Associations between alcohol and cannabis use before and during the COVID-19 pandemic: Results of a community survey

Kimberly Goodyear [a,b,*], Patience Moyo [c], Jaqueline C. Avila [a], Jasjit S. Ahluwalia [a], Mollie A. Monnig [a]

[a] Center for Alcohol and Addiction Studies, Department of Behavioral and Social Sciences, Brown University, Providence, RI, USA
[b] Center for Alcohol and Addiction Studies, Department of Psychiatry and Human Behavior, Brown University, Providence, RI, USA
[c] Center for Gerontology and Healthcare Research, Department of Health Services, Policy and Practice, Brown University, Providence, RI, USA

ARTICLE INFO

ABSTRACT

The COVID-19 pandemic has impacted individuals around the world, creating unprecedented challenges. Due to lockdowns and social distancing measures, many people have turned to contactless modes of obtaining alcohol and other substances (e.g., home delivery). This study investigated associations between alcohol and cannabis use before and during the initial months of the COVID-19 pandemic and factors associated with use. An online, cross-sectional survey with a non-probability sample ($N = 1126$) was conducted in Northeast states during June-July 2020. Outcomes examined prevalence of alcohol and cannabis use for the overall sample and predictors of use in individuals who used substances. In the overall sample, we found that alcohol and cannabis use decreased from before to during the pandemic. For individuals who drank alcohol, higher pre-pandemic drinking, mid-range household income, and obtaining alcohol through home delivery were associated with higher alcohol drinking during the pandemic. For individuals who used cannabis, higher pre-pandemic cannabis use and obtaining cannabis through home delivery were associated with higher cannabis use during the pandemic. Overall, from before to during the pandemic, we found a decrease in the proportion of individuals who used substances and no changes in quantity for individuals who continued to use substances. Home delivery was associated with greater use of alcohol and marijuana, supporting a need for further research on risk factors for heavier substance use.

1. Introduction

There has been increased social distancing and other public health measures to stop the spread of the novel coronavirus SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). The COVID-19 pandemic has differentially impacted individuals, and those with compromised immune systems, psychiatric conditions, or substance use disorders have been especially vulnerable to worsening mental health problems (Pfefferbaum & North, 2020). In addition, since the start of the COVID-19 pandemic, there is evidence of increased alcohol consumption (Pollard, Tucker, & Green, 2020) and other substance use (Czeisler et al., 2020) under certain circumstances.

The sales of alcohol and other commodities shifted to online, curbside pick-up and delivery in response to stay-at-home orders and closures of restaurants and other businesses (Norris, Taylor Jr, & Taylor, 2021). While most states deemed liquor stores and cannabis dispensaries

as essential businesses, several states closed liquor stores and recreational cannabis dispensaries (Redford & Dills, 2021). Based on previous public health crises, it has been postulated that lack of access or decreased physical/financial availability of substances like alcohol could potentially result in a decrease in consumption (Rehm et al., 2020). However, disruptions in ability to access alcohol and other substances can also lead to consequences such as withdrawal or changes in use, sometimes leading to other substance use. For example, a study showed that participants without access to cannabis products started using or increased their use of other substances, most commonly alcohol, during the pandemic (Boehnke, McAfee, Ackerman, & Kruger, 2021). A recent systematic review on the impact of the pandemic on alcohol use reported mixed findings as studies found decreased, unchanged, and increased alcohol use (Roberts et al., 2021). The same systematic review found a trend of increased non-alcohol substance (e.g., cannabis, opioids, methamphetamines, cocaine, benzodiazepines) use during the

---

pandemic. These disparate findings could be due to data collection in different countries/places, phases of the pandemic or sample size differences, which points to a need for further scrutiny of how the COVID-19 pandemic has impacted alcohol and other substance use.

Given the potential rise in number of individuals consuming alcohol and other substances during the pandemic, the first objective of this project was to examine associations in substance use (alcohol and cannabis) before COVID-19 and during the initial months of the COVID-19 pandemic. The second objective was to examine how differences across use status varied by sociodemographic characteristics and other measures (e.g., access to alcohol). We hypothesized that alcohol and marijuana use would be more likely during the pandemic compared to the pre-pandemic period. We also hypothesized that the quantity of the substance from pre-pandemic to during the pandemic would increase.

