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Alcohol desire influenced by memory recollection and personality

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ABSTRACT

Alcohol use is driven not only by environmental cues but also by individual differences in motivational style. Recent work has demonstrated how memory cues can reduce subsequent desire for alcohol, yet it remains unclear how personality traits shape this effect. To address this, we recruited male and female participants (N = 169) who completed the behavioural inhibition/approach system (BIS/BAS) scales and were then cued to recall either a previous alcohol drinking episode and estimate the number of alcohol calories consumed (Alcohol Cue, AC) or a control (Neutral Cue, NC). They then rated their desire for alcohol (DAQ). Findings revealed lower desire for those in the AC compared to NC group and separately, a positive association between alcohol desire and BAS and particularly BAS-Drive. We further found that a measure of residual BAS (BAS less BIS) was positively related to desire but did not moderate the effect of memory cue. These findings suggest that being reminded of a previous drinking episode can exert a modest but consistent influence on alcohol desire.

1. Introduction

Globally, it has been estimated that approximately 2.6 million deaths were caused by alcohol consumption in 2019 (WHO, 2024). The European Region is the heaviest-drinking area in the world, where alcohol is responsible for 1 in 4 deaths of 19–24-year-olds (WHO, 2024). Many studies focus solely on heavy use or alcohol addiction, potentially missing much of the public health burden. A large body of evidence demonstrates the so called 'preventive paradox': while the heaviest drinkers carry the highest individual risks, the far higher number of light-to-moderate drinkers account for the majority of alcohol-attributable harm at the population level, including injuries, cancers, and cognitive decline (Danielsson et al., 2012; Kreitman, 1986). In other words, small relative risks multiplied across a very large, exposed group generate a greater total burden than the extreme risks confined to a small minority. It is therefore clear that any reduction in consumption would have positive effects on public health. However, while national campaigns/government policy (e.g. health labelling on alcohol products, pricing) can have some influence on drinking behaviour, it is an individual's desire to drink that ultimately influences drinking patterns.

The link between alcohol and memory has been examined comprehensively in terms of its potentially impairing effects (Gunn et al., 2018) and separately, how memory reconsolidation (e.g. by counterconditioning) can reduce alcohol craving (see review Barak & Goltseker, 2021). However, the role of more simple (non-reconsolidated) memory recall in influencing prospective alcohol motivation has only recently been studied, where it was shown that when individuals were cued to recall a previous alcohol drinking episode in detail, they consumed alcohol at a slower rate (Stafford et al., 2024), suggesting a reduced desire for alcohol. Theoretically, that finding is linked to a large body of work from the food domain, where being reminded of a previously eaten meal acted to reduce snack intake (e.g. Higgs, 2002; Collins & Stafford, 2015) and separately, desire for food in an online experiment (Arthur et al., 2021). The proposed mechanism for this effect is that the memory cue activates a set of schemas related to weight gain concerns and normative beliefs on not eating between meals that all invoke dietary restraint (Arthur et al., 2021). Returning to effects in the alcohol domain, while Stafford et al. (2024) provide some initial evidence for

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this phenomenon, a number of issues remain, including whether the effect is seen in more explicit measures, notably alcohol desire, and how individual differences influence the effect. Additionally, one of the limitations of the previous study was that the sample was restricted to females and hence it is unclear if similar effects would be observed in males. Given that men generally consume more alcohol than women (ONS, 2024) and the number of alcohol related deaths worldwide are substantially larger for men (WHO, 2018), this is particularly important.

In terms of individual differences, Reinforcement Sensitivity Theory (Gray, 1979), is particularly relevant here, in that via its two main components (Behavioural Approach System, BAS/Behavioural Inhibition System, BIS), it proposes contrasts in sensitivity to reinforcers. Whilst BAS is linked more toward reward signals that trigger goal directed activity and positive reinforcement, in contrast, BIS connects more to punishment, non-reward and novelty, leading to behavioural inhibition (Quilty & Oakman, 2004). Using valid, reliable measures to measure BIS/BAS, work has demonstrated positive associations between BAS and alcohol desire (Franken, 2002). This suggests that individuals who are more sensitive to rewarding stimuli (e.g. alcohol), express a more potent desire. Relating these findings to the present study, this suggests that the inhibitory effect of memory (being reminded of a previous drinking episode) on alcohol desire might be *reduced* for those with *higher* BAS. To test this hypothesis, we recruited female and males who were habitual alcohol consumers. They first completed the BIS/BAS scales (Carver & White, 1994) and were then randomly allocated to either an alcohol cue (AC) or neutral memory cue (NC) condition (per previous study, Stafford et al., 2024) and finally their desire for alcohol was measured. We predicted that alcohol desire would be lowest in the AC group, and this would be moderated by BAS.

