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Increased alcohol use during the COVID-19 pandemic: The effect of mental health and age in a cross-sectional sample of social media users in the U.S.

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ABSTRACT

The COVID-19 pandemic has triggered a public health crisis of unprecedented scale. Increased alcohol use has been extensively documented during other crises, particularly among persons with anxiety and depression. Despite COVID-19's differential impact by age, the association of age, mental health and alcohol use during the pandemic has not been explored. This study aimed to examine whether age modified the association of anxiety and depressive symptoms with alcohol use during the COVID-19 pandemic. Two online surveys were administered to U.S. adult social media users in March and April 2020. Generalized linear models were conducted in 2020 among 5850 respondents (52.9% female; 22.0% aged 18–39 years, 47.0% aged 40–59 years, and 31.0% aged ≥ 60 years) to examine if age modified the association of anxiety and depression symptomatology and alcohol use. Overall, 29% of respondents reported increased alcohol use. Adjusted odds ratios of reporting increased alcohol use were 1.41 (95% CI = 1.20–1.66) among respondents with anxiety symptoms and 1.64 (95% CI = 1.21–2.23) among those with depressive symptoms compared to those without such symptoms. Whereas respondents aged 18–39 years had the highest probability of reporting increased alcohol use, the probability of older persons (40–59 and ≥ 60 years) reporting increased drinking was much greater among those with symptoms of anxiety and depression, compared to those without symptoms. These findings warrant age-differentiated public health messaging on the risks of excessive alcohol use and scale-up of substance use services for middle-aged and older adults with symptoms of depression and anxiety.

1. Introduction

The emergence and rapid spread of the novel coronavirus disease (COVID-19) across the United States (U.S.) has created a public health and social crisis at a scale unprecedented in recent U.S. history (Fauci et al., 2020). Millions of people saw their lives disrupted; some suffered the direct health effects of COVID-19 (Centers for Disease Control and Prevention, 2020); many more had their lives upended by the slowing economy and unemployment (Gangopadhyaya and Garrett, 2020; Baker et al., 2020). Quarantine and social distancing, necessary measures to mitigate the pandemic, may further worsen stress-related mental health (Galea et al., 2020). Previous research has documented elevated alcohol use in response to stressors (Keyes et al., 2012), including economic

crises (de Goeij et al., 2015), and disasters (Keyes et al., 2012; Vlahov et al., 2004; Wu et al., 2008). The American Psychological Association has called for increases in mental health services to respond to an impending parallel epidemic of mental illness brought on by social isolation coupled with economic insecurity (Brooks et al., 2020; Horesh and Brown, 2020; Chang et al., 2013), and public health experts have warned about possible increases in alcohol use during COVID-19 (Clay and Parker, 2020; Koob, 2020).

Depression and anxiety symptoms, already major causes of disability (Friedrich, 2017), are further exacerbated by disasters (Galea et al., 2020; Pfefferbaum and North, 2020). Several meta-analyses have estimated elevated odds of developing depressive disorders following humanitarian emergencies (Bonde et al., 2016; Tang et al., 2014). For

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example, exposure to natural disasters was associated with over a two-fold increase in developing depressive disorders (Bonde et al., 2016), while emerging epidemics, such as SARS and H1N1, were associated with poor long-term mental health outcomes among those affected (Mak et al., 2009; Chen et al., 2006; Wong et al., 2007; Wheaton et al., 2012; Elizarrarás-Rivas et al., 2010). In addition to the detrimental consequences of acute stress, prolonged social separation can also impair mental health (Person et al., 2004; Lu and Jennifer, 2020; Shultz et al., 2016). Three years after the 2003 SARS outbreak in China, odds of developing depression among hospital staff who had been quarantined were more than four-fold those who had not been (Liu et al., 2012). See the Conceptual Model in Fig. S1 in the Appendix.

