Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Longitudinal associations with alcohol consumption during the first COVID-19 lockdown: Associations with mood, drinking motives, context of drinking, and mental health

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ABSTRACT

Background: Coronavirus (COVID-19) resulted in lockdown measures in the UK, which has impacted alcohol use. Alcohol is often used as a coping mechanism and there are public health concerns regarding excessive consumption due to the pandemic. We aimed to longitudinally assess drinking behaviors, and associated factors, during the first UK government-mandated lockdown.
Methods: An online survey was distributed through social media (8th April 2020, onwards). Fortnightly follow up surveys were emailed to participants. The primary outcome measure was 'weekly unit consumption' and data was collected on a range of potentially related factors: demographics, factors relating to COVID-19 (e.g., health, work status), drinking motives, context of drinking, drinking intentions, mood, depression and anxiety.
Findings: A total of 539 self-selected participants completed the baseline survey, with 186 completing at least 3 follow up surveys for multilevel modelling analysis. Personal coping motives, anxiety, drinking at home alone, and drinking at home with others were positively associated with alcohol consumption during lockdown. The following baseline measures also predicted increased consumption: male gender, lower education, and higher AUDIT scores (based on behavior prior to lockdown). Findings were consistent when utilizing an inverse probability weight to account for predictors of attrition (female, younger age, higher baseline AUDIT scores).
Conclusions: Those already drinking at hazardous levels were more likely to increase their consumption, as were those who were drinking to cope. As we recover from the pandemic, there is a need for widespread alcohol support, and certain groups may need targeted support.

1. Introduction

Coronavirus 2 (SARS-CoV-2), commonly known as COVID-19, was first identified in 2019 in Wuhan, the capital of China's Hubei province, and has since spread globally, resulting in an ongoing pandemic (Hui et al., 2020). Through efforts to contain and prevent spread, countries have implemented a range of social distancing measures. The UK government implemented a 'lockdown' period from March 23rd 2020, which involved people staying in their home except for one form of exercise per day or essential shopping. Transition out of the first UK lockdown began in early June 2020, although a range of regional and national social distancing measures have been in place since that time, with a second national lockdown from the 5th November 2020 to late December 2020 and a third national lockdown from the 6th January 2021 until April 2021.

In addition to the direct effects of COVID-19 on a person's physical health, international and UK data suggests that lockdown has impacted alcohol consumption (Callinan et al., 2020; Garnett et al., 2021; Jackson et al., 2020; Oldham et al., 2021; Tran et al., 2020). Across the UK, alcohol purchasing increased in the weeks prior to lockdown (Kantar., 2020) suggesting stockpiling behavior. A representative study found that 26 % of participants reported drinking more during, relative to before, lockdown, but almost half of the sample reported drinking less (Garnett et al., 2021). However, the Global Drug Survey (GDS) found that, of 2039 UK respondents, 48 % reported drinking more (27 % reported drinking less), and 52 % reported drinking more frequently (25 %

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reported drinking less frequently) (Winstock et al., 2020). Importantly, evidence shows that the first UK lockdown was associated with an increase in the prevalence of hazardous drinking, particularly in women (Jackson et al., 2020).

It is clear that COVID has impacted alcohol use, so identifying what factors may be a risk for increased drinking is needed. As with previous pandemics/epidemics (Stuijfzand et al., 2020), COVID-19 and its associated lockdown measures are related to increased feelings of stress, depression, anger, fear, loneliness/isolation, and boredom (Groarke et al., 2020; Röhr et al., 2020), all of which can negatively impact mental health (Hossain et al., 2020). It is well-established that alcohol can be used as a coping mechanism to deal with negative mood states and stress (Keyes et al., 2011), and there have been warnings made around a potential public health crisis relating to excessive alcohol consumption during lockdown (Clay and Parker, 2020). If coping motives are responsible for increased drinking, this is important, as these motives are positively associated with alcohol-related problems, relative to positive reinforcing drinking motives (Cooper et al., 2016).

The UK Household Longitudinal Study showed a significant increase in mental health problems during April 2020 (compared with data from 2017 to 2019), which was more pronounced in women than men (Daly et al., 2020). A number of sources have reported a greater increase in women's, relative to men's, drinking (Garnett et al., 2021; Jackson et al., 2020), and this fits with evidence that women are more likely than men to report drinking to alleviate negative affect (Peltier et al., 2019). Context might also influence drinking behavior. Drinking alone is linked to higher levels of consumption required to reach intoxication (Davies et al., 2021), drinking to cope (Irizar et al., 2020), and alcohol-related problems (Keough et al., 2015). During lockdown, heavy drinking may be partially explained by a greater sense of isolation (Luchetti et al., 2020) and potential stress around financial concerns (Wilson et al., 2020).

By identifying the factors associated with increased alcohol use, we can develop future targeted prevention and interventions strategies to reduce alcohol harm (Cooke and Crawford, 2021; Kuntsche et al., 2006). This UK-based survey measured self-reported alcohol use before and during lockdown in a self-selected sample, while also measuring a range of factors that may affect drinking behavior. We hypothesized that coping drinking motives, negative mood, depression, and anxiety would be significantly associated with increased alcohol use. We hypothesized that individual factors of gender (being female), parental responsibility (dependent children living at home), financial status (e.g., loss of earnings), and isolation would also be significantly associated with greater alcohol consumption during lockdown in the UK. The study procedure and hypotheses have been pre-registered online https://aspredicted.org/d8yf8.pdf.

