Available online at www.sciencedirect.com
ScienceDirect
Eating Behaviors 7 (2006) 291–299
EATING BEHAVIORS

Smoking in eating disorders

Doris Anzengruber [a,b], Kelly L. Klump [c], Laura Thornton [d], Harry Brandt [e], Steve Crawford [e], Manfred M. Fichter [f,g], Katherine A. Halmi [h], Craig Johnson [i], Allan S. Kaplan [j], Maria LaVia [a], James Mitchell [k], Michael Strober [l], D. Blake Woodside [j], Alessandro Rotondo [m], Wade H. Berrettini [n], Walter H. Kaye [d], Cynthia M. Bulik [a,*]

[a] *Department of Psychiatry, University of North Carolina at Chapel Hill, NC, United States*
[b] *Leopold-Franzens-Universität, Innsbruck, Austria*
[c] *Department of Psychology, Michigan State University, East Lansing, MI, United States*
[d] *Department of Psychiatry, University of Pittsburgh, Pittsburgh, PA, United States*
[e] *Department of Psychiatry, University of Maryland School of Medicine, Baltimore, MD, United States*
[f] *Department of Psychiatry, University of Munich (LMU), Munich, Germany*
[g] *Roseneck Hospital for Behavioral Medicine, Prien, Germany*
[h] *New York Presbyterian Hospital — Westchester Division, Weill Medical College of Cornell University, White Plains, NY, United States*
[i] *Laureate Psychiatric Clinic and Hospital, Tulsa, OK, United States*
[j] *Department of Psychiatry, The Toronto Hospital, Toronto, Canada*
[k] *Neuropsychiatric Research Institute, Fargo, ND*
[l] *Neuropsychiatric Institute and Hospital, School of Medicine, University of California at Los Angeles, Los Angeles, CA, United States*
[m] *Department of Psychiatry, Neurobiology, Pharmacology and Biotechnologies, University of Pisa, Italy*
[n] *Department of Psychiatry, University of Pennsylvania, School of Medicine, Philadelphia, PA, United States*

Received 19 December 2005; received in revised form 30 May 2006; accepted 2 June 2006

Abstract

Objective: Smoking has been reported as an appetite and weight control method in eating disorders; however, few studies have explored patterns of smoking across subtypes of eating disorders. The aim of this paper was to explore the patterns and prevalence of smoking behavior in 1524 women from two of the multisite Price Foundation Genetic studies.
Method: Smoking behavior was assessed in 306 individuals with anorexia nervosa-restricting type (RAN), 186 with anorexia nervosa-purging type (PAN), 180 with anorexia nervosa and bulimia nervosa (ANBN), 107 with anorexia nervosa-binging type (BAN), 71 individuals with purging type-bulimia nervosa (PBN), and 674 female community controls. We compared smoking prevalence and smoking behaviors across eating disorder (ED) subtypes and in comparison to controls using the Fagerstrom Test of Nicotine Dependence (FTND).
Results: Overall, women with eating disorders reported higher rates of smoking and greater nicotine dependence than controls. Women with binge/purge subtypes of eating disorders reported the highest rates of smoking of all of the subtypes. Smoking in eating disorders was related to impulsive personality traits.
Conclusions: Women with eating disorders appear to be at increased risk for smoking, particularly those who binge eat and/or

* Corresponding author. University of North Carolina at Chapel Hill, 101 Manning Drive, CB #7160, Chapel Hill, NC 27599-7160, United States. Tel.: +1 919 843 1689; fax: +1 919 966 5628.
E-mail address: cbulik@med.unc.edu (C.M. Bulik).

1471-0153/$ - see front matter
doi:10.1016/j.eatbeh.2006.06.005

purge and display impulsive personality characteristics. Given the high prevalence, the impact of ongoing smoking on maintenance of eating disorders symptoms is worthy of both clinical and research attention.

Keywords: Smoking; Anorexia nervosa; Eating disorders; Bulimia nervosa

1. Smoking and anorexia nervosa

Previous studies have shown that smoking behavior is more prevalent in individuals with eating disorders than expected in age and gender matched individuals in the population (Welch & Fairburn, 1998; Wiseman, Turco, Sunday, & Halmi, 1998). Preliminary investigations suggest that differences may exist in the prevalence of smoking across eating disorder subtypes (Bulik, Epstein, McKee, & Kaye, 1991; Haug, Heinberg, & Guarda, 2001; Wiederman & Pryor, 1996). Bulik et al. (1991) and Haug et al. (2001) reported a higher prevalence of smoking in a clinical sample of individuals with bulimia nervosa (BN) than in individuals with anorexia nervosa (AN), whereas another study using a community sample did not detect eating disorder subtype differences in smoking prevalence (von Ranson, Iacono, & McGue, 2002). These studies were small samples and did not explore smoking behavior across the entire spectrum of eating disorders diagnoses.