Problem alcohol use and internalizing disorders such as anxiety and depression are often co-morbid; an estimated 40% of U.S. adults with major depression and about 37%–61% of those with generalized anxiety disorder experience co-morbid alcohol use disorder (Hasin et al., 2005; Smith and Randall, 2012). People with existing mental health disorders are more likely to increase alcohol use in response to stressors, as documented following terrorist attacks and natural disasters (Agyapong et al., 2018; Vlahov et al., 2006). The disruptive and stressful conditions created by COVID-19, coupled with social distancing and quarantine requirements, are likely to exacerbate problem alcohol use among persons with symptoms of anxiety and depression (Galea et al., 2020; Pfefferbaum and North, 2020).

Perceived risk and severity may also be associated with internalizing disorders and alcohol use following exposure to stressors, as in the aftermath of SARS, where higher levels of perceived risk were associated with increased odds of severe depressive symptoms (Liu et al., 2012). Following terrorist attacks, comorbid depression and higher perceived risk and severity were associated with increased alcohol use among hospital staff (Grieger et al., 2003).

The mental health consequences of COVID-19, as well as mitigation strategies, may have differential effects as a function of age (Armitage and Nellums, 2020; Berg-Weger and Morley, 2020). Older age increases the risk of mortality and morbidity due to COVID-19 (Cummings et al., 2020; CDC COVID-19 Response Team, 2020), therefore older people may feel more anxious and/or threatened by COVID-19 than younger people. In the U.S., the prevalence of alcohol use disorder is lowest among adults ≥ 65 years and highest among those 18–29 year-old (Grant et al., 2015), with heavy drinking progressively declining over the lifetime (Mulia et al., 2017). Epidemiological studies have shown that the prevalence of depression and anxiety is lowest among older adults (Jorm, 2000), and highest among middle-aged adults (Hasin et al., 2005). However, social isolation and increased perceived COVID-19 risk and severity may modify age-specific patterns of alcohol use, depression, and anxiety (Hasin et al., 2005; Kuerbis and Sacco, 2012). Existing research suggests that older adults are most vulnerable to problem alcohol use in response to situations of loneliness and isolation (Wang and Andrade, 2013).

To inform public health messaging and programs to prevent problem alcohol use in the context of COVID-19, this study investigated age-specific alcohol use and mental health status at the start of the pandemic in the U.S. We analyzed repeated cross-sectional survey data collected in the Spring of 2020 to assess:

- 1) The association of mental health indicators, including symptoms of depression and anxiety, and perceived COVID-19 risk and severity, with self-reported increases in alcohol use; and
- 2) The moderating effect of age on these associations.

2. Participants and methods

Methods for the study design and data collection have been described in detail elsewhere (Ali et al., 2020). Briefly, the study population consisted of English-speaking adults (aged ≥ 18 years) residing in the U.S. who use social media. Recruitment was conducted via a social

media-based advertisement campaign, which targeted U.S. residents, aged ≥ 18 years, of all genders, resulting in a self-selected non-probability sample of respondents who use Facebook and its associated platforms. A study advertisement appeared on a potential participant's social media page; clicking on it opened an English-language survey administered online via Qualtrics (Provo, UT). Data was collected in two waves, from March 20–30, and from April 16–21, 2020. In March, 236,017 individuals were exposed to the advertisement, resulting in 9609 clicks and 6602 responses. In April, the advertisement was shown to 250,701 individuals, resulting in 9281 clicks and 6676 responses. Software settings precluded respondents from completing the survey more than once. Respondents received no incentives to complete the survey. The New York University Institutional Review Board reviewed the study procedures and approved the study as exempt; the need for explicit written or oral consent was also waived. Survey reporting follows the American Association for Public Opinion Research (AAPOR) guidelines (The American Association for Public Opinion Research, 2016).

2.1. Survey measures

COVID-19-related changes in alcohol use, for purposes of the analysis, the outcome variable, was assessed by the question “Since hearing about the Coronavirus outbreak, how has your alcohol use behavior changed?” Response options included “Much more,” “Little more,” “No change,” “Little less,” and “Much less.” Respondents were instructed to chose “Not applicable” if they did not drink alcohol. The question was adapted from surveys administered during the SARS epidemic (Lau et al., 2005). The variable was dichotomized as “drinking more” (combining “Much more” and “Little more” responses) and “no change or drinking less.” Respondents who answered “Not applicable” –non drinkers– were excluded in the primary analysis.