2. Methods

2.1. Baseline survey

2.1.1. Participant characteristics

We measured demographic information (age, gender, ethnicity, highest level of education, employment status, household income) and other individual factors that may influence lockdown experiences (whether participants were living alone, how many others were in the household, parental status, whether occupation had been affected by COVID-19, whether household income had been affected by COVID-19, and keyworker status).

2.1.2. COVID-19 status

Participants were asked if they had a previous or current diagnosis of COVID-19, or whether they thought that they had had it (without a diagnosis), with the following options: no, think so but not confirmed, yes (diagnosed), prefer not to say.

2.1.3. Health

A single item self-reported health question assessed general health with a five-point scale ranging from Excellent to Poor (Bombak, 2013).

2.1.4. Mental health

Generalized anxiety disorder was measured using the Generalized Anxiety Disorder (GAD-2) (Kroenke et al., 2007), a two-item scale measured on a four-point scale, ranging from not at all to nearly every day. Depression was measured using the Patient health questionnaire (PHQ-2) (Kroenke et al., 2003), a two-item scale measured on a four-point scale, ranging from not at all to nearly every day. Responses to these scales were kept as continuous variables.

2.1.5. Alcohol use disorders identification test (AUDIT) (Saunders et al., 1993)

A 10-item clinical screening tool, with scores ranging from 0 to 40, used to identify hazardous (score 8–15) and harmful (score ≥16) alcohol use. McDonald's omega (ω) indicated good internal reliability (ω = 0.80) (McDonald, 1981). The AUDIT was administered as a retrospective measure of typical behavior prior to lockdown.

2.1.6. Timeline follow back questionnaire (TLFB) (Sobell et al., 1986)

A self-report measure which estimates weekly alcohol consumption in UK units. Participants self-reported what a 'typical week' of alcohol use was prior to lockdown (retrospective report). Participants then recorded how much alcohol they had consumed over the past week (i.e., in the week before completing the baseline survey, during lockdown). Participants reported the number of drinks for the following: wine, beer/lager/cider, spirits, and alcopops. Drinks were converted to weekly unit (8 g alcohol) consumption.

2.1.7. Context of drinking

Context of drinking was determined across four items covering different drinking contexts (at home alone, at home with others, with others online, and with others in public) on a four-point scale ranging from Always to Never.

2.1.8. Drinking motives

Were assessed across 13 motive items on a three-point scale (Never, Sometimes, Always) (available in supplementary materials). Confirmatory factor analysis using a polychoric correlation matrix and diagonally weighted least squares estimation, to account for the ordinal nature of the data, showed that items loaded on to three factors (eigenvalues above 1 and factor loadings for each item above 0.40): personal coping (e.g., to feel less stressed), social coping (e.g. peer pressure), and positive reinforcing (e.g. to celebrate) motives. The Kaiser-Meyer-Olkin (KMO) test indicated that sampling adequacy was moderate (0.69) (Kaiser, 1970). McDonald's omega indicated good internal reliability for personal coping (ω = 0.84) and social coping (ω = 0.74), but mediocre internal reliability for social positive (ω = 0.57) (McDonald, 1981).

2.1.9. Drinking intentions

We created two items requiring participants to report how many days they intended to drink alcohol over the next two weeks, and how many and what type of drinks (wine, beer/lager/cider, spirits, and alcopops) they intended to consume on drinking days (converted to units). These two items were combined to determine planned units for the upcoming week.

2.1.10. Brief Mood Introspection Scale (BMIS) (Mayer and Gaschke, 1988)

The BMIS assessed 16 mood-adjectives on a seven-point Likert scale. The scale yields measure of overall pleasant-unpleasant mood, arousal-calm mood, positive-tired mood, and negative-calm mood. McDonald's omega was obtained for each individual scale (i.e., pleasant scale, unpleasant scale), with moderate internal reliability for the positive scale

($\omega = 0.67$), and good internal reliability for the remaining scales (ω ranged from 0.78 to 0.87). An additional three items which may be relevant to COVID-19 lockdown were added (bored, lonely, afraid).

2.2. Subsequent surveys

The subsequent surveys were shorter than the initial survey and included measures of COVID-19 status; anxiety (GAD-2) depression (PHQ-2); AUDIT-C (the standard 3-item version of the AUDIT, phrased to capture behavior over the preceding 2 weeks, measuring frequency of consumption, typical units on a drinking occasion, and frequency of binge drinking (Bush et al., 1998)); alcohol use (TLFB); drinking intentions; drinking context; drinking motives and BMIS with additional items.

2.3. Procedure

A link to the baseline survey was posted on various social media platforms (e.g., Facebook, twitter) from 8th April 2020, onwards. Self-selecting sampling was used, whereby potential participants could click on the link which would take them to the participant information sheet. If participants completed the informed consent form, the survey was launched. To conform to ethical guidelines, participants were free to leave questions blank or respond, 'I prefer not to answer this question'. After completing the survey, participants were asked to leave their contact details (email address) so that subsequent surveys could be sent to them at fortnightly intervals. There were four subsequent surveys, with the final subsequent survey being completed on the 6th July 2020. The study was approved by the University of Liverpool's Ethics Committee.

