HHS Public Access

Author manuscript

Addict Behav. Author manuscript; available in PMC 2017 February 01.

Published in final edited form as:

Addict Behav. 2016 February ; 53: 46–52. doi:10.1016/j.addbeh.2015.09.018.

Psychosocial and Metabolic Function by Smoking Status in Individuals with Binge Eating Disorder and Obesity

Tomoko Udo, Ph.D.[1], **Marney A. White, Ph.D.**[2], **Rachel D. Barnes**[2], **Valentina Ivezaj, Ph.D.**[2], **Peter Morgan, M.D.**[2], **Robin M. Masheb, Ph.D.**[2], and **Carlos M. Grilo, Ph.D.**[2,3]

[1] School of Public Health, University at Albany, State University of New York, Rensselaer, NY

[2] Yale University School of Medicine, New Haven, CT

[3] CASAColumbia, New Haven, CT

Abstract

Individuals with binge eating disorder (BED) report smoking to control appetite and weight. Smoking in BED is associated with increased risk for comorbid psychiatric disorders, but its impact on psychosocial functioning and metabolic function has not been evaluated. Participants were 429 treatment-seeking adults (72.4% women; mean age 46.2 ± 11.0 years old) with BED comorbid with obesity. Participants were categorized into current smokers (*n* = 66), former smokers (*n* = 145), and never smokers (*n* = 218). Smoking status was unrelated to most historical eating/weight variables and to current eating disorder psychopathology. Smoking status was associated with psychiatric, psychosocial, and metabolic functioning. Compared with never smokers, current smokers were more likely to meet lifetime diagnostic criteria for alcohol (OR = 5.51 [95% CI = 2.46–12.33]) and substance use disorders (OR = 7.05 [95% CI = 3.37–14.72]), poorer current physical quality of life, and increased risk for metabolic syndrome (OR = 1.80 [95% CI = 0.97–3.35]) and related metabolic risks (reduced HDL, elevated total cholesterol). On the other hand, the odds of meeting criteria for lifetime psychiatric comorbidity or metabolic abnormalities were not significantly greater in former smokers, relative to never smokers. Our findings suggest the importance of promoting smoking cessation in treatment-seeking patients with BED and obesity for its potential long-term implications for psychiatric and metabolic functioning.

Keywords

Smoking; binge eating disorder; obesity; comorbidity; metabolic syndrome

1. Introduction

Binge eating disorder (BED), a formal diagnosis in the *DSM-5*. BED is defined by recurring episodes of binge eating (eating unusually large amount of food accompanied by feelings of loss of control) and marked distress but without extreme weight compensatory behaviors

Corresponding Author: Tomoko Udo, Ph.D.; 1 University Place, Rensselaer, NY 12144; Phone: 518-486-5572; Fax: 518-402-0414; tschaller@albany.edu..

(such as purging) that characterize bulimia nervosa (American Psychiatric Association, 2013). BED is more prevalent than other forms of eating disorders (Hudson, Hiripi, Pope, & Kessler, 2007; Kessler et al., 2013). It is strongly associated with the severity of obesity (Hudson et al., 2007), which is one of the risk factors for cardiovascular diseases, type-II diabetes, and certain cancers (Kessler et al., 2013; Ogden, Yanovski, Carroll, & Flegal, 2007). High comorbidity between BED and other psychiatric disorders, including anxiety disorders, mood disorders, and substance use disorders (SUD), have also been reported (Hudson et al., 2007; Kessler et al., 2013). In addition, maladaptive eating patterns associated with BED (e.g., meal skipping, irregular meal consumption) have been linked to metabolic abnormalities (Roehrig, Masheb, White, & Grilo, 2009; Sierra-Johnson et al., 2008). BED has also been found to be a psychiatric disorder with significant impact on the quality of life in general (Baiano et al., 2014; Winkler et al., 2014).

Binge eating has been associated with increased risk for cigarette smoking (Kelly-Weeder, Jennings, & Wolfe, 2012; Kelly-Weeder, Phillips, Leonard, & Veroneau, 2014). Cigarette smoking suppresses appetite and reduces energy intake and expenditure at a cellular level (Chen, Saad, Sandow, & Bertrand, 2012). Thus, cigarette smoking as an unhealthy weight control method has been long documented among smokers, particularly among women (Pomerleau et al., 1993). Weight and appetite control by cigarettes appears to be also common among individuals with disordered eating (Camp, Klesges, & Relyea, 1993; Klesges, Elliott, & Robinson, 1997; Pomerleau et al., 1993; White, 2012). Smokers with weight-concerns reported stronger beliefs in the effectiveness of cigarette in weight control, and the association was particularly strong for those with a history of disordered eating, including binge eating (White, McKee, & O'Malley S, 2007). Furthermore, compensatory smoking (i.e., smoking in reaction to an undesired behavior) has been associated with frequency of binge eating (White, 2012). Thus, although those with BED do not engage in weight compensatory behaviors, such as vomiting, that are used to counteract the effects of binge eating (American Psychiatric Association, 2013), smoking may still be used as a method of appetite and weight control, and may partly explain the comorbidity between BED and smoking.

Despite strong associations between smoking and binge eating, very few studies have specifically investigated the combined problems of smoking and BED. Among 103 females with BED and obesity, White and Grilo (2006) found higher rates of comorbid depressive disorder, panic disorder, posttraumatic disorder, and substance use disorders in lifetime daily female smokers with BED, compared with females who never smoked. Another study with 91 females with BED and obesity also reported that former female smokers were more likely to report rigid dieting strategies than females who never smoked with BED (White & Grilo, 2007). These studies suggest that there are important differences among individuals with BED based upon smoking status.

