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Did the acute impact of the COVID-19 pandemic on drinking or nicotine use persist? Evidence from a cohort of emerging adults followed for up to nine years

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ABSTRACT

Objective: This study examined the impact of the COVID-19 pandemic on drinking and nicotine use through June of 2021 in a community-based sample of young adults.
Method: Data were from 348 individuals (49% female) enrolled in a long-term longitudinal study with an accelerated longitudinal design: the National Consortium on Alcohol and Neurodevelopment in Adolescence (NCANDA) Study. Individuals completed pre-pandemic assessments biannually from 2016 to early 2020, then completed up to three web-based, during-pandemic surveys in June 2020, December 2020, and June 2021. Assessments when individuals were 18.8–22.4 years old ($N = 1{,}458$) were used to compare drinking and nicotine use pre-pandemic vs. at each of the three during-pandemic timepoints, adjusting for the age-related increases expected over time.
Results: Compared to pre-pandemic, participants were less likely to report past-month drinking in June or December 2020, but there was an increase in drinking days among drinkers in June 2020. By June 2021, both the prevalence of past-month drinking and number of drinking days among drinks were similar to pre-pandemic levels. On average, there were no statistically significant differences between pre-pandemic and during-pandemic time points for binge drinking, typical drinking quantity, or nicotine use. Young adults who reported an adverse financial impact of the pandemic showed increased nicotine use while their peers showed stable or decreased nicotine use.
Conclusion: Initial effects of the pandemic on alcohol use faded by June 2021, and on average there was little effect of the pandemic on nicotine use.

1. Introduction

Advent of the coronavirus 2019 disease (COVID-19) pandemic was associated with changes in drinking and drug use among young adults. For alcohol, most studies found increases in the number of days drinking (Graupensperger, Fleming, et al., 2021; Jackson et al., 2021; Lechner et al., 2020; Papp & Kouros, 2021; Schepis et al., 2021; White et al., 2020) and decreases in the number of drinks consumed per occasion (Graupensperger, Fleming, et al., 2021; Jackson et al., 2021; Jaffe et al., 2021; White et al., 2020), though other studies have found no significant

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change (Fruehwirth et al., 2021; Minhas et al., 2021) or a decrease (Jaffe et al., 2021) in the number of days drinking. Studies found no change in the number of days using nicotine (Papp & Kouros, 2021) and no change (Graupensperger, Fleming, et al., 2021) or increases (Papp & Kouros, 2021; Schepis et al., 2021) in the number of days using cannabis during the pandemic.

The emergent literature has three key limitations. First, it is unclear whether the initial effects of the pandemic on drinking and nicotine use in the Spring-Summer of 2020 persisted over time. Most published work has focused on the immediate impact of public health policies to reduce the impact of the pandemic in March 2020 (e.g. changes in drinking after university closings; Bollen et al., 2021; Bonar et al., 2021; Graupensperger, Jaffe, et al., 2021; Jaffe et al., 2021; Lechner et al., 2020; Papp & Kouros, 2021; Ryerson et al., 2021; Schepis et al., 2021; White et al., 2020).

Second, those studies with more extended follow-up (del Vera et al., 2021) have not been designed to distinguish pandemic effects from maturation effects (Shadish et al., 2002), leaving it unclear to what extent the observed changes in drinking or nicotine use are specifically due to the COVID-19 pandemic. Developmental increases in drinking and drug use are expected as young adults mature, even absent a pandemic (Brown et al., 2008; Schulenberg et al., 2021). Thus, characterizing the effects of the pandemic in the medium- and long-term requires a design that can subtract out the developmental change that would be expected outside the pandemic context.

Third, initial evidence regarding an important potential moderator of the pandemic's impact—its impact on financial security—has been mixed. One study (Papp & Kouros, 2021) found financial strain was linked to greater pandemic-related increases in nicotine use during March and April 2020 while another study (Minhas et al., 2021) found loss of income did not moderate pandemic-related changes in drinking during June 2020. The financial impact of the pandemic on U.S. adults has been heterogenous and time-varying (Chetty et al., 2020), so both replication and extension of these findings with a longer period follow-up is warranted.

