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Pain Severity and Alcohol Use Among Daily Tobacco Cigarette Smokers

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Background and Objectives: Pain is associated with hazardous alcohol use. Drinkers have reported using alcohol for pain-coping, and negative affect may be a key mechanism in pain-induced motivation to drink. However, no previous study has examined pain severity in relation to alcohol consumption, dependence, and alcohol-related consequences. Moreover, no studies have examined pain-alcohol interrelations among tobacco cigarette smokers. These secondary analyses tested the hypotheses that greater past 4-week pain severity would be positively associated with indices of hazardous drinking (ie, quantity/frequency, harmful use, and dependence), and that the current pain intensity would be positively/indirectly associated with the urge to drink via negative affect.
Methods: Participants included 225 daily smokers (43% female; $M_{CPD} = 22$) who completed the baseline session for a larger experimental study.
Results: Every one-point increase in pain severity was associated with a 47% increased likelihood of hazardous drinking, and pain severity was positively associated with quantity/frequency of alcohol consumption, harmful patterns of drinking, and alcohol dependence level (Ps < .05). Pain intensity was indirectly associated with urge to drink via negative affect ($P < .05$).
Conclusions: These findings provide initial evidence that smokers with greater pain severity may also report hazardous patterns of alcohol use.
Scientific Significance: This is the first study to demonstrate that past 4-week pain severity may be one factor that maintains three conceptually distinct patterns of hazardous drinking among smokers. The current results also provide the first evidence that greater pain intensity may be associated with an increased urge to drink alcohol, via negative affect. (Am J Addict 2020;00:00–00)

INTRODUCTION

Approximately 86% of American adults report lifetime use of alcohol,[1] and greater than 25% endorse hazardous patterns of drinking (eg, excessive frequency and quantity of consumption, drinking that causes harm, and dependence/addiction).[2] Hazardous alcohol use is responsible for over 5% of all deaths worldwide[3] and is the third leading cause of preventable death in the United States.[4] The Alcohol Use Disorders Identification Test (AUDIT), developed by the World Health Organization (WHO) to identify hazardous patterns of alcohol use,[5] assesses alcohol consumption (eg, frequency/quantity of drinking), dependence symptoms (eg, impaired control over drinking), and alcohol-related consequences (eg, injuries) over the last 30 days. In addition, the AUDIT provides a cut-off score for hazardous drinking,[5] which can be used in conjunction with more detailed information regarding consumption level, signs of dependence, and present harm when determining appropriate treatment recommendations.[5]

There is growing empirical and clinical interest in the role of pain in hazardous drinking.[6,7] Pain is more common among problem drinkers than nonproblem drinkers,[8] and individuals with chronic pain (vs no pain) are twice as likely to meet the diagnostic criteria for alcohol dependence.[9] An established reciprocal model posits that pain and alcohol use interact in the manner of a positive feedback loop, resulting in the exacerbation of both conditions over time.[7] For example, regular alcohol use has been implicated in the onset and progression of several painful conditions,[10,11] pain intensity has been positively associated with AUDIT total scores,[12] and laboratory pain induction has been shown to increase the urge to drink.[13] Alcohol has also been shown to confer acute analgesia,[14] and, consistent with negative reinforcement models of addiction,[15] amelioration of negative affect has been identified as a key mechanism in the effects of experimental pain induction on motivation to drink alcohol.[7,13]

Despite this emerging literature, we are not aware of any studies that examined pain severity in relation to three specific patterns of hazardous drinking (ie, excessive frequency/quantity of consumption, drinking that causes harm, and drinking that results in dependence/addiction). To inform the development of tailored alcohol interventions, it is important to assess each of these three conceptually

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distinct patterns of consumption.[5] For example, previous research has found that pain-related anxiety (ie, a pain-related cognitive-affective construct that reflects the tendency to respond to pain with anxiety/fear) was positively associated with harmful drinking and drinking that results in dependence/addiction, but was not related to quantity/frequency of consumption.[16] Accordingly, it is important to test the associations between pain severity and each of these indices of drinking.

