Binge eating behaviours and food cravings in women with Polycystic Ovary Syndrome

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Abstract:

Polycystic Ovary Syndrome (PCOS), the most common endocrine condition in women, is often anecdotally associated with binge eating behaviours and food cravings; however there is a paucity of research. This study aimed to report the prevalence of binge eating and food cravings and their relation to obesity risk in women with PCOS. Participants completed an online survey including the Bulimia Investigatory Test, Edinburgh, Food Cravings-Trait Questionnaire and the Three Factor Eating Questionnaire revised-18. The study included obese (n=340), overweight (n=70) and lean (n=45) women with PCOS and lean healthy women (n=40). Sixty percent of obese women with PCOS were categorised with binge-eating behaviour, with 39% presenting with clinically significant behaviour. Obese women with PCOS presented with high mean food cravings-trait scores (131.6±28.9) that were significantly greater compared with lean (114.0±34.9) and overweight women with PCOS (120.1±29.5; $p<0.001$). Multiple regression exploring relations between eating styles and adiposity explained 59% of the variance in binge eating symptom scores in women with PCOS ($F = 173.8$; $p<0.001$, $n=463$): significant predictors were food cravings total score (beta =0.52; $p<0.001$), emotional eating score (beta =0.16; $p<0.001$), BMI (beta= 0.13; $p<0.001$) and uncontrolled eating score (beta =0.10; $p<0.01$). Compared with lean healthy women, lean women with PCOS exhibited significantly higher binge eating symptom scores (10.9±7.8 versus 7.4±6.0; $p<0.05$), though similar total food craving scores (114.0±34.9 versus 105.6±26.6: NS). This study is the largest, to date, to robustly report that a high proportion of women with PCOS exhibit binge eating behaviours. We recommend screening women with PCOS for binge eating behaviours to help inform the choice of weight management approach for this clinical population.

Key words: Polycystic ovary syndrome, Obesity, Binge eating, Food cravings, eating disorders

Abbreviations:

PCOS: Polycystic ovary syndrome

Introduction

Polycystic ovary syndrome (PCOS) is the most common endocrine condition in women, affecting up to 18% of women (1) and is characterised by a heterogeneous presentation of hyperandrogenism and ovulatory dysfunction. Women with PCOS have a greater insulin resistance, risk of developing type 2 diabetes (2), and a greater risk of being overweight and obese compared with healthy controls (BMI >30 RR 2.77 (95% CI 1.88 to 4.10) (3). Obesity significantly worsens all metabolic and reproductive outcomes for women with PCOS (4), though importantly as little as 5% weight loss has been shown to improve reproductive, metabolic and clinical markers (5, 6). Weight management through lifestyle modification is the first line treatment within international guidelines for the management of PCOS (7-11), although the effectiveness of such treatments is limited.

Binge eating has been shown to predict excess weight gain (12), obesity onset (13), weight regain after dieting (14) and failed weight loss (15). Binge eating behaviour is characterized by: (i) eating, in a discrete period of time, an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances; and (ii) a sense of lack of control over eating (16). There is a paucity of studies exploring disordered eating behaviours in women with PCOS; small studies have indicated a higher prevalence of PCOS in patients with eating disorders (17, 18). There are also reports suggesting both that disordered eating and bulimia nervosa are more common among women with PCOS (19-21), though others have reported no difference (22). Furthermore, a meta-analysis showed an increased prevalence of depression and anxiety associated with PCOS compared with controls (23, 24), and it is known that negative emotions are a key predictor of binge eating (25, 26). Binge eating is positively associated with hyperandrogenism (27) and amenorrhea (28), with hyperandrogenism implicated within the pathogenesis of anovulation and menstrual irregularities (29, 30). The role of circulating testosterone concentrations in the aetiology of eating disorders has yet to be fully elucidated (31). Elevated testosterone concentrations may promote bulimic behaviours by influencing food cravings and impulse control (31, 32). A suggestion supported by the observation that anti androgenic treatment reduces bulimic behaviour (33). An alternative hypothesis is that recurrent binge eating may increase insulin levels, which, via decreased concentrations of sex hormone binding globulin, increase free circulating testosterone(34), ultimately negatively impacting upon follicular maturation and ovulation (28).

Food cravings and obesity are positively correlated (35, 36) with evidence that individuals who are obese have higher frequencies of food cravings than healthy weight individuals (37). Food cravings may also discriminate between successful and unsuccessful dieters (38, 39). Recently, it has been reported that food craving was identified as a significant partial mediator in the relationships between elevated BMI and binge eating episodes (40). A food craving has been defined as an intense desire directed at a specific food or drink that is hard to resist (41). Craved and binged foods usually have a high energy density and fat content (42, 43) and previous studies have reported strong associations between cravings and intake of high-fat foods, sweets, and fast-food (44, 45). Food cravings are often anecdotally reported by women with PCOS (46); and a pilot study indicated women with PCOS had significantly higher Food Cravings-Trait scores compared with healthy women (47). Raised androgens and menstrual disturbances have been associated with greater food cravings in women without PCOS (48). The underlying mechanism for the relationship is unclear; although circulating testosterone has been shown to stimulate appetite (49) and is associated with impaired impulse control, irritability and depression (32, 50). Accordingly, it has been proposed that elevated levels of androgens may promote food cravings (51).

