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Research Paper

Trends in cannabis use among U.S. adults amid the COVID-19 pandemic

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ABSTRACT

Background: The COVID-19 pandemic has had an impact on mental health and alcohol use in the US, however there is little research on its impacts on cannabis use. Considering the role of cannabis as a coping strategy or self-medicating behavior, there is a need to understand how individuals who use cannabis have adapted their use amid the pandemic. Therefore, this study examined changes in self-reported cannabis use among US adults in the context of COVID-19 pandemic by (1) describing trends of use during the first 8 months of the pandemic among adults who used cannabis in this period; and (2) characterizing trends of use within sociodemographic subgroups and by state cannabis policy status.

Methods: The sample consisted of 1,761 US adults who used cannabis at least once during the 8-month study period from the nationally representative Understanding America Study. Linear mixed-effect models were used to model changes in the number of days of past-week cannabis use across 16 waves from March 10, 2020, to November 11, 2020.

Results: Compared to early March, the number of days cannabis was used per week was significantly higher at the start of April (β=0.11, 95% CI=0.03, 0.18) and May (β=0.21,95% CI=0.05, 0.36). In subsequent months (June - November), the number of days of cannabis use attenuated to levels comparable to March. Trends of cannabis use across the study period generally did not differ across sociodemographic characteristics and state cannabis policy status.

Conclusion: Though increases in use were marginal among many groups, the evolving pandemic and the growing concern for the mental health of segments of the U.S. population warrant close monitoring of coping behaviors, including substance use.

Introduction

On March 11th, 2020 the World Health Organization (WHO) declared the severe acute respiratory syndrome coronavirus (SARS-CoV-2) a pandemic (World Health Organization, 2020), and by March 13th, the United States (US) president declared it a National Emergency (White House, 2020). Within weeks of these declarations, states and localities across the US began to institute stay-at-home orders, closure of non-essential businesses, and many Americans began the transition to remote work (American Journal of Managed Care, 2020). These disruptions have led to rising unemployment (Gallant, Kroft, Lange, & Notowidigdo, 2020), market volatility (Ali, Alam, & Rizvi, 2020), housing and food insecurity (Morales, Morales, & Beltran, 2021; Waxman, Gupta, & Karpman, 2020; Wolfson & Leung, 2020), and social isolation (Loades et al., 2020; Usher, Bhullar, & Jackson, 2020). As a result, concerns about a 'second pandemic', constituting an increase in psychiatric and substance use disorders, began to emerge (Canady, 2020).

Since the early 2000's, the US has seen a shift in state cannabis policies, which have been found to be associated with increased prevalence of cannabis use and cannabis use disorders among sections of the population (Goodwin et al., 2021; Hasin et al., 2017; Lloyd & Striley, 2018), with 29 states operating medical cannabis dispensaries and an additional 8 states operating both recreational and medical dispensaries as

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of March 2020 (National Conference of State Legislatures., 2020). Studies of the effects of cannabis policies on adult use have shown increased cannabis use and use disorders in states with medical cannabis policies (Hasin et al., 2017; Lloyd & Striley, 2018). In addition, epidemiological surveys of substance use in the US have shown increases in cannabis use since 2002, with significant increases among certain sociodemographic groups including men, Black people, young adults, low-income groups, and those never-married (Hasin, Shmulewitz, & Sarvet, 2019). With regards to accessibility of cannabis products, most states with operating dispensaries declared them essential businesses during the COVID-19 pandemic (Cherney, 2020), along with liquor and tobacco retailers, which should have provided continued access to cannabis products for purchase. However, it is unclear how accessibility to cannabis products was impacted in states with no legal cannabis options. Moreover, other factors beyond cannabis accessibility may have impacted cannabis use behavior during the COVID-19 pandemic (e.g., stay-at-home orders, remote work, the economic impact of the pandemic, etc.) and studies investigating trends in cannabis use over the course of the pandemic are needed.

Emerging literature on the effects of the pandemic on mental health and substance use have shown symptoms of depression (Ettman et al., 2020; McGinty, Presskreischer, Han, & Barry, 2020), anxiety (Holingue et al., 2020; Huckins et al., 2020), loneliness (Killgore, Cloonan, Taylor, & Dailey, 2020; Liu, Zhang, Wong, Hyun, & Hahm, 2020), and alcohol consumption (Barbosa, Cowell, & Dowd, 2021; Nordeck et al., 2021; Pollard, Tucker, & Green, 2020) increasing in some segments of the population early on in the pandemic. Elevated mental distress in the population due to COVID-related stressors may increase the use of cannabis as a coping strategy or self-medicating behavior. A cross-sectional study of emerging adults in Canada found that self-isolation and motives to use cannabis for coping with depression were associated with cannabis use during the pandemic (Bartel, Sherry, & Stewart, 2020). A study of individuals who used cannabis in the Netherlands showed that 41% of respondents reported increased cannabis use since lockdown measures were instituted, with stress and mental health significantly associated with reported increases (Van Laar et al., 2020). However, studies on cannabis use in the US during the COVID-19 pandemic remain sparse and further investigation of long-term outcomes of the pandemic, including potential changes in substance use behaviors, is warranted.