1.1. Current study

This study addressed the three limitations identified above using data from a prospective cohort of emerging adults participating in an accelerated longitudinal design: the National Consortium on Alcohol & Neurodevelopment in Adolescence (NCANDA) Study (Brown et al., 2015). Participants were assessed repeatedly from 2016 to early 2020, then completed up to three-web based surveys over the first 15 months of the COVID-19 pandemic. First, we tested whether drinking and nicotine use at surveys in June 2020, December 2020, and June 2021 had changed relative to pre-pandemic levels. Second, we tested whether the degree of pandemic-related change in drinking and nicotine use depended on the degree to which the pandemic impacted the individual's financial security.

2. Material and methods

2.1. Sample and design

Procedures were approved by Institutional Review Boards at each study site. The NCANDA Study was designed to investigate the impact of heavy alcohol use on neurodevelopment. 831 participants ages 12–21 years old were recruited into NCANDA in 2012–2014 and have been followed prospectively at five study sites across the U.S: Duke University, University of Pittsburgh Medical Center (UPMC), Oregon Health & Science University (OHSU), University of California San Diego (UCSD), and SRI International (SRI). Exclusion criteria were intentionally minimized: participants lived within 50 miles of the study site, had no MRI contraindications, had no reported prenatal or perinatal exposures or complications, had no pervasive developmental disorder, had no current or persistent major psychiatric disorder that would interfere with the protocol, and were not taking medications known to affect brain function or blood flow (see Brown et al., 2015). Each site aimed to recruit a community sample representative of the racial/ethnic distributions of their county. Participants were recruited through announcements at local schools and colleges, public notices, and targeted catchment-area calling. The current study draws data from 348 participants ages 12–15 years old at study entry—older participants were excluded to minimize the potential for cohort effects on drinking and nicotine use (discussed further below). 49% of participants were female. 13% identified as Hispanic; 68% as White, 12% as Black, 7% as Asian, and 8% as Alaskan Native or Pacific Islander. 84% of participants had 1 + parent(s) who completed a Bachelor's degree.

After completing their baseline assessment at study entry, participants were assessed every six months going forward with a combination of in-person assessments (annual basis) and phone interviews (midyear and annual) (Brown et al., 2015). The timing of follow-up visits was anchored to the date of the participant's baseline assessment (+6, + 12, +18 months, etc.). "Pre-pandemic" observations were any assessment occurring between study entry and March 19, 2020, the date of the first state-issued stay-at-home order, so each youth could contribute multiple assessments. Among youth contributing pre-pandemic data to analyses ($n = 281$), there were an average of 3.0 pre-pandemic assessments ($SD = 1.7$, range = [1, 7]).

During the COVID-19 pandemic, participants were invited to complete three web-based surveys in June 2020 (dates of completion: June 19-July 20), December 2020 (December 7-December 24), and June 2021 (June 7-June 25). Of the 348 participants included in analyses, 237 completed the June 2020 survey, 213 completed the December 2020 survey, and 195 completed the June 2021 survey. Completers of the pre-pandemic and during-pandemic assessments were sociodemographically similar (Table S1). Among the youth contributing during-pandemic data to analyses ($n = 288$), there were an average of 2.2 ($SD = 0.8$) during-pandemic observations. Altogether, 60 youth contributed only pre-pandemic data, 67 youth contributed only during-pandemic data, and 221 youth contributed both pre- and during-pandemic data.

2.2. Measures

2.2.1. Drinking and nicotine use

At each web-based survey during the pandemic, participants reported the number of days in the past 30 days they (a) had a drink containing alcohol, (b) consumed ≥ 5 alcoholic drinks (≥4 for females) within an occasion (i.e., binge drank), or (c) smoked or vaped a nicotine product. Response options included 0, 1–2, 3–5, 6–9, 10–19, 20–29, and 30 days; responses were rescaled to the midpoint of the stated range. Participants also reported the typical number of drinks they consumed within each 24-hour period of drinking in the past 30 days, on a free-response scale.

At each biannual assessment as part of the ongoing NCANDA protocol (Brown et al., 2015), participants had answered each of the drinking and nicotine use items described above. Item responses were free-form, so we rescaled them to match the corresponding value on the discrete scale used on the web-based, during-pandemic surveys. Nicotine use was measured only at midyear assessments and the typical number of drinks was measured only at annual assessments.

2.2.2. Financial impact of the pandemic

At the June 2021 during-pandemic survey, participants rated the extent to which the COVID-19 pandemic had negatively impacted their financial security on a five-point scale ranging from *no impact* (0) to *extreme impact* (4). 52% of participants endorsed some financial impact.