2. Methods

2.1. Participants

We analyzed data from an online, cross-sectional survey with a convenience sample that examined substance use, mental health, and health behaviors during the COVID-19 pandemic (Monnig et al., 2021). Survey participants were recruited from June 18 to July 19, 2020 and paid through Amazon's Mechanical Turk (MTurk). MTurk is a crowdsourcing platform that has been used extensively and reliably by various disciplines to recruit participants and collect data online (Boehnke et al., 2021). Participants were ≥ 18 years old, residing in pre-selected Northeast states (Connecticut, Massachusetts, New Jersey, New York, Rhode Island) and had an active MTurk account. To ensure a diverse sample, quotas based on age, gender, race and ethnicity were used. Race and ethnicity quotas were as follows: 40 % non-Hispanic White, 25 % Hispanic non-Black, 25 % Black any ethnicity, and 10 % non-Hispanic non-White. Within each racial/ethnic group, the following age quotas were applied: 10 %, 18–25 years; 20 %, 25–35 years; 20 %, 35–45 years; 25 %, 45–55 years; and 25 %, ≥55 years. Within each cell type, quotas stipulated equal proportions of men and women. Informed consent was obtained from all participants before beginning the survey. Participants were paid $10 upon survey completion. This study was reviewed by Brown University's Institutional Review Board (IRB) and was determined to be exempt from requiring IRB approval.

Participants were excluded if they did not pass at least two of the three validity checks embedded in the survey ($n = 12$), showed other invalid response patterns ($n = 18$), or were identified as a duplicate respondent ($n = 17$) (see Monnig et al., 2021 for further details). This project was pre-registered at https://osf.io/5md93. The analytic plan was slightly altered due to aforementioned participants exclusions and low cell counts for specific substances (i.e., the number of individuals using stimulants).

2.2. Measures

Substance use and access. Alcohol and cannabis use were recorded retrospectively using the Timeline Followback (TLFB) Interview (Sobell & Sobell, 1992) for the last week of February (February 23–29, 2020) before the start of pandemic in the United States (U.S.) and for the seven days preceding the survey (during the pandemic). The quantity of alcohol and cannabis used was measured as the total standard drinks and average drinks per drinking day (DDD) and total cannabis episodes, respectively, calculated from the TLFB for individuals who endorsed using these substances.

Access to substances was defined as "did you obtain alcohol and cannabis?" (yes/no). If the participant responded "yes," then they were asked how they obtained alcohol (by purchasing in store or restaurant, by home delivery or from another source, labeled as "other access") and how they obtained recreational or medical cannabis (by purchasing in a store, by home delivery or from another source, labeled as "other

access").

Sociodemographic characteristics. Participants were asked age; sex; gender; race, ethnicity; education level; income in dollars; how many adults (18 and older) live in the household; how many children (below the age of 18) live in the household; essential worker status: defined as "an essential worker is someone whose work is critical to business operations and/or meeting basic human needs and is required to attend work during the COVID pandemic"; employment status: asked as "have you, or has anyone in your household experienced a loss of employment since March 13, 2020?" (yes/no); state of residence (Connecticut, Massachusetts, New Jersey, New York, Rhode Island); worried about COVID-19: asked as "how worried are you about your risk of becoming infected with the novel coronavirus, or COVID-19?" (Not worried or had COVID/somewhat worried/moderately worried/very worried).

Table 1

Sociodemographic characteristics and related measures in the overall sample ($N = 1126$).

Measure		$M (\pm SD)$ or N (%)
Age, years		40.9 (13.5)
Sex/Gender[1]	Male	553 (49.1)
	Female	534 (47.4)
	Other	39 (3.5)
Race	White	566 (50.3)
	African American/Black	162 (14.4)
	Other	398 (35.3)
Ethnicity	Hispanic, Latino/a, or Spanish origin	303 (26.9)
	Not of Hispanic, Latino/a or Spanish origin	823 (73.1)
Education	High school or lower	109 (9.7)
	Some college	225 (20.0)
	College graduate	573 (50.9)
	Graduate degree	219 (19.4)
Annual household income ($)	<25,000	131 (11.6)
	25,000–34,999	129 (11.5)
	35,000–49,999	163 (14.5)
	50,000–74,999	300 (26.6)
	75,000–99,999	195 (17.3)
	100,00–149,999	132 (11.7)
	>150,000	75 (6.7)
Adults in the household	1 adult	201 (17.9)
	2 adults	518 (46.0)
	3 adults	223 (19.8)
	4 or more adults	160 (14.2)
Children (<18 years old) in the household	0 children	622 (55.2)
	1 child	285 (25.3)
	2 children	163 (14.5)
	3 or more children	56 (5.0)
Essential worker	Yes	396 (35.2)
	No	651 (57.8)
	Unsure	57 (5.1)
Loss of employment[2]	Yes	467 (41.5)
	No	659 (58.5)
Worried about COVID-19[3]	Not worried/had COVID	159 (14.1)
	Somewhat worried	312 (27.7)
	Moderately worried	371 (32.9)
	Very worried	284 (25.2)
State of residence	Connecticut	273 (24.2)
	Massachusetts	246 (21.8)
	New Jersey	171 (15.2)
	New York	315 (28.0)
	Rhode Island	121 (10.7)

M = mean; SD = standard deviation.