As the literature grows in monitoring the effects of the pandemic on mental health and alcohol use in the US, it is also important to examine potential changes in cannabis use. The aims of this study were to (1) describe changes in days of past-week cannabis use from March 10th through November 11th, 2020 among US adults who reported cannabis use in a nationally representative panel and (2) characterize differences in trends of use within sociodemographic subgroups and by state cannabis policy status.

Methods

Participants

Participants were sampled from the Understanding America Study (UAS), a probability-based, nationally representative Internet panel of adults (aged 18 years or older). The UAS has recruited participants using Address Based Sampling (ABS) since 2014, in which postal records are used to select a simple random sample from a listing of residential addresses across the US. The recruitment involved invitation by mail, with potential participants without prior internet access were provided with tablets and broadband internet connections to facilitate data collection. Once respondents enrolled in the panel, they were surveyed via computer, mobile device, or tablet. Individuals are considered eligible to join the panel if they are aged 18 years or older and are a member of the contacted household (defined as anyone living in a residence with an enrolled respondent in the UAS). Additional details regarding the UAS methodology can be found at the UAS website (https://UASdata.usc.edu).

This study used data from 16 waves of the UAS's COVID-19 Longitudinal Survey, a high-frequency longitudinal data collection with baseline data collection running from March 10 to March 31, 2020. All existing members of the UAS were invited to participate in the survey. Starting on April 1, respondents were invited to participate in bi-weekly surveys according to a staggered schedule, whereby one fourteenth of the sample was invited every day. Every respondent had 14 days to complete the survey; thus, the waves following baseline overlap in calendar time. In the initial survey, respondents were asked for consent to participate in the bi-weekly surveys. Only respondents who consented were asked to complete a subsequent survey on their assigned day. As not all eligible participants had consented by the start of the second wave, the response rate as a percentage of the complete UAS sample was lower in earlier follow-ups.

Overall, there were 8547 eligible panel members invited to participate in the March survey. Among those invited, 6932 (81.1%) completed the survey at baseline, March 10 - March 31, 2020. For purposes of our analyses, we included only those participants who reported at least one day of cannabis use across the survey period. The percentage of participants reporting cannabis use at each wave ranged from 9.2% in wave 14 to 11.3% in wave 3 (data not shown). On average, those who reported ever using cannabis included higher proportions of individuals who were younger, identified as being Black or Hispanic/Latinx, were living at or below the Federal Poverty Level, and came from states with both medical and recreational cannabis policies. Comparisons between adults who reported using cannabis and those who did not report using cannabis during the survey period are displayed in the online supplement Table S2.

Surveys with complete data on cannabis use and all sociodemographic characteristics of interest were included in the analytic sample. In total, 1761 unique participants were included; 39.9% completed 16 surveys, 12.6% completed 15 surveys, 7.6% completed 14 surveys, and the remaining 39.9% completed between one and thirteen surveys (see online supplment Table S1 for number of observations per day). Details for participant inclusion and exclusion at each survey are displayed as a flow diagram inonline supplement Figure S1.

Measures

Number of past-week cannabis use days. Participants were provided with a pre-specified list of activities and asked, "Out of the past 7 days, what is your best estimate of the number of days that you did each of the following activities?" From the list of activities, we used responses for the activity, "Used cannabis." Responses ranged from 0 (used cannabis on none of the past 7 days) to 7 (used cannabis on all of the past 7 days).

Survey date. The number of days between March 10 and the survey date was entered into each model as a continuous variable (range, 0–244). Given evidence of non-linear changes in cannabis use over time, we modeled the relationship between survey date and cannabis use with restricted cubic splines, which produce smoothed curves for the relationship between continuous exposures and outcomes. Cubic splines capture trends that may be missed when categorical or strictly linear terms are used (Gauthier, Wu, & Gooley, 2020). We generated splines with five knots using the defined percentiles recommended by Harrell (5, 27.5, 50, 72.5, and 95) to allow for greater variability in modeling and for more flexible interpretation of these nonlinear trends (Harrell, 2015). The knots corresponded to the following calendar dates: March 16, May 19, July 8, August 27, and October 17, 2020.