In addition, no previous work has tested indirect associations between spontaneous pain intensity (ie, pain in the absence of an experimental stimulus) and the urge to drink alcohol via negative affect. Indeed, negative affect has been hypothesized to be a key mechanism in pain-substance interrelations.[6,7,17] Pain has consistently been associated with increased negative affect among tobacco cigarette smokers,[18–20] and preliminary experimental work has provided causal evidence that negative affect mediates the effects of pain induction on the motivation to drink alcohol.[13] Although laboratory pain models offer advantages with regard to internal validity (eg, standardized application of painful stimuli), a critical next step is to increase external validity by examining the indirect association between spontaneous pain intensity and self-reported urge to drink alcohol, via negative affect.

Finally, we are not aware of any studies that examined pain-alcohol interrelations among tobacco cigarette smokers, which is surprising given that smokers (vs nonsmokers) are more likely to endorse pain,[21–23] report excessive drinking,[24] and meet the criteria for alcohol dependence.[25] Moreover, nicotine and alcohol co-use has been associated with poorer health outcomes,[26,27] and it is important to identify factors that contribute to concurrent use, in order to inform the development of tailored interventions. Given established bidirectional associations between pain and substance use,[7] as well as converging evidence that pain is a potent motivator of nicotine and alcohol use,[19,28,29] it is possible that smokers with pain (vs no pain) are more likely to consume alcohol and engage in problematic patterns of drinking in an effort to extend/supplement the analgesic effects of nicotine.[30]

Thus, the goal of the current analyses was to test the following hypotheses among a sample of current tobacco cigarette smokers: (1) that greater past 4-week pain severity would be associated with an increased likelihood of scoring above the AUDIT cut-off for hazardous drinking; (2) that past 4-week pain severity would be positively associated with consumption-related variables (ie, typical quantity of alcohol consumption, the number of drinking days each month, and the largest number of drinks consumed in a single day), and indices of excessive alcohol use (ie, hazardous drinking, harmful use, and dependence); and (3) that current (ie, past 24-hour) pain intensity would be positively and indirectly associated with the current urge to drink alcohol, via self-reported negative affect.

METHODS

Participant Recruitment and Procedure

These data were collected during the baseline portion of a primary study testing the effects of nicotine deprivation on pain reactivity.[31] Participants were recruited from the local community. All inclusion and exclusion criteria for this study were consistent with those of the parent study and were assessed via self-report during a telephone-based screening procedure.[31] Specifically, participants were included if they smoked more than or equal to 15 cigarettes per day and were able to speak and read English. Participants were excluded if they endorsed current chronic pain, use of prescription pain medications, or current attempts to reduce or quit smoking. Participants provided informed consent and biochemical verification of smoking status via exhaled carbon monoxide ($CO \geq 8$ ppm). A total of 225 participants completed all baseline measures and were included in the current analyses.

Measures

Pain

Past 4-week pain severity was assessed using a single item (ie, "How much bodily pain have you had during the past 4 weeks?")[32] that was rated on a 6-point scale ranging from 0 (*none*) to 5 (*very severe*). Past 24-hour pain intensity was assessed using a 0 (*no pain*) to 10 (*pain as bad as you can imagine*) numerical rating scale (NRS; "Please rate your pain by selecting the number that tells how much pain you had, on average, during the last 24 hours"). The NRS is commonly used in both clinical and research settings.[33] Finally, pain persistence was assessed using a single item ("On how many days in the last 180 days (6 months) have you had pain?").

Alcohol Use

Alcohol consumption was assessed using the 10-item AUDIT, which is a reliable and valid assessment of alcohol use problems among adults.[5] Items are rated on scales from 0 (*Never*) to 4 (*4 or more times a week*) and summed to generate a total score. A total score cut-off of more than or equal to 8 for men and more than or equal to 7 for women is indicative of hazardous drinking behavior.[5] The AUDIT also includes three subscales that assess unique patterns of alcohol use. The AUDIT-Consumption subscale assesses the quantity/frequency of alcohol use, the AUDIT-Harmful use subscale assesses drinking that results in consequences to physical and mental health, and the AUDIT-Dependence subscale assesses for drinking that has resulted in dependence/addiction. Internal consistency of the AUDIT in the current sample was good ($\alpha = .84$), and correlations between subscales ranged from $r = .45$ to $.65$ ($Ps < .001$). Outcomes also included the self-reported largest number of drinks consumed in a single day, number of days alcohol was consumed in the past 30 days, and the typical number of drinks consumed on each day over the past 30 days (standard drink: 12 oz of beer, 4 oz of wine, or 1 oz of liquor).

