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Drinking during social isolation: investigating associations between stress, inhibitory control, boredom, drinking motives, and alcohol use

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ABSTRACT

Background: We aimed to assess whether stress, boredom, drinking motives, and/or inhibitory control were related to alcohol use during a period of social isolation.
Method: Analyses were carried out on questionnaire data ($N = 337$) collected during the first wave of the COVID-19 pandemic (7 April–3 May 2020). We first assessed changes in drinking behavior, stress and boredom. We then regressed drinking behavior on drinking motives, inhibitory control, stress, and boredom. We also investigated interactions between change in stress/boredom and inhibitory control.
Results: A minority of respondents reported increased alcohol use (units = 23.52%, drinking days = 20.73%, heavy days = 7.06%), alcohol-related problems (9.67%), and stress (36.63%). Meanwhile, most respondents reported increased boredom (67.42%). Similarly, boredom significantly increased ($B = 21.22$, $p < .001$), on average, while alcohol-related problems decreased ($B = -1.43$ $p < .001$). Regarding drinking motives, decreased alcohol-related problems were associated with social drinking motives ($B = -0.09$, $p = .005$). Surprisingly, risk-taking was associated with decreased alcohol-related problems ($B = -0.02$, $p = .008$) and neither stress nor boredom independently predicted changes in alcohol use. Finally, several significant interactions suggested that those who were more impulsive and less bored were more likely to report increased alcohol use and vice versa.
Conclusions: These data provide a nuanced overview of changes in drinking-related behavior during the COVID-19-induced period of social isolation. While most people reduced their drinking, there was evidence of complex interactions between impulsivity and boredom that may be explored in future studies.

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Introduction

Increased mortality and morbidity have been linked to social isolation (e.g. loneliness) for decades (e.g. House et al. 1988). A large volume of theoretical and empirical work states that this effect ultimately results from increased activation of the hypothalamic pituitary adrenocortical (HPA) axis (Cacioppo et al. 2015). Chronic HPA axis activation results in dysfunctional stress responses and deficits in emotional regulation (Milivojevic and Sinha 2018). In turn, these neuroadaptations contribute to the development and maintenance of addiction and offer an explanation as to why stress is a prominent risk factor for alcohol misuse (e.g. Jose et al. 2000; Ruisoto and Contador 2019).

Poor inhibitory control (i.e. impulsivity) is a multifaceted construct (Strickland and Johnson 2021) that has been established as a risk factor for alcohol misuse (e.g. Dalley and Ersche 2019; Lee et al. 2019). Evidence for this is provided by pre-clinical experimental work (e.g. Belin et al. 2008; Kreek et al. 2005), neuroimaging studies (e.g. Bosker et al. 2017; Voon et al. 2020), and heritability studies (e.g. Karlsson Linnér et al. 2021). However, relatively little has been completed in the way of understanding the contextual conditions under which this effect may differ. Nevertheless, recent work has shown that in times of acute stress, those who have lower inhibitory control tend to crave and consume more alcohol (Clay et al. 2018; Clay and Parker 2018).

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'Boredom' (i.e. the inability to find satisfaction or interest while participating in an activity) has also been associated with addictive behaviors such as gambling (Eastwood and Mercer 2010) and alcohol misuse (Biolcati et al. 2018). Those with reduced inhibitory control tend to have greater boredom proneness (Struk et al. 2016; Isacescu et al. 2017). Therefore, poor inhibitory control may moderate the relationship between boredom and alcohol use, whereby the impact of boredom on alcohol use is greater among those with poor inhibitory control.

Other well-researched moderators of drinking behavior exist: so-called drinking motives (Cooper 1994). Several general patterns emerge when examining the impact of drinking motives on alcohol use: social motives (i.e. drinking to improve social situations) tend to be related to drinking frequency; enhancement motives (i.e. drinking to increase positive affect) are related to heavy drinking; coping motives (drinking to reduce negative affect) are associated with a greater number of alcohol-related problems; and conformity motives (i.e. drinking to fit in with a group) are typically negatively associated with frequency and quantity of alcohol use (Kuntsche et al. 2005, 2014; Lyvers et al. 2010). Drinking motives have also been shown to impact alcohol use following crisis. For example, after the 9/11 terrorist attack, Beseler et al. (2011) found that both drinking to cope and drinking for enjoyment (i.e. enhancement) were associated with increased alcohol use. Similarly, 'drinking to cope' has been highlighted as a prominent risk factor for increased alcohol use during the COVID-19 pandemic in the USA (Rodriguez et al. 2020) and Canada (Wardell et al. 2020).

The COVID-19 pandemic and associated 'lockdowns' (i.e. government mandated periods of social isolation characterized by orders to remain at home to mitigate the spread of disease; Anderson et al. 2020) have resulted in increased mental distress worldwide through (for example) social isolation, loss of income, increased childcare responsibilities, and monotony (Bhattacharjee and Acharya 2020; Gavin et al. 2020; Ornell et al. 2020; Pfefferbaum and North 2020). Thus, the pandemic presents a naturalistic source of negative affect. Early in the pandemic, several scholars warned that long-term isolation may create an unforeseen public health crisis involving increased alcohol consumption (Clay and Parker 2020; Finlay and Gilmore 2020; Ramalho 2020). As a result, attempts were made to synthesize work conducted in-relation to other crises involving trauma (e.g. the 9/11 attack), epidemic outbreaks (e.g. the 2002-03 SARS pandemic), and economic hardship (e.g. the 2008 recession) in relation to alcohol use (Gonçalves et al. 2020). Ultimately, two opposing scenarios were proposed (Rehm et al. 2020): (1) increased psychological distress may drive an increase in alcohol use and related harms; (2) alcohol policies which reduce the physical and financial availability of alcohol would cause a reduction in alcohol consumption and associated problems.