Sociodemographic characteristics. Sociodemographic characteristics were measured at baseline as time-fixed variables. These variables included age (18–29, 30–49, 50–64, or 65+), sex (female or male), and race/ethnicity (non-Hispanic White, non-Hispanic Black,

Hispanic/Latino of any race, or other [American Indian or Alaskan Native, Asian, Pacific Islander, or Multi-racial]). Poverty status was determined by the Federal Poverty Level (FPL) and calculated based on household income. The median of each reported income category was used to estimate total household income. This estimate was used to dichotomously classify individuals as living in a household above or below the FPL according to the 2020 Federal Poverty Guidelines. Cutoffs for the 48 contiguous states and the District of Columbia range from $12,760 for a household of 1 person to $44,120 for a household of 8 persons, with $4480 added for each additional person (Office of the Assistant Secretary for Planning and Evaluation, 2020). Household structure was classified into five categories (living alone, living with a partner only, living with a partner and children, living with children only, and other [such as living with parents or other relatives, and living with non-relatives]).

State cannabis policy status. The state cannabis policy variable was generated using the state of residence at Wave 1 (March 2020). Status of cannabis legalization within each state was obtained from the National Conference of State Legislature's website (National Conference of State Legislatures., 2020). The variable was categorized according to whether or not cannabis use was legalized and if states had sanctioned the operation of dispensaries by the start of the study period. The 9 states in which dispensaries were operating for both medical and recreational cannabis were classified as having both policies. The 28 states with medical (but no recreational) dispensaries operating were classified as having a policy for medical cannabis only. The remaining 14 states where no legalization of cannabis exists were classified as having full prohibition. An overview of categorization of each state and number of respondents per state is provided in Table S3.

Statistical analysis

Analyses were conducted in three parts. First, the associations between each of the sociodemographic characteristics and the frequency of cannabis use were examined across the full survey period. Second, a single model with the splines for days since March 10 as covariates examined trends in cannabis use across time. Third, a sequence of models with interactions between the splines for days since March 10 and each of the identified sociodemographic characteristics determined whether trends in cannabis use over time differed between subgroups. We used mixed-effects linear regression models with a random intercept for participants to accommodate repeated measures. The general specification for these models is provided in the online supplement. Joint Wald tests were used to determine if interactions were significant. The *margins* and the *xbrcspline* commands in Stata were used to generate linear predictions of cannabis use and to estimate differences in the frequency of cannabis use on given survey dates compared to March 11, respectively, in the overall analytic sample and stratified by each sociodemographic subgroup (Orsini, 2009). March 11 was used as the reference date rather than March 10 due to a higher number of observations on that survey date (519 versus 109, respectively).

We conducted additional sensitivity analyses using the entire UAS sample, including participants who reported no cannabis use over the entire study period.

All analyses incorporated survey weights that accounted for probabilities of sample selection and survey non-response at baseline and are aligned with Current Population Survey benchmarks. Statistical significance was assessed at the $p<.05$ level. Analyses were conducted using Stata version 16 (StataCorp Inc., College Station, TX) and R (R studio version 1.2.5042; R version 4.0.0).

Results

Associations of sociodemographic characteristics with frequency of past-week cannabis use

Sample characteristics and differences in the average frequency of past-week cannabis use across the survey period are reported in Table 1. The frequency of cannabis use was higher among men, reporting an average of 0.43 more days of cannabis use (β=0.43; 95% Confidence Interval [CI]=0.19, 0.67) compared to women respondents during the study period. Frequency of cannabis use was lower among Hispanic/Latinx (β=−0.45; 95% CI=−0.75, −0.15) compared to White respondents; among adults living with children only (β=−0.69; 95% CI=−1.21, −0.16) compared to adults living alone; and among older adults (65+: β=−0.43; 95% CI=−0.84, −0.03) compared to those ages 18–29. Frequency of cannabis use was also lower among adults living in states with legalized medical and recreational cannabis laws (β=−0.35; 95% CI=−0.69, −0.01) compared to adults living in states with full cannabis prohibition. No significant differences in the frequency of cannabis use were observed between those living above or below the FPL.

Trends of past-week cannabis use

Differences in the frequency of past-week cannabis use, on given survey dates compared to March 11, are reported in Table 2. Compared to March 11, US adults who used cannabis reported 0.11 (95% CI=0.03, 0.18) more cannabis use days on April 1 and 0.21 (95% CI=0.05, 0.36) more cannabis use days on May 1, on average. Thereafter and through November 1, the frequency of cannabis use was not significantly different from March 11.