2.3. Analytic plan

Analyses were conducted in R v4.1.2 (R Core Team, 2021). We estimated the impact of the COVID-19 pandemic by comparing observations of same-age youth assessed at four different timepoints: (a) pre-pandemic (up to 7 observations from 2016-early 2020), (b) June 2020, (c) December 2020, and (d) June 2021. Conceptually, we used the pre-pandemic data to construct a reference curve for the expected drinking or nicotine use as a function of age, then compared that reference curve to the observed drinking and nicotine use as a function of age at each survey wave during the pandemic. In this way, we sought to distinguish the effects of the pandemic from age-related changes in drinking or nicotine use that would have occurred even outside the pandemic context.

We restricted the sample to participants $\leq$ age 15.8 years at study entry (in 2012–2014) to reduce potential cohort effects on drinking and nicotine use introduced by study entry criteria or by secular changes in drinking or nicotine use among U.S. young adults between 2016 and 2021 (e.g., advent of vaping increasing the prevalence of nicotine use). If cohort effects were present, they would be confounded with the effect of the COVID-19 pandemic (Fosse & Winship, 2019). Preliminary analyses showed date of birth was not predictive of drinking or nicotine use in the restricted sample after controlling for age, suggesting any remaining cohort effects were minimal (see supplement for further discussion). In addition, we restricted observations to those of participants ages 18.8–22.4 years old at each timepoint, to ensure we had observations covering the same age span at each of the four assessment timepoints and avoid extrapolation beyond the common region of support (Stuart, 2010).

Outcomes included the proportion of young adults drinking or using nicotine, the number of days drinking or using nicotine among those reporting any use, and the typical number of drinks per drinking day (Table 1 reports descriptive statistics for each variable). Longitudinal data were modeled using generalized estimating equations (GEEs). Regressions were fit in the *geepack* package (Højsgaard et al., 2005), clustering observations on participant, specifying an exchangeable correlation structure, and using robust standard errors. For dichotomous dependent variables, a logistic link function was used. Model specification included fixed effects for sex, race, ethnicity, study site, age at observation, age-at-observation-squared, and timepoint of assessment. Participant sex, race, ethnicity, and study site were included as covariates given previous work has established they predict alcohol and nicotine use (Schulenberg et al., 2021). Age at observation was included to implement our age-based identification strategy (Fosse & Winship, 2019); both linear and quadratic effects were included to account for nonlinear developmental changes in alcohol and nicotine use across this age range (Schulenberg et al., 2021). Timepoint of assessment was a four-level categorical variable (levels: pre-pandemic, June 2020, December 2020, June 2021), represented by dummy variables with pre-pandemic as the reference level.

Follow-up models investigated whether the effect of the COVID-19 pandemic varied as a function the impact of the pandemic on participants' financial security. We expanded the primary model described above by adding the main effect of financial impact and terms capturing the interaction of financial impact with timepoint. We then tested the statistical significance of the interaction via a Wald test (Højsgaard et al., 2005).

3. Results

Regression models compared drinking (Table 2) and nicotine use (Table 3) at the three during-pandemic timepoints to drinking and nicotine use pre-pandemic. Fig. 1, Panel A graphs the model-estimated means for a 20-year-old participant across timepoints, which are interpreted next. Compared to pre-pandemic (69%), significantly fewer participants reported any past-month drinking in June 2020 (60%; p =.01) and December 2020 (60%; p =.03), with the difference no longer being statistically significant in June 2021 (65%; p =.43). Compared to pre-pandemic, those reporting any past-month drinking drank on 1.83 (SE = 0.54) more days in June 2020 (p <.001), with the difference no longer being statistically significant in December 2020 (+0.48 days, p =.37) or June 2021 (+0.85 days, p =.13).

Compared to pre-pandemic, there were no significant differences at any of the three during-pandemic timepoints in the number of drinks on a typical drinking day or the binge drinking or nicotine use outcomes (ps = 0.10-0.97). Tables 2 and 3 reports the corresponding effect sizes. Compared to pre-pandemic, 4–5% fewer participants engaged in past-month binge drinking in June 2020 and December 2020, though neither difference was statistically significant (ps = 0.12-0.23).