2.4. Data analysis plan

2.4.1. Data reduction

Participants who did not complete at least 90 % of the survey were first excluded due to insufficient data on primary outcome and demographic measures. Where remaining participants (i.e., those who completed at least 90 % of the survey) had missing data for less than 10 % of each questionnaire within a survey (distributed at random across the survey as opposed to being missing due to participants not completing the survey), mean imputation (a single imputation method) was used. Missing values for each questionnaire were replaced with the mean of the available questionnaire items, for each participant. Participants who had completed fewer than three surveys were excluded from the multilevel models (MLM). Participants who did not leave an email address (N = 170) could not be contacted to complete follow-up surveys and were only included in baseline analysis.

2.4.2. Baseline analysis

Exploratory linear regression analyses were conducted to determine the sociodemographic characteristics or individual factors associated with units consumed at baseline (past weekly alcohol consumption), controlling for typical weekly units (before lockdown). The sociodemographic and individual factors (explanatory variables) were categorical, with the most common group being used as reference groups. Additional exploratory linear regressions were conducted to examine whether the context of drinking items, mood items, drinking motivation items, and mental health items, were associated with units consumed at baseline, controlling for typical weekly units. The standardized Beta (β) coefficients, with 95 % confidence intervals (CIs) and p values are reported.

2.4.3. Multilevel modelling

First, linear regression analyses were conducted to explore the associations between the measures of alcohol consumption (past weekly consumption, planned units, and AUDIT-C scores) and timepoint. Random effects multi-level models (MLM) were used to analyze predictors of alcohol consumption (past weekly consumption, at baseline and all four subsequent surveys), due to the hierarchical data structure (timepoints > participants) which are likely to be highly correlated and violate the assumption of independent data. MLM partitions the overall variance in the outcome into separate levels, determining predictors of within and between subject variances. Two-level (timepoints > participants) random intercept, fixed slope models were tested. The linear MLM were conducted using the *mixed* command in STATA SE 15.

The level one predictor variables (vary by timepoint) included variables from the subsequent surveys: mood items (two BMIS scales and three additional items), drinking motives (three factors), context of drinking (four items), anxiety and depression. The predictors were added in separate blocks. Block one included two BMIS scales (pleasant-unpleasant and arousal-calm scales) and three additional mood items. The negative-calm and positive-tired BMIS scales were not included in the model as they were highly correlated with the other scales ($r > 0.70$). Block two included the three drinking motive factors. Block three included the two mental health items, and block four included the context of drinking items.

All significant level one predictor variables were kept in the model and then level two predictors were added in blocks. The level two predictors (vary by participant) included variables from the initial survey: AUDIT scores, demographic variables (age, gender, education, income), individual factors (living alone, living with, keyworker status, occupation affected by COVID-19, and household income affected by COVID-19), COVID-19 status. Block one included AUDIT scores only. Block two included the demographic variables, and block three included the individual factors. The continuous level one predictors were group mean centered (i.e., centered against the mean for each participant), leaving only the deviation of each variables.

The coefficient estimates, standard errors, 95 % CIs and p values are reported for each explanatory variable. The log-likelihood and intraclass correlation coefficient (ICC, the proportion of variance explained at a participant level) are reported for each block.

2.4.4. Predictors of attrition

Logistic regressions were run to determine predictors of completing fewer than three surveys (attrition), compared with completing three or more surveys. Variables which were significant predictors of both attrition and the outcome were included in creating the inverse probability weight, which was then applied to the previously outlined MLM, giving more weight to participants with the characteristics associated with attrition. The inverse probability weight was created using the *pweight* command in STATA SE 15.

3. Results

3.1. Participant characteristics

A total of 539 self-selecting participants (74 % female) completed at least 90 % of the baseline survey. Of these participants, 215 completed survey two, 169 completed survey three, 136 completed survey four and 97 completed survey five. The mean age of respondents was 38.94 years old (SD $\pm$ 13.36), ranging from 18 to 72 years old. For the whole sample, the mean ($\pm$SD) AUDIT score at baseline was 7.09 ($\pm$5.14), with 31 % of the sample scoring above the cut-off for hazardous drinking and 10 % scoring above the cut-off for harmful drinking.

Descriptive statistics for each measure of alcohol consumption, mood, drinking motives, and mental health, are shown in Supplementary Table 1, for those who completed three or more sessions only. The mean (±SD) for typical weekly units (before lockdown) was 32.57 (±31.54). The mean (±SD) units at baseline (past weekly unit consumption) were 38.19 (±33.55), significantly decreasing over time (β = -6.47, SE = 0.68, 95 % CI = -7.81 to -5.13, p < .01). Mean (±SD) planned units at baseline were 12.30 (±8.79), significantly decreasing over time (β = -1.47, SE = 0.20, 95 % CI = -1.87 to -1.07, p < .01). The AUDIT-C was administered at each follow up survey (not at baseline), with scores significantly increasing over time (β = 0.68, SE = 0.09, 95 % CI = 0.49, to 0.86, p < .01).

3.2. Baseline analysis

The results are shown in Table 1. Due to insufficient data, we were not able to explore the associations between some sociodemographic variables or individual factors with consumption (e.g., ethnicity, COVID-19 status). Those with A-level education or equivalent reported significantly lower consumption at baseline, than those with a bachelor's degree (p = .035). Those with a household income above £31k per year reported significantly higher consumption at baseline, than those with a household income below £21k per year (ps<.05). Keyworkers reported significantly higher consumption, compared to non-keyworkers (p = .010).

