International Journal of Behavioral Medicine (2019) 26:69–75
https://doi.org/10.1007/s12529-018-9755-7

Sex-Specific Link Between Emotional Vulnerability and Poor Weight Control in Cigarette Smokers

Samantha G. Farris[1] · Bailey J. O'Keeffe[2] · Ana M. Abrantes[2,3] · Angelo M. DiBello[4]

Published online: 31 October 2018
© International Society of Behavioral Medicine 2018

Abstract

Background Cigarette smoking and poor weight control independently and synergistically increase risk for morbidity and mortality. However, few studies have examined the etiological role of emotion-regulatory dysfunction in the link between smoking and poor weight control, as well as the possible moderating role of sex.

Method Participants ($n = 577$; $M_{age} = 44.42$; $SD = 13.80$; 52.7% female) were daily smokers who completed a single survey online through Qualtrics. Emotional vulnerability was indexed by a latent construct comprised of the subscales from the Distress Tolerance Scale (DTS) and the Anxiety Sensitivity Index-3 (ASI-3). A regression model was constructed to examine the relation between emotional vulnerability and poor weight control, measured via body mass index (BMI).

Results Emotional vulnerability was significantly and positively associated with BMI ($b = .08$, $p = .020$). The effect was moderated by sex, such that emotional vulnerability was significantly related to BMI in female smokers ($b = .15$, $p = .002$), but not in male smokers ($b = .01$, $p = .806$).

Conclusions Emotional vulnerability appears to be a novel female-specific psychological mechanism related to poor weight control in smokers. Possible limitations are discussed.

Keywords Distress intolerance · Anxiety sensitivity · Smoking behaviors · Body mass index · Sex differences

Introduction

The link between cigarette smoking and weight control is complex. On the one hand, epidemiological data indicate that smokers have a lower body mass index (BMI) compared to non-smokers [1, 2] perhaps due to the metabolic suppressing effects of nicotine [3]. On the other hand, 45% of smokers are overweight/obese [4] and the combined effects of obesity and smoking confer an increased risk of mortality [5]. Poor weight control in smokers appears to be linked, at least in part, to smoking heaviness [6–8] and the coupling of problem health behaviors (e.g., poor diet, physical inactivity, greater alcohol consumption), which may outweigh the metabolic suppressing effects of nicotine [6].

There are also important biological sex differences that may influence poor weight control in smokers. Data indicate that the association between daily cigarette consumption and central fat accumulation is stronger in females compared to males [1, 7], suggesting a unique vulnerability in female smokers. Moreover, compared to male smokers, female smokers more commonly smoke for weight management reasons [9] and are also less successful in quitting smoking [10, 11], especially in the context of weight concerns [12]. More broadly, the prevalence of multimorbidity (i.e., co-occurrence of two or more chronic conditions) is higher in females compared to males [13–16], particularly the co-occurrence of mixed physical and mental health problems [13]. Thus, there may be unique risk and maintaining psychological factors that contribute to poor weight control in female smokers.

Difficulties tolerating and responding adaptively to negative distress states (i.e., emotional vulnerability) is one candidate factor that may play an etiological role in smoking and poor weight control in female smokers. There is a well-documented 2:1 female-to-male sex difference in the prevalence of anxiety

✉ Samantha G. Farris
samantha.farris@rutgers.edu

[1] Rutgers, The State University of New Jersey, Piscataway, NJ 08854, USA

[2] Butler Hospital, Providence, RI, USA

[3] Alpert Medical School of Brown University, Providence, RI, USA

[4] City University of New York, Brooklyn College, Brooklyn, NY, USA

disorders [17, 18] and depressive disorders [19]. This may account for why females report greater sensitivity to, and intolerance of, psychological and physical distress states than males [20–22]. Additionally, compared to males, females demonstrate greater reliance on emotion-focused coping strategies in response to negative distress states [23], including greater reliance on cigarettes to relieve negative affect [24–26]. Indeed, emotional vulnerability is implicated in the development and maintenance of cigarette smoking [27], particularly in female smokers [28]. In the context of negative mood or stress, female smokers report greater negative affect [26], stronger cigarette craving [25, 26], and demonstrate greater nicotine consumption [28] than male smokers.

Emotional vulnerability is also associated with poor weight control, indicated by emotional eating behavior [29–31] and physical inactivity [32]. Specifically, the tendency to be fearful of bodily sensations (i.e., anxiety sensitivity) and a low capacity to withstand distress (i.e., distress intolerance) is associated with emotional eating behavior, cue-induced eating, and overeating behaviors, particularly in response to negative emotional states [29, 30]. This association differs between sex, such that emotional vulnerability, and stress in general, may lead to greater calories consumed in females and fewer calories consumed in males [33, 34]. Moreover, difficulties with emotion regulation is also associated with more sedentary behavior in females [32, 34], which may contribute to poor weight control.