We did not find evidence that the degree to which the pandemic impacted participants' financial security moderated the pandemic's impact on drinking outcomes (Wald test ps = 0.19–0.93; Table 4). We found evidence that the degree to which the pandemic impacted participants' financial security moderated the pandemic's impact on the number of days using nicotine among past-month users (Wald test p <.001; Table 5) but not the prevalence of past-month nicotine use (Wald test p =.07; Table 5). Fig. 1, Panel B graphs the interactions for the nicotine use outcomes. Among those reporting any past-month nicotine use, participants who experienced moderate-to-extreme financial impact increased the number of days using nicotine while those with no financial impact decreased the number of days using nicotine in June 2020 (p =.01).

4. Discussion

We investigated changes in drinking and nicotine use from pre-pandemic baseline over the first 15 months of the COVID-19 pandemic in a sample of 348 emerging adults ages 18–22 years old. Compared to pre-pandemic, in June 2020, fewer young adults reported past-month drinking, but those who did were drinking on more days. Compared to pre-pandemic, in December 2020, fewer young adults reported past-month drinking, but those who did were no longer drinking on significantly more days. By follow-up in June 2021, on average, there were no significant differences from pre-pandemic patterns of alcohol and nicotine use.

Findings are consistent with previous short-term studies (Jackson et al., 2021; Jaffe et al., 2021; Lechner et al., 2020; Papp & Kouros, 2021; Schepis et al., 2021; White et al., 2020) showing a pandemic-

Table 1
Descriptive Statistics for Dependent Variables.

Measure	*N*	Proportion	Mean	*SD*	Skewness	Min.	Max.
Any alcohol use in past month (yes/no)	1,485	66%	–	–	–	–	–
Among those with past-month drinking, # days drank	980		6.3	6.0	1.6	1.5	30
Among those with past-month drinking, # drinks on typical drinking day	700		3.2	2.5	2.2	0.5	20
Any days with 5 + drinks (males) or 4 + drinks (females) in past month (yes/no)	1,485	40%	–	–	–	–	–
Among those with past-month binge drinking, # days had 5 + drinks (males) or 4 + drinks (females)	592		4.1	4.2	2.5	1.5	24.5
Any nicotine product use in past month (yes/no)	1,051	25%	–	–	–	–	–
Among those with past-month nicotine product use, # days used	259		14.8	11.4	0.2	1.5	30

Note. N = number of observations, SD = standard deviation, Min. = minimum, Max. = maximum.

Table 2
Regression Models for Testing Impact of COVID-19 Pandemic on Drinking.

	Any alcohol use in past month (yes/no)				Among those with past-month drinking:						Any days with 5 + drinks (males) or 4 + drinks (females) in past month (yes/no)				Among those with past-month binge drinking:			
					# days drank				# drinks on typical drinking day						# days 5 + drinks (males) or 4 + drinks (females)			
	$N_{partic} = 348$, $N_{obs} = 1485$				$N_{partic} = 285$, $N_{obs} = 980$				$N_{partic} = 269$, $N_{obs} = 700$				$N_{partic} = 348$, $N_{obs} = 1485$				$N_{partic} = 215$, $N_{obs} = 592$			
Term	**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***		**B**	**SE**	***p***		**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***	
(Intercept)	–	0.72	0.24	0.003	5.85	0.63	<0.001		4.60	0.35	<0.001		–	0.32	0.22	0.15	3.92	0.43	<0.001	
Age	1.67	0.51	0.08	<0.001	1.30	0.24	<0.001		−0.11	0.12	0.36		1.46	0.38	0.08	<0.001	−0.05	0.24	0.84	
Age^2	1.02	0.01	0.06	0.80	0.33	0.19	0.09		−0.04	0.08	0.62		0.96	−0.04	0.05	0.41	0.30	0.20	0.13	
COVID-19: June 2020	0.68	−0.38	0.15	0.01	1.83	0.54	<0.001		−0.32	0.20	0.10		0.80	−0.22	0.14	0.12	0.11	0.46	0.81	
COVID-19: December 2020	0.69	−0.37	0.17	0.03	0.48	0.54	0.37		−0.08	0.25	0.73		0.82	−0.20	0.17	0.23	−0.05	0.51	0.92	
COVID-19: June 2021	0.85	−0.16	0.20	0.43	0.85	0.56	0.13		0.14	0.28	0.61		1.18	0.17	0.19	0.37	−0.02	0.51	0.97	

Note. N_{partic} = number of participants in model, N_{obs} = number of observations in model, B = coefficient, SE = standard error, p = p-value. Table reports five GEE regression models, one for each dependent variable. Exponentiated coefficients are reported only for regressions fit with logistic link function. Age was centered at 20 years old. Fixed effects for participant sex, race, ethnicity, and study site are omitted. Given reference levels of covariates, intercept is the estimated mean for white, non-Hispanic, male participant, aged 20 years old, at the UC San Diego study site, at an observation before the COVID-19 pandemic.