The results are shown in Table 2. At baseline, participants who reported drinking at home alone and drinking at home with others (sometimes, almost always, and always), drank significantly more units compared with those who reported "never" drinking at home alone or drinking at home with others (ps<.01). Those who "sometimes" drank online with others, drank significantly more units than those who "never" drank online with others (p < .01). The BMIS pleasant-unpleasant scale was negatively associated with units consumed, meaning those feeling more unpleasant consumed more units (p = .047), and the negative-calm scale was positively associated, meaning those feeling more negative consumed more units (p = .043). Being lonely was also positively associated with consumption (p = .022). Personal coping, social positive and social coping drinking motivations were all significantly, positively associated with consumption (ps<.01).

3.3. Multilevel modelling

Participants who only completed the baseline survey and did not leave an email address were removed (N = 170), as they could not have completed the follow up data. Only participants who completed three or more sessions were included in the multilevel modelling (N = 186).

The null model with no random intercept was estimated, i.e., past weekly unit consumption (N obs. = 719. β = 23.97 (95 % CI: 21.85–26.10), p < .01, var(residual) = 845.45, AIC = 6890.40, BIC = 6899.56). Then, a null model with a random intercept (participant) was estimated (N obs. = 719. N participants = 186. β = 24.74 (95 % CI: 21.20–28.28), p < .01, var(residual) = 355.05, AIC = 6615.38, BIC = 6629.11), and the ICC indicated that 59 % of the variance in alcohol consumption was at a participant level. A Likelihood Ratio Test was significant (Likelihood Ratio $X^2(1) = 277.02$. p < .01), indicating that MLM is appropriate for the data.

The results are presented in Table 3. Higher self-reported personal coping drinking motives and higher self-reported anxiety were significantly positively associated with alcohol consumption. Drinking at home, alone (always, compared to never), and drinking with someone else at home (sometimes, almost always, and always, compared to never), were significantly positively associated with alcohol consumption. Sometimes drinking with others in public (compared to never) was significantly negatively associated with alcohol consumption.

All significant level one predictor variables were retained in the model, and level two predictors were added. The following baseline variables significantly positively predicted increased alcohol consumption: higher AUDIT scores, being male (compared to female), and GCSE level education (compared to bachelor's degree).

The final model is presented in Table 4 and included the following predictors: gender, education, AUDIT scores at baseline, personal coping motives, drinking alone at home, drinking with others at home, and anxiety. Anxiety was no longer significant when all variables were included in the model. The overall model predicted 43 % of the variance in alcohol consumption at the participant level (N obs. = 613. N participants = 184. Log Likelihood = -2800.85, p < .01, var(residual) = 383.33, AIC = 5647.32, BIC = 5726.85).

3.4. Predictors of attrition

Logistic regressions were used to explore predictors of attrition, examining factors associated with completing fewer than three surveys (N = 198), compared to those who had completed three or more surveys (N = 186). The results are shown in Supplementary Table 2. Men were less likely to drop out, compared to women (OR = 0.56, 95 % CI: 0.34 to 0.90). Those of a younger age were more likely to drop out (OR = 0.97, 95 % CI: 0.96 to 0.99), as were those with higher AUDIT scores at baseline (OR = 1.06, 95 % CI: 1.02–1.11). Those who lived with four or more people were more likely to drop out, compared to those living alone (OR = 2.48, 95 % CI: 1.10–5.58). Those whose occupation had been affected by COVID-19 were less likely to drop out (than those whose occupation had not been affected) (OR = 0.58, 95 % CI: 0.37 to 0.91).

Gender, age, and AUDIT scores at baseline were significant predictors of both attrition and the outcome (units consumed in the past week). These variables were used to create the inverse probability weight, giving more weight to women, those of a younger age, and those with higher AUDIT scores at baseline.

3.5. Multilevel modelling: inverse probability weight

The results of the multilevel modelling, with the inverse probability weight, are presented in Supplementary Tables 3 & 4. The inverse probability weight did not alter the significant findings. The overall model, with the inverse probability weight, predicted 45 % of the variance in alcohol consumption at the participant level (N obs. = 602. N participants = 180. Log Likelihood = -5706.82, p < .01, var(residual) = 373.93, AIC = 11447.64, BIC = 11522.45). The goodness of fit criteria shows that the inverse probability weight did not improve the fit of the overall model, as the AIC and BIC are smaller in the previous model.

4. Discussion

4.1. Key findings

We present the findings of a longitudinal multilevel modelling analysis of alcohol consumption, and associated factors, during the first government-mandated lockdown in the UK (March - May 2020). As hypothesized, higher personal coping drinking motives and higher self-reported anxiety were associated with greater alcohol consumption during lockdown. However, anxiety was no longer significant in the final model, suggesting that anxiety is accounted for by other variables known to be associated with consumption, such as coping motives (Stewart et al., 2001). Social positive and social coping motives were not longitudinally associated with alcohol consumption but were positively associated with alcohol consumption at baseline. This may reflect a lack of opportunity to drink in group settings and the relative strength of drinking for personal coping motives during this time.

The context of drinking is important, as previous findings suggest that drinking at home and alone is associated with more harmful drinking behaviors and drinking to cope (Keough et al., 2018; Skrzynski and Creswell, 2020; Wardell et al., 2020). The current study showed a

Table 1

Participant characteristics at baseline (N = 539). Exploratory univariate linear regressions to determine associations with units consumed in the week before baseline survey, controlling for typical units consumed before COVID-19.