There is an inadequate understanding of eating behaviours in women with PCOS. If binge eating and food cravings are common in this group, this needs to be highlighted to help clinicians focus on appropriate interventions and strategies to promote weight loss. Weight loss has already been identified as a key treatment for reproductive and metabolic outcomes for women with PCOS, but one which women report difficulty achieving. This study aims to report the prevalence of binge eating and food cravings and their relation to obesity risk in women with PCOS. It is hypothesised that a high proportion of binge eating and food craving behaviours will be identified.

2. Methods

2.1 Participants

The study recruited 583 women with PCOS and 95 women without PCOS (Figure 1). Healthy lean women were matched for weight, age and ethnicity to lean women with PCOS. Recruitment of study participants utilised social media sites and email advertisements at the University of Surrey. Participant eligibility was determined by a screening questionnaire. All women were at least 18 years of age. Participants were excluded if they were pregnant or breastfeeding. For women with PCOS, a diagnosis of PCOS by a healthcare professional was required. All overweight and obese women with PCOS were invited to participate in the 'Dieting experience' survey. Ethical approval was granted by the procedures of the

University of Roehampton and University of Surrey. The studies were carried out in accordance with The Code of Ethics within the Declaration of Helsinki.

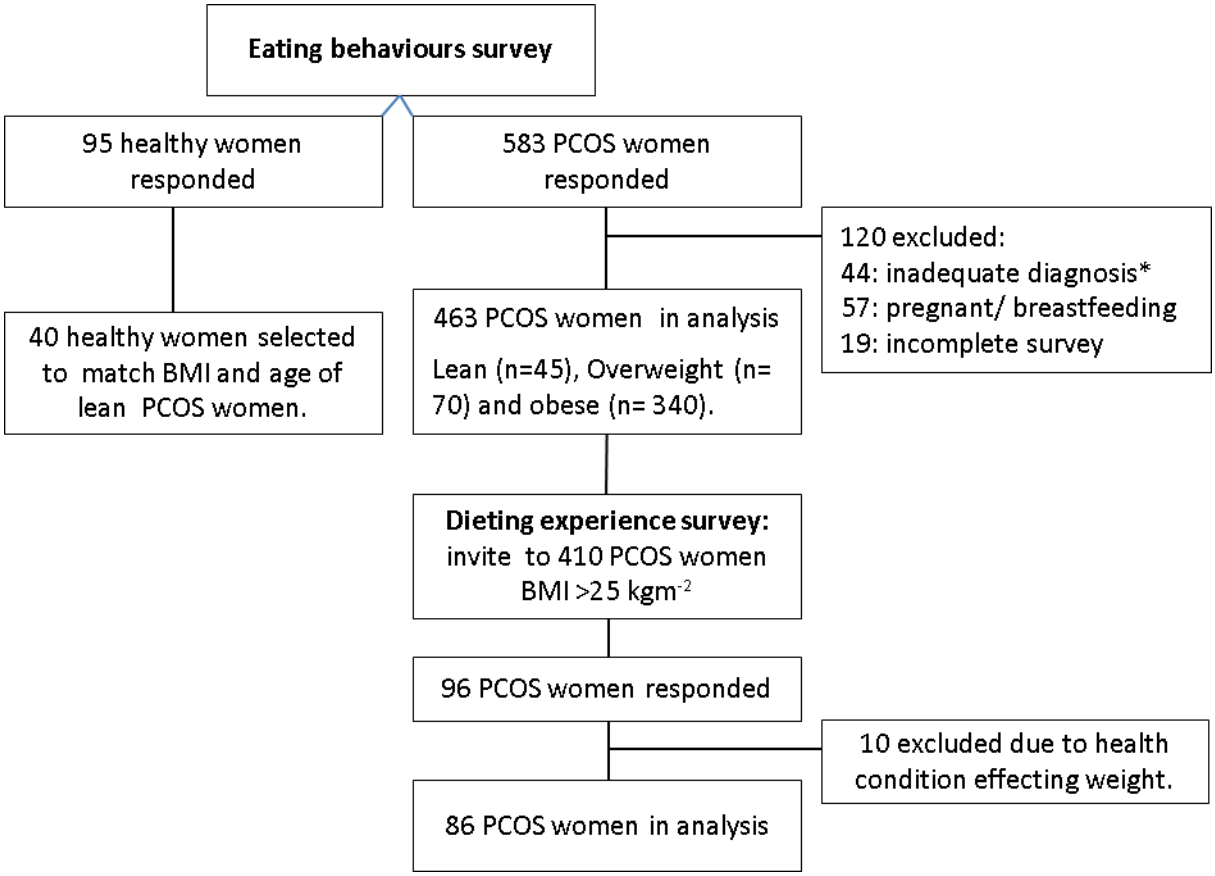

Figure 1. Recruitment of participants
* Inadequate diagnosis was a diagnosis by someone other than a healthcare professional. Data for the Dieting experience survey was collected anonymously.