Table 3
Regression Models for Testing Impact of COVID-19 Pandemic on Nicotine Use.

	Dependent Variable						
	Any nicotine product use in past month (yes/no)				**Among those with past-month nicotine product use: # days used**		
	$N_{partic} = 335$, $N_{obs} = 1051$				$N_{partic} = 123$, $N_{obs} = 259$		
Term	**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***
(Intercept)	–	−0.46	0.28	0.10	15.63	2.13	<0.001
Age	1.40	0.34	0.11	0.002	0.79	1.14	0.49
Age^2	0.93	−0.08	0.06	0.21	0.11	0.63	0.86
COVID-19: June 2020	1.03	0.03	0.15	0.83	1.29	1.61	0.42
COVID-19: December 2020	1.12	0.11	0.18	0.53	−1.00	1.78	0.58
COVID-19: June 2021	1.14	0.13	0.22	0.55	−0.67	2.13	0.75

Note. N_{partic} = number of participants in model, N_{obs} = number of observations in model, B = coefficient, SE = standard error, p = p-value. Table reports two GEE regression models, one for each dependent variable. Exponentiated coefficients are reported only for regressions fit with logistic link function. Age was centered at 20 years old. Fixed effects for participant sex, race, ethnicity, and study site are omitted. Given reference levels of covariates, intercept is the estimated mean for white, non-Hispanic, male participant, aged 20 years old, at the UC San Diego study site, at an observation before the COVID-19 pandemic.

related increase in the number of days drinking. In our data, this change reflected a different distribution of drinking across the population: compared to pre-pandemic, fewer young adults were drinking, but those who did drank more frequently.

While two previous studies found decreases in binge drinking (Bonar et al., 2021; Graupensperger, Jaffe, et al., 2021), we did not find a statistically significant change in the number of days of binge drinking at any timepoint in the current study. However, the non-significant reduction we observed in binge drinking in June and December 2020 (Fig. 1) was directionally consistent with these previous studies. In addition, the timeframe of measurement may explain the discrepancy: those two previous studies focused on changes earlier during the pandemic, in March and April 2020, whereas another study (Fruehwirth et al., 2021) focusing on changes in June and July 2020 (similar to our study) also found no significant change in binge drinking.

As in one previous study (Papp & Kouros, 2021), we did not find an average effect of the pandemic on nicotine use. However, this appeared to obscure opposing changes among those who suffered vs. did not experience impacts on their financial security. Relative to pre-pandemic, in June 2020, those with past-month nicotine use had increased the number of days using if they experienced financial impact and had stable or decreased number of days using if they denied experiencing financial impact (p =.01). Loss of job or reduction in work hours could increase smoking during periods of boredom at home or to cope with the attendant stress (Klein et al., 2021). This pattern is consistent with the larger literature documenting how the pandemic may exacerbate health disparities based on pre-existing socioeconomic advantage (Karmakar et al., 2021; Lopez et al., 2021). However, moderation of multiple outcomes was tested, so the current findings should be regarded as preliminary and await replication.

This study had limitations. First, findings may not generalize beyond emerging adults ages 18–22 years old (Ohannessian, 2021). Second, for nicotine use, we did not measure the quantity used each day, which could have changed. Third, we did not consider other substances such as cannabis. Fourth, the mode of assessment differed from the pre-