Possible anxiety and depression related to COVID-19 were assessed with an adapted version of the 4-item Patient Health Questionnaire (PHQ-4) (Lowe et al., 2010; Jalloh et al., 2018). The scale is composed of two subscales: the Generalized Anxiety Disorder 2 (GAD-2) scale (two items) and the PHQ-2 scale (two items), assessing anxiety and depression symptomatology, respectively. The stem question was, “Over the last 7 days, how often have you been bothered by any of the following problems because of the Coronavirus outbreak?” Response options were rated on a 4-point Likert scale ranging from “Not at all” to “Nearly every day.” A score of ≥ 3 in either subscale, respectively, indicated possible anxiety or depression; variables for each condition were dichotomized by this standard cutoff. Both scales demonstrated good internal reliability (Spearman-Brown reliability estimate $\rho = 0.74$ for anxiety, and $\rho = 0.79$ for depression).

Perceived severity was assessed by the question “On a scale from 0–10, if you were infected with Coronavirus, how severe do you think it would be?” ranging from “Not severe” (0) to “Very severe” (10). *Perceived risk* was assessed by the question “On a scale from 0–10, what do you think is your risk of getting infected with Coronavirus?” ranging from “Not at all likely” (0) to “Extremely likely” (10). Based on the distribution of the responses, both questions were recoded as low (answers 0–4), medium (answer 5), and high (answers 6–10) perceived severity and risk.

Respondents' socio-demographic information included: sex, age (collected by decade and recoded as young adults, 18–39 years; middle-aged adults, 40–59 years, and older adults, ≥ 60 years), race (recoded as non-Hispanic white and non-white because of low numbers among minority groups), educational attainment, employment status (employed, unemployed, unpaid labor –child and elderly care– or student, and retired), and residence type (urban, suburban, and rural). State of residence was recorded in the survey and used as the cluster variable.

2.2. Statistical analysis

Distributions (frequencies and %) were used to describe the

characteristics of the total sample and also by drinking behaviour (increased alcohol use due to COVID-19: Y/N). Pearson’s chi-squared tests (categorical variables) were used to test differences by drinking behaviour, followed by post hoc pairwise comparisons. Unadjusted generalized linear models (GLM) were used to estimate the odds ratios and 95% confidence intervals of age, possible depression, possible anxiety, perceived severity, and perceived risk. The models were then adjusted for all significant socio-demographic characteristics and survey wave. Two additional models tested the effect of age on the association of anxiety and depressive symptoms on alcohol use. All models accounted for clustering due to state of residence and were estimated specifying the ‘binary’ family and the ‘logit’ link. The predicted probabilities were calculated using the Stata ‘margins’ command, and graphed with ‘marginsplot.’ Complete case analysis was used; none of the predictor variables were missing more than 6.4% ($n = 375$) of data points. Multicollinearity was estimated using correlations and post hoc variance inflation factor; a variance inflation factor of ≥ 10 was considered problematic and indicative that a variable should be removed from the multivariable model. Supplementary analysis, which compares drinkers to non-drinkers, was conducted to identify possible biases and generalizability limitations by drinking status: Pearson’s chi-squared and t -tests were used to describe the demographic differences between drinkers and non-drinkers. All analyses were performed in 2020 on Stata version 15.1 (StataCorp, College Station, TX).

3. Results

Of 12,910 eligible respondents, 10,780 (83.5%) completed the question assessing changes in alcohol use since COVID-19 (Table S1). The current analytic sample includes 5850 (54.3%) of respondents who indicated they consumed alcohol. Among these, 19.8% ($n = 1156$) of respondents reported drinking less; 51.2% ($n = 2997$) reported no change in drinking behaviour; and 29% ($n = 1697$) reported drinking more during the COVID-19 pandemic.