Variable	N (%) missing	N (%)	F (df)	Adj R-squared	β	95 % CI	P value
Demographics							
Gender	0 (0.00		83.60 (3, 535)	0.32			
Female		397 (73.65)			Ref.		
Male		134 (24.86)			−1.17	−7.10 to 4.75	0.698
Non-binary/transgender/other		8 (1.48)			/	/	/
Age (Mean (±SD))	2 (0.37)	38.94 (13.36)	124.23 (2, 532)	0.32	0.15	−0.05 to 0.34	0.136
Ethnicity	0 (0.00)		/	/			
White		520 (96.47)			/		
Asian		6 (1.11)			/	/	/
Black		1 (0.19)			/	/	/
Other		12 (2.23)			/	/	/
Education	1 (0.19)		50.60 (5, 532)	0.32			
Bachelor's degree		170 (31.60)			Ref.		
Post-graduate degree		165 (30.67)			−3.86	−10.23 to 2.50	0.233
GCSE or below		33 (6.13)			3.08	−8.08 to 14.24	0.588
A-levels or equivalent		159 (29.55)			**−6.93**	**−13.36 to -0.49**	**0.035**
Other		11 (2.04)			5.91	−24.02 to 12.21	0.522
Household income	0 (0.00)		42.91 (6, 532)	0.32			
Less than £20k		93 (17.25)			Ref.		
£21k to £30k		86 (15.96)			8.06	−0.64 to 16.76	0.069
£31k to £40k		71 (13.17)			**9.75**	**0.59 to 18.92**	**0.037**
£41k to £70k		164 (30.43)			**9.68**	**2.13–17.22**	**0.012**
£71k+		64 (11.87)			**9.70**	**0.26 to 19.14**	**0.044**
Prefer not to say		61 (11.32)			3.85	−5.73 to 13.44	0.430
Living alone	0 (0.00)		82.90 (3, 535)	0.32			
No		468 (86.83)			Ref.		
Yes		69 (12.80)			−3.83	−11.36 to 3.69	0.317
Prefer not to say		2 (0.37)			/	/	/
N others in household	0 (0.00)		49.81 (5, 533)	0.31			
0		108 (20.04)			Ref.		
1		173 (32.10)			1.62	−5.55 to 8.78	0.658
2		96 (17.81)			−1.31	−9.51 to 6.89	0.754
3		102 (18.92)			4.80	−3.27 to 12.87	0.243
4+		60 (11.13)			0.57	−8.86 to 10.00	0.906
Parental status	190 (35.25)		107.88 (2, 346)	0.38			
No		281 (80.52)			Ref.		
Yes		68 (19.48)			1.81	−5.72 to 9.34	0.636
Individual factors							
COVID-19 key worker	0 (0.00)		85.72 (3, 535)	0.32			
No		401 (74.40)			Ref.		
Yes		133 (24.68)			**7.67**	**1.86 to 13.48**	**0.010**
Prefer not to say		5 (0.93)			/	/	/
Occupation affected	0 (0.00)		63.47 (4, 534)	0.32			
No		157 (29.13)			Ref.		
Yes		366 (67.90)			5.22	−0.33 to 10.78	0.065
Prefer not to say		7 (1.30)			/	/	/
Don't know		9 (1.67)			/	/	/
Income affected	0 (0.00)		63.16 (4, 534)	0.32			
No		351 (65.12)			Ref.		
Yes		170 (31.54)			2.29	−3.20 to 7.77	0.413
Prefer not to say		4 (0.74)			/	/	/
Don't know		14 (2.60)			/	/	/
COVID-19 status							
Have you had COVID-19?	0 (0.00)		/	/			
No		465 (86.27)			/		
Think so, not confirmed		72 (13.36)			/	/	/
Yes, diagnosed		2 (0.37)			/	/	/
Prefer not to say		0 (0.00)			/	/	/
Do you currently have COVID-19?	0 (0.00)		/	/			
No		526 (97.59)			/		
Think so, not confirmed		11 (2.04)			/	/	/
Yes, diagnosed		1 (0.19)			/	/	/
Prefer not to say		1 (0.19)			/	/	/
Health							
Health	0 (0.00)		49.97 (5, 533)	0.31			
Excellent		88 (16.33)			Ref.		
Very good		230 (42.67)			1.22	−6.13 to 8.57	0.745
Good		163 (30.24)			5.67	−2.11 to 13.45	0.153
Fair		45 (8.35)			1.52	9.21 to 12.25	0.781
Poor		13 (2.41)			0.97	−16.38 to 18.33	0.913

Table 2
Exploratory univariate linear regression analyses to determine the baseline associations with units consumed in the week prior to baseline survey (N = 539), controlling for typical units before COVID-19. Explanatory variables are context of drinking, mood, drinking motives, and mental health.

