HHS Public Access

Author manuscript

Exp Clin Psychopharmacol. Author manuscript; available in PMC 2018 August 01.

Published in final edited form as:

Exp Clin Psychopharmacol. 2017 August ; 25(4): 235–241. doi:10.1037/pha0000132.

Premenstrual symptoms and factors implicated in smoking cessation among woman smokers

Raina D. Pang, Ph.D.[a], **Nafeesa Andrabi, B.A.**[a], and **Adam M. Leventhal, Ph.D.**[a,b]

University of Southern California

Abstract

Premenstrual symptoms (PMS) may reduce smoking cessation success. Yet, little is known about the factors that may impact smoking cessation among women with elevated PMS, leaving little data to guide smoking cessation science and practice for this population. This cross-sectional study is a secondary analysis of data from laboratory studies focused on menstrual cycle effects and smoking. Premenopausal woman daily smokers (n=157) completed self-report measures of tobacco dependence and other cessation-relevant factors (i.e., smoking cessation history, withdrawal during previous quit attempts, use of smoking cessation aids) as well as a measure assessing three domains of PMS—affective, water retention, and pain. After controlling for depression and race, affective PMS were associated with greater daytime tobacco dependence, withdrawal symptoms during most recent quit attempt, and number of smoking cessation aids used in past quit attempts (βs=.19–.28, ps<.05). Additionally, affective PMS were associated with increased odds of having used e-cigarettes during past quit attempts (*OR*[95% *CI*] = 1.54 [1.06–2.24]) after adjusting for depression and race. These results across different domains of PMS suggest that affective PMS may play a particularly important role in smoking cessation. Women with elevated affective PMS may be more inclined to try cessation aids and require special clinical attention to controlling tobacco withdrawal during quit attempts to increase success.

Keywords

premenstrual symptoms; tobacco dependence; smoking characteristics; withdrawal; smoking cessation aids

Premenstrual symptoms (PMS) consist of affective (e.g., irritability, anger) and physical (e.g., tender breasts, bloating) symptoms that reach peak severity during the week before menstrual onset and completely resolve by the week after menstrual onset. One study

Correspondence concerning this article should be addressed to Raina D. Pang, University of Southern California Keck School of Medicine, Department of Preventive Medicine, 2001 N. Soto Street, Room 318C, Los Angeles, CA 90032; Tel: 1-323-442-7251; Fax: 1-323-442-2359; rpang@usc.edu.

[a]Department of Preventive Medicine, University of Southern California Keck School of Medicine, Department of Preventive Medicine, 2001 N. Soto Street, Los Angeles, CA 90032

[b]Department of Psychology, 3620 South McClintock Ave.

Disclosures

Authors Pang and Leventhal designed the studies and wrote the protocols. Authors Pang and Andrabi managed literature searches and summaries of previous work. Pang undertook statistical analysis and wrote the first draft of the manuscript. All authors contributed to and approved the final manuscript.

None of the authors report a conflict of interest related to submission of this manuscript.

showed that women with greater variability in PMS across the menstrual cycle had an increased likelihood of relapse during a smoking cessation attempt (Allen, Allen, & Pomerleau, 2009). Additionally, Sakai and Ohashi (2013) reported that during menstrual phases associated with increased PMS (i.e., around menstruation) but not in phases during which PMS are typically minimal (i.e., week after menstrual onset to ovulation), number of cigarettes smoked was positively associated with PMS (Sakai & Ohashi, 2013). Lastly, a recent meta-analysis reported that tobacco withdrawal is greatest during the luteal phase, which includes the week before menstrual onset when PMS are elevated (Weinberger et al., 2015). Taken together these findings suggest that PMS may be an important factor in smoking behavior and cessation outcomes. However, very little is known about the factors that may impede or facilitate smoking cessation among women with elevated PMS.

Characteristics that are known to impact smoking cessation including tobacco dependence severity, cessation history, withdrawal symptoms during quit attempts, and use of smoking cessation aids during quit attempts (Hymowitz et al., 1997; Piper et al., 2011; Smith et al., 2015; Ussher, Kakar, Hajek, & West, 2016), are all important factors in understanding why women with elevated PMS may attempt to quit smoking and ultimately succeed or fail. Understanding how PMS associate with these cessation relevant characteristics can help practitioners identify strategies to promote cessation among this population and guide scientists in the search for mechanisms linking PMS and menstrual-related factors (e.g., estrogen, progesterone; Schiller, Saladin, Gray, Hartwell, & Carpenter, 2012; Sofuoglu, Babb, & Hatsukami, 2001) and smoking.

An overlooked issue is that PMS are not unifactorial and have several distinct syndrome domains—affective (e.g., irritability, sadness), water retention (e.g. feeling bloated), and pain (e.g., backaches, joint and muscle pain: Allen, McBride, & Pirie, 1991). It is unclear whether certain symptom domains may be more or less closely linked with cessation-relevant factors and ultimately cessation outcome. If certain domains are less reliably associated with cessation-relevant factors, then interventions targeting such domains may have little impact in smoking cessation treatment and should be deprioritized in favor of treatments that consider domains that are more closely associated with smoking.