Alcohol Urge

The Alcohol Urge Questionnaire (AUQ) is an 8-item scale that assesses the current desire to drink alcohol.[34] Participants are asked to indicate their current (ie, "right now") agreement with 8 items, using a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Items are summed to generate a total score, with higher scores indicating greater alcohol urge. The AUQ had acceptable internal consistency ($\alpha = .75$) in the current sample, and a previous work has demonstrated high concurrent validity with other measures of alcohol urge.[34]

Negative Affect

The negative affect subscale of the Positive and Negative Affect Schedule (PANAS-NA) was used to measure current intensity of negative emotions.[35] Participants were instructed to indicate the extent to which they currently (ie, "right now") experienced 10 different negative emotions (eg, "irritable," "distressed," and "nervous") using a 5-point scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Items were summed to generate a total score, with higher scores indicating greater state negative affect. The PANAS-NA has demonstrated good internal reliability and validity,[35] and evinced good internal consistency in the current sample ($\alpha = .89$).

Cigarette Dependence

Cigarette dependence was measured using the Heaviness of Smoking Index (HSI),[36] which is comprised of two items (ie, "How soon after you wake up do you smoke your first cigarette?" and "How many cigarettes per day do you smoke?"). Items are summed to generate a continuous total score (range 0-6), with higher scores indicating greater levels of cigarette dependence.

Sociodemographic Characteristics

Participants reported a range of sociodemographic characteristics, including age, race, gender, ethnicity, education, marital status, and annual income.

Data Analytic Plan

First, we conducted a hierarchical logistic regression to test the association between past 4-week pain severity and the likelihood of scoring above the AUDIT cut-off for hazardous drinking (AUDIT total score ≥ 8 for males and ≥ 7 for females). Second, we conducted separate hierarchical linear regression models to test associations between past 4-week pain severity and AUDIT-total scores, scores on each of the AUDIT subscales (ie, consumption, harmful use, and dependence), typical quantity of alcohol consumption, the number of drinking days each month, and the largest number of drinks consumed in a single day. For each model, independent variables were entered in the following order: Step 1 (gender, age, and cigarette dependence); Step 2 (past 4-week pain severity). Third, we examined the indirect association between past 24-hour average pain and current urge to drink alcohol via negative affect using the PROCESS Macro for SPSS.[37] We focused on past 24-hour pain intensity (vs past 4-week pain severity) because we determined that exploring relations between past 24-hour pain, current negative affect, and current urge to drink alcohol was more conceptually and temporally appropriate than relating past 4-week pain severity to current negative affect/urge to drink. Gender, age, and cigarette dependence were included as covariates in all models, given previously observed relations with alcohol consumption.[38–40]

RESULTS

Participant Characteristics

Participants included 225 daily tobacco cigarette smokers (43.1% female; $M_{age} = 41$, SD = 12.3; 58.2% white), who smoked an average of 22 cigarettes per day ($M = 22.0$ and SD = 13.1), and reported a moderate level of cigarette dependence ($M = 3.8$ and SD = 1.3). More than 85% of participants endorsed past 4-week pain, with 41% reporting at least moderate pain severity over the past 4 weeks. On average, participants reported pain on 48 (SD = 61.2) out of the past 180 days, with nearly half (49%) endorsing pain on fewer than 14 days. The majority of participants were single, with a high school degree or general education diploma (GED) as their highest level of education, and an annual income of less than $50 000. Just under one-third of participants (32.4%) scored above the AUDIT cut-off for hazardous drinking. Additional sociodemographic data are presented in Table 1.

Past 4-Week Pain Severity and Likelihood of Hazardous Drinking

Approximately 19% ($n = 6$) of individuals with no past 4-week pain scored above the AUDIT cut-off for hazardous drinking, compared with 34.5% ($n = 67$) of those with past 4-week pain. Logistic regression analyses indicated that past 4-week pain severity was positively associated with the likelihood of scoring above the AUDIT cut-off for hazardous drinking (adjusted odds ratio [AOR] = 1.47, 95% confidence interval [CI]: 1.15-1.87, $P = .002$; Table 2). More specifically, every one-point increase in pain severity (range 0-5) was associated with a 47% increased likelihood of screening positively as a hazardous drinker.