The impact of comorbid BED and smoking has not been evaluated beyond comorbid psychiatric disorders and features of eating disorders. In addition, due to small sample sizes, the previous studies were not able to examine the differences between current and former smoking history. Poorer health-related quality of life, which is defined as physical, psychological, and social well-being (World Health Organization, 1948), has been shown in

current smokers compared with former and never smokers (McClave, Dube, Strine, & Mokdad, 2009; Sarna, Bialous, Cooley, Jun, & Feskanich, 2008). In addition, a recent population-based study in the Netherlands reported that smoking increased risk for metabolic syndrome (MetS), particularly among those who are overweight and obese (Slagter et al., 2013). The study also found that MetS rates were lower in former smokers than current heavy smokers, although their rate was higher than non-smokers. Thus, a smoking history may moderate the impact of BED on health-related outcomes other than eating disorder features and psychiatric comorbidity. This is an important question since it informs of the types of additional screening and intervention needed by those with BED.

In sum, the present study aimed to further expand our knowledge regarding the role of smoking history in BED by: 1) comparing current, former, and never smokers rather than a lifetime smoking history on clinical presentation of BED and associated psychosocial and metabolic measures, and 2) evaluating psychosocial functioning and metabolic measures, in addition to current eating disorder features and psychiatric comorbidity.

2. Methods and materials

2.1. Participants

Participants were 429 respondents (311 women, 118 men; mean age 46.2 ± 11.0 years old) to an advertisement for treatment studies for BED with obesity All participants were obese (BMI ≥ 30 kg/m^2), and met *DSM-5* criteria for BED. Exclusion criteria were: current anti-depressant therapy, severe psychiatric problems (lifetime bipolar disorders and schizophrenia), current substance use dependence (current substance abuse or lifetime abuse/dependence was not excluded), severe medical problems (e.g., cardiac and liver diseases), and uncontrolled hypertension, thyroid conditions, or diabetes. Mean body mass index (BMI) was 38.2 (*SD* = 6.5). 74.2% were women, and racial/ethnic composition was 72.4% Caucasian, 16.1% African American, and 11.6% Hispanic/other. 18.4% completed high school, 34.7% attended some college, and 42.1% completed college. Written informed consent was obtained from participants and the research was approved by the Yale Human Investigation Committee.

2.2. Measures

2.2.1. Diagnosis of psychiatric disorders—The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I/P; First, Spitzer, Gibbon, & Williams, 1995) was used to assess DSM-IV axis I psychiatric disorders mood disorders (non-bipolar disorders), anxiety disorders, alcohol use disorders (AUD), and substance use disorders (SUD), which included both alcohol and/or other drug use problems. The diagnosis of BED was determined using DSM-5 criteria based on converging findings from the SCID-I/P and the Eating Disorder Examination interview (EDE; Fairburn & Cooper, 1993) (described below).

2.2.2. Definition of smoking history—Participants were categorized as a current smoker if they answered “yes” to the question, “Do you currently smoke cigarettes?” Participants were categorized as a former smoker if the participants answered “no” to this question, but said “yes” to the question, “In your entire life, have you smoked at least 100

cigarettes?," or provided a specific answer to the question, "When did you stop smoking cigarettes regularly?" Those who answered "no" to all of the above questions were defined as a never smoker. The questionnaire also asked the age when participants began to smoke cigarettes regularly, and the number and frequency of cigarettes per day during the heaviest smoking period.

2.2.3. History of BED and features of eating disorders—The EDE (Fairburn & Cooper, 1993) interview assesses eating disorders and their features. The EDE focuses on the frequency of different forms of overeating in the past 28 days, including objective bulimic episodes (i.e., binge eating defined as consuming unusually large quantities of food coupled with a subjective sense of loss of control). The EDE comprises four subscales (Restraint, Eating Concern, Shape Concern, and Weight Concern) and a global score. The items assessing these four scales are rated on a 7-point scale (0–6), with higher scores reflecting greater severity or frequency. The EDE interview is a well-established measure (Grilo, Masheb, & Wilson, 2001) with good inter-rater and test-retest reliability in individuals with BED (Grilo, Masheb, Lozano-Blanco, & Barry, 2004).

The Questionnaire for Eating and Weight Patterns-Revised (QEWP-R; Yanovski, Nelson, Dubbert, & Spitzer, 1993), used in the DSM-IV field trials for BED, assesses the age of first becoming overweight (by at least 10 lbs as a child or 15 lbs as an adult except for pregnancy), age of binge eating onset, and age of dieting onset.

The Weight and Eating History Interview is a structured clinical interview to assess current and historical obesity-related variables of interest, including a total number of times they tried dieting, and number of times they tried supervised diets.

The Emotional Overeating Questionnaire (EOQ; Masheb & Grilo, 2006) is a self-report questionnaire that assesses the frequency of eating an unusually large amount of food in response to nine different emotions in the past 28 days. Participants rated the frequency of overeating in response to each emotion on a 7-point scale (0 = no days, 1 = 1-5 days, 2 = 6-12 days, 3 = 13-15 days, 4 = 16-22 days, 5 = 23-27 days, and 6 = everyday). The mean of the nine components was calculated as a global emotional eating score. The validity and reliability of EOQ in BED patients have previously been established (Masheb & Grilo, 2006). The internal consistency of EOQ scale for this study was high (Cronbach's alpha = 0.86).

