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Depression Symptoms and Body Dissatisfaction Association Among Polycystic Ovary Syndrome Women

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Abstract

Objective—One publication reported that lower body satisfaction and lower education were independent predictors of depression in polycystic ovary syndrome (PCOS) women. This study replicates that analysis using different instruments, and adds androgen levels to the model.

Methods—Cross-sectional analysis of questionnaires (Quick Inventory of Depressive Symptomatology-Self-Report, Body Esteem Scale) and serum androgens from a community cohort with (n=94) and without (n=96) PCOS, matched by BMI category. Non-parametric tests, Spearman correlations, and negative binomial regression models were analyzed.

Results—Depression symptoms were common (40–60% in lean, overweight and obese BMI categories) in the PCOS cohort, albeit generally of mild severity. The PCOS women had similar depression symptom severity ($P > 0.20$) and similar body dissatisfaction ($P \geq 0.25$) as the regularly cycling women in total and stratified by BMI category. In both the PCOS and non-PCOS cohorts, depression symptom severity was positively correlated with dissatisfaction with physical appearance and physical conditioning ($P < 0.02$). Body dissatisfaction (especially perception of physical conditioning) was strongly associated with more severe depression symptoms in non-obese PCOS women (BMI<30, $P < 0.04$) before and after controlling for age, testosterone and free testosterone. In contrast, for obese women with PCOS, depression was unrelated to body dissatisfaction after controlling for age.

Conclusions—Among non-obese PCOS women, their subjective body image was strongly associated with the severity of their depression symptoms. Most of the obese PCOS cohort had low body satisfaction and depression symptoms, therefore individual differences in the body dissatisfaction scores were not helpful in identifying depression symptom severity. Neither testosterone nor free testosterone were associated with depression symptom severity in PCOS women after controlling for body dissatisfaction and age.

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Keywords

Androgens; Body image; Body mass index; Body satisfaction; Depression; Endocrinology; Polycystic ovary syndrome

Introduction

Polycystic Ovary Syndrome (PCOS) is the most common endocrine disorder of reproductive age women[1]. Approximately 6.5% of women of reproductive age have PCOS[2,3], which is characterized by irregular or absent menstrual periods and hyperandrogenic manifestations such as acne and hirsutism[4]. The prevalence of depression and depression symptoms is significant in women with PCOS (29%[5] to 50%[6] in small cohorts). In one recent report, women with PCOS were found to have a 3.8 times higher lifetime incidence of depressive episodes (per clinical interviews) than age-, but not BMI-, matched women[7].

An association between elevated testosterone levels and depression has been reported among non-PCOS premenopausal women [8,9] and women undergoing the menopausal transition[10], although reports of no association exist among postmenopausal women[11] and African-American women aged 49–65[12]. Free testosterone has been reported to have an inverse association with depression symptoms in elderly women[13] and in women with anorexia nervosa[14]. Lower serum dehydroepiandrosterone sulfate (DHEAS) has been linked with increased depression symptoms in African-American women aged 49–65[12]. Several studies of women with PCOS (with modest sample sizes) have failed to find an association between depression and serum levels of DHEAS[6], sex hormone binding globulin (SHBG)[6,15,16], and testosterone[6,15–18]. In contrast, a study by Weiner et al [15] did find a curvilinear relationship between free testosterone and the depression scores among PCOS women (depression scores were lower for women with very high or very low free testosterone). The solitary publication on a possible relationship between excess androgens and body dissatisfaction within the PCOS population reported that lower body satisfaction was associated with hyperandrogenism (free androgen index > 4.5) before and after adjustment for psychological measures (self-esteem and negative appearance scales, $P < 0.03$, no comparison group)[19].

PCOS women have lower body satisfaction compared with controls[15,20,21]. One publication reported that lower body satisfaction, lower satisfaction with appearance, and lower education were independent predictors of depression in PCOS women after controlling for age and body mass index (BMI) [20]. Two other studies collected body satisfaction and depression data in PCOS women[15,21], but did not analyze the relationship between those parameters. Among females who received medical care at a centralized facility[22] and individuals in a weight loss facility[23], body image dissatisfaction mediated the association between obesity and depression.