Past 4-Week Pain Severity and Patterns of Alcohol Use

Past 4-week pain severity was positively associated with AUDIT-total scores ($\beta = .221$, $P = .001$; $\Delta R^2 = .048$, $P = .001$). In terms of quantity and frequency of alcohol consumption, more severe pain was associated with a greater number of drinking days over the past 30 days ($\beta = .163$, $P = .015$; $\Delta R^2 = .026$, $P = .015$; Table 3), consuming a larger number of alcoholic beverages in a single day ($\beta = .137$, $P = .033$; $\Delta R^2 = .018$, $P = .033$; Table 3), and AUDIT-Consumption subscale scores ($\beta = .139$, $P = .037$; $\Delta R^2 = .019$, $P = .037$; Table 3). No association was observed

TABLE 1. Sociodemographic, pain, and alcohol use characteristics

	Total $N = 225$, n (%)
Sex	
Female	97 (43.1%)
Race	
Black or African American	86 (38.2%)
White	131 (58.2%)
Other	8 (3.6%)
Ethnicity	
Hispanic	9 (4%)
Marital status	
Single	136 (60.4%)
Married	36 (16%)
Divorced/separated/widowed	53 (28.6%)
Income	
<$10 000	88 (39.1%)
$10 000-$49 999	105 (46.7%)
$50 000-$89 999	29 (12.9%)
Over $90 000	3 (1.3%)
Education	
Did not graduate high school	52 (23.1%)
High school graduate or GED	78 (34.7%)
Some college/technical school/ associate's degree	80 (35.6%)
4-year college degree	7 (3.1%)
Some school beyond 4-year college degree	7 (3.1%)
Professional degree	1 (0.4%)
Past 4-week pain severity	
None	31 (13.8%)
Very mild	50 (22.2%)
Mild	51 (22.7%)
Moderate	67 (29.8%)
Severe	24 (10.7%)
Very severe	2 (0.9%)
Hazardous drinking[a]	73 (32.4%)
	M (SD)
Age	41 (12.31)
Cigarettes per day	22.04 (13.05)
Cigarette dependence[b]	3.78 (1.34)
Past 24-hour average pain intensity	2.27 (2.514)
AUDIT[c]	
Total score	6.32 (7.45)
Hazardous drinking subscale	3.10 (3.176)
Harmful use subscale	1.96 (3.158)
Alcohol dependence subscale	1.26 (2.635)
Alcohol urge	1.86 (1.040)
Negative affect	16.95 (7.428)

AUDIT = Alcohol Use Disorders Identification Test.
[a]Alcohol use disorders identification test total score ≥8 for men and ≥7 for women.
[b]Heaviness of smoking index.
[c]Alcohol use disorders identification test.

TABLE 2. Logistic regression: likelihood of hazardous drinking[a] as a function of past 4-week pain severity

Variable	B	SE	AOR	95% CI	P
Sex (female)	−0.779	0.311	0.459	(0.249, 0.844)	.012*
Age	0.001	0.012	1.001	(0.978, 1.025)	.938
Cigarette dependence[b]	0.063	0.110	1.065	(0.859, 1.321)	.567
Past 4-week pain severity	0.383	0.124	1.467	(1.151, 1.869)	.002**

Results shown are from the second step of the logistic regression model.
AOR = adjusted odds ratio; AUDIT = Alcohol Use Disorders Identification Test; CI = confidence interval.
[a]AUDIT total score ≥7 for females and ≥8 for males.
[b]Heaviness of smoking index.
*$P < .05$, **$P < .01$.

between past 4-week pain severity and the usual number of drinks consumed per drinking day in the past 30 days ($P = .443$).

Past 4-week pain severity was also positively associated with AUDIT-Harmful use subscale scores ($\beta = .235$, $P < .001$; $\Delta R^2 = .054$, $P < .001$; Table 3), accounting for over 5% of the total variance in harmful patterns of alcohol use. Similarly, pain severity was associated with AUDIT-Dependence subscale scores ($\beta = .175$, $P = .009$; $\Delta R^2 = .030$, $P = .009$; Table 3), accounting for 3% of the total variance in level of alcohol dependence symptoms.

