

# eScholarship@UMassChan

## I smoke to cope with pain: patients' perspectives on the link between cigarette smoking and pain

Item Type	Journal Article
Authors	Lee, Megan;Snow, Jennifer;Quon, Caroline;Selander, Kim;DeRycke, Eric;Lawless, Mark;Driscoll, Mary;Ditre, Joseph W.;Mattocks, Kristin M;Becker, William C.;Bastian, Lori A.
Citation	<p>&lt;p&gt;Lee M, Snow J, Quon C, Selander K, DeRycke E, Lawless M, Driscoll M, Ditre JW, Mattocks KM, Becker WC, Bastian LA. I smoke to cope with pain: patients' perspectives on the link between cigarette smoking and pain. Wien Klin Wochenschr. 2021 Oct;133(19-20):1012-1019. doi: 10.1007/s00508-021-01931-x. Epub 2021 Aug 30. PMID: 34460005. &lt;a href="https://doi.org/10.1007/s00508-021-01931-x"&gt;Link to article on publisher's site&lt;/a&gt;&lt;/p&gt;</p>
DOI	<a href="https://doi.org/10.1007/s00508-021-01931-x">10.1007/s00508-021-01931-x</a>
Rights	Copyright © 2021, This is a U.S. Government work and not under copyright protection in the US; foreign copyright protection may apply
Download date	2026-03-05 18:12:57
Link to Item	<a href="https://hdl.handle.net/20.500.14038/46977">https://hdl.handle.net/20.500.14038/46977</a>



# I smoke to cope with pain: patients' perspectives on the link between cigarette smoking and pain

Megan Lee · Jennifer Snow · Caroline Quon · Kim Selander · Eric DeRycke · Mark Lawless · Mary Driscoll · Joseph W. Ditre · Kristin M. Mattocks · William C. Becker · Lori A. Bastian

Received: 19 June 2021 / Accepted: 23 July 2021 / Published online: 30 August 2021

© This is a U.S. Government work and not under copyright protection in the US; foreign copyright protection may apply 2021

## Summary

**Background** For people with chronic pain, cigarette smoking is associated with greater pain intensity and impairment. Researchers have hypothesized a reciprocal relationship in which pain and smoking exacerbate each other, resulting in greater pain and increased smoking. This study aimed to qualitatively examine patient perspectives on this association.

**Methods** A retrospective thematic analysis of smoking cessation counseling notes for 136 veterans in the Pain and Smoking Study, a tailored smoking cessation trial, was conducted. A validated codebook was applied to each counseling note by four independent coders using Atlas.ti (Atlas.ti, Berlin, Germany). Coders partic-

ipated in a consensus-forming exercise with salient themes validated among the wider research team.

**Key results** Participants averaged 60 years of age (range 28–77 years) and were 9% female. The median number of cigarettes smoked per day was 15, with a mean pain intensity score in the last week (from 0–10) of 5.1. While not all patients acknowledged a connection between pain and smoking, we found that (1) pain motivates smoking and helps manage pain-related distress, as a coping strategy and through cognitive distraction, and (2) pain motivates smoking but smoking does not offer pain relief. Concerns about managing pain without smoking was identified as a notable barrier to cessation.

**Conclusion** Many patients with chronic pain who smoke readily identified pain as a motivator of their smoking behavior and are reluctant to quit for this reason. Integrated interventions for smokers with pain should address these perceptions and expectancies and promote uptake of more adaptive self-management strategies for pain.

**Disclaimer** The opinions expressed here are those of the authors and do not represent the official policy or position of the U.S. Department of Veterans Affairs or the U.S. government.

M. Lee, BS · J. Snow, MSc · C. Quon, BS · K. Selander, MS · E. DeRycke, MPH · M. Lawless, MSW · M. Driscoll, PhD · W. C. Becker, MD · L. A. Bastian, MD MPH (✉)  
Pain Research, Informatics, Multimorbidities, and Education (PRIME) Center, VA Connecticut Healthcare System West Haven, 950 Campbell Avenue, Building 35A, Room 201, West Haven, CT 06516-2770, USA  
lori.bastian@yale.edu

M. Lee, BS · M. Driscoll, PhD · W. C. Becker, MD · L. A. Bastian, MD MPH  
Yale University School of Medicine, New Haven, CT, USA

J. W. Ditre, PhD  
Department of Psychology, Syracuse University, Syracuse, NY, USA

K. M. Mattocks, PhD  
University of Massachusetts Medical School, Worcester, MA, USA

VA Central Western Massachusetts Healthcare System, Leeds, MA, USA

**Keywords** Tobacco · Chronic pain · Smoking cessation · Qualitative research · Coping strategy

## Introduction

Smokers report significantly greater pain intensity, more frequent pain, greater pain-related functional interference, and more prescribed opioid use compared to non-smokers [1–7]. In a conceptual synthesis, Ditre et al. hypothesized a reciprocal model for the link between pain and smoking fueled by myriad social, biological, and physiological factors in which pain and smoking exacerbate each other, resulting in a positive feedback loop of greater pain and increased smoking [8, 9]. This feedback loop has been validated in recent studies showing that pain increases

the urge to smoke in a dose-dependent relationship, [10–12] and that smokers with co-occurring pain are less likely to initiate and maintain a cessation attempt [13].