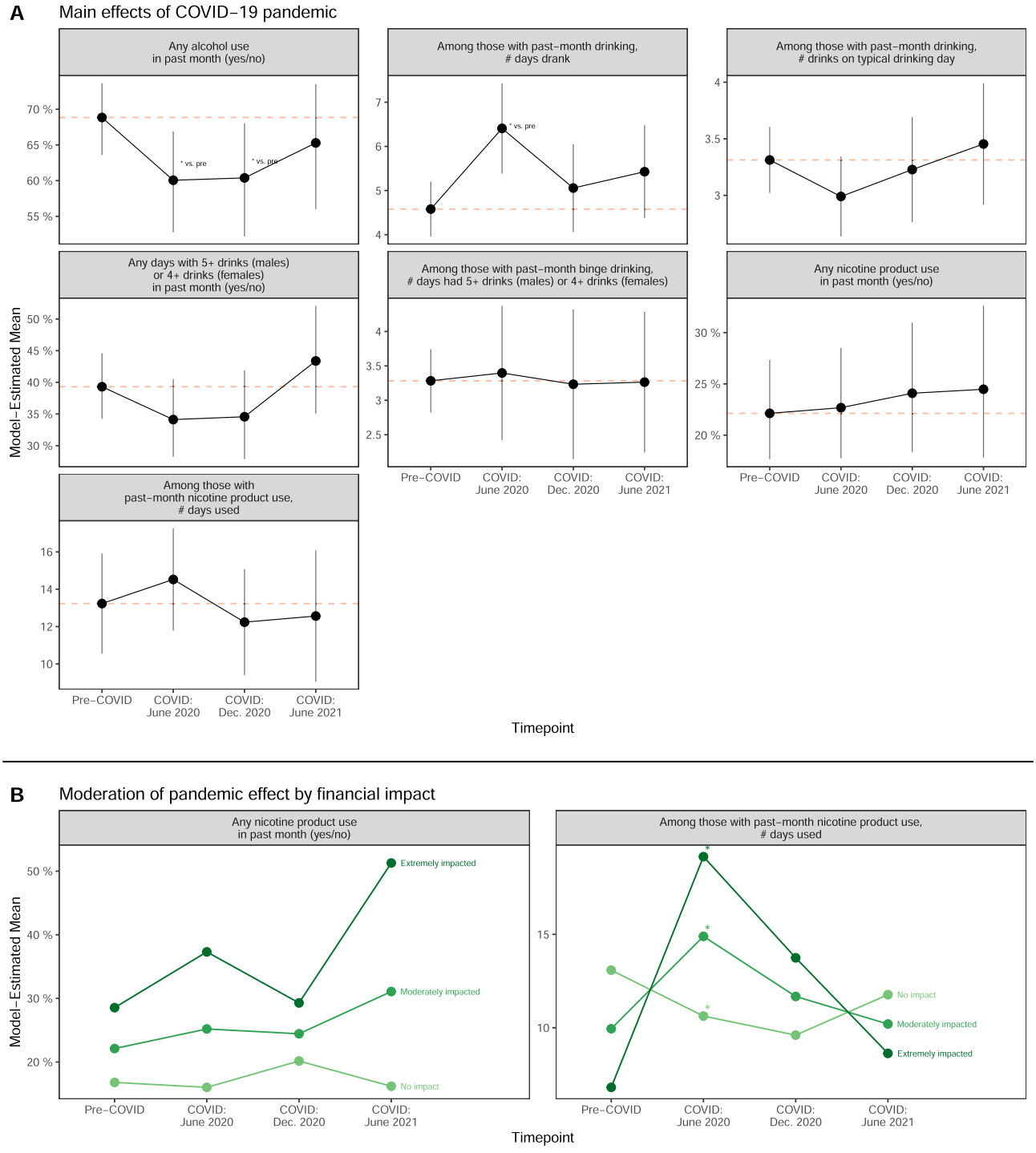

Fig. 1. Changes in Drinking and Nicotine Use Associated with COVID-19 Pandemic. Note. Data drawn from a sample of emerging adults, the National Consortium on Alcohol and Neurodevelopment (NCANDA) Study. Participants (49% female) were ages 18–22 when contributing data to these analyses. Upper set of panels (A) graph model-estimated means across timepoints per regressions reported in Tables 2 and 3. Means were estimated for a person age 20 years old, averaging over covariate levels and weighting in proportion to their sample frequency (Lenth, 2018). Horizontal, dashed red lines indicate the mean level pre-COVID, for reference. Vertical bars indicate asymptotic 95% confidence intervals. Asterisks next to dots indicate estimated mean at the during-pandemic assessment was significantly different (p <.05) from estimated mean at pre-pandemic assessments. Lower set of panels (B) graphs model-estimated means across timepoints as a function of the pandemic's cumulative impact on financial security. Means were estimated for a person age 20 years, averaging over covariate levels and weighting in proportion to their sample frequency (Lenth, 2018). Asterisks indicate the model-estimated means differed significantly (p <.05) at that timepoint as a function of the level of cumulative financial impact. All models adjusted for age; thus, the above plots compare estimated means for same-age-youth at each longitudinal timepoint, subtracting out any expected developmental increase in drinking or nicotine use. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 4
Regression Models for Drinking Outcomes with Interaction Terms for Impact of Pandemic on Financial Security.