2. Method

2.1. Participants

Sample size was estimated via power analysis calculations (G*Power 3.1) given f = 0.25, power 0.8, a = 0.05, which recommended $N = 128$ participants. Given possible attrition we overrecruited to a final sample size of $N = 169$ participants (125 females, 44 males; $M_{age} = 24.1$ $SD_{age} = 10.8$; range 18–67). Participants were recruited via social media adverts and through the University's Department of Psychology Participant Pool, where it was advertised as "Understanding dimensions in drinking behaviour". Participants were only able to participate if they were over the age of 18 and consumed at least 2 UK alcohol units (equivalent to ~500 ml beer or 2 × 25 ml spirits) per week. University participants were granted course credit for study completion. The study was given ethical approval from the University Ethics committee (2024-138). All participants gave informed consent prior to commencing study.

2.2. Design

This study used a between-subjects design where participants were randomly allocated to one of two cue conditions: an Alcohol Cue (AC, experimental condition) or Neutral Cue (NC, control condition). The main dependent variables were the participant's desire for alcohol with BIS/BAS scores used to explore this relationship.

2.3. Materials

2.3.1. Alcohol Use Disorders Identification Test (AUDIT)

The Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993) was used to record participants' level of alcohol consumption. This measure is a screening test for potential hazardous, harmful, or dependent alcohol consumption. The test includes 10 questions regarding frequency, quantity, and consequences of drinking behaviour, ranked in severity. Each of the questions receives a score of between '0' (e.g. 'Never' or 'No' response) to '4' (e.g. 'Daily or almost daily' response). Scoring below 8 points indicates low risk, 8–15 points indicates increasing risk, 16–19 points indicates higher risk and scoring 20+ infers potential dependence (Chodkiewicz et al., 2020). This test was used due to high reliability and validity, with strong internal consistency (Cronbach's Alpha: 0.83) and test-retest reliability (Correlation: 0.81) (Daeppen et al., 2000).

2.3.2. Memory cues

We used the same memory cues from our previous study (Stafford et al., 2024), where individuals in the Memory Cue condition were asked to "*Please consider and write about the most recent time you consumed alcohol. Please report anything relating to the last time you drank alcohol, such as who you were with, what you drank and where you were drinking. Think about the total number of calories you consumed from those alcoholic drinks and write down what you estimate that to be (approximately)*". Those within the Control condition were asked to: "*Please consider and write in the text box below about the most recent time you went on a car journey. Please report anything relating to the last car journey you made, such as who you were with, what sort of vehicle you used, and where you were going*". The idea of using a car journey was simply to provide a control condition that permitted a specific (rather than general) event to recall, but would also be unlikely to involve drinking alcohol.

2.3.3. Behavioural Inhibition and Behavioural Activation (BIS/BAS) scales

The BIS/BAS scale (Carver & White, 1994) were used to measure individuals' general motivation systems. The BIS/BAS scale contains four subscales: BIS/punishment sensitivity scale, BAS reward responsiveness, BAS drive, and BAS fun seeking. The BIS/punishment sensitivity scale measures one's reaction to the anticipation of punishment. The BAS reward responsiveness consists of items that focus on positive response to the anticipation or occurrence of reward. The BAS drive contains items that pertain to the consistent strife toward desired goals. BAS fun seeking refers to items reflecting a desire for new rewards, and a willingness to spontaneously approach a potentially rewarding goal. The 20-item questionnaire requires participants to rate on a Likert scale the degree to which they agree with the prompt, from 1 (strongly agree) to 4 (strongly disagree). Scale scores are calculated by summing the respective items, with high scores indicating a high tendency toward that (BIS/BAS) dimension. The scale has high reliability (Heponiemi et al., 2003), with Cronbach's Alphas of: BIS (0.83), BAS reward responsiveness (0.68), BAS drive (0.82), BAS fun seeking (0.74), Global BAS (0.83).