Pain-related anxiety (i.e., tendency to respond to pain with anxiety or fear) [14] is conceptualized as a trigger to smoke, diminishes smokers' self-efficacy to make a quit attempt, and has been implicated in the maintenance of tobacco dependence [15–19, 46]. Previous research suggests that smokers with chronic pain may have underdeveloped coping skills [20, 21, 47]. Combined with data showing that nicotine may have an acute analgesic effect on pain, [22] people who smoke and live with chronic pain face compounded challenges when trying to quit.

Few qualitative studies have explored how patients perceive their smoking behavior in different populations with pain. Hooten et al. interviewed 18 smokers with chronic pain undergoing a 3-week outpatient pain treatment program. Smoking was an important coping strategy for pain and distress, and patients using opioids reported that opioids stimulated smoking [23]. Aimer et al. interviewed 36 current or former smokers with rheumatoid arthritis (RA). Most (64%) were unaware of a link between smoking and RA, thus not perceiving RA as a reason to quit [24].

The present study aimed to identify and examine perspectives and knowledge of the link between smoking and pain among veterans enrolled in a smoking cessation trial who currently smoke and have chronic pain. We sought to uncover whether patients recognized a relationship at all between their pain and smoking behavior and elucidate their motives for continuing to smoke despite these contradictions. Understanding patient perspectives on this linkage will inform the design of integrated interventions that address both smoking cessation and pain management.

## Methods

This study was conducted as a sub-study of the Pain and Smoking Study (ClinicalTrials.gov NCT02971137), which is a randomized control trial of smoking cessation plus cognitive behavioral intervention (CBI) versus standard smoking cessation counseling in veterans who smoke and have chronic pain. The CBI focused on psychoeducational and skills-based approaches based on the VAs pain self-management program [25]. Male and female veterans ( $n = 136$ ) who were current smokers (defined as  $\geq 7$  cigarettes in past 7 days) and had chronic pain (defined as pain intensity  $\geq 4/10$  for more than 3 months) at the Connecticut Veterans Administration (VA) and Northampton VA were included. Protocols and consent documents were approved by the VA Connecticut Institutional Review Board.

## Recruitment process

Veterans receiving care at VA Connecticut and Northampton VA were identified from the electronic medical record using a data pull for smoking status and pain intensity based on vital signs and health factors. We sent an introductory letter to 3478 potentially eligible participants that described the study and informed them that they would be contacted about participating unless they called a toll-free number to refuse participation, of which 720 were unable to be reached by telephone. Of the 2758 patients contacted, 2319 declined to participate. The remaining 439 were called by a study member to complete an eligibility screening, of whom 50 failed. Then, 389 patients consented and were enrolled, and 371 completed baseline survey assessments over the phone. Of the 186 patients randomized to the CBI arm, the 136 patients who completed the first counseling session were included in this study. All patients gave their informed consent prior to their inclusion in the study. Patients were randomized to one of two treatment groups. The present study is an analysis of the participants who were assigned to the CBI treatment group and completed the first counseling session, which included asking the veteran about perceived connections between smoking and pain.

## Measures

Demographics and clinical variables were collected during baseline phone surveys and included age, gender, race, marital status, educational attainment, work status, smoking measures (cigarettes smoked per day and pack/year smoking history), measures of pain intensity on an 11-point scale (from 0 as no pain, to 10 as worst pain imaginable) [26] and pain interference, on a self-rated 11-point scale about how much pain interferes with daily life (from 0 as does not interfere, to 10 as completely interferes) [27].

One PASS study counselor conducted five standardized counseling sessions with each patient and wrote notes on what the patient discussed, which included summary statements and direct quotes. We analyzed the first session counseling notes, in which the veteran's perception of the relationship between pain and smoking from the first counseling session was discussed. These notes were manually extracted into Atlas.ti Version 7 (Atlas.ti, Berlin, Germany) for the current analysis.

## Analysis

To characterize the sample, frequencies and proportions were calculated for the demographic and clinical data. In terms of qualitative analysis, extracted clinical notes were examined by qualitative content analysis to identify relevant themes. First, we conducted open coding with a randomly selected subset

of clinical notes (about a quarter of the full sample) during which four coders identified key concepts that emerged from the text. Then, we created a codebook focused on the pain and smoking relationship, comprised of commonly observed themes in participant notes. The codebook was validated among the larger study team before four independent coders applied it to the full sample of session notes using Atlas.ti. The four individual coders' codes were then merged, and the four coders participated in a consensus forming activity during which each use of a code was discussed for consistency and validity. A single validated code with all participants notes was reviewed by the wider study team [28]. The current study explored emergent themes around the perceived connection between pain and smoking. We identified representative quotes, written in either third person from the counselor's summary statements or in first person from direct patient quotes, from session notes to illustrate these themes.