Following these predictions, recent work has tried to characterize those most at-risk of increased alcohol consumption, although this literature offers a somewhat mixed picture. Several studies provide evidence that increased distress was associated with increased drinking (Koopmann et al. 2020; Neill et al. 2020; Tran et al. 2020; Garnett et al. 2021; Jacob et al. 2021). Conversely, in a large-scale study comprising data from 21 European countries, Kilian et al. (2021) found evidence that drinking decreased in most countries and that this reduction was primarily driven by reduced availability of alcohol. Nevertheless, increased distress dampened this relationship. Additionally, recent work has shown that impulsivity acts as a moderator of stress-related pandemic drinking (Clay et al. 2021). However, that paper reports a secondary analyses of birth cohort data, and such surveys prioritize brevity and breadth. Thus, single-item measures of impulse-control were utilized, which were not empirically validated and may suffer from reduced content validity.

Overall, previous research provides strong evidence for the prediction that those who increased their drinking during the pandemic were drinking to cope, which may be moderated by impulsivity, and limited evidence that a reduction in affordability or availability played a role. Therefore, our work here was motivated by the need to evaluate risk factors for those who increased their drinking during the pandemic; whether they were drinking to cope and whether this relationship, if present, was moderated by impulsivity (using empirically validated measures).

As we move out of the pandemic, this work is of importance as it pertains to drinking in the home (versus in public settings). For instance, prior to the pandemic, a significant proportion of alcohol was consumed at home (perhaps due to convenience, cost, safety, autonomy, and stress relief) (e.g. Foster and Ferguson 2012; Callinan et al. 2016). Moreover, most long-term harms that occur because of alcohol use (e.g. liver disease and cancer) are linked to *total* alcohol consumption (GBD 2016 Alcohol Collaborators 2018). However, research typically focuses on public drinking (Callinan and MacLean 2020). Thus, if a large amount of alcohol is typically consumed in the home, further research which focuses on drinking in this setting is crucial in reducing the burden of alcohol, and data collected during the COVID-19 pandemic provides the perfect opportunity for this (Callinan and MacLean 2020).

We aimed to investigate how some of the theoretical mechanisms that underlie alcohol use (in a non-clinical sample in the hope that our results are generalizable to as many people as possible) may have operated during a period of social isolation brought on by the COVID-19 pandemic. We hope that this increased theoretical understanding of socially isolated home drinking, will have broader implications beyond the pandemic by, for instance, identifying those most at-risk of future alcohol-related long-term harm.

We preregistered several hypotheses[1]: (1) alcohol use would increase during social isolation; (2) both coping and enhancement motives would be associated with increased

[1]The original preregistration listed ten hypotheses. Data testing hypotheses one to seven and hypothesis nine are reported in the main body of this paper. These have been briefly summarized in the Introduction. As there was no significant association between a change in stress and perceived stress reactivity (see Appendices) our planned moderation analysis, detailed in hypothesis eight of the preregistration, was not conducted. As this is a two-part study, Hypothesis 10 pertains to additional longitudinal work which is, to date, ongoing.

alcohol use; (3) poor inhibitory control, stress, and boredom would be positively associated with an increase in alcohol use; and (4) the association between poor inhibitory control would be greater among those with higher negative affect (stress and boredom).

Materials and methods

Recruitment

A survey designed to assess changes in, and factors related to, drinking behavior during social isolation was created using Qualtrics (Provo, Utah). The survey was developed in English, and then translated into French, Spanish, Italian, Portuguese (European and Brazilian), and Hebrew by the native speaking authors. Some wording had to be changed slightly to retain the original meaning and to ensure consistency across countries. Participants were eligible if they were $\geq$ 18 years of age, had a reliable internet connection, and they were proficient in at least one of the languages listed above. Participants could complete the survey on either a computer, smartphone, or tablet. All responses were completed between 7 April 2020 and 3 May 2020. During this time, the survey was advertised by several news media outlets and throughout the co-authors' networks via email, word-of-mouth, and social media. All participants gave their informed consent and were not compensated. The study was approved by the University of Portsmouth Science Faculty Ethics Committee (ref: SFEC 2020-030).

Demographic information

Demographic data collected were age, gender, ethnicity, country of residence, education level, occupation, whether the respondent was a key worker, gross individual income over the last 12 months, subjective social status, marital status, the number of people in the same household as the respondent, number of offspring, who the respondent was isolated with, and whether the respondent was suffering from any COVID-19 associated symptoms. Country of residence was recoded to reflect sub-regions of the world based on the United Nations M49 Standard (United Nations 2020). This allowed us to find a balance between the number of levels and the number of participants within each level (Hox et al. 2018). The gross individual income question was presented in local currency relative to British Pounds and then recoded to relative income using World Bank adjusted net national income per capita data (The World Bank 2020), where:

$$\text{Relative Income} = \frac{\text{Income}}{\text{Income per Capita}} \tag{1}$$

An index of socioeconomic status (SES), combining relative income, education, occupation, and subjective social status (Diemer et al. 2013), was calculated using exploratory factor analysis (EFA) – see Appendices. This allowed us to conserve statistical power during hypothesis testing by controlling for the variables entered into the final EFA using a single model parameter. Similar approaches to creating an index of SES have been published elsewhere (e.g. Scharoun-Lee et al. 2009; Yu et al. 2014).

Alcohol use and drinking behavior

Alcohol Use Disorders Identification Test (*AUDIT*): The AUDIT was created by the World Health Organization as a brief assessment of alcohol misuse (Babor et al. 1992, 2001). It has been shown to have excellent psychometric properties when used to assess alcohol use disorders in a variety of settings (Fleming et al. 1991; Claussen and Aasland 1993). The AUDIT is scored on a scale from 0 to 40, where scores between 0 and 7 indicate low-risk drinking, scores between 8 and 15 indicate increasing risk of harm, scores between 16 and 19 higher risk drinking, and a score >20 suggests alcohol dependence. Internal consistency of the AUDIT in the present study was good, Cronbach's $\alpha = 0.78$.