Taken together, emotional vulnerability may inform the linkage between smoking and poor weight control [35, 36], and this may emerge as a female-specific risk mechanism. The current study aimed to evaluate the association between emotional vulnerability and poor weight control, indexed by BMI, among male and female smokers. Reflecting the findings of Bernstein and colleagues [37], emotional vulnerability was examined via a latent construct tapping (a) sensitivity to arousal sensations and (b) perceived intolerance to psychological distress states. Consistent with our sex-specific hypothesis, the current study also evaluated the moderating role of sex in the association between emotional vulnerability and BMI. It was hypothesized that emotional vulnerability would be directly associated with BMI and that this relation would be stronger in female smokers compared to male smokers.

Method

Participants and Procedure

Participants were adult daily smokers in the USA recruited for a larger online study on "emotion, health, and smoking." The current study reflects secondary data analysis of the parent study (manuscript under review). Data were exclusively collected through the Qualtrics participant pool based on pre-specified criteria of being ≥ 18 years of age and a daily smoker. Data collection was managed by Qualtrics Panels service. Qualtrics Panels utilizes "burst" sampling with replacement to disperse the survey to participants who are members of Qualtrics Panels meeting these preliminary criteria. Interested participants then completed a screening survey to determine eligibility and were included if they met the following criteria: (a) ≥ 18 years of age, (b) daily smoking for ≥ 1 year, (c) smoking ≥ 5 cigarettes/day, and (d) cigarette use as primary tobacco product. If participants reduced their smoking rate by more than half in the past 6 months, they were excluded. Participants received compensation in the form of Qualtrics credits that could be used to purchase gift cards or other items through the Qualtrics Panels portal. The parent study consisted of a baseline battery of self-report measures followed by a computerized experimental task. The study took approximately 40 min to complete. All data in the current study were collected during the baseline assessment, prior to the experimental task. The study protocol was approved by the Institutional Review Board where the study was conducted.

A total of 3113 individuals completed the screening, and 1316 were eligible and completed the study. Cases were excluded from analysis if any of four of the embedded validity "check" questions were answered incorrectly ($n = 697$). Of the remaining 619 cases, 30 were excluded from the current secondary analyses due to invalid height/weight estimates (i.e., incorrectly entered data/misunderstanding of instructions; $n = 30$) and 12 were excluded for reporting < 70% accuracy of height and/or weight ($n = 12$; see "Weight Control" in measures below). Thus, the final sample included 577 participants.

Measures

Demographics Biological sex, age, race, marital status, and educational attainment were self-reported.

Cigarette Dependence The *Fagerström Test for Cigarette Dependence* (FTCD) [38] is a 6-item scale used to assess level of cigarette dependence. Higher scores reflect higher dependence with scores ranging from 0 to 10.

Weight Control *Body mass index* (BMI) was used to indicate poor weight control, which was calculated based on self-reported weight and height ([weight(lbs) / [height (in)]^2 × 703]. Perceived accuracy of self-reported height and weight was rated on a 0 to 100% scale of accuracy confidence. Cases with accuracy confidence > 70% were retained; average accuracy ratings were high for height ($M = 98.0\%$, $SD = 4.13\%$) and weight ($M = 96.6\%$, $SD = 5.16\%$).

Emotional Vulnerability The *Distress Tolerance Scale* (DTS) [39] is a 14-item self-report measure of one's perceived tolerance for psychological distress. Items are scored from 1

(strongly agree) to 5 (strongly disagree), with higher mean scores reflecting higher perceived tolerance for psychological distress. The DTS yields four subscales, including appraisal of emotions as acceptable (e.g., "My feelings of distress or being upset scare me"), absorption or level of attention to emotions (e.g., "My feelings of distress are so intense that they completely take over"), ability to regulate emotions (e.g., "I'll do anything to stop feeling distressed or upset"), and ability to tolerate emotions (e.g., "Feeling distressed or upset is unbearable to me"). The DTS items and four-factor structure have been validated in cigarette smokers [40]. The *Anxiety Sensitivity Index-3* (ASI-3) [41] includes 18 items scored from 0 (very little) to 4 (very much), with higher sum scores reflecting greater concerns about the consequences of anxiety and arousal sensations. The three subscales are physical concerns (e.g., "It scares me when my heart beats rapidly"), cognitive concerns (e.g., "When I cannot keep my mind on a task, I worry that I might be going crazy"), and social concerns (e.g., "I worry that other people will notice my anxiety"). The ASI-3 items and three-factor structure have been validated in cigarette smokers [42].