The goals of this report are to quantify among women with PCOS the relationship between depression symptom severity and body dissatisfaction, and to determine if the inclusion of androgen levels improves the ability to predict depression symptom severity. Our a priori hypothesis was that there was a positive association between depression symptom severity and body dissatisfaction based on one prior report[20]; there was no initial expectation for the addition of androgens to the model.

Methods

This study was approved by the University of Virginia's Internal Review Board. The population studied consisted of n=94 untreated women diagnosed with PCOS and a comparison sample of n=96 women with regular menses. This publication is a cross-sectional analysis of baseline data.

PCOS cohort enrollment criteria

Inclusion criteria were: a) a diagnosis of PCOS, as confirmed through the study using the NICHD criteria of oligomenorrheic and non-diabetic, with self-reported hirsutism and/or acne and/or elevated free testosterone (>6.8 pg/mL)[24], b) aged 18 to 43 years, c) weight of 250 pounds (113 kg) or less, and d) at least one menses in the past six months but no more than eight periods in the most recent 12 months without hormonal intervention. Free testosterone was calculated from testosterone and sex hormone binding globulin levels[25–27], and an elevated level was defined as “ >6.8 pg/mL” for females.[28] Exclusion criteria were: a) use of metformin or hormonal contraceptives in the 60 days prior to enrollment, b) currently pregnant or breastfeeding during the prior 30 days, and c) bleeding/coagulation conditions that would contraindicate a blood draw. Women were recruited from the community, as described elsewhere[29].

Data on the PCOS symptoms (menstrual pattern, hirsutism, acne) were self-reported. Androgens were assayed on fasting blood samples. After eligibility confirmation, self-administered questionnaires were implemented (demographic/reproductive history, the Body Esteem Scale (BES)[30], and the Quick Inventory of Depressive Symptoms(QIDS-SR16)[31]). Height and weight were measured (for calculating BMI) by trained nurses.

Comparison cohort

Anonymous waiting room surveys (BES and the QIDS-SR16) were implemented at three university OB/GYN and Family Medicine clinics (80% of the sample), and the university cafeterias (20% of the sample) in the fall 2009/winter 2010 (exempt IRB study). This convenience cohort was selected due to resource limitations, and these women were not compensated for completing the surveys. Of the women who agreed to participate, 96 respondents were healthy female volunteers who had never been diagnosed with PCOS, had regular menses, and were aged 18 to 44 years, not currently pregnant, and not within three months of delivery. Women self-reported their weight and height in ranges (4 weight categories, 3 height categories) designed to distinguish obese, overweight and lean BMI levels, as it was known upfront that the results would be analyzed in those three BMI categories based on preliminary data analyses. This cohort served as a reference population for the depression and body satisfaction scores.

Questionnaires

Body dissatisfaction was measured using the validated Body Esteem Scale[30], which is composed of 35 items and contains factorially-derived measures of both male and female body satisfaction. Respondents rate each of the 35 items (body parts and functions) on a 5 point Likert scale with responses ranging from 1 (“Have strong negative feelings”) to 5 (“Have strong positive feelings”). The range of valid total scores is 35 – 175, with a lower score indicating greater body dissatisfaction. This tool consists of three subscales: sexual attractiveness, weight concern, and physical condition. The sexual attractiveness subscale assesses body parts whose appearance can generally be changed through cosmetics, but not exercise. The weight concern subscale addresses physical appearance items that can be altered through exercise or dietary habits, rather than cosmetics. The physical condition subscale addresses such items as stamina and agility, and generally consists of

characteristics that are not readily visible to others. The scale has a high test-retest reliability[32]. Missing data (8 blanks, or 0.3% of the PCOS dataset) were imputed using the average score of the corresponding subscale, as suggested by the BES author [personal communication].

Depression symptoms were measured with the Quick Inventory of Depressive Symptomatology-Self Report 16[31], which covers the nine symptomatic domains that are used to assess depressive episodes or major depressive disorders as described by the DSM-IV criterion. The individual self-reports the severity and frequency of symptoms over the last 7 days using a score of 0 – 3. The total scores range between 0 and 27, with higher scores reflecting more severe depression symptoms (0–5 no symptoms, 6–10 mild symptoms, 11–15 moderate symptoms, 16–20 severe symptoms, and 21–27 very severe symptoms). The internal consistency (Cronbach's alpha) was 0.86, and the QIDS-SR16 scores are strongly correlated with both the Inventory of Depressive Symptomatology tool and the Hamilton Rating Scale of Depression[31].