It is also unclear whether the nature of smoking in individuals with eating disorders is the same as smoking in the general population. Given the well-known effects of smoking on weight and appetite (Austin & Gortmaker, 2001; Crisp et al., 1998; Delnevo, Hrywna, Abatemarco, & Lewis, 2003; Field et al., 2002; French, Perry, Leon, & Fulkerson, 1994; Klesges, Meyers, Klesges, & La Vasque, 1989; Tomeo, Field, Berkey, Colditz, & Frazier, 1999), smoking in individuals with eating disorders could be motivated more by desires for weight control than nicotine dependence.

The goal of the present study was to provide extensive information about patterns of smoking behavior in women with eating disorders using a large well-characterized sample. We also sought to explore the relation between smoking behavior, eating disorder subtypes, and personality characteristics. Our primary hypotheses, based on the extant literature were that: (1) the prevalence of smoking would be higher in individuals with eating disorders than in matched female controls; (2) the prevalence of smoking would be higher in individuals with bulimic subtypes of eating disorders than in the restricting subtype of AN. Second, given the known effects of smoking on body weight, we hypothesized that weight control would underlie smoking in women with eating disorders which would be reflected in lower levels of nicotine dependence than controls. Third, we hypothesized that when controlling for eating disorder subtype, individuals with eating disorders who smoke will be characterized by higher novelty seeking and impulsivity than those who do not smoke. Finally, focusing on the weight control aspect of smoking, we hypothesized that individuals with eating disorders who smoked, especially current smokers would have lower body mass indices than non-smokers.

2. Method

2.1. Participants

All participants were from two of the multisite international Price Foundation Genetic Studies of Eating Disorders: one focusing on families with BN ("BN Affected Relative Pair Study") (Kaye et al., 2004) and another focusing on individuals with AN and their parents ("AN Trios") (see Reba et al., 2005). Both studies were designed to identify susceptibility loci involved in risk for AN and BN.

Informed consent was obtained from all study participants, and all sites received approval from their local Institutional Review Board. Brief descriptions of each study are provided below. Full details on the BN study (Kaye et al., 2004) and AN (see Reba et al., 2005) study are available elsewhere.

2.1.1. BN affected relative pair study

The sample for this study included both probands and affected relatives. Probands met the following criteria: (1) DSM-IV (American Psychiatric Association, 1994) diagnosis of BN, purging type, with the additional requirement of at least a six-month period of binge eating and vomiting at least twice a week; and (2) age between 13 and 65 years. Affected relatives were biological family members of the proband who: (1) were between the ages of 13 and 65 years;

and (2) had a lifetime eating disorder diagnosis of DSM-IV BN, purging type or non-purging type, modified DSM-IV AN (i.e., criterion D not required), or EDNOS (subthreshold AN, subthreshold BN, or subthreshold mixed). For the complete list of inclusion and exclusion criteria for probands and relatives, see Kaye et al. (2004).

2.1.2. AN trios study

Probands: The sample for this study included individuals with AN and their parents. Probands were required to meet the following criteria: (1) modified (i.e., amenorrhea not required) DSM-IV (American Psychiatric Association, 1994) lifetime diagnosis of AN that was present at least three years prior to study entry; (2) low weight that is/was less than 5th percentile of BMIs for age and gender according to the Hebebrand chart of NHANES epidemiological sample (Hebebrand, Himmelmann, Heseker, Schafer, & Remschmidt, 1996); (3) AN onset prior to age 25; (4) weight that is/was controlled through restricting and/or purging; and (5) age between 13 and 65. Potential probands were excluded if they reported maximum BMI since puberty >27 kg/m^2 for females and >27.8 kg/m^2 for males. Parents were not required to meet any inclusion/exclusion criteria, as they only provided DNA; they did not complete any study assessments. Thus, only the probands from the larger study were included in the present analyses.

Comparison Group: Healthy control women were recruited to serve as controls for the genetic analyses. These women were primarily of European ancestry and were recruited by advertisements in the local communities of the participating sites. For the present study, the comparison sample consisted of 674 healthy women [age *M*(SD)=27.0(8.3)]. All of the individuals were 18–65 years old, at normal weight with a lifetime adult BMI between 19 and 27, and matched with the eating disorder participants based on site, age range, ethnicity and highest educational level completed. BMI exclusions were designed to screen for eating disorders (on the low end) and obesity on the upper end to be consistent with exclusion criteria in the eating disorders groups. Comparison women were excluded if they: (1) reported any history of an eating disorder or eating disordered behaviors, as defined by a score of 20 or higher on the Eating Attitudes Test; (2) had a first degree relative (mother, father or sibling) with an eating disorder; or (3) had any psychiatric, alcohol use, or drug use disorder defined by the presence of an Axis 1 disorder on the Structured Clinical Interview for DSM-IV (SCID) Screen Patient Questionnaire. All of the healthy control women completed the same battery of personality and symptom measures as probands.

Data were available from 897 female probands with an eating disorder diagnosis (age *M*(SD)=26.3(8.3)). Due to their low frequency, the following individuals were excluded from analyses: 14 male participants, 4 individuals with non-purging bulimia nervosa, 24 individuals with eating disorders not otherwise specified (EDNOS), and 5 individuals who were missing data on smoking behaviors. The final sample comprised 850 probands.