3.1. Socio-demographic characteristics

Table 1 presents the socio-demographic characteristics of the entire sample and by changes in alcohol use. Proportionally more women reported an increase in alcohol use compared to men (33% vs. 24%) since first hearing about COVID-19. A larger proportion of respondents under 40 years of age reported increased alcohol use (40%), compared to 30% of those aged 40–59 years, and 20% of those aged 60 years or over. Slightly over a quarter (26%) of those without a Bachelor’s degree reported increased alcohol use compared to 32% of those with higher education. Almost a third of those who were employed (31%) and unemployed (31%) reported increased alcohol use compared to 20% of those who were retired. Proportionally fewer respondents in rural areas (25%) reported increased alcohol use compared to 31% of those in suburban and urban areas.

3.2. Mental health and perceived COVID-19 threat

Nearly half (47%) of survey respondents experienced symptoms of anxiety and 30% reported symptoms of depression associated with COVID-19 (Table 1). Among those with increased alcohol use, 59% experienced anxiety and 41% experienced depression, compared to 43% and 25%, respectively, among those who did not report increased alcohol use. Those reporting increases in alcohol use had a higher mean perceived risk for COVID-19 (5.3 vs. 5.1), but lower perceived severity of disease (5.6 vs. 5.8). Proportionally fewer people who perceived themselves at low COVID-19 risk reported increases in alcohol use (34% vs. 31%). Conversely, respondents who perceived themselves at high risk of disease were more likely to report increased drinking (43% vs. 47%) (See Table S2). In contrast, low perceived severity was associated with proportionally more respondents reporting increased drinking

Table 1

Characteristics of 5850 survey respondents in the U.S. who consumed alcohol during the COVID-19 pandemic, March–April 2020.

	Total sample	Reported increased drinking due to COVID-19		p-value ^a
		No ($n = 4153$, 71.0%)	Yes ($n = 1697$, 29.0%)	
Sex, n (%) ^b				<0.001
Male	2735 (47.1)	2078 (50.4)	657 (39.0)	
Female	3068 (52.9)	2042 (49.6)	1026 (61.0)	
Age, n (%)				<0.001
18–39	1282 (22.0)	772 (18.6)	510 (30.0)	
40–59	2752 (47.0)	1923 (46.3)	829 (48.9)	
≥ 60	1816 (31.0)	1458 (35.1)	358 (21.1)	
Race, n (%) ^b				0.035
White, non-Hispanic	5219 (93.2)	3669 (92.7)	1550 (94.3)	
Non-white	382 (6.8)	288 (7.3)	94 (5.7)	
Educational attainment, n (%) ^b				<0.001
High school / GED or below	572 (10.5)	448 (11.6)	124 (7.7)	
Some college / Associate’s degree	1786 (32.6)	1310 (33.8)	476 (29.7)	
Bachelor’s degree	1682 (30.7)	1155 (29.8)	527 (32.9)	
Master’s degree or higher	1435 (26.2)	960 (24.8)	475 (29.7)	
Employment status, n (%) ^b				<0.001
Employed	3484 (63.5)	2400 (61.8)	1084 (67.4)	
Unemployed	606 (11.0)	417 (10.7)	189 (11.8)	
Unpaid labor or student	283 (5.2)	170 (4.4)	113 (7.0)	
Retired	1118 (30.4)	896 (23.1)	222 (13.8)	
Residence, n (%) ^b				<0.001
Rural	1635 (29.8)	1223 (31.5)	412 (25.6)	
Suburban	2919 (53.2)	2012 (51.8)	907 (56.4)	
Urban	937 (17.1)	648 (16.7)	289 (18.0)	
Time of survey, n (%)				<0.001
March	2864 (49.0)	2150 (51.8)	714 (42.1)	
April	2986 (51.0)	2003 (48.2)	983 (57.9)	
COVID-19-related anxiety, n (%) ^{b,c}	2607 (47.2)	1663 (42.6)	944 (58.5)	<0.001
COVID-19-related depression, n (%) ^{b,c}	1633 (29.6)	967 (24.7)	666 (41.3)	<0.001
Perceived COVID-19 risk, mean (SD) ^{b,d}	5.2 (2.3)	5.1 (2.3)	5.3 (2.3)	0.002
Perceived COVID-19 severity, mean (SD) ^{b,d}	5.7 (2.3)	5.8 (2.3)	5.6 (2.3)	0.030

Note. GED = high school equivalency exams SD = standard deviation percentages may not sum to 100 due to rounding.