Results

Sample Characteristics

Participants ($n = 577$; $M_{age} = 44.42$; $SD = 13.80$; 52.7% female) identified race as White (90.1%), Black/African-American (4.2%), Asian (2.1%), American Indian/Alaska Native (1.6%), or other (2.1%), and 7.3% of participants identified ethnicity as Hispanic. The majority of the sample completed at least some college (71.4%). On average, participants started to smoke at age 16.0 years ($SD = 4.79$), had been smoking for 25.7 years ($SD = 14.35$), had smoked 17.0 cigarettes per day ($SD = 8.38$), and had moderate levels of cigarette dependence ($M_{FTCD} = 5.3$, $SD = 1.98$). Average BMI was in the overweight range ($M = 27.9$, $SD = 7.31$) and 29.5% had an obese BMI (≥ 30). Initial *t* tests and chi-squared tests indicated that male and female smokers did not significantly differ on demographic or smoking characteristics. Male and female smokers also did not differ on BMI, however, the presence of obese BMI (≥ 30) was more common in female smokers (33.6%) compared to male smokers (24.9%), $\chi^2(1) = 5.172$, $p = .023$. Please see Table 1 for means, standard deviations, and between-group comparisons.

Model Specification and Evaluation

To extend the initial exploratory factor analysis from Bernstein and colleagues [37], a Confirmatory Factor Analysis (CFA) was conducted to evaluate the latent construct of emotional vulnerability as indexed by the DTS and the ASI-3. Analyses were conducted using AMOS 22.0. Structural equation modeling with maximum likelihood imputation and estimation was used. Model fit was assessed using the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). Values .90 or above on the CFI and .95 or above on the TLI are considered to indicate good model fit [43, 44]. For the RMSEA, values of .00 to .05 indicate excellent fit, values of .06 to .08 indicate reasonable fit, and values above .10 suggest poor fit. A confidence interval (CI) is also calculated for the RMSEA to describe the accuracy of the RMSEA estimate. Ideally, the lower limit of the 90% CI includes 0 or is < 0.05, and the upper limit is < 0.08 [45].

Next, a regression model was constructed to test the main effect of emotional vulnerability and sex in terms of BMI, and the moderating role of sex in the association between emotional vulnerability and BMI. Analyses were conducted using the PROCESS macro, model 1 [46]. The regression analysis was conducted in SAS 9.4. Prior to running the model, continuous predictor variables were mean centered to aid in interpretation of results. A significant interaction term was probed using tests of simple slopes [47, 48]. High and low values were specified as one standard deviation above the mean and one standard deviation below the mean, respectively.

Measurement Model

In order to test the fit of the proposed latent construct (emotional vulnerability), an initial measurement model was constructed. For these analyses, the DTS was recoded such that higher scores on the higher order factor emotional vulnerability reflect greater intolerance and increased sensitivity (i.e., lower scores on the higher order factor reflect tolerance and lower sensitivity). The four subscales of the DTS and the three subscales of the ASI-3 were used as indicators of the latent variable; indicators from the same measure were allowed to correlate. The model indicated an acceptable fit (χ^2 (6) = 8.040 $p = .235$; CFI = .999, TLI = .996, RMSEA = .034 [90% CI .000, .080]). Please refer to Fig. 1 for a visual representation of the significant parameter estimates. Based on the strong model fit, this emotional vulnerability variable, reflecting the combination of the DTS and the ASI-3, was used as the primary predictor in our regression model.

Regression Analysis

In the regression model, it was hypothesized that the higher order variable "emotional vulnerability" would be associated with higher BMI. The main effects of sex and cigarette dependence were included as covarying factors. Results indicated that emotional vulnerability was significantly and positively associated with BMI ($b = .08$, $SE = .034$, $t = 2.32$, $p = .020$). Level of cigarette dependence was not significantly related