Serum assays (PCOS cohort only)

Total testosterone, DHEAS, and SHBG were directly measured using standard chemiluminescent enzyme-linked immunoassays on the Immulite 2000 instrument. The analytical sensitivity of testosterone was 15 mg/dL with a coefficient of variation (cv) of 13.0% among high-normal female levels (mean 86.1 ng/dL). For DHEAS, the analytical sensitivity was 3 ug/dL with a cv=9.8% at mean DHEAS levels of 1.63. For SHBG, the analytical sensitivity was 0.02 nmol/L, with a cv=5.2% at a mean range of 21–63 nmol/L. Free testosterone was mathematically derived[25–28], which is an estimation technique that was critically evaluated and supported relative to direct measures of free testosterone[25]. All assays were performed in the UVa General Clinical Research Center Core Lab. All biological samples represent follicular phase or anovulatory cycle values.

Statistical analyses

The BES subscale scores, the QID-SR16 scores, and demographic factors were compared between the PCOS and non-PCOS cohorts using the Student t-test. Wilcoxon rank sum tests were utilized to compare the levels of total testosterone, free testosterone and SHBG by self-report of hirsutism and self-report of acne within the PCOS cohort. Within both cohorts, univariate associations between the composite depression scores and (a) the demographic variables, (b) the BES subscale scores, and (c) the PCOS patient's androgen and SHBG levels were evaluated using Spearman rank correlation coefficients.

Through the analysis it became evident that BMI was related to both the BES subscales and depression symptoms, hence a graphic investigation of the depression/BES relationship by BMI strata was undertaken. These BMI strata were: lean ($BMI < 25$), overweight ($25 \leq BMI < 30$) and obese ($30 \leq BMI$)[33]. The graphs demonstrated differential associations between depression and BES subscales by BMI, hence the subsequent analyses were conducted for lean/overweight separately from obese women. Due to small sample size in the overweight category and the similarity of the depression/BES correlations in the overweight and lean PCOS categories, those sub-cohorts were combined in the models.

Multivariable (Negative-Binomial) regression models were developed with the QIDS-SR16 depression score as the outcome (dependent) variable by BMI strata. Modeling was restricted to the PCOS cohort, because only those women had androgen data. The base model included predictor variables of body dissatisfaction (subscales that demonstrated a statistical correlation with depression symptoms) and age as a potential confounder[20,34]. The subsequent model added any androgen (or SHBG) that demonstrated a statistical

correlation with depression symptoms. Alpha = 0.10 was used for variable selection in order to be more rather than less inclusive of any factor that might prove to be informative in a multivariable model. Otherwise, the criterion for statistical significance was $P \leq 0.05$. The principle of maximum likelihood was utilized to estimate the regression model parameters and type III likelihood-ratio tests were conducted to determine the level of significance of each predictor variable.

Lastly, a sensitivity analysis was conducted to exclude potential bias from the use of any depression/anxiety medication. To assess this possibility, the multivariate models were rerun including only the women for whom data was available on current anxiety/depression medication use and who self-reported not to currently use these medications. Results for the restricted PCOS population were compared with the full PCOS population.

Results

Among the PCOS participants, the mean BMI was 30.3 and the mean age was 27.2 years (Table I). All three BMI groups contained women age under 25 years and over 35 years, and non-Caucasian women. The comparison cohort was somewhat older than the PCOS cohort, with a mean age in the 30–34 year bracket ($P < 0.01$). There were no differences between the PCOS and comparison cohorts by race ($P > 0.29$). Among the PCOS cohort, 49% self-reported acne and 73% self-reported hirsutism (data not displayed). Note that only limited demographics were included in the comparison cohort in order to maintain anonymity for IRB purposes.