Typical Atypical Drinking Diary (*TADD*): The TADD was used to retrospectively assess alcohol use (Patterson et al. 2019). When completing the TADD, participants fill in two weekly diaries: one for typical weeks and another for atypical weeks (i.e. either less than or greater than a typical week). Participants specified the type, strength, volume, and quantity of the beverages they consumed for each day of the 7-day week and then estimated how many weeks they drank this typical/atypical amount during the specified period. Participants were asked to estimate what they drank before (i.e. 'before the COVID-19 induced isolation') and during (i.e. 'after the COVID-19 induced isolation') social isolation. This method allows for the calculation of units,[2] drinking days, and heavy drinking days[3] per week. Research indicates that the TADD is more accurate and time-efficient than other retrospective assessments of drinking, such as the Timeline Followback (Patterson et al. 2019).

Alcohol Problems Questionnaire (*APQ*): Alcohol-related problems were assessed using the Alcohol Problems Questionnaire (Drummond 1990). The APQ is a standalone scale that consists of 44 binary (yes/no) items designed to assess alcohol-related problems across four domains: commonly faced alcohol-related problems, problems related to romantic relationships, problems related to children, and problems related to work. Therefore, the maximum score on the APQ is 44, with a higher score reflecting a greater number of alcohol-related problems faced. Here, we added a 'Not Applicable' option to the latter subscales to allow the questionnaire to be relevant to a larger proportion of the population than the original scale. For instance, an 18-year-old student may not have any children. We also changed the wording for questions about romantic relationships from 'spouse' to 'spouse/partner' for the same reason. The APQ has been shown to have good validity and test-retest reliability (Williams and Drummond 1994). In the present study, the internal consistency was excellent, Cronbach's $\alpha = 0.94$.

[2]1 unit = 8 g of pure ethanol.

[3]1 heavy day = >8 units per day for men and >6 units per day for women.

Drinking motives

Drinking motives were assessed using the *Revised Drinking Motives Questionnaire* (DMQ–R; Cooper 1994). The DMQ-R is a 20-item scale which proposes four motives for alcohol consumption: conformity (e.g. 'so you won't feel left out'); coping (e.g. 'drinking to forget your problems'); enhancement (e.g. 'to have fun'); and social (e.g. 'because it helps you enjoy a party'). Here, participants responded to each item using a 5-point Likert scale (1 = Almost never/never, 2 = Some of the time, 3 = Half of the time, 4 = Most of the time, 5 = Almost always/always). Each subscale contains five items. Thus, the maximum score per subscale is 25, with higher scores indicating greater endorsement of a motive. The DMQ-R has been shown to have good validity across cultures and in a variety of age groups (Fernandes-Jesus et al. 2016). Here, the internal consistency of the DMQ-R subscales ranged from acceptable to excellent, Cronbach's αs = 0.68–0.89.

Negative affect

Short stress overload scale (SOS–S)

Self-report stress levels were measured before (i.e. 'before the COVID-19 related isolation') and during (i.e. 'since the COVID-19 related isolation') social isolation using the SOS-S (Amirkhan 2018). The SOS-S is a 10-item scale designed to act as a brief diagnostic tool for stress and stress-related disorders and has been shown to have good psychometric properties. Here, participants responded to each item using a five-point Likert scale (1 = Not at all: 5 = A lot). Therefore, the maximum score on the SOS-S is 50, with higher scores reflecting greater levels of stress. In the present study, internal consistency was excellent, Cronbach's αs = 0.90–0.92.

Perceived stress reactivity scale (PSRS)

Stress reactivity was assessed using the 23-item PSRS (Schlotz et al. 2011). The PSRS is a standalone scale with five subscales: prolonged reactivity, reactivity to work overload, reactivity to social conflict, reactivity to failure, and reactivity to social evaluation. Participants responded to each item using a 3-point Likert-type scale that varied depending on the framing of each item (e.g. 'When tasks and duties build up to the extent that they are hard to manage…', 0 = '…I am generally untroubled', 1 = '…I usually feel a little uneasy', 2 = '…I normally get quite nervous'). Therefore, the maximum total score on the PSRS is 46, with higher scores indicating greater levels of stress reactivity. The psychometric properties of the PSRS has been established in several countries, with scores correlating with numerous stress-related disorders (Schlotz et al. 2011). In the present study, the internal consistency was good, Cronbach's α = 0.88.

Multidimensional state boredom scale (MSBS)

Boredom before and during social isolation was assessed using the MSBS (Fahlman et al. 2013). The MSBS is a 29-item scale with good psychometric properties that can be used to quantify boredom by either using the total score or across five subscales: disengagement, high arousal, low arousal, inattention, and time perception. Here, participants responded to each statement using a seven-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = Neutral, 5 = Somewhat agree, 6 = Agree, 7 = Strongly agree). Thus, the maximum score was 203, where higher scores reflect greater levels of boredom. The internal consistency here was excellent with Cronbach's α ranging from 0.96 to 0.97.

Inhibitory control

The shortened urgency, premeditation, perseverance, sensation seeking, positive urgency, impulsive behaviour scale (S-UPPSP)

The S-UPPSP was used to assess negative urgency (i.e. the tendency to act rashly under extreme negative emotions), lack of premeditation (i.e. the tendency to act without thinking), lack of perseverance (i.e. the inability to remain focused on a task), sensation seeking (i.e. the tendency to seek out novel and thrilling experiences), and positive urgency (i.e. the tendency to act rashly under extreme positive emotions) (Cyders et al. 2014). The S-UPPSP is a 20-item scale where participants rate several statements related to their impulsive behavior on a four-point Likert-type scale (1 = Agree strongly, 2 = Agree some, 3, Disagree some, 4 = Disagree strongly). Each subscale is made up of four items; therefore, the maximum score on each subscale is 16, with higher scores reflecting a greater level of impulsivity. Numerous studies have suggested associations between impulsive traits measured using the original and shortened UPPS-P scales and alcohol use (e.g. Coskunpinar et al. 2013). In the present study, internal consistency of each subscale ranged from acceptable to good, Cronbach's α = 0.67–0.82.