Trends of past-week cannabis use among sociodemographic subgroups and by state cannabis policy status

The predicted frequency of past-week cannabis use over the survey period for each sociodemographic subgroup is displayed in Fig. 1. Interactions between survey date and sex, age, race/ethnicity, household structure, FPL, and state cannabis policy were not statistically significant, indicating that trends of cannabis use did not differ among respondents in different sociodemographic and state policy groups. women, individuals living above the FPL, and those living in states with medical only cannabis policies experienced increases in cannabis use days on April 1 and May 1. Women increased their cannabis use by 0.13 days on April 1 (95% CI= 0.04, 0.22) and 0.25 days on May 1 (95% CI=0,06, 0.44), while those above the FPL increased their use by 0.10 days on April 1 (95% CI=0.02, 0.18) and 0.20 days on May 1 (95% CI=0.03, 0.36). For adults living in states with legalized medical cannabis, there were increases in the number of cannabis use days across the first two months of the survey period (April 1: β=0.16; 95% CI=0.04, 0.27; May 1: β=0.32; 95% CI=0.07, 0.56). The group with the longest sustained increase in cannabis use days compared to March 11th were individuals living with only their partner, indicating increases for the first three months (April 1: β=0.17; 95% CI=0.04, 0.29; May 1: β=0.34; 95% CI=0.08, 0.59; June 1: β=0.33; 95% CI=0.04, 0.62). Complete results for each sociodemographic subgroup are displayed in Table 2.

Sensitivity analyses including the entire UAS sample

We conducted additional sensitivity analyses using the entire UAS sample, including participants who reported no cannabis use over the

Table 1
Descriptive statistics of sample characteristics for US adults at the first survey wave and associations with frequency of cannabis use across the survey period (n = 1761).

Variable	n (%)	Cannabis use frequency (Mean, SD)[a]	β [b] (95% CI)
Sex			
Female	900 (51.1)	2.08 (2.82)	Ref
Male	861 (48.9)	2.85 (3.02)	**0.43 (0.19, 0.67)**
Age			
18–29	407 (23.1)	2.55 (2.93)	Ref
30–49	807 (45.8)	2.53 (3.01)	−0.12 (−0.44, 0.19)
50–64	361 (20.5)	2.46 (2.96)	0.10 (−0.26, 0.46)
65+	187 (10.6)	1.92 (2.66)	**−0.43 (−0.84, −0.03)**
Race			
White	990 (56.2)	2.59 (3.00)	Ref
Black	280 (15.9)	2.15 (2.81)	−0.27 (−0.66, 0.12)
Hispanic/Latinx	340 (19.3)	2.21 (2.87)	**−0.45 (−0.75, −0.15)**
Other	151 (8.6)	2.49 (2.93)	−0.29 (−0.67, 0.11)
Household structure			
Alone	338 (19.2)	2.52 (2.92)	Ref
With partner only	392 (22.3)	2.51 (2.96)	−0.003 (−0.37, 0.37)
With partner & kids	356 (20.2)	2.67 (3.06)	−0.18 (−0.58, 0.21)
With kids only	102 (5.8)	1.31 (2.27)	**−0.69 (−1.21, −0.16)**
Other	572 (32.5)	2.42 (2.94)	−0.12 (−0.47, 0.22)
Federal poverty level			
Above	1263 (71.7)	2.43 (2.93)	Ref
At or below	498 (28.3)	2.48 (3.00)	0.22 (−0.07, 0.50)
State cannabis policy			
Full prohibition	464 (26.4)	2.48 (3.00)	Ref
Medical only	775 (44.0)	2.46 (2.94)	−0.14 (−0.50, 0.22)
Medical and recreational	521 (29.6)	2.40 (2.90)	**−0.41 (−0.73, −0.08)**

Notes: All values are weighted. Bold font indicates statistical significance. [a]Mean reflects the mean number of days cannabis was used within each group across the entire study period. [b]β is difference in the number of days cannabis was used across the study period compared to the referent.

entire study period (Table S4). While the number of cannabis use days and therefore coefficients related to levels of use were consistently lower due to the inclusion of a large number of participants with no cannabis use, significance results were largely the same as those presented in the main manuscript. The only exception was that there was no significant difference in frequency of cannabis use days between baseline and May 1, 2020 for White respondents when using the full UAS sample. There were sociodemographic differences observed between those in the full sample compared to those included in the analytic sample with respect to sex, age, race, household structure, poverty status, and state cannabis policy (Table S2). However, the pattern of results in the complete sample of those who used cannabis and did not use cannabis was broadly similar to the main analyses (Table S4), suggesting that our findings were not sensitive to the exclusion of individuals who used cannabis during the study period.