[1] Cisgender male if sex = "male" and gender = "man" and no other gender endorsed; cisgender female if sex = "female" and gender = "woman" and no other gender endorsed; and other for all other combinations.

[2] Question asked: Have you, or has anyone in your household experienced a loss of employment since March 13, 2020?

[3] Question asked: how worried are you about your risk of becoming infected with the novel coronavirus, or COVID-19?

2.3. Data analysis

2.3.1. Descriptive analyses for the overall sample

Data analysis was conducted with the Statistical Package for Social Sciences 26.0 (SPSS 26.0, IBM Corp.) and the level of statistical significance was set to $p < .05$. We first descriptively compared the proportion of individuals who used alcohol and cannabis, and the quantity of alcohol and cannabis used before and during the pandemic using McNemar's tests. We also compared modes of access to alcohol and cannabis, with the latter considering both medical and recreational use.

We then conducted descriptive analyses with chi-square tests and independent samples *t*-tests to examine differences across all sociodemographic characteristics on alcohol and cannabis use status (yes/no) before and during the pandemic.

2.3.2. Regression analyses

We conducted linear regression models to assess factors associated with alcohol and cannabis use quantity (total standard drinks, average DDD and total episodes) for individuals who used these substances prepandemic and during the pandemic. Only significant predictors from the descriptive analyses were included in the regression models to avoid overfitting each model.

2.4. Results

2.4.1. Participant characteristics

The final analytic sample included 1126 participants. Sociodemographic characteristics are presented in Table 1. About half of the sample was male (49.1 %), White (50.3 %), college graduates (50.9 %), living with two adults in the household (46.0 %) and had no children in the household (55.2 %). The average age was 40.9 years and about one-quarter of the sample had an annual income between $50,000-$74,999. About 35 % of participants identified as essential workers and about 41 % experienced loss of employment in their household since the start of COVID-19.

2.4.2. Substance use

About 46 % of the overall sample used alcohol before COVID-19 and that number reduced to about 42 % during COVID-19 ($p < .001$) (Table 2). For individuals who drank alcohol, total standard drinks and average DDD was nearly the same before and during COVID-19 and about 46 % of all participants did not obtain alcohol in the four weeks prior to completing the survey.

Almost 13 % of the overall sample used cannabis before COVID-19 and this percentage reduced to about 11 % during COVID-19 ($p = .009$). For individuals who used cannabis, total cannabis episodes stayed about the same before and during COVID-19. When examining access to cannabis overall, about 78 % of participants did not obtain cannabis and for those with access, 18.1 % had access to recreational cannabis and 12.6 % had access to medical cannabis (Table 2).

2.4.3. Descriptive results on use status for alcohol and cannabis

Prevalence of Substance Use Before and During COVID-19. Before COVID-19, the percentage of males (50.6 %) who used alcohol was the highest among the sex/gender categories and lowest (36.3 %) during COVID-19. Individuals who made >$150,000 (56 %) and had 2 adults in the household (46.9 %) had higher alcohol use. During COVID-19, alcohol use was lower for those who did not obtain alcohol (13.5 %) and higher for those with home delivery (68.4 %) and other access (66.4 %).

Cannabis use was higher for individuals with some college education (19.1 %) before COVID-19 and higher for individuals with high school or lower education (18.3 %) during COVID-19. Before COVID-19, cannabis use was higher among younger individuals (mean = 37.4 years) compared to individuals who did not use cannabis and during COVID-19, cannabis use was higher among Rhode Island residents (19 %), individuals very worried about COVID-19 (15.7 %) and individuals who had other access to cannabis (63.2 %) (see **Supplemental Table**).

2.4.4. Regression models

Associations of Alcohol Use. In the sample restricted to individuals who used alcohol before and during COVID-19, the linear regression model with total standard drinks showed that total standard drinks during COVID-19 was higher for every-one-unit increase in total standard drinks before COVID-19, ($\beta = 0.07$, $p < .001$). Compared to participants who had home delivery of alcohol, participants who did not obtain alcohol had lower standard drinks during COVID-19 ($\beta = -0.92$, $p < .001$).

The model with average DDD showed that that average DDD during COVID-19 was higher for every-one-unit increase in average DDD before

Table 2

Proportions of alcohol, cannabis and opioid use before and during the COVID-19 pandemic in the overall sample ($N = 1126$).