2.3.4. Desires for Alcohol Questionnaire-6 (DAQ-6)

The DAQ-6 was used to measure individuals' desire to drink (Mo et al., 2013), which was developed from earlier versions of the DAQ (Love et al., 1998).

This 6-item questionnaire uses a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The questionnaire measures how much an individual desires an alcoholic beverage, through questions such as "*I would accept a drink now if it was offered to me*". Scores are calculated by adding the total of each answer. This scale has been shown to have high reliability with Cronbach's Alpha 0.89 (Mo et al., 2013).

2.4. Procedure

The experiment was developed and hosted using Gorilla Software. On accessing the study, participants then completed a consent form, and answered demographic questions including age, gender, and how many units of alcohol they drink per week. Next, participants completed the BIS/BAS scale and were then randomly allocated to either the alcohol condition, or the control condition, and answered the question for their condition accordingly. Next, participants completed the DAQ-6 questionnaire, followed by the AUDIT. All participants completed the survey in this same order. Finally, they were taken to the debrief page at the end of the study, where they were also thanked for their time.

2.5. Data analysis

Data were exported from Gorilla Software to SPSS Statistics (v29). Five participants were removed from the sample due to being outliers in DAQ and BAS, as identified via box plots (IQR > 1.5). The main study findings were unaffected by their removal. The data for the remaining participants ($n = 164$) were checked to see the assumptions were met for regression analyses, in terms of multicollinearity, independence, linearity and normality of residuals. The data were then entered into a hierarchical linear regression analyses using the criterion variable of alcohol desire (DAQ-6) and the predictor variables of Memory Condition, BAS (3 subscales), BIS and Gender, Condition x Gender, entered using blockwise entry. Additional moderation analyses were completed to explore the relationship between Memory Condition and BIS/BAS, which entailed standardising the scores for each variable (converting to z scores) and then computing a new variable (BIS-BAS balance) that represented the difference between BIS/BAS, i.e. BAS less BIS score, as used in previous research (Lertladaluck et al., 2020); where higher scores indicated stronger approach tendencies. The moderation analysis was completed using Process (version 4.2, Hayes & Rockwood, 2017).

3. Results

3.1. Sample characteristics

Sample characteristics are shown in Table 1. There were no differences between conditions for demographics and alcohol consumption data.

3.2. Alcohol Desire

Regression analysis (Table 2) revealed a significant effect of Condition on alcohol desire which was lower in the Alcohol Cue versus Neutral Cue group (Fig. 1), which supports our prediction. There were also positive associations between the BAS subscales and desire; most consistently for BAS-Drive where increases were related to greater desire for alcohol (Table 2). Gender had a significant effect with higher alcohol desire for males compared to females but the interaction with Condition was not significant. To further understand any differences between males and females, we completed analyses within each Condition (Table 3), which revealed higher BIS for females versus males in both Conditions. In the Neutral Cue (Control) condition only, we also found a trend toward higher alcohol desire in males versus females.

To explore the BAS findings further, we completed a moderation analyses between alcohol desire and Condition, using BIS-BAS balance (see Data Analysis) as the moderator.

This revealed significant relationships between desire and Condition and separately, desire and BIS-BAS, but BIS-BAS was not a significant moderator (Table 4). This suggests that whilst there were separate effects for Condition and BIS-BAS on alcohol desire, contrary to prediction, the effects of Condition were not moderated by BIS-BAS.

Table 1
Mean (SD) participant characteristics.

	Alcohol memory cue ($N = 87$)	Neutral cue (control) ($N = 77$)	Group differences
Age	24.4 (10.9)	23.6 (10.2)	$F < 1$, NS
AUDIT	19.2 (5.9)	19.7 (4.7)	$F < 1$, NS
Units per week	9.6 (10.1)	9.5 (7.6)	$F < 1$, NS
Gender (M/F)	19/68	23/54	NS
BAS reward responsiveness	16.0 (1.8)	16.1 (1.7)	$F < 1$, NS
BAS drive	9.9 (1.9)	10.3 (1.9)	$F = 1.2$, NS
BAS fun seeking	11.5 (1.8)	11.4 (1.9)	$F < 1$, NS
BIS	21.4 (3.8)	22.1 (3.7)	$F = 1.3$, NS
Alcohol desire (DAQ-6)	12.3 (6.4)	14.5 (7.4)	$F = 4.05$, $p = .046$

Table 2
Effects of memory condition, BAS, BIS and gender on alcohol desire (DAQ-6).