2.2. Measures

2.2.1. Clinician rated assessments

Eating Disorder Diagnoses: Lifetime histories of eating disorders in probands and affected relatives were assessed with the Structured Inventory of Anorexia Nervosa and Bulimic Syndromes [SIAB (Fichter, Herpertz, Quadflieg, & Herpertz-Dahlmann, 1998)]. Additional information regarding eating disorder recovery status as well as the presence or absence of eating disorder symptoms was also obtained by an expanded version of Module H of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) (First, Spitzer, Gibbon, & Williams, 1997). Training procedures for the SIAB and SCID have been described in detail elsewhere. (Kaye et al., 2000).

2.2.2. Self report assessments

Smoking: The *"Your Smoking History"* questionnaire (Fox Chase Cancer Center) was used to assess smoking behaviors. This assessment was only completed by participants who endorsed a history of smoking: *This questionnaire is to be completed by people who currently smoke cigarettes or who have smoked cigarettes in the past*. It included the *Fagerstrom Test of Nicotine Dependence (FTND)*, a self-report questionnaire designed to obtain quantitative and diagnostic information about nicotine dependence. The FTND is a revised version of the original Fagerstrom Tolerance Questionnaire (FTQ) which contains 6 of the original 8 questions about smoking behavior (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Higher scores suggest greater tolerance to nicotine. Pomerleau et al. (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994) showed that while FTQ and FTND were largely comparable, the FTND demonstrated higher internal consistency (0.61). Although only fair, this is the most widely used measure of nicotine dependence and an improvement over the earlier version. The "Your Smoking History" measure also assessed history of quitting smoking.

Table 1
Prevalence of smoking across participant groups

Groups	Smoker % (*n*)	Non-smoker % (*n*)	Odds Ratio (95% CI)
Control (*n*=674)	29.7 (200)	70.3 (474)	–
RAN (*n*=306)	25.5 (78)	74.5 (228)	0.85 (0.62, 1.15)
BPAN (*n*=293)	39.9 (117)	60.1 (176)	1.56 (1.17, 2.08)
BN (*n*=251)	61.0 (153)	39.0 (98)	3.33 (2.44, 4.55)

Note. RAN=restricting anorexia nervosa, BPAN=anorexia nervosa with binging and or purging behaviors, BN=history of bulimia nervosa, with or without a history of anorexia. Odds ratios compare rate of smoking in eating disorder groups compared to controls.

Personality: The *Temperament and Character Inventory (TCI)* (Cloninger, Svrakic, & Przybeck, 1993) was used to assess personality characteristics. The TCI is a 240-item instrument that is divided into four temperament dimensions (i.e., novelty seeking, harm avoidance, reward dependence and persistence) and three character dimensions (i.e., self-directedness, cooperativeness, and self-transcendence). The TCI subscales show adequate internal consistency ranging from .76 to .89 (Cloninger et al., 1993).

Impulsivity: The *Barratt Impulsivity Scale-11* (Barratt, 1983) is a 30-item self-report instrument which assesses three aspects of impulsivity: cognitive impulsiveness, motor impulsiveness and non-planning impulsiveness. This instrument has been used extensively in eating disorder research (e.g., Bulik, Sullivan, Fear, & Pickering, 1997). The BIS was only administered to a subset of individuals in the BN-ARP study, and thus, sample sizes for analyses examining this scale are smaller than those for the other measures.

Body Mass Index kg/m^2 (BMI): Self-reported height and weight were used to calculate current, past minimum and past maximum BMI.

2.3. Statistical analyses

Statistical analyses were conducted using the GENMOD procedure of SAS version 8.1 (SAS Institute Inc., 2004). We first examined the prevalence of smoking across eating disorder diagnostic subtypes and controls using logistic regression. Current, past, and non-smokers in all the eating disorder groups and controls were compared on the lowest, highest, and current BMI as well as the personality items using analysis of variance. Within the subsample of smokers, we used logistic regressions to examine categorical variables (e.g., patterns of smoking behaviors, quitting history) and analysis of variance (ANOVA) to examine continuous variables (e.g., the number of months since last smoked). In all analyses, age at time of interview was entered as a covariate to control for the possible effects of age on smoking behavior or other variables. For the variables assessing quitting history, we entered the smoking dependence (FTND) variable as a covariate in the models. Except where noted, corrections for non-independence were performed using Generalized Estimating Equations, as described previously (Klump et al., 2000).

3. Results

3.1. Prevalence of smoking behaviors in women with eating disorders and control women

Participants: Prior to data analyses, various DSM-IV diagnostic eating disorder subtypes (restricting type AN; purging-type AN (i.e., use of regular purging to reduce weight, but no regular binge eating); binge eating AN (i.e., regular binge eating with or without regular purging); BN, purging type; BN, non-purging type; and individuals with a history of both AN and BN, were compared on prevalence of smoking. No significant differences were found between participants with purging-type AN and with binge eating AN or between those with BN and individuals with a history of both AN and BN. Thus, our final diagnostic groupings were as follows: restricting type AN (RAN, $n=306$); AN with binge eating and/or purging (BPAN, $n=293$); individuals with a history of BN, with or without a history of AN, (BN, $n=251$), and controls ($n=674$).

