Reproductive Sciences (2020) 27:432–442
https://doi.org/10.1007/s43032-019-00061-0

ORIGINAL ARTICLE

Disparate Relationship of Sexual Satisfaction, Self-Esteem, Anxiety, and Depression with Endocrine Profiles of Women With or Without PCOS

Aleksandra Glowinska[1] · Antoni J Duleba[2] · Monika Zielona-Jenek[3] · Martyna Siakowska[1] · Leszek Pawelczyk[1] · Beata Banaszewska[1]

Received: 24 February 2019 / Accepted: 15 May 2019 / Published online: 1 January 2020

Abstract

Women with polycystic ovary syndrome (PCOS) are at increased risk of psychological distress including anxiety and depressive symptoms. However, less is known about sexual satisfaction and self-esteem as well as the relationship of these aspects of psychological function with clinical and hormonal profiles associated with PCOS. This cross-sectional study compared women with PCOS ($N = 96$) and healthy controls ($N = 47$). This study assessed sexual function (primary outcome), self-esteem, anxiety, and depression as well as evaluation of clinical, endocrine, and metabolic parameters. Overall, sexual satisfaction scores were comparable among women with and without PCOS. However, psychosexual function of women with PCOS exhibited distinguishing characteristics. The unconscious aspect of sexuality: frequency of erotic dreams, significantly correlated with free testosterone ($\rho = 0.24$, $P = 0.03$) and DHEAS ($\rho = 0.31$, $P = 0.004$) only in the PCOS group. In contrast, in women with PCOS, the frequency of masturbation did not correlate with endocrine profiles, but correlated with trait anxiety ($\rho = 0.21$, $P = 0.049$) and depression ($\rho = 0.21$, $P = 0.05$). Only one aspect of self-esteem (body appearance) was reduced in the PCOS group ($P = 0.02$) and was related to BMI and androgen. Women with PCOS had greater state anxiety ($P = 0.02$) and depression ($P < 0.001$); these scores correlated with BMI. However, anxiety and depression correlated with testosterone only in women without PCOS. The above findings indicate that PCOS is associated with a broad range of alterations of psychological function including psychosexual aspects; these alterations are in complex relationship with BMI and androgen levels.

Keywords Polycystic ovary syndrome · Sexual satisfaction · Self-esteem · Anxiety · Depression

Introduction

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder among women in reproductive age with estimates of prevalence ranging from 6 to 18% [1–4]. Although the diagnosis of PCOS is based exclusively on reproductive criteria (oligo/anovulation, hyperandrogenism, and/or PCO on ultrasound) [5], women with this endocrinopathy are at an increased risk of a broad range of comorbidities including metabolic and cardiovascular disorders [1, 6–9] and psychological distress e.g. depressive symptoms and anxiety [10–14] with severity that may even exceed symptoms experienced by women after mastectomy [15]. Some, but not all studies, revealed an association of PCOS with worsened self-esteem, especially with regard to body image [16–19].

Less is known about the quality of sex life of these patients. Some investigators reported that women with PCOS have poorer sexual function especially with regard to desire and

Aleksandra Glowinska and Antoni J Duleba are co-first authors.

✉ Antoni J Duleba
aduleba@ucsd.edu

[1] Division of Infertility and Reproductive Endocrinology, Department of Gynecology, Obstetrics and Gynecological Oncology, Poznan University of Medical Sciences, 60-535 Poznan, Poland

[2] Division of Reproductive Endocrinology and Infertility, Department of Reproductive Medicine, University of California San Diego, La Jolla, CA 92093-0633, USA

[3] Department of Social and Clinical Sexology, Faculty of Psychology and Cognitive Sciences, Adam Mickiewicz University, Szamarzewskiego 89, 60-568 Poznań, Poland

arousal [20], while others did not observe any significant difference [21]. Complex and occasionally inconsistent observations were reported with regard to sexual satisfaction, whereby some studies demonstrated decreased sexual satisfaction in women with PCOS [22, 23], while others documented deterioration in overall sexual satisfaction (emotional closeness with an intimate partner, quality of the sexual relationship) but not in sexual desire and orgasms [24].