Variable	R square	F change	Standardised (beta) coefficients	*t*-Value	*p*-Value
Model 1	0.02	4.05			.046
Condition[a]			0.16	2.01	.046
Model 2	0.07	8.01			.005
Condition			0.15	2.01	.046
BAS reward responsiveness			0.22	2.83	.005
Model 3	0.13	10.16			.002
Condition			0.13	1.79	.075
BAS reward responsiveness			0.12	1.55	.124
BAS drive			0.25	3.19	.002
Model 4	0.15	3.95			.049
Condition			0.15	1.96	.052
BAS reward responsiveness			0.06	0.72	.474
BAS drive			0.20	2.45	.015
BAS fun seeking			0.17	1.99	.049
Model 5	0.15	0.852			.357
Condition			0.14	1.88	.063
BAS reward responsiveness			0.05	0.53	.599
BAS drive			0.21	2.49	.014
BAS fun seeking			0.18	2.09	.038
BIS			0.07	0.92	.357
Model 6	0.19	7.69			.006
Condition			0.11	1.55	.124
BAS reward responsiveness			0.02	0.22	.828
BAS drive			0.21	2.53	.012
BAS fun seeking			0.21	2.39	.018
BIS			0.15	1.92	.057
Gender[b]			0.22	2.77	.006
Model 7	0.19	0.11			.74
Condition			0.10	1.17	.24
BAS reward responsiveness			0.02	0.17	.865
BAS drive			0.21	2.51	.013
BAS fun seeking			0.21	2.39	.018
BIS			0.15	1.89	.06
Gender[b]			0.19	1.73	.086
Cond × gender			0.04	0.33	.74

[a] Condition coded where 0 = Alcohol Cue, 1 = Control.
[b] Gender coded where 0 = Female, 1 = Male.

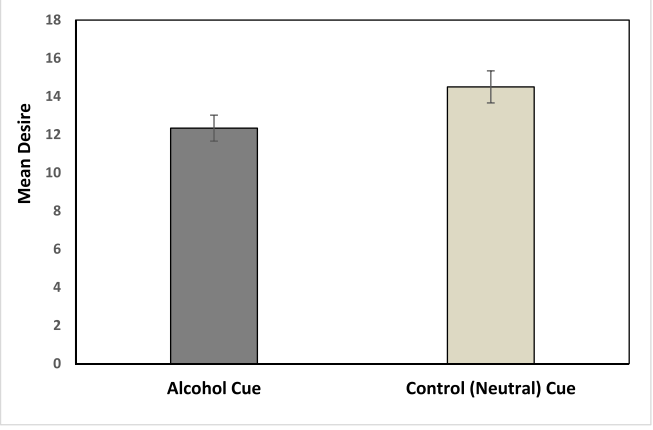

Fig. 1. Mean alcohol desire (DAQ-6) by memory condition.

4. Discussion

This study provides clear evidence that recalling a previous drinking episode reduces the subsequent desire for alcohol. Participants exposed to the alcohol memory cue reported significantly lower desire than those

Table 3
Gender differences (mean/SD) in BAS/BIS, alcohol desire (DAQ-6) within each condition.

	Alcohol memory cue		
	Female (N = 68)	Male (N = 19)	Group differences
BAS reward responsiveness	16.2 (1.8)	15.6 (1.7)	$F = 1.4$, $p = .2$
BAS drive	10.0 (1.9)	9.7 (1.7)	$F < 1$, NS
BAS fun seeking	11.5 (1.9)	11.4 (1.8)	$F < 1$, NS
BIS	22.3 (3.5)	18.4 (3.2)	$F = 18.08$, $p < .001$
Alcohol desire (DAQ-6)	12.0 (6.6)	13.6 (5.6)	$F < 1$, NS