Approximately half the PCOS and comparison cohorts (53% and 51%, respectively) scored as having symptoms of depression ($P = 0.68$, Table II). The majority of the PCOS sample with depression symptoms in each of the three BMI groups scored as having mild symptoms. The total depression symptom score did not vary by BMI strata within the PCOS cohort ($P = 0.07$), whereas the depression symptom severity was related to BMI strata within the comparison cohort ($P = 0.0049$). The depression symptom score was not related to age in the PCOS ($P = 0.19$) or comparison cohorts ($P = 0.63$).

The body satisfaction distribution overall and within BMI strata was similar in the PCOS and comparison cohorts ($P > 0.05$, Table III). The body dissatisfaction within the PCOS cohort was generally greater in the obese group than the lean group ($P < 0.001$ for the weight concern and physical condition subscales, not significant for the sexual attractiveness subscale). Within the comparison cohort, only the weight concern subscale was related to BMI ($P = 0.0025$).

Among the PCOS population, increased depression symptom severity was strongly correlated with increased body dissatisfaction (denoted by a negative coefficient because the lower BES scores represents greater dissatisfaction) measured through the weight concern and physical condition subscales ($P < 0.01$, Table IV). Among the lean and overweight PCOS women, this same association was evident (all $P < 0.04$). In contrast, among the obese PCOS women, the depression symptom severity was only correlated with the BES-physical condition subscale ($P < 0.04$). Among the comparison cohort, there was strongly correlation between all three body dissatisfaction subscales and depression symptoms ($P \leq 0.01$), however this pattern was not evident when the comparison women were stratified by BMI. Depression symptom severity was only correlated with body dissatisfaction for the physical condition subscale among the lean and obese non-PCOS women and only for the sexual attractiveness subscale among the obese non-PCOS women (all $P < 0.03$).

Within the PCOS cohort, total testosterone (ng/dL) ranged from 19.0 to 161.0 with a mean of 56.8 and 68.4 for non-obese and obese women, respectively. SHBG (nmol/L) ranged

from 2.0 – 86.0 with a mean of 38.7 and 25.6 for non-obese and obese women. Free testosterone (pg/mL) ranged from 3.0 to 45.9 with a mean of 10.4 and 15.7 for non-obese and obese subjects. DHEAS (ug/dL) ranged from 27.1 to 479.3 with a mean of 197.4 for non-obese and 166.4 for obese women. There was no association between self-reported hirsutism and either total testosterone, free testosterone, or SHBG ($P = 0.27, 0.14, 0.15$, respectively). There was an association between self-reported acne and SHBG ($P = 0.02$), but not between self-reported acne and either total or free testosterone ($p=0.38$ and 0.84 , respectively).

Correlations of these androgens (plus SHBG) with the depression symptom severity indicated no relationship with either SHBG or DHEAS ($P \geq 0.21$, data not shown). Graphs of the individual data points (not shown) supported the observation that testosterone and free testosterone were the two most likely androgens to consider in a multivariate model, and that the relationship appeared to be inverse (i.e., greater depression symptom severity at lower androgen levels).

The linear regression model for the non-obese women with PCOS (Table V) shows that the depression symptom score had the strongest association with the BES-physical condition subscale (inverse association, $P = 0.02$), followed by a non-significant association with the BES-weight concern subscale (inverse association, $P < 0.10$). These relationships held true after the inclusion of androgens, which were not statistically significant ($P > 0.50$). In contrast, the linear regression model for the obese women with PCOS indicated that the depression symptom severity was not related to either the BES-weight concern subscale or the BES-physical condition subscale scores ($P > 0.35$), but that depression symptoms may be related to lower levels of free testosterone in a larger cohort, as the p-value was marginal ($P = 0.08$). If we had included a covariate for BMI in the model and used the entire PCOS cohort instead of stratifying by BMI, these relationships above would not have been apparent. Using the entire PCOS cohort, all covariates in the full model (BES weight concern, BES physical condition, testosterone, free testosterone, age, BMI) except for BMI were not significant ($p>0.14$, model not displayed). Post-hoc, the restriction of the PCOS cohort to those who did not report current use of depression/anxiety medications (and for whom this data was known) did not alter the multivariate relationships within either the non-obese or obese PCOS cohorts (data not shown).