Discussion

To our knowledge, this is the first study to examine trends of cannabis use during the COVID-19 pandemic in a general population sample of U.S. adults. The prevalence of cannabis use in this study population ranged between 9.2 and 11.3% at each wave. This is slightly lower compared to national estimates of past month cannabis use of 11.9% in 2019 among US adults 18 or older (Substance Abuse and Mental Health Services Administration, 2020). Our analyses show that, within the overall sample of adults who reported any cannabis use during the study period, there were statistically significant increases in the number of past-week cannabis use days at the start of the pandemic (April - May) compared to baseline (March 2020); thereafter, these increases returned to levels comparable to March for the remainder of the study period (June - November). When comparing cannabis use at the first of each month to the start of the study, several of the identified sociodemographic groups also demonstrated increased cannabis use in April, May, and June, including: women, non-Hispanic White people; individuals living with only their partner; those reporting a household income not at the FPL; and those living in states with medical cannabis but not recreational only policies. Similar to the overall sample, frequency of past-week cannabis use in these groups returned to levels comparable to baseline for the remainder of the study period. Collectively, these findings offer new insight into patterns of cannabis use over time throughout the pandemic among U.S. adults.

Our findings are broadly consistent with studies from other countries, including some European countries and Canada (European Monitoring Centre for Drugs and Drug Addiction, 2020; Imtiaz et al., 2020; Rolland et al., 2020; Vanderbruggen et al., 2020). In a study of adults who use cannabis in the European Union, self-reported cannabis use remained stable overall, with 42% of participants reporting no change in use between April 8 and May 25, 2020. Increases in frequency and quantity of cannabis use were larger among those who used cannabis regularly rather than occasionally (European Monitoring Centre for Drugs and Drug Addiction, 2020). Another repeated cross-sectional study of Canadian adults showed cannabis use in the overall population remained unchanged during the pandemic between May and June 2020. Though about 50% of the individuals who reported using cannabis stated that their cannabis use had increased, the reported number of days cannabis was used in the last seven days remained stable over the study period (Imtiaz et al., 2020). Other cross-sectional studies from France and Belgium at the start of national lockdowns further reported findings of overall cannabis use remaining stable (Rolland et al., 2020; Vanderbruggen et al., 2020). Though these findings are generally consistent with ours, comparison is limited due to the non-representative and cross-sectional nature of these studies that report changes only in the first wave of lockdowns between March and June 2020.

The U.S. context of cannabis policies and access is important to consider when reflecting on factors that may have influenced these trends. The marginal changes in cannabis use among some groups early on in the pandemic may have been influenced by public health measures implemented to reduce the spread of COVID-19. One such consideration is the role of stay-at-home orders and social distancing measures indirectly impacting behaviors among those who obtain cannabis through

Table 2
Average number of past-week cannabis use days at baseline (March 11th, 2020) and differences in the frequency of cannabis use days at the beginning of each month by sociodemographic characteristics, among US adults in the UAS Panel, 2020 (n = 1761).