Domain-specific risk-taking scale (DOSPERT)

The DOSPERT was administered to assess risk-taking (Blais and Weber 2006). The DOSPERT is a 30-item scale designed to assess five sub-domains risk-taking: ethical, financial, health, recreational, and social. Here, participants rate how likely it is that they would engage with each activity or behavior using a 7-point Likert scale (1 = Extremely unlikely, 2 = Moderately unlikely, 3 = Somewhat unlikely, 4 = Not sure, 5 = Somewhat likely, 6 = Moderately likely, 7 = Extremely likely). Scores can be summed across all items or by subscale. Each subscale contains six-items. Therefore, the maximum score overall is 210, with higher scores indicating a greater propensity to take risks. The DOSPERT has been shown to be a reliable and valuable assessment of 'real world' risk-taking via questionnaire (e.g. Highhouse et al. 2017). Here, the internal consistency of the DOSPERT was good, Cronbach's α = 0.82.

Procedure

After informed consent was confirmed, participants reported their demographic information before completing the remaining scales in counterbalanced order to eliminate order effects. Scales that measured both pre- and intra-isolation data (e.g. the TADD) were presented as one block, whereby the scale which sought pre-isolation responses was presented first.

Sample

Due to limited financial and temporal resources, we used opportunity/snowball sampling to collect data from as many participants as possible within the study period (Lakens 2022). Overall, 1148 responses were recorded. Of these, 811 were excluded to ensure data integrity: 39.55% had >40% missing data[4]; 21.43% reported living in sub-regions with an inadequate number of responses[5]; 7.40% were classified as multivariate outliers based upon a Mahalanobis distance that is significant at $p < .001$ (Verardi and Dehon 2010; Tabachnick and Fidell 2014) and 0.17% were considered clear univariate outliers (see Appendices); 0.87% reported experiencing no social isolation; 0.52% were test data; 0.44% had gender recorded as transgender or 'prefer not to say' and 0.09% had ethnicity recorded as 'prefer not to say'[6]; and 0.17% were duplicate responses. This left 337 cases for analysis. A simulation-based sensitivity power analysis (Lakens 2022) showed that our design had sufficient statistical power $(1 - \beta) = 80\%$ to detect an effect size of $B = 0.0015$ for our most complex model. Details of the sensitivity power analysis can be seen in the Appendices. Sociodemographic characteristics of the sample are shown in Table 1.

Analysis

Data, preregistered hypotheses, and code for analyses are posted on the Open Science Framework at https://osf.io/mnz34/. Data were analyzed using Stata IC (version 16.1) and R (version 4.0.4).

Missing data

Missing data was dealt with using multiple imputation (MI; Enders 2010). White et al. (2011, p. 388) recommended that '*m* should be at least equal to the percentage of incomplete cases'. Here, the overall percentage of cases with incomplete data on analysis variables was 37.69%. Therefore, we used the *mi impute chained* command in Stata to generate 40 imputed datasets, using predictive mean matching, with $\mathbf{d} = 5$ (Schenker and Taylor 1996). Graphical diagnostics (see Appendices) suggested that the datasets should be separated by at least 125 iterations of the imputation algorithm, thus we conservatively saved each dataset after the 150th iteration. The imputation model included all variables used in subsequent analyses together with the hypothesized interaction terms and three auxiliary variables that were believed to be correlated with missingness (percent progress in survey, date of response, AUDIT score). Interaction terms were imputed and estimated following Enders et al. (2014).

Descriptive and inferential statistics

Change scores were calculated for units, drinking days, heavy drinking days, alcohol–related problems, stress, and boredom, using the *mi passive* command. Descriptive statistics were calculated for each of the key study variables. Bivariate relationships were explored using Pearson correlations (see Appendices). Linear mixed-effects models (LMMs) were used to test our hypotheses. We included sub-region as a random effect to improve inference and generalizability (Barr et al. 2013). We first assessed change in alcohol use, stress, and boredom by entering change scores and covariates into models as fixed effects and interpreting the intercept (analogous to a one sample *t*-test comparing the change score to zero). Next, we regressed change in alcohol use scores on our predictors of interest and covariates. Finally, we entered our hypothesized interactions into the models.

All continuous predictor variables were grand mean centered to aid interpretation and reduce potential collinearity. Models were separated by construct to conserve statistical power and to avoid erroneously conditioning the model estimates (Mcmullin et al. 2021). We implemented Benjamini and Hochberg's (1995) method of false discovery rate (FDR) control for pre-registered confirmatory analyses to reduce the probability of making a type I error due to multiple testing (Glickman et al. 2014). Significant interactions were probed using the Johnson-Neyman (JN) technique (Johnson and Neyman 1936) as suggested by Hayes (2017). Covariates included in all models were: age (e.g. Leigh and Stacy, 2004), gender (e.g. White et al. 2015), ethnicity (e.g. Twigg and Moon 2013), SES (e.g. Probst et al. 2020), the number of COVID-19 symptoms experienced (e.g. Chaaban et al. 2021), and whether the participant was isolated with children (e.g. MacMillan et al. 2021). Models including stress as a predictor also controlled for perceived stress reactivity (e.g. Clay and Parker 2018). As the sample lacked ethnic diversity, a dichotomous White/non-White variable was used. As the *margins* command is incompatible with imputed data, the first complete dataset was used to probe and visualize significant interactions. For brevity, non-significant LMM results are reported in the Appendices. Results were considered significant when $p < .05$.

Results

Table 2 displays the descriptive statistics for the main study variables, in terms of alcohol use and drinking behavior, drinking motives, stress, boredom, and inhibitory control. See Table S2 for correlations between variables.

[4]Royston (2004) recommends that caution should be taken when implementing multiple imputation when the proportion of missing data exceeds 50%. Therefore, acting conservatively, we used 40% as our cut off.

[5]When utilizing multilevel analyses, the minimum sample size at each level of a random effect (e.g. a sub-region) should be ≥10 (Hox et al. 2018).

[6]Analysis of such low numbers of participants would lead to low power and unstable parameter estimates.

Table 1. Sociodemographic characteristics of the sample.