^a p -values derived from Pearson’s chi squared or t -tests.

^b Percentages presented excluded participants with missing responses from denominators; among these total n (% not missing) ranged from 5475 (93.6%) to 5803 (99.2%).

^c Respondents who scored ≥ 3 on the generalized anxiety disorder 2-item (GAD-2) scale or the patient health Questionnaire-2 (PHQ-2) scale, respectively.

^d Range = 0–10.

(26% vs. 29%) while high perceived severity was associated with fewer respondents reporting this behaviour (54% vs. 50%) (Table S2 and Figs. S2 to S4 in the Appendix).

3.3. Multivariable analysis

Table 2 presents the results of the multivariable models. In adjusted analysis, we observed an inverse age gradient whereby older age was associated with lower odds of reporting increased alcohol use (40–59 year-olds vs. 18–39 year-olds: adjusted odds ratio [AOR] = 0.73; 95% confidence interval [CI] = 0.63, 0.83; ≥60 year-olds vs. 18–39 year-olds: AOR = 0.44; 95% CI = 0.40, 0.48). Persons with symptoms of anxiety or depression had significantly higher odds of reporting increased alcohol use compared to those without such symptoms, and these associations remained significant after controlling for socio-demographic characteristics (among persons with anxiety symptoms: AOR = 1.41; 95% CI = 1.20, 1.66; among persons with possible depression: AOR = 1.64; 95% CI = 1.21, 2.23). In adjusted analysis, high perceived COVID-19 risk and severity appeared to convey a small protective effect (AOR_{perceived high vs. low risk} = 0.97; 95% CI = 0.95, 0.99 and AOR_{perceived high vs. low severity} = 0.86; 95% CI = 0.79, 0.93).

3.4. Moderation analysis

Age modified the association of possible depression and anxiety with alcohol use, as shown graphically in Figs. 1 and 2 and quantitatively in Table S3. The interaction effects in the GLMs were all significant ($p < 0.001$). As presented in Figs. 1 and 2, the probability of older persons reporting increased alcohol use was markedly higher among those reporting symptoms of anxiety and depression, as compared to those who did not. In comparison, young adults had the highest probability of increasing their alcohol use due to COVID-19, regardless of their mental health status. Table S3 presents the odds of increased alcohol use given possible anxiety or depression by age category. Among young adults, adjusted odds of increased alcohol use were 1.37 (95% CI = 1.06, 1.77) for those with depression symptomatology compared to those without; but among older adults, odds were 2.39 (95% CI = 1.70, 3.37) for those

Table 2

Adjusted and unadjusted odds ratios of reporting increased drinking due to COVID-19 among survey respondents in the U.S. during the COVID-19 pandemic, March–April 2020.

	Reported increased alcohol use due to COVID-19	
	OR (95% CI)	AOR (95% CI) ^a
Age		
18–39	1	1
40–59	0.65 (0.55, 0.76)	0.73 (0.63, 0.83)
≥60	0.37 (0.31, 0.44)	0.44 (0.40, 0.48)
COVID-19-related anxiety ^b		
No	1	1
Yes	1.90 (1.68, 2.16)	1.41 (1.20, 1.66)
COVID-19-related depression ^b		
No	1	1
Yes	2.13 (1.85, 2.45)	1.64 (1.21, 2.23)
Perceived COVID-19 risk		
Low	1	1
Medium	1.04 (0.90, 1.20)	0.96 (0.75, 1.22)
High	1.17 (0.98, 1.40)	0.97 (0.95, 0.99)
Perceived COVID-19 severity		
Low	1	1
Medium	0.88 (0.74, 1.04)	0.90 (0.70, 1.16)
High	0.82 (0.74, 0.92)	0.86 (0.79, 0.93)

Note. OR = Odds Ratio CI = Confidence Interval AOR = Adjusted Odds Ratio.
^a Generalized linear model (GLM) adjusted for sex, race, education, work status, residency area and survey wave and with robust standard errors accounting for state clustering.
^b Cutoff score ≥3 on the Generalized Anxiety Disorder 2-item (GAD-2) scale or the Patient Health Questionnaire-2 (PHQ-2) scale, respectively.