	Mean number of cannabis use days in the past week on March 11	Difference in frequency of cannabis use[a] at the beginning of each month β (95% CI)								p-value for Interaction[b]
		04/01	05/01	06/01	07/01	08/01	09/01	10/01	11/01	
Total	2.39	**0.11**	**0.21**	0.16	0.03	0.02	0.07	0.04	−0.04	
		(0.03, 0.18)	**(0.05, 0.36)**	(−0.02, 0.34)	(−0.16, 0.21)	(−0.16, 0.20)	(−0.11, 0.25)	(−0.14, 0.21)	(−0.23, 0.15)	
Sex										
Female	2.10	**0.13**	**0.25**	0.17	−0.02	−0.03	0.05	0.03	−0.05	0.51
		(0.04, 0.22)	**(0.06, 0.44)**	(−0.05, 0.40)	(−0.24, 0.21)	(−0.25, 0.19)	(−0.17, 0.27)	(−0.19, 0.24)	(−0.29, 0.19)	
Male	2.74	0.08	0.15	0.14	0.07	0.07	0.09	0.05	−0.03	
		(−0.04, 0.19)	(−0.08, 0.39)	(−0.15, 0.43)	(−0.22, 0.37)	(−0.21, 0.36)	(−0.19, 0.38)	(−0.22, 0.32)	(−0.33, 0.27)	
Age										
18–29	1.65	0.10	0.19	0.13	0.00	0.00	0.04	−0.06	−0.23	0.22
		(−0.09, 0.29)	(−0.22, 0.59)	(−0.35, 0.62)	(−0.50, 0.49)	(−0.49, 0.49)	(−0.44, 0.5)	(−0.49, 0.37)	(−0.69, 0.24)	
30–49	2.85	**0.12**	0.23	0.15	−0.03	−0.05	0.02	−0.04	−0.15	
		(0.01, 0.23)	(−0.01, 0.47)	(−0.14, 0.44)	(−0.33, 0.26)	(−0.32, 0.23)	(−0.25, 0.28)	(−0.30, 0.22)	(−0.44, 0.14)	
50–64	2.07	0.08	0.17	0.24	0.24	0.19	0.16	0.22	0.32	
		(−0.06, 0.21)	(−0.11, 0.45)	(−0.09, 0.56)	(−0.09, 0.57)	(−0.13, 0.52)	(−0.19, 0.51)	(−0.13, 0.57)	(−0.07, 0.71)	
65+	2.09	0.11	0.20	0.08	−0.11	−0.03	0.15	0.12	−0.01	
		(−0.05, 0.27)	(−0.14, 0.53)	(−0.29, 0.45)	(−0.45, 0.22)	(−0.35, 0.29)	(−0.22, 0.51)	(−0.25, 0.49)	(−0.44, 0.43)	
Race										
White	2.41	**0.10**	0.19	0.16	0.06	0.09	0.14	0.08	−0.05	0.27
		(0.01, 0.19)	(0.00, 0.38)	(−0.07, 0.38)	(−0.17, 0.29)	(−0.13, 0.31)	(−0.08, 0.37)	(−0.14, 0.29)	(−0.29, 0.19)	
Black	2.63	0.17	0.30	0.10	−0.29	−0.35	−0.22	−0.23	−0.31	
		(−0.04, 0.39)	(−0.15, 0.76)	(−0.45, 0.64)	(−0.86, 0.28)	(−0.91, 0.20)	(−0.77, 0.32)	(−0.77, 0.31)	(−0.89, 0.28)	
Hispanic/Latinx	2.39	0.09	0.20	0.23	0.18	0.14	0.15	0.20	0.26	
		(−0.09, 0.28)	(−0.20, 0.60)	(−0.24, 0.69)	(−0.28, 0.63)	(−0.30, 0.58)	(−0.29, 0.60)	(−0.24, 0.64)	(−0.22, 0.74)	
Other	1.86	0.09	0.18	0.17	0.07	0.01	0.03	−0.07	−0.13	
		(−0.09, 0.27)	(−0.21, 0.57)	(−0.31, 0.65)	(−0.44, 0.59)	(−0.45, 0.46)	(−0.45, 0.40)	(−0.44, 0.29)	(−0.65, 0.39)	
Household structure										
Alone	2.58	0.17	0.34	0.35	0.23	0.17	0.13	−0.02	−0.23	0.13
		(−0.01, 0.35)	(−0.04, 0.73)	(−0.12, 0.81)	(−0.25, 0.70)	(−0.26, 0.61)	(−0.29, 0.56)	(−0.42, 0.38)	(−0.70, 0.25)	
With partner only	2.41	**0.17**	**0.34**	**0.33**	0.18	0.12	0.15	0.17	0.18	
		(0.04, 0.29)	**(0.08, 0.59)**	**(0.04, 0.62)**	(−0.09, 0.46)	(−0.14, 0.39)	(−0.14, 0.44)	(−0.11, 0.44)	(−0.12, 0.48)	
With partner & kids	2.85	0.07	0.13	0.05	−0.10	−0.07	0.03	0.03	−0.01	
		(−0.12, 0.27)	(−0.29, 0.55)	(−0.45, 0.55)	(−0.59, 0.39)	(−0.55, 0.41)	(−0.46, 0.53)	(−0.46, 0.52)	(−0.52, 0.49)	
With kids only	1.95	0.21	0.37	0.15	−0.25	−0.24	0.00	0.07	0.05	
		(−0.01, 0.42)	(−0.09, 0.83)	(−0.39, 0.69)	(−0.78, 0.28)	(−0.73, 0.25)	(−0.49, 0.49)	(−0.41, 0.55)	(−0.55, 0.65)	
Other	1.93	0.02	0.04	−0.02	−0.09	−0.05	0.02	−0.03	−0.13	
		(−0.10, 0.15)	(−0.22, 0.30)	(−0.33, 0.29)	(−0.42, 0.24)	(−0.37, 0.27)	(−0.30, 0.34)	(−0.34, 0.28)	(−0.48, 0.22)	
Federal poverty level										
Above	2.40	**0.10**	**0.20**	0.15	0.02	0.02	0.07	0.02	−0.08	0.96
		(0.02, 0.18)	**(0.03, 0.36)**	(−0.05, 0.35)	(−0.17, 0.22)	(−0.17, 0.21)	(−0.13, 0.26)	(−0.17, 0.21)	(−0.28, 0.13)	
At or below	2.38	0.12	0.23	0.18	0.03	0.02	0.09	0.09	0.06	
		(−0.04, 0.28)	(−0.11, 0.57)	(−0.23, 0.59)	(−0.39, 0.45)	(−0.39, 0.43)	(−0.31, 0.49)	(−0.29, 0.47)	(−0.37, 0.48)	
State cannabis policy										
Full prohibition	2.62	0.07	0.12	−0.01	−0.23	−0.25	−0.19	−0.26	−0.39	0.08
		(−0.09, 0.24)	(−0.23, 0.46)	(−0.44, 0.41)	(−0.67, 0.22)	(−0.69, 0.19)	(−0.62, 0.23)	(−0.67, 0.14)	(−0.83, 0.04)	
Medical only	2.27	**0.16**	**0.32**	0.28	0.13	0.17	0.26	0.19	0.04	
		(0.04, 0.27)	**(0.07, 0.56)**	(−0.01, 0.57)	(−0.15, 0.42)	(−0.09, 0.44)	(0.00, 0.53)	(−0.07, 0.45)	(−0.25, 0.33)	
Medical & recreational	2.38	0.05	0.11	0.12	0.08	0.03	0.01	0.07	0.15	
		(−0.05, 0.15)	(−0.10, 0.32)	(−0.12, 0.36)	(−0.15, 0.32)	(−0.20, 0.26)	(−0.23, 0.26)	(−0.18, 0.32)	(−0.13, 0.43)	