Discussion

Summary

Our investigation revealed a strong positive association between depression symptom severity and dissatisfaction with their physical appearance (“weight concern” subscale) and physical conditioning in women with PCOS ($P \leq 0.003$). The prevalence and severity of depression symptoms was greater in obese than lean women with PCOS. Higher BMI was associated with greater body dissatisfaction with physical appearance ($P < 0.001$).

These associations were also found in a comparison cohort of primarily gynecology patients without PCOS matched by three BMI tiers, thus implying that BMI may be a stronger factor underlying depression symptoms and body satisfaction than having PCOS.

Multivariate modeling stratified by BMI found depression symptoms were associated with dissatisfaction with physical conditioning among non-obese women with PCOS, after controlling for age. Body dissatisfaction was not associated with depression symptom severity in the obese PCOS women in the multivariate models after controlling for age. We do not interpret these results as meaning that body dissatisfaction is unrelated to depression symptoms in obese PCOS women. The correlation statistics demonstrate an association

between QIDS and physical condition body dissatisfaction within the obese PCOS cohort. The clinical application of our findings is that, among non-obese PCOS women, what is most important in predicting a woman's depression symptom severity is her subjective evaluation of her own body image. Most of the obese PCOS women had low body satisfaction and so individual differences in the body dissatisfaction scores were not as helpful in identifying depression symptoms.

Novel to this research topic is the inclusion of both body satisfaction and androgens in a PCOS depression model. Testosterone (free and total) was not related to depression symptom severity in the non-obese PCOS subjects after controlling for body dissatisfaction and age. Among the obese PCOS women, free testosterone was marginally associated with depression symptom severity ($P = 0.08$), which may be more relevant in a larger cohort. SHBG, DHEAS and total testosterone were all unrelated to depression symptom severity in this cohort.

Comparison to relevant literature

The only prior analysis of body image and depression in PCOS women reported that three factors were independent predictors of worse depression in $n=40$ PCOS women: two body dissatisfaction measures, and lower education [20]. That model controlled for age and BMI, neither of which was an independent predictor of depression. Our findings are not entirely consistent with their results. Their population had higher BMI than ours (their mean BMI was 33.8; 68% were obese, 18% overweight, and 15% lean), whereas we had a greater proportion of non-obese subjects. More importantly, discrepancies between the two studies may be due to the differing body image questionnaires. Neither of the two instruments they administered (Multidimensional Body-Self Relations Questionnaire – Appearance Scales[36], and a “body features satisfaction” tool developed expressly for that study) were validated. In contrast, the Body Esteem Scale instrument used in this study was validated[30,32].

Based upon 27 PCOS patients and 27 BMI-matched healthy controls,[15] free testosterone was reported to exhibit a curvilinear association with depression (less depression among PCOS women with very high or very low free testosterone), and was more predictive than total testosterone or SHBG. The free androgen index was unrelated to having had any major depressive disorder or a recurrent depressive disorder in a cohort of $n=49$ women with PCOS with a similar weight distribution to ours (mean BMI 29.1 kg/m²)[7]. Among a second cohort of $n=23$ PCOS women, there was no association found between bioavailable testosterone and depression[17], and two additional cohorts of $n=150$ [37] and $n=103$ [6] PCOS women found no association between depression and DHEAS, SHBG, nor total testosterone. Our findings support further investigation on the relationship between free testosterone and depression symptoms among obese PCOS women.

Our depression symptom scores support the few prior reports of a high prevalence of depression/depression symptoms in women with PCOS[6,20,35], albeit at a mild severity. Comparison of the depression symptom prevalence in our non-PCOS cohorts to the literature is challenging due to the variety of depression-related instruments and definitions. Two large studies would imply that our non-PCOS cohort is not representative of the general female population, as the 53% prevalence of depression symptoms is much higher than the 13% of obstetrics/gynecology patients and 16% of female primary care patients in the US with “mood disorders” using a Pfizer questionnaire[38,39] and the one-week 13.5% prevalence of “depressive episodes” and ICD-10 “mixed anxiety/depression” using the Clinical Interview Schedule in reproductive age British women[40]. On the other hand, the prevalence of depressive symptoms in female primary care patients in a recent US study was 44.9% using the 36-item Short Form Health Survey[41]. Our lack of difference in the

prevalence of depression symptoms between the PCOS and non-PCOS cohorts is not supported by the limited literature that controlled for BMI levels: Weiner et al[15] also reported higher state and trait depression in PCOS women than in BMI-match controls using the State-Trait Depression Adjective Check List.

