Alcohol 133 (2026) 87–98

Contents lists available at ScienceDirect

Alcohol

journal homepage: www.alcoholjournal.org/

Psychological distress is associated with 1-item hangover severity, but not the severity of somatic symptom clusters

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ARTICLE INFO

Keywords:
Hangover
Alcohol hangover
Distress
Coping
COVID-19

ABSTRACT

Alcohol hangover, the physical and psychological symptoms experienced after a single drinking episode, have been associated with pain catastrophising which may suggest a role of psychological distress in hangover experience. Interactions between alcohol hangover experience and psychological distress may have implications for drinking behaviours and future health outcomes. The COVID-19 pandemic caused increases in psychological distress and may therefore have also altered peoples experience of hangover. This study investigated relationships between income loss during the COVID-19 pandemic, psychological distress, maladaptive coping, and hangover symptom severity using cross-sectional survey data. Structural equation modelling indicated a direct relationship between psychological distress and a one-item measure of hangover severity, as well as an indirect effect via maladaptive coping. Unexpectedly, maladaptive coping related negatively with the one-item hangover severity measure. Comparatively, no relationships were observed between psychological distress or maladaptive coping with measures of the severity of hangover symptom clusters. Differing relationships observed between psychological distress/maladaptive coping and hangover severity measurements may be due to the broader nature of the one-item hangover severity measure, in comparison to ratings of specific hangover symptoms included in the hangover symptom clusters. Collectively, these results provide novel insight into the complex relationships between psychological distress, coping, and different measures of hangover severity. They also highlight methodological considerations in measuring hangover severity. Future research should replicate these findings in more diverse samples and further explore biological and cognitive outcomes linked to hangover measurements.

1. Introduction

The alcohol hangover is a collection of both physiological and psychological symptoms that occur following acute alcohol consumption, when blood alcohol concentration is approaching zero (Palmer et al., 2020; van Schrojenstein Lantman et al., 2016). Psychological factors may contribute to variability in hangover severity. The severity of hangover symptoms; including headache, gastrointestinal complaints, and increased anxiety; have been associated with psychological responses to acute stress and pain (Royle et al., 2020; Saeed et al., 2021). For example, Royle et al. (2020) reported that cognitive responses to pain were associated with multiple hangover symptom clusters, including headache and thirst symptoms, and gastric and cardiovascular symptoms, based on a two-factor model of the Acute Hangover Scale (Rohsenow et al., 2007). Comparatively, estimated blood alcohol concentration (eBAC) was associated only with headache and thirst symptoms. These findings suggest that psychological processes involved in pain appraisal may play an important role in the subjective experience of hangover symptoms beyond the pharmacological effects of alcohol alone.

More broadly, psychological coping processes are closely linked to levels of psychological distress across a range of populations, including; individuals exposed to trauma (Littleton et al., 2007), cancer patients (Morris et al., 2018; Shin et al., 2020), and general population samples

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https://doi.org/10.1016/j.alcohol.2026.04.002
Received 31 October 2025; Received in revised form 15 March 2026; Accepted 5 April 2026
Available online 6 April 2026

(Eisenbarth, 2004; Nielsen & Knardahl, 2014). Maladaptive coping strategies have consistently been associated with higher levels of psychological distress, whereas adaptive coping strategies are associated with lower distress. Psychological distress has also been shown to influence the perception and severity of pain across multiple health conditions (Cassar et al., 2018; Jang et al., 2018; Zimmers et al., 2023). Taken together, these findings suggest that psychological distress may contribute to the experience and severity of hangover symptoms.

Psychological distress can be conceptualised as a potential product of several factors: sociodemographic (e.g. age, gender, and genetic factors), stress-related (e.g. stress, anxiety, and depression), and personal resources (e.g. self-esteem, and social support); and represents a mental state that drives both physiological and behavioural responses (Drapeau et al., 2012). Increased psychological distress is associated with poorer health-related behaviour (McKenzie & Harris, 2013), including increased alcohol consumption, in a variety of cultures (Balogun et al., 2014; Chang et al., 2022; Deasy et al., 2015; Mathiesen et al., 2012; McKenzie & Harris, 2013; Thandi et al., 2015), and risk for addiction (Geisner et al., 2004; Lechner et al., 2021; Thandi et al., 2015). In addition, psychological distress has been associated with various markers of inflammation, including increased white blood cell counts in general populations (Baek et al., 2019), and fibrinogen in healthy young adults (Goldman-Mellor et al., 2010), indicating increased immune system activity. Likewise, oxidative stress has been associated with psychological distress in both clinical and healthy populations (Aschbacher & Mason, 2019; Hassan et al., 2016). Oxidative stress represents a disruption to homeostasis (Sies, 2019) that may also contribute to addiction (Koob & Volkow, 2010). Psychological distress is then associated with both inflammation and oxidative stress, which are also thought to contribute to the experience of hangover symptomology (Mackus et al., 2020; Turner et al., 2024; van de Loo et al., 2020).

The COVID-19 pandemic has drawn particular attention to psychological distress (Burke et al., 2020; Daly & Robinson, 2022; Gómez-Salgado et al., 2020; Hamza et al., 2021; Heath et al., 2020; Mazza et al., 2020; Petzold et al., 2020; Pink et al., 2021; Prout et al., 2020; Qiu et al., 2020; Roma et al., 2020), as the restrictions imposed by national and local lockdowns have implications for population well-being (Rossi et al., 2020; Torales et al., 2020). Financial insecurity during the pandemic has been associated with increased depressive symptoms in a North American sample (Zheng et al., 2021) and increases in psychological distress between pre-pandemic and during-pandemic measurements were associated with lower household income prior to the pandemic (Breslau et al., 2021). This is thought to be due to increased financial vulnerability associated with income loss or changing employment conditions. Similar results have shown that reduced income is associated with higher risk of psychological distress in a socio-economically vulnerable sample from Brazil (Santana et al., 2021), and that income loss leads to financial distress and poorer well-being in a sample from Chile (Borrescio-Higa et al., 2022). Likewise, in the UK, psychological distress during the COVID-19 pandemic was increased compared to pre-pandemic measures (Patel et al., 2022). Further, mental distress has been associated with financial worries, with financial worries being related to changes in the number of hours being worked during the pandemic (Wolfe & Patel, 2021), indicating that income loss acts as a stressor that promotes psychological distress. Research conducted during the period of the COVID-19 pandemic has also shown a relationship between increased psychological distress and increased engagement with drinking behaviours (Lechner et al., 2020; Rodriguez et al., 2020), with increases in risky drinking behaviour observed over time in both US (Lechner et al., 2021), and Finnish samples (Oksanen et al., 2021).