Variable	Total (SD)	Female (SD)	Male (SD)
N	337	243	94
Age	34.69 (12.84)	32.96 (11.70)	39.18 (14.53)
Ethnicity			
White	95.25%	94.24%	97.87%
Black	0.30%	0.41%	0.00%
Asian	2.08%	2.06%	2.13%
Mixed	2.08%	2.88%	0.00%
Other	0.30%	0.41%	0.00%
Sub-region			
N. Europe	39.17%	41.56%	32.98%
E. Europe	5.04%	4.12%	7.45%
S. Europe	21.07%	19.34%	25.53%
W. Europe	13.06%	13.58%	11.70%
N. America	15.73%	16.46%	13.83%
Oceania	5.93%	4.94%	8.51%
Education			
GCSE/GED	6.23%	5.76%	7.45%
A-levels/high-school diploma	18.69%	16.87%	23.40%
Undergraduate degree	22.85%	22.63%	23.40%
Graduate degree	31.45%	32.51%	28.72%
Doctoral degree or higher	20.77%	22.22%	17.02%
Occupation			
Full-time students	23.44%	25.51%	18.09%
Never worked/long-term unemployment	13.35%	9.88%	22.34%
Consultant	2.37%	2.06%	3.19%
Skilled laborer	4.15%	2.88%	7.45%
Trained professional	22.85%	23.87%	20.21%
Support staff	4.45%	4.53%	4.26%
Administrative staff	6.53%	8.64%	1.06%
Junior management	10.98%	11.11%	10.64%
Middle management	8.01%	8.64%	6.38%
Upper management	3.86%	2.88%	6.38%
Key worker = Yes	21.07%	17.70%	29.79%
Income			
Under £2500	14.24%	15.23%	11.70%
£2500 to £4999	4.45%	4.94%	3.19%
£5000 to £9999	7.42%	5.76%	11.70%
£10,000 to £14,999	10.68%	11.93%	7.45%
£15,000 to £19,999	10.09%	11.11%	7.45%
£20,000 to £24,999	7.72%	9.05%	4.26%
£25,000 to £29,999	8.31%	8.23%	8.51%
£30,000 to £34,999	6.82%	8.64%	2.13%
£35,000 to £39,999	4.15%	3.29%	6.38%
£40,000 to £44,999	4.75%	4.94%	4.26%
£45,000 to £49,999	3.26%	2.88%	4.26%
£50,000 or more	18.10%	13.99%	28.72%
Subjective social status			
Working class	15.13%	16.05%	12.77%
Lower-middle class	39.76%	40.33%	38.30%
Upper-middle class	43.03%	41.15%	47.87%
Upper class	2.08%	2.47%	1.06%
Marital status			
Single/separated/widowed/divorced	56.08%	60.91%	43.62%
Married/domestic partnership	43.92%	39.09%	56.38%
Experienced COVID-19 symptoms	15.43%	14.40%	18.09%
No. people in same household	2.65 (1.18)	2.69 (1.21)	2.55 (1.08)
No. offspring	0.55 (0.99)	0.46 (0.94)	0.78 (1.08)
Isolated with[a]			
Alone	11.57%	10.70%	13.83%
With children	67.56%	67.36%	68.09%
With romantic partner	62.50%	61.98%	63.83%
With parents	18.15%	20.66%	11.70%
With siblings	2.98%	4.13%	0.00%
With housemates	8.33%	7.85%	9.57%
With friends	1.19%	1.65%	0.00%
With extended family	20.83%	16.94%	30.85%

Note. Data are presented as mean (SD) for continuous measures and % for categorical measures. Symptoms included: (1) a high temperature, (2) a new, continuous cough, (3) a continuous headache, (4) a loss of taste and/or smell, (5) muscle aches, (6) a sore throat. Countries in the sample included: Australia ($n = 17$), Austria ($n = 3$), Bulgaria ($n = 1$), Canada ($n = 3$), Denmark ($n = 2$), Finland ($n = 1$), France ($n = 18$), Germany ($n = 21$), Hungary ($n = 14$), Ireland ($n = 1$), Italy ($n = 63$), Luxembourg ($n = 1$), New Zealand ($n = 3$), Portugal ($n = 4$), Romania ($n = 1$), Russia ($n = 1$), Serbia ($n = 1$), Spain ($n = 3$), Switzerland ($n = 1$), United Kingdom ($n = 128$), United States ($n = 50$).

[a] $n = 336$.

Table 2. Descriptive statistics (M and SD) for main study variables ($N = 337$).

Variable	Total (SD)	Female (SD)	Male (SD)	% Miss.
AUDIT	6.52 (4.35)	6.10 (3.89)	7.62 (5.23)	12.76
Alcohol units change	−1.57 (6.89)	−0.87 (6.84)	−3.38 (6.72)	12.46
Drinking days change	−0.21 (1.50)	−0.05 (1.41)	−0.62 (1.63)	12.46
Heavy days change	−0.12 (0.61)	−0.13 (0.66)	−0.10 (0.45)	12.46
APQ change	−1.39 (2.19)	−1.46 (2.21)	−1.21 (2.14)	8.61
DMQ-R social	13.67 (5.25)	13.59 (5.23)	13.86 (5.31)	9.79
DMQ-R coping	8.56 (3.63)	8.60 (3.59)	8.46 (3.75)	9.79
DMQ-R enhancement	11.58 (4.86)	11.57 (5.00)	11.61 (4.49)	9.79
DMQ-R conform	6.69 (2.16)	6.68 (2.12)	6.71 (2.26)	9.79
SOS-S change	−0.83 (5.91)	−0.89 (6.35)	−0.67 (4.62)	11.28
PSRS total	22.19 (7.98)	23.66 (7.74)	18.4 (7.33)	11.28
MSBS change	18.51 (33.29)	19.71 (35.75)	15.41 (25.79)	9.79
SUPPS-P negative urgency	8.58 (2.59)	8.67 (2.59)	8.34 (2.59)	12.17
SUPPS-P premeditation	6.80 (2.01)	6.83 (2.04)	6.72 (1.94)	12.17
SUPPS-P perseverance	7.22 (1.95)	7.16 (1.93)	7.37 (1.98)	12.17
SUPPS-P sensation seeking	9.39 (2.76)	9.13 (2.68)	10.06 (2.87)	12.17
SUPPS-P positive urgency	6.76 (2.25)	6.70 (2.29)	6.91 (2.15)	12.17
DOSPERT total	87.11 (20.14)	85.83 (19.28)	90.41 (21.95)	11.87

Note. Summary statistics calculated using imputed data ($m = 40$). 1 unit = 8 g pure ethanol; 1 heavy day = consuming >8 units per day for men or >6 units per day for women; APQ: Alcohol Problems Questionnaire; DMQ-R: Revised Drinking Motives Questionnaire; SOS-S: Short Stress Overload Scale; PSRS: Perceived Stress Reactivity Scale; MSBS: Multidimensional State Boredom Scale; SUPPS-P: The Shortened Urgency, Premeditation (lack of), Perseverance (lack of), Sensation Seeking, Positive Urgency, Impulsive Behavior Scale; DOSPERT: Domain-Specific Risk-taking Scale.

