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Female Smokers Show Lower Pain Tolerance in a Physical Distress Task

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Abstract

Numerous studies have established a link between distress tolerance and smoking cessation outcomes. The present study examined whether smoking status affected physical distress tolerance, and considered this question separately for men and women. The sample was comprised of healthy adults, 56 smokers (63% male) and 58 nonsmokers (62% female). The pain stimulus was a cold pressor task. Outcome variables were seconds immersed in cold water when pain was first reported (threshold), and total seconds immersed in cold water (tolerance). Participants verbally reported their pain rating on a 0-100 scale after the task, and then completed the McGill Pain Questionnaire-Short Form. Smokers displayed lower pain tolerance than nonsmokers ($p = .045$), and women displayed lower pain tolerance than men ($p = .017$). Female smokers had significantly lower pain tolerance than other groups ($p = .001$). There were no significant differences in pain threshold or pain perception by smoking status or gender ($p > .05$). Lower physical distress tolerance could place female smokers at risk for difficulty in quitting smoking. This population needs additional research to better understand their unique pain experience and how physical distress tolerance impacts their smoking cessation outcomes.

Keywords

distress tolerance; cold pressor; smoking; tobacco use; pain; gender

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Conflict of Interest

All authors declare that they have no conflicts of interest.

Contributors

Kim Pulvers designed the study, wrote the protocol, trained research staff, supervised data collection, wrote the introduction, statistical analysis, and discussion, analyzed data and wrote the results.

Anna Hood collected data, conducted literature searches and contributed to the introduction and discussion, wrote the methods, analyzed data, and contributed to the results.

Eleuterio Limas conducted literature searches and contributed to the introduction, results, and discussion.

Marie Thomas provided statistical analysis consultation and input on the writing of the paper.

All authors contributed to and have approved the final manuscript.

1. Introduction

Persistence with stressful tasks of a physical (Hajek, Belcher, & Stapleton, 1987) or psychological (Brandon et al., 2003) nature reflects an adaptive ability to tolerate distress. Distress tolerance (DT) is associated with more successful smoking cessation (Rodman, Daughters, & Lejuez, 2009) and other positive markers for substance abuse recovery such as staying in treatment. (Daughters et al., 2005; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). Despite the importance of understanding the relationship between DT and addictive behaviors, few recent studies have examined differences in DT between smokers and nonsmokers.

Pain tolerance is a marker of the broader construct, distress tolerance. Investigating performance on physically painful tasks is important given that pain is a trigger for smoking (Ditre & Brandon, 2008). The goal of the present study was not to disentangle previous mixed findings regarding the relationship between smoking and pain (Ditre, Brandon, Zale, & Meagher, 2011), but to evaluate differences in norms in DT on a physically stressful task between smokers and nonsmokers. Smokers were tested on an ad-libitum smoking day to capture their responses on a “typical” day. This is a departure from previous work which has manipulated nicotine exposure, with many studies finding greater pain threshold and tolerance for smokers receiving nicotine than nonsmokers, or smokers deprived of nicotine (Ditre et al, 2011).

1.1 Study Purpose

Using a cognitive theory of addiction framework (Beck, Wright, Newman, & Liese, 1993), we hypothesized that smokers would show lower pain tolerance than nonsmokers. Given the chronic effects of smoking on pain among women (Girdler et al., 2005; Woodsie, 2000), and that previous work has found gender differences in physical DT (Brown et al., 2008; Daughters, 2005; Hajek et al., 1987), it was hypothesized that women would show lower pain tolerance than men. The pattern of differences between smokers and nonsmokers was expected to be similar for men and women; thus no interaction of smoking status and gender was anticipated. However, extending the logic, female smokers were expected to show the lowest tolerance of all groups. Although not a primary research question, the present study also examined differences in pain threshold and pain perception between smokers and nonsmokers, and directional hypotheses were not made.

2. Method

2.1 Participants

An initial telephone screening of 274 participants deemed 96 participants medically ineligible and 32 participants ineligible because of their current smoking status (any smoking level was acceptable, so long as it had been consistent for one year). Participants reporting any conditions they perceived as health issues, in addition to presence of specific contra-indications for the cold pressor task such as circulatory problems and hand injury, were medically ineligible. A further 32 participants were eligible but did not appear for their scheduled appointment. Eligible participants who completed the entire study ($n=114$, 50% males) were aged 18 – 73 years old ($M=34.0$, $SD=14.0$). The smokers ($n=56$) reported smoking an average of 10.94 ($SD=6.08$) cigarettes a day for an average of 9 years ($SD=9.68$ years). Nonsmokers ($n=58$) were defined as having not smoked for at least one year prior to the study. Participants predominantly identified themselves as Caucasian (65%) and the majority (72%) had an annual household income of less than \$34,000. There were no significant demographic differences between smokers and nonsmokers.

2.2 Measures

2.2.1 Cold Pressor Apparatus—The pain stimulus, a refrigerating bath (JeioTech Inc) continually circulated 0°Celsius water. Participants submerged their non-dominant hand up to the wrist for as long as tolerable, with an uninformed maximum duration of five minutes.