Psychological distress has been associated with the occurrence and exacerbation of somatic symptoms (Clarke et al., 2008; Kozlowska, 2013; Seto & Nakao, 2017), including headache (Aaseth et al., 2011; Hoge et al., 2007; Kristoffersen et al., 2018) and stomach pain or nausea (Hoge et al., 2007; Koloski et al., 2003; Levy et al., 2006). These symptoms have a high prevalence in hangover (Penning et al., 2012) and may be exacerbated during hangover as physiological effects of distress overlap with proposed hangover mechanisms (Mackus et al., 2020; Turner et al., 2024; van de Loo et al., 2020). Despite commonalities in the proposed mechanisms, no research has sought to model the relationships between distress, coping, and hangover experience.

Collectively the extant literature may suggest that increased psychological distress, such as that precipitated by income loss during the COVID-19 pandemic, may also have exacerbated the hangover experience, with the potential for further negative consequences as a product of changed drinking behaviour that may have downstream effects on health outcomes (Išerić et al., 2024; Piasecki et al., 2010). Furthermore, these relationships may be mediated by the adoption of maladaptive coping strategies.

The current investigation was therefore designed in order to; (1) confirm the 2-factor structure of the acute hangover scale observed in Royle et al. (2020); (2) examine the relationship between psychological distress associated with income loss during the COVID-19 pandemic and severity of hangover symptomology; and (3) investigate whether any relationship between psychological distress and hangover symptom severity was mediated by tendencies toward maladaptive coping. It was hypothesised that; (1) headache, tiredness, and thirst symptoms will load significantly on to a factor representing headache and thirst symptoms, and that dizziness/faintness, loss of appetite, stomach ache, nausea, and heart racing symptoms will load on to a second factor representing gastric and cardiovascular symptoms of hangover; (2) income loss associated with the COVID-19 pandemic will be associated with greater psychological distress; psychological distress will be positively associated with the adoption of maladaptive coping strategies and hangover symptom cluster severity; maladaptive coping will be positively associated with hangover symptom cluster severity; and (3), that maladaptive coping will mediate the relationship between psychological distress and hangover symptom severity.

2. Methods

2.1. Participants

A total of 645 UK-based participants aged 18 and over were recruited via social media advertising. Participants completed surveys as part of a multi-wave investigation. The current study presents a cross-sectional analysis of data drawn from wave 1 of the investigation. Wave 1 of data collection ran from 31st of May 2020 till the 7th of November 2020. During this time, UK citizens were under instructions to work at home (aside from keyworkers), mandated wearing of masks, and socialising in groups of no more than six individuals (Institute for Government, 2022). Participants were entered into a prize draw for Amazon vouchers for each wave of the investigation they completed (£10 at wave 1, £20 for wave 2, £30 for wave 3, and £50 for wave 4). Ethical approval for the study was granted by the School of Health & Society Ethics Committee at University of Salford, UK (HSR1920-089). All participants provided informed consent and participants were free to withdraw at any time without revealing the reason for discontinuing.

Of the 645 participants that completed the first wave of the survey, 482 provided full datasets, of which 136 reported at least some level of hangover symptomology associated with the greatest amount of alcohol they had consumed in the last week. A further 7 participants were removed as outliers during analysis based on Mahalanobis distance probabilities of $< .001$ (for p1 and p2; Collier, 2020), resulting in a sample of 129 participants (see Fig. 1). The final sample had an average age of 30.01 years (*SD*: 11.86 years), and were predominantly female (21 males, 108 females).

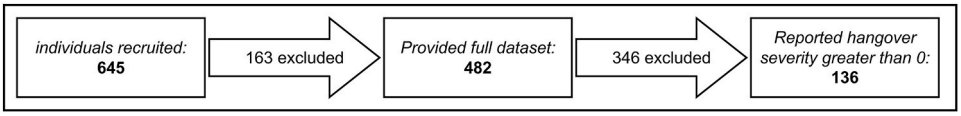

Fig. 1. Flowchart of exclusions.

2.2. Materials

2.2.1. Demographics & income

Participants were asked for their age, gender, height, weight, and which of 10 possible options best described their occupation (Health and social care, Education, Retail, Hospitality and leisure, Manufacturing, Professional services, Construction, Transport and storage, or Student). Participants were also asked to indicate their income (in Great Britain Pound), both prior to the COVID-19 pandemic and at the time of completing the survey (during the period of COVID lockdowns in the UK). Specifically, participants were asked "prior to the COVID-19 situation, how much did you earn after taxes?". Participants completed a free-text response to indicate a number and selected from 'weekly', 'fortnightly', 'monthly', or 'yearly' to indicate a frequency. For measures of current income participants were asked "how much do you currently earn after taxes?", with the same response format.

2.2.2. Psychological distress – stress, depression, anxiety, and loneliness

The 21-item self-report Depression, Anxiety, and Stress Scales (DASS; Henry & Crawford, 2005) was used to assess psychological distress. Participants responded on a scale of 0 (did not apply to me at all) to 3 (applied to me very much or most of the time) to statements assessing depression (e.g. "I couldn't seem to experience any positive feeling at all"), stress (e.g. "I found it hard to wind down"), and anxiety (e.g. "I felt I was close to panic"). Scores for depression, anxiety, and stress calculated as the sum of responses on each subscale multiplied by 2 (to normalize scores against the DASS-42), with higher scores indicating a greater level of depression/anxiety/stress. Each subscale therefore has a range of possible scores of 0 – 42. Each subscale has also been shown to have high reliability, with Chronbach's alphas of .94 for depression, .87 for anxiety, and .91 for stress (Antony et al., 1998). In the current investigation, Chronbach's alphas of .91, .81, and .88 were achieved for the depression, anxiety, and stress scales, respectively.

Participant loneliness was assessed using both the UCLA Loneliness Scale (Russell, 1996), and a separate single item that addressed loneliness explicitly, with both addressing loneliness in the past week. The UCLA Loneliness Scale is a 3-item measure, with participants responding on a 3-point scale to questions regarding feelings of loneliness (e.g. "How often do you feel left out?"). Overall scores were calculated as the sum of items, resulting in a range of possible scores from 3 to 9, with higher scores indicating greater loneliness. The 3-item UCLA loneliness scale has shown fair reliability (Chronbach's alpha = .72; Hughes et al., 2004). The single further item included was 'During the past week, how often have you been lonely?', and this was included as part of a broader questionnaire addressing the participants experience of the COVID-19 pandemic. Responses to this item were collected on a 5-point scale (often/always, some of the time, occasionally, hardly ever, or never), with lower scores indicating greater loneliness.