2.2 Assessments and measurements

The online survey was presented on the Bristol Online Survey and SurveyMonkey® platforms. Informed consent procedures were embedded into the survey. Participants were asked questions relating to PCOS diagnosis, other medical conditions, self-reported PCOS symptoms, weight, height and dieting history similar to a previous study (52). Amenorrhea was considered present if participants provided a negative response to “have you had a period in the previous 12 months?”

The following validated questionnaires were used:

i) The Bulimia Investigatory Test, Edinburgh, (BITE) (53); recognised for its validity and reliability (54), is a 33-item self-report measure designed to identify individuals with symptoms of bulimia or binge eating. It consists of a symptom scale and a severity scale,

which provides an index of the severity of binging and purging behaviour as defined by their frequency.

ii) The Food Cravings Questionnaire–Trait (FCQ–T), a 39-item self-report questionnaire whereby participants indicate how frequently each statement 'would be true for you in general' using a 6-point scale [range: 1 ('never or not applicable') to 6 ('always')]. Nine trait craving domains (Table 2) have been reported in healthy participants (55), those with eating disorders (56) and obese populations (57).

iii) The Three Factor Eating Questionnaire- Revised 18 (TFEQ-R18 version 2)(58), was selected to establish cognitive restraint, uncontrolled and emotional eating in the participants. It consisted of 18 statements, which participants indicate there agreement on a Likert like scale. The results are calculated into scores from 1 to 4, with higher values indicating more of the behaviour.

The dieting experience survey for overweight and obese women with PCOS included items assessing dieting circumstances and perception of dieting strategies through an online questionnaire previously published by (59, 60).

2.3 Data analysis

Frequencies and descriptive statistics were generated using IBM® Statistical Package for the Social Sciences® (SPSS®) version 21. Data are presented as means ± SD or number and percent. Normality of data was assessed; independent t tests were used to compare variables between healthy women and women with PCOS; Mann-Whitney was used for non-parametric data. Cohen's d values and eta squared were calculated to establish size of effect. One-way or two-way ANOVA with Bonferroni post-hoc correction was chosen to compare variables between weight categories for women with PCOS. Partial correlations were used to control for body mass index (BMI). Multiple regression analysis with predictor values entered simultaneously was used to explore variance of binge eating behaviours, as measured by BITE symptom score; independent variables were total food cravings trait score, BMI, uncontrolled eating and emotional eating scores from TFEQ-R18.

3. Results

3.1 Population characteristics

The majority of women with PCOS were obese (73.4%; n=340), 15.1% (n=70) were overweight and 9.7 % (n=45) were lean. Women with PCOS had a mean ± SD weight of 98.6± 27.4kg (n=460) and BMI of 36.0±9.1 kgm^{-2} (n=458). The majority of participants were Caucasian (84.7%), with 3.9% mixed race, 2.6% Black, 2.2% Asian and 6.7% classified as 'other'. Responses were from North America (n=303), Europe (n=107), Australasia (n=36) and other continents (n=17).

Diagnosis of PCOS was by a hospital or specialist doctor (60%), general practitioner (38%) or nurse (2%). Prevalence of PCOS symptoms included hirsutism 85% (n=392); acne 56% (n=257) and irregular menstruation 55% (n=255). Thirty one women reported a diagnosis of type 2 diabetes, 32 reported having depression and 11 reported a diagnosis of an eating disorder (table 1).

Table 1. Age, BMI and self-reported symptoms of women with PCOS

	Lean n=45	**Overweight n=70**	**Obese n=340**
Age (years)	31.3 (5.6)	31.4 (7.6)	32.63 (7.3)
BMI (kgm-2)	22.5 (1.8)	27.3 (1.4)	39.7 (7.3)
Response to the question: Do you have…			
Hirsutism	71%	81%	87%[a]
Acne	62%	46%	57%
Irregular menses	51%	53%	56%
Amenorrhea	2%	9%	14%[a]
Positive response to the question: Do you have any other medical conditions?			
Type 2 diabetes	2%	6%	8%
Depression	11%	14%	5%[a]
An eating disorder	2%	1%	2%
Weight management			
Dieting to lose weight	27%	40%	47%[a]
Agree with the statement 'I am a yo-yo dieter'	35%	33%	57%

No significant difference between BMI groups in age (p=0.23, One way ANOVA). [a]Significant difference between BMI groups in prevalence hirsutism (χ^2 p=0.012; Cramer V=0.14), amenorrhea (χ^2 p=0.044; Cramer V=0.12), depression (χ^2 p=0.012; Cramer V=0.14) and dieting to lose weight (χ^2 p<0.001; Cramer V=0.24).