	Neutral cue (control)		
	Female (N = 54)	Male (N = 23)	Group differences
BAS reward responsiveness	15.9 (1.7)	16.6 (1.8)	$F = 2.7$, $p = .1$
BAS drive	10.2 (1.7)	10.6 (2.3)	$F < 1$, NS
BAS fun seeking	11.4 (1.8)	11.3 (2.3)	$F < 1$, NS
BIS	22.8 (3.5)	20.3 (3.7)	$F = 7.63$, $p = .007$
Alcohol desire (DAQ-6)	13.5 (7.2)	16.9 (7.3)	$F = 3.60$, $p = .062$

Table 4
Main and moderating effects of memory condition, BIS/BAS on alcohol desire (DAQ-6).

Variable	Standardised (beta) coefficients	*t*-Value	*p*-Value
Condition[a]	0.17	2.16	.032
BIS/BAS	0.24	2.37	.019
Condition × BIS/BAS	0.06	0.56	.57

[The overall model was significant $F(3, 160) = 3.89$, $p = .01$, $R^2 = 0.07$].
[a] Condition coded where 0 = Alcohol Cue, 1 = Control.

in the neutral condition, directly supporting our prediction. These findings build on our earlier work (Stafford et al., 2024), where individuals asked to recollect a previous alcohol episode subsequently consumed an alcoholic beverage more slowly than those in the control condition, which suggested a reduced motivation for alcohol. In the current study, we used a different outcome measure (DAQ-6) of alcohol motivation but the same memory cue, which led to reduced alcohol desire. Collectively, these two studies demonstrate that both indirect and direct measures of alcohol motivation are sensitive to alcohol memory cues. One of the limitations of the previous study was that the sample consisted of females only and we were therefore uncertain whether similar effects would be observed in males. The present study's findings revealed that the effects of the alcohol memory cue are similar across males and females.

In terms of individual differences, we found that higher BAS, particularly BAS-Drive, was associated with greater alcohol desire. This extends earlier work by Franken (2002), who reported the same pattern in a smaller sample of heavy drinkers using the same measures (BIS/BAS scales; DAQ-16, Love et al., 1998). The replication of this association across different drinking populations reinforces the link, and suggests that personality traits, and reward sensitivity in particular, exert a robust influence on alcohol desire. We also observed that a measure of residual BAS (i.e. BAS less BIS) was positively associated to alcohol desire, which suggests that a potentially more accurate measure of reward that takes into account both behavioural traits is also related to alcohol desire. Previous research found that whilst increases of BIS were associated with lower alcohol consumption (Wardell et al., 2011), thought to be reflective of avoidant behaviour, but when combined with 'high' BAS, this resulted in an increase in alcohol consumption. That finding suggested that individuals more anxious (high BIS) but also more geared toward rewards such as alcohol (High BAS), might expect greater relief for their anxiety from alcohol, thus explaining increased consumption.

In terms of Gender, we found that overall, males had a higher desire for alcohol than females, which given the tendency for higher alcohol consumption in males is not surprising (ONS, 2024). Interestingly, when looking within each condition, that gender difference is maintained in the Neutral (though not statistically significant) but not Alcohol Cue condition which suggests that recalling a previous episode of consumption acts to mute any Gender differences. The differences in personality within each condition revealed higher BIS for females compared to males, and a trend toward differences higher BAS-Reward, both of which align with the findings of previous research (e.g. Wardell et al., 2011).

The absence of a moderating effect of residual BAS was against our prediction, as we expected the memory induced reduction in alcohol desire to be attenuated by sensitivity to rewards. This could suggest that whilst memory and BAS have independent effects, there really is no moderating effect or that our study was not sensitive enough to detect such effects. In terms of the latter, it could be that an alternative (less direct) method of alcohol motivation (e.g. quantity of alcohol consumed or drink duration) might elicit different findings. Relevant here is work from the food domain which found that memory manipulation led to a reduction in subsequent snack intake which was not moderated by reward reactivity (Seguias & Tapper, 2018). Whilst that work utilized a different but related measure of reward sensitivity (RST-PQ, Corr & Cooper, 2016) in a food paradigm, it may still be suggestive that memory cue effects observed in the current study are not moderated by reward sensitivity.