Prevalence of Smoking: Table 1 presents the prevalence of smoking across eating disorder subtypes and in controls. The effect of age on smoking status was not significant ($\chi^2=1.36$, $df=1$, $p=0.24$); however the effect of group was significant ($\chi^2=63.95$, $df=3$, $p<0.0001$). Post hoc pairwise comparisons confirmed hypothesized elevations in the prevalence of smoking in two of the eating disorder subgroups. The prevalence of smoking was significantly higher in

Table 2
Frequency of smoking behaviors by participant group

Groups	1. How soon after waking do you smoke your first cigarette?[a]			2. Is it difficult to refrain from smoking in forbidden places?		3. Which cigarette would you hate to give up most?		4. Do you smoke more frequently during the first few hours after waking?		5. Do you smoke if you are so ill that you are in bed most of the day?	
	Within 5 minutes % (n)	Within 1 hour % (n)	After 1 hour % (n)	No % (*n*)	Yes % (*n*)	First in the morning % (n)	All others % (*n*)	No % (*n*)	Yes % (*n*)	No % (*n*)	Yes % (*n*)
Control (*n*=200)	3.0 (6)	33.5 (67)	63.5 (127)	94.9 (186)	5.1 (10)	10.9 (21)	89.1 (172)	95.9 (188)	4.1 (8)	92.4 (181)	7.6 (15)
RAN (*n*=78)	7.7 (6)	52.6 (41)	39.7 (31)	88.0 (66)	12.0 (9)	23.3 (17)	76.7 (56)	81.3 (61)	18.7 (14)	73.0 (54)	27.0 (20)
BPAN (*n*=117)	15.4 (18)	47.0 (55)	37.6 (44)	84.4 (97)	15.6 (18)	32.5 (37)	67.5 (77)	82.6 (95)	17.4 (20)	67.0 (77)	33.0 (38)
BN (*n*=153)	18.3 (28)	46.4 (71)	35.3 (54)	74.5 (114)	25.5 (39)	36.0 (55)	64.0 (98)	83.7 (128)	16.3 (25)	64.0 (98)	36.0 (55)

[a] An ordinal model for multinomial data without GEE corrections was used to analyze this 3-response item question.

BPAN and BN groups in comparison to controls (respectively: $\chi^2=8.73$, $df=1$, $p=0.0031$; $\chi^2=51.48$, $df=1$, $p<0.0001$) and in comparison to the RAN group (respectively: $\chi^2=12.01$, $df=1$, $p=0.0005$; $\chi^2=54.22$, $df=1$, $p<0.0001$). The RAN and control groups did not differ in prevalence of smoking ($\chi^2=1.18$, $df=1$, $p<0.278$).

There were no significant differences in the age of onset of smoking between women with eating disorders who smoked [RAN *M*(SD)=16.8(3.4); BPAN *M*(SD)=17.4(3.7); BN *M*(SD)=16.8(3.4)] and control smokers [*M*=16.6 (2.6)] ($\chi^2=4.01$, $df=3$, $p=.26$). However, in women with eating disorders who smoked, the majority began smoking after the onset of their eating disorder (59.1%) versus before (40.9%) ($\chi^2=11.3$, $df=1$, $p=0.0008$).

Nicotine Dependence and Smoking Behaviors: Overall, levels of nicotine dependence differed significantly across groups (Total FTND scores: $\chi^2=59.05$, $df=3$, $p=0.0001$). Post-hoc tests indicated that control smokers (*M*(SD)=1.32 (1.73)) had significantly lower FTND scores than all other groups (RAN *M*(SD)=2.59 (2.57), $\chi^2=12.45$, $df=1$, $p=0.0004$; BPAN *M*(SD)=3.14 (2.63), $\chi^2=36.49$, $df=1$, $p<0.0001$; BN *M*(SD)=3.46 (2.84), $\chi^2=46.01$, $df=1$, $p<0.0001$) and that the RAN group had significantly lower scores than the BN group ($\chi^2=3.98$, $df=1$, $p<0.0461$). During their period of greatest smoking, control women smoked significantly fewer cigarettes per day (*M*(SD)=11.4 (8.2)) than women in the eating disorder groups (RAN *M*(SD)=15.2 (13.1), $\chi^2=5.23$, $df=1$, $p<0.0221$; BPAN *M* (SD)=17.5 (13.7), $\chi^2=14.69$, $df=1$, $p<0.0001$; BN *M*(SD)=18.3 (13.3), $\chi^2=24.84$, $df=1$, $p<0.0001$; total model fit $\chi^2=32.94$, $df=3$, $p=.0001$).