3.2 Food cravings in women with PCOS

Nearly all of the women with PCOS self-reported craving foods (99%); these included savoury and sweet, energy dense, high carbohydrate and high fat foods. BMI groups differed in FCQ-T scores (one-way ANOVA group effect, F(2, 452) = 10.0 p <0.001); multiple comparisons between groups (Bonferroni-adjusted) confirmed that obese women had significantly higher trait food craving scores than either lean (p=0.001) or overweight (p=0.01) women with PCOS (Table 2); specifically greater scores on the sub scales*: 'Having intentions and plans to consume food', 'Lack of control over eating', 'Emotions that may be experienced before or during food cravings or eating'* and *'Guilt from cravings/for giving into cravings'* compared with lean women with PCOS (all p<0.01) (table 2). Total food cravings and BMI were weakly correlated (r = 0.21; p<0.01).

Higher FCQ-T scores were observed in women with PCOS with acne (n=257) compared to those without acne (n=206)(130±3 versus 124±3; p=0.02, Cohen's d =0.22). Hirsutism in women with PCOS did not significantly affect their reported food cravings whether assessed by BMI sub-group or with all weight categories combined (hirsute PCOS: n=392, FCQ-T

score 127±30; non-hirsute PCOS: n=71, FCQ-T= 127±32; p=0.8). Similarly neither depression nor irregular menses were found to significantly impact on FCQ-T within the PCOS cohort. When FCQ-T scores were compared between sub-groups of PCOS women with and without specific symptoms, only amenorrhea (n=55) was associated with greater food cravings (139±32 versus126.2±30 for all other women; p=0.03, Cohen's d =0.42). Obese women with PCOS who reported being on a diet to lose weight had similar FCQ-T scores compared with obese women with PCOS not dieting (132±27 n=159; versus 133±31 n=132, p=0.77). However, one subscale did differ by dieting status, i.e. those on a diet to lose weight had a higher score for '*Guilt from cravings and/or for giving into them'* compared to those not dieting (12.1±2.4 versus 11.5±3.0 respectively; p=0.049, Cohen's d =0.22).

Table 2. Food craving scores* for women with PCOS (mean (SD)).

	Lean n=45	**Overweight n=70**	**Obese n=340**
Total food cravings score (FCQ-T)	**114.0 (34.9)**	**120.1(29.5)**	**131.6 (28.9)[ac]**
Subscales:			
Having intentions and plans to consume food	9.1 (3.2)	9.8 (2.8)	10.9 (2.6)[ac]
Anticipation of positive reinforcement that may result from eating	14.7 (4.3)	14.2 (4.2)	15.7 (4.4)[d]
Anticipation of relief from negative states and feelings as a result of eating	8.0 (3.4)	7.9 (3.1)	8.9 (2.9)[d]
Lack of control over eating	16.3 (7.2)	18.4 (6.1)	20.4 (5.6)[ad]
Thoughts or preoccupation with food	18.1(7.8)	18.6 (7.3)	20.8 (7.0)[b]
Craving as a physiological state	13.1 (3.0)	13.3 (3.0)	14.1 (3.1)
Emotions that may be experienced before or during food cravings or eating	11.9 (5.1)	13.6 (4.5)	14.5 (4.1)[a]
Cues that may trigger food cravings	13.1 (4.3)	13.3 (4.0)	14.6 (3.7)[d]
Guilt from cravings and/or for giving into them	9.6 (3.7)	11.0 (3.4)	11.8 (2.7)[a]

[a]p<0.01, [b]p<0.05: significantly different between lean and obese women with PCOS;
[c]p<0.01, [d]p<0.05: significantly different between overweight and obese women with PCOS; one-way ANOVA with Bonferroni post-hoc adjustment.
*Possible ranges for the scale scores: Total score, 39-234; Having intentions and plans to consume food, 3-18; Anticipation of positive reinforcement that may result from eating, 5-30; Anticipation of relief from negative states and feelings as a result of eating, 3-18; Lack of control over eating, 6-36; Thoughts or preoccupation with food,7-42; Craving as a physiological state, 4-24; Emotions that may be experienced before or during food cravings or eating, 4-24; Cues that may trigger food cravings, 4-24; Guilt from cravings and/or for giving into them, 3-18.

3.3 Binge eating behaviours in women with PCOS

Only 20% of obese women with PCOS were free of both compulsive eating and binge-eating (Figure 2). Sixty percent of obese women with PCOS (n =200) presented scores that indicated binge eating behaviour; 39% presented with clinically significant or high degree of severity (n=130) (table 3), but only 2% of obese women with PCOS reported a diagnosed eating disorder (table1). A significantly greater proportion of obese women with PCOS exhibited binge eating behaviours compared with overweight and lean women with PCOS (Figure 2).