The present study examined associations of domains of PMS with tobacco dependence and other cessation-relevant factors. Extant literature suggests that women may be particularly prone to smoke during increased negative affect as a way to relieve negative affect (Perkins, Giedgowd, Karelitz, Conklin, & Lerman, 2012; Weinberger & McKee, 2012) and express increased expectations that smoking relieves negative affect (Pang, Zvolensky, Schmidt, & Leventhal, 2014); thus we hypothesized that affective PMS would more closely associate with tobacco dependence and other cessation-relevant factors than other domains of PMS (i.e., water retention, pain). Additionally, given the literature documenting that depressive symptoms are associated with increased tobacco dependence (Dierker et al., 2015; Leventhal, Zvolensky, & Schmidt, 2011), inclination to make more quit attempts (Cooper, Borland, McKee, Yong, & Dugue, 2016), failed cessation attempts (Zvolensky, Bakhshaie, Sheffer, Perez, & Goodwin, 2015), and withdrawal symptoms (Leventhal, Ameringer, Osborn, Zvolensky, & Langdon, 2013), we wanted to determine whether PMS were uniquely associated with tobacco dependence and cessation-relevant factors above and

beyond variance contributed by depressive symptoms and other key variables identified in preliminary analyses.

Method

Participants

The study presents secondary results of data from two laboratory studies focused on menstrual cycle effects on cognitive performance and smoking behavior in woman smokers (Chung et al., 2017; Pang et al., 2017). Participants included 157 non-treatment seeking woman smokers recruited from the Los Angeles area via advertisements announcing the opportunity to take part in laboratory studies investigating menstrual cycle effects on smoking from 2013–2015. Participants included were 18–40 years old, regular smokers (report ≥ 10 cigarettes/day) for 2+ years, breath carbon monoxide (CO) level ≥ 10 ppm, with normal menstrual cycles of average cycle length 24–35 days for the past 3 months. Participants were excluded for use of hormonal birth control or other hormonal medications in the past 3 months, pregnancy or breastfeeding in the past 6 months, current non-nicotine substance use disorder, current use of psychiatric medications implicated in smoking cessation (e.g., Chantix, Wellbutrin) or nicotine replacement products, current regular use of other tobacco products, and the desire to quit smoking in the next 30 days.

Procedure

Following a phone eligibility screening, participants attended a screening session at the laboratory occurring anytime in their menstrual cycle, which involved informed consent, breath alcohol and CO level analysis, and administration of the Structured Clinical Interview for DSM-IV Non-Patient Edition (First, Spitzer, Gibbon, & Williams, 2002). Participants with a positive breath alcohol analysis (i.e., BrAC > 0.00 g/dl) were rescheduled for a different day. Participants found eligible after in person screening completed the paper-and-pencil measures described below. Eligible participants went on to complete 3 experimental sessions following the screening study visit (not described here). The University of Southern California Internal Review Board approved the protocol.

Measures

Premenstrual symptoms—The Shortened Premenstrual Assessment Form (PAF; Allen, et al., 1991) measured severity of PMS experienced during a woman's last cycle. Participants rated 10-items in terms of the extent of symptom change between the premenstrual phase versus the rest of the menstrual cycle (1 = *no change* to 6 = *extreme change*). The instructions for the PAF were designed to help participants distinguish PMS from chronic symptoms (e.g., depression, physical symptoms) by providing guidelines for the timing of the symptoms (i.e., week before menstrual onset) and inquiring about change in symptoms. Three subscales were used: PAF-Affect (4 items, e.g., "Outburst of irritability or bad temper", "Feeling sad or blue"), PAF-Water Retention (3 items, e.g., "Weight gain", "Feeling bloated"), and PAF-Pain (3 items, e.g., "Backaches, joint and muscle pain, or joint stiffness", "Pain tenderness, enlargement or swelling of breasts"). In this study, PAF subscales were strongly correlated (rs=.55–.71, ps<.001).

Tobacco dependence—The Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) was used to assess tobacco dependence severity on a scale of 0–10. The FTND has been separated into two factors (Richardson & Ratner, 2005): morning smoking (2 items, e.g., "Do you smoke more frequently during the first hours after waking then during the rest of the day?") and daytime smoking (3 items, e.g., "Do you smoke if you are so ill that you are in bed most of the day?").

Smoking history—The smoking history questionnaire (Brown, Lejuez, Kahler, & Strong, 2002) asked about total number of past serious quit attempts and severity of 12 withdrawal symptoms (e.g., irritability, increased weight gain, craving: Hughes, 2007a) experienced during most recent quit attempt (1=*not at all* to 5=*very severe*). An average score for all withdrawal symptoms was computed. In the current study, scores of withdrawal during most recent quit attempt were positively correlated with FTND scores (r=.32, p<.001), which supports convergent validity of this scale. This questionnaire also assessed use (0=*no use*, 1=*use*) of cessation aids during past quit attempts Additionally, a sum score of all cessation aids was computed.