Table 1 Descriptive summary of sample characteristics

Variable	Total ($n = 577$)	Males ($n = 273$)	Females ($n = 304$)	t or x^2
Age	44.4 (13.80)	43.8 (14.68)	44.9 (12.96)	− 0.95
Race $_{(non\text{-}White)}$	57 (9.9%)	31 (11.4%)	26 (8.6%)	1.27
Cigarettes/day $_{(past\ week)}$	17.2 (8.28)	16.7 (7.86)	17.7 (8.63)	− 1.47
Cigarette dependence (FTCD)	5.3 (1.98)	5.2 (1.89)	5.5 (2.06)	− 1.59
Body mass index (BMI)	27.9 (7.32)	27.7 (6.60)	28.1 (7.92)	− 0.65
Obese BMI (≥ 30)	170 (29.5%)	68 (24.9%)	102 (33.6%)	5.17**
Distress Tolerance Scale (DTS)	3.3 (1.01)	3.3 (0.97)	3.2 (1.05)	1.23
Anxiety Sensitivity Index-3 (ASI-3)	22.3 (18.26)	23.1 (18.68)	21.6 (17.88)	0.94

Independent t tests revealed no significant differences between male and female smokers on any of the variables except for obese BMI (≥ 30) (**$p < .05$)

to BMI ($b = -.01$, $SE = .151$, $t = -0.10$, $p = .921$), nor was sex ($b = .99$, $SE = .589$, $t = 1.68$, $p = .094$).

To test the moderating role of sex in the association between emotional vulnerability and BMI, the interaction of emotional vulnerability and sex was examined. Tests of the two-way interaction revealed a significant interaction between emotional vulnerability and sex in terms of BMI ($b = .13$, $SE = .067$, $t = 2.01$, $p = .044$). Follow-up tests of simple slopes revealed that there was a significant effect of emotional vulnerability on BMI for female smokers ($b = .15$, $SE = .047$, $t = 3.07$, $p = .002$) but not male smokers ($b = .01$, $SE = .048$, $t = .25$, $p = .806$). See Fig. 2 for a visual representation of the significant interaction between emotional vulnerability and sex in terms of BMI.

Post hoc Analyses

Two post hoc regression models were constructed to test the unique effects of DTS and ASI-3 in terms of BMI, as well as their interactive effects with sex. In the first model, results revealed a significant main effect of DTS in terms of BMI ($b = .79$, $SE = .312$, $t = 2.52$, $p = .012$); however, the DTS by sex interaction term was non-significant ($b = .49$, $SE = .615$, $t = .85$, $p = .393$). In the second model, results revealed a significant main effect of ASI-3 in terms of BMI ($b = .04$, $SE = .016$, $t = 2.40$, $p = .017$); however, the ASI-3 by sex interaction was non-significant ($b = 1.01$, $SE = .609$, $t = 1.66$, $p = .097$).

Discussion

Given the complex nature between smoking and weight control, we evaluated the role of emotional vulnerability as a risk factor for poor weight control in adult male and female smokers. First, findings validate the emotional vulnerability as a higher order construct, comprised of distress intolerance and anxiety sensitivity, in this sample of cigarette smokers. Second, emotional vulnerability appears to be associated with elevated BMI, after adjusting for cigarette dependence. This finding is generally consistent with previous research showing that an increased sensitivity to negative distress states is associated with elevated BMI in both non-smokers [29, 30] and smokers [49]. This relationship is further supported by growing evidence linking emotional vulnerability to various health-risk behaviors such as maladaptive eating [29–31] and physical inactivity [32], which can both contribute to obesity. Because smokers, relative to the general population, experience higher rates of affective psychopathology and negative affective states [50], they may be more prone to emotion-motivated problematic health behaviors that contribute to poor weight control. As such, difficulties regulating and responding to distressing emotional and physical states may play an etiological role in poor weight control among smokers.

Third, findings also provide novel sex-specific evidence of the association between emotional vulnerability and poor weight control in female smokers, relative to male smokers. Interestingly, the unique effects of anxiety sensitivity and distress intolerance did not result in sex-specific vulnerability for BMI, suggesting that the unique combination of the DTS and ASI-3 into the emotional vulnerability construct that confers distinct risk with respect to BMI in female smokers. The pattern of results is consistent with the observation that females, compared to males, are more likely to have anxiety and depressive psychopathology [17, 18, 20] and are more vulnerable to multimorbidity of mental and physical health conditions [13]. Females also tend to rely on avoidance-focused coping strategies as a "quick fix" for managing distress compared to males [23], which may explain why females respond to stress and/or negative emotions with greater nicotine consumption [24–26] and emotional eating [29, 30]. More research is needed to understand how emotionally vulnerable female smokers make choices regarding maladaptive coping behaviors. For example, some female smokers may rely on cigarettes as a preferred coping behavior in response to distress (i.e., leading to less emotional eating and potentially lower BMI), whereas for others, emotional eating may emerge as the preferred method over cigarette use. This is consistent with emerging