2.2.4. Psychosocial functioning—Perceived Stress Scale (PSS) assesses the perception of stress based on 10 questions about thoughts and feelings in the past month (Cohen, 1988), with demonstrated validity associated with diverse health behaviors including disrupted eating (Striegel-Moore et al., 2007). The participants were asked to rate their feelings on a 4-point Likert scale (0 = never to 4 = very often; score range = 0-40). The internal consistency of EOQ scale for this study was high (Cronbach's alpha = 0.82).

The Beck Depression Inventory (BDI; Beck & Steer, 1987; Beck & Steer, 1993) is a psychometrically sound, widely used measure of the features of depression, and its psychometric properties have been established in various clinical and non-clinical

populations (Beck, Steer, & Garbin, 1988). The BDI consists of 21 questions regarding levels and symptoms of depression in the past week. Higher scores reflect higher levels of depression and negative affect. The internal consistency of BDI for this study was high (Cronbach's alpha = 0.90).

The 36-Item Short Form Survey (SF-36) consists of 36 questions regarding health-related quality of life (Ware & Sherbourne, 1992), with well-established reliability and validity (McHorney, Ware, Lu, & Sherbourne, 1994; McHorney, Ware, & Raczek, 1993). For the current study, we calculated physical and mental component summaries (standardized score range = 0-100, with a mean of 50 with a standard deviation of 10 [i.e., t-score]).

2.2.5. Metabolic measures—Participants' height was measured and weight was determined using a high capacity digital scale; these measurements were used to calculate BMI. Patients were instructed to wear light clothing and remove their shoes. Waist circumference, heart rate, and blood pressure were measured by trained research staff. For heart rate and blood pressure, the average of two measurements was calculated. Fasting lipid profile (total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides), glucose levels, and glycated hemoglobin A1c (HbA1c) were obtained through serum samples analyzed by Quest Diagnostics (Madison, New Jersey). Individuals were categorized as having metabolic syndrome (MetS) if they had three or more of the five criteria outlined by the National Cholesterol Education Program's Adult Treatment Panel III guidelines (2001): a) Central or abdominal obesity (> 40 inches for men, > 35 inches for women); b) Triglycerides ≥ 150 mg/dL; c) Reduced HDL cholesterol (< 40 mg/dL for men, < 50 mg/dL for women); d) Systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg; and e) Fasting glucose ≥ 110 mg/dL.

2.3. Analysis

Analysis of variance (ANOVA; for continuous variables) and chi-square tests (for categorical variables) were used to compare features of eating disorders, psychosocial characteristics, and metabolic measures among current smokers, former smokers, and never smokers. For significant omnibus ANOVA tests, Tukey-Kramer post-hoc comparison was used to probe the significant differences between smoking groups. For significant omnibus chi-square tests, we used comparing cells approach to probe the significant differences between smoking groups (Marascuilo & Serlin, 1988; Sharpe, 2015). Logistic regression was used to calculate odds ratios for having a positive lifetime SCID diagnosis for other psychiatric disorders, and meeting clinical criteria for metabolic abnormalities, with never smokers as a reference group. Due to the exploratory nature of the study, the current study did not correct for family-wise errors.

3. Results

3.1. Smoking group categorization

A total of 66 individuals (15.4%) reported they currently smoke cigarettes. 145 individuals (33.8%) reported they used to smoke but successfully quit smoking. 218 individuals (50.8%) reported that they never smoked in their lifetime. Current smokers were significantly

younger than former and never smokers (Table 1). Current and former smokers did not significantly differ in average age onset of regular smoking, the highest number of cigarettes per day, or frequency of smoking. A chi-square test for racial/ethnicity composition was significantly different by the smoking status; former and never smokers consisted primarily of Caucasians (68.1% and 65.0%, respectively) whereas the proportions of Caucasians and African Americans were similar in current smokers (45.5% and 42.4%, respectively). Post-hoc cell comparisons indicated that the proportion of African Americans was significantly greater in current smokers than former smokers. Current smokers were also less educated, compared with former and never smokers; 46.9% of former smokers and 47.3% of never smokers completed college education whereas 13.6% of current smokers completed college education. Post-hoc cell comparisons indicated that a significantly less proportion of current smokers completed college educations than former and never smokers. Therefore, we included age, race, and education as covariates in the subsequent analyses. Sex was also included as a covariate due to known sex differences in smoking-related behaviors (Waldron, 1991), and the previous findings on greater risk for metabolic abnormalities in men than women with BED (Blomquist et al., 2012; Roehrig et al., 2009; Udo et al., 2013).

3.2. History of BED and features of eating disorders

There were few significant differences in history of eating disorders and features of eating disorders (Table 2). EDE Restraint differed significantly by smoking status, $F(2, 411) = 3.25$, $p = .04$; there was a statistical trend for former smokers to report greater dietary restraint than current smokers ($p = .06$). EOQ score also differed by smoking status, $F(2, 417) = 3.57$, $p = .03$. Current smokers reported significantly more frequent emotional overeating than the never smokers.

3.3. Psychosocial functioning and comorbid psychiatric disorders

Current smokers reported significantly poorer physical functioning component than never smokers, $F(2, 415) = 3.05$, $p = .04$. There were no other significant differences in psychosocial functioning BDI, perceived stress, and SF-36 mental health component by smoking status (all p's > .05).

