CI]	RR	[95% CI]	RR	[95% CI]
Overall	7.63	[7.47, 7.79]	6.97	[6.84, 7.11]	7.63	[7.49, 7.78]	7.77	[7.62, 7.92]	8.22	[8.06, 8.37]	8.12	[7.97, 8.26]
Sex												
Male	6.86	[6.67, 7.05]	6.47	[6.31, 6.64]	7.03	[6.86, 7.20]	7.17	[6.99, 7.35]	7.48	[7.30, 7.67]	7.40	[7.22, 7.58]
Female	8.74	[8.46, 9.03]	7.55	[7.32, 7.79]	8.25	[8.01, 8.49]	8.30	[8.05, 8.56]	8.98	[8.72, 9.24]	8.91	[8.67, 9.15]
Age group												
<10 years	–	–	–	–	–	–	–	–	–	–	–	–
10–17 years	9.32	[8.86, 9.80]	7.98	[7.61, 8.38]	7.29	[6.98, 7.62]	7.34	[7.02, 7.67]	5.88	[5.63, 6.14]	5.82	[5.59, 6.07]
18–20 years	6.34	[5.94, 6.78]	5.45	[5.13, 5.80]	6.08	[5.72, 6.45]	6.48	[6.09, 6.89]	6.34	[5.96, 6.73]	6.14	[5.79, 6.52]
21–24 years	5.77	[5.43, 6.13]	5.34	[5.05, 5.65]	5.74	[5.44, 6.06]	5.68	[5.37, 6.00]	6.01	[5.69, 6.34]	6.33	[6.01, 6.67]
25–34 years	5.28	[5.06, 5.51]	4.79	[4.61, 4.98]	5.27	[5.08, 5.46]	5.21	[5.01, 5.41]	5.44	[5.24, 5.64]	5.36	[5.17, 5.56]
35–44 years	4.76	[4.51, 5.02]	4.32	[4.11, 4.54]	4.83	[4.60, 5.06]	4.59	[4.37, 4.82]	5.44	[5.20, 5.70]	5.32	[5.08, 5.56]
45–54 years	4.04	[3.78, 4.32]	3.90	[3.67, 4.16]	4.59	[4.33, 4.88]	4.36	[4.09, 4.64]	5.54	[5.22, 5.89]	5.36	[5.05, 5.70]
55–64 years	3.47	[3.15, 3.83]	3.36	[3.07, 3.69]	3.98	[3.67, 4.32]	3.89	[3.56, 4.25]	4.69	[4.31, 5.11]	5.37	[4.96, 5.80]
≥65 years	3.82	[2.99, 4.88]	4.51	[3.73, 5.46]	4.88	[4.13, 5.77]	5.45	[4.62, 6.42]	6.43	[5.51, 7.51]	6.44	[5.61, 7.38]

Notes: Estimates are crude relative risks. Results for the <10 years age group are not shown due to the low frequency of visits that were both cannabis-related and mental health–related. RR = relative risk; CI = confidence interval.

related visits (Table 3). Further, the crude rate of cannabis-related visits increased over time for all age groups except the age 45–54 and 55–64 groups. The youngest and oldest age groups showed the largest increases over time (e.g., 42% per year, on average, for age <10 years; 12% per year for ages 10–17; and 10% per year for ages 65+ years). Statistical tests of the differences between age groups in time trends in cannabis-related visits from 2016 to 2021 are shown in Table S2. Results were similar whether estimates were unadjusted or adjusted for sociodemographic covariates.

Relative to other age groups, the adolescent age group (ages 10–17 years) showed the highest rate of visits for a primary mental health condition (Table 3). Further, the rate of hospital visits with a primary diagnosis of a mental health condition increased over time for all age groups under age 45. The increase was largest for the age 10–17 group (crude 12% increase in visits per year, on average). Statistical tests of the differences between age groups in time trends for visits with a primary diagnosis of a mental health conditions are shown in Table S3. Results were similar whether estimates were unadjusted or adjusted for sociodemographic covariates.

There were age differences in the association between cannabis-related visits and visits for a primary mental health condition (Table 4, Figure 1). Adolescents ages 10–17 generally showed the highest cannabis-related risk of a primary diagnosis of a mental health condition. However, the age groups showed different trends in the cannabis–mental health association over time (i.e., there was a three-way interaction between cannabis, age group, and time in predicting mental health–related visits; Table S4). Specifically, the cannabis-related risk of a primary diagnosis of a mental health condition decreased for youth under age 18 years, did not change for older adolescents (ages 18–20 years), and increased over time for adults ages 21 years and older (Table S5). The age 65+ group showed the largest increase in cannabis-related risk for a primary diagnosis of a mental health condition from 2016 to 2021, going from a crude RR of 3.82 in 2016 to 6.44 in 2021. Results were similar whether estimates were unadjusted or adjusted for sociodemographic factors and alcohol and other substance-related diagnoses.