2.2.2 Tolerance and Pain Measures—*Pain threshold* was the amount of time elapsed until participants first felt “pain.” *Pain tolerance* was the total amount of time participants kept their hand in the water. Both variables were measured with a stopwatch, with timing beginning at hand immersion to the wrist. After the task, participants verbally indicated the *pain* of the task (0 – 100 pain index, with zero indicating no pain, and 100 the worst pain imaginable).

2.2.3 McGill Pain Questionnaire Short Form (MPQ-SF)—The MPQ-SF is a pain rating scale that consists of 15-descriptor items, items 1-11 relate to sensory pain dimensions (e.g. shooting), and items 12-15 relate to affective pain dimensions (e.g. fearful) (Melzack 1987). Participants rated items 1-16 on a 4-point scale, ranging from zero (no pain) to four (severe). Total scores can range from 0 to 60, with higher scores representing higher pain levels. The MPQ-SF had a Cronbach’s alpha of .87 in the present study.

2.3 Procedure

Participants were recruited through media advertisements and flyers seeking smokers and nonsmokers. Eligible participants did not abstain from eating or drinking, and smokers had no tobacco restrictions prior to the experiment. Participants affiliated with the university ($n = 9$) received compensation of \$10; all other participants ($n = 105$) received \$25. The Institutional Review Board at California State University San Marcos approved the research, and written informed consent was used.

2.4 Statistical Analyses

Box plots were used to examine dispersion (Howell, 2010). Given that the pain threshold and tolerance variables were positively skewed, log 10 transformations were performed to improve normality. Untransformed means and standard deviations are reported to improve interpretability of the results. We conducted separate two-way ANOVA’s with smoking status and gender as fixed factors and pain threshold, pain tolerance, and pain perception as outcome variables. A single, a-priori planned comparison was performed between female smokers and all other groups (female nonsmokers, male smokers, and male nonsmokers) on pain tolerance to test the hypothesis that female smokers would display the lowest physical distress tolerance.

3. Results

Visual inspection of the untransformed data showed large differences in the ranges for pain tolerance variables, with smokers showing less dispersion compared to nonsmokers, and women showing less dispersion than men (see Figure 1). Dispersion was comparable for pain threshold and pain perception.

The two-way ANOVA showed that smokers displayed significantly lower pain tolerance than nonsmokers ($F_{1,110} = 4.11, p=.045, \eta_p^2=.036$) and that women displayed significantly lower pain tolerance than men ($F_{1,110} = 5.87, p=.017, \eta_p^2=.051$; see Table 1). This pattern of differences between smokers and nonsmokers was similar for men and women, evidenced by a non-significant interaction ($F_{1,110} = .934, p=.336, \eta_p^2=.008$). As hypothesized, female smokers had significantly lower pain tolerance than all other groups combined ($t_{41} = -3.57, p=.001$) (see Table 1). There were no significant main effects or interactions for pain

threshold or pain perception measured by the verbal 0-100 scale or the multi-dimensional MPQ-SF *ns*, $p > .05$, although the difference between men and women on the verbal pain ($F_{1, 110} = 3.90$, $p = .051$, $\eta_p^2 = .034$) and MPQ-SF ($F_{1, 104} = 3.54$, $p = .063$, $\eta_p^2 = .033$) measures approached significance.

4. Discussion

The present study found that smokers had lower pain tolerance than nonsmokers. This extends previous research showing smokers' lower persistence with psychological stress (Quinn, et al., 1996) to tolerance of physical stress. Considerable variability of smokers versus nonsmokers' pain tolerance scores was observed. Nonsmokers pain tolerance times varied from zero to the maximum 300 seconds, whereas almost all of the smokers' times did not exceed 100 seconds. Most past research does not present variance, or do not compare smokers and nonsmokers, so it is difficult to know if this data is consistent with prior research. Although this variability data is descriptive, it does provide support for the hypothesis that smokers and nonsmokers differ in their physical distress tolerance.

The study also found that women displayed lower pain tolerance than men, which is consistent with previous research. The finding that women and men showed comparable pain threshold yet different pain tolerance is also consistent with previous research distinguishing pain threshold and pain tolerance as independent constructs (Campbell, Edwards, & Fillingim, 2005). Furthermore, female smokers displayed lower pain tolerance than other groups, with comparable self-reported pain threshold and pain perception. This suggests that female smokers are less willing or able to tolerate a similar level of physical distress (e.g., pain threshold and pain perception). This has implications for smoking cessation, given that physical withdrawal symptoms may occur, especially early in a quit attempt. Moreover, to the extent that smoking provides relief from pain, female smokers with pain conditions may need additional support during cessation.