Indirect Association Between Pain Intensity and Urge to Drink Via Negative Affect

Analysis revealed a significant indirect association between past 24-hour pain intensity and current urge to drink via self-reported negative affect ($b = 0.018$ [SE = 0.010], 95% CI [0.003, 0.045]). Specifically, pain intensity was positively associated with current negative affect, which in turn, was associated with greater current urge to drink alcohol (see Fig. 1).

DISCUSSION

This is the first study to examine relations between pain severity and hazardous patterns of alcohol use among daily tobacco cigarette smokers. Results indicated that every one-point increase in past 4-week pain severity was associated with a 47% increased likelihood of scoring above the AUDIT cut-off for hazardous drinking. AUDIT scores in this range are indicative of more severe alcohol problems and dependence, which typically warrants more intensive treatment.[5] Results further indicated that past 4-week pain severity was positively associated with AUDIT-total scores, quantify/frequency of alcohol consumption, number of drinking days over the past 30 days, maximum number of drinks consumed during one occasion, harmful patterns

TABLE 3. Associations between past 4-week pain and frequency and indices of hazardous drinking

	Largest number of drinks in a single day			Number of drinking days in the past 30 days			Number of drinks per day on drinking days in past 30 days			AUDIT-harmful use			AUDIT-dependence symptoms			AUDIT-alcohol consumption		
Variables	β	t	P	β	t	P	β	t	P	β	t	P	β	t	p	β	t	P
Sex	.343	5.360	.000	.139	2.075	.039	.140	2.066	.040	.191	2.864	.005	.164	2.465	.014	.238	3.670	.000
Age	−.013	−0.197	.884	−.007	−0.104	.917	.012	0.184	.854	−.068	−1.038	.300	−.068	−1.026	.306	−.057	−.883	.378
Cigarette dependence[a]	−.075	−1.174	.242	.016	0.237	.813	−.008	−0.126	.900	−.010	−.155	.877	−.001	−.018	.986	−.067	−1.044	.298
Past 4-week pain severity	.137	2.144	.033	.163	2.442	.015	.052	.769	.443	.139	2.098	.037	.175	2.642	.009	.235	3.637	.000
R^2	0.109			0.023			0.002			0.036			0.037			0.084		
ΔR^2	0.018			0.026			0.003			0.019			0.030			0.054		
F for ΔR^2	4.596**			5.962*			0.591*			4.403**			6.978*			13.226**		

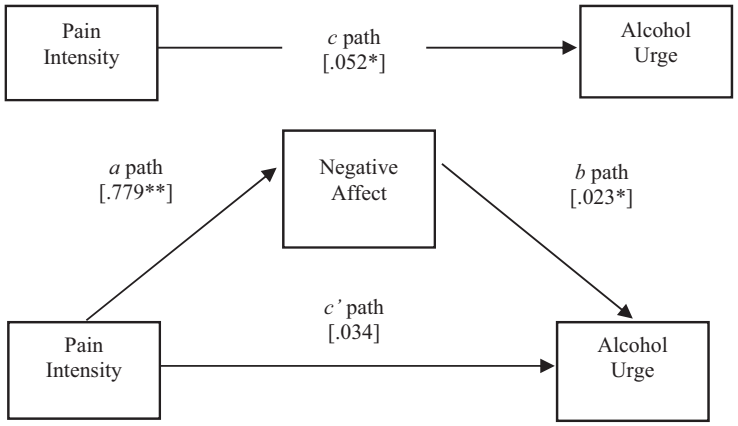
Results shown are from the second step of each linear regression model.
AUDIT = Alcohol Use Disorders Identification Test.
[a]Heaviness of smoking inventory.
*$P < .05$, **$P < .01$.

of alcohol use (eg, blackouts and alcohol-related injuries), and level of dependence symptoms (eg, impaired control over drinking, increased salience of drinking). Finally, results indicated that past 24-hour pain intensity was indirectly associated with the current urge to drink via self-reported negative affect.