Depressive symptoms—The Center for Epidemiologic Studies Depression Scale (CESD; Radloff, 1977) measured frequency (0=*rarely or none of the time* to 3=*most or all of the time*) of depressive symptoms (e.g., "I felt sad", "I felt that everything I did was an effort") over the past week. A mean score was computed.

Demographics, Smoking, and Menstrual Cycle Characteristics—Demographics (e.g., age and race/ethnicity), smoking characteristics (e.g., cigarettes/per day), and menstrual cycle characteristics (e.g., average cycle length, last menstrual onset) were assessed to describe sample and include as potential covariates. Menstrual cycle characteristics were used to estimate next menstrual onset by adding the average cycle length to the last menstrual onset. Given that the PAF asked about change in symptoms during the premenstrual phase, defined in the questionnaire as seven days prior to menstrual onset, PMS phase coded sessions occurring seven days before next expected menstrual onset as 0 and sessions during any other time of the cycle as 1.

Data Analysis

We first examined correlations between PAF subscales and demographic and smoking related characteristics and obtained descriptive statistics and Cronbach's alphas (when applicable) for all key variables. We then ran a series of linear (for continuous outcomes) and logistic (for dichotomous outcomes) regression models to determine the associations between PAF subscales and tobacco dependence and cessation-relevant factors with and without controlling for potential confounders. Depression was included as a planned covariate in all adjusted regression models in order to examine the predictive validity of PAF subscales on outcome variables beyond that of shared variance with depressive symptoms. Demographic or smoking related characteristics that were significantly correlated with any PAF subscales were also entered as covariates in adjusted models. Only participants reporting at least one serious quit attempt completed questions on cessation history and

cessation aids use; thus, these analyses were limited to participants reporting at least one serious quit attempt. As this was the first study to examine relations between PMS components to some of the cessation relevant factors, findings significant at an unadjusted alpha level of .05 are reported. However, given the exploratory nature of this study, we also used a Benjamin and Hochberg correction for multiple tests to control for the overall error rate within each family of criterion variables: tobacco dependence (FTND Total, Morning Smoking, Daytime Smoking), cessation history (quit attempts, withdrawal during last quit attempt), and cessation aids (other tobacco, e-cigarettes, nicotine replacement, medication, cessation aids sum). Data was analyzed using IBM SPSS Statistics version 22. Results are reported as standardized regression coefficients (βs) or odds ratios.

Results

See Table 1 for internal reliability of key measures and descriptives in full sample and by quit attempts (0 quit attempts vs. 1 or more quit attempts). Twenty-five percent of the sample reported 0 serious past quit attempts. There were no significant differences between participants reporting 0 serious past quit attempts compared to those reporting at least 1 serious past quit attempt (Table 1). As expected, depression symptoms significantly correlated with all of the PAF subscales (rs=.18–.40, ps<.03). Black (vs. other race) participants showed significant point biserial correlations with all PAF subscales (r_{pb}s=.20–.22, ps<.02). There were no significant correlations between any of the PAF subscales with age, cigs/day, and years regular smoker (rs=−.08-.05, ps>.15). There was also no significant correlation between any of the PAF subscales and whether participants were within 7 days of their next expected period (rs=.03–.13, ps>.09). Therefore, all regression models controlled for Black race/ethnicity as well as the planned covariate of depression symptoms.

In unadjusted models, PAF-Affect was associated with increased daytime tobacco dependence (β=.23, p=.004), tobacco withdrawal during most recent quit attempt (β=.35, p<.001), and total number of cessation aids used during past quit attempts (β=.33, p=.003). PAF-Affect also significantly associated with a 70% (*95% CI*=21–138%) increased odds of use of e-cigarettes in past quit attempts. After applying a Benjamin and Hochberg correction, all significant unadjusted associations between PAF-Affect and cessation relevant factors remained significant. In models adjusting for depression symptoms and race, PAF-Affect was associated with increased daytime tobacco dependence (β=.19, p=.04), tobacco withdrawal during most recent quit attempt (β=.28, p=.01), total number of cessation aids used during past quit attempts (β=.27, p=.03), and 54% (*95% CI*=6–124%) increased odds of e-cigarettes use in past quit attempts. The adjusted association between PAF-Affect and past quit withdrawal remained significant after applying a Benjamin and Hochberg correction.

PAF-Water Retention and PAF-Pain were positively associated with withdrawal during past quit attempts in unadjusted models (βs=.21–.25, ps<.03). The unadjusted association between PAF-Water Retention and past quit withdrawal remained significant after applying a Benjamin and Hochberg correction for multiple testing, but the unadjusted association between PAF-Pain and past quit withdrawal did not. After adjusting for depression and

Black race/ethnicity, there were no significant associations between PAF-Water Retention and PAF-Pain on any cessation relevant factors (Table 2).