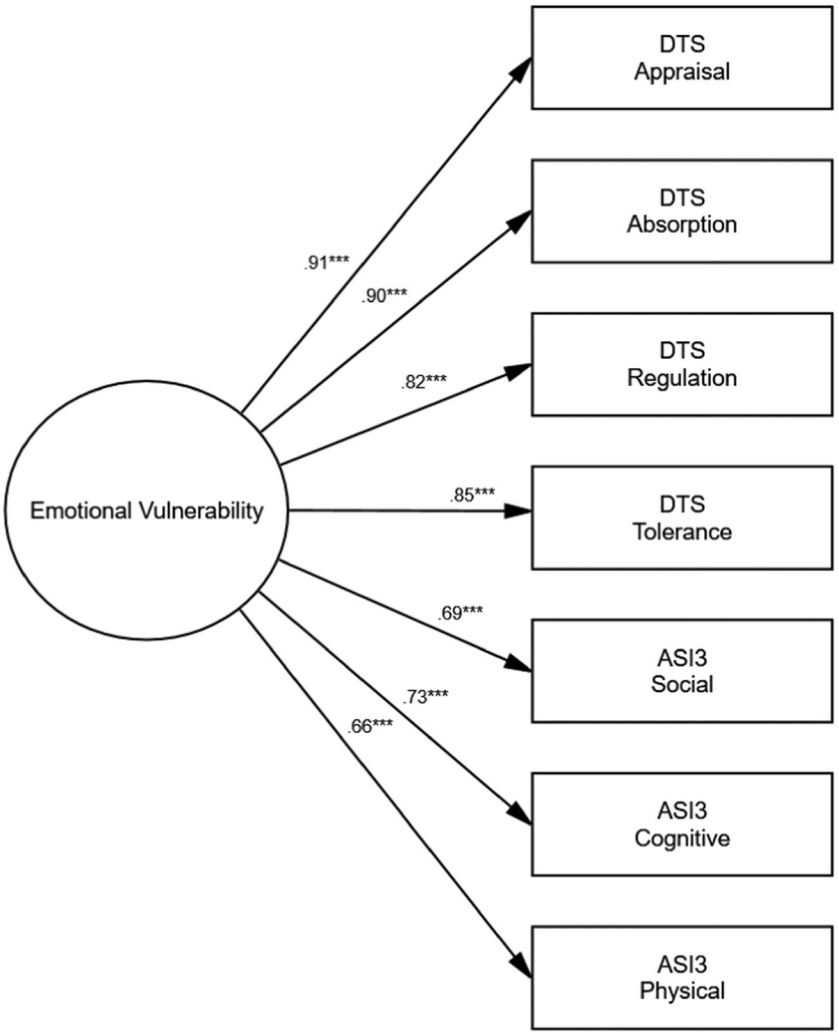

Fig. 1 Measurement model. All estimates reflect standardized regression weights. ***$p < .001$

literature on the shared neural mechanisms of addictive substances, including food [51].

There are a number of limitations that merit discussion. First, these data were cross-sectional in nature thus directionality of these associations is unknown, and it is unknown how potentially changing levels of smoking and/or emotional vulnerability may affect BMI over time. Second, we relied exclusively on self-reported assessments, including self-reported height and weight to derived BMI. While confidence in one's self-reported height and weight was measured and only cases with high perceived accuracy were retained, there may still be possible reporting bias for BMI. Additional objective indices of poor weight control (e.g., body adiposity index) [52] are recommended for use in future studies. Third, this study utilized on an online-based research platform for data collection, which has both advantages and disadvantages. While online-based studies can increase feasibility and timeliness of data collection, the ease of accessing online studies can increase the number of non-serious respondents [53]. In the current study, 53% of initially eligible participants were identified as invalid respondents due to not passing attentional control check questions and were excluded from analyses. Such cases can increase noise in data and decrease power if not identified (i.e., via consistency, validity, or seriousness check procedures