## Results

### Participant characteristics

Veterans were on average, 60 years old (range from 28 to 77 years), and 9% female (See Table 1), 62% of participants identified as White and 31% participants identified as Black. Around half were married, and about a third had high school graduate degree or less. Over 70% were unemployed. The median number of cigarettes smoked per day was 15, with a median of 21 pack years. The mean pain intensity score in the last

**Table 1** Characteristics of the PASS qualitative study sample ( $n = 136$ )

Participant characteristics	$N = 136$
Median age, years (IQR)	60.5 (51.5–66.0)
Male (%)	124 (91.2)
Race/ethnicity (%)	
White	83 (61.5)
Black	41 (30.4)
Hispanic	7 (5.2)
More than one race	3 (2.2)
Other	1 (0.7)
Married/living with partner (%)	69 (51.5)
High school graduate or less (%)	47 (34.6)
Self-reported work status (%)	
Full-time	31 (23.0)
Part-time	12 (8.9)
Not employed	92 (68.1)
Cigarettes per day, median (IQR)	15 [8.5–20]
Pack years, median (IQR)	21 [8.8–41.5]
Pain intensity in last week (0–10), mean (SD)	5.1 (1.6)
Pain interference, mean (SD)	5.5 (2.2)
PASS Pain and Smoking Study, IQR interquartile range, SD standard deviation	

**Table 2** Relationship between pain and smoking

Theme	Illustrative quote
<i>Pain motivates smoking and smoking helps manage pain-related distress</i>	
Smoking is used as a coping strategy for emotional distress related to pain	"In the absence of other vices to cope, I smoke when I am in pain."
	"Veteran reports smoking more when her pain is high; stating 'I know it doesn't help the pain but I think to myself, this will make me feel better.'"
	"He feels smoking has helped 'calm me down' which in turn has helped manage his pain."
	"He describes having a difficult time separating physical pain from emotional pain. He identifies being quite anxious which leads to feeling physically tense and subsequently experiencing physical pain."
	"He finds himself smoking more when his pain is high and believes this is to manage his anxiety which is triggered by pain."
	"If I have to live in severe pain, I am not going to quit smoking."
Smoking helps serve as a cognitive distraction from pain/taking a break from pain	"He has noticed smoking more when his pain is higher and attributes the subsequent relief he experiences to 'the distraction of smoking.'"
	"He finds that he smokes more when he has a pain flare-up. He describes smoking during those times as a 'reprieve' from focusing on the pain. He associates smoking with being deployed and how for 5–10 min, you were able to just focus on smoking and nothing else."
<i>Pain motivates smoking but smoking does not offer pain relief</i>	
More pain leads to more smoking but not relief	"Smoking more when her pain is high and that doing so does not offer her any tangible relief."
	"Does smoke more when his pain is high but believes it doesn't help. 'It's just a habit.'"

week (from 0–10) was 5.1 (SD: 1.6) and mean pain interference rating was 5.5 (SD: 2.2).

Two major themes were identified by participants (See Table 2): (1) pain motivates smoking and smoking helps manage pain-related distress, and (2) pain motivates smoking but smoking does not offer pain relief. Within theme 1, two sub-themes were identified: (1a) smoking is used as a coping strategy for emotional distress triggered by pain, (1b) smoking helps serve as a cognitive distraction from pain.

Although these themes were well represented by the data, a notable subset of veterans did not feel there was a connection between their smoking behavior and pain. These veterans reported no change in smoking behavior when confronted with pain: "Veteran does not believe that there is a connection between his pain and smoking, nor is he more likely to smoke when his pain is high."

### Theme 1: pain motivates smoking and smoking helps manage pain-related distress

Many participants in this category believed that pain triggered their smoking behavior, especially when they had a flare-up: "Veteran believes he smokes more when experiencing a pain flare-up. However, he does not think smoking actually relieves the pain, but rather serves as a 'crutch.'"

*Sub-theme 1a: smoking is used as a coping strategy for emotional distress related to pain*

The most common way participants thought about smoking was as a way to cope with chronic pain: “In the absence of other vices to cope, I smoke when I am in pain.” Many participants talked about how smoking eased their experience and helped them better handle their pain: “smoking makes the pain bearable and it calms me down.” Others recognized that this alleviation was more mental than physical: “I know it doesn’t help the pain, but it soothes me.” One participant was even more direct, pinpointing that smoking for her was not a way to relieve herself of pain but to improve her mood: “Veteran reports smoking more when her pain is high; stating ‘I know it doesn’t help the pain but I think to myself, this will make me feel better.’”

Many participants talked about how the calming effect of smoking was beneficial for tolerating pain: “He feels smoking has helped ‘calm me down’ which in turn has helped manage his pain.” Others felt that the functional impacts of pain led them to their increased smoking behavior: “When I am not mobile because of my pain, I smoke more. It relaxes me.” Others emulated this feeling of paradox and reasoned that the relaxation was not physical but psychological: “It’s gotta be psychological because I know it doesn’t make the pain better.”

Similarly, other participants conceptualized smoking as a way to deal with the stress and anxiety of pain: “She states living with pain causes stress and smoking relieves stress.” One participant elaborated on this connection: “He describes having a difficult time separating physical pain from emotional pain. He identifies being quite anxious which leads to feeling physically tense and subsequently experiencing physical pain.” In this way, one participant felt that smoking relieved both the “emotional stress he experiences in the context of pain [and] the anticipation of pain.” More specifically, many participants used smoking as a way to manage pain-related anxiety: “He finds himself smoking more when his pain is high and believes this is to manage his anxiety which is triggered by pain.” In these participants, pain and the apprehension of pain precipitated significant anxiety, and thus smoking was a self-medicating treatment to help alleviate the mental strain of living with chronic pain.

Consequently, concerns about coping with chronic pain without smoking was identified as a notable barrier to smoking cessation: “If I have to live in severe pain, I am not going to quit smoking.” Many participants were worried about losing their primary coping strategy: “My mind asks, what am I going to do if I don’t smoke?” He feels fear and anxiety are difficult triggers for him to manage.” Many veterans were concerned about being able to calm themselves down when their pain was high, and one compared quitting smoking to “losing an old friend.”