We also explored other FTND items to determine whether patterns of smoking behavior differed between individuals with eating disorders and controls. Table 2 presents results examining FTND questions 1–5. The results for question 1 (i.e., how soon after waking they smoked their first cigarette) indicated a significant difference across groups ($\chi^2=40.17$ $df=3$; $p<0.0001$). Post hoc tests showed that significantly more control women smoked their first cigarette greater than one hour after waking as compared to the women in the eating disorder groups (control vs. RAN: $\chi^2=12.08$ $df=1$; $p=0.001$; control vs. BPAN: $\chi^2=23.14$ $df=1$; $p=0.0001$; control vs. BN: $\chi^2=31.8$ $df=1$; $p=0.0001$). For question 2 – difficulty refraining from smoking in forbidden places – the groups differed significantly from each other ($\chi^2=26.65$ $df=3$; $p<0.0001$). Post hoc tests indicated that (1) significantly fewer control women reported having difficulty refraining as compared to the women with BPAN ($\chi^2=6.34$ $df=1$; $p=0.012$) and BN ($\chi^2=24.66$ $df=1$; $p=0.0001$); and (2) fewer individuals with RAN ($\chi^2=5.71$ $df=1$; $p=0.016$) and BPAN ($\chi^2=4.02$ $df=1$; $p=0.045$) reported having difficulty refraining than individuals in the BN group. Significant differences between participant groups were also observed for question 3 — which cigarette would you hate most to give up ($\chi^2=34.39$; $df=3$; $p<0.0001$). Only 10% of the control sample indicated that they would hate to give up the first cigarette in the morning in comparison to between 23–37% of the eating disorder groups (control vs. RAN: $\chi^2=4.95$ $df=1$; $p=0.026$; control vs. BPAN: $\chi^2=17.51$ $df=1$; $p<0.0001$; control vs. BN: $\chi^2=25.13$ $df=1$; $p<0.0001$).

Questions 4 – do you smoke more frequently in the first few hours after awakening – and 5 – do you smoke even when you are ill in bed all day – also differed across groups ($\chi^2=22.77$; $df=3$; $p=0.0001$; $\chi^2=50.30$; $df=3$; $p<0.0001$, respectively). But, again, the post hoc tests indicated that the primary differences were between the control group and the eating disorder groups, with the control group having fewer positive endorsements for both items (Question 4 — control vs. RAN: $\chi^2=9.06$ $df=1$; $p=0.023$; control vs. BPAN: $\chi^2=11.30$ $df=1$; $p=0.001$; control vs.

Table 3
Frequency of quitting by participant group

	Are you currently a smoker?		Have you made a serious attempt to quit smoking in your life?		Have you ever quit completely for at least 24 hours?		Have you ever quit completely for at least 7 days?	
	No % (*n*)	Yes % (*n*)	No % (*n*)	Yes % (*n*)	No % (*n*)	Yes % (*n*)	No % (*n*)	Yes % (*n*)
Control	47.7 (94)	52.3 (103)	17.4 (34)	82.6 (162)	2.0 (4)	98.0 (192)	12.8 (25)	87.2 (171)
RAN	41.6 (32)	58.4 (45)	28.0 (21)	72.0 (54)	6.7 (5)	93.3 (70)	20.0 (15)	80.0 (60)
BPAN	31.9 (37)	68.1 (79)	21.6 (25)	78.4 (91)	5.2 (6)	94.8 (110)	18.1 (21)	81.8 (95)
BN	41.7 (63)	58.3 (88)	23.0 (35)	77.0 (117)	8.6 (13)	91.4 (139)	22.9 (35)	77.1 (118)

*RAN = restricting anorexia nervosa, BPAN = anorexia nervosa with binging and or purging, BN = bulimia nervosa with or without a history on anorexia nervosa.

BN: $\chi^2=10.25$ $df=1$; $p=0.021$; Question 5 — control vs. RAN: $\chi^2=11.45$ $df=1$; $p=0.001$; control vs. BPAN: $\chi^2=23.89$ $df=1$; $p<0.0001$; control vs. BN: $\chi^2=32.82$ $df=1$; $p<0.0001$).

Quitting Attempts: Table 3 presents the percentage of individuals who report currently smoking, and the percentage of individuals who report having made attempts to quit smoking, who report having successfully quit smoking for 24 hours, and who report having successfully quit smoking for at least 7 days. Controlling for nicotine dependence, no significant group differences were found for the number of participants who currently smoke $\chi^2=3.29$, $df=3$, $p=0.35$), who have made quit attempts ($\chi^2=4.89$, $df=3$, $p=.18$), who reported quitting for 24 h ($\chi^2=3.12$, $df=3$, $p=.37$), and who reported quitting for at least 7 days ($\chi^2=2.06$, $df=3$, $p=.56$).

3.2. BMI comparisons

Table 4 presents the current BMI, and minimum and maximum BMI of participants divided by participant group and history of smoking (i.e., non-smoker, past smoker, current smoker). Analyses of variance were conducted comparing the BMI measures between the smoking groups in participants with eating disorders (controls were removed for these analyses), controlling for age at interview and for eating disorder subtype. Although there was a trend for current BMI to differ across the smoking groups ($\chi^2=9.16$, $df=2$, $p=0.010$), post hoc tests indicated that past smokers had higher current BMI values than non-smokers ($\chi^2=9.06$, $df=1$, $p=0.003$) and than current smokers ($\chi^2=4.20$, $df=1$, $p=0.040$). No significant group differences in lifetime maximum BMI were observed ($\chi^2=0.61$, $df=2$, $p=0.74$). However, there were significant differences across groups for lifetime minimum BMI ($\chi^2=6.13$, $df=2$, $p=0.047$). Post hoc tests revealed that non-smokers had lower minimum BMI values than past smokers ($\chi^2=4.86$, $df=1$, $p=0.027$).