Collectively, these findings expand on previous research showing that daily (vs non-daily) drinkers are more likely to endorse pain,[10,41] and that individuals with chronic pain (vs no pain) are more likely to be dependent on alcohol,[9] by demonstrating a positive covariation between pain severity and hazardous patterns of alcohol consumption. The observed indirect association between pain intensity and urge to drink via a negative affect adds to a growing literature indicating that pain can be a potent motivator of substance use in general,[7] and alcohol use in particular,[13] at least partly via processes consistent with negative reinforcement and self-medication.[15,30] Indeed, this is the first study to examine indirect associations between spontaneous pain intensity (ie, pain in the absence of an experimental stimulus) and urge to drink via negative affect.

This is also the first study to examine pain-alcohol interrelations among daily tobacco cigarette smokers. Relative to the general population, smokers are four times more likely to be dependent on alcohol,[25] and are more likely to experience severe pain.[23,42] Research has further shown that co-use of tobacco and alcohol is highly prevalent among individuals with chronic pain,[43,44] and the current findings suggest that pain severity may be one factor that contributes to the maintenance of problem drinking among smokers. Future research would benefit from examining whether associations between pain severity and hazardous patterns of drinking are more prevalent/pronounced among concurrent alcohol and tobacco users (vs alcohol users who do not smoke cigarettes).

Several important limitations should be noted. First, these are cross-sectional secondary analyses. Thus, it is unclear whether observed associations are due to the effects of pain severity on the development/maintenance of problematic patterns of alcohol use, or to the effects of hazardous drinking on the onset/progression of pain. Further research is needed to determine whether pain severity has predictive utility in the development and maintenance of hazardous drinking and whether the co-use of alcohol and tobacco/nicotine increases the risk of developing more severe pain. Second, the sample was comprised of fairly heavy daily cigarette smokers ($M_{CPD} = 22$), and future work would benefit from examining the covariation between pain severity and hazardous drinking among lighter and intermittent smokers. Third, because participants were excluded from the primary study if they endorsed current chronic pain, the extent to which these findings are applicable to treatment-seeking pain patients remains unclear (though 86% of the current sample did endorse the presence of past 4-week pain). Future research should attempt to replicate these findings among individuals with chronic pain and should conduct a more



Note. Analysis statistically adjusted for gender, age, and cigarette dependence; covariates (i.e., gender, age, cigarette dependence) not pictured in the figure for simplicity; * $p \leq .05$, ** $p < .01$.

Model Coefficients

		Consequent						
		M (NEGATIVE AFFECT)				*Y* (ALCOHOL URGE)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X (PAIN INTENSITY)	*a*	.779	.192	.000	*c'*	.034	.028	0.221
M (NEGATIVE AFFECT)					*b*	.023	.010	0.017
Gender		–.482	.973	–.495		.358	.137	0.010
Age		–.027	.039	.499		.002	.006	0.7262
Cigarette dependence		.483	.361	.182		–.060	.051	0.241
constant	i_1	14.737	2.312	<.001	i_2	1.338	.355	<.001
		R^2 =.081 F (4,220) = 4.837, p < .001				R^2 = .070 F (5,219) = 3.2841, p < 0.01		

FIGURE 1. Indirect association between past 24-hour pain intensity and alcohol urge via negative affect.

thorough assessment of chronic pain status and severity (eg, via medical chart review). Moreover, the type, duration, and etiology of past 4-week pain were not assessed in this study and future work is needed to better characterize pain symptoms and test their relation to alcohol use/dependence. Fourth, although participants were excluded if they endorsed the use of prescription pain medications, the use of other substances (eg, cannabis and nonprescription pain medications) was not consistently assessed among the sample. Future work is needed to determine whether the use of other substances beyond nicotine and alcohol influences pain-alcohol relations.

In summary, these data provide initial evidence that smokers with greater pain severity may also report more hazardous patterns of alcohol use. Despite emerging evidence of comorbidity and reciprocity in terms of a vicious feedback cycle,[6,7] we are not aware of any treatments that have been developed to reduce hazardous drinking or co-use of alcohol and tobacco in the context of pain. Personalized feedback interventions represent one promising avenue for integrated treatment, in that they are typically brief, easily disseminated, and could be adapted to aid the development of discrepancy between current drinking behavior and desire to mitigate pain.[45]

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

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