*Sub-theme 1b: smoking helps serve as a cognitive distraction from pain/taking a break from pain*

Participants also described smoking as a distraction from the pain: “He has noticed smoking more when his pain is higher and attributes the subsequent relief he experiences to ‘the distraction of smoking.’” When the feeling of pain takes over, some veterans expressed that smoking was a way to shift focus away from the pain: “He finds that he smokes more when he has a pain flare up. He describes smoking during those times as a ‘reprieve’ from focusing on the pain. He associates smoking with being deployed and how for 5–10 min, you were able to just focus on smoking and nothing else.” The idea of using smoking as a way to take a break extends into taking a pause from focusing on the pain: “He described noticing that he does smoke more when his pain is higher and that he immediately reaches for a cigarette when he needs to take a break due to his pain. During these times, he finds smoking is a distraction from his pain.” Many veterans described how smoking was a way to “take your mind off of the pain” and, even more generally, smoking was “a few minutes of not focusing on my life.” One veteran felt that smoking did decrease his pain level, but “it’s psychological, not physical. It’s a distraction.”

**Theme 2: pain motivates smoking but smoking does not offer pain relief**

Some smokers felt that although they smoked more when their pain was high, smoking had no direct influence on their pain. One participant reported “smoking more when her pain is high and that doing so does not offer her any tangible relief.” Another explained that he “does smoke more when his pain is high but believes it doesn’t help. ‘It’s just a habit.’” One veteran did not feel there was an association between his pain and smoking, yet found himself smoking more when he had higher pain: “He does find that he smokes when his pain is higher, however, he does not associate smoking being triggered or relieving pain.” One participant took this a step further and identified that smoking, in the long run, resulted in worsened pain: “He does identify smoking more when his pain is higher, though he believes doing so intensifies his pain.”

**Discussion**

Our study revealed that while not all veterans who smoke tobacco cigarettes and have chronic pain perceive a connection between smoking and pain, many recognize that smoking helps them manage their emotional response to pain. One group of patients noted their smoking mitigates the experience of pain and describes using smoking as a coping strategy for or distraction from pain-related distress. Thus, cop-

ing with pain was identified as a significant barrier to smoking cessation. Another group of patients noted that although they tended to smoke more when their pain was higher, smoking did not offer pain relief, and some veterans did not perceive a relationship between smoking and pain at all. Although evidence suggests a bi-directional association in which smoking leads to increased pain and increased pain leads to more smoking [20, 22], few studies have examined this relationship from the patient's perspective, which reveals top areas to target when designing smoking cessation interventions.

Most patients in our study reported that more pain led to more smoking, which aligns with the results of several experimental studies [8, 11, 12]. In a study of 36 smokers, Dhingra et al. found that patients experienced the most pain when they were about to smoke, indicating that pain may trigger smoking behavior [29]; however, pain levels before and after smoking were the same, [29], which supports the opinion of some veterans in our study that smoking does not actually decrease pain itself. Similarly, Jamison et al. found that most patients with back pain reported a need to smoke when they were in pain, but over 90% believed that smoking had no effect on their pain intensity [30].

In our study, some patients characterized this behavioral response by perceiving smoking as a coping strategy for or cognitive distraction from pain, thus therapeutic opportunities can focus on coping strategies and replacement behavior for smoking. In the study by Hooten et al., the authors found that treatment-seeking pain patients reported that they smoke in response to pain, use tobacco to cope with pain, and endorse pain as a barrier to quitting smoking [23]. Similarly, in a qualitative study of 48 patients with fibromyalgia, Weingarten et al. found that smoking had no direct impact on pain but improved anxiety and irritability associated with pain [31]. Tobacco smoking has been hypothesized to help people cope with stress by relieving negative affect, [32–34] and some qualitative studies revealed that in military culture, tobacco smoking is viewed as a form of stress relief [35–37]. The idea of smoking as “taking a break” is common as well [38], especially for military members undergoing rigorous training in the service [35–37, 39]; however, research shows that, in reality, tobacco users tend to report having more stress than non-smokers and that smoking largely relieves the stress of nicotine addiction [40, 41]. Coaching people who smoke about adaptive coping strategies to promote both smoking cessation and pain self-management can improve pain-related anxiety and lead to increased confidence in ability to quit [42].

The link between smoking and pain has been analyzed quantitatively by Ditre et al., who surveyed 75 smokers to assess interrelations between pain and smoking [43]. They developed a 9-item tool called the Pain and Smoking Inventory (PSI) based on three do-

main (pain as a motivator of smoking, the use of tobacco to cope with pain, and pain as barrier to smoking cessation) to assess how smokers perceive their pain and smoking behavior to be interrelated. This was validated in a population of people with human immunodeficiency virus (HIV), and PSI scores were higher in smokers who had pain than those with no pain [44]. Furthermore, higher PSI scores were associated with greater pain and pain interference [44]. Understanding how each patient perceives this link is important to predict cessation outcomes, as Endrighi et al. found that in patients with mobility impairments, the PSI domain of smoking to cope with pain was associated with lower odds of abstinence from smoking [45].