Measure		$M\ (\pm SD)$ or N (%)		*p*-value
		Before COVID-19	During COVID-19	
Alcohol use	**Yes**	**523 (46.4)**	**476 (42.3)**	**< 0.001**
	No	**603 (53.6)**	**650 (57.7)**	
Total standard drinks		12.0 (19.4)	11.9 (14.8)	0.775
Average DDD		3.1 (3.5)	2.9 (2.6)	0.277
Access to alcohol during the past 4 weeks[1]	Did not obtain		520 (46.2)	
	Delivery		171 (15.2)	
	Other access[2]		435 (38.6)	
Cannabis use	**Yes**	**145 (12.9)**	**127 (11.3)**	**0.009**
	No	**981 (87.1)**	**999 (88.7)**	
Cannabis episodes		22.6 (30.3)	23.6 (30.2)	0.780
Access to cannabis during the past 4 weeks[1]	Did not obtain		882 (78.3)	
	Delivery		100 (8.9)	
	Other access[3]		144 (12.8)	
Obtained recreational cannabis	Yes		204 (18.1)	
	No		921 (81.8)	
Obtained medical cannabis	Yes		142 (12.6)	
	No		984 (87.4)	

McNemar's tests (in bold font) indicated significant changes in proportions for alcohol and cannabis use before and during the COVID-19 pandemic. Quantity of alcohol (total standard drinks, average DDD) and cannabis episodes were restricted to participants who endorsed yes to using those substances.

M = mean; SD = standard deviation; DDD = drinks per drinking day.

[1] Percentages do not total to 100 % because participants were able to endorse more than one type of access.

[2] Purchasing in a store, restaurant or another source during COVID-19.

[3] Purchasing in a store or another source during COVID-19.

Table 3

Linear regression to estimate predictors of alcohol use quantity for individuals who used alcohol during COVID-19 (*n* = 470). Only significant predictors from the descriptive analyses were included in the regression model.

Predictors	Total standard drinks during COVID-19		Average DDD during COVID-19	
	β coefficient (95 % CI)	*p*-value	β coefficient (95 % CI)	*p*-value
Total standard drinks before COVID-19[1]	**0.07 (0.06; 0.08)**	**< 0.001**	NA	
Average DDD before COVID-19	NA		**0.11 (0.09; 0.13)**	**< 0.001**
Sex				
Male	0.06 (-0.18; 0.31)	0.603	−0.08 (-0.19; 0.03)	0.144
Other	−0.57 (-1.31; 0.18)	0.136	−0.12 (-0.47; 0.22)	0.490
Annual household income ($)				
<$25,000	−0.27 (-0.72; 0.18)	0.238	−0.16 (-0.36; 0.05)	0.137
$25,000-$34,999	−0.10 (-0.60; 0.39)	0.680	−0.11 (-0.34; 0.11)	0.321
$35,000-$49,999	−0.36 (-0.78; 0.06)	0.094	**−0.26 (-0.46; −0.07)**	**0.007**
$75,000-$99,999	−0.08 (-0.44; 0.28)	0.657	−0.06 (-0.22; 0.10)	0.491
$100,00-$149,999	−0.05 (-0.43; 0.33)	0.804	−0.06 (-0.23; 0.11)	0.471
>$150,000	0.03 (-0.42; 0.49)	0.888	−0.05 (-0.25; 0.16)	0.644
Adults in the household				
1 Adult	−0.10 (-0.46; 0.27)	0.610	−0.11 (-0.28; 0.06)	0.196
3 adults	−0.07 (-0.37; 0.24)	0.675	−0.06 (-0.20; 0.08)	0.388
4 + adults	0.02 (-0.36; 0.41)	0.901	−0.07 (-0.25; 0.10)	0.393
Age	0.01 (-0.00; 0.02)	0.192	−0.00 (-0.00; 0.00)	0.922
Access to alcohol				
Did not obtain	**−0.92 (-1.34; −0.50)**	**< 0.001**	**−0.32 (-0.51; −0.13)**	**0.001**
Other access	−0.08 (-0.35; 0.20)	0.588	0.03 (-0.10; 0.16)	0.637

Reference groups: female; $50,000-$74,999; 2 adults; home delivery.
CI = confidence interval; DDD = drinks per drinking day; NA = not applicable.
Adjusted total standard drinks R^2 = 0.504; Adjusted average DDD R^2 = 0.290.
[1] During the last week of February (February 23–29, 2020).