Understanding the way that female smokers experience physical distress is important given that they appear to have more difficulty quitting smoking than men. Previous research demonstrated that women were less likely to quit smoking successfully compared to men. (Torchalla, Hemsing, & Greaves, 2011). For example, a meta-analysis of nicotine patch trials showed that only about half as many women showed an increase in quitting as men (Perkins & Scott, 2008). Moreover, women suffer more from severe symptoms of negative mood even after overnight abstinence (Xu et al., 2008). According to a recent meta-analysis, researchers found that men maintained short and long-term smoking abstinences significantly longer than women in nicotine replacement therapy aided smoking cessation programs (Cepeda-Benito, Reynoso, & Erath, 2004).

The present study yields insight into a possible mechanism for women's difficulty quitting smoking. In as much as tolerance of physical stress maps to persistence and discomfort associated with smoking cessation, it is evident that female smokers are disadvantaged compared to male smokers. Indeed, smokers in general are disadvantaged compared to nonsmokers. Although the directionality of the link between lower physical stress tolerance and smoking status is unknown, there is evidence that increasing distress tolerance improves cessation rates (Brown et al., 2008). Drawing from the cognitive theory of substance abuse (Beck et al., 1993), individuals may use smoking as a coping device for distress tolerance deficits. With improvements in distress tolerance, there could be a reduction in the need for smoking. Findings from the present study suggest that this is especially important for female smokers. Future research testing distress tolerance interventions (Brown et al., 2008) to improve smoking cessation outcomes is recommended, especially for female smokers and other at-risk groups.

Notably, the present study did not assess time since last cigarette, which did not allow controlling for potential analgesic effects of acute smoking. In addition, future research should use objective physiological measures of stress such as collecting cortisol and measuring skin conductance levels to supplement subjective pain ratings, especially among those for whom English is a second language. Finally, the present findings can be expanded in future research by studying “never smokers” rather than non-smokers defined as no smoking in the past year, as well as testing heavier smokers.

5. Conclusion

Overall female smokers showed lower pain tolerance than others, at a comparable pain level. Given these findings, further research should clarify biological and psychosocial factors impacting female smokers experience with physical distress. Results of these studies could lead to tailored interventions for female smokers in order to improve their cessation outcomes, particularly those that provide support early in a quit attempt when physical distress is especially likely to occur.

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Highlights

- Female smokers showed lower pain tolerance than male smokers, male nonsmokers, and female nonsmokers
- Pain threshold and perception were similar across all group comparisons
- Female smokers' lower physical distress tolerance may factor into women's difficulty quitting smoking

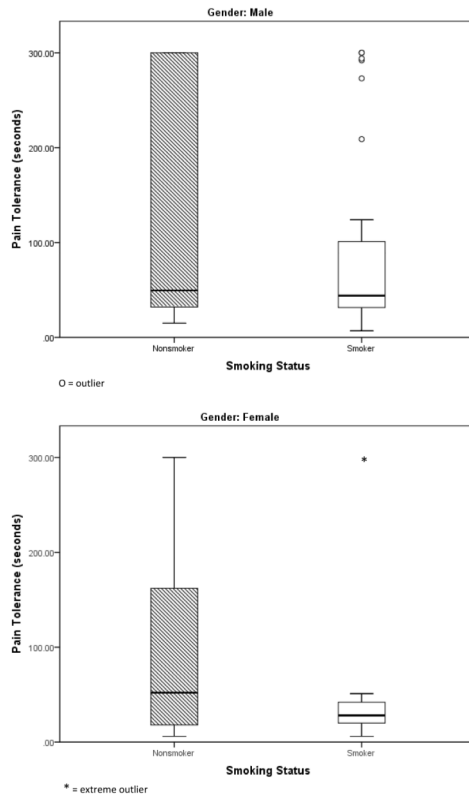


Figure 1. Variability between Smokers and Nonsmokers on Pain Tolerance, by Gender

Table 1

Responses in the Cold Pressor Task.

Condition	Cold Pressor Pain (seconds)						Pain Rating (0-100)		MPQ-SF (Total Score)			
	Tolerance		Threshold		M		SD		M		SD	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Smokers	70.71 (84.61) ^a		19.41 (23.59)		54.64 (26.00)		17.07 (9.57)					
Nonsmokers	102.36 (106.56) ^a		22.11 (27.22)		61.86 (24.17)		14.96 (8.35)					
Women	75.46 (90.47) ^b		19.18 (25.03)		63.63 (23.11)		17.25 (9.13)					
Men	98.18 (103.19) ^b		22.40 (25.89)		53.00 (26.34)		14.74 (8.77)					
Female Smokers	42.24 (60.27) [*]		12.67 (7.68)		62.33 (26.07)		19.51 (10.39)					
Female Nonsmokers	94.83 (99.87) ⁺		23.09 (30.61)		64.39 (21.56)		15.97 (8.21)					
Male Smokers	87.80 (92.96) ⁺		23.58 (28.78)		50.03 (25.21)		15.65 (8.91)					
Male Nonsmokers	114.68 (118.07) ⁺		20.40 (20.62)		57.73 (27.98)		13.11 (8.51)					

shared letter subscripts indicate significant differences, $p < .05$ ^{*} (female smokers) vs. + (all other groups combined), $p < .01$