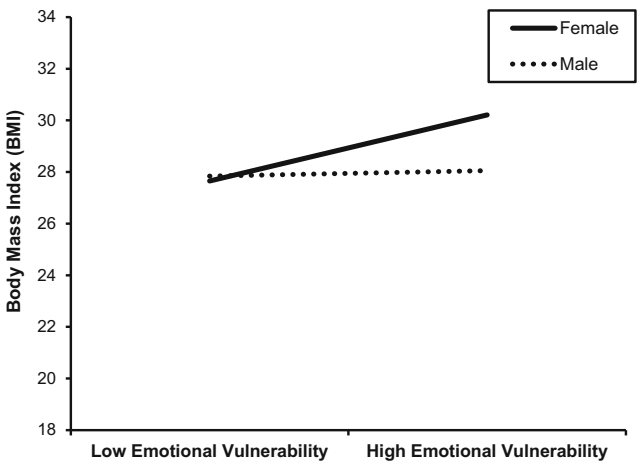

Fig. 2 Interaction of emotional vulnerability and sex in relation to BMI

[53]) and removed from analyses. Our data collection and screening procedures enabled us to identify invalid respondent cases in "real time" during the data collection process and we continued enrollment until our target sample size (with valid respondents) was obtained. Fourth, we did not examine a number of other potential proximal risk factors that could influence the relationship between smoking and BMI such as physical activity, diet, and alcohol use. These risk factors should be included and examined in future studies. Lastly, the sample consisted of non-treatment-seeking smokers, who may have a lower prevalence of obesity than treatment-seeking smokers [54]. The sample was also relatively homogeneous in terms of race and ethnicity, and was generally well-educated. Future studies should examine these relationships in more heterogeneous samples of smokers.

Despite these limitations, the current study provides initial evidence for emotional vulnerability as a potential risk factor for poor weight control in female smokers. A next step could be the examination of mechanisms that underlie the present findings. For example, given that acute distress is often considered a necessary context to "activate" emotional vulnerability [55, 56], a future laboratory-based examination of eating behaviors in response to acute stress among male and female smokers could help explain the role of emotional eating as contributing to overweight/obesity in this population. Further, because emotional vulnerability is a malleable psychological factor [57], future studies may examine it as a promising therapeutic target for smoking and weight control interventions in female smokers [58]. Through decreased reliance on emotion-focused eating behaviors and increased engagement in health-promoting, adaptive coping behaviors (e.g., physical activity), emotionally vulnerable females may experience better weight control and smoking outcomes over time.

Authors' Contributions Dr. Farris and Ms. O'Keeffe reviewed the literature, and Dr. Farris wrote the first draft of the manuscript. Dr. DiBello conducted the data analyses. All authors contributed and approved the final version of the manuscript.

Funding Information This study was funded by a Qualtrics Behavioral Research Grant. The first author's effort was supported by a grant from the National Heart, Lung, and Blood Institute (T32-HL076134-11).

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required. No identifying information was collected. This article does not contain any studies with animals performed by any of the authors.

References

1. Akbartabartoori M, Lean MEJ, Hankey CR. Relationships between cigarette smoking, body size and body shape. Int J Obes. 2005;29:236–43.
2. Sneve M, Jorde R. Cross-sectional study on the relationship between body mass index and smoking, and longitudinal changes in body mass index in relation to change in smoking status: the Tromsø Study. Scand J Public Health. 2008;36:397–407.
3. Harris KK, Zopey M, Friedman TC. Metabolic effects of smoking cessation. Nat Rev Endocrinol. 2016:299–308.
4. Gregg EW, Cheng YJ, Cadwell BL, Imperatore G, Williams DE, Flegal KM, et al. Secular trends in cardiovascular disease risk factors according to body mass index in US adults. J Am Med Assoc. 2005;293:1868–74.
5. Freedman DM, Sigurdson AJ, Rajaraman P, Doody MM, Linet MS, Ron E. The mortality risk of smoking and obesity combined. Am J Prev Med. 2006;31:355–62.
6. Chiolero A, Jacot-Sadowski I, Faeh D, Paccaud F, Cornuz J. Association of cigarettes smoked daily with obesity in a general adult population. Obesity. 2007;15:1311–8.
7. Clair C, Chiolero A, Faeh D, Cornuz J, Marques-Vidal P, Paccaud F, et al. Dose-dependent positive association between cigarette smoking, abdominal obesity and body fat: cross-sectional data from a population-based survey. BMC Public Health. 2011;11:23.
8. Dare S, Mackay DF, Pell JP. Relationship between smoking and obesity: a cross-sectional study of 499,504 middle-aged adults in the UK general population. PLoS One. 2015;10:e0123579.
9. Cawley J, Markowitz S, Tauras J. Lighting up and slimming down: the effects of body weight and cigarette prices on adolescent smoking initiation. J Health Econ. 2004;23:293–311.
10. Piper ME, Cook JW, Schlam TR, Jorenby DE, Smith SS, Bolt DM, et al. Gender, race, and education differences in abstinence rates among participants in two randomized smoking cessation trials. Nicotine Tob Res. 2010;12:647–57.
11. Scharf D, Shiftman S. Are there gender differences in smoking cessation, with and without bupropion? Pooled- and meta-analyses of clinical trials of Bupropion SR. Addiction. 2004;99:1462–9.
12. Perkins KA. Smoking cessation in women - special considerations. CNS Drugs. 2001;15:391–411.
13. Agur K, McLean G, Hunt K, Guthrie B, Mercer SW. How does sex influence multimorbidity? Secondary analysis of a large nationally representative dataset. Int J Environ Res Public Health. 2016;13.
14. Prados-Torres A, Poblador-Plou B, Calderón-Larrañaga A, Gimeno-Feliu LA, González-Rubio F, Poncel-Falcó A, et al. Multimorbidity patterns in primary care: interactions among chronic diseases using factor analysis. PLoS One. 2012;7.
15. Salisbury C, Johnson L, Purdy S, Valderas JM, Montgomery AA. Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. Br J Gen Pract. 2011;61:e12–21.
16. Uijen A, van de Lisdonk E. Multimorbidity in primary care: prevalence and trend over the last 20 years. Eur J Gen Pract. 2008;14:28–32.
17. McLean CP, Anderson ER. Brave men and timid women? A review of the gender differences in fear and anxiety. Clin Psychol Rev. 2009;29:496–505.
18. McLean CP, Asnaani A, Litz BT, Hofmann SG. Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. J Psychiatr Res. 2011;45:1027–35.
19. Kessler RC, McGonagle KA, Swartz M, Blazer DG, Nelson CB. Sex and depression in the National Comorbidity Survey I: lifetime prevalence, chronicity and recurrence. J Affect Disord. 1993;29:85–96.