There are also limited and inconsistent observations with regard to the relationship of sexual function with clinical and hormonal profiles associated with PCOS, especially the role of BMI and hyperandrogenism. High BMI correlated with reduced quality of life but not with sexual function [24]; however, in another study, high BMI was associated with a significant reduction in the orgasm/completion subdomain [23]. Conflicting findings were also described with respect to the relationship of hyperandrogenism and sexual function. Rellini et al. observed a negative relationship of sexual desire among women with clinical hyperandrogenism but not with the actual androgen level [25] while other investigators observed a significant negative correlation between sexual function and testosterone level [26]. In contrast, Stovall et al. noted that women with highest testosterone level had also significantly better sexual function [23].

In view of the above outlined findings and discordant reports, this study was designed to carry out a comprehensive evaluation of the relationship of sexual satisfaction and other relevant psychological functions with clinical, endocrine, and metabolic profiles of women with and without PCOS. In particular, we focused on the relationship of psychosexual characteristics with BMI and testosterone level.

Subjects and Methods

Subjects

The study evaluated 94 women in the PCOS group and 47 in the control group. Women with prior clinical diagnosis and treatment of depression or anxiety were not included in this study. Women with PCOS were recruited from the Gynecology Clinic at the Poznan University of Medical Sciences. Women in the control group were recruited via Internet advertisements. PCOS was defined according to the Rotterdam consensus criteria and had at least two of the following: (1) clinical or chemical hyperandrogenism; (2) oligo- or amenorrhea; and/or (3) polycystic ovarian morphology as determined by transvaginal ultrasound [27]. Congenital adrenal hyperplasia was excluded on the basis of morning follicular phase 17-hydroxyprogesterone below 2 ng/mL. None of the subjects had elevated prolactin, thyroid disease, Cushing disease, diabetes mellitus, or symptoms of any other endocrinopathy. During the 3 months before the study, none of the study subjects used any form of oral contraceptives, other steroid hormones, or any other medications likely to affect ovarian function, insulin sensitivity, or lipid profile.

The criteria for selection to the control group ($n = 47$) were regular menstruation and no clinical symptoms of hyperandrogenism. The subjects in the control group were selected from the initial pool of 63 volunteers to match the control and the PCOS groups with regard to age and social parameters. Clinical, hormonal, and biochemical tests were carried out in the follicular phase of the natural menstrual cycle. Recruitment and testing were carried out at the Poznan University of Medical Sciences between December 2012 and March 2015. Participation was voluntary and anonymous. Informed consent was obtained from all participants.

Procedures

All participants received an envelope containing information regarding the nature of the study, two copies of informed consent and a set of questionnaires. All study subjects were evaluated at baseline during the follicular phase of a natural cycle or after medroxyprogesterone-induced menses. Clinical assessments included determinations of body mass index (BMI), hirsutism (Ferriman and Gallwey score), and acne score. Acne was scored using a 4-point scale described previously [28]. Hormonal and metabolic tests were performed after 3days of carbohydrate intake of 300 g/day to standardize conditions prior to glucose tolerance test. Venous blood was collected between 0700 and 0800 h after an overnight fast. Serum specimens were stored at − 70 °C until analysis was performed. A 2-h oral glucose tolerance test was performed with determinations of glucose and insulin in the fasting state as well as after a 75-g glucose load at 30, 60, 90, and 120 min. Glucose was determined using the enzymatic reference method with hexokinase on Roche Cobas 6000 System (Roche Polska sp z o.o., Warsaw, Poland). Insulin, total testosterone, LH, FSH, prolactin, SHBG, 17-hydroxyprogesterone, and dehydroepiandrosterone sulfate (DHEAS) were determined using specific electrochemiluminescence assays (Automated Cobas 6000 System; Roche Polska sp z o.o., Warsaw, Poland). The calculation of insulin sensitivity index was performed using glucose and insulin levels obtained during an oral glucose tolerance test as described by Matsuda and DeFronzo [29]. Total cholesterol and triglycerides were determined using enzymatic colorimetric assays (Automated Cobas 6000 System; Roche Polska sp z o.o., Warsaw, Poland). High-density lipoprotein (HDL) was separated by precipitating apolipoprotein-B (Roche Polska sp z o.o., Warsaw, Poland). LDL was calculated using the Friedwald formula.