Discussion

In this study, we found that affective PMS were associated with increased daytime tobacco dependence, withdrawal during past quit attempts, and use of smoking cessation aids particularly e-cigarettes during quit attempts. These effects remained even when controlling for depression symptoms, which is suggestive that affective PMS associates with these effects even after accounting for the shared variance of general affective symptoms. However, it is important to note that only the adjusted association between affective PMS and withdrawal during past quit attempts was significant after correcting for multiple testing. Thus, these findings should be interpreted with caution until replicated. These findings expand previous work showing associations between PMS and withdrawal symptoms (Allen, Hatsukami, Christianson, & Nelson, 1999) and expectations that smoking abstinence results in withdrawal (Pang et al., 2016), to suggest that women who experience more severe affective PMS may also experience greater withdrawal during quit attempts. Daytime tobacco dependence has been interpreted to assess the persistence in which nicotine levels are maintained at a given threshold throughout the day (Richardson & Ratner, 2005). Perhaps women who experience greater affective PMS experience greater compulsion to smoke throughout the day to maintain steady nicotine levels.

We also found that affective PMS were associated with increased use of cessation aids during quit attempts. Replacement of nicotine via pharmacological (e.g., nicotine patch/gum) or other tobacco products (e.g., e-cigarettes) has been shown to reduce withdrawal symptoms (Schlagintweit, Greer, Good, & Barrett, 2015; Walele, Sharma, Savioz, Martin, & Williams, 2015). These aids may be particularly important in facilitating smoking cessation efforts in women. Smith et al. (2015) showed that when stratifying quit attempt success by cessation aid use, women were less successful then males at quitting if no smoking cessation aids were used but were equally successful when cessation medications were used (Smith, et al., 2015). Furthermore, there is some evidence that nicotine aids may reduce PMS (Allen, Hatsukami, Christianson, & Brown, 2000). Interestingly, e-cigarettes were the only aid that independently associated with affective PMS. Currently, the use of e-cigarettes as a smoking cessation aid is highly debated (Bullen, 2014). There is some evidence that smokers perceive e-cigarettes to be more efficacious than other smoking cessation aids (e.g., NRT, medications: Barbeau, Burda, & Siegel, 2013; Nelson et al., 2015). Despite the potential for more acceptable use as a cessation aid in smokers, a recent meta-analysis found that e-cigarette use was associated with lower odds of smoking cessation (Kalkhoran & Glantz, 2016). It will be important for future studies to investigate the use of e-cigarettes in females with high affective PMS to see whether these devices may reduce withdrawal and aid in smoking cessation or lead to dual use.

In this study we found a positive association between withdrawal during past quit attempts and water retention PMS and pain PMS, but these findings were not significant in adjusted models. There is some literature showing associations between pain and smoking heaviness (Bakhshaie et al., 2016) and daily smoking (Aigner et al., 2015). It is possible that the

cyclical nature of pain PMS may associate differently with smoking relevant outcomes than chronic pain, which has received more attention in the smoking literature.

This study was cross sectional and cannot determine causality. It will be important for future longitudinal studies to further examine the directionality of the current findings. Additionally, this study used retrospective recall of PMS and withdrawal symptoms during previous quit attempts, which may result in biased reporting of these symptoms (Hughes, 2007b; Marvan & Cortes-Iniestra, 2001). However, we did not find any associations between phase of the session (i.e., women completing the surveys within 7 days of their next expected menstrual onset vs. any other time of the cycle) and reported premenstrual symptoms. This suggests that women were retrospectively reporting changes they usually experience in relation to the premenstrual symptoms rather than current symptoms as described in the survey instructions. Additionally, we do not have information on the timing of the last quit attempt. Given evidence suggesting that severity of withdrawal varies by menstrual phase (Weinberger, et al., 2015), it is possible that the timing of the last quit attempt could influence severity of withdrawal experienced and subsequently reported. Thus, it will be important for future studies to investigate these symptoms prospectively. There is also the possibility that associations between affective PMS and withdrawal symptoms may reflect differences in symptom reporting. However, since we control for depression symptoms, which have overlapping negative affect symptoms as affective PMS, it would appear that these associations do not occur simply as a result of high symptom reporting in some individuals. The FTND showed modest to low internal consistency, which is consistent with prior published work (Korte, Capron, Zvolensky, & Schmidt, 2013; Pang et al., 2014). Poor internal consistency of this measure may occur due to the low item count for subscales (Cortina, 1993) and forced dichotomous scores for some items (Korte, et al., 2013). Lastly, this study utilized a non-treatment seeking premenopausal free cycling sample and results may not generalize to smokers making a quit attempt or women excluded from the study due to hormonal and reproductive status (e.g., women using hormonal birth control, postmenopausal women).

This study reports findings that affective PMS were associated with increased withdrawal during most recent quit attempt, increased daytime tobacco dependence, and greater use of e-cigarettes as a smoking cessation aid. Importantly, these findings remained after controlling for depression symptoms suggesting that mood disturbances related to the menstrual cycle may result in a unique vulnerability to tobacco dependence and withdrawal. Thus, accounting for depression symptoms alone in tobacco studies sensitive to affect changes may not adequately address affective symptomology associations with smoking in women. We did not find any significant associations between water retention PMS and pain PMS and cessation-relevant factors in adjusted models. If these patterns of associations between PMS domains and cessation relevant factors are replicated, then these results could have implications for treating smokers who experience severe PMS. Specifically, given these associations it appears that women with high affective PMS may be particularly vulnerable and may require special attention to combat withdrawal symptoms during cessation attempts.