Compared with never smokers, a significantly greater proportion of current smokers and former smokers met diagnostic criteria (current abuse or lifetime abuse and dependence) for AUD, $\chi^2(2) = 16.45$, $p < .01$, and SUD, $\chi^2(2) = 30.94$, $p < .01$ (Table 3). Adjusting for covariates, current smokers were more likely to meet diagnostic criteria for AUD (OR = 5.51 [95% CI = 2.46-12.33], $p < .01$) and SUD (OR = 7.05 [95% CI = 3.37-14.72], $p < .01$). Current smokers and never smokers did not significantly differ in the likelihood of meeting diagnostic criteria for mood or anxiety disorder. Former smokers and never smokers were not significantly different in the likelihood of meeting diagnostic criteria for any comorbid psychiatric disorders (all p's > .05).

3.4. Metabolic Measures

Compared with former and never smokers, current smokers showed significantly lower HDL, $F(2, 387) = 5.74$, $p < .01$ (Table 4). Accordingly, significantly greater proportion of current smokers showed clinically reduced levels of HDL, compared with former and never

smokers, $\chi^2(2) = 8.61$, $p < .05$. A significantly greater proportion of former smokers showed clinically elevated fasting glucose level than never smokers, $\chi^2(2) = 13.55$, $p < .01$ (Table 4).

Multiple logistic regressions adjusting for covariates revealed that current smokers were more likely to meet clinical criteria for elevated total cholesterol levels (OR = 2.20 [95% CI = 1.20-4.02], $p = .04$) and MetS (OR = 1.80 [95% CI = 0.97-3.35], $p = .03$), compared with never smokers. There were no other significant differences in the likelihood for having metabolic abnormalities between current and never smokers (all *p's* > .05). The likelihood of meeting clinical criteria for metabolic abnormalities did not significantly differ between former and never smokers (all *p's* > .05).

4. Discussion

The present study compared history of BED, current features of eating disorder, psychosocial functioning, psychiatric comorbidity, and metabolic measures by smoking status among individuals seeking treatment for BED comorbid with obesity. Overall, increased odds of metabolic abnormalities were found in BED patients who are also current smokers, but not in patients who are former smokers, which suggests a potential benefit of smoking cessation. The rate of MetS in the current study was similar to that of previous studies with comorbid obesity and BED (Blomquist et al., 2012; Roehrig et al., 2009; Udo et al., 2013). All smoking groups showed higher rates of MetS (32.9% [never smokers], 40.0% [former smokers], and 48.5% [current smokers]) than the age-adjusted rate of MetS in the U.S. adult population (23.4%; Ford, Giles, & Dietz, 2002). Yet, a greater proportion of current smokers also met clinical criteria for reduced levels of HDL cholesterol, compared with former and never smokers. Adjusting for age, sex, and other demographic information, compared with never smokers, current smokers were 1.8 times more likely to show clinically elevated total cholesterol levels and 2.2 times more likely to meet criteria for MetS.

On the other hand, the odds of having metabolic abnormalities were not significantly elevated for former smokers, compared with never smokers. This contrasts with a recent population-based study in the Netherlands and a meta-analysis on the association between smoking and MetS that reported significantly higher risk for MetS in former smokers than never smokers (Lasser et al., 2000; White & Grilo, 2007). These studies also reported the risk for MetS was significantly lower risk for MetS in former smokers than current smokers. In our study, former smokers reported significantly higher frequency of dieting behavior, compared with never and current smokers. Frequent dieting has been associated with lower risk for having metabolic abnormalities in individuals with BED and obesity (Blomquist et al., 2012). Furthermore, in line with White and Grilo (2007), which reported more rigid dieting strategies in former female smokers with comorbid obesity and BED, former smokers also showed statistical trend for higher levels of dietary restraint than current smokers. Therefore, our findings that the likelihood of having MetS was not significantly different between former smokers relative to never smokers may perhaps be attributable to their rigorous effort to regulate food intake.

Studies have also reported the association between binge eating and poor smoking cessation outcomes, as well as weight gain after smoking cessation (White, Masheb, & Grilo, 2010; White, Peters, & Toll, 2010). Our new findings observed for BED, when considered alongside those reported poorer outcomes for smoking cessation programs, suggest that clinicians should assess for smoking behaviors in their patients with BED and obesity. Clinically, there is some support for addressing both smoking and eating/weight concerns emerging from controlled treatment research with CBT (Levine, et al., 2010). Although such methods have not yet been tested specifically with obese patients with BED who smoke, simultaneously addressing disordered eating, weight/shape concerns, and smoking seems logical and may enhance treatment outcomes.