2.2.3. Coping

The use of coping strategies was assessed using the brief Coping Orientation to Problems Experienced Inventory (COPE; Carver, 1997). The COPE scale consists of 28 items measured on a scale from 1 ('I haven't been doing this at all') to 4 ('I've been doing this a lot) and assesses how often participants adopt approaches to coping with hardships (e.g. "I've been giving up trying to deal with it", or "I've been learning to live with it"). The brief-COPE can be assessed in a variety of ways, for example, it may be scored to consider 14 facets of coping (e.g. active coping, planning, and venting, etc.), or these facets may be mapped to 3 broader approaches to coping (problem-focused, emotion-focused, and avoidant coping; Carver, 1997). There are, however, inconsistencies in the factor structure of the brief-COPE across different samples (Solberg et al., 2022), as such, this factor structure will be assessed in the current investigation. This will be achieved using a split sample approach in which the data from participants who did not report hangover (and thus will not be included in modelling of hangover severity) will be used for exploratory factor analysis of brief-COPE responses. Confirmatory factor analysis will then be used to confirm this factor structure for the brief-COPE within the sample that did report hangover.

2.2.4. Alcohol consumption and hangover symptomology

General alcohol drinking habits were assessed using an adapted version of the Quick Drinking Screen (QDS; Sobell et al., 2003). For this measure, participants are presented with information on what constitutes a 'standard drink' or 'unit' of alcohol (for our UK based sample, one unit is equivalent to 8 g of ethanol). To characterise their drinking habits, participants were asked; 'How often do you have a drink containing alcohol?' (response options; never, monthly or less, 2-4 times a month, 2-3 times a week, 4 or more times a week), 'How many standard alcohol units do you have on a typical day when drinking?' (response options for 1 to 9 units, with the option to specify higher numbers); 'how often do you have 7.5 or more standard units on one occasion?' (response options; never, less than monthly, monthly, weekly, daily or almost daily), 'in the past week, how many days did you drink alcohol?' (response options; 0 to 7), 'in the past week, how many days did you get drunk?' (response options; 0 to 7), 'in the past week, how many times did you have more than 5 units (if female)/6 units (if male) on one occasion?' (response options; 0 to 7). For the calculation of estimated peak BAC's on the heaviest drinking occasion in the past week, participants were asked; 'in the past week what was the greatest number of alcoholic drinks you had on one occasion?' (response options; 0 to 30, with the option to specify higher numbers), and 'on that occasion (previous question), over how many hours did you consume alcohol?' (response options; 1 to 24).

Alcohol hangover symptoms were measured retrospectively in relation to the heaviest drinking episode in the past week, using the Acute Hangover Scale (AHS; Rohsenow et al., 2007). The AHS consists of 8 items representing symptoms of the hangover experience (e.g. "headache") as well as a single item addressing 'hangover', with participants rating the severity of included symptoms on a scale of 0 (none) to 7 (incapacitating). The AHS has shown good reliability (Chronbach's alpha = 0.84; Rohsenow et al., 2007). Total score on the AHS is calculated as a mean of items, resulting in a possible score range of 0 – 7, with higher scores indicating a more severe hangover, however, analysis in the current investigation will be based on the factors identified in Rossi et al. (2020). The AHS was selected as a measure of hangover severity due to both its symptomatic approach to assessment of hangover, and its popularity within hangover literature. A single-item hangover severity rating was also assessed using the 'hangover' item from the AHS, based on the recommendations of Verster et al. (2020), who argue that single-item measures capture greater variation in the experience of hangover due to a holistic approach that incorporates all symptoms experienced by an individual, in comparison to the specific symptoms measured in other hangover measures such as the AHS. As such, single-item measures of hangover may display differing relationships with predictors of hangover experience.

2.2.5. Unused measures

A number of other questionnaires were completed by participants that are not included as part of analyses in the current report. These included; COVID-19 related questions addressing the participants experience of the pandemic (e.g. whether their work situation had changed, and how much time they spent engaging with COVID-19 related media), and the Acceptance and Action Questionnaire version 2 (AAQ-2; Bond et al., 2011), which was used to assess psychological flexibility. Resilience was measured using the 6-item Brief Resilience Scale (BRS; Smith et al., 2008). The BRS addresses the participants perceived ability to recover from stress, with items responded to on a scale of 1 (strongly disagree) to 5 (strongly agree). Total score was calculated as a sum of all items with higher scores indicating greater resilience. Data related to these measures is reported elsewhere (Keenan et al., 2024).

2.3. Procedure

The survey was presented on Gorilla.sc™ (www.gorilla.sc; Anwyl-Irvine et al., 2021; Anwyl-Irvine et al., 2019; Tomczak et al., 2023) and accessed via weblink. After presentation of an information sheet and completion of a consent form, questionnaires were completed in a set order: demographics, COVID-19 related questions, alcohol consumption, AHS, BRS, DASS, COPE, AAQ-2, and the loneliness scale. Alcohol hangover severity ratings were provided for the heaviest drinking occasion in the past week, and information on this drinking was collected as part of the alcohol consumption questionnaire to allow for estimation of BACs.

2.4. Data analysis

Three structural equation models were created to test the hypotheses that a decrease in income resulting from the COVID-19 pandemic would be indirectly associated with increases in the severity of hangover, via distress and maladaptive coping. Three models were constructed to separately predict the 2 hangover symptom clusters (headache and thirst, and gastric and cardiovascular symptoms), as well as the 1-item hangover severity score. Because a change score was being used as a primary predictor variable, the baseline value for each individual's income prior to the lockdowns caused by the COVID-19 pandemic was included as a control variable.

A range of indices were used to evaluate model fit. The standardised root mean residual (SRMR) was considered indicative of good fit when values were less than 0.06, and indicative of acceptable fit when values were greater than 0.06 but less than 0.08. The root mean square error of approximation (RMSEA) parsimony adjusted measure was considered indicative of good fit when the value was less than 0.06, with values between 0.06 and 0.08 being considered indicative of an acceptable fit. The Tucker Lews index (TLI) and Comparative Fit index (CFI) were both considered as indicative of good fit when values were greater than 0.95, and acceptable fit when values were less than 0.95 but greater than 0.90 (Hu & Bentler, 1999).

As multiple measures of distress were taken (including DASS stress, depression, and anxiety scores, as well as measures of loneliness), a confirmatory factor analysis (CFA; Bollen, 1989) was performed to establish how these might load on to a latent variable for psychological distress. Likewise, two latent variables have been proposed to account for measurements provided by the AHS. These were also assessed using CFA. Finally, as multiple structures have been proposed for the brief-COPE (Solberg et al., 2022), a split sample approach using participants excluded from the main analysis was adopted, and exploratory factor analysis (EFA) used to develop an appropriate model for the brief-COPE in this context. These results were confirmed using CFA with the sample used for structural modelling. Maximum likelihood estimators were used to validate these models.

3. Results

3.1. Demographics and descriptive statistics

Participants included in the structural analysis were predominantly students (46.5%). Participants also reported working in education (17.8%), health and social care (17.8%), retail (5.4%), hospitality (4.7%), professional services (2.3%), manufacturing (0.8%), and other fields (4.7%). 23.3% of participants reported that there had been no change to their work situation as a result of the COVID-19 pandemic, 7.8% reported working from home some of the time, 33.3% reported working from home all of the time, 3.9% reported working reduced hours, and 31.0% reported no longer working, with one participant not responding. For the question addressing loneliness in the past week, 14.0% reported often/always feeling lonely, 26.4% reported some of the time, 20.2% reported occasionally, 17.8% reported hardly ever, and 21.7% reported never.