20. Altemus M, Sarvaiya N, Neill Epperson C. Sex differences in anxiety and depression clinical perspectives. Front Neuroendocrinol. 2014;35:320–30.
21. Deacon BJ, Abramowitz JS, Woods CM, Tolin DF. The Anxiety Sensitivity Index - revised: psychometric properties and factor structure in two nonclinical samples. Behav Res Ther. 2003;41:1427–49.
22. Maeng LY, Milad MR. Sex differences in anxiety disorders: interactions between fear, stress, and gonadal hormones. Horm Behav. 2015;76:106–17.
23. Matud MP. Gender differences in stress and coping styles. Personal Individ Differ. 2004;37:1401–15.
24. Pang RD, Zvolensky MJ, Schmidt NB, Leventhal AM. Gender differences in negative reinforcement smoking expectancies. Nicotine Tob Res. 2015;17:750–4.
25. Perkins KA, Karelitz JL, Giedgowd GE, Conklin CA. Negative mood effects on craving to smoke in women versus men. Addict Behav. 2013;38:1527–31.
26. Wray JM, Gray KM, Mcclure EA, Carpenter MJ, Tiffany ST, Saladin ME. Gender differences in responses to cues presented in the natural environment of cigarette smokers. Nicotine Tob Res. 2014;17:438–42.
27. Leventhal AM, Zvolensky MJ. Anxiety, depression, and cigarette smoking: a transdiagnostic vulnerability framework to understanding emotion-smoking comorbidity. Psychol Bull. 2015;141:176–212.
28. 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 Tob Res. 2012;14:1418–25.
29. Hearon BA, Utschig AC, Smits JAJ, Moshier SJ, Otto MW. The role of anxiety sensitivity and eating expectancy in maladaptive eating behavior. Cogn Ther Res. 2013;37:923–33.
30. Kozak AT, Davis J, Brown R, Grabowski M. Are overeating and food addiction related to distress tolerance? An examination of residents with obesity from a U.S. metropolitan area. Obes Res Clin Pract. 2017;11:287–98.
31. Forman EM, Butryn ML, Hoffman KL, Herbert JD. An open trial of an acceptance-based behavioral intervention for weight loss. Cogn Behav Pract. 2009;16:223–35.
32. Isasi CR, Ostrovsky NW, Wills TA. The association of emotion regulation with lifestyle behaviors in inner-city adolescents. Eat Behav. 2013;14:518–21.
33. Grunberg NE, Straub RO. The role of gender and taste class in the effects of stress on eating. Health Psychol. 1992;11:97–100.
34. Hearon BA, Quatromoni PA, Mascoop JL, Otto MW. The role of anxiety sensitivity in daily physical activity and eating behavior. Eat Behav. 2014;15:255–8.
35. Gifford EV, Lillis J. Avoidance and inflexibility as a common clinical pathway in obesity and smoking treatment. J Health Psychol. 2009;14:992–6.
36. Farris SG, Zvolensky MJ, Robles Z, Schmidt NB. Examining substance use and affective processes as multivariate risk factors associated with overweight body mass among treatment-seeking smokers. Psychol Health Med. 2015;20:846–57.
37. Bernstein A, Zvolensky MJ, Vujanovic AA, Moos R. Integrating anxiety sensitivity, distress tolerance, and discomfort intolerance: a hierarchical model of affect sensitivity and tolerance. Behav Ther. 2009;40:291–301.
38. Fagerström K. Determinants of tobacco use and renaming the FTND to the Fagerström test for cigarette dependence. Nicotine Tob Res. 2012:75–8.
39. Simons JS, Gaher RM. The distress tolerance scale: development and validation of a self-report measure. Motiv Emot. 2005;29:83–102.