COVID-19, (β = 0.11, *p* <.001). Compared to participants with an income from $50,000-$74,999, participants with an income of $35,000-$49,999 had lower average DDD (β = -0.26, *p* <.01). Compared to participants who had home delivery of alcohol, participants who did not obtain alcohol had lower average DDD during COVID-19 (β = -0.32, *p* =.001) (Table 3).

Associations of Cannabis Use. In the sample restricted to individuals who used cannabis before and during COVID-19, the linear regression model showed that total cannabis episodes during COVID-19 was higher for every-one-unit increase in total cannabis episodes before COVID-19, (β = 0.06, *p* <.001). Compared to participants who had home delivery of cannabis, participants who did not obtain cannabis had lower total cannabis episodes during COVID-19 (β = -1.28, *p* =.048) (Table 4).

3. Discussion

The objective of this study was to quantify associations of alcohol and cannabis use before and during the COVID-19 pandemic and examine how differences across use status varied by sociodemographic characteristics and other measures. Our approach used an online survey in a non-probability sample of residents of five Northeast states (CT, MA, NJ, NY, RI). During the time of data collection, these states represented the highest number of COVID-19 cases and deaths per capita (Dong, Du, & Gardner, 2020). Our survey captured detailed data on alcohol and cannabis use during a one-week period both pre-pandemic (February 23–29, 2020) and in the early months (June and July) of the pandemic. The main findings of this study shed light on changes in substance use during the pandemic and related factors such as access to alcohol and cannabis. We hypothesized that alcohol and other substances use would be more prevalent and the intensity of substances used would increase during the pandemic compared to the pre-pandemic period. Surprisingly, we found that in the overall sample, the proportions of alcohol use and cannabis use decreased significantly. Second, higher pre-pandemic drinking, household income in the range of $35,000-$49,999, and obtaining alcohol through home delivery were statistically associated with greater alcohol drinking during the COVID-19 pandemic. Third, higher pre-pandemic cannabis use episodes and obtaining cannabis

through home delivery were statistically associated with greater cannabis use episodes during the pandemic.

Our study adds to the recent studies that have investigated changes in alcohol use in U.S. adults during the COVID-19 pandemic. In a longitudinal survey study with a nationally representative sample, Pollard et al. (2020) found an overall increase in frequency of drinking in women, non-Hispanic White individuals, and participants 30–59 years of age. In another longitudinal survey with a representative sample, Nordeck et al. (2021) identified an increase in drinking frequency from March 2020 to July 2020 among current drinkers but did not examine alcohol use quantity. In that study, males, older adults, those living with

Table 4

Linear regression to estimate predictors of total cannabis episodes for individuals who used cannabis during COVID-19 (*n* = 126). Only significant predictors from the descriptive analyses were included in the regression model.

Predictors	Total episodes during COVID-19	
	β coefficient (95 % CI)	*p*-value
Total episodes before COVID-19[1]	**0.06 (0.05; 0.07)**	**< 0.001**
Education		
High school or lower	−0.49 (-1.38; 0.41)	0.283
Some college	−0.31 (-1.01; 0.39)	0.377
Graduate degree	0.44 (-0.45; 1.33)	0.325
Worried about Covid-19		
Not worried/had COVID	0.61 (-0.25; 1.46)	0.164
Moderately worried	−0.00 (-0.74; 0.73)	0.995
Very worried	−0.61 (-1.46; 0.24)	0.156
Age	0.00 (-0.02; 0.03)	.0.688
State of Residence		
Connecticut	−0.07 (-0.93; 0.80)	0.879
New Jersey	−0.39 (-1.41; 0.62)	0.4442
New York	−0.33 (-1.18; 0.52)	0.443
Rhode Island	−0.19 (-1.07; 0.68)	0.660
Access to Cannabis		
Did not obtain	**−1.28 (-2.55; −0.01)**	**0.048**
Other Access	0.28 (-0.52; 1.08)	0.5

Reference groups: college graduate; somewhat worried; Massachusetts; home delivery.
CI = confidence interval; Adjusted R^2 = 0.629.
[1] During the last week of February (February 23–29, 2020).