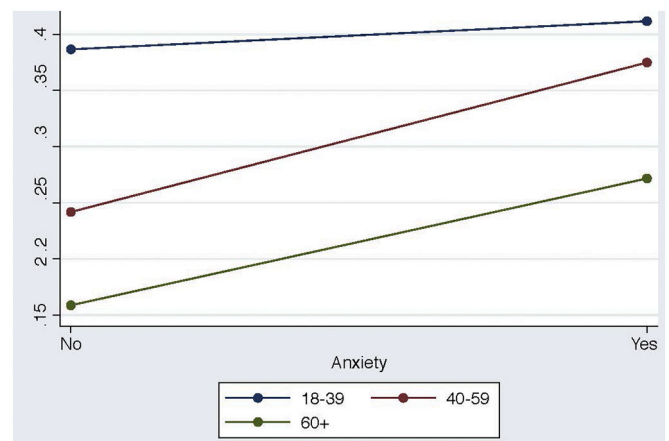


Fig. 1. Predicted probability of drinking by age and anxiety.

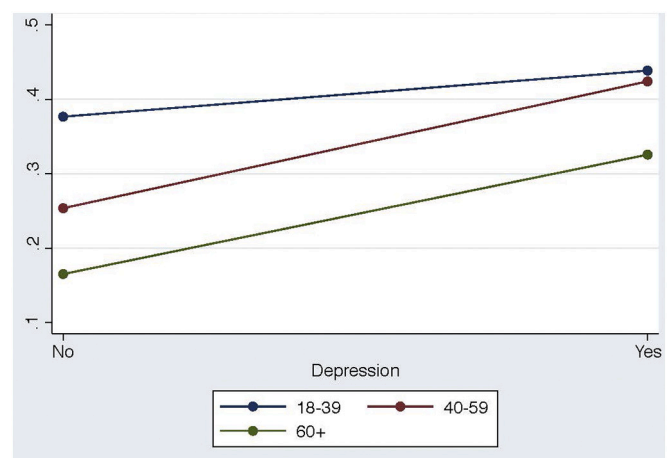


Fig. 2. Predicted probability of drinking by age and depression.

with depression symptomatology compared to those without.

3.5. Supplementary analysis

To gauge the generalizability of our sample, Table S1 describes selected characteristics of drinkers and non-drinkers. Younger (aged 18–39 vs. 60+ years), non-Hispanic employed white males, who held a Bachelors’ degree or higher and lived in urban or suburban areas, were more likely to report being drinkers compared to other respondents. Also, there were proportionally more drinkers in the April survey than in the March survey (51.0% vs. 49.0%). However, there were no significant differences in the proportion of respondents reporting experiencing anxiety or depression, nor by the level of perceived COVID-19 severity and risk. In Table S4, we can also observe that a smaller proportion of survey respondents were alcohol drinkers compared to the U.S. population aged 18 and over (54.3% vs. 69.5%).

4. Discussion

In our sample, 29% of survey respondents reported increased alcohol use since the start of the COVID-19 pandemic. These findings are consistent with the literature that suggests that exposure to stress is a driver of alcohol consumption at the individual and population levels (Keyes et al., 2012). For example, about 25% of respondents reported increased alcohol consumption after 9/11 (Vlahov et al., 2002). Similarly, exposure to hurricane-related traumatic events was associated with an increase in the number of annual drinks reported (Cerda et al.,

2011; Ma and Smith, 2017). While increased alcohol use during times of stress does not necessarily constitute an alcohol use disorder in itself, increasing alcohol use may be indicative of maladaptive coping, which has been associated with problem alcohol use, including heavy episodic drinking (Colder et al., 2019). We considered if the increase in self-reported alcohol use might have been due to seasonality. However, research on seasonality suggests that alcohol consumption peaks in January and June (Cho et al., 2001; Carpenter, 2003). Since our survey took place in the Spring, seasonality research would predict the opposite, a reduction in self-reported alcohol use. We should note that since the aim of the study was to identify groups that may be at higher risk for problem alcohol use, to inform prevention and screening efforts, we opted to focus on those individuals who reported increased alcohol use rather than on differences among those who did not change or reduced their drinking levels.