	Dependent Variable																
	Any alcohol use in past month (yes/no)				**Among those with past-month drinking:**						**Any days with 5 + drinks (males) or 4 + drinks (females) in past month (yes/no)**				**Among those with past-month binge drinking:**		
					# days drank			**# drinks on typical drinking day**							**# days 5 + drinks (males) or 4 + drinks (females)**		
	$N_{partic} = 264$, $N_{obs} = 1238$				$N_{partic} = 217$, $N_{obs} = 808$			$N_{partic} = 206$, $N_{obs} = 585$			$N_{partic} = 264$, $N_{obs} = 1238$				$N_{partic} = 165$, $N_{obs} = 475$		
	Wald test for interaction: chisq(3) = 1.67, p =.64				**Wald test for interaction: chisq(3) = 1.95, p =.58**			**Wald test for interaction: chisq(3) = 4.21, p =.24**			**Wald test for interaction: chisq (3) = 4.78, p =.19**				**Wald test for interaction: chisq(3) = 0.46, p =.93**		
Term	**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***	**B**	**SE**	***p***	**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***
(Intercept)	–	0.34	0.32	0.29	5.72	0.85	<0.001	4.91	0.44	<0.001	–	0.22	0.31	0.47	4.20	0.64	<0.001
Age	1.62	0.48	0.09	<0.001	1.10	0.28	<0.001	−0.15	0.13	0.26	1.45	0.37	0.09	<0.001	−0.07	0.26	0.80
Age^2	1.02	0.02	0.06	0.77	0.42	0.21	0.053	−0.01	0.08	0.92	0.95	−0.05	0.06	0.37	0.33	0.22	0.13
COVID-19: June 2020	0.65	−0.42	0.22	0.049	1.49	0.78	0.06	−0.54	0.27	0.048	0.68	−0.39	0.21	0.07	0.31	0.75	0.68
COVID-19: December 2020	0.79	−0.23	0.23	0.30	0.43	0.69	0.53	−0.48	0.38	0.21	0.89	−0.12	0.23	0.61	−0.50	0.67	0.45
COVID-19: June 2021	0.81	−0.21	0.25	0.40	1.14	0.69	0.10	−0.00	0.38	0.99	1.08	0.07	0.25	0.77	0.04	0.59	0.95
Total pandemic impact on finances	1.07	0.07	0.11	0.56	0.32	0.25	0.19	−0.21	0.14	0.14	0.94	−0.06	0.11	0.57	0.13	0.25	0.61
Total pandemic impact on finances × COVID-19: June 2020	1.10	0.10	0.14	0.49	0.53	0.59	0.37	0.27	0.20	0.18	1.30	0.26	0.14	0.07	−0.17	0.46	0.71
Total pandemic impact on finances × COVID-19: December 2020	0.93	−0.07	0.15	0.63	0.25	0.52	0.63	0.44	0.27	0.10	0.94	−0.06	0.12	0.62	0.47	0.75	0.53
Total pandemic impact on finances × COVID-19: June 2021	1.15	0.14	0.18	0.44	−0.04	0.51	0.94	0.17	0.19	0.37	1.16	0.15	0.14	0.29	−0.06	0.28	0.84

Note. N_{partic} = number of participants in model, N_{obs} = number of observations in model, B = coefficient, SE = standard error, p = p-value. Reports five GEE regression models, one for each dependent variable. Exponentiated coefficients are reported only for regressions fit with logistic link function. Age was centered at 20 years old. Fixed effects for participant sex, race, ethnicity, and study site are omitted. "Total pandemic impact on finances" is on 5-point scale ranging from 0 (no impact) to 4 (extreme impact).

Table 5
Regression Models for Nicotine Use Outcomes with Interaction Terms for Impact of Pandemic on Financial Security.