Only few differences were found in history of BED and features of eating disorder by smoking status. Current smokers reported poorer physical quality of life and were more likely to meet lifetime diagnosis for AUD and SUD compared with never smokers. When adjusting for age, gender, and other socioeconomic variables, current smokers in this study were 5.5 times more likely to meet criteria for lifetime AUD and 7.1 times more likely to meet criteria for lifetime SUD, compared with never smokers. The prevalence of AUD and SUD in our current smokers, however, is similar to the rates reported in the U.S. population studies whereas the prevalence was lower in former and never smokers (Lasser et al., 2000; Smith, Mazure, & McKee, 2014). This again highlights how self-report of current smoking may also signal other health risk behaviors. Neither current nor former smokers, however, showed elevated risk for mood disorder or anxiety disorder. These patterns of psychiatric comorbidity appear different from a previous study that reported elevated prevalence of comorbid depressive disorder, panic disorder, and posttraumatic disorder in women with BED (White & Grilo, 2006). Whereas White and Grilo (2006) focused on women with eating disorders, the current study included both sexes. Sex difference in the prevalence of BED is substantially small relative to other eating disorders (2.0% in men vs. 3.0% in women; Hudson et al., 2007) and studies have reported few significant sex differences in the severity of BED (Barry, Grilo, & Masheb, 2002; Guerdjikova, McElroy, Kotwal, & Keck, 2007). Yet, men are underrepresented in clinical studies of this disorder (Franko et al., 2012). Another distinct strength of the present study was a large sample size that allowed comparison of current, former, and never smokers, rather than a comparison of lifetime smokers vs. never smokers (e.g., White & Grilo, 2006). Collectively, differences in the sample characteristics and operationalization of smoking status might have contributed to inconsistent findings. Further research is needed to clarify smoking-by-sex interaction and comorbid psychiatric disorders by smoking status in individuals with obesity and BED.

There are also several limitations upon interpretation of the current study. Our study findings may not be generalizable to non-treatment seeking or younger individuals with BED, or individuals with BED who are normal weight or overweight. Exclusion of those who are taking anti-depressant or who are diagnosed with severe psychiatric issues might have also affected our findings on comorbid psychiatric disorders. Current substance and alcohol dependence was also exclusion criteria for this study, which might have led to underestimation of SUD and AUD. We note, however, that only few individuals were excluded from the study due to meeting current dependence criteria. In addition, exclusion of individuals with uncontrolled diabetes and hypertension might have contributed to

underestimation of individuals with MetS in the current study. Our smoking assessment protocol was general in nature and failed to capture extensive smoking behavior data as the study was not designed to examine the dose-response relationship between smoking (i.e., frequency and quantity of smoking or severity of nicotine dependence) and psychosocial and metabolic function. Combining individuals with different levels of cigarette smoking might have contributed to some of the non-significant differences between smoking groups. Thus, whether duration of smoking cessation and levels of smoking (heavy vs. light smoking) were related with metabolic abnormalities would be an interesting question to investigate for future studies. Smoking status was defined based on self-report, and thus confirmation with biological indicators of smoking status (e.g., CO readings, urine CO levels) would have strengthened the study. It is also worth mentioning that compared with former and never smokers, a larger proportion of current smokers were racial minorities and lower education. Although we have controlled these differences in the analyses, such basic socioeconomic differences by smoking status suggest that efforts to address comorbid smoking and BED in clinics and hospitals serving low socioeconomic status areas may also have significant clinical and public health implications.

In summary, in this treatment-seeking patient group with BED comorbid with obesity, current smokers were characterized by elevated physical and psychiatric problems, including increase risk for MetS and comorbid AUD and SUD, and impaired physical quality of life. In contrast, former smokers did not show significantly elevated risk for metabolic abnormalities or comorbid AUD and SUD. This is the first study to report the association between active cigarette smoking and elevated risk for MetS in individuals with obesity and BED. Obesity and maladaptive eating behaviors associated with BED are linked with increased risk for MetS (Roehrig et al., 2009; Sierra-Johnson et al., 2008). Therefore, comorbidity between BED, obesity, and smoking can potentially have serious long-term health implications due to the strong relationship of MetS with cardiovascular diseases and type-II diabetes (Isomaa et al., 2001). Thus, screening for smoking status in individuals with BED and obesity is indicated, and providing support for smoking cessation may be beneficial.

Acknowledgements

This research was supported, in part, by grants from the National Institutes of Health (K24 DK070052, R01 DK49587, K12 DA031050, K23 DK092279); Dr. Grilo was also supported, in part, by CASA Columbia. The funding agencies and sources had no role in the preparation or the content of this paper.

TU performed the analyses and led the writing of the manuscript. CMG conceived and carried out the study. MAW, RDB, VI, PM, and RMM carried out the study. All authors were involved in writing the paper and had final approval of the submitted manuscript.

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th. Washington, D. C.: 2013.

Baiano M, Salvo P, Righetti P, Cereser L, Baldissera E, Camponogara I, Balestrieri M. Exploring health-related quality of life in eating disorders by a cross-sectional study and a comprehensive review. BMC Psychiatry. 2014; 14:165. doi: 10.1186/1471-244x-14-165. [PubMed: 24898768]

Barry DT, Grilo CM, Masheb RM. Gender differences in patients with binge eating disorder. International Journal of Eating Disorders. 2002; 31(1):63–70. [PubMed: 11835299]

Beck, AT.; Steer, R. Manual for revised Beck Depression Inventory. Psychological Corporation; New York: 1987.

Beck AT, Steer R, Garbin M. Psychometric properties of the Beck Depression Inventory: 25 years of evaluation. Clinical Psychology Review. 1988; 8:77–100.

Beck, AT.; Steer, RA. Manual for the Beck Depression Inventory. Psychological Corporation; San Antonio, TX: 1993.