Even though this study observed that men were more likely than women to be drinkers, women were more likely than men to report increased alcohol use due to COVID-19. These findings are similar to those post-9/11 in New York (Vlahov et al., 2006) and one year after SARS in Hong Kong (Lau et al., 2005) where proportionally more women reported increased drinking compared to men. Such sex differences in behaviour may be explained by physiological mechanisms that make women more prone to using alcohol to regulate negative affect and stress reactivity (Peltier et al., 2019).

The odds of reporting increased alcohol use were higher for persons with symptoms of anxiety and depression. This is expected from the literature (Boden and Fergusson, 2011; Gimeno et al., 2017) and consistent with what was observed following 9/11, whereby higher prevalence of depressive symptoms was observed among those with incident drinking problems (23.5%) (Vlahov et al., 2006) and hospital staff after the SARS outbreak in China (Wu et al., 2008).

People who perceived that they were at higher risk for COVID-19 or that COVID-19 would be more severe were slightly less likely to increase their drinking than those who perceived low risk and severity. Public health messaging about the adverse effect of alcohol on the immune system may have served as a disincentive to drinking among those more concerned about COVID-19 (Koob, 2020; World Health Organization, 2020). High perceived risk of disease was prevalent in countries affected by SARS (de Zwart et al., 2009) and Ebola (Jalloh et al., 2018), and associated with poor mental health (Jalloh et al., 2018). In the aftermath of a sniper attack in Washington, less perceived safety was associated with higher odds of increased drinking (Fullerton et al., 2015). Findings from other emergencies indicate a positive association of level of distress, perceived risk, and alcohol consumption (Fullerton et al., 2015). However, even though perceived COVID-19 risk and severity were negatively associated with increased alcohol use, the associations were not as robust as with possible depression or anxiety. Furthermore, alcohol use patterns and COVID-19 risk and severity may be affected by other factors, such as having comorbidities, which could be an unmeasured confounder attenuating this association.

There was an inverse association between age and the likelihood of reporting increased alcohol use due to COVID-19. The same pattern was observed in the aftermath of 9/11; older people (≥ 65 year-olds) were less likely than the youngest group to report increased alcohol use (Vlahov et al., 2002). Although COVID-19-associated symptoms of anxiety and depression, and increased alcohol use were less often reported in the older age groups, their co-morbid impact was greater in middle-aged and elder adults. The observed age gradient in risk of severe COVID-19 (Verity et al., 2020) may have played a role in the age-specific effect of drinking and mental health documented in our study. A longitudinal study in Australia found no age and depression interaction on problem alcohol use in the general population (Tait et al., 2012); however, the effect of trauma was not considered. In longitudinal studies that consider the experience of trauma, older age has been found to be associated with increased mental health disorders (Yzermans et al., 2005).