Strengths and limitations

Strengths of this study design include the inclusion of PCOS women from the general community (approximately 40% had not been diagnosed with PCOS prior to study enrollment), and use of validated questionnaires. The sample size was greater than most of the research relevant to this topic (generally 25–55 PCOS subjects[15,17,20,21,42]), although less than the one sizeable study on the psychology of PCOS conducted through the internet[35]. Inclusion of a comparison cohort matched on BMI category enhanced our ability to add perspective on the aspects of depression symptoms and body dissatisfaction that are not unique to PCOS. Consideration of androgens within this depression symptom/body dissatisfaction analysis adds new knowledge to the literature.

Collection of weight and height in categories rather than as a continuous variable from the comparison cohort limited the possible statistical techniques to apply to those data. However as women tend to underreport their weight and this underreporting increases with higher BMI[43,44], the use of 3 BMI categories might actually minimize self-reporting bias. While the comparison cohort was on average older than the PCOS cohort, this is not a source of bias because age was not related to depression symptom score in either cohort. Due to resource limitations, the comparison cohort was a convenience sample which was more representative of an OB/GYN/family practice clinic population than the general female population and, without funding, we were unable to include a serum androgen measurement. Lastly, the study lacked objective measures of acne and hirsutism, which might or might not have been informative for our final model.

Clinical significance

Body dissatisfaction may be a precipitating force underlying depression symptoms in women with PCOS. Stokes and Frederick-Recascino[45] found happiness to be significantly and positively correlated to body image among non-PCOS women of reproductive ages ($p<0.01$)[45]. Several studies have reported that PCOS women have a worse body image than women without PCOS[15,20,21,46], although this was not true with the Body Esteem Scale instrument controlling for BMI category. A theme among qualitative research among PCOS women is a lack of feeling feminine[47], the desire to “pass” through the use of hair removal techniques[21], and stigmatization related to PCOS symptoms[47]. While hirsute women have been reported to have greater body dissatisfaction and tendencies towards social avoidance[21,48], there has not been an association reported between depression and the degree of hirsutism [17,21] or the severity of acne [17] among PCOS women.

Busy clinicians may be apt to presume a lean PCOS woman is satisfied overall in her body appearance and that an obese PCOS woman is not. Research supports a relationship between weight and body dissatisfaction (greater body dissatisfaction with heavier weight[49]), with less emphasis on physical size among Black women[50]. While our data support the observation that higher BMI is associated with worse depression symptoms, this study demonstrated that a proportion of non-obese PCOS women also have low body satisfaction and their degree of body dissatisfaction is correlated with the severity of their depression symptoms. These data imply that all PCOS women regardless of BMI should be screened for depression.

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Table I

Participant demographics and reproductive history.

Factor	Lean PCOS n=33	Overweight PCOS n=11	Obese PCOS n=50	Comparison Non-PCOS n=96
Age N (%)				
18–19	6 (18.2)	1 (9.1)	0 (0.0)	0 (0.0)
20–24	15 (45.5)	5 (45.5)	12 (24.0)	13 (13.5)
25–29	8 (24.2)	3 (27.3)	15 (30.0)	21 (21.9)
30–34	2 (6.1)	0 (0.0)	13 (26.0)	15 (15.6)
35–39	2 (6.1)	1 (9.1)	6 (12.0)	23 (24.0)
40–44	0 (0.0)	1 (9.1)	4 (8.0)	24 (25.0)
MEAN (SD)	24.3 (5.2)	26.0 (7.5)	29.0 (6.1)	n/a
Body mass index	22.5 (1.6)	27.9 (1.6)	35.9 (3.7)	n/a
MEAN (SD)				
Number of menses in most recent 12 month time period without hormonal medication.	5.4 (2.4)	4.2 (2.1)	4.6 (2.3)	Regular menses
MEAN (SD)				
Race/ethnicity N (%)				
Caucasian	21 (63.6)	9 (81.8)	38 (76.0)	64 (68.1)
African-American	5 (15.1)	0 (0.0)	9 (18.0)	23 (24.5)
Other	8 (24.2)	2 (18.2)	3 (6.0)	7 (7.5%) (missing 2)
Currently on depression/anxiety medication. n/N (%)	0/24 (0.0)	3/9 (33.3)	6/45 (13.3)	19/96 (19.8)