Our study found that pain was a barrier to smoking cessation for many veterans, and mechanisms in place that may make it harder for patients with pain to quit smoking. In a study of 132 smokers with pain, Zale et al. found that smokers who endorsed pain in the last month had more difficulty quitting and had lower confidence in their ability to remain abstinent [46]. In a study of 151 chronic pain patients, Patterson et al. found that smokers who used smoking as a coping strategy for pain experienced greater pain intensity, interference, and fear of pain than those who did not [47]. Increased pain sensitivity, as measured by the cold pressor test, has also been shown to predict greater risk of relapse after smoking cessation [48]. Furthermore, Ditre et al. demonstrated that after abstaining from smoking for 12–24 h, smokers have increased capsaicin-induced pain intensity, suggesting that smokers may feel increased pain in the early smoking cessation phase, which can impair cessation attempts [49].

Our study showed that some veterans did not recognize a connection between pain and their smoking behavior, revealing a prime target for smoking cessation interventions. This lack of connection may be due to a lack of smoking education and counseling during clinical visits [50–52]. This theme is echoed in a qualitative analysis of smoking cessation in people with rheumatoid arthritis, in which participants revealed the paucity of information they had received about the connection between smoking and their disease [53]. Therapies that help patients understand this link can help motivate them to initiate smoking cessation and maintain abstinence. In a trial of 99 patients with chronic pain who smoke, Hooten et al. found that those who received a brief pain and smoking intervention that taught patients about the discrepancy between continued smoking and desired pain outcomes were more likely to endorse a willingness to quit smoking [54]. Similarly, in a trial of 71 participants, Zale et al. found that a brief motivational intervention aimed at increasing knowledge of the pain-smoking relationship in smokers with pain increased engagement in cessation treatment at 1-month follow-up [55]. These targeted treatments may lessen

the extent to which pain serves as a barrier to smoking cessation, thus improving patient willingness to quit.

This study was a part of the Pain and Smoking study, a trial that examines whether cognitive behavioral interventions can improve cessation rates. As noted by Ditre et al., individuals who smoke to cope with pain may need treatments focused on adaptive approaches to pain management prior to engaging a cessation attempt [55]. Cognitive behavioral techniques have been shown as effective ways to help patients manage pain [56, 57] and these findings highlight the importance of developing interventions for smokers with pain that address other mechanisms for coping. This trial promotes cognitive behavioral pain management techniques that are tailored to also promote smoking cessation in the context of pain (e.g., physical activity, progressive muscle relaxation, and pleasant activity scheduling), [58] based on standard approaches rooted in behavioral treatment principles, social cognitive theory [59], motivational interviewing [60] and the VA's existing pain self-management program [40]. Recognizing patients' motivations to continue their smoking behavior allows clinicians to create and adapt better treatment programs that can help patients stop smoking while improving their pain management.

Future studies should look at how mental health conditions, such as depression and posttraumatic stress disorder, [61, 62] also factor into the relationship between pain and smoking. Smokers may experience worse depression than nonsmokers [63–65] and those with comorbid mental illnesses may have complicated reasons for smoking [66, 67]. Previous studies have suggested that people who smoke need higher doses of opioids and are more likely to abuse opioids, [68–70] and are more likely to require higher doses of certain pain medications such as duloxetine [71, 72]. Future studies should also analyze how patients perceive their overall pain management strategies relate to smoking.

Our study has several important limitations. First, we recruited patients with chronic pain who smoke, were interested in quitting within the next 30 days, and willing to participate in a smoking cessation intervention. These patients may not generalize to all patients who smoke and have chronic pain. Second, this study relied on retrospective analysis of semi-structured session notes and thus data were not collected specifically for this purpose. We could only address themes that naturally came up in the session. A future prospective qualitative study may be able to delve deeper into some of these concepts. Third, only two VA facilities were used in this study, and results may not represent veterans who received care at other facilities. Our study nevertheless provides important insights with regard to patients' experiences with the link between smoking and pain and helps researchers and clinicians understand the need for substituting

another coping mechanism for smoking to help patients cope with pain.

## Conclusion

Most patients with chronic pain who smoke readily identified pain as a motivator of their smoking behavior and are reluctant to quit for this reason. Integrated interventions for smokers with pain should address these perceptions and expectancies and promote uptake of more adaptive self-management strategies for pain.

**Acknowledgements** This publication was made possible by the Yale School of Medicine Fellowship for Medical Student Research.

**Funding** This material is based upon work supported by the Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, and Health Services Research and Development # IIR 15-092, and CIN 13-407.

**Author Contribution** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Megan Lee, Jennifer Snow, Caroline Quon, Kim Selander, Eric DeRycke, Mark Lawless, Mary Driscoll, Joseph W. Ditre, Kristin M. Mattocks, William C. Becker, and Lori A. Bastian. The first draft of the manuscript was written by Megan Lee, Mary Driscoll, Joseph W. Ditre, Kristin M. Mattocks, William C. Becker, and Lori Bastian, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

## Declarations

**Conflict of interest** M. Lee, J. Snow, C. Quon, K. Selander, E. DeRycke, M. Lawless, M. Driscoll, J.W. Ditre, K.M. Mattocks, W.C. Becker and L.A. Bastian declare that they have no competing interests.

**Ethical standards** All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional and/or national research committee and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

## References

1. De Vita MJ, Maisto SA, Ansell EB, Zale EL, Ditre JW. Pack-years of tobacco cigarette smoking as a predictor of spontaneous pain reporting and experimental pain reactivity. *Exp Clin Psychopharmacol.* 2019;27(6):552–60.
2. Pisinger C, Aadahl M, Toft U, Birke H, Zytphen-Adeler J, Jørgensen T. The association between active and passive smoking and frequent pain in a general population. *Eur J Pain.* 2011;15(1):77–83.
3. Volkman JE, DeRycke EC, Driscoll MA, Becker WC, Brandt CA, Mattocks KM, et al. Smoking status and pain intensity among OEF/OIF/OND veterans. *Pain Med.* 2015;16(9):1690–6.