a partner/alone/with a partner and children, those with higher incomes, and non-Hispanic White individuals showed sustained increases in drinking frequency over time. Finally, a cross-sectional survey examined changes in alcohol consumption among current drinkers from February 2020 to April 2020 and reported greater drinks per day and binge drinking in all demographic groups during the pandemic, as well as higher proportions of women and non-Hispanic Black individuals exceeding recommended drinking limits (Barbosa, Cowell, & Dowd, 2021). While the former studies demonstrated an increase in drinking during the pandemic, studies in other countries (López-Bueno et al., 2020; Wang et al., 2020) and the U.S. and Canada (McPhee et al., 2020; Wardell et al., 2020) have shown a decrease or little change in alcohol use. These findings are in line with other studies that showed a decrease in alcohol use among college drinkers (Jackson, Merrill, Stevens, Hayes, & White, 2021; White, Stevens, Hayes, & Jackson, 2020), suggesting a possible age factor to reductions in drinking during the pandemic. The current study identified an overall *decrease* in the proportion of alcohol use, from 46 % to 42 %, and while not directly tested in the overall proportions of alcohol use, factors such as age may have contributed to these differences. The main difference between our study and previous studies that found increased drinking was that we did not limit our analyses to current drinkers to discern prevalence. Thus, our study adds to prior research by investigating changes in proportions of alcohol use in a community sample of drinkers and non-drinkers.

In addition, we identified an overall decrease in cannabis use, from 13 % to 11 %. In contrast, another study in the U.S. illustrated that there has been increased use of cannabis during the pandemic (Rogers, Shepherd, Garey, & Zvolensky, 2020), and other countries have reported similar findings (Marais, Soderstrom, & Fatovich, 2020; Vanderbruggen et al., 2020). See Roberts et al. (2021) for a full review on alcohol and other substance use during the pandemic. The differences in cannabis found between our study and others could be due to the fact that we restricted our data to Northeast states.

In addition, we identified several predictors statistically associated substance use quantity. For both alcohol and cannabis, pre-pandemic use was a consistent predictor of use during the pandemic. Demographic predictors of substance use were relatively limited. Importantly, mode of access to alcohol or cannabis was associated with quantity of use. The finding that obtaining alcohol or cannabis through home delivery was associated with higher quantity of use is novel. Researchers have raised concern about relaxation of policies regarding delivery of substances during the pandemic (Matthay & Schmidt, 2021). However, our study is the first to our knowledge to present empirical data from the U.S. on home delivery of alcohol and cannabis during the pandemic in relation to levels of consumption. Consistent with our findings, a recent study in New Zealand found that online purchase of alcohol was associated with heavier drinking in the past week (Huckle, Parker, Romeo, & Casswell, 2021). Due to the observational nature of our study, we are unable to determine whether accessing alcohol or cannabis through home delivery is causally related to higher levels of consumption. However, a substantial body of research on alcohol outlet density presents strong evidence that greater physical availability of alcohol promotes higher consumption (Campbell et al., 2009; Middleton et al., 2010; Popova, Giesbrecht, Bekmuradov, & Patra, 2009; Sherk et al., 2018).

Limitations of our study include the use of a cross-sectional design with an online convenience sample. Data from this study was collected during the early stages of the pandemic, and while informative, substance use patterns may evolve as the pandemic continues. Although we collected detailed data on substance use for seven-day periods before and during the pandemic, it is possible that recall bias affected participants' ability to report their substance use accurately. In addition, because we only collected substance use for the past seven days, we may have missed important benchmarks such as initiation or resumption of use that occurred throughout the pandemic. However, seven-day periods were chosen to reduce participant burden in the context of an

online survey and sufficiently characterized typical substance use behaviors. As with all self-report measures, responses may be subject to desirability bias, although the deidentified nature of data collection would likely decrease such influences. Our sample had relatively high income and education, which may limit the generalizability of our results.

Strengths of the study include the assessment of substance use during the early stages of the pandemic, which is important for implementing policies (e.g., restrictions on obtaining substances) for future public health emergencies. To ensure relevance to the immediate public health crisis, our survey centered on the five Northeast states with highest COVID-19 infection and deaths rates per capita at the time of the study (Dong et al., 2020). While generalizability may be limited by restricting to the Northeast states, inclusion of states with similar COVID guidelines also reduced variability, which could have potentially impacted observed patterns of substance use. Lastly, we recruited a diverse sample by implementing quotas based on age, gender, race and ethnicity.

In conclusion, this study expands on the mixed findings on alcohol and cannabis use during the COVID-19 pandemic. If supported by other research, these findings have potential implications for public policy. Following 42 % growth in online alcohol sales in 2020, the U.S. is projected to become the largest market for alcohol ecommerce by the end of 2021 (IWSR, 2021). Alcohol home delivery is legal in most U.S. states, and regulations have become more permissive during the pandemic. In particular, regulations changed to allow restaurants and bars to deliver alcohol, and many states have extended these changes as the pandemic persists. Less is known about the prevalence and consequences of home cannabis delivery due to its recent emergence and mixed legality across states. Overall, the public health harms entailed by relaxation of substance delivery regulations are an important yet under-recognized COVID-19 impact. As the pandemic continues to persist, identification of risk factors for substance use and other related problems will be a necessary endeavor moving forward.