n/a = insufficient detail to perform this calculation

Table II

QIDS-SR16 total depression symptom severity score (TDS) by cohort and BMI-stratum.

Cohort/BMI-Stratum	TDS Mean (SD) Range [Min, Max]	p-value*	Severity Level		
			None (%)	Mild (%)	Moderate (%) Severe or Very Severe (%)
PCOS full cohort n=94	6.7 (4.3) [0, 21]	0.68	47%	40%	6%
Lean PCOS n=33	5.4 (3.2) [0, 14]	0.25	57%	36%	6%
Overweight PCOS n=11	5.6 (2.9) [2, 10]	0.29	55%	45%	0%
Obese PCOS n=50	7.8 (4.8) [0, 21]	0.99	40%	40%	8%
p-value** across BMI stratum (PCOS cohort)	0.07				12%
Comparison full cohort, n=96	6.7 (4.4) [0, 20]		49%	29%	19%
Lean Comparison n=34	4.6 (2.9) [0, 14]		71%	24%	6%
Overweight Comparison N=17	7.4 (4.3) [2, 15]		41%	29%	29%
Obese Comparison n=45	8.0 (4.8) [2, 20]	36%	33%	24%	7%
p-value** across BMI stratum (comparison cohort)	0.0049				

Severity interpretation: none = 0 – 5, mild = 6 – 10, moderate = 11 – 15, severe = 16 – 20, very severe = 21 – 27 Severity percentages may not add to 100% due to rounding.

* Wilcoxon p-value comparing PCOS women to Comparison cohort within each BMI stratum

** Wilcoxon p-value comparing across BMI strata within the PCOS (or comparison) cohort

Table III

BES subscale scores by cohort and BMI-stratum.

Cohort/BMI-Stratum	BES-Sexual Attractiveness Subscale, Mean (SD) Range [Min, Max]	p-value *	BES-Weight Concern Subscale, Mean (SD) Range [Min, Max]	p-value *	BES-Physical Condition Subscale, Mean (SD) Range [Min, Max]	p-value *
PCOS full cohort, n=94	43.0 (7.8) [24, 61]	0.15	24.5 (8.7) [10, 46]	0.13	28.6 (7.2) [15, 45]	0.75
Lean PCOS n=33	41.9 (7.3) [28, 61]	0.62	29.1 (7.9) [14, 44]	0.25	31.5 (5.6) [18, 44]	0.20
Overweight PCOS n=11	45.6 (7.6) [34, 60]	0.33	26.0 (7.6) [14, 40]	0.56	28.9 (6.6) [20, 41]	0.92
Obese PCOS n=50	43.2 (8.2) [24, 61]	0.25	21.2 (8.0) [10, 46]	0.21	26.7 (7.7) [15, 45]	0.29
p-value ** across BMI stratum (PCOS cohort)	0.32		0.0001		0.0013	
Comparison full cohort, n=96	45.6 (9.6) [24, 65]		27.2 (10.8) [10, 50]		28.9 (7.7) [13, 45]	
Lean Comparison n=34	42.7 (6.7) [31, 58]		31.6 (8.6) [12, 50]		29.7 (6.0) [20, 44]	
Overweight Comparison, n=17	50.1 (10.2) [37, 65]		25.8 (11.3) [13, 50]		29.5 (9.0) [15, 45]	
Obese Comparison n=45	46.1 (10.6) [24, 65]		24.3 (11.2) [10, 50]		28.1 (8.4) [13, 45]	
p-value ** across BMI stratum (comparison cohort)	0.06		0.0025		0.52	

* Wilcoxon p-value comparing PCOS women to Comparison cohort (within each BMI stratum or in total based on the row heading)

** Wilcoxon p-value comparing across BMI strata within the PCOS (or comparison) cohort

Table IV

Spearman rank correlations (r_s) for the univariate association between the body esteem score and the QIDS-SR total depression symptom score (TDS).