Changes in alcohol use, stress, and boredom

Figure 1 shows changes in alcohol use, stress, and boredom. A sizeable number of respondents reported increased alcohol use (units = 23.52%, drinking days = 20.73%, heavy days = 7.06%), alcohol-related problems (9.67%), and stress (36.63%). Meanwhile, the majority of respondents reported increased boredom (67.42%). Results from the unadjusted models, which tested whether change occurred on average, suggested that alcohol units ($B = -1.53$, FDR-adjusted p = .004) and alcohol-related problems ($B = -1.47$, FDR-adjusted p < .001) decreased. Meanwhile, boredom ($B = 18.16$, p = FDR-adjusted p < .001) increased. In the adjusted models, there was evidence to suggest that alcohol-related problems ($B = -1.43$ FDR-adjusted p < .001) decreased while boredom increased ($B = 21.22$, FDR-adjusted p < 001). No other significant changes were found.

Associations between drinking motives and alcohol use behavior

Social motives were associated with a decrease in alcohol-related problems ($B = -0.09$, FDR-adjusted p = .005). No other significant relationships were found.

Associations between inhibitory control, stress, boredom, and alcohol use

Risk-taking (DOSPERT score) was associated with a decrease in alcohol-related problems ($B = -0.02$, FDR-adjusted p = .008). No other significant associations were found.

Moderation analyses suggested that boredom modified the relationship between lack of premeditation and the number of units consumed per week ($B = -0.02$, FDR-adjusted p = .034), the number of weekly drinking days ($B = -0.004$, FDR-adjusted p = .027), and the number of heavy drinking days ($B = -0.002$, FDR-adjusted p = .048). No other significant interactions were observed. JN plots (see Figure 2) revealed that those who were *more impulsive and less bored tended* to report *increased alcohol use*, and vice-versa. Specifically, a decrease of ≥16 MSBS points was associated with an increase in the number of units consumed. Whereas an increase of ≥28 points was associated with a decrease in the number of units consumed. Similarly, decreased MSBS scores were associated with an increased number of drinking days. Meanwhile, an increase of <19 MSBS points was associated with a decrease in drinking days. Finally, a decrease of ≥16 MSBS points was associated with an increase in the number of heavy drinking days. Whereas an increase of ≥ 18 MSBS points was associated with an increase in the number of heavy drinking days.

Discussion

The present study aimed to better understand how a period of social isolation, brought about by the recent COVID-19 pandemic, affected alcohol use. By assessing associations between changes in drinking behavior, drinking motives, inhibitory control, stress, and boredom, we provide a nuanced overview of how some of the theoretical mechanisms which underlie alcohol use and misuse may have operated during this time.

We found that approximately 1 in 4 respondents reported drinking more and around 1 in 10 reported experiencing an increased number of alcohol-related problems. These findings correspond to similar work conducted during the COVID-19 pandemic (Koopmann et al. 2020; Neill et al. 2020; Tran et al. 2020; Clay et al. 2021; Garnett et al. 2021; Jacob et al. 2021; Schmits and Glowacz 2021; Kilian et al. 2022). Most respondents reported feeling more bored during lockdown, as in previous work (Martarelli and Wolff 2020; Jackson et al. 2021; Latif and Karaman 2021). Stress levels, however, either stayed the same or decreased for most and, despite our prediction, stress was not significant in any model. Our findings are at odds with previous literature that has found the pandemic has been associated with increased mental distress (Bhattacharjee and Acharya 2020; Gavin et al. 2020; Ornell et al. 2020; Pfefferbaum and North 2020), and that pandemic-related distress was associated with increased drinking (Koopmann et al. 2020; Neill et al. 2020; Tran et al. 2020; Garnett et al. 2021; Jacob et al. 2021).

One explanation for this discrepancy may be that the physiological and psychological effects of acute vs. chronic stress differ (Stephens and Wand 2012; Crosswell and Lockwood 2020). Thus, it is plausible that the effect of stress on drinking differs as a function of the timescale and severity. Alternatively, it may be due to differences in measures used; several studies cited above utilized measures that are typically used to diagnose manifestations of poor mental health (e.g. depression, anxiety) in clinical settings, while we used a measure of *perceived stress*. Similar to us, other non-clinical studies carried out during the pandemic, using momentary assessments of positive and negative affect, suggested that preconsumption affect was not associated with