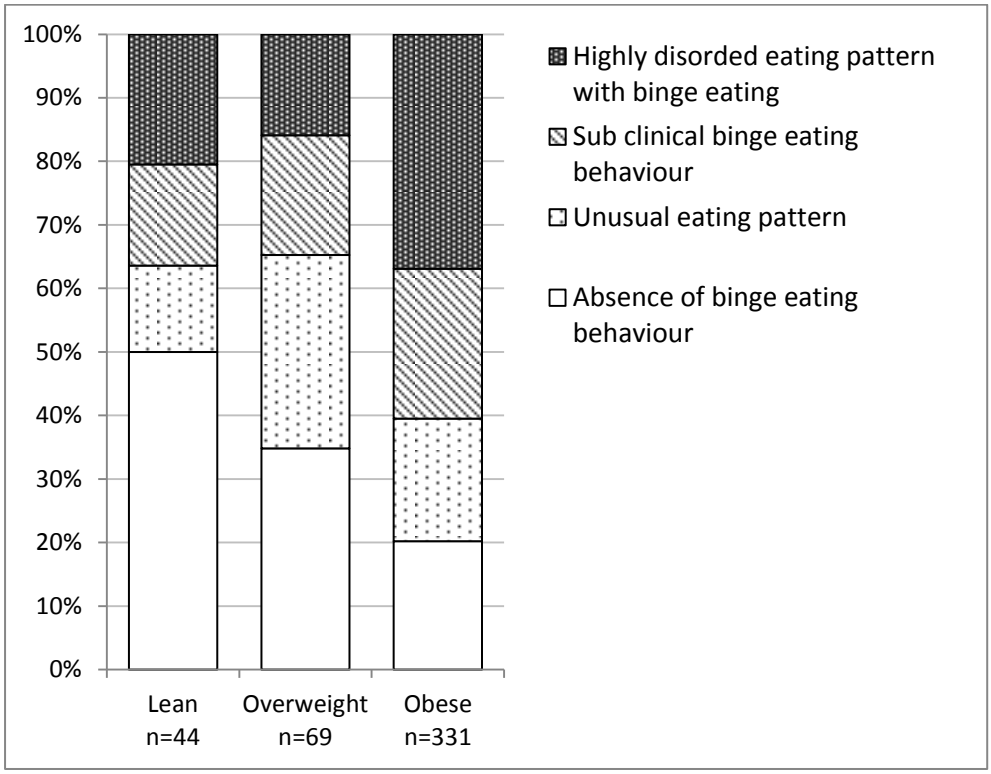

Figure 2. Proportion of women with PCOS exhibiting binge eating behaviour.
Significant difference in proportion of binge eating symptoms between BMI groups (χ^2 p<0.001, Cramer's V =0.25).

Similar to the results for reported food-cravings, sub-groups created according to the presence or absence of specific symptoms (hirsutism, depression or irregular menses) did not show different binge eating symptom scores. However once again, women who reported acne (n=257) had higher binge eating symptom scores (16.0±7 versus 13.6±7; p=0.01, Cohen's d =0.32) than those without (n=206), likewise those who reported amenorrhea (n=55) when compared with women who reported having menses in the previous 12 months (n=408; 17.0±7.0 versus 14.7±7.1; p=0.02, Cohen's d =0.33). Obese women with PCOS who reported being on a diet to lose weight had similar binge eating symptom scores compared with obese women with PCOS not dieting (16.5±6.3, n=159; versus 16.0±7.1, n=132, p=0.36).

Table 3. Binge eating scores from women with PCOS.

	Lean n=44	**Overweight n=69**	**Obese n=331**
Binge eating symptom score*; Mean (SD)	**10.9 (7.8)**	**12.4 (6.8)**	**15.9 (6.8)[ab]**
Subscales:			
Absence of both compulsive eating and binge-eating.	50% n=22	34.8% n=24	20.2% n=67
Unusual eating pattern might be a compulsive	13.6% n=6	30.4% n=21	19.3% n=64

eater who eats excessively but does not binge-eat.			
Subclinical group of binge-eaters, either in the initial stages of the disorder or recovered bulimics.	15.9% n=7	18.8% n=13	23.6% n=78
Highly disordered eating pattern and the presence of binge-eating.	20.5% n=9	15.9% n=11	36.9% n=122
Binge eating severity score*; Mean (SD)	**2.8 (2.1)**	**3.6 (3.3)**	**4.3 (3.2)[a]**
Normal	86.4% n=38	76.8% n=53	60.7% n=201
Clinically significant behaviour	13.6% n=6	14.5% n=10	32.3% n=107
High degree of severity	0% n=0	8.7% n=6	6.9% n=23

[a]p<0.01: significantly different between lean and obese women with PCOS;
[b]p<0.01: significantly different between overweight and obese women with PCOS; analysis by one-way ANOVA with Bonferroni post-hoc adjustment. * Possible range for binge eating symptom score, 0-30; binge eating severity score, 2-39.