For questions addressing drinking habits, 14.0% reported drinking 4 or more times a week, 45.7% reported drinking 2 – 3 times a week, 30.2% reported drinking 2 – 4 times a month, and 10.1% reported drinking monthly or less. Participants also reported the frequency with which they drank 5 units (for females) or 6 units (for males), with 14.0% reporting that they never drank in this volume, 36.4% reporting less than monthly, 28.7% reporting monthly, 19.4% reporting weekly, and 1.6% reporting this level of drinking on a daily or almost daily basis. See Table 1 for further descriptives.

3.2. Characterisation of latent variables

Prior to assessment of structural models, latent variables representing distress, coping, and hangover symptom clusters were validated.

3.2.1. Latent variable for distress

As a variety of measurements of wellbeing were taken, including depression, anxiety, and stress (using the DASS), as well as 2 measures of loneliness (the UCLA loneliness scale, and a further item addressing loneliness), a confirmatory factor analysis was performed to examine whether these measurements loaded on to the same latent variable (psychological distress). As there is a theoretical link between loneliness and depression (Erzen & Çikrikci, 2018), a covariance was added between the error terms for these variables. A covariance was also added between the 2 measurements of loneliness included. This model provided a good fit to the data (CFI = .995, TLI = .984, RMSEA .065, SRMR = .024) and each measurement loaded significantly on to the 'psychological distress' latent variable (all β's > .47, p's < .003).

Table 1
Descriptive statistics.

	Mean	Standard deviation	range
Wage change (%)	−10.52	39.10	−100 to 567
Prior income (£ per annum)	16,723	23,742	0 to 192,000
DASS - Depression	14.12	10.85	0 to 40
DASS - Anxiety	10.23	7.92	2 to 34
DASS - Stress	15.98	10.14	0 to 40
Resilience	18.63	5.26	6 to 30
UCLA Loneliness	5.40	1.90	3 to 9
AHS	1.04	0.92	0.11 to 4.22
eBAC (g‰)	0.70	0.46	0.15 to 2.60

AHS = Acute hangover scale, eBAC = Estimated blood alcohol concentration in grams permille (g‰). Wage change (%) was calculated based on the participants current income in relation to their income pre-pandemic. Participants reporting complete loss of income therefore indicated a −100% change, though there was no upper bound on potential increases. A small number of participants reported very high percentage changes in income (>500%), but this represented changes from very low income (£1800 - £3600 per annuum) to income levels that were comparatively high, but still low in comparison to average UK income (£12,000 to £23,000).

3.2.2. Latent variables for hangover severity

Previous research has indicated a potential 2 factor structure of hangover symptoms included in the AHS (Royle et al., 2020). A confirmatory factor analysis was therefore carried out to confirm this dataset fit with a 2-factor model including 'headache & thirst', and 'gastric and cardiovascular' symptoms, with a correlation between these two latent variables. This model provided an acceptable fit to the data (CFI = .949, TLI = .925, RMSEA = .073, SRMR = .057). Each measurement loaded significantly on to its corresponding factor; headache, tiredness, and thirst, on 'headache & thirst'; dizziness/faintness, appetite loss, stomach ache, nausea, and heart racing, on 'gastric and cardiovascular' symptoms (all β′s > .54, *p*'s < .001).

3.2.3. Latent variables for coping

A number of structures have been suggested for the brief-COPE (for a review, see Solberg et al., 2022), however there is large variation in the number of factors proposed (ranging from 2 to 15). As there is currently no consensus on the factor structure of the brief-COPE, a split sample approach was adopted to determining an appropriate structure for inclusion in further modelling. An exploratory factor analysis (EFA) was carried out on data derived from participants who were excluded from the structural equation analysis (exclusions due to reporting no hangover symptomology following their heaviest drinking episode in the past week). The total sample of participants excluded from the primary analysis, but with complete data on the brief COPE scale, consisted of 283 participants (mean age: 29.54, SD: 12.67) with 232 females, 47 males, and 4 participants who reported their gender as 'other'. The EFA was carried out in JASP (0.18.1) using principal axis factoring and a parallel analysis approach. Results indicated a 6-factor solution, with factors indicating; reframing, social support, maladaptive coping, humour, spirituality, and drug use. Table 2 shows each factor and the items included, along with loadings.

Confirmatory factor analysis in our investigation sample was carried out with correlations between each factor. Covariances were added between a number of items of the brief-COPE, based on both a theoretical basis and modification indices exceeding a value of 8. These covariances and theoretical justifications are indicated in Table 3.

Model fit estimates were calculated using a maximum likelihood approach, and indicated acceptable fit (CFI = .939, TLI = .925, RMSEA .057, SRMR = .082). Each measurement loaded significantly on to the latent variables for each factor (all β′s > .29, $p \leq .025$). As previous research has indicated a relationship between maladaptive coping strategies and hangover symptom cluster severity (Terpstra et al., 2022), this factor of the brief-COPE was used in structural models.

3.3. Structural model evaluations

Testing of the hypothesised indirect effects between income change associated with the COVID-19 pandemic and hangover severity indicators, via psychological distress and maladaptive coping, was achieved with bias corrected bootstrapping with 95% confidence intervals (N = 2000). Maximum likelihood estimators were used to validate these models. For direct effects between variables, standardised regression coefficient values are presented within figures, with unstandardized regression coefficient values provided in tables.

Prior to analysis, relationships between age and variables of theoretical interest (distress, hangover symptom cluster severity, prior income and income change, and maladaptive coping) were investigated via correlations. As these correlations indicated a relationship between age and prior income (r = .219, *p* = .010), a covariance between these variables was included in all models. Age also correlated with psychological distress (r = −0.211, *p* = 0.013) and maladaptive coping (r = −0.258, *p* = .002), for which age was treated as a predictor. No correlation was observed between age and headache and thirst symptoms (r = 0.007, *p* = .935), gastric and cardiovascular symptoms (r = −0.002, *p* = 0.979), or income change (r = 0.094, *p* = .274).

Table 2
Item loadings in exploratory factor analysis of brief-COPE in split sample.