Cohort/BMI-Stratum	BES-Sexual Attractiveness Subscale vs. TDS r_s (p-value)	BES-Weight Concern Subscale vs. TDS r_s (p-value)	BES-Physical Condition Subscale vs. TDS r_s (p-value)
PCOS full cohort n=94	-0.16 (0.12)	-0.30 (0.003)	-0.32 (0.002)
Lean PCOS n=33	-0.37 (0.04)	-0.37 (0.03)	-0.38 (0.03)
Overweight PCOS n=11	0.12 (0.73)	-0.72 (0.01)	-0.79 (0.003)
Obese PCOS n=50	-0.16 (0.26)	-0.07 (0.63)	-0.13 (.036)
Comparison full cohort, n=96	-0.26 (0.01)	-0.38 (<0.001)	-0.40 (<0.001)
Lean Comparison n=34	-0.34 (0.051)	-0.33 (0.056)	-0.44 (0.009)
Overweight Comparison n=17	-0.35 (0.167)	-0.38 (0.132)	-0.40 (0.111)
Obese Comparison n=45	-0.39 (0.008)	-0.14 (0.344)	-0.33 (0.026)

Table V

Multivariate negative-binomial regression model for the prediction of the log_e (Total Depression Symptom Score) in PCOS women by BMI stratum.

NON-OBESE Model Base	Predictor	Estimate β [95% CI]	LR-Statistic	P-value
NON-OBESE Model Base	Intercept	3.544 [2.649, 4.435]		
	BES Subscale: Weight Concern	-0.019 [-0.041, 0.003]	2.95	0.086
	BES Subscale: Physical Condition	-0.042 [-0.073, 0.022]	7.06	0.008
	Age	-0.003 [-0.047, 0.146]	0.05	0.817
	3-DF Global Test for Model		19.35	<0.001
	2-DF Global Test of BES		18.91	<0.001
	Intercept	3.763 [2.856, 4.660]		
	BES Subscale: Weight Concern	-0.020 [-0.041, 0.003]	3.00	0.083
	BES Subscale: Physical Condition	-0.036 [-0.070, -0.005]	5.19	0.023
	Age	-0.007 [-0.032, 0.018]	0.33	0.565
	Total Testosterone	-0.004 [-0.015, 0.008]	0.38	0.538
	Free Testosterone	-0.006 [-0.056, 0.042]	0.06	0.802
	5-DF Global Test for Model		22.07	<0.001
	2-DF Global Test for BES		16.81	<0.001
	2-DF Global Test for Hormones		2.72	0.257
OBESE	Predictor	Estimate β [95% CI]	LR-Statistic	P-value
Base	Intercept	1.736 [0.712, 2.746]		
	BES Subscale: Weight Concern	0.008 [-0.020, 0.036]	0.35	0.553
	BES Subscale: Physical Condition	-0.013 [-0.042, 0.016]	0.79	0.375
	Age	0.016 [-0.011, 0.044]	1.45	0.229
	3-DF Global Test for Model		2.12	0.549
	2-DF Global Test for BES		0.81	0.667
	Intercept	2.493 [1.249, 3.741]		
	BES Subscale: Weight Concern	0.009 [-0.019, 0.036]	0.39	0.532
Base + Androgens	BES Subscale: Physical Condition	-0.013 [-0.042, 0.016]	0.81	0.368
	Age	-0.000 [-0.031, 0.031]	0.00	0.997
	Total Testosterone	0.005 [-0.006, 0.016]	0.70	0.404
	Free Testosterone	-0.038 [-0.082, 0.005]	2.99	0.084
	5-DF Global Test for Model		6.78	0.238
	2-DF Global Test for BES		0.81	0.667
	2-DF Global Test for Hormones		4.66	0.097

LR = likelihood ratio; CI = confidence interval; DF = degrees of freedom.