Blomquist KK, Milsom VA, Barnes RD, Boeka AG, White MA, Masheb RM, Grilo CM. Metabolic syndrome in obese men and women with binge eating disorder: Developmental trajectories of eating and weight-related behaviors. Comprehensive Psychiatry. 2012; 53(7):1021–1027. doi: 10.1016/j.comppsych.2012.02.006. [PubMed: 22483368]

Camp DE, Klesges RC, Relyea G. The relationship between body weight concerns and adolescent smoking. Health Psychology. 1993; 12(1):24–32. [PubMed: 8462495]

Chen H, Saad S, Sandow SL, Bertrand PP. Cigarette smoking and brain regulation of energy homeostasis. Front Pharmacol. 2012; 3:147. doi: 10.3389/fphar.2012.00147. [PubMed: 22848202]

Cohen, S. Perceived stress in a probability sample of the United States. In: Spacapan, SE., editor. The social psychology of health. Sage Publications, Inc.; Thousand Oaks, CA: 1988. p. 31-67.

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA. 2001; 285(19):2486–2497. [PubMed: 11368702]

Fairburn, CG.; Cooper, Z., editors. The Eating Disorder Examination. 12th. Guilford Press; New York, NY: 1993.

First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JBW. Structured Clinical Interview for DSM-IV, Patient Edition. American Psychiatric Press; Washington, D. C.: 1995.

Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: Findings from the third National Health and Nutrition Examination Survey. JAMA. 2002; 287(3):356–359. [PubMed: 11790215]

Franko DL, Thompson-Brenner H, Thompson DR, Boisseau CL, Davis A, Forbush KT, Wilson GT. Racial/ethnic differences in adults in randomized clinical trials of binge eating disorder. Journal of Consulting and Clinical Psychology. 2012; 80(2):186–195. doi: 10.1037/a0026700. [PubMed: 22201327]

Grilo CM, Masheb RM, Lozano-Blanco C, Barry DT. Reliability of the Eating Disorder Examination in patients with binge eating disorder. International Journal of Eating Disorders. 2004; 35:80–85. [PubMed: 14705160]

Grilo CM, Masheb RM, Wilson GT. Different methods for assessing the features of eating disorders in patients with binge eating disorder: A replication. Obesity Research. 2001; 9:418–422. [PubMed: 11445665]

Guerdjikova AI, McElroy SL, Kotwal R, Keck PE Jr. Comparison of obese men and women with binge eating disorder seeking weight management. Eating and Weight Disorders. 2007; 12(1):e19–23. [PubMed: 17384521]

Hudson JI, Hiripi E, Pope HG Jr. Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. Biological Psychiatry. 2007; 61(3):348–358. doi: 10.1016/j.biopsych.2006.03.040. [PubMed: 16815322]

Isomaa B, Almgren P, Tuomi T, Forsen B, Lahti K, Nissen M, Groop L. Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care. 2001; 24(4):683–689. [PubMed: 11315831]

Kelly-Weeder S, Jennings KM, Wolfe BE. Gender differences in binge eating and behavioral correlates among college students. Eating and Weight Disorders. 2012; 17(3):e200–202. [PubMed: 23086256]

Kelly-Weeder S, Phillips K, Leonard K, Veroneau M. Binge eating and weight loss behaviors of overweight and obese college students. Journal of the American Association of Nurse Practitioners. 2014; 26(8):445–451. doi: 10.1002/2327-6924.12070. [PubMed: 24170676]

Kessler RC, Berglund PA, Chiu WT, Deitz AC, Hudson JI, Shahly V, Xavier M. The prevalence and correlates of binge eating disorder in the World Health Organization World Mental Health Surveys. Biological Psychiatry. 2013; 73(9):904–914. doi: 10.1016/j.biopsych.2012.11.020. [PubMed: 23290497]

Klesges RC, Elliott VE, Robinson LA. Chronic dieting and the belief that smoking controls body weight in a biracial, population-based adolescent sample. Tobacco Control. 1997; 6(2):89–94. [PubMed: 9291216]

Lasser K, Boyd JW, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: A population-based prevalence study. JAMA. 2000; 284(20):2606–2610. [PubMed: 11086367]

Levine MD, Perkins KA, Kalarchian MA, Cheng Y, Houck PR, Slane JD, Marcus MD. Bupropion and cognitive behavioral therapy for weight-concerned women smokers. Archives of Internnal Medicine. 2010; 170:543–550.

Marascuilo, LA.; Serlin, RC. Statistical methods for the social and behavioral sciences. W. H. Freeman; New York: 1988.

Masheb RM, Grilo CM. Emotional overeating and its associations with eating disorder psychopathology among overweight patients with binge eating disorder. Intternational Journal of Eating Disorders. 2006; 39(2):141–146. doi: 10.1002/eat.20221.

McClave AK, Dube SR, Strine TW, Mokdad AH. Associations between health-related quality of life and smoking status among a large sample of U.S. adults. Prev Med. 2009; 48(2):173–179. doi: 10.1016/j.ypmed.2008.11.012. [PubMed: 19103219]

McHorney CA, Ware JE Jr. Lu JF, Sherbourne CD. The MOS 36-item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. Medical Care. 1994; 32:40–66. [PubMed: 8277801]

McHorney CA, Ware JE Jr. Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Medical Care. 1993; 31:247–263. [PubMed: 8450681]

Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. Gastroenterology. 2007; 132(6):2087–2102. doi: 10.1053/j.gastro.2007.03.052. [PubMed: 17498505]

Pomerleau CS, Ehrlich E, Tate JC, Marks JL, Flessland KA, Pomerleau OF. The female weight-control smoker: a profile. Journal of Substance Abuse. 1993; 5(4):391–400. [PubMed: 8186673]