Factor	#	Brief-COPE item:	Item loading
Factor 1: Reframing	7	I've been taking action to try to make the situation better.	0.674
	2	I've been concentrating my efforts on doing something about the situation I'm in.	0.639
	14	I've been trying to come up with a strategy about what to do.	0.634
	12	I've been trying to see it in a different light, to make it seem more positive.	0.553
	25	I've been thinking hard about what steps to take.	0.546
	1	I've been turning to work or other activities to take my mind off things.	0.536
	17	I've been looking for something good in what is happening.	0.452
	24	I've been learning to live with it.	0.427
	20	I've been accepting the reality of the fact that it has happened.	0.402
Factor 2: Social support	10	I've been getting help and advice from other people.	0.875
	5	I've been getting emotional support from others.	0.837
	15	I've been getting comfort and understanding from someone.	0.742
	23	I've been trying to get advice or help from other people about what to do.	0.657
Factor 3: Maladaptive	13	I've been criticizing myself.	0.805
	6	I've been giving up trying to deal with it.	0.585
	26	I've been blaming myself for things that happened	0.571
	16	I've been giving up the attempt to cope.	0.428
Factor 4: Humour	28	I've been making fun of the situation.	0.917
	18	I've been making jokes about it.	0.871
Factor 5: Spirituality	27	I've been praying or meditating	0.726
	22	I've been trying to find comfort in my religion or spiritual beliefs	0.725
Factor 6: Drug use	11	I've been using alcohol or other drugs to help me get through it.	0.752
	4	I've been using alcohol or other drugs to make myself feel better	0.714

Table 3
Covaried items in brief-COPE CFA.

Covaried items	Basis
14, 25 & 23	All items relate to planning
13 & 26	Self-blame facet of the brief-COPE
10 & 23	Informational support facet of the brief-COPE
24 & 20	Acceptance facet of the brief-COPE
17 & 24	Relate to reframing of a stressor (looking for good/learning to live with)
12 & 17	Positive reframing facet of the brief-COPE
5 & 23	Relate to social support.

3.3.1. Headache and thirst symptoms

The model for headache and thirst symptoms was a good fit for the data (CFI = .963, TLI = .952, RMSEA = .048, SRMR = .063). See Fig. 2 for standardised regression coefficients.

Bias corrected confidence intervals and unstandardized regression weights for direct effects are reported in Table 4, and regression weights for indirect effects are reported in Table 5. Results indicated no direct or indirect relationships of income change on distress, coping, or hangover. Likewise, no direct or indirect relationships were found for distress, coping, and headache and thirst hangover symptoms.

3.3.2. Gastric and cardiovascular symptoms

The model for gastric and cardiovascular symptoms was an acceptable fit for the data (CFI = .939, TLI = .925, RMSEA = .056, SRMR =

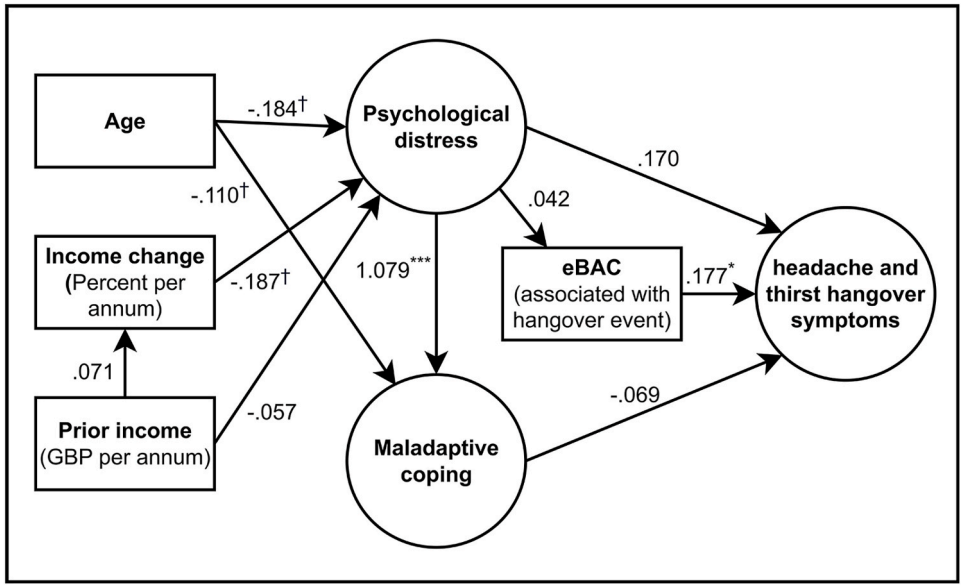

Fig. 2. Model for associations between COVID-19 related income-loss, distress and the 'headache and thirst' hangover symptom cluster severity.
Values are standardised regression coefficients; †p < .1 * p < .05, **p < .01, ***p < .001, significance indicated is for bias-corrected bootstrapped analyses. For ease of interpretation, residuals and covariances are not visually represented. BAC = estimated blood alcohol concentration.

Table 4
Hypothesised direct effects for 'headache and thirst' model.

Association	b (SE)	*p*	95% CI
Prior income → Income change	<.001 (<.001)	.164	>-.001 to < .001
Prior income → Distress	<.001 (<.001)	.485	>-.001 to < .001
Income change → Distress	−.044 (.023)	.061	−.057 to .028
Age → Distress	−.142 (.076)	.062	−.297 to −.007
Distress → Maladaptive coping	.043 (.009)	<.001	.028 to .059
Distress → BAC	.002 (.004)	.528	−.005 to .010
Age → Maladaptive coping	−.003 (.003)	.131	−.009 to .000
Maladaptive coping → headache & thirst	−.165 (5.203)	.629	−18.959 to 1.898
BAC → headache & thirst	.333 (.220)	.035	.001 to .869
Distress → headache & thirst	.016 (.209)	.439	−.054 to .787

Table 5
Hypothesised indirect effects for 'headache and thirst' model.

Association	b (SE)	*p*	95% CI
Income change → Distress → Coping → headache & thirst.	<.001 (.011)	.562	−.003 to .026
Income change → Distress → BAC → headache & thirst.	<.001 (<.001)	.272	−.001 to .000
Distress → Coping → headache & thirst.	−.007 (.208)	.635	−.528 to .097
Distress → BAC → headache & thirst	.001 (.002)	.310	−.001 to .007

.072). See Fig. 3 for standardised regression coefficients.

Bias corrected confidence intervals and unstandardized regression weights for direct effects are reported in Table 6, and for indirect effects are reported in Table 7. In line with the model of headache and thirst symptoms, no direct or indirect effects of income change were found, and there were no direct or indirect effects of distress and coping on gastric and cardiovascular symptoms.

3.3.3. 1-Item hangover severity

The model for the 1-item hangover severity score was a good fit for the data (CFI = .973, TLI = .964, RMSEA = .045, SRMR = .053). See Fig. 4 for standardised regression coefficients.

Bias corrected confidence intervals and unstandardized regression weights for direct effects are reported in Table 8, and for indirect effects are reported in Table 9. In contrast to models of the headache and thirst and gastric and cardiovascular hangover symptoms, indirect effects of income on hangover severity were indicated in this model via distress and coping. No direct effect of income change on distress was found. Direct effects were also found for relationships between distress and maladaptive coping, distress and 1-item hangover severity, and maladaptive coping and 1-item hangover severity.