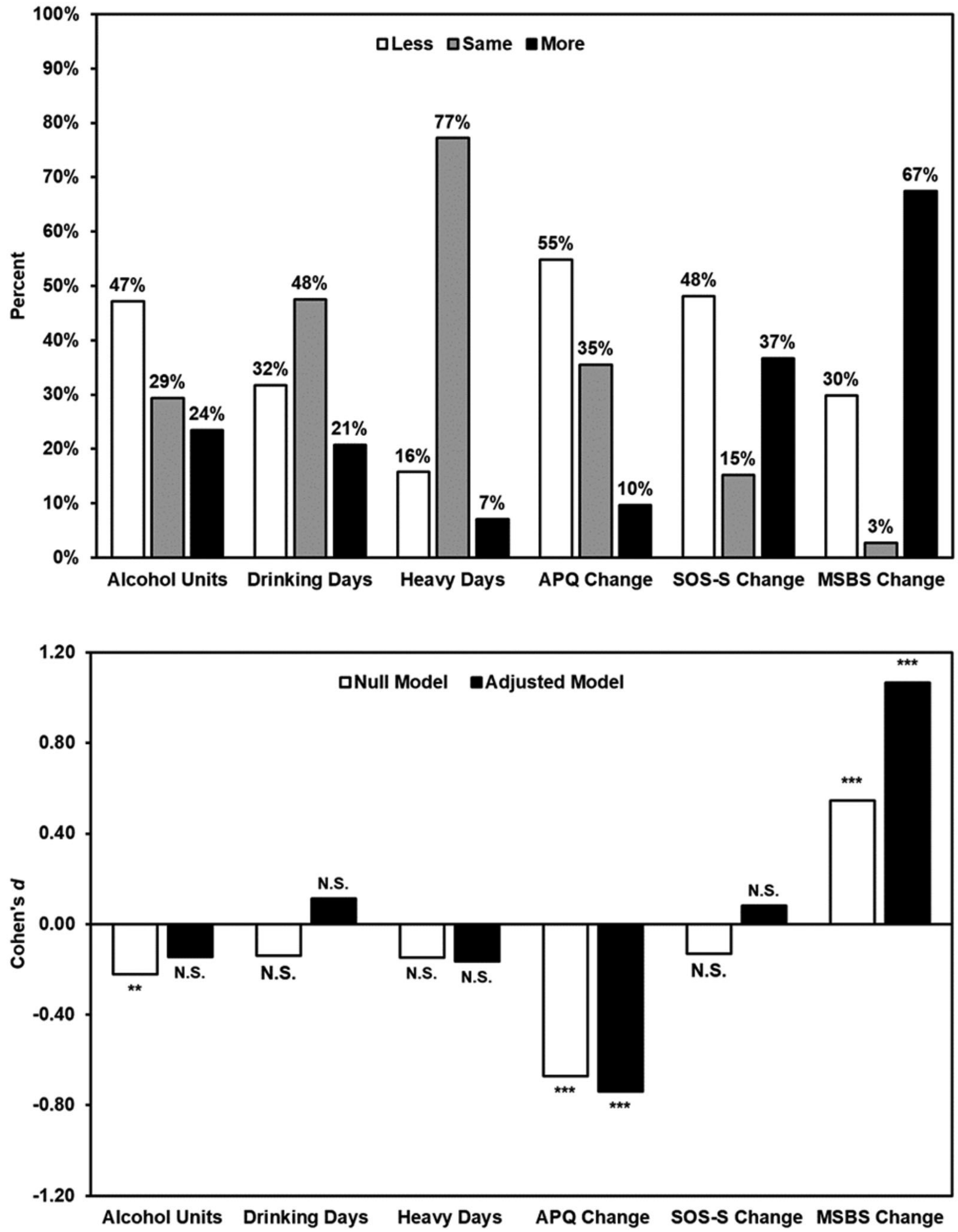

Figure 1. Changes in alcohol use, alcohol-related problems, stress, and boredom during social isolation ($N = 337$). *Note.* Both prevalence estimates (top) and effect sizes (bottom) were calculated using imputed data ($m = 40$). Adjusted models controlled for age, gender, ethnicity, socioeconomic status, the number of symptoms experienced, and whether the respondent was isolating with children. 1 unit = 8 g pure ethanol; 1 heavy day = consuming >8 units per day for men or >6 units per day for women; APQ: Alcohol Problems Questionnaire; SOS-S: Short Stress Overload Scale; MSBS: Multidimensional State Boredom Scale. *FDR-adjusted $p < .05$, **FDR-adjusted $p < .01$, ***FDR-adjusted $p < .001$.

increased drinking during the pandemic (Tovmasyan et al. 2022). Finally, the discrepancy may relate to the nature of our sample, which was predominantly highly educated Westerners.

Those who were high in risk-taking (DOSPERT total score) tended to face fewer alcohol-related problems during social isolation, despite impulsivity (i.e. the tendency to take risks) being an established risk factor for addictive behaviors (see Dalley and Ersche 2019; Lee et al. 2019 for reviews). However, boredom was found to be a critical moderator here: those who were less impulsive (in terms of lack of premeditation), who also reported feeling more bored, were more likely to increase alcohol use during the isolation and vice versa. Previous research has identified boredom as a risk-factor for health risk behaviors, such as substance misuse (e.g. Wegner and Flisher 2009). However, we found that although most participants reported increased boredom, the majority also reported a decrease in alcohol use. A reason for the decreased alcohol use in those that were showing higher rates of boredom may relate to the lack of interest in alcohol outside of the typical situations. For example, drinking is typically a social activity (e.g. Niland et al. 2013), and we found that social motives were the most endorsed drinking motive among our sample; indeed, those with higher