Roehrig M, Masheb RM, White MA, Grilo CM. The metabolic syndrome and behavioral correlates in obese patients with binge eating disorder. Obesity. 2009; 17(3):481–486. doi: 10.1038/oby.2008.560. [PubMed: 19219063]

Sarna L, Bialous SA, Cooley ME, Jun HJ, Feskanich D. Impact of smoking and smoking cessation on health-related quality of life in women in the Nurses' Health Study. Quality of Life Research. 2008; 17(10):1217–1227. doi: 10.1007/s11136-008-9404-8. [PubMed: 18931942]

Sharpe D. Your chi-square test is statistically significant: Now what. Practical Assessment, Research & Evaluation. 2015; 20

Sierra-Johnson J, Unden AL, Linestrand M, Rosell M, Sjogren P, Kolak M, Hellenius ML. Eating meals irregularly: A novel environmental risk factor for the metabolic syndrome. Obesity. 2008; 16(6):1302–1307. doi: 10.1038/oby.2008.203. [PubMed: 18388902]

Slagter SN, van Vliet-Ostaptchouk JV, Vonk JM, Boezen HM, Dullaart RP, Kobold AC, Wolffenbuttel BH. Associations between smoking, components of metabolic syndrome and lipoprotein particle size. BMC Med. 2013; 11:195. doi: 10.1186/1741-7015-11-195. [PubMed: 24228807]

Smith PH, Mazure CM, McKee SA. Smoking and mental illness in the US population. Tobacco Control. 2014; 23(e2):e147–153. doi: 10.1136/tobaccocontrol-2013-051466. [PubMed: 24727731]

Striegel-Moore RH, Dohm FA, Kraemer HC, Schreiber GB, Taylor CB, Daniels SR. Risk factors for binge-eating disorders: An exploratory study. International Journal of Eating Disorders. 2007; 40(6):481–487. doi: 10.1002/eat.20400. [PubMed: 17573685]

Udo T, McKee SA, White MA, Masheb RM, Barnes RD, Grilo CM. Sex differences in biopsychosocial correlates of binge eating disorder: A study of treatment-seeking obese adults in

primary care setting. General Hospital Psychiatry. 2013; 35(6):587–591. doi: 10.1016/j.genhosppsych.2013.07.010. [PubMed: 23969142]

Waldron I. Patterns and causes of gender differences in smoking. Social Science & Medicine. 1991; 32(9):989–1005. [PubMed: 2047903]

Ware JE Jr. Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Medical Care. 1992; 30(6):473–483. [PubMed: 1593914]

White MA. Smoking for weight control and its associations with eating disorder symptomatology. Comprehensive Psychiatry. 2012; 53(4):403–407. doi: 10.1016/j.comppsych.2011.05.007. [PubMed: 21741037]

White MA, Grilo CM. Psychiatric comorbidity in binge-eating disorder as a function of smoking history. Journal of Clinical Psychiatry. 2006; 67(4):594–599. [PubMed: 16669724]

White MA, Grilo CM. Symptom severity in obese women with binge eating disorder as a function of smoking history. International Journal of Eating Disorders. 2007; 40(1):77–81. doi: 10.1002/eat.20334. [PubMed: 16958111]

White MA, Masheb RM, Grilo CM. Self-reported weight gain following smoking cessation: A function of binge eating behavior. International Journal of Eating Disorders. 2010; 43(6):572–575. doi: 10.1002/eat.20729. [PubMed: 19718662]

White MA, McKee SA, O'Malley S S. Smoke and mirrors: Magnified beliefs that cigarette smoking suppresses weight. Addictive Behaviors. 2007; 32(10):2200–2210. doi: 10.1016/j.addbeh.2007.02.011. [PubMed: 17428615]

White MA, Peters EN, Toll BA. Effect of binge eating on treatment outcomes for smoking cessation. Nicotine & Tobacco Research. 2010; 12(11):1172–1175. doi: 10.1093/ntr/ntq163. [PubMed: 20889472]

Winkler LA, Christiansen E, Lichtenstein MB, Hansen NB, Bilenberg N, Stoving RK. Quality of life in eating disorders: A meta-analysis. Psychiatry Research. 2014; 219(1):1–9. doi: 10.1016/j.psychres.2014.05.002. [PubMed: 24857566]

World Health Organization. Constitution of the World Health Organization. World Health Organization; Geneva: 1948.

Yanovski SZ, Nelson JE, Dubbert BK, Spitzer RL. Association of binge eating disorder and psychiatric comorbidity in obese subjects. American Journal of Psychiatry. 1993; 150(10):1472–1479. [PubMed: 8379549]

Table 1

Participants Characteristics by Smoking Status

	Current smokers (*n* = 66)	Former smokers (*n* = 145)	Never smokers (*n* = 218)
Age †	41.9 (9.6)	48.4 (10.6) *a*	46.0 (11.4) *a*
Female (%)	80.3	73.8	69.4
Race (%) †			
Caucasian	45.5	68.1	65.0
African American	42.4	16.7 *a*	20.7
Hispanic	7.6	7.6	9.7
Other	4.5	4.6	4.6
Education (%) †			
College	13.6	46.9 *a*	47.3 *a*
Some college	40.9	34.3	33.0
High school	33.3	16.8	15.1
Less than high school	12.2	2.0	4.6
Age onset of regular smoking	19.0 (6.1)	17.7 (3.5)	---
Highest number of cigarettes per day	17.7 (12.2)	16.0 (12.9)	---
Highest frequency of smoking (%)			
Every day	82.5	74.5	---
5-6 days a week	7.9	5.7	---
3-4 times per week	3.2	12.8	---
1-2 times per week	4.8	2.8	---
A few times per month or less	1.6	4.3	---

Notes.