4. Discussion

This study sought to explore relationships between income loss associated with the COVID-19 pandemic, psychological distress, coping, and hangover symptom severity. The three primary aims of the investigation were to; Confirm the 2-factor model of the AHS found by Royle et al. (2020); examine the relationship between psychological distress associated with income loss during the COVID-19 pandemic and severity of hangover symptomology; and investigate whether any relationship between psychological distress and hangover symptom severity was mediated by tendencies toward maladaptive coping. It was hypothesised that; (1) headache, tiredness, and thirst symptoms would load significantly on to a factor representing headache and thirst symptoms, and that dizziness/faintness, loss of appetite, stomach ache, nausea, and heart racing symptoms will load on to a second factor representing gastric and cardiovascular symptoms of hangover; (2) income loss associated with the COVID-19 pandemic would be associated with greater psychological distress; psychological distress would be positively associated with the adoption of maladaptive coping strategies and hangover symptom cluster severity; maladaptive coping would be positively associated with hangover symptom cluster severity; and (3), that maladaptive coping would mediate the relationship between psychological distress and hangover symptom severity. Hypothesis 1 was confirmed, with the predicted symptom clusters supported by confirmatory factor analysis. Mixed results were obtained with regards to hypotheses 2 & 3; COVID-19 related income loss did not predict increased psychological distress in this sample, In contrast to our hypothesis. Likewise, distress and maladaptive coping were not predictors of hangover symptom cluster severity in structural models, and thus,

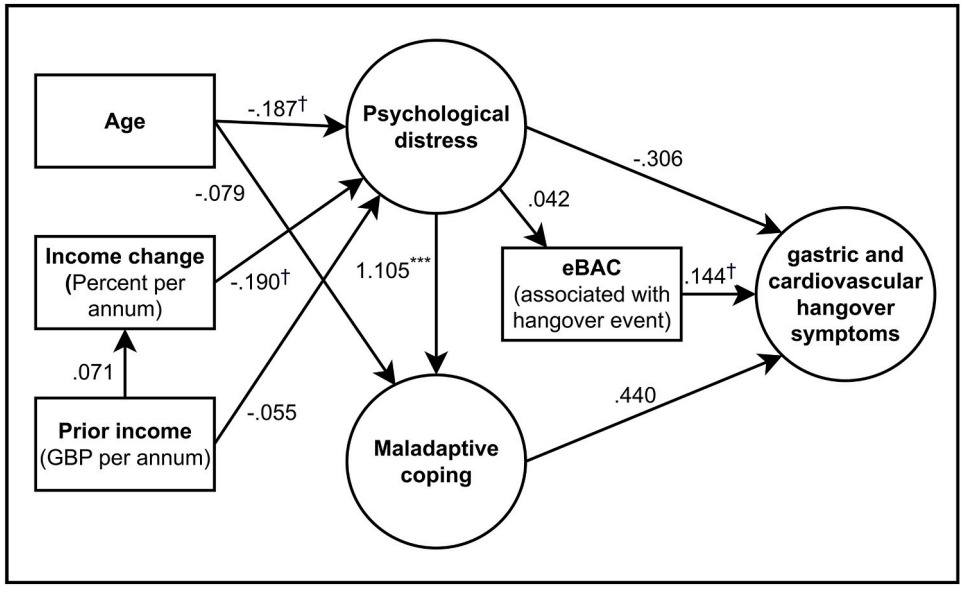

Fig. 3. Model for associations between COVID-19 related income-loss, distress and the 'gastric and cardiovascular' hangover symptom cluster severity.
Values are standardised regression coefficients; †p < .1 * p < .05, **p < .01, ***p < .001, significance indicated is for bias-corrected bootstrapped analyses. For ease of interpretation, residuals and covariances are not visually represented. BAC = estimated blood alcohol concentration.

Table 6
Hypothesised direct effects for 'gastric and cardiovascular' model.

Association	b (SE)	*p*	95% CI
Prior income → Income change	<.001 (<.001)	.165	>-.001 to < .001
Prior income → Distress	<.001 (<.001)	.526	>-.001 to < .001
Income change → Distress	−.044 (.023)	.056	−.090 to .002
Age → Distress	−.143 (.075)	.054	−.284 to .003
Distress → Maladaptive coping	.043 (.009)	<.001	.029 to .063
Distress → BAC	.002 (.004)	.549	−.006 to .011
Age → Maladaptive coping	−.002 (.002)	.279	−.008 to .002
Maladaptive coping → Gastric & Cardio	.699 (4.194)	.198	−.913 to 18.364
BAC → Gastric & Cardio	.178 (.146)	.060	−.006 to .620
Distress → Gastric & Cardio	−.019 (.173)	.276	−.894 to .039

Table 7
Hypothesised indirect effects for 'gastric and cardiovascular' model.

Association	b (SE)	*p*	95% CI
Income change → Distress → Coping → Gastric & Cardio	−.001 (.009)	.132	−.094 to .001
Income change → Distress → BAC → Gastric & Cardio	<.001 (<.001)	.241	>-.001 to < .001
Distress → Coping → Gastric & Cardio	.030 (.174)	.193	−.030 to .774
Distress → BAC → Gastric & Cardio	<.001 (.001)	.287	−.001 to .005

maladaptive coping did not act as a mediator, indicating hypotheses 2 and 3 were not confirmed for models assessing hangover symptom clusters. In comparison, hypotheses 2 and 3 were confirmed (with the exception of income loss effects) for models examining a single-item measure of hangover severity. This model did indicate relationships between psychological distress and hangover severity, as well as between maladaptive coping and hangover severity, though the relationship between maladaptive coping and hangover severity was in the opposite direction to that predicted. Maladaptive coping also acted as a partial mediator of the relationship between distress and 1-item hangover severity in this model.

4.1. AHS symptom clusters

Confirmatory factor analysis indicated that the 2-factor model of the AHS, consisting of 'headache and thirst symptoms' and 'gastric and cardiovascular symptoms', was an acceptable fit for the data, in line with the results of Rossi et al. (2020). The presence of these symptom clusters may be examined from several non-exclusive perspectives. First, symptoms included in the 'headache and thirst' cluster are highly prevalent in hangover, being the 3 most reported symptoms across several studies (Penning et al., 2012; Rohsenow et al., 2007; Slutske et al., 2003). Second, the symptom clusters may be representative of classes of hangover, where more severe hangovers are indicated by the presence of 'gastric and cardiovascular' symptoms. This approach was taken to the classification of hangover severity in early research (Harburg et al., 1993), however, no validated scales of hangover based on this approach currently exist. Finally, these symptom clusters may be related to overlapping but distinct mechanisms, such as alternate alcohol metabolism pathways, and may also be associated with distinct behavioural outcomes.