40. Leyro TM, Bernstein A, Vujanovic AA, McLeish AC, Zvolensky MJ. Distress tolerance scale: a confirmatory factor analysis among daily cigarette smokers. J Psychopathol Behav Assess. 2011;33:47–57.
41. Taylor S, Zvolensky MJ, Cox BJ, Deacon B, Heimberg RG, Ledley DR, et al. Robust dimensions of anxiety sensitivity: development and initial validation of the Anxiety Sensitivity Index-3. Psychol Assess. 2007;19:176–88.
42. Farris SG, DiBello AM, Allan NP, Hogan J, Schmidt NB, Zvolensky MJ. Evaluation of the anxiety sensitivity index-3 among treatment-seeking smokers. Psychol Assess. 2015;27.
43. Kline RB. Principles and practice of structural equation modeling. Struct Equ Model. 2011.
44. Hooper D, Coughlan J, Mullen MR. Structural equation modeling: guidelines for determining model fit. Electron J Bus Res Methods. 2008;6:53–60.
45. Kenny DA. Measuring model fit. 2015. Retreived from http://davidakenny.net/cm/fit.htm. Accessed 17 Feb 2018.
46. Hayes A. Introduction to mediation, moderation, and conditional process analysis. New York: Guilford; 2013. p. 3–4.
47. Aiken LS, West SG. Multiple regression. Mult. Regres. Test. Interpret. Interact. 1991.
48. Cohen J, Cohen P, West SG, Aiken L. Applied multiple regression/correlation analysis for the behavioral sciences. 2nd ed. Hillsdale: Lawrence Erlbaum Assoc; 2003.
49. Farris SG, Paulus DJ, Gonzalez A, Mahaffey BL, Bromet EJ, Luft BJ, et al. Posttraumatic stress symptoms and body mass index among World Trade Center disaster-exposed smokers: a preliminary examination of the role of anxiety sensitivity. Psychiatry Res. 2016;241:135–40.
50. Lasser K, Boyd JW, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: a population-based prevalence study. J Am Med Assoc. 2000;284:2606.
51. Volkow ND, Wang GJ, Tomasi D, Baler RD. The addictive dimensionality of obesity. Biol Psychiatry. 2013;73:811–8.
52. Bergman RN, Stefanovski D, Buchanan TA, Sumner AE, Reynolds JC, Sebring NG, et al. A better index of body adiposity. Obesity. 2011;19:1083–9.
53. Aust F, Diedenhofen B, Ullrich S, Musch J. Seriousness checks are useful to improve data validity in online research. Behav Res Methods. 2013;45:527–35.
54. LaRowe TL, Piper ME, Schlam TR, Fiore MC, Baker TB. Obesity and smoking: comparing cessation treatment seekers with the general smoking population. Obesity. 2009;17:1301–5.
55. Abrantes AM, Strong DR, Lejuez CW, Kahler CW, Carpenter LL, Price LH, et al. The role of negative affect in risk for early lapse among low distress tolerance smokers. Addict Behav. 2008;33:1394–401.
56. Farris SG, Zvolensky MJ, Otto MW, Leyro TM. The role of distress intolerance for panic and nicotine withdrawal symptoms during a biological challenge. J Psychopharmacol. 2015;29:783–91.
57. Zvolensky MJ, Garey L, Allan NP, Farris SG, Raines AM, Smits JAJ, et al. Effects of anxiety sensitivity reduction on smoking abstinence: an analysis from a panic prevention program. J Consult Clin Psychol. 2018;86:474–85.
58. Bloom EL, Wing RR, Kahler CW, Thompson JK, Meltzer S, Hecht J, et al. Distress tolerance treatment for weight concern in smoking cessation among women: The WE QUIT Pilot Study. Behav Modif. 2017;41:468–98.