Notes. [a]Referent is the frequency of cannabis use on 03/11/2020 with β as the difference in number of days cannabis was used at the first of each month compared to March 11th. [b]Interaction terms are between the splines for days since 03/10/2020 and each sociodemographic characteristic. Bold font indicates statistical significance.

illicit markets or peers. For example, our data show that in states where cannabis is prohibited, days of cannabis use had a decreasing trend, although not statistically significant, over the course of the COVID-19 pandemic, with November having the greatest decrease compared to March. The study from the European Union notes that Ireland, Italy, Poland, and Portugal were the countries with the largest proportions of cannabis use reduction or stopped use, citing Italy's restrictions on movement within regions and Portugal's reported decrease in availability as factors in impeding access to cannabis (European Monitoring Centre for Drugs and Drug Addiction, 2020). On the other hand, in states where medical (and not recreational) cannabis was legally available, the level of cannabis use across the first 8 months of the pandemic was either similar to or modestly greater than baseline. Increased use in states that allow medical cannabis use may be an indicator of an exacerbation of common conditions treated with medical cannabis, including anxiety and insomnia. A prior study of US adults who use cannabis medicinally found that those with anxiety or depression reported increased use during the pandemic (Vidot et al., 2020).

Though the current study does not indicate that cannabis use increased significantly during the pandemic, there is a need to continue public health surveillance to monitor changes in cannabis use. As states expand efforts to vaccinate the larger US population and social distancing measures begin to be lifted in parts of the US, cannabis availability may return to normal for portions of the population that may have had limited access to cannabis during earlier phases of the pandemic. In the interest of further understanding the long-term effects of the pandemic on cannabis use, monitoring and further studies are needed. Future research should also explore associations between changes in cannabis use and mental health status before, during, and following the pandemic.

This study has several limitations that should be considered when interpreting findings. First, the survey only included measures of quantity, contents, or mode of cannabis consumption at two time points,