4.2. Psychological distress, coping, and hangover severity

Counter to the study hypotheses, no significant relationship was observed between income change and distress across the models for participants who had reported hangover in the last week, though a reduction in income was associated with increased psychological distress across the whole UK sample (Keenan et al., 2024). A possible explanation for the lack of observed relationships in this sample is that, contrary to our initial expectations, average income had in fact increased for participants between the time prior to COVID-19 restrictions and the point of data collection. This may have been driven by the inclusion of participants starting from a relatively low income, including a high proportion of students (46.5%) who did have a significantly lower income than participants across other professions ($t(127) = 3.53$, $p < .001$). Mean income prior to the pandemic was reported as £16,723, which is considerably below the median income in the UK of £32,300 (ONS, 2023). These participants may also have been less exposed to the impacts of income loss due to reduced costs (e.g. if living with parents). Participants on lower incomes may have also benefitted from support schemes implemented by the UK government, such as

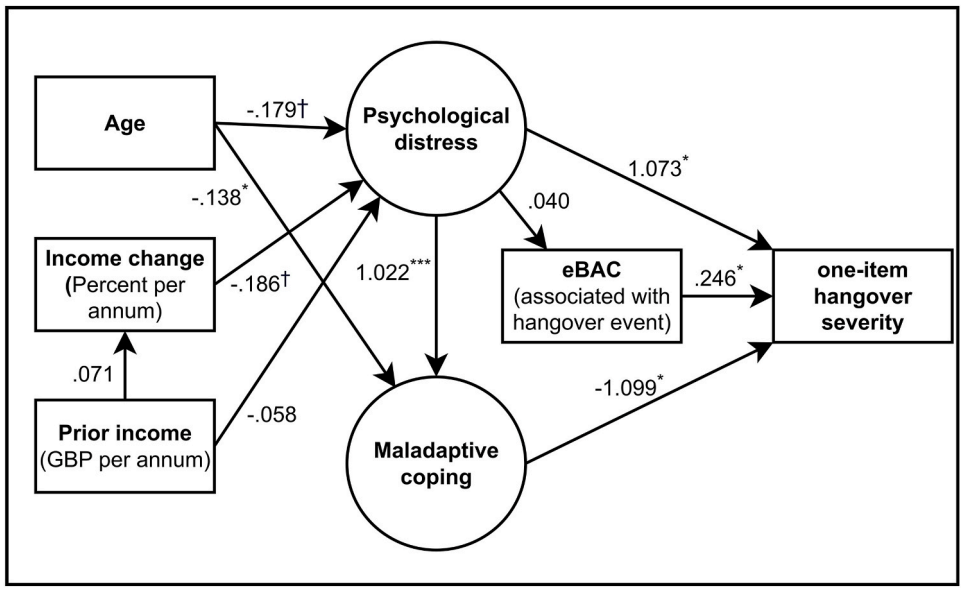

Fig. 4. Model for associations between COVID-19 related income-loss, distress and the '1-item hangover symptom severity.
Values are standardised regression coefficients; †p < .1 * p < .05, **p < .01, ***p < .001, significance indicated is for bias-corrected bootstrapped analyses. For ease of interpretation, residuals and covariances are not visually represented. BAC = estimated blood alcohol concentration.

Table 8
Hypothesised direct effects for '1-item hangover' model.

Association	b (SE)	*p*	95% CI
Prior income → Income change	<.001 (<.001)	.165	>-.001 to < .001
Prior income → Distress	<.001 (<.001)	.485	>-.001 to < .001
Income change → Distress	−0.44 (.023)	.059	−.088 to .003
Age → Distress	−.138 (.076)	.065	−.283 to .008
Distress → Maladaptive coping	.041 (.008)	.001	.028 to .059
Distress → BAC	.002 (.004)	.560	−.006 to .011
Age → Maladaptive coping	−.004 (.002)	.010	−.010 to −.001
Maladaptive coping → 1-item hangover	−4.426 (19.909)	.028	−55.888 to −.258
BAC → 1-item hangover	.797 (.345)	.011	.160 to 1.498
Distress → 1-item hangover	.174 (.788)	.037	.005 to 2.520

Table 9
Hypothesised indirect effects for '1-item hangover' model.

Association	b (SE)	*p*	95% CI
Income change → Distress → Coping → 1-item hangover	.008 (.036)	.033	<.001 to .155
Income change → Distress → BAC → 1-item hangover	<.001 (<.001)	.351	−.001 to < .001
Distress → Coping → 1-item hangover	−.182 (.786)	.022	−2.506 to −.015
Distress → BAC → 1-item hangover	.002 (.004)	.462	−.004 to .011

furlough payments. Indeed, it has been noted that the implementation of job support programs and an expanded welfare system during the COVID-19 pandemic may have actually reduced disposable income inequality (Blundell et al., 2024), which may have limited effects of income loss on psychological distress. Students do tend to be employed in roles that have more unstable income, as evidenced by reliance on seasonal work (Save the Student, 2022), so furlough may have actually reduced uncertainty for them. Alternatively, given the observation of a relationship between income loss and distress across the whole UK sample (Keenan et al., 2024), the lack of relationship observed in those who reported hangover in the past week may have been because those who continued drinking to levels that produced hangover during the pandemic were those less exposed to income losses, and were therefore more able to afford alcohol. These factors may explain differences between the current investigation and other investigations assessing the impact of the COVID-19 pandemic on income and factors of psychological distress, which have indicated that income loss does lead to increases in distress in those who are employed (de Miquel et al., 2022) or older samples (Hertz-Palmor et al., 2021; Shevlin et al., 2020).

Whilst previous research has indicated that there is a relationship between stress/distress and general drinking habits (Balogun et al., 2014; Chang et al., 2022; Deasy et al., 2015; Mathiesen et al., 2012; McKenzie & Harris, 2013; Thandi et al., 2015), eBAC's indicating circulating alcohol in the body for the specific drinking session associated with the reported hangover were not predicted by levels of distress. eBAC's were significantly associated with the severity of headache and thirst symptoms, as well as with a 1-item hangover severity measure, however, eBAC did not reach significance as a predictor of gastric and cardiovascular symptoms. This result is in line with previous research on symptom clusters of the AHS (Royle et al., 2020). Results for the relationship between eBAC and gastric and cardiovascular symptom may be indicative of a non-linear relationship between alcohol consumption and these symptoms of hangover, given that alcohol consumption is a prerequisite of the hangover state. If gastric and cardiovascular symptoms are more likely to occur at higher eBAC's, then the lack of relationship observed in the current sample may be due to the relatively low eBAC's reported.

As predicted, psychological distress was associated with maladaptive coping across all models, however, neither distress nor coping were associated with headache and thirst or gastric and cardiovascular hangover symptom cluster severity. In contrast, both psychological distress and maladaptive coping were associated with a 1-item hangover severity score. The relationship between increased distress and more severe hangover may be explained by biological links with oxidative stress and inflammation. Psychological distress is associated with elevated indicators of inflammation and oxidative stress (Aschbacher & Mason, 2019; Baek et al., 2019; Goldman-Mellor et al., 2010; Hassan et al., 2016), which are also thought to underly hangover symptomology (Mackus et al., 2020; Turner et al., 2024; van de Loo et al., 2020). Increased psychological distress may therefore increase baseline levels of oxidative stress and inflammation that are further exacerbated by hangover.