	Dependent Variable						
	Any nicotine product use in past month (yes/no)				Among those with past-month nicotine product use: # days used		
	$N_{partic} = 264$, $N_{obs} = 916$				$N_{partic} = 93$, $N_{obs} = 207$		
	Wald test for interaction: chisq (3) = 7.14, p =.07				Wald test for interaction: chisq(3) = 18.20, p <.001		
Term	**Odds Ratio**	**B**	**SE**	***p***	**B**	**SE**	***p***
(Intercept)	–	−1.06	0.40	0.008	13.03	3.00	<0.001
Age	1.36	0.31	0.13	0.01	1.28	1.31	0.33
Age^2	0.93	−0.07	0.07	0.31	−0.01	0.65	0.99
COVID-19: June 2020	0.94	−0.06	0.21	0.78	−2.46	2.56	0.34
COVID-19: December 2020	1.25	0.22	0.23	0.32	−3.48	2.46	0.16
COVID-19: June 2021	0.96	−0.04	0.28	0.88	−1.31	2.89	0.65
Total pandemic impact on finances	1.19	0.17	0.14	0.22	−1.57	1.35	0.24
Total pandemic impact on finances × COVID-19: June 2020	1.12	0.11	0.11	0.30	3.70	1.43	0.010
Total pandemic impact on finances × COVID-19: December 2020	0.95	−0.05	0.12	0.70	2.60	1.52	0.09
Total pandemic impact on finances × COVID-19: June 2021	1.29	0.25	0.17	0.13	0.78	2.15	0.72

Note. N_{partic} = number of participants in model, N_{obs} = number of observations in model, B = coefficient, SE = standard error, p = p-value. Reports two GEE regression models, one for each dependent variable. Exponentiated coefficients are reported only for regressions fit with logistic link function. Age was centered at 20 years old. Fixed effects for participant sex, race, ethnicity, and study site are omitted. "Total pandemic impact on finances" is on 5-point scale ranging from 0 (no impact) to 4 (extreme impact).

pandemic (in-person or via phone) to during-pandemic (via web) assessments, potentially introducing differences.[1] Fifth, secular changes in the rates of alcohol or nicotine use among young adults between 2016 and 2021 could be confounding the effect of the pandemic, potentially introducing bias.[2] Sixth, pre-pandemic responses on a free-response scale had to be mapped onto the discrete response options (e.g., "12 days" was recoded as "10–19 days"), potentially limiting precision. Seventh, we assessed the degree to which the pandemic impacted individuals' financial security but not the form of this impact (e.g., loss of job). Eighth, pre-pandemic observations were not anchored to the months of June and December, so seasonal effects could explain part of the observed differences.

We reported here the most extended follow-up to date of pandemic-related changes in drinking and nicotine use in emerging adults. The study had several further strengths. We used seven years of pre-pandemic assessments and a rigorous age-based design to identify the pandemic's impact over and above typical developmental changes. We incorporated three assessments spanning the first 15 months of the pandemic to study whether early changes in drinking and nicotine use persisted. Participants spanned five sites across the U.S and multiple racial and ethnic backgrounds. Finally, we focused on a critical developmental period (emerging adulthood) associated with elevated risk for problematic use (Schulenberg et al., 2021).

In summary, in a heterogeneous group of young adults, pandemic-related changes in drinking patterns were no longer detectable in June 2021. Pandemic-related increases in nicotine use occurred only for participants who reported greater impact of the pandemic on their financial security—these subgroup effects were no longer statistically significant in June 2021, though a large effect size for past-month nicotine use remained. Thus, those whose financial security has been adversely impacted by the pandemic may reflect a vulnerable group worth targeting for supports to manage drinking and nicotine use. Continued follow-up beyond summer 2021 is necessary to verify that the pandemic's effects on drinking and nicotine use have indeed faded and understand the pandemic's long-run impacts of substance use trajectories into adulthood.

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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 data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2022.107313.

[1] To probe potential differences by mode-of-assessment, we asked 32 participants to complete the web-based survey again at their next annual visit within the ongoing NCANDA Study protocol. This gave us the opportunity to compare a participant's past-month alcohol use reported on the same day (a) via the web-based surveys used to measure drinking during the pandemic versus (b) via the interviews used to measure pre-pandemic drinking. In paired comparisons responses to the two formats, we found no significant differences in the number of days drinking (p=.13), the number of drinks per typical drinking day (p=.69), or the number of days with 5+ (males) or 4+ (females) drinks (p=.26).

[2] We did not find evidence of cohort effects after restricting the sample (see supplement). To probe cohort effects, we tested whether participant date of birth predicted the drinking and nicotine use outcomes when adjusting for age. Date of birth had a non-significant and weak association with all outcomes, suggesting any cohort effect was minimal.

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