4. Weingarten TN, Podduturu VR, Hooten WM, Thompson JM, Luedtke CA, Oh TH. Impact of tobacco use in patients presenting to a multidisciplinary outpatient treatment program for fibromyalgia. *Clin J Pain*. 2009;25(1):39–43.
5. Bastian LA, Gray KE, DeRycke E, Mirza S, Gierisch JM, Haskell SG, et al. Differences in active and passive smoking exposures and lung cancer incidence between veterans and non-veterans in the Women's Health Initiative. *Gerontologist*. 2016;56(Suppl 1):S102–S11.
6. Weingarten TN, Moeschler SM, Ptaszynski AE, Hooten WM, Beebe TJ, Warner DO. An assessment of the association between smoking status, pain intensity, and functional interference in patients with chronic pain. *Pain Physician*. 2008;11(5):643–53.
7. LaRowe LR, Ditre JW. Pain, nicotine, and tobacco smoking: current state of the science. *Pain*. 2020;161(8):1688–93.
8. Ditre JW, Brandon TH. Pain as a motivator of smoking: effects of pain induction on smoking urge and behavior. *J Abnorm Psychol*. 2008;117(2):467–72.
9. Ditre JW, Brandon TH, Zale EL, Meagher MM. Pain, nicotine, and smoking: research findings and mechanistic considerations. *Psychol Bull*. 2011;137(6):1065–93.
10. Bakhshajie J, Ditre JW, Langdon KJ, Asmundson GJ, Paulus DJ, Zvolensky MJ. Pain intensity and smoking behavior among treatment seeking smokers. *Psychiatry Res*. 2016;237:67–71.
11. Ditre JW, Heckman BW, Butts EA, Brandon TH. Effects of expectancies and coping on pain-induced motivation to smoke. *J Abnorm Psychol*. 2010;119(3):524–33.
12. Parkerson HA, Asmundson GJG. The role of pain intensity and smoking expectancies on smoking urge and behavior following experimental pain induction. *Drug Alcohol Depend*. 2016;164:166–71.
13. Powers JM, LaRowe LR, Heckman BW, Ditre JW. Pain characteristics and nicotine deprivation as predictors of performance during a laboratory paradigm of smoking cessation. *Psychol Addict Behav*. 2020;34(2):341–50.
14. McCracken LM, Zayfert C, Gross RT. The pain anxiety symptoms scale: development and validation of a scale to measure fear of pain. *Pain*. 1992;50(1):67–73.
15. Ditre JW, LaRowe LR, Vanable PA, De Vita MJ, Zvolensky MJ. Computer-based personalized feedback intervention for cigarette smoking and prescription analgesic misuse among persons living with HIV (PLWH). *Behav Res Ther*. 2019;115:83–9.
16. Ocañez KL, McHugh RK, Otto MW. A meta-analytic review of the association between anxiety sensitivity and pain. *Depress Anxiety*. 2010;27(8):760–7.
17. Ditre JW, Zale EL, Kosiba JD, Zvolensky MJ. A pilot study of pain-related anxiety and smoking-dependence motives among persons with chronic pain. *Exp Clin Psychopharmacol*. 2013;21(6):443–9.
18. LaRowe LR, Langdon KJ, Zvolensky MJ, Zale EL, Ditre JW. Pain-related anxiety as a predictor of early lapse and relapse to cigarette smoking. *Exp Clin Psychopharmacol*. 2017;25(4):255–64.
19. LaRowe LR, Zvolensky MJ, Ditre JW. The role of anxiety-relevant transdiagnostic factors in comorbid chronic pain and tobacco cigarette smoking. *Cogn Ther Res*. 2019;43(1):102–13.
20. Ditre JW, Zale EL, LaRowe LR. A reciprocal model of pain and substance use: transdiagnostic considerations, clinical implications, and future directions. *Annu Rev Clin Psychol*. 2019;15:503–28.
21. Hooten WM, Townsend CO, Bruce BK, Warner DO. The effects of smoking status on opioid tapering among patients with chronic pain. *Anesth Analg*. 2009;108(1):308–15.