Table 4
Means (SD) for BMI variables

Groups		Current BMI	Lowest BMI	Highest BMI
CON* (*n*=674)	Non-smokers (*n*=474)	22.1 (1.8)	20.5 (1.4)	23.1 (1.9)
	Past smoker (*n*=96)	22.1 (1.8)	20.3 (1.1)	23.3 (1.9)
	Current smoker (*n*=104)	22.4 (1.9)	20.6 (1.4)	23.6 (2.0)
RAN (*n*=306)	Non-smokers (*n*=228)	17.4 (2.8)	13.5 (1.9)	20.6 (2.4)
	Past smoker (*n*=32)	18.6 (3.1)	14.2 (2.0)	22.1 (2.3)
	Current smoker (*n*=46)	17.9 (3.0)	13.5 (1.9)	21.5 (2.2)
BPAN (*n*=293)	Non-smokers (*n*=176)	18.1 (2.7)	13.6 (2.0)	21.1 (2.3)
	Past smoker (*n*=37)	18.2 (2.6)	13.8 (2.0)	21.6 (2.2)
	Current smoker (*n*=80)	18.2 (2.7)	14.1 (1.9)	21.5 (2.5)
BN (*n*=251)	Non-smokers (*n*=98)	20.2 (3.0)	15.8 (2.7)	23.7 (2.9)
	Past smoker (*n*=64)	21.8 (3.5)	16.7 (2.8)	24.6 (3.7)
	Current smoker (*n*=89)	20.4 (3.0)	16.0 (3.0)	24.0 (3.1)

*CON= controls, RAN = restricting anorexia nervosa, BPAN = anorexia nervosa with binging and or purging, BN = bulimia nervosa with or without a history on anorexia nervosa.

3.3. Personality characteristics

When controlling for eating disorder subtype and age, we found that smokers scored significantly higher on TCI Novelty Seeking ($\chi^2=54.36$, $p=0.0001$ and the BIS-11 Cognitive ($\chi^2=9.32$, $p=0.002$), Motor ($\chi^2=33.64$, $p<0$ .0001), and Non-Planning subscales ($\chi^2=30.21$, $p<0.0001$) than non-smokers. In addition, we found that women who had successfully quit for at least 7 days scored higher on TCI self-directedness than those who had not quit ($\chi^2=4.01$; $p=0.045$).

4. Discussion

The goal of the present study was to report the prevalence of smoking and features of smoking behavior in individuals with eating disorders. Confirming our first primary hypothesis, the prevalence of smoking in the eating disorder groups marked by binge eating or purging was higher than in the control group or in individuals with restricting AN. Although both controls and women with eating disorders began smoking around the same age (16–17 years), of note, smoking most commonly occurred after the onset of an eating disorder in the eating disorder sample.

Contrary to our hypothesis, women with eating disorders who smoked actually reported greater nicotine dependence than controls. This was reflected in their smoking of more cigarettes at the time of greatest smoking, and FTND items related to morning smoking, difficulty restraining from smoking, and giving up the first cigarette of the day. Indeed, with the exception of individuals with RAN, women with eating disorders subtypes that included binge eating and purging scored higher than controls on all indices of nicotine dependence. These findings may reflect a general tendency for women with bulimia nervosa to have greater risk for all substance use disorders (Bulik et al., 2004a) and impulse control problems (Fernandez-Aranda et al., submitted for publication). This interpretation is further supported by the elevated scores on impulsivity and novelty seeking amongst those who smoked.

An important exception to greater smoking frequency and severity in individuals with eating disorders was the RAN group who did not differ significantly from controls on smoking prevalence. This also parallels studies of other forms of substance use where lower rates are seen in the RAN subgroup who also display lower levels of impulsivity and novelty seeking (Bulik et al., 2004b; Klump et al., 2004).

Our hypothesis relating to BMI was partially supported. We hypothesized that individuals with eating disorders who smoked, especially current smokers, would have lower body mass indices than non-smokers. Past smokers did report higher current BMI than either non-smokers or current smokers possibly reflecting the documented increase in weight associated with quitting smoking (Perkins, 1993).

Finally, both individuals with eating disorders and controls attempted to quit smoking at similar rates. Of interest, higher self-directedness was associated with attempts to quit for seven days or more. According to Cloninger et al. (1993), self-directedness is a developmental process that encompasses several distinct aspects, including acceptance of responsibility for one's choices, identification of individually valued goals and purposes, resourcefulness, and self-acceptance. Self-directedness has been associated with rapid and positive treatment response in both BN and major depression (Bulik, Sullivan, McIntosh, Carter, & Joyce, 1999; Joyce, Mulder, & Cloninger, 1994), has been shown to improve with successful treatment of BN (Anderson, Joyce, Carter, McIntosh, & Bulik, 2002), and has been reported to be associated with maintenance of abstinence from smoking (Matheny & Weatherman, 1998). Therapeutic approaches to enhance self-directedness may assist both with recovery from an eating disorder and smoking cessation.