Author JCA, JS and MAM designed the study and wrote the protocol. Author KG and Author MAM conducted literature searches and provided summaries of previous research studies. Author KG conducted the statistical analysis. Author KG wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Declaration of Competing 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.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.abrep.2022.100455.

References

Barbosa, C., Cowell, A. J., & Dowd, W. N. (2021). Alcohol Consumption in Response to the COVID-19 Pandemic in the United States. *Journal of Addiction Medicine, 15*(4), 341–344. https://doi.org/10.1097/adm.0000000000000767

Boehnke, K. F., McAfee, J., Ackerman, J. M., & Kruger, D. J. (2021). Medication and substance use increases among people using cannabis medically during the COVID-19 pandemic. *International Journal on Drug Policy, 92*, 103053. https://doi.org/10.1016/j.drugpo.2020.103053

Campbell, C. A., Hahn, R. A., Elder, R., Brewer, R., Chattopadhyay, S., Fielding, J., … Middleton, J. C. (2009). The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms. *American Journal of Preventive Medicine, 37*(6), 556–569. https://doi.org/10.1016/j.amepre.2009.09.028

Czeisler, M.É., Lane, R. I., Petrosky, E., Wiley, J. F., Christensen, A., Njai, R., … Barger, L. K. (2020). Mental health, substance use, and suicidal ideation during the COVID-19 pandemic—United States, June 24–30, 2020. *Morbidity and Mortality Weekly Report, 69*(32), 1049.

Dong, E., Du, H., & Gardner, L. (2020). An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infectious Diseases, 20*(5), 533–534. https://doi.org/10.1016/s1473-3099(20)30120-1

Huckle, T., Parker, K., Romeo, J. S., & Casswell, S. (2021). Online alcohol delivery is associated with heavier drinking during the first New Zealand COVID-19 pandemic restrictions. *Drug and alcohol review, 40*(5), 826–834. https://doi.org/10.1111/dar.13222

Iwsr. (2021). Beverage alcohol ecommerce value grows by 42% in 2020, to reach US$24 billion. Retrieved from https://www.theiwsr.com/beverage-alcohol-ecommerce-value-grows-by-42-in-2020-to-reach-us24-billion/.

Jackson, K. M., Merrill, J. E., Stevens, A. K., Hayes, K. L., & White, H. R. (2021). Changes in Alcohol Use and Drinking Context due to the COVID-19 Pandemic: A Multimethod Study of College Student Drinkers. *Alcoholism, Clinical and Experimental Research, 45*(4), 752–764. https://doi.org/10.1111/acer.14574

López-Bueno, R., Calatayud, J., Casaña, J., Casajús, J. A., Smith, L., Tully, M. A., … López-Sánchez, G. F. (2020). COVID-19 Confinement and Health Risk Behaviors in Spain. *Frontiers in Psychology, 11*, 1426. https://doi.org/10.3389/fpsyg.2020.01426

Marais, C., Soderstrom, J., & Fatovich, D. (2020). Comparison of illicit drug-related presentations to the emergency department: Pre-COVID versus COVID. *Emerg Med Australas, 32*(5), 901. https://doi.org/10.1111/1742-6723.13597

Matthay, E. C., & Schmidt, L. A. (2021). Home delivery of legal intoxicants in the age of COVID-19. *Addiction, 116*(4), 691–693. https://doi.org/10.1111/add.15289

McPhee, M. D., Keough, M. T., Rundle, S., Heath, L. M., Wardell, J. D., & Hendershot, C. S. (2020). Depression, Environmental Reward, Coping Motives and Alcohol Consumption During the COVID-19 Pandemic. *Frontiers in Psychiatry, 11*, Article 574676. https://doi.org/10.3389/fpsyt.2020.574676

Middleton, J. C., Hahn, R. A., Kuzara, J. L., Elder, R., Brewer, R., Chattopadhyay, S., … Lawrence, B. (2010). Effectiveness of policies maintaining or restricting days of alcohol sales on excessive alcohol consumption and related harms. *American Journal of Preventive Medicine, 39*(6), 575–589. https://doi.org/10.1016/j.amepre.2010.09.015

Monnig, M. A., Padovano, H. T., Sokolovsky, A. W., DeCost, G., Aston, E. R., Haass-Koffler, C. L., … Ahluwalia, J. S. (2021). Association of Substance Use With Behavioral Adherence to Centers for Disease Control and Prevention Guidelines for COVID-19 Mitigation: Cross-sectional Web-Based Survey. *JMIR public health and surveillance, 7*(11), Article e29319.