In the model of 1-item hangover severity, maladaptive coping acted

as a partial mediator of the relationship between distress and hangover severity. Interestingly, the relationship between maladaptive coping and 1-item hangover severity score in this investigation was negative, with increases in maladaptive coping associated with reduced hangover severity. This contrasts with past findings indicating a positive relationship between use of avoidant coping and hangover severity (Terpstra et al., 2022), as well as results indicating that higher tendency toward catastrophising is associated with greater hangover severity (Royle et al., 2020; Saeed et al., 2021). The finding that maladaptive coping was negatively associated with hangover severity may represent a protective effect of tendencies toward maladaptive coping in alcohol hangover, if maladaptive coping tendencies are related to negative expectancies of alcohol consumption consequences. It has been proposed that avoidant coping and alcohol expectancies interact in the prediction of drinking behaviour and development of alcohol abuse disorder (Hasking & Oei, 2008), with alcohol expectancies acting as a mediator of alcohol consumption habits (Hasking et al., 2011). If a tendency toward maladaptive coping is associated with negative alcohol expectancies, this may limit alcohol consumption as research has found that expectations of cognitive impairment are associated with reduced alcohol consumption in participants aged over 25 (Pabst et al., 2014), thus reducing the severity of hangover experienced.

One potential explanation for the discrepancy in results between symptom clusters and the 1-item hangover severity score, is that the hangover symptom clusters derived from the AHS measure the severity of somatic symptoms, but do not capture broader variance in unassessed hangover symptoms that are considered by participants as part of single-item measures (Verster et al., 2020). This may suggest that distress and maladaptive coping strategies are associated with non-somatic symptoms of hangover such as hangover anxiety and depression, but not symptoms associated with the experience of physical pain or discomfort. Past research has indicated that general measures of anxiety and depression, components of psychological distress, are associated with anxiety and depression during hangover (Tellez-Monnery et al., 2023). This difference in hangover severity measurements may also explain why associations between maladaptive coping and hangover symptom cluster severity were not observed in the current study.

4.3. Limitations and future research

One important limitation of the current investigation is that hangover severity was assessed retrospectively. Retrospective self-report is known to be susceptible to recall bias and effects of memory reconstruction processes, whereby individuals infer past experiences based on beliefs, semantic knowledge, and current affective state, rather than retrieving a complete record of the original experience (Robinson & Clore, 2002). Pain reports have been shown to differ between retrospective self-report measures and more 'real-time' measures obtained using ecological momentary assessment (EMA) approaches (Stone et al., 2004). In particular, mood-congruent memory effects suggest that individuals experiencing higher levels of negative affect or distress may recall past pain experiences as more negative or severe than they were at the time they occurred (Houtveen & Oei, 2007). Consequently, the observed associations between psychological distress, maladapative coping, and the single-item measure of hangover severity may reflect, at least in part, the influence of participants current psychological state on their retrospective evaluation of hangover experiences rather than processes occurring in hangover itself. Future research should therefore consider employing real-time or near real-time data collection approaches for hangover severity measurement, such as EMA or daily diary designs, which would allow relationships between psychological distress, coping strategies, and hangover symptom severity to be examined closer to the time of symptom experience.

Notably, the influence of retrospective evaluation may also differ across hangover measurement approaches. In the present study, psychological distress and maladaptive coping were associated with the single-item measure of hangover severity but not with the severity of somatic symptom clusters. This pattern may support interpretations that single-item measures of hangover severity capture more global evaluations of hangover experience (Verster et al., 2020). These global evaluations of hangover may be more susceptible to cognitive appraisal processes, including distress-related biases in recall, whereas symptom-specific ratings may reflect more discrete physiological experiences.These findings do not, however, clarify which hangover measures may have associations with cognitive effects, or physiological mechanisms. Indeed, indications that one-item hangover severity are related to distress and coping may indicate that it reflects broader subjective appraisal processes and therefore may not correspond as closely to objective outcomes. Both broader symptomatic measures of hangover severity, including one-item measures, and measures of hangover based on ratings of specific symptoms, have failed to show consistent relationships with changes in cognitive performance (Gunn et al., 2020), or have shown relationships with only limited tasks within cognitive batteries (Alford et al., 2020). Evidence has indicated that some specific hangover symptoms are associated (or not) with performance in some tasks (Ayre et al., 2021), and as such, further research should investigate relationships between both somatic symptom and symptom cluster severity ratings, one-item hangover severity ratings, and cognitive outcomes across different domains.

Results of the current investigation also indicated that maladaptive coping was, counterintuitively, a negative predictor of 1-item hangover severity. This may indicate that a tendency toward maladaptive coping is protective with regard to experience of alcohol hangover severity, potentially due to a relationship with negative alcohol outcome expectancies. Relationships between coping and alcohol expectancies, however, have not been directly tested, and warrants confirmation in a broader sample. Alternatively, since analyses only reveal associations, it may be that reductions in maladaptive coping are caused by increased experience of transient negative states such as hangover, rather than increases in maladaptive coping causing reduced hangover severity. The current exploratory study was derived from a relatively small sample of predominantly female participants. Given potential gender differences in hangover symptom severity at higher BACs between male and female participants (van Lawick van Pabst et al., 2019), results of the structural models need confirmation in broader samples, particularly given that this sample is unlikely to be representative with greater numbers of students than in the general population. Approximately 5% of the UK adult population are students, in comparison to 46.5% in the current sample (Higher Education Statistics Agency, 2023).

4.4. Conclusion

The current study sought to confirm the 2-factor structure of the AHS observed by Rossi et al. (2020) and explore whether income loss associated with the COVID-19 pandemic was associated with psychological distress, coping, and hangover severity. Results confirmed the 2-factor structure of the AHS, consisting of 'headache and thirst' and 'gastric and cardiovascular' symptoms. Results did not reveal increases in psychological distress associated with income loss during the COVID-19 pandemic, nor was distress and coping associated with somatic symptom clusters of the hangover included in the AHS. Distress, however, was associated with a single-item hangover measure that may capture the broader hangover experience, including psychological effects such as hangover mood effects, and this relationship was partially mediated by maladaptive coping. These results provide novel insight into the intricate relationships between psychological distress, coping, and hangover severity, as well as informing debate surrounding hangover severity measurement.

CRediT authorship contribution statement

Sam Royle: Writing – original draft, Visualization, Methodology,

Investigation, Formal analysis, Data curation, Conceptualization. **Gregory S. Keenan:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Robert C.A. Bendall:** Writing – review & editing, Supervision, Conceptualization. **Lauren Owen:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Lynne P. Marrow:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data associated with the current project has been made publicly available online: https://osf.io/ewmtq/overview.

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