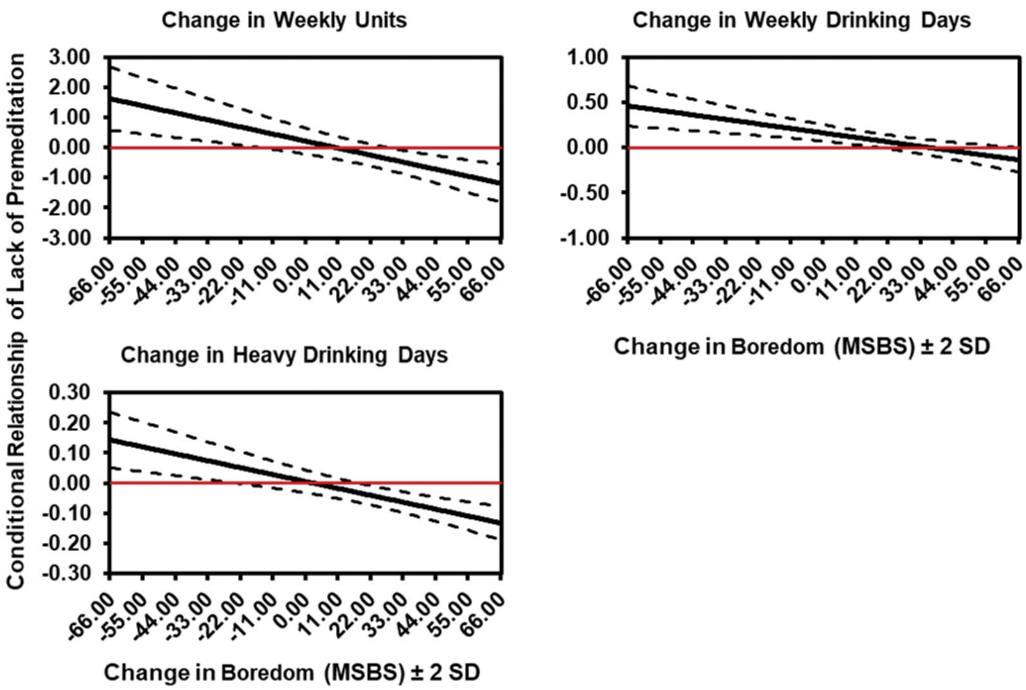

Figure 2. Johnson-Neyman plots illustrating significant inhibitory control x boredom interactions ($N = 337$). *Note.* Models were fitted using imputed data ($m = 40$). Models were adjusted for age, gender, ethnicity, socioeconomic status, the number of symptoms experienced and whether the respondent was isolating with children. The first imputed dataset was used to visualize statistically significant interactions. 1 unit = 8 g pure ethanol; 1 heavy drinking day = consuming > 8 units per day for men or > 6 units per day for women. Dashed lines represent the 95% CI.

social drinking motives reported fewer alcohol-related problems. Thus, this suggested that, on average, our sample were motivated to drink when in social situations; something clearly impacted significantly by the social isolation.

Reward expectancy (i.e. the anticipated reward associated with alcohol consumption) is determined by drinking motives, with those who tend to 'drink to cope' showing the highest anticipated reward expectancy (Birch et al. 2004; Grant and Stewart 2007). In our sample, coping was the one of the least endorsed motives, suggesting that our sample were low in this trait. In this sense, the expected positive reinforcement associated with drinking (i.e. alleviation of the boredom) would not be a strong motivator to drink in our sample. Further research is needed to disentangle the relationship between drinking motives, reward expectancy, boredom and alcohol consumption.

Boredom is associated with a negative affective state, which can be high- or low- arousal (Fahlman et al. 2013). In either case, boredom is associated with anhedonia, thus theoretically decreasing the pleasure associated with usually rewarding activities (Watson et al. 2020). Although typically boredom-induced anhedonia is not associated with substance misuse (Nikčević et al. 2017), boredom is a complex and multifaceted phenomenon (Raffaelli et al. 2018). Therefore, as people were exposed to an unprecedented period of social isolation, and subsequently high levels of boredom were reported here and in other studies (e.g. Droit-Volet et al. 2020), it may be that the phenomenon experienced during the pandemic is dissimilar (in terms of intensity and duration) than previous work (e.g. laboratory-based studies) or during previous times. Taken together, these factors may offer a potential explanation for our findings.

Limitations

We acknowledge several study limitations. First, there were relatively high levels of attrition. This may have been driven by the length of the survey as several relatively long and detailed psychometric instruments were employed. However, a limitation of previous work in this area is that brief single-item measures, that may be limited by reduced content validity, were used (Clay et al. 2021). Thus, the present work overcomes this limitation, providing nuance at the expense of sample size. Nevertheless, the bias introduced by missing data was minimized by employing multiple imputation. Second, respondents tended to be White, highly educated, and relatively wealthy. Ultimately, this may limit the generalizability of our findings to those with similar sociodemographic characteristics. Similarly, the COVID-19 pandemic has been an unprecedented time, thus pandemic-related findings may only hold true inside this timeframe. Third, self-report measures are prone to measurement error. For instance, there is no way to independently verify self-report drinking and people typically under-estimate their alcohol consumption on questionnaires (Northcote and Livingston 2011). Fourth, 'true' baselines for drinking behavior, stress, and boredom were unavailable and retrospective measures were employed as a proxy. Therefore, causal inference is precluded. Fifth, accurately estimating determinants of change is notoriously difficult and these considerations informed our analysis. Therefore, we purposefully tried to avoid spurious findings by not including baseline measures in our models (i.e. by using change scores instead) (Glymour et al. 2005). Finally, there are other *potential* confounding factors that were not accounted for here, such as mood disorders (Charles et al. 2021), as these data were not available.

Conclusions

We aimed to understand how a period of long-term social isolation affected alcohol use, particularly focusing on drinking motives, negative affect (i.e. stress and boredom), and inhibitory control. Our rationale was not just to characterize patterns observed during COVID-19, but to use the government-enforced lockdowns to model theoretical mechanisms by which alcohol consumption in the home could be affected by periods of enforced social isolation. We found that approximately one-quarter of respondents reported drinking more and around one tenth reported facing an increased number of alcohol related problems. Coupled with recent national statistics, which suggest that alcohol-related deaths in the UK reached an all-time high in 2020 (14 deaths per 100,000 people) (Office for National Statistics 2021), it is clear an 'at risk' group of individuals, who deserve immediate attention, may also require the allocation of future resources to mitigate harm. Surprisingly, however, increased risk-taking was associated with a decrease in the number of alcohol-related problems faced during social isolation and there was no evidence of an association between either stress or boredom and a change in alcohol use behavior. Moreover, several significant interactions suggested that those who were more impulsive and less bored were more likely to report increased alcohol use and vice versa. Therefore, during a period of social isolation, some theoretical mechanisms which underlie alcohol use and misuse may not be observed. This has important implications when considering mechanisms of alcohol misuse; researchers should potentially consider evaluating people's social interactions and isolation status during future work and interventions.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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This article has earned the Center for Open Science badges for Open Data and Preregistered through Open Practices Disclosure. The data are openly accessible at https://osf.io/bctgp and https://osf.io/rvuej. To obtain the author's disclosure form, please contact the Editor.

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