Questionnaire	N (%) missing	N (%) / Mean (SD)	F (df)	Adj R-squared	β	95 % CI	P value
Context of drinking							
At home alone	6 (1.11)		74.82 (4, 528)	0.36			
Never		268 (50.28)			Ref.		
Sometimes		104 (19.51)			**17.09**	**10.54 to 23.63**	**0.000**
Almost always		50 (9.38)			**14.72**	**5.84 to 23.59**	**0.001**
Always		111 (20.83)			**15.08**	**8.69 to 21.46**	**0.000**
At home with others	7 (1.3)		74.95 (4, 527)	0.36			
Never		177 (32.27)			Ref.		
Sometimes		104 (19.55)			**12.48**	**5.50 to 19.47**	**0.000**
Almost always		82 (15.41)			**22.45**	**14.86 to 30.04**	**0.000**
Always		169 (31.77)			**13.17**	**7.08–19.26**	**0.000**
Online with others	9 (1.67)		71.17 (4, 525)	0.35			
Never		269 (50.75)			Ref.		
Sometimes		196 (36.98)			**14.19**	**11.16–24.56**	**0.000**
Almost always		32 (6.04)			3.55	−9.86 to 17.09	0.513
Always		33 (6.23)			−1.58	−11.23 to 14.98	0.769
In public with others	10 (1.86)		60.49 (4, 524)	0.31			
Never		498 (95.95)			Ref.		
Sometimes		17 (3.28)			3.14	−10.66 to 17.48	0.634
Almost always		2 (0.39)			/	/	/
Always		2 (0.39)			/	/	/
BMIS							
Pleasant-unpleasant scale	105 (19.48)	64.81 (±14.12)	103.43 (2, 431)	0.32	**−0.20**	**−0.41 to -0.00**	**0.047**
Arousal-calm scale	104 (19.29)	46.38 (±6.56)	101.17 (2, 434)	0.32	0.21	−0.23 to 0.64	0.349
Positive-tired scale	98 (18.18)	28.01 (±6.18)	105.76 (2, 438)	0.32	−0.35	−0.81 to 0.11	0.132
Negative-calm scale	96 (17.81)	23.38 (±6.09)	104.30 (2, 440)	0.32	**0.48**	**0.01 to 0.94**	**0.043**
Bored	37 (6.86)	4.32 (±2.03)	112.85 (2, 499)	0.31	0.86	−0.44 to 2.15	0.194
Lonely	79 (14.66)	3.67 (±1.95)	108.74 (2, 444)	0.33	**1.70**	**0.39 to 3.02**	**0.011**
Afraid	92 (17.07)	3.40 (±2.09)	109.13 (2, 457)	0.32	0.63	−0.78 to 2.03	0.380
Drinking Motives							
Personal coping	24 (4.45)	11.18 (±3.75)	222.27 (2, 512)	0.46	**3.64**	**3.00–4.27**	**0.000**
Social positive	24 (4.45)	4.72 (±1.73)	136.04 (2, 512)	0.34	**2.63**	**0.44 to 0.57**	**0.001**
Social coping	23 (4.27)	3.45 (±0.97)	144.21 (2, 513)	0.36	**6.28**	**3.69 to 8.87**	**0.000**
Mental health							
GAD 2	5 (0.93)	2.05 (±1.93)	119.83 (2, 531)	0.31	0.26	−1.06 to 1.57	0.701
PHQ 2	5 (0.93)	1.67 (±1.76)	120.33 (2, 531)	0.31	0.67	−0.77 to 2.11	0.362

BMIS; Brief Mood Introspection Scale. DMQ; Drinking Motives Questionnaire. PHQ; Patient Health Questionnaire. GAD; Generalised Anxiety Disorder.

strong association between always drinking at home alone and increased consumption, whereas drinking online with others or in public with others was not associated. Further, being male, lower educational attainment, and higher AUDIT scores at baseline were significant predictors of increased alcohol consumption during the study.

An inverse probability weight was used to account for predictors of attrition, which notably included being female, younger age, and higher AUDIT scores at baseline, with the latter being harmonious with existing research (Radtke et al., 2017). Both actual and planned unit consumption decreased over time, which may reflect greater attrition from those with higher AUDIT scores at baseline (Radtke et al., 2017). However, AUDIT-C scores increased over time. This finding is not clear, but it may reflect a discrepancy between the drink diary measure and the AUDIT-C. The diary concentrates on recording how many drinks are consumed each day, while the AUDIT-C items measure frequency and quantity of alcohol use, and frequency of binge drinking. In line with recent evidence, it may be that a greater proportion of participants increased their frequency of drinking, but only a small proportion of participants increased the amount consumed and frequency of binge drinking (Oldham et al., 2021; Winstock et al., 2020).

Two opposing predictions have been proposed regarding the impact of the pandemic on alcohol consumption - the first being an increase in consumption in some populations, relating to distress, and the second being a decrease, due to reduced availability of alcohol, both physically and financially (Rehm et al., 2020). Our sample showed an overall decrease in planned and consumed weekly units, but we were able to determine longitudinal associations with consumption. Several UK cross-sectional reports have identified self-reported increases

(between one fifth and one third of participants) and decreases (approximately one quarter) in alcohol consumption at the beginning of the pandemic (Alcohol Change UK, 2020; Garnett et al., 2021; Institute of Alcohol Studies (IAS), 2020; Jackson et al., 2020; Winstock et al., 2020). A cross-sectional survey found that increased consumption was associated with being female, younger, having a higher education and higher income, and having an anxiety disorder (Garnett et al., 2021). However, cross-sectional studies have causal attribution limitations (Levin, 2006), whereas the present findings (though not as representative) were able to identify the characteristics of those who were more likely to increase their consumption during lockdown, and thus are perhaps at more at risk of alcohol-attributable harm.