All psychological questionnaires were self-reported. Sexual Satisfaction Scales were obtained from a 20-item test designed to comprehensively assess satisfaction from sexual activity [30]. The test measures three separate aspects of sexual function. Physical satisfaction sub-scale consists of 10 items and measures physical gratification and pleasure that a patient derives from sexual contacts. Emotional satisfaction sub-scale consists of 4 items describing sense of security, closeness, and love that accompany sexual contact within relationships. Satisfaction with control sub-scale (6 items) measures the level of sense of control over how, when, and whether a patient has sex with her partner. The three aspects are conceptualized as distinct components of sexual satisfaction affected by different factors (somatic and psychological), so they are not summed to any global score. Higher sub-scale scores reflect greater level of sexual satisfaction. In addition to the above tests, the subjects were asked to answer additional questions evaluating frequency of masturbation ("I often masturbate"), frequency of erotic dreams ("I often have erotic dreams"), and pain during intercourse ("I experience pain during intercourse"). To answer these questions, the subjects were instructed to use a 5-point Likert scale identical to the scale used in the Sexual Satisfaction Scale: 1, I strongly disagree; 2 I disagree; 3, I am undecided; 4, I agree; and 5, I strongly agree. Ninety one women in the PCOS group (95%) and 44 women in the control group (94%) were sexually active.

The Multidimensional Self-Esteem Inventory (MSEI) is based on a theoretical model of self-concept and self-esteem [31]. The test consists of 116 items, measuring global self-esteem and its eight detailed components: competence, lovability, likability, personal power, self-control, moral self-approval, body appearance, and body functioning. It contains also two additional scales: identity integration to measure global self-concept's cohesion and defensive self-enhancement scale to assess the level of need for social approval (differentiate between "truly high" and "defensively high" self-esteem). Scale scores are calculated with higher scores reflecting greater levels of self-esteem.

The State-Trait Anxiety Inventory (STAI) consists of two sub-scales, each containing 20 items [32]. STAI-1 assesses state anxiety, defined as an unpleasant emotional arousal in face of threatening demands or dangers. STAI-2 assesses trait anxiety. The last reflects the individual stable tendency to respond with state anxiety in the anticipation of threatening situations. Beck's Depression Inventory (BDI) is a 21-item self-completed depression severity scale for adults [33].

Statistical Analysis

Statistical analysis was performed using JMP 13.0 (SAS, Cary, NC). P values < 0.05 were considered significant. Comparisons between groups were performed using unpaired t test; in the absence of a normal distribution (evaluated by Shapiro-Wilk test), Box Cox transformation or non-parametric testing (Wilcoxon/Kruskal–Wallis, Wilcoxon-signed rank) was carried out. Correlations between ordinal variables were performed using Spearman's rank test. Comparison of correlation coefficients was performed following Fisher Z-transformation (https://www.psychometrica.de/correlation.html). Linear mixed regression modeling was performed to evaluate the relationship of the psychological test results with the presence or absence of PCOS as well as clinical, endocrine, and metabolic parameters. Power analysis revealed that the sample size was sufficient to identify 10% difference in the primary outcome (sexual satisfaction) with alpha error of 0.05 and beta error of 0.2 (for PCOS and control samples at a ratio of 2:1).