Discussion

This study of statewide Arizona hospital discharge data from 2016 to 2021 revealed four key findings. First, the rate of cannabis-related hospital visits increased from 2016 to 2021, particularly for visits by youth and adults ages 65+, two age groups that are thought to be especially vulnerable to cannabis-related problems (Meier et al., 2024). Second, the rate of hospital visits with a primary diagnosis of a mental health condition increased from 2016 to 2021, particularly for visits by teens. Third, there was a tendency for cannabis-related hospital visits to be visits with a primary diagnosis of a mental health condition, and this association could not be fully explained by elevated rates of alcohol and other substance-related diagnoses among cannabis-related visits. Fourth, the tendency for cannabis-related visits to be visits with a primary diagnosis of a mental health condition increased over time, particularly for visits by adults ages 65+.

Cannabis-related hospital visits accounted for only about 1.5% of all hospital visits from 2016 to 2021 but comprised a larger proportion of male and young-adult visits (ages 18–24) compared with female visits and visits by other age groups. The rate of cannabis-related hospital visits increased over time, from 1,301.50 cannabis-related visits per 100,000 visits in 2016 to 1,565.54 visits per 100,000 visits in 2021—a 20% increase. This increase occurred largely during a time when medical cannabis use was legal, but nonmedical adult use was not. The increase was larger for female visits compared with male visits, consistent with a closing of the sex gap in cannabis use (Crocker et al., 2023) and was larger for visits by the youngest (under age 18) and oldest (ages 65+)

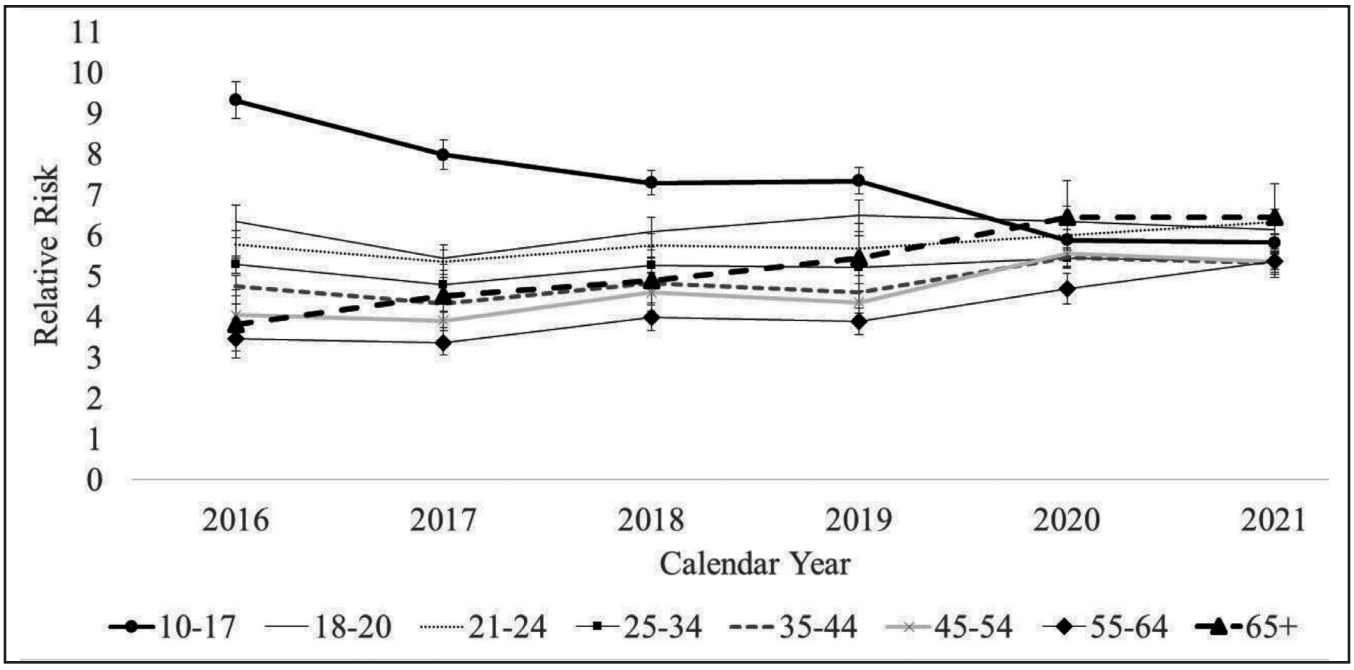

FIGURE 1. The association between cannabis-related hospital visits and mental health–related hospital visits from 2016 to 2021, by age group. Error bars are 95% confidence intervals.

age groups compared with other age groups. These trends in Arizona from 2016 to 2021 are broadly consistent with reported trends in nationwide ED data from 2017 to 2018 (Roehler et al., 2022).