Several limitations of our study should be noted. First, we used self-report measures of smoking instead of more reliable structured interview methods. Future research should directly interview women about their smoking patterns to corroborate our results. Second, our control women were screened to be free of any Axis I disorder pathology yielding a psychiatrically healthy control group. Despite these exclusion criteria, rates of smoking in our controls (29%) were similar to those from general population samples of women (22%) (United States Department of Health and Human Services, 2001), suggesting that they represented a reasonable comparison group for this investigation.

Third, we did not ask the women directly about their reasons for smoking. Thus, our hypotheses about smoking as a weight control measure were addressed indirectly. Future studies should directly examine the perceived reasons for smoking initiation and maintenance in women with eating disorders. Ideally, these studies would use longitudinal designs that could more clearly delineate the time course of the eating disorder and smoking initiation and cessation.

Despite these limitations, our findings highlight smoking as a significant health problem in women with eating disorders that may require unique treatment and prevention strategies. Smoking has been shown to slow weight gain

during re-feeding in AN (van Wymelbeke, Brondel, Marcel-Brun, & Rigaud, 2004). The implications of these findings for clinical practice are noteworthy. Clinicians need to monitor patients with eating disorders for smoking initiation, explore the relation between smoking and weight loss behaviors, and recognize that smoking may be counterproductive to treatment goals of weight gain and appetite regulation. Moreover, the presence of more severe nicotine dependence in eating disorder patients relative to controls highlights the need for future studies examining the effect of dependence on treatment, the effectiveness of smoking cessation programs in eating disorders patients, and the implications for these findings for etiologic and prevention research.

Acknowledgements

The authors wish to thank the Price Foundation for the support of the clinical collection of participants and support of data analysis. The authors acknowledge the staff of the Price Foundation Collaborative Group for their efforts in participant screening and clinical assessments. The authors are indebted to the participating families for their contribution of time and effort in support of this study. Support was provided by the National Institute of Mental Health MH 66117.

References

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders*, Fourth Ed. Washington, D.C.: American Psychiatric Association Press.

Anderson, C. B., Joyce, P. R., Carter, F. A., McIntosh, V. V., & Bulik, C. M. (2002). The effect of cognitive-behavioral therapy for bulimia nervosa on temperament and character as measured by the temperament and character inventory. *Comprehensive Psychiatry*, *43*(3), 182−188.

Austin, S. B., & Gortmaker, S. L. (2001). Dieting and smoking initiation in early adolescent girls and boys: A prospective study. *American Journal of Public Health*, *91*(3), 446−450.

Barratt, E. S. (1983). The biological basis of impulsiveness. *Personal and Individual Differences*, *4*, 387−391.

Bulik, C. M., Epstein, L. H., McKee, M., & Kaye, W. (1991). Drug use in women with bulimia and anorexia nervosa. *NIDA Research Monograph*, *105*, 462−463.

Bulik, C., Klump, K., Thornton, L., Kaplan, A., Devlin, B., Fichter, M., et al. (2004). Alcohol use disorder comorbidity in eating disorders: A multicenter study. *Journal of Clinical Psychiatry*, *65*, 1000−1006.

Bulik, C. M., Klump, K. L., Thornton, L., Kaplan, A. S., Devlin, B., Fichter, M. M., et al. (2004). Alcohol use disorder comorbidity in eating disorders: A multicenter study. *Journal of Clinical Psychiatry*, *65*(7), 1000−1006.

Bulik, C. M., Sullivan, P. F., Fear, J., & Pickering, A. (1997). Predictors of the development of bulimia nervosa in women with anorexia nervosa. *Journal of Nervous and Mental Disorders*, *185*(11), 704−707.

Bulik, M., Sullivan, P., McIntosh, V., Carter, F., & Joyce, P. (1999). Predictors of rapid response to cognitive-behavioral therapy in women with bulimia nervosa. *International Journal of Eating Disorders*, *26*, 137−144.

Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry*, *50*(12), 975−990.

Crisp, A. H., Halek, C., Sedgewick, P., Stravraki, C., Williams, E., & Kiossis, I. (1998). Smoking and pursuit of thinness in schoolgirls in London and Ottawa. *Postgraduate Medical Journal*, *74*(874), 473−479.

Delnevo, C. D., Hrywna, M., Abatemarco, D. J., & Lewis, M. J. (2003). Relationships between cigarette smoking and weight control in young women. *Family and Community Health*, *26*(2), 140−146.

Fernandez-Aranda, F., Pinheiro, A. P., Thornton, L., Strober, L., Berrettini, W. H., Crow, S., et al. (submitted for publication). Impulse control disorders in women with eating disorders.

Fichter, M., Herpertz, S., Quadflieg, N., & Herpertz-Dahlmann, B. (1998). Structured interview for anorexic and bulimic disorders for DSM-IV and ICD-10: Updated (third) revision. *International Journal of Eating Disorders*, *24*, 227−249.

Field, A. E., Austin, S. B., Frazier, A. L., Gillman, M. W., Camargo, C. A., Jr., & Colditz, G. A. (2002). Smoking, getting drunk, and engaging in bulimic behaviors: In which order are the behaviors adopted? *Journal of the American Academy of Child and Adolescent Psychiatry*, *41*(7), 846−853.