† = significant *F*- or chi-square statistics at $p < .05$.

a = significantly different from current smokers.

Table 2

History of BED and Features of Eating Disorder by Smoking Status

	Current Smokers (*n* = 66)	Former Smokers (*n* = 145)	Never Smokers (*n* = 218)
BMI	41.0 (0.93)	39.7 (0.70)	39.2 (0.62)
Age of first time overweight	21.6 (1.56)	22.5 (1.34)	21.4 (1.22)
Age of binge eating onset	26.0 (1.84)	28.5 (1.61)	27.5 (1.44)
Age of dieting onset	28.4 (1.37)	29.2 (1.17)	28.9 (1.05)
# of times on a diet *	15.5 (15.62)	33.0 (13.57)	15.7 (12.29)
Eating Disorder Examination Interview			
Global	2.59 (0.13)	2.77 (0.11)	2.56 (0.10)
Restraint †	1.43 (0.18)	1.89 (0.16)	1.61 (0.14)
Eating concern	1.99 (0.18)	2.13 (0.16)	2.03 (0.14)
Shape concern	3.71 (0.17)	3.72 (0.14)	3.54 (0.13)
Weight concern	3.21 (0.15)	3.33 (0.13)	3.07 (0.12)
Mean emotional overeating †	2.33 (0.18)	1.96 (0.15)	1.85 (0.13) *a*

Notes.

* Statistics are based on log-transformed values. Age, sex, race/ethnicity, and education were included as covariates.

† = significant *F*-statistics *at* $p < .05$ and $p < .01$.

a = significantly different from current smokers.

Table 3

Comorbid Lifetime Psychiatric Disorders and Psychosocial Functioning by Smoking Status

	Current Smokers (*n* = 60)	Former Smokers (*n* = 137)	Never Smokers (*n* = 199)
Perceived Stress	21.2 (1.33)	21.5 (1.13)	20.6 (1.01)
BDI	19.7 (1.27)	17.4 (1.08)	16.8 (0.96)
SF-36			
Mental health component	39.7 (1.61)	41.6 (1.37)	42.6 (1.23)
Physical health component †	37.5 (1.42)	40.0 (1.21)	41.1 (1.37) *a*
% meeting diagnostic criteria			
Alcohol use disorders ‡	35.0	23.4	12.6 *a, b*
Substance use disorders ‡	50.0	33.6	16.1
Mood disorder	51.7	50.4	49.8
Anxiety disorder	45.0	46.0	35.7 *a, b*

Notes. Age, sex, race/ethnicity, and education were included as covariates in the analyses of continuous variables.

† = significant *F*- or Chi-square statistics at $p < .05$ and $p < .01$.

‡ = significant *F*- or Chi-square statistics at $p < .05$ and $p < .01$.

a = significantly different from current smokers;

b = significantly different from former smokers.

Table 4

Metabolic Measures by Smoking Status

	Current Smokers (*n* = 66)	Former Smokers (*n* = 145)	Never Smokers (*n* = 218)
Waist	49.5 (0.79)	47.9 (0.68)	47.6 (0.60)
Heart rate	77.9 (1.70)	75.7 (1.46)	74.8 (1.28)
Systolic blood pressure	129.6 (2.04)	130.9 (1.75)	130.9 (1.54)
Diastolic blood pressure	81.5 (1.42)	80.6 (1.21)	81.8 (1.07)
Fasting glucose level *	118.13 (4.91)	111.67 (4.13)	107.76 (3.78)
HbA1c *	6.41 (0.13)	6.20 (0.11)	6.09 (0.10)
Total cholesterol	188.29 (5.32)	183.70 (4.53)	181.81 (4.14)
% ≥ 150 mg/dL	40.9	35.9	34.3
HDL ‡	43.73 (1.86)	50.66 (1.58) *a*	49.35 (1.45) *a*
LDL	113.59 (4.69)	106.54 (3.29)	108.14 (3.60)
Triglycerides *	163.16 (11.50)	142.01 (9.76)	140.87 (8.23)
% meeting criteria for symptoms of metabolic syndrome (MetS)			
Meeting criteria for MetS	48.5	40.0	32.9
Central or abdominal obesity (> 40 inches for men, > 36 inches for women)	95.5	93.1	91.7
Triglycerides ≥ 150 mg/dL	27.3	29.7	26.0
Reduced HDL cholesterol (< 40 mg/dL for men, < 50 mg/dL for women) †	54.6	35.9 *a*	35.9 *a*
Blood pressure ≥ 130/85 mmHg	48.5	44.1	48.9
Fasting glucose ≥ 110 mg/dL ‡	21.2	26.9	11.9 *b*

Notes.

*Statistics are based on log-transformed values. Age, sex, race/ethnicity, and education were included as covariates in the analyses of continuous variables.

†= significant *F*- or Chi-square statistics at $p < .05$ and $p < .01$.

‡= significant *F*- or Chi-square statistics at $p < .05$ and $p < .01$.

a= significantly different from current smokers.

b= significantly different from former smokers.