Reflecting further on the relationship between the alcohol memory cue and desire, the work here is contrasted to a body of other research that has focused on reducing alcohol craving/consumption in dependent and/or heavy consumers via memory 'reconsolidation' (see review on pharmacological or behavioural interventions, Barak & Goltseker, 2021). In one study, participants who were given an alcohol related cue (to activate reward memory) followed by a single counterconditioning (disgust based) phase, reduced their habitual alcohol consumption, especially at 9 months (Gale et al., 2021). Such effects are theorized to operate via a sensitive period ('window') between retrieval of alcohol associated memories and consolidation whereby interference (e.g. counterconditioning) can act to disrupt or 'reconsolidate' the original memory and thereby reduce craving for alcohol. Relating those findings to the present study, it may seem surprising that an 'undirected' (i.e. without pos/neg instruction) memory cue can also induce a reduction in alcohol desire, albeit in a relatively short time period. In the absence of an intervention phase, it would seem unlikely that the alcohol memory had been reconsolidated as in that earlier work (Gale et al., 2021). The theoretical basis for our current and previous work (Stafford et al., 2024) is based in the food domain and the link between memory for a recently consumed meal leading to reduce subsequent food intake (Higgs, 2002). Interestingly, in adapting the food-based paradigm to alcohol, we found in our preliminary (unpublished) work that the effects were more consistent when the alcohol cue instruction included the need to estimate the number of alcohol related calories. We propose that this acts to qualify the alcohol memory cue, which could be positive or negative, to induce greater reflection on consuming additional calories and thereby reducing alcohol desire. Interestingly, we had speculated (Stafford et al., 2024) that such a prompt on calories was especially relevant to female participants, as shown in previous research (Bowden et al., 2022), but since there were no overall Memory cue/Gender differences in the present study, it could be that males are similarly sensitive to such calorie effects.

In terms of limitations, in the present study we examined the influence of one model of personality (Reinforcement Sensitivity Theory, RST) and hence we are unsure how other models would relate to alcohol

cues/desire. The rationale for using RST was based on the stronger observed association (Franken, 2002; McCusker & Brown, 1991) between key elements of the model (reward sensitivity) and alcohol compared to other models such as Eysenck's Personality theory (Eysenck & Eysenck, 1985). However, it is possible that other measures of personality such as the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ; Zuckerman, 2002) might be more appropriate for alcohol related work (Adan et al., 2016). It is also important to acknowledge that the outcome measure is based on a single timepoint and hence it is unclear the extent to which the effects of the alcohol cue would endure with time and if repetition of the same memory cue exerts similar effects. This is particularly relevant for individuals who are not alcohol dependent (where memory 'reconsolidation' might be more appropriate) but may still wish to reduce the amount of alcohol consumed. Another limitation worth considering is whether a more directed instruction in the Alcohol Cue condition, to elicit a clearer/stronger alcohol memory, might result in greater effects on alcohol desire. This could be meaningfully explored in future work on this topic (for example asking about a 'significant' drinking occasion rather than the 'most recent'). A final limitation concerns the demographic composition of the sample. Although no exclusion criteria were applied, recruitment through the university participant pool resulted in a predominantly younger and female sample. While there were no group differences on these variables, this demographic skew limits generalisability and may have reduced sensitivity to potential age- or sex-related variation in cue effects.

In conclusion, we found that alcohol memory cues reduced desire to consume alcohol, and separately that BAS-related traits predicted higher desire. We further demonstrated that gender did not moderate the effect, suggesting the mechanism generalises across genders. Taken together, these findings show that a simple, low-cost memory cue, recalling a previous drinking episode and reflecting on the calories consumed, reliably reduces desire for alcohol across genders. This points to a potentially scalable behavioural strategy for reducing alcohol motivation in everyday settings.

CRediT authorship contribution statement

Lorenzo D. Stafford: Writing – original draft, Supervision, Formal analysis. **Kayley Aggas:** Project administration, Data curation. **Jennifer Seddon:** Writing – review & editing. **Richard J. Stevenson:** Writing – review & editing. **Emily Nicholls:** Writing – review & editing. **Christof Lutteroth:** Writing – review & editing. **Matthew O. Parker:** Writing – review & editing.

Declaration of competing interest

The authors declare no conflicts of interest.

Data availability

Study data are freely available upon publication via the University's repository.

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