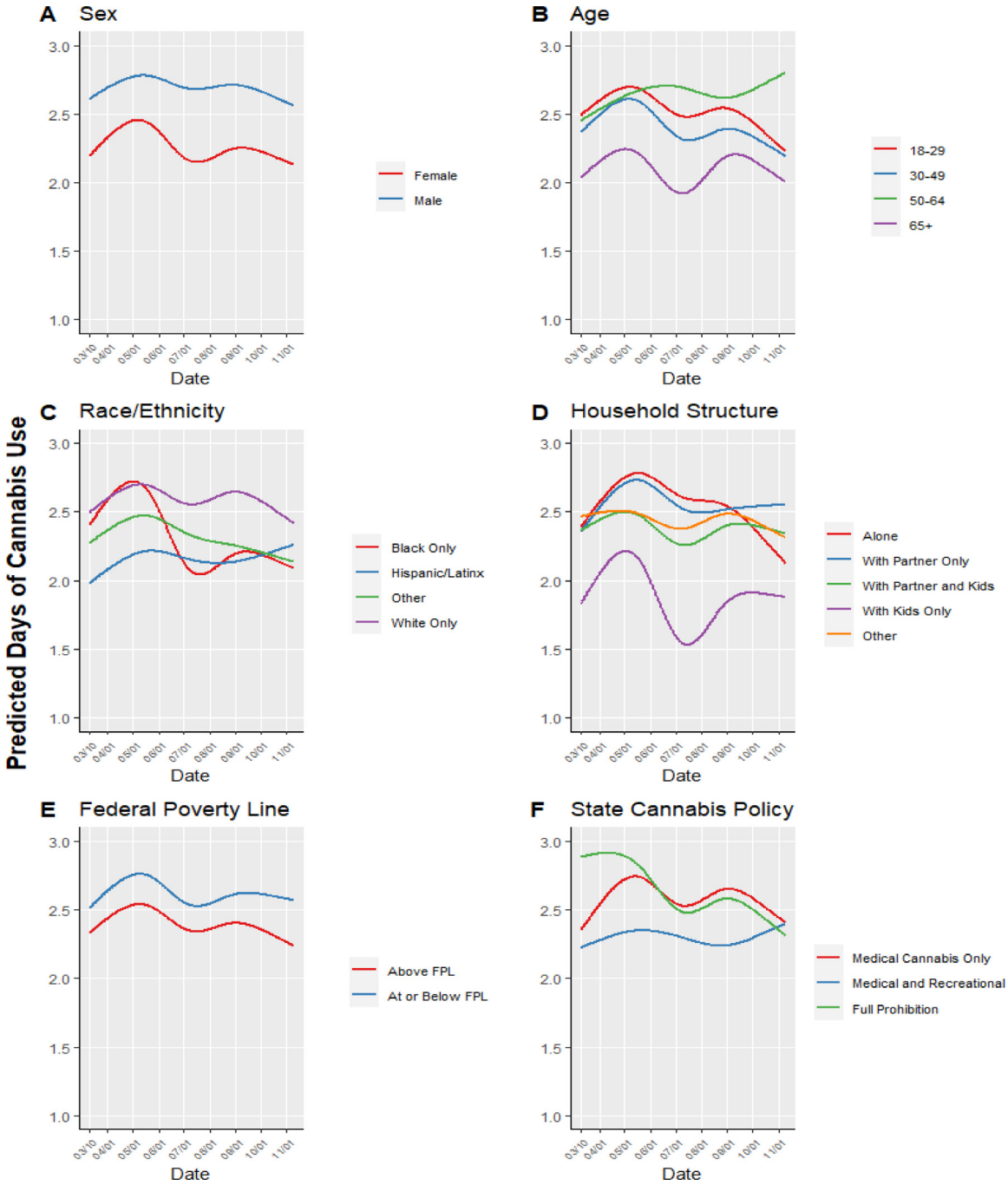

Fig. 1. Linear prediction of the number of days in the past week cannabis was used by date of survey completion, stratified by different sociodemographic characteristics, among US adults in the UAS Panel who used cannabis at least once during between March and November, 2020 (n = 1761).

Waves 4 and 5. Therefore, we are not able to understand changes in cannabis use that may be more clinically meaningful over time, such as quantity and mode of consumption. Second, there are sociodemographic characteristics known to be associated with cannabis use behaviors, such as education (Hasin et al., 2019) and sexual or gender identity (Substance Abuse and Mental Health Services Administration, 2020), that were not examined in this study. In addition, although most states with operational dispensaries deemed them "essential services", there were some time-variant changes in guidelines, including capacity limits, operating curbside pick-up, and delivery, that we were not able to account for in our analyses. These quickly evolving guidelines may have impacted individual access to cannabis and potentially cannabis use behaviors within certain populations. Further, due to small sample size, some sociodemographic groups were combined in our analyses; for example, Native Hawaiian/Pacific Islanders, American Indian/Alaskan Natives, and those reporting more than one race were categorized as "Other." It is also noted that some categories consisted of small sample sizes that may lack the statistical power to capture differences in trends across subgroups. These groups should be considered for future research to understand trends of cannabis use among these populations. Third, the analyses were conducted among individuals who ever used cannabis during the study period (March 10 - November 11, 2020) and may not be representative of all adults who use cannabis. Fourth, this panel did not have data on cannabis use prior to March 10th, and therefore we were not able to identify initiators of cannabis use or capture changes in cannabis use that may have occurred before the start of lockdown

measures. Fourth, although our survey weights were adjusted for nonresponse using baseline characteristics, they were not poststratified to account for nonresponse at each follow-up wave, which may have affected the representativeness of our sample and the generalizability of our findings.

Conclusion

In the United States, adults who used cannabis reported statistically significant increases in cannabis use days in April and May compared to March 2020, while reported cannabis use returned to levels comparable to March in June through November. Statistically significant increases in use during the early months of the pandemic were seen among several sociodemographic groups, including women, those living with only their partner, those living above the FPL, and those residing in states with medical cannabis only policies. Though increases in use were marginal among many groups, these population-level increases may mask individual, or group trajectories of reduction or escalation of cannabis use during the pandemic. Furthermore, there may exist individuals who increased their cannabis use during the pandemic and may have developed symptoms of cannabis use disorder (CUD), which were not assessed in the current study. Therefore, concerns for the mental health of the U.S. population warrants close and ongoing monitoring of coping behaviors, including substance use, during the current pandemic as well as future outbreaks and major disasters.

Declarations of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2021.103517.

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