22. Ditre JW, Heckman BW, Zale EL, Kosiba JD, Maisto SA. Acute analgesic effects of nicotine and tobacco in humans: a meta-analysis. *Pain*. 2016;157(7):1373–81.
23. Hooten WM, Vickers KS, Shi Y, Ebnet KL, Townsend CO, Patten CA, et al. Smoking cessation and chronic pain: patient and pain medicine physician attitudes. *Pain Pract*. 2011;11(6):552–63.
24. Aimer P, Stamp L, Stebbings S, Valentino N, Cameron V, Treharne GJ. Identifying barriers to smoking cessation in rheumatoid arthritis. *Arthritis Care Res (Hoboken)*. 2015;67(5):607–15.
25. Stewart MO, Karlin BE, Murphy JL, Raffa SD, Miller SA, McKellar J, et al. National dissemination of cognitive-behavioral therapy for chronic pain in veterans: therapist and patient-level outcomes. *Clin J Pain*. 2015;31(8):722–9.
26. Lauridsen HH, Hartvigsen J, Manniche C, Korsholm L, Grunnet-Nilsson N. Responsiveness and minimal clinically important difference for pain and disability instruments in low back pain patients. *BMC Musculoskelet Disord*. 2006;7:82.
27. Tan G, Jensen MP, Thornby JI, Shanti BF. Validation of the Brief Pain Inventory for chronic nonmalignant pain. *J Pain*. 2004;5(2):133–7.
28. Morse JM. Critical analysis of strategies for determining rigor in qualitative inquiry. *Qual Health Res*. 2015;25(9):1212–22.
29. Dhingra LK, Homel P, Grossman B, Chen J, Scharaga E, Calamita S, et al. Ecological momentary assessment of smoking behavior in persistent pain patients. *Clin J Pain*. 2014;30(3):205–13.
30. Jamison RN, Stetson BA, Parris WC. The relationship between cigarette smoking and chronic low back pain. *Addict Behav*. 1991;16(3–4):103–10.
31. Weingarten TN, Vincent A, Luedtke CA, Beebe TJ, Welch TL, Chong EY, et al. The perception of female smokers with fibromyalgia on the effects of smoking on fibromyalgia symptoms. *Pain Pract*. 2016;16(8):1054–63.
32. Kassel JD, Stroud LR, Paronis CA. Smoking, stress, and negative affect: correlation, causation, and context across stages of smoking. *Psychol Bull*. 2003;129(2):270–304.
33. Kosiba JD, Zale EL, Ditre JW. Associations between pain intensity and urge to smoke: testing the role of negative affect and pain catastrophizing. *Drug Alcohol Depend*. 2018;187:100–8.
34. Li HC, Chan SS, Lam TH. Smoking among Hong Kong Chinese women: behavior, attitudes and experience. *BMC Public Health*. 2015;15:183.
35. Smith EA, Malone RE. Mediatory myths in the U.S. military: tobacco use as “stress relief”. *Am J Health Promot*. 2014;29(2):115–22.
36. Haddock CK, Taylor JE, Hoffman KM, Poston WS, Peterson A, Lando HA, et al. Factors which influence tobacco use among junior enlisted personnel in the United States Army and Air Force: a formative research study. *Am J Health Promot*. 2009;23(4):241–6.
37. Gierisch JM, Straits-Tröster K, Calhoun PS, Beckham JC, Acheson S, Hamlett-Berry K. Tobacco use among Iraq- and Afghanistan-era veterans: a qualitative study of barriers, facilitators, and treatment preferences. *Prev Chronic Dis*. 2012;9:E58.
38. Delaney H, MacGregor A, Amos A. “Tell them you smoke, you'll get more breaks”: a qualitative study of occupational and social contexts of young adult smoking in Scotland. *BMJ Open*. 2018;8(12):e23951.
39. Singaraju RC, Myers JN, Owczarzak JT, Gielen AC. Combat readiness, harm aversion, and promotion eligibility: a qualitative study of U.S. servicemembers views