3.4 Emotional eating, cognitive restraint and uncontrolled eating scores in women with PCOS

Emotional eating scores were higher in obese compared with lean women with PCOS (obese 2.7±0.8, overweight 2.5±0.8 and lean 2.3±0.9; p=0.006, eta squared =0.021, post hoc obese versus lean p=0.013; score ranges from 1-4). Emotional eating scores were positively associated with total food craving score (r=0.74; p<0.001) and binge eating symptom score (r=0.64, p<0.001). These strong correlations remained when controlled for BMI. Conversely, cognitive restraint scores were lower in obese compared with lean women with PCOS (obese 2.5±0.7, overweight 2.7±0.8 and lean 2.8±0.8; p=0.001, eta squared =0.027, post hoc obese versus lean p=0.004). Weak negative associations were observed between cognitive restraint scores and total food craving score (r=-0.23, p<0.001) and binge eating symptom score (r=-0.15, p=0.01), although when controlled for the influence of BMI only the weak correlation with food cravings remained (r=-0.2, p<0.001). There was a trend towards greater uncontrolled eating scores in obese women with PCOS (obese 2.6±0.4, overweight; 2.5±0.4 and lean 2.5±0.5; p=0.053). Uncontrolled eating scores were positively associated with total food craving score (r=0.67; p<0.001) and binge eating symptom score (r=0.56, p<0.001). These strong correlations remained when controlled for BMI.

3.5 Association between binge eating and food cravings in women with PCOS

Binge eating symptom score and food cravings total scores were strongly correlated (r=0.745; p<0.001, n=463 women with PCOS. Multiple regression analysis to predict contribution to binge eating symptom score included BMI, total food cravings score, uncontrolled, emotional and cognitive restraint eating scores as predictor variables. The model explained 57% of the variance in binge eating symptom scores (F(df1, df2)=130.4; p<0.001): food cravings total score (beta =0.53; p<0.001), emotional eating score (beta =0.18; p<0.001), BMI (beta= 0.11; p<0.001) and uncontrolled eating score (beta =0.09

p=0.02) independently contributed to this explained variance, whereas cognitive restraint was not an independent predictor (beta 0.03; p=0.28).

3.6 Comparisons between lean healthy women and lean women with PCOS

Lean healthy women (n=40) and lean women with PCOS (n=45) were similar in ethnicity (both >95% Caucasian), age (28.3±8.5 years and 31.3±5.6 years; p=0.07) and BMI (21.8±1.6kgm^{-2} and 22.5±1.8 kgm^{-2}; p=0.09). They returned similar total food craving scores, although, women with PCOS reported significantly higher scores on the food craving sub-scale *'Anticipation of Positive Reinforcement That May Result From Eating'* (p=0.017, Cohen's *d* = 0.52) and *'Anticipation of Relief From Negative States and Feelings as a Result of Eating'* (p=0.009, Cohen's *d* = 0.56) compared with lean healthy women (table 4). Significantly higher mean binge eating score was observed in lean women with PCOS compared with lean healthy women (10.9±7.8 versus 7.4±6.0, p=0.024; Cohen's *d* = 0.50 (table 4). Lean women with PCOS had a significantly higher proportion of subclinical/ highly disordered eating (36%, n=16) compared with lean healthy women (12%, n=5; χ^2 p=0.02 phi =0.28). Multiple regression analysis to predict contribution to binge eating symptom score included PCOS diagnosis, BMI, uncontrolled eating score, emotional eating score and total food cravings score as predictor variables. The model explained 68% of the variance in binge eating symptom scores (F(df1, df2)=31.2; p<0.001); food cravings total score (beta =0.72; p<0.001), PCOS status (beta 0.14; p=0.042), independently contributed to this explained variance, however emotional eating score (beta =0.07; p=0.9), uncontrolled eating score (beta =0.107; p=0.23) and BMI (beta= 0.008; p=0.91) did not.

Table 4. Food craving and binge eating scores from lean healthy women and lean women with PCOS.

	Healthy n=40	**PCOS n=45**
Total food cravings score*; Mean (SD)	**105.6 (26.6)**	**114.0 (34.9)**
Subscales:		
Having intentions and plans to consume food	8.6 (2.4)	9.1 (3.2)
Anticipation of positive reinforcement that may result from eating	12.6 (3.8)[a]	14.7 (4.3)[a]
Anticipation of relief from negative states and feelings as a result of eating	6.4 (2.2)[a]	8.0 (3.4)[a]
Lack of control over eating	14.5 (5.4)	16.3 (7.2)
Thoughts or preoccupation with food	17.3 (6.2)	18.1(7.8)
Craving as a physiological state	12.3 (3.1)	13.1 (3.0)
Emotions that may be experienced before or during food cravings or eating	11.2 (4.2)	11.9 (5.1)
Cues that may trigger food cravings	14.0 (4.2)	13.1(4.3)
Guilt from cravings and/or for giving into them	8.8 (3.6)	9.6 (3.7)
Binge eating symptom score*; Mean (SD)	**7.4 (6.0)**	**10.9 (7.8)** [a]

Absence of both compulsive eating and binge-eating.	65% n=26	50% n=22
Unusual eating pattern might be a compulsive eater who eats excessively but does not binge-eat.	17.5% n=7	13.6% n=6
Subclinical group of binge-eaters, either in the initial stages of the disorder or recovered bulimics.	5.0% n=2	15.9% n=7
Highly disordered eating pattern and the presence of binge-eating	7.5% n=3	20.5% n=9
Binge eating severity score*; Mean (SD)	**2.0 (2.2)**	**2.8 (2.1)**
Normal	89.5% n=34	86.4% n=38
Clinically significant behaviour	7.9% n=3	13.6% n=6
High degree of severity	2.6% n=1	0% n=0

[a]p<0.01: Significant difference between healthy and PCOS women; independent t test.
*See Tables 2 and 3 for notes on possible scale score ranges.