The increase in the rate of cannabis-related hospital visits in the older adult age group is especially noteworthy because older adults represent a growing portion of the U.S. population and, as a group, have shown large increases in cannabis use (Han & Palamar, 2020). A recent study from California reported that cannabis-related ED visits among older adults increased from 303 to 395 visits per 100,000 visits from 2016 to 2019—a 30% increase (Han et al., 2023). In Arizona, the corresponding increase was from 236 to 342 hospital visits per 100,000 visits by older adults—a 45% increase. The findings from the two states further show that the large increase in the rate of cannabis-related hospital visits was not evident among adults generally but rather was specific to older adults, suggesting an increasing need for prevention and intervention targeted to older adults.

The rate of mental health–related hospital visits increased from 2016 to 2021, particularly for youth ages 10–17. The large increase among youth visits in 2020 suggests that COVID-19 may have played a role, consistent with previous studies (Chadi et al., 2021; Krass et al., 2021). Other age groups showed much smaller increases in the rate of mental health–related hospital visits from 2016 to 2021, except the middle age and older adult age groups, which showed no change.

From 2016 to 2021, cannabis-related hospital visits were 7.75 times as likely as visits that were not cannabis-related to have a primary diagnosis of a mental health condition, and this association could not be fully explained by elevated rates of alcohol and other substance-related diagnoses among cannabis-related visits. The mental health conditions that were most strongly linked with cannabis-related visits were mood disorders, psychosis, and personality disorders, similar to studies of the general population (Gobbi et al., 2019). Like other studies, we also found an association between cannabis-related hospital visits and visits for self-harm or suicide attempt (Fontanella et al., 2021; Gobbi et al., 2019; Gordon et al., 2024; Myran et al., 2024; Oladunjoye et al., 2023), highlighting the importance of understanding the mechanisms underlying this association. In general, the cannabis–mental health association was larger for female visits compared with male visits, which is consistent with a prior study of ED visits (Salas-Wright et al., 2019). However, evidence of sex differences is inconsistent (Halladay et al., 2019; Kozak et al., 2021). The cannabis–mental health association was also generally larger for visits by adolescents ages 10–17 compared with other age groups.

The tendency for cannabis-related hospital visits to be visits with a primary diagnosis of a mental health condition increased from 2016 to 2021. The increase was similar for males and females, but there were marked age differences. Specifically, the association between cannabis-related visits and visits with a primary diagnosis of a mental health condition increased for adults ages 21+, and especially for adults ages 55–65 and ages 65+. In contrast, this association decreased for adolescents. Increasing trends, which were observed for adult visits, could occur as a consequence of

increases in cannabis use and potency, including increases in use of cannabis to treat mental health conditions. Decreasing trends in cannabis–mental health associations, which were observed for adolescent visits, show that mental health problems became less concentrated among cannabis users as mental health problems increased broadly in this age group, likely in association with the pandemic.

This study has limitations. First, this is an observational, cross-sectional study that cannot determine causality. Analyses controlled for a number of potential confounders, but some potential confounders, such as tobacco smoking, are not well-represented by diagnostic codes in hospital discharge records. Second, the data do not distinguish between medical and nonmedical cannabis use or capture information on quantity and frequency of cannabis use, cannabinoid concentration, and route of administration. Third, diagnostic coding in hospital records is known to contain inaccuracies. ICD codes may underestimate the true cannabis-related burden (Hendrickson et al., 2021). Nonetheless, it is clear from prior research that ICD codes from hospital discharge data have a meaningful signal (Crocker et al., 2021, 2023; Fink et al., 2023). Fourth, the data represent hospital visits and not patients. Fifth, the findings from Arizona may not generalize to other U.S. states.

This study also has implications. The rate of cannabis-related hospital visits is increasing in Arizona, particularly for youth and older adults, and the association between cannabis-related visits and mental health–related visits is increasing, particularly for older adults. Therefore, targeted prevention and intervention efforts are needed for youth and older adults. Whereas adolescents are a recognized at-risk group, older-adult risk is less recognized. Many adults use cannabis to treat mental health conditions (Boehnke et al., 2022; Kendzor et al., 2022), but there is limited evidence supporting cannabis use as an effective treatment for mental health conditions (Black et al., 2019). Further, reductions in cannabis use are associated with improved mental health (Hser et al., 2017). Medical providers in hospital settings have an opportunity to provide education, brief intervention, and referral to treatment for cannabis use but may require training on the benefits and risks of cannabis use, including medical use (Rønne et al., 2021). Cessation of cannabis use should be encouraged among patients with mental health conditions. Additional research is needed on cannabis–physical health associations, because some, but not all, studies suggest an association between cannabis use and poorer physical health (Campeny et al., 2020; Meier et al., 2019, 2022; Myran et al., 2022; Rumalla et al., 2016), and older adults may be especially vulnerable to the negative effects of cannabis use on physical health.

Conflict-of-Interest Statement

The authors have no conflicts to declare.

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