- on tobacco use and control in the military. *Mil Med.* 2019;184(3–4):e175–e82.
40. Stein RJ, Pyle SA, Haddock CK, Poston WS, Bray R, Williams J. Reported stress and its relationship to tobacco use among U.S. military personnel. *Mil Med.* 2008;173(3):271–7.
  41. Nesbitt PD. Smoking, physiological arousal, and emotional response. *J Pers Soc Psychol.* 1973;25(1):137–44.
  42. LaRowe LR, Rother Y, Powers JM, Zvolensky MJ, Venable PA, Ditte JW. Pain self-efficacy, race, and motivation to quit smoking among persons living with HIV (PLWH). *Addict Behav.* 2020;105:106318.
  43. Ditte JW, Zale EL, Heckman BW, Hendricks PS. A measure of perceived pain and tobacco smoking interrelations: pilot validation of the pain and smoking inventory. *Cogn Behav Ther.* 2017;46(4):339–51.
  44. Weinberger AH, Seng EK, Ditte JW, Willoughby M, Shuter J. Perceived interrelations of pain and cigarette smoking in a sample of adult smokers living with HIV/AIDS. *Nicotine Tob Res.* 2019;21(4):489–96.
  45. Endrighi R, Ruelas N, Dunsiger S, Borrelli B. Perceived pain and smoking interrelations and expectancies are associated with pain and smoking cessation in individuals with mobility impairments. *Nicotine Tob Res.* 2021;23(1):179–85.
  46. Zale EL, Ditte JW, Dorfman ML, Heckman BW, Brandon TH. Smokers in pain report lower confidence and greater difficulty quitting. *Nicotine Tob Res.* 2014;16(9):1272–6.
  47. Patterson AL, Gritzner S, Resnick MP, Dobscha SK, Turk DC, Morasco BJ. Smoking cigarettes as a coping strategy for chronic pain is associated with greater pain intensity and poorer pain-related function. *J Pain.* 2012;13(3):285–92.
  48. Nakajima M, al'Absi M. Enhanced pain perception prior to smoking cessation is associated with early relapse. *Biol Psychol.* 2011;88(1):141–6.
  49. Ditte JW, Zale EL, LaRowe LR, Kosiba JD, De Vita MJ. Nicotine deprivation increases pain intensity, neurogenic inflammation, and mechanical hyperalgesia among daily tobacco smokers. *J Abnorm Psychol.* 2018;127(6):578–89.
  50. Luxton NA, MacKenzie R, Shih P. Smoking cessation care in cardiothoracic surgery: a qualitative study exploring the views of Australian clinicians. *Heart Lung Circ.* 2019;28(8):1246–52.
  51. Holtrop JS, Malouin R, Weismantel D, Wadland WC. Clinician perceptions of factors influencing referrals to a smoking cessation program. *BMC Fam Pract.* 2008;9:18.
  52. Nelson KE, Hersh AL, Nkoy FL, Maselli JH, Srivastava R, Cabana MD. Primary care physician smoking screening and counseling for patients with chronic disease. *Prev Med.* 2015;71:77–82.
  53. Roelsgaard IK, Thomsen T, Østergaard M, Semb AG, Andersen L, Esbensen BA. How do people with rheumatoid arthritis experience participation in a smoking cessation trial: a qualitative study. *Int J Qual Stud Health Well-being.* 2020;15(1):1725997.
  54. Hooten WM, LaRowe LR, Zale EL, Ditte JW, Warner DO. Effects of a brief pain and smoking cessation intervention in adults with chronic pain: a randomized controlled trial. *Addict Behav.* 2019;92:173–9.
  55. Zale EL, Maisto SA, De Vita MJ, Hooten WM, Ditte JW. Increasing cessation motivation and treatment engagement among smokers in pain: a pilot randomized controlled trial. *Exp Clin Psychopharmacol.* 2020; <https://doi.org/10.1037/pha0000424>.
  56. Morley S, Eccleston C, Williams A. Systematic review and meta-analysis of randomized controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache. *Pain.* 1999;80(1–2):1–13.
  57. Williams AC, Eccleston C, Morley S. Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database Syst Rev.* 2012;11:CD7407.
  58. Murphy JL, Raffa SD, Clark ME, Kerns RD, Karlin BE. Cognitive behavioral therapy for chronic pain among veterans. Therapist manual. Washington, DC: U.S. Department of Veterans Affairs; 2014.
  59. Bandura A. Social foundations of thought and action: a social cognitive theory. Hoboken: Prentice-Hall; 1986. p. xiii, 617.
  60. Bennett G. Miller, W. R. and Rollnick, S. (1991) Motivational interviewing: Preparing people to change addictive behavior. New York: Guilford Press, 1991. Pp. xvii + 348. £24.95 hardback, £11.50 paper. ISBN 0-89862-566-1. *J Community Appl Soc Psychol.* 1992;2(4):299–300.
  61. Harder LH, Chen S, Baker DG, Chow B, McFall M, Saxon A, et al. The influence of posttraumatic stress disorder numbing and hyperarousal symptom clusters in the prediction of physical health status in veterans with chronic tobacco dependence and posttraumatic stress disorder. *J Nerv Ment Dis.* 2011;199(12):940–5.
  62. Zale EL, Maisto SA, Ditte JW. Anxiety and depression in bidirectional relations between pain and smoking: implications for smoking cessation. *Behav Modif.* 2016;40(1–2):7–28.
  63. Klungsoyr O, Nygård JF, Sørensen T, Sandanger I. Cigarette smoking and incidence of first depressive episode: an 11-year, population-based follow-up study. *Am J Epidemiol.* 2006;163(5):421–32.
  64. Pasco JA, Williams LJ, Jacka FN, Ng F, Henry MJ, Nicholson GC, et al. Tobacco smoking as a risk factor for major depressive disorder: population-based study. *Br J Psychiatry.* 2008;193(4):322–6.
  65. Murphy JM, Horton NJ, Monson RR, Laird NM, Sobol AM, Leighton AH. Cigarette smoking in relation to depression: historical trends from the Stirling County Study. *Am J Psychiatry.* 2003;160(9):1663–9.
  66. Keller-Hamilton B, Moe AM, Breitborde NJK, Lee A, Ferketich AK. Reasons for smoking and barriers to cessation among adults with serious mental illness: a qualitative study. *J Community Psychol.* 2019;47(6):1462–75.
  67. Mak YW, Loke AY, Chiang VCL. Co-occurrence of schizophrenia and smoking: a qualitative study. *Hong Kong Med J.* 2019;25(Suppl 2):21–7.
  68. Shen L, Wei K, Chen Q, Qiu H, Tao Y, Yao Q, et al. Decreased pain tolerance before surgery and increased postoperative narcotic requirements in abstinent tobacco smokers. *Addict Behav.* 2018;78:9–14.
  69. Hooten WM, Shi Y, Gazelka HM, Warner DO. The effects of depression and smoking on pain severity and opioid use in patients with chronic pain. *Pain.* 2011;152(1):223–9.
  70. Zale EL, Dorfman ML, Hooten WM, Warner DO, Zvolensky MJ, Ditte JW. Tobacco smoking, nicotine dependence, and patterns of prescription opioid misuse: results from a nationally representative sample. *Nicotine Tob Res.* 2015;17(9):1096–103.
  71. Oliveira P, Ribeiro J, Donato H, Madeira N. Smoking and antidepressants pharmacokinetics: a systematic review. *Ann Gen Psychiatry.* 2017;16(1):17.
  72. Fric M, Pfuhlmann B, Laux G, Riederer P, Distler G, Artmann S, et al. The influence of smoking on the serum level of duloxetine. *Pharmacopsychiatry.* 2008;41(4):151–5.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.