The UK findings from the GDS indicated that 49 % of people with a mental health problem reported drinking more alcohol due to increased COVID-19 related stress, compared to 33 % of those without a mental health problem (Winstock et al., 2020), with similar findings observed in Australian and US data (Rodriguez et al., 2020; Tran et al., 2020). In line with this, we showed that self-reported anxiety and personal coping drinking motives were associated with greater consumption. The COVID-19 pandemic has had major psychological impact, clearly increasing psychological distress (Daly et al., 2020; Niedzwiedz et al., 2020; O'Connor et al., 2020; Pierce et al., 2020). Our findings add to the growing literature that people suffering mental health problems, particularly anxiety-related, may be especially vulnerable to increased alcohol use during this time (Pierce et al., 2020; Rodriguez et al., 2020; Tran et al., 2020). Contrarily, emerging evidence highlights a polarizing impact of COVID-19-related stress, showing associations with both decreased consumption and increased consumption (Garnett et al.,

Table 3
Multilevel modelling analyses. Level one predictors (vary by time point) and level two predictors (vary by participant) of units consumed each week, for participants who completed 3 or more sessions (N = 186). Level one predictors are group mean centred. Missing data was imputed if less than 10 % was missing for each questionnaire.

Level one predictors	N (obs) / N (groups)	Estimate (SE)	95 % CI	P value
Block 1	520 / 167			
Pleasant-unpleasant scale		−0.01 (0.11)	−0.22 to 0.21	0.963
Arousal-calm scale		0.16 (0.22)	−0.27 to 0.59	0.463
Bored		0.48 (0.78)	−1.04 to 2.01	0.533
Lonely		0.44 (0.82)	−1.18 to 2.05	0.595
Afraid		0.47 (0.82)	−1.14 to 2.08	0.570
Log-likelihood (P > Chi2)	*−2378.89 (0.6160)*	*ICC = 0.63*		
Block 2	628 / 186			
DMQ personal coping		**1.57 (0.46)**	**0.67 to 2.47**	**0.001**
DMQ social positive		−1.14 (1.05)	−3.21 to 0.92	0.278
DMQ social coping		0.93 (0.74)	−0.52 to 2.38	0.209
Log-likelihood (P > Chi2)	*−2905.77 (0.0032)*	*ICC = 0.55*		
Block 3	719 / 186			
GAD 2		**2.37 (0.86)**	**0.69 to 4.06**	**0.006**
PHQ 2		−1.38 (0.96)	−3.26 to 0.50	0.150
Log-likelihood (P > Chi2)	*−3300.89 (0.0218)*	*ICC = 0.59*		
Block 4	643 / 184			
Context of drinking – alone				
Never		1.00		
Sometimes		4.93 (2.84)	−0.63 to 10.50	0.082
Almost always		5.76 (4.10)	−2.28 to 13.79	0.160
Always		**8.93 (2.90)**	**3.25 to 14.61**	**0.002**
Context of drinking – with someone at home				
Never		1.00		
Sometimes		**7.93 (3.15)**	**1.76 to 14.09**	**0.012**
Almost always		**9.34 (3.52)**	**2.44 to 16.23**	**0.008**
Always		**7.59 (2.92)**	**1.87 to 13.31**	**0.009**
Context of drinking – online				
Never		1.00		
Sometimes		4.10 (2.32)	−0.44 to 8.64	0.077
Almost always		2.64 (3.99)	−5.17 to 10.45	0.508
Always		−1.61 (3.84)	−9.14 to 5.93	0.676
Context of drinking – public				
Never		1.00		
Sometimes		**−7.64 (1.63)**	**-10.83 to -4.46**	**0.000**
Almost always		2.68 (9.05)	−15.06 to 20.42	0.767
Always		−4.75 (5.42)	−15.36 to 5.86	0.381
Log-likelihood (P > Chi2)	*−2951.80*	*0.58*		
Level two predictors				
Block 1	613 / 184			
Baseline AUDIT scores		**1.88 (0.38)**	**1.13 to 2.63**	**0.000**
Log-likelihood (P > Chi2)	*−2808.42 (0.000)*	*ICC = 0.52*		
Block 2	607 / 182			
Age		0.20 (0.12)	−0.05 to 0.44	0.114
Gender:		Ref: female		
Male		**14.95 (3.66)**	**7.78 to 22.11**	**0.000**
Education:		Ref: bachelors		
Postgraduate		−1.69 (4.14)	−9.80 to 6.42	0.684
GCSE or below		**25.12 (7.65)**	**10.13 to 40.11**	**0.001**
A-levels		1.39 (13.88)	−9.62 to 6.93	0.750
Income:		Ref: less than £21k		
£21 to £31k		7.37 (5.79)	−3.99 to 18.72	0.204
£31 to £40k		7.25 (6.30)	−5.09 to 19.59	0.250
£41 to £70k		5.04 (5.36)	−5.46 to 15.54	0.347
£71k+		1.66 (6.62)	−11.32 to 14.64	0.802
Log-likelihood (P > Chi2)	*−2773.32 (0.000)*	*ICC = 0.49*		
Block 3	613 / 184			
Living alone:		Ref: no		
Yes		12.94 (8.18)	−3.10 to 28.98	0.114
Living with:		Ref: 0		
1		6.26 (6.96)	−7.38 to 19.91	0.368
2		3.63 (7.28)	−10.64 to 17.91	0.618
3		10.48 (7.89)	−4.98 to 25.94	0.184
4+		12.39 (9.47)	−6.17 to 30.96	0.191
COVID-19 key worker:		Ref: no		
Yes		5.19 (4.02)	−2.70 to 13.07	0.197
Occupation affected:		Ref: no		
Yes		0.44 (4.24)	−7.87 to 8.75	0.917
Income affected:		Ref: no		
Yes		6.99 (3.83)	−0.52 to 14.50	0.068
Log-likelihood (P > Chi2)	*−2812.33 (0.000)*	*ICC = 0.54*		

Table 4
Final multilevel model containing only significant level one predictors (vary by time point) and level two predictors (vary by participant) of units consumed each week, for participants who completed 3 or more sessions (N = 186). Level one predictors are group mean centred. Missing data was imputed if less than 10 % was missing for each questionnaire.