Acknowledgments

This research is a secondary analysis of two laboratory studies investigating menstrual cycle effects on cognitive behavior and smoking. This study was supported by funds from Tobacco-Related Disease Research Program of the University of California, Grant Number 22FT-0062, NIDA grants K01-DA040043 and R21 DA034768. Funding sources had no role other than financial support.

This research was supported by funds from Tobacco-Related Disease Research Program of the University of California, Grant Number 22FT-0062, NIDA grants K01-DA040043 and R21 DA034768.

References

Aigner, CJ., Cinciripini, PM., Anderson, KO., Baum, GP., Gritz, ER., Lam, CY. The Association of Pain With Smoking and Quit Attempts in an Electronic Diary Study of Cancer Patients Trying to Quit. Nicotine & Tobacco Research. 2015. http://dx.doi.org/10.1093/ntr/ntv118

Allen SS, Allen AM, Pomerleau CS. Influence of phase-related variability in premenstrual symptomatology, mood, smoking withdrawal, and smoking behavior during ad libitum smoking, on smoking cessation outcome. Addictive Behaviors. 2009; 34:107–111. http://dx.doi.org/10.1016/j.addbeh.2008.08.009. [PubMed: 18818024]

Allen SS, Hatsukami D, Christianson D, Brown S. Effects of transdermal nicotine on craving, withdrawal and premenstrual symptomatology in short-term smoking abstinence during different phases of the menstrual cycle. Nicotine & Tobacco Research. 2000; 2:231–241. [PubMed: 11082823]

Allen SS, Hatsukami DK, Christianson D, Nelson D. Withdrawal and pre-menstrual symptomatology during the menstrual cycle in short-term smoking abstinence: effects of menstrual cycle on smoking abstinence. Nicotine & Tobacco Research. 1999; 1:129–142. [PubMed: 11072394]

Allen SS, McBride CM, Pirie PL. The shortened premenstrual assessment form. Journal of Reproductive Medicine. 1991; 36:769–772. [PubMed: 1765953]

Bakhshaie J, Ditre JW, Langdon KJ, Asmundson GJ, Paulus DJ, Zvolensky MJ. Pain intensity and smoking behavior among treatment seeking smokers. Psychiatry Research. 2016; 237:67–71. http://dx.doi.org/10.1016/j.psychres.2016.01.073. [PubMed: 26921054]

Barbeau AM, Burda J, Siegel M. Perceived efficacy of e-cigarettes versus nicotine replacement therapy among successful e-cigarette users: a qualitative approach. Addiction Science & Clinical Practice. 2013; 8:5. http://dx.doi.org/10.1186/1940-0640-8-5. [PubMed: 23497603]

Brown RA, Lejuez CW, Kahler CW, Strong DR. Distress tolerance and duration of past smoking cessation attempts. Journal of Abnormal Psychology. 2002; 111:180–185. [PubMed: 11866171]

Bullen C. Electronic cigarettes for smoking cessation. Current Cardiology Reports. 2014; 16:538. http://dx.doi.org/10.1007/s11886-014-0538-8. [PubMed: 25303892]

Chung, J., Liautaud, MM., Brar, G., Kirkpatrick, MG., Leventhal, AM., Pang, RD. Menstrual Phase and Smoking Deprivation on Smoking-Related Outcomes. Paper presented at the Collaborative Perspectives on Addiction; Albuquerque, NM. 2017.

Cooper, J., Borland, R., McKee, SA., Yong, HH., Dugue, PA. Depression motivates quit attempts but predicts relapse: differential findings for gender from the International Tobacco Control Study. Addiction. 2016. http://dx.doi.org/10.1111/add.13290

Cortina JM. What is coefficient alpha? An examination of theory and applications. Journal of Applied Psychology. 1993; 78:98.

Dierker L, Rose J, Selya A, Piasecki TM, Hedeker D, Mermelstein R. Depression and nicotine dependence from adolescence to young adulthood. Addictive Behaviors. 2015; 41:124–128. http://dx.doi.org/10.1016/j.addbeh.2014.10.004. [PubMed: 25452055]

First, MB., Spitzer, Gibbon, Williams. Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Non-Patient Edition. (SCID-I/NP). New York: Biometrics Research, New York State Psychiatric Institute; 2002.

Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerstrom Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. British Journal of Addiction. 1991; 86:1119–1127. [PubMed: 1932883]

Hughes JR. Effects of abstinence from tobacco: valid symptoms and time course. Nicotine & Tobacco Research. 2007a; 9:315–327. http://dx.doi.org/10.1080/14622200701188919. [PubMed: 17365764]

Hughes JR. Measurement of the effects of abstinence from tobacco: a qualitative review. Psychology of Addictive Behaviors. 2007b; 21:127–137. http://dx.doi.org/10.1037/0893-164X.21.2.127. [PubMed: 17563132]

Hymowitz N, Cummings KM, Hyland A, Lynn WR, Pechacek TF, Hartwell TD. Predictors of smoking cessation in a cohort of adult smokers followed for five years. Tobacco Control. 1997; 6(Suppl 2):S57–62.

Kalkhoran S, Glantz SA. E-cigarettes and smoking cessation in real-world and clinical settings: a systematic review and meta-analysis. The Lancet Respiratory Medicine. 2016; 4:116–128. http://dx.doi.org/10.1016/s2213-2600(15)00521-4. [PubMed: 26776875]

Korte KJ, Capron DW, Zvolensky M, Schmidt NB. The Fagerstrom test for nicotine dependence: do revisions in the item scoring enhance the psychometric properties? Addictive Behaviors. 2013; 38:1757–1763. http://dx.doi.org/10.1016/j.addbeh.2012.10.013. [PubMed: 23254226]

Leventhal AM, Ameringer KJ, Osborn E, Zvolensky MJ, Langdon KJ. Anxiety and depressive symptoms and affective patterns of tobacco withdrawal. Drug and Alcohol Dependence. 2013; 133:324–329. http://dx.doi.org/10.1016/j.drugalcdep.2013.06.015. [PubMed: 23896304]

Leventhal AM, Zvolensky MJ, Schmidt NB. Smoking-related correlates of depressive symptom dimensions in treatment-seeking smokers. Nicotine & Tobacco Research. 2011; 13:668–676. http://dx.doi.org/10.1093/ntr/ntr056. [PubMed: 21471305]

Marvan ML, Cortes-Iniestra S. Women's beliefs about the prevalence of premenstrual syndrome and biases in recall of premenstrual changes. Health Psychology. 2001; 20:276–280. [PubMed: 11515739]

Nelson VA, Goniewicz ML, Beard E, Brown J, Sheals K, West R, Shahab L. Comparison of the characteristics of long-term users of electronic cigarettes versus nicotine replacement therapy: A cross-sectional survey of English ex-smokers and current smokers. Drug and Alcohol Dependence. 2015; 153:300–305. http://dx.doi.org/10.1016/j.drugalcdep.2015.05.005. [PubMed: 26026493]

Pang RD, Bello MS, Stone MD, Kirkpatrick MG, Huh J, Monterosso J, … Leventhal AM. Premenstrual symptoms and smoking-related expectancies. Addictive Behaviors. 2016; 57:38–41. http://dx.doi.org/10.1016/j.addbeh.2016.01.015. [PubMed: 26869196]

Pang RD, Hom MS, Geary BA, Doran N, Spillane NS, Guillot CR, Leventhal AM. Relationships between trait urgency, smoking reinforcement expectancies, and nicotine dependence. Journal of Addictive Diseases. 2014; 33:83–93. http://dx.doi.org/10.1080/10550887.2014.909695. [PubMed: 24784229]

Pang, RD., Liautaud, M., Kirkpatrick, M., Huh, J., Monterosso, JR., Leventhal, AM. Transdermal nicotine patch and ovarian hormone effects on smoking related outcomes after overnight abstinence. Paper presented at the Collaborative Perspectives on Addiction; Albuquerque, NM. 2017.

Pang, RD., Zvolensky, MJ., Schmidt, NB., Leventhal, AM. Gender Differences in Negative Reinforcement Smoking Expectancies. Nicotine & Tobacco Research. 2014. http://dx.doi.org/10.1093/ntr/ntu226

Perkins KA, Giedgowd GE, Karelitz JL, Conklin CA, Lerman C. Smoking in response to negative mood in men versus women as a function of distress tolerance. Nicotine & Tobacco Research. 2012; 14:1418–1425. http://dx.doi.org/10.1093/ntr/nts075. [PubMed: 22416115]

Piper ME, Schlam TR, Cook JW, Sheffer MA, Smith SS, Loh WY, … Baker TB. Tobacco withdrawal components and their relations with cessation success. Psychopharmacology. 2011; 216:569–578. http://dx.doi.org/10.1007/s00213-011-2250-3. [PubMed: 21416234]

Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. Applied Psychological Measurement. 1977; 1:385–401. http://dx.doi.org/10.1177/014662167700100306.