3.7 Dieting experience in women with PCOS

The eating behaviours study indicated a high proportion of overweight and obese women with PCOS expressed an interest in losing weight (96% and 99% respectively). Despite these intentions only 47% of obese women with PCOS reported to be modifying their diet to promote weight loss and a further 11% were modifying their diet to avoid weight gain (40% and 11% comparatively for overweight women with PCOS). This was explored further in the Dieting Experience Survey completed by 86 overweight or obese women with PCOS; mean BMI 37.4±7.1kgm^{-2} (6 participants had incomplete data for their BMI). Most of the respondents were of Caucasian ethnicity 86% (n=74). Nearly all (93%) of the women reported to have been on diets previously to lose weight, though only 13% reported stopping the diet as they had attained their goal of weight loss or duration. Hunger and frustration were the most common reason for abandoning a dietary change (57%) followed by perceived ineffectiveness of the diet (40%) and expense (35%). Barriers reported to 'often' or 'routinely' impact on achieving their goal of staying healthy were; *'too tired'* (71%), '*interferes with other responsibilities'* (57%), *'lack of time'* (55%), *'embarrassment about my appearance'* (46%), *'feeling what I do does not help'* (46%), *'lack of money'* (40%), and *'lack of help from healthcare professionals'* (24%).

4. Discussion

4.1 Binge eating behaviour

The current study has reported binge eating behaviour in the majority of obese women with PCOS, and more than a third of overweight and healthy weight women with PCOS. This is the first time binge eating has been reported with a validated tool in a large cohort of women with PCOS. Regression analysis demonstrated the interrelationship between binge eating

behaviours and food cravings in the women with PCOS, similar to previous studies in obese and overweight non PCOS participants (61, 62).

Direct comparisons with published studies of non PCOS populations need to take into account different methods for assessing binge eating behaviour. The prevalence of clinically significant binge eating behaviour in our cohort of obese women with PCOS (39%) is greater than reports in non PCOS obese women within a large Italian study whereby 24-32% of obese women were classified as exhibiting binge eating behaviour as defined by a score ≥18 on the Binge Eating scale (63), similarly, in the United States, 27% of overweight/obese women had some bingeing or probable binge eating disorder (64). Larrson *et al.* (2015) also recently reported women with PCOS (n=72) had a higher Eating Attitudes Test score, reflecting disordered eating, compared with controls (n=30), though women with PCOS had a significantly higher BMI (19). Our cohort of lean women with PCOS had significantly higher binge eating symptom scores compared with lean healthy women in agreement with the findings of Hart *et al.* (2012)(47).
Women with PCOS who reported amenorrhea had significantly higher binge eating symptom scores compared with those with menses, this agrees with the association between binge eating and menstrual dysfunction in women without PCOS observed by Algars *et al.* (2014)(28). The pathogenesis is believed to involve elevated testosterone (31), we did observe higher binge eating symptom scores in PCOS women with acne compared to those without acne, however, scores were similar in hirsute and non-hirsute women with PCOS, although it should be noted that the study was not powered to detect differences between symptom sub-groups and so these results should be viewed with caution. We suggest future studies explore menstrual dysfunction and hyperandrogenism in relation to eating behaviours in women with PCOS including investigation of hormonal influencers in binge eating (65) which was beyond the scope of this study.

Binge eating has a complex and incompletely understood aetiology. Contributing factors include anxiety, depression and negative body image (66-68), all frequently observed in women with PCOS (23, 24, 69). Rodino *et al.* (2016) recently reported that infertile obese women, including a small cohort of obese women with PCOS experienced lower self-esteem, body shape concerns and binge eating behaviours (70). Our study was not powered to report a difference in binge eating symptoms and depression and there is a gap in the literature exploring this potential relationship in PCOS especially given the high prevalence of depression in women with PCOS (24). Further research into the causes and possible long term consequences of binge eating behaviours in lean women with PCOS is needed to investigate whether bingeing contributes to future weight gain in this syndrome.