N (observations) / N (participants) = 613 / 184			
Level one predictors	Estimate (SE)	95 % CI	P value
DMQ personal coping	**1.03 (0.49)**	**0.08 to 1.98**	**0.034**
GAD 2	1.65 (0.94)	−0.19 to 3.48	0.098
Context of drinking – alone			
Never	1.00		
Sometimes	3.69 (2.94)	−2.06 to 9.45	0.209
Almost always	4.39 (4.19)	−3.82 to 12.61	0.295
Always	**7.72 (2.97)**	**1.90 to 13.55**	**0.009**
Context of drinking – with someone at home			
Never	1.00		
Sometimes	**7.33 (3.25)**	**0.96 to 13.70**	**0.024**
Almost always	**11.06 (3.51)**	**4.18 to 17.94**	**0.002**
Always	**8.29 (2.99)**	**2.43 to 14.15**	**0.006**
Level two predictors			
Baseline AUDIT scores	**1.69 (0.35)**	**0.99 to 2.38**	**0.000**
Gender:	Ref: female		
Male	**12.86 (3.38)**	**6.24 to 19.48**	**0.000**
Education:	Ref: bachelors		
Postgraduate	−2.93 (3.79)	−10.00–4.88	0.440
GCSE or below	**24.96 (7.03)**	**11.26 to 38.84**	**0.000**
A-levels	−0.60 (13.02)	−8.28 to 7.08	0.879
Log-likelihood (P > Chi2) = -2805.66 (0.0000)	*ICC = 0.43*		

2021).

Of interest, we found that women and those of a younger age were more likely to drop out of the study, with a UK survey finding that women and younger people showed the highest increases in psychological distress (Niedzwiedz et al., 2020), which could be indicative of why these groups were less likely to continue with our study. It is also noteworthy that our sample included a large proportion of hazardous and harmful drinkers, and we observed the expected link between higher AUDIT scores and increased consumption. It is possible that COVID has reinforced pre-COVID drinking tendencies, with risky drinkers more likely to use alcohol as a coping mechanism (Bradley et al., 1992; Carey and Correia, 1997).

4.2. Strengths and limitations

There are several strengths to this study. We aimed to recruit 300 participants and recruited 539 participants at baseline, after data cleaning, with almost 200 participants completing at least three follow up surveys, which is sufficient for exploring group differences and producing unbiased standard errors (Maas and Hox, 2005). This study measured a range of factors established as being associated with alcohol use (e.g., drinking motives, mood, mental health). In terms of limitations, there may be a self-selection bias due to the study attracting those interested in their drinking behavior and/or the effects of COVID-19 on their drinking. Previous surveys have also shown higher respondent rates from dependent drinkers compared with national estimates, but also greater attrition rates for heavier drinkers (Boniface et al., 2017; Devaux and Sassi, 2016; Mongan et al., 2020). Due to the online nature of the study, only those with access to the internet were able to participate. Further, the measures have reduced reliability as they relied on self-report, for example, we did not have a pre-lockdown measure of alcohol consumption and were reliant on retrospective recall which could be subject to recall bias (Dulin et al., 2017; Sobell et al., 1986; Stevens et al., 2020). Average weekly unit consumption showed a large

decrease from baseline to survey two, which is in line with existing evidence showing a fall in consumption early in lockdown (Stevely et al., 2021), but it may indicate self-monitoring of consumption through participating in the study, which is typical of studies where participants are required to record their consumption (Jones et al., 2018; McCambridge et al., 2014). A final limitation is that the sample is not completely representative of typical drinkers in the UK general population, with 10 % of the sample meeting criteria for harmful drinking at baseline, compared to 3% in the general population (McManus et al., 2016). Although this reduces the generalizability of the findings, it has important implications for those in the general population who are drinking at higher levels and more at risk of alcohol harm.

4.3. Conclusions

A few months into the pandemic, there was a call for research to inform public health action for mental health and at-risk alcohol consumption (Clay and Parker, 2020; Finlay and Gilmore, 2020). Those who are already drinking at hazardous levels and those who report negative coping motives, were more likely to increase their consumption during lockdown in the UK, suggesting that there may be an increasing population who are at risk of more serious alcohol harm. Those with certain characteristics, i.e., male gender, lower education, hazardous or harmful drinkers, may need targeted interventions.

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Contributors

AR conceptualised the research, the design of the methodology, and contributed to the writing, reviewing, and editing of the manuscript, as well as supervising the research. PI conducted the data cleaning and data

analysis, and contributed to writing, reviewing and editing the manuscript. AJ contributed to the conceptualisation of the study and contributed to the data collection. AJ, PC, and LG all contributed to the development of the statistical analysis plan and contributed to the analyses. These authors all provided feedback on the manuscript. GK preregistered the research online. SG, CR, GK and RC all provided extensive feedback on the manuscript, contributing to the reviewing and editing of the manuscript.

Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2021.108913.

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