Richardson CG, Ratner PA. A confirmatory factor analysis of the Fagerstrom Test for Nicotine Dependence. Addictive Behaviors. 2005; 30:697–709. http://dx.doi.org/10.1016/j.addbeh.2004.08.015. [PubMed: 15833575]

Sakai H, Ohashi K. Association of menstrual phase with smoking behavior, mood and menstrual phase-associated symptoms among young Japanese women smokers. BMC Women's Health. 2013; 13:10. http://dx.doi.org/10.1186/1472-6874-13-10. [PubMed: 23452831]

Schiller CE, Saladin ME, Gray KM, Hartwell KJ, Carpenter MJ. Association between ovarian hormones and smoking behavior in women. Experimental and Clinical Psychopharmacology. 2012; 20:251–257. http://dx.doi.org/10.1037/a0027759. [PubMed: 22545725]

Schlagintweit HE, Greer H, Good KP, Barrett SP. The impact of anticipated and unanticipated smoking opportunities on cigarette smoking and nicotine lozenge responses. Drug and Alcohol Dependence. 2015; 147:97–102. http://dx.doi.org/10.1016/j.drugalcdep.2014.12.012. [PubMed: 25561388]

Smith PH, Kasza KA, Hyland A, Fong GT, Borland R, Brady K, … McKee SA. Gender differences in medication use and cigarette smoking cessation: results from the International Tobacco Control Four Country Survey. Nicotine & Tobacco Research. 2015; 17:463–472. http://dx.doi.org/10.1093/ntr/ntu212. [PubMed: 25762757]

Sofuoglu M, Babb DA, Hatsukami DK. Progesterone treatment during the early follicular phase of the menstrual cycle: effects on smoking behavior in women. Pharmacology, Biochemistry and Behavior. 2001; 69:299–304.

Ussher M, Kakar G, Hajek P, West R. Dependence and motivation to stop smoking as predictors of success of a quit attempt among smokers seeking help to quit. Addictive Behaviors. 2016; 53:175–180. http://dx.doi.org/10.1016/j.addbeh.2015.10.020. [PubMed: 26547043]

Walele, T., Sharma, G., Savioz, R., Martin, C., Williams, J. A randomised, crossover study on an electronic vapour product, a nicotine inhalator and a conventional cigarette. Part B: Safety and subjective effects. Regulatory Toxicology and Pharmacology. 2015. http://dx.doi.org/10.1016/j.yrtph.2015.12.004

Weinberger AH, McKee SA. Gender differences in smoking following an implicit mood induction. Nicotine & Tobacco Research. 2012; 14:621–625. http://dx.doi.org/10.1093/ntr/ntr198. [PubMed: 21908458]

Weinberger AH, Smith PH, Allen SS, Cosgrove KP, Saladin ME, Gray KM, … McKee SA. Systematic and Meta-Analytic Review of Research Examining the Impact of Menstrual Cycle Phase and Ovarian Hormones on Smoking and Cessation. Nicotine & Tobacco Research. 2015; 17:407–421. http://dx.doi.org/10.1093/ntr/ntu249. [PubMed: 25762750]

Zvolensky MJ, Bakhshaie J, Sheffer C, Perez A, Goodwin RD. Major depressive disorder and smoking relapse among adults in the United States: a 10-year, prospective investigation. Psychiatry Research. 2015; 226:73–77. http://dx.doi.org/10.1016/j.psychres.2014.11.064. [PubMed: 25650047]

Public Significance Statement

This study found that negative emotion related premenstrual symptoms associated with increased daytime tobacco dependence, withdrawal during past quit attempts, and increased likelihood of using smoking cessation aids. These findings advance our understanding on the role of negative emotion related to the menstrual cycle on factors related to smoking cessation success.

Table 1

Sample descriptives in full sample and in those reporting 0 quit attempts vs. 1 or more quit attempts.

	Range	Chronbach's α	N	Full Sample M (SD) or N (%)	0 Quits[a] M (SD) or N (%)	1+ Quit[b] M (SD) or N (%)	t or x [d]
Demographics							
Age	18–40	-	157	29.55 (6.07)	28.88 (6.74)	29.79 (5.83)	−0.82
Black race/ethnicity (0=Black)	-	-	157	69 (44.0%)	21 (52.5%)	48 (41.0%)	1.59
Smoking Characteristics							
Years Regular Smoker	0–25	-	157	10.96 (6.42)	9.50 (6.34)	11.45 (6.39)	−1.67
No. Cigs/day	5–40	-	156	14.26 (5.27)	14.48 (5.83)	14.18 (5.09)	0.30
Tobacco Dependence							
FTND	0–10	.52	155	4.84 (1.96)	4.43 (2.18)	4.98 (1.86)	−1.56
Factor 1: Morning Smoking	0–2	.50	155	1.05 (0.80)	0.85 (0.83)	1.11 (0.78)	−1.80
Factor 2: Daytime Smoking	0–8	.29	155	1.79 (1.05)	1.73 (1.18)	1.82 (1.01)	−0.48
Cessation Aids							
Other Tobacco (0=no use)	0–1	-	80	71 (88.8%)	-	71 (88.8%)	-
E-Cig (0=no use)	0–1	-	80	52 (65.0%)	-	52 (65.0%)	-
NRT (0=no use)	0–1	-	83	59 (71.1%)	-	59 (71.1%)	-
Medication (0=no use)	0–1	-	80	76 (95.0%)	-	76 (95.0%)	-
Cessation Aids Sum	0–4	-	83	0.78 (0.91)	-	0.78 (0.91)	-
Cycle Characteristics							
Average Cycle Length	24–35	-	157	29.37 (1.91)	29.53 (1.51)	29.32 (2.03)	0.58
PMS phase (0=7 days prior to menstrual onset)	0–1	-	157	31 (19.8%)	10 (25.0%)	21 (18.0%)	0.94
Interpersonal Factors							
PAF Affect	1–6	.90	157	2.78 (1.44)	2.68 (1.27)	2.82 (1.50)	−0.55
PAF Water Retention	1–6	.82	157	2.95 (1.51)	2.77 (1.54)	3.01 (1.49)	−0.87
PAF Pain	1–6	.75	157	3.05 (1.43)	2.93 (1.48)	3.09 (1.42)	−0.63
CESD Total	0–3	.91	157	0.61 (0.51)	0.68 (0.49)	0.59 (0.52)	1.03