4.1. Strengths and limitations

Our study findings should be considered in light of its limitations. First, the study design is based on repeated cross-sectional measures as opposed to a cohort study. Combining data from two survey waves, while controlling for multiple potential confounders and accounting for the clustering effect of the state of residence, permitted us to benefit from a larger number of respondents in analysis, which is one of the strengths of the current study. Second, the sample was drawn from a population of Facebook users. Although close to 70% of people in the U.S. have Facebook accounts and three-quarters of them use the platform daily (Pew Research Center, 2019), Facebook users are not representative of the U.S. population as a whole. It is also known that certain groups, such as Black and Latinx populations, are less likely to participate in online surveys (Sullivan et al., 2011). Indeed, our sample of respondents was overwhelmingly non-Hispanic white and, thus, our results may not be generalizable to other racial and ethnic minority groups in the U.S. As we collected data, we attempted to address this bias by creating an ad tailored to Black Facebook users. A mitigating factor, however, is that our survey had respondents from every state, and respondents were balanced in terms of age and residence area. We should note that our sample had an overrepresentation of respondents in their 50s and 60s compared to the U.S. population, as shown in Table S4. In addition, the survey may have been less accessible to respondents without a computer or Internet connection at home – 11.2% and 19.6% of U.S. households (U.S. Census Bureau, 2019), respectively – who are predominantly of low socio-economic status. Third, as with other web-based surveys, it is challenging to assess nonresponse bias (Sullivan et al., 2011), particularly because the invitations were distributed following Facebook's ad algorithm rather than a predesigned sampling strategy. As is known, interest in the topic impacts response rates (Fan and Yan, 2010). Participants who responded to the survey are likely to diverge in systematic and unmeasured ways from those who opted not to respond creating a selection bias, e.g., might have been more interested in the topic, had more free time, fewer concerns with the 'big brother syndrome' (Rosenfeld et al., 1996), etc. Furthermore, drinkers and non-drinkers are likely different. However, we were able to assess and compare differences between the respondents who consumed and did not consume alcohol, finding that white, employed, males with higher education were more likely than other groups to be drinkers (Table S1). Because we did not have data from before the COVID-19 pandemic to compare changes in alcohol use, we relied on a self-reported measure of alcohol use, as was done in the context of the SARS epidemic, rather than instruments to screen for or diagnose alcohol use disorders. Thus, this measure is likely biased by measurement error and does not serve to assess the prevalence of problem alcohol use in the sample. In addition, social desirability response bias may have impacted responses related to mental health state and alcohol use behaviours (Latkin et al., 2017). However, some surveys have found limited social desirability bias in alcohol use self-reports (Kypri et al., 2016) and the anonymity of the survey collection method may have served to lessen this bias (Booth-Kewley et al., 2007). Despite these limitations, our chosen data collection methods had the advantage of permitting us to gather unique data on the mental health status and substance use patterns of a geographically diverse U.S.-based population in a short amount of time and at a low cost during the early stages of the COVID-19 pandemic.

5. Conclusions

The high proportion of respondents reporting increased alcohol use due to COVID-19 is consistent with calls about the pandemic triggering an epidemic of problem alcohol use (Galea et al., 2020). People who drink to cope, with co-morbid anxiety and depression, will be more likely to report increased substance use following traumatic stress, as such caused by COVID-19 (Agyapong et al., 2018). Lessons from previous post-disaster research indicate that early intervention for

substance use is warranted to mitigate the pandemic's worse mental health impacts (Wang et al., 2013). Public health systems should be prepared to actively reach out to those with existing mental health conditions, including substance use disorders, who may have their conditions aggravated by COVID-19, particularly in the context of new barriers to accessing care (Yao et al., 2020). The observed age effect in our study suggests a need for tailoring public health messaging on substance use by age groups; and intensifying substance use prevention and treatment efforts for those who are more likely to engage in problem alcohol use in response to stress (Ornell et al., 2020). Outreach efforts should focus on those who are most vulnerable to both COVID-19 and problem alcohol use, including older adults and those with a history of mental health disorders (Ohinmaa et al., 2010). More effective programs are individually tailored, considering risks and personal context (Gimeno et al., 2017; National Institute on Drug Abuse, 2018). Innovative strategies are needed to deliver mental health services for those in need while maintaining social distance; it is necessary to make substance use treatment services accessible, perhaps via Telehealth or other novel counseling approaches, while maintaining affordability and quality (Samuels et al., 2020; Coulton et al., 2017).

Credit author statement

AC: Conceptualization, Data curation, Methodology, Formal analysis, Visualization, Writing - original draft; SHA: Data curation, Methodology, Writing - review & editing; AMJ, JF, YT: Methodology, Writing - review & editing; RJD: Conceptualization, Methodology, Supervision, Writing - review & editing.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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