4.2 Food craving

Food cravings are often anecdotally reported by women with PCOS (46), though there is a paucity of research and the current study is the first to report food cravings in a large cohort of women with PCOS using a validated tool. Our cohort reported food craving questionnaire-Trait (FCQ-T) scores in the obese women with PCOS (131.6±28.9) that were higher than published values for non PCOS populations, e.g. 111.5±36.8 in an Italian cohort of 411 overweight and obese women, and 86 obese men (71) and 119.2±31.4 for 109 overweight and obese in the United States (57). Direct comparisons are limited by the fact that these studies include males and overweight participants; further studies are needed to compare food cravings in obese women with and without PCOS. Of interest, food craving scores for obese women with PCOS are more similar to the scores reported by Jarosz *et al.* (2007) in obese women with binge eating disorder or bulimia (137.6±40.2 n=7) or night eating syndrome (122.5±19.0 n=16) (72) and normal-weight university students with food addiction (147.1±34.5, n = 48) (38), although some of those scores were based on very small numbers. The current study revealed lean women with PCOS and lean healthy women had similar total FCQ-T scores; however, women with PCOS did have greater 'anticipation of positive reinforcement that may result from eating' and 'anticipation of relief from negative states and feelings as a result of eating'. These both address feelings of satisfaction from eating and the clinical relevance of these aspects needs to be explored in more detail. Of note, although food cravings are strongly correlated to binge eating, which is highly prevalent in women with PCOS, the facets of food cravings that distinguished PCOS from healthy women are those concerning anticipation of reinforcement and relief from negative emotions and these may be crucial for the development of binge eating (73). Women with PCOS who reported amenorrhea had significantly higher FCQ-T scores compared with those with menses; this agrees with the association reported between menstrual dysfunction and fast food cravings in overweight/ obese women (48). However, like binge eating symptom scores, FCQ-T scores were higher in PCOS women with acne compared to those without acne, though scores were similar in hirsute and non-hirsute women with PCOS; whereas Lim *et al.* (2009) observed greater high fat food cravings in women with hyperandrogenism (48). This is an area for further study that requires more robust measurements of menstrual function and androgen excess in women with PCOS.

Another factor that may influence food cravings is dieting status, i.e. restricting energy intake to lose weight: repeatedly eating palatable energy-rich food such as chocolate when hungry has been shown to exacerbate craving in established chocolate cravers and induce craving in previously non-cravers (43). Therefore, we examined whether trait craving or binge eating scores differed by dieting status in obese women with PCOS; by and large, there were no

differences, with the exception that dieting women reported slightly more guilt at having cravings or giving in to them, presumably because such behaviour was contrary to their attempts to limit energy intake. In agreement with this, when controlled for BMI, there was no correlation between cognitive restraint eating and food craving scores.

4.3 Weight management

A large proportion of the overweight and obese women with PCOS were not following dietary modifications to prevent weight gain or promote weight loss, although the majority of women had tried to lose weight in the past. Similarly a high dropout rate has been reported in a meta-analysis of 10 lifestyle intervention program studies in infertile overweight or obese women (74). In our study only 13% of overweight and obese women with PCOS reported attaining their goal of weight or duration as their reason for stopping the diet emphasising the difficulty associated with weight loss and weight maintenance in this population. Barriers to successful weight loss included feeling frustrated and hungry, interference with other responsibilities, adherence difficulty, lack of time and tiredness, are in line with people wanting to lose weight (59, 75). The hunger reported by women could allude to the lower meal stimulated grehlin levels measured in women with PCOS (76), additionally studies have shown than testosterone stimulates food intake (49). Given that weight management is the primary treatment for women with PCOS understanding the barriers and reasons for non-compliance is crucial.

4.4 Clinical Implications

Binge eating behaviours may be a contributor to the difficulties associated with weight management reported amongst women with PCOS**.** It is important that the high prevalence of binge eating behaviours in women with PCOS is included within clinical guidelines, with suggested screening for disordered eating to help towards appropriate strategies to help women with binge eating behaviours (77). In particular in lean women with PCOS, often overlooked in the clinical and research setting, strategies to help with binge eating behaviours could be an effective intervention to prevent future weight gain. To strengthen the evidence it is important that the high prevalence of binge eating behaviours in obese women with PCOS reported in this study is explored in a large case control study. The prevalence of food cravings in PCOS is less clear. Cognitive behavioural therapy (78) and mindfulness (79) within interventions to help individuals reduce their food cravings has been successful, though further study in this area is needed before clinical interventions are recommended (36). In addition to the limitations of the present study highlighted above, the self-report nature of the PCOS diagnosis should be noted, with limited information on hyperandrogenism and menstrual function collected. Information on menstrual cycle was not

collected, which would have been valuable given the variations in food cravings through the menstrual cycle shown previously (80); however this should not have affected between group comparisons.

4.5 Conclusion

This study is the largest, to date, to robustly report binge eating and food cravings in women with PCOS, contributing significantly to the existing anecdotal evidence and small scale studies. Such disordered eating behaviours may be a contributor to and/ or a function of the difficulties with weight management reported amongst women with PCOS. Clinician awareness of binge eating in individual women with PCOS should influence the choice of weight management approaches: thus screening of overweight and obese women with PCOS for binge eating is recommended. To further our understanding of disordered eating behaviours in women with PCOS we suggest, BMI matched case-control, studies to assess the influence of medication, hormonal and psychological contributors to binge eating behaviours in women with PCOS.

Acknowledgments:

Thanks to R Evill and A Calvert for their help with data collection. The studies were funded by the University of Roehampton and University of Surrey.

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