*Note. N*s ranged from [a]40, [b]80–117 due to missing data. FTND = Fagerström test of nicotine dependence; PMS = Premenstrual phase vs. other phase; PAF = Premenstrual Assessment Form; CESD = Center for Epidemiologic Studies Depression Scale. [d]There were no significant differences on any sample descriptives between those reporting 0 serious past quit attempts and those reporting 1 or more past quit attempts.

Exp Clin Psychopharmacol. Author manuscript; available in PMC 2018 August 01.

Table 2

Individual regression models of associations between premenstrual symptoms subscales and smoking characteristics.

	PAF-Affect		PAF-Water Retention		PAF-Pain	
	***β* (*95% CI*) or OR (*95% CI*)[a]**	***β* (*95% CI*) or OR (*95% CI*)[b]**	***β* (*95% CI*) or OR (*95% CI*)[a]**	***β* (*95% CI*) or OR (*95% CI*)[b]**	***β* (*95% CI*) or OR (*95% CI*)[a]**	***β* (*95% CI*) or OR (*95% CI*)[b]**
Tobacco Dependence						
FTND	.11 (−.04, .27)	.13 (−.04, .30)	−.04 (−.20, .12)	−.03 (−.19, .13)	− .06 (−.22, .10)	−.05 (−.21, .11)
Factor 1: Morning Smoking	−.05 (−.21, .11)	−.05 (−.22, .13)	−.10 (−.26, .06)	−.08 (−.24, .08)	−.12 (−.28, .04)	−.10 (−.26, .06)
Factor 2: Daytime Smoking	**.23 (.08, .39)** **	.19 (.01, .37) *	.10 (−.06, .26)	.07 (−.09, .23)	.10 (−.06, .26)	.07 (−.09, .24)
Cessation History						
QA (0=0 QA)	1.07 (0.83, 1.38)	1.13 (0.84, 1.52)	1.12 (0.87, 1.42)	1.12 (0.87, 1.45)	1.09 (0.84, 1.40)	1.09 (0.84, 1.40)
SHQ Withdrawal	**.35 (.18, .52)** ***	**.28 (.08, .48)** **	**.25 (.08, .44)** **	.18 (.00, .38)	.21 (.03, .41) *	.14 (−.05, .34)
Cessation Aids						
Other Tobacco (0=no use)	1.38 (0.87, 2.18)	1.45 (0.85, 2.48)	1.21 (0.75, 1.94)	1.24 (0.74, 2.07)	1.16 (0.73, 1.86)	1.22 (0.73, 2.03)
E-Cig (0=no use)	**1.70 (1.21, 2.38)** **	1.54 (1.06, 2.24) *	1.12 (0.81, 1.54)	1.01 (0.72, 1.42)	1.12 (0.82, 1.54)	1.02 (0.72, 1.43)
NRT (0=no use)	1.07 (0.78, 1.48)	0.91 (0.62, 1.33)	0.97 (0.69, 1.36)	0.86 (0.60, 1.24)	0.93 (0.67, 1.30)	0.78 (0.54, 1.14)
Medication (0=no use)	1.43 (0.73, 2.78)	1.58 (0.76, 3.28)	0.69 (0.29, 1.64)	0.65 (0.26, 1.63)	1.06 (0.53, 2.10)	1.02 (0.50, 2.06)
Cessation Aids Sum	**.33 (.12, .54)** **	.27 (.03, .51) *	.04 (−.20, .29)	−.04 (−.29, .21)	.08 (−.14, .31)	.00 (−.23, .23)

*Note. N*s ranged due to missing data and exclusion of individuals reporting 0 serious quit attempts for proportion quit attempts over one day, withdrawal, and cessation aids.

[a]Individual regression models involve a single measure of premenstrual symptoms as the sole predictor of each smoking outcome.

[b]Individual regression models involve a single measure of premenstrual symptoms as the sole predictor of each smoking outcome adjusted for race and depression symptoms. Associations that survived Benjamin and Hochberg correction are bolded.

FTND = Fagerström test of nicotine dependence; QA= Quit attempts; SHQ = Smoking History Questionnaire; NRT = Nicotine Replacement Therapy (gum or patch); PAF = Premenstrual Assessment Form.

* p < .05.

** p < .01.

*** p < .001.