Nordeck, C. D., Riehm, K. E., Smail, E. J., Holingue, C., Kane, J. C., Johnson, R. M., … Thrul, J. (2021). Changes in drinking days among United States adults during the COVID-19 pandemic. *Addiction.* https://doi.org/10.1111/add.15622

Norris, C. L., Taylor Jr, S., & Taylor, D. C. (2021). Pivot! How the restaurant industry adapted during COVID-19 restrictions. *International Hospitality Review, ahead-of-print* (ahead-of-print). doi:10.1108/IHR-09-2020-0052.

Pfefferbaum, B., & North, C. S. (2020). Mental Health and the Covid-19 Pandemic. *New England Journal of Medicine, 383*(6), 510–512. https://doi.org/10.1056/NEJMp2008017

Pollard, M. S., Tucker, J. S., & Green, H. D., Jr. (2020). Changes in Adult Alcohol Use and Consequences During the COVID-19 Pandemic in the US. *JAMA Network Open, 3*(9), e2022942–e. https://doi.org/10.1001/jamanetworkopen.2020.22942

Popova, S., Giesbrecht, N., Bekmuradov, D., & Patra, J. (2009). Hours and days of sale and density of alcohol outlets: Impacts on alcohol consumption and damage: A systematic review. *Alcohol and Alcoholism, 44*(5), 500–516. https://doi.org/10.1093/alcalc/agp054

Redford, A., & Dills, A. K. (2021). The political economy of drug and alcohol regulation during the COVID-19 pandemic. *Southern economic journal.* https://doi.org/10.1002/soej.12496. doi:10.1002/soej.12496

Rehm, J., Kilian, C., Ferreira-Borges, C., Jernigan, D., Monteiro, M., Parry, C. D. H., … Manthey, J. (2020). Alcohol use in times of the COVID 19: Implications for monitoring and policy. *Drug and alcohol review, 39*(4), 301–304. https://doi.org/10.1111/dar.13074

Roberts, A., Rogers, J., Mason, R., Siriwardena, A. N., Hogue, T., Whitley, G. A., & Law, G. R. (2021). Alcohol and other substance use during the COVID-19 pandemic: A systematic review. *Drug and Alcohol Dependence, 229*(Pt A), Article 109150. https://doi.org/10.1016/j.drugalcdep.2021.109150

Rogers, A. H., Shepherd, J. M., Garey, L., & Zvolensky, M. J. (2020). Psychological factors associated with substance use initiation during the COVID-19 pandemic. *Psychiatry Research, 293*, Article 113407. https://doi.org/10.1016/j.psychres.2020.113407

Sherk, A., Stockwell, T., Chikritzhs, T., Andréasson, S., Angus, C., Gripenberg, J., … Woods, J. (2018). Alcohol Consumption and the Physical Availability of Take-Away Alcohol: Systematic Reviews and Meta-Analyses of the Days and Hours of Sale and Outlet Density. *Journal of Studies on Alcohol and Drugs, 79*(1), 58–67.

Sobell, L. C., & Sobell, M. B. (1992). *Timeline follow-back. In Measuring alcohol consumption* (pp. 41–72). Springer.

Vanderbruggen, N., Matthys, F., Van Laere, S., Zeeuws, D., Santermans, L., Van den Ameele, S., & Crunelle, C. L. (2020). Self-Reported Alcohol, Tobacco, and Cannabis Use during COVID-19 Lockdown Measures: Results from a Web-Based Survey. *European Addiction Research, 26*(6), 309–315. https://doi.org/10.1159/000510822

Wang, Y., Lu, H., Hu, M., Wu, S., Chen, J., Wang, L., … Liao, Y. (2020). Alcohol Consumption in China Before and During COVID-19: Preliminary Results From an Online Retrospective Survey. *Frontiers in Psychiatry, 11*, Article 597826. https://doi.org/10.3389/fpsyt.2020.597826

Wardell, J. D., Kempe, T., Rapinda, K. K., Single, A., Bilevicius, E., Frohlich, J. R., … Keough, M. T. (2020). Drinking to Cope During COVID-19 Pandemic: The Role of External and Internal Factors in Coping Motive Pathways to Alcohol Use, Solitary Drinking, and Alcohol Problems. *Alcoholism, Clinical and Experimental Research, 44*(10), 2073–2083. https://doi.org/10.1111/acer.14425

White, H. R., Stevens, A. K., Hayes, K., & Jackson, K. M. (2020). Changes in alcohol consumption among college students due to COVID-19: Effects of campus closure and residential change. *Journal of Studies on Alcohol and Drugs, 81*(6), 725–730.