First, M., Spitzer, R., Gibbon, M., & Williams, J. (1997). *Structured clinical interview for DSM-IV Axis I Disorders, Research Version, Patient Edition.* New York: Biometrics Research, New York State Psychiatric Institute.

French, S. A., Perry, C. L., Leon, G. R., & Fulkerson, J. A. (1994). Weight concerns, dieting behavior, and smoking initiation among adolescents: A prospective study. *American Journal of Public Health*, *84*(11), 1818−1820.

Haug, N. A., Heinberg, L. J., & Guarda, A. S. (2001). Cigarette smoking and its relationship to other substance use among eating disordered inpatients. *Eating and Weight Disorders*, *6*(3), 130−139.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom, K. O. (1991). The Fagerstrom Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction*, *86*(9), 1119−1127.

Hebebrand, J., Himmelmann, G. W., Heseker, H., Schafer, H., & Remschmidt, H. (1996). Use of percentiles for the body mass index in anorexia nervosa: Diagnostic, epidemiological, and therapeutic considerations. *International Journal of Eating Disorders*, *19*, 359−369.

Joyce, P. R., Mulder, R. T., & Cloninger, C. R. (1994). Temperament predicts clomipramine and desipramine response in major depression. *Journal of Affective Disorders*, *30*, 35−46.

Kaye, W. H., Devlin, B., Barbarich, N., Bulik, C. M., Thornton, L., Bacanu, S. A., et al. (2004). Genetic analysis of bulimia nervosa: Methods and sample description. *International Journal of Eating Disorders*, *35*(4), 556−570.

Kaye, W. H., Lilenfeld, L. R., Berrettini, W. H., Strober, M., Devlin, B., Klump, K. L., et al. (2000). A search for susceptibility loci for anorexia nervosa: Methods and sample description. *Biological Psychiatry*, *47*(9), 794−803.

Klesges, R. C., Meyers, A. W., Klesges, L. M., & La Vasque, M. E. (1989). Smoking, body weight, and their effects on smoking behavior: A comprehensive review of the literature. *Psychological Bulletin*, *106*(2), 204−230.

Klump, K. L., Bulik, C. M., Pollice, C., Halmi, K. A., Fichter, M. M., Berrettini, W. H., et al. (2000). Temperament and character in women with anorexia nervosa. *Journal of Nervous and Mental Disease*, *188*(9), 559−567.

Klump, K. L., Strober, M., Johnson, C., Thornton, L., Devlin, B., Fichter, M. M., et al. (2004). Personality characteristics in women before and after recovery from an eating disorder. *Psychological Medicine*, *34*, 1407−1418.

Matheny, K., & Weatherman, K. (1998). Predictors of smoking cessation and maintenance. *Journal of Clinical Psychology*, *54*, 223−235.

Perkins, K. A. (1993). Weight gain following smoking cessation. *Journal of Consulting and Clinical Psychology*, *61*(5), 768−777.

Pomerleau, C. S., Carton, S. M., Lutzke, M. L., Flessland, K. A., & Pomerleau, O. F. (1994). Reliability of the Fagerstrom Tolerance Questionnaire and the Fagerstrom Test for Nicotine Dependence. *Addictive Behaviors*, *19*(1), 33−39.

Reba, L., Thornton, L., Tozzi, F., Klump, K. L., Brandt, H., Crawford, S., et al. (2005). Relationships between features associated with vomiting in purging-type eating disorders. *International Journal of Eating Disorders*, *38*(4), 287−294.

SAS Institute Inc (2004). *SAS/STAT® software: Version 9.* Cary, NC: SAS Institute, Inc.

United States Department of Health and Human Services (2001). *Women and smoking: A report of the surgeon general.* Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control.

Tomeo, C. A., Field, A. E., Berkey, C. S., Colditz, G. A., & Frazier, A. L. (1999). Weight concerns, weight control behaviors, and smoking initiation. *Pediatrics*, *104*(4 Pt 1), 918−924.

van Wymelbeke, V., Brondel, L., Marcel-Brun, J., & Rigaud, D. (2004). Factors associated with the increase in resting energy expenditure during refeeding in malnourished anorexia nervosa patients. *American Journal of Clinical Nutrition*, *80*(6), 1469−1477.

von Ranson, K., Iacono, W., & McGue, M. (2002). Disordered eating and substance use in an epidemiological sample: I. Associations within individuals. *International Journal of Eating Disorders*, *31*, 389−403.

Welch, S. L., & Fairburn, C. G. (1998). Smoking and bulimia nervosa. *International Journal of Eating Disorders*, *23*(4), 433−437.

Wiederman, M. W., & Pryor, T. (1996). Substance use among women with eating disorders. *International Journal of Eating Disorders*, *20*(2), 163−168.

Wiseman, C. V., Turco, R. M., Sunday, S. R., & Halmi, K. A. (1998). Smoking and body image concerns in adolescent girls. *International Journal of Eating Disorders*, *24*(4), 429−433.