Results

Table 1 summarizes comparisons of the PCOS group and the control group with regard to clinical evaluations and laboratory tests. The groups were of comparable age; however, women with PCOS had significantly greater BMI, hirsutism, and acne scores and higher levels of testosterone, LH, and prolactin. PCOS was also associated with lower SHBG and HDL cholesterol but higher triglycerides, higher fasting glucose and insulin, and reduced insulin sensitivity index. As presented in Table 2, both groups were comparable with regard to education and family status; however, the groups differed with regard to the treatment of infertility. Notably, treatment of infertility was not associated with a significant difference in depression scores and anxiety scores.

Findings of psychological tests are summarized in Tables 3 and 4. Sexual Satisfaction Scales (SSS) provide evaluations of physical sexual satisfaction (SS-P), emotional sexual satisfaction (SS-E), and satisfaction with control (SS-C). Women with PCOS and control subjects had comparable scores for SS-P, SS-E, and SS-C. Furthermore, when each of the 21 items of SSS was evaluated (not shown), there was no significant difference between PCOS and control groups in responses to any of the test items. In bivariate analysis, there was no correlation of any of these scales with any other parameters listed in Table 1. In multivariate models, when accounting for the study group (i.e., presence or absence of PCOS), SS-E correlated negatively with BMI ($P = 0.02$; Fig. 1); however, SS-P and SS-C did not significantly correlate with BMI, total testosterone, or any of the clinical, endocrine, or metabolic parameters (listed in Table 1). All three sexual satisfaction scales correlated positively (all at $P < 0.001$) with body appearance scale (MSEI-BAP) and negatively (all at $P < 0.05$) with STAI-1 (state anxiety) and depression scores (BDI). Women in the PCOS group and in the control group did not differ with

Table 1 Comparison of clinical, endocrine, and metabolic parameters in women with PCOS and in control subjects

Variable	PCOS, $N = 96$	Control, $N = 47$	Comparison between groups, P value
Age	28.6 ± 0.5	29.5 ± 0.7	0.23
BMI	26.5 ± 0.6	23.5 ± −0.7	0.001
Hirsutism (Ferriman–Gallwey)	9.2 ± 0.3	3.0 ± 0.3	< 0.001
Acne (score; 0–3 scale)	1.0 ± 0.1	0.1 ± 0.1	< 0.001
Total testosterone (ng/mL)	0.51 ± 0.02	0.30 ± 0.02	< 0.001
Free testosterone (ng/dL)	0.85 ± 0.05	0.35 ± 0.03	< 0.001
DHEAS (μmol/mL)	8.12 ± 0.37	7.03 ± 0.41	0.06
FSH (IU/L)	5.8 ± 0.2	5.8 ± 0.3	0.87
LH (IU/L)	7.0 ± 0.4	10.9 ± 0.7	< 0.001
Prolactin (ng/mL)	25.9 ± 1.9	12.8 ± 1.3	< 0.001
SHBG (nmol/L)	51.1 ± 3.9	78.1 ± 5.9	< 0.001
Total cholesterol (mg/dL)	181 ± 3	181 ± 5	0.95
LDL cholesterol (mg/dL)	101 ± 3	97 ± 4	0.45
HDL cholesterol (mg/dL)	61 ± 2	72 ± 2	< 0.001
Triglycerides (mg/dL)	96 ± 4	63 ± 3	< 0.001
Fasting glucose (mg/dL)	89.3 = 0.7	87 ± 1	0.03
Fasting insulin (μU/mL)	10.4 ± 0.5	7.7 ± 0.5	< 0.001
Insulin sensitivity index	5.2 ± 0.5	7.0 ± 0.5	0.002

Each value represents mean ± SEM

regard to frequency of masturbation, erotic dreams, or pain during intercourse (Table 3).

In the PCOS group, frequency of erotic dreams, an unconscious component of sexuality, significantly correlated with free testosterone ($\rho = 0.24$, $P = 0.03$) and DHEAS ($\rho = 0.31$, $P = 0.004$); however, in the control group, there was no significant correlation (Spearman ρ) with free testosterone ($\rho = -0.10$, $P = 0.52$) or DHEAS ($\rho = -0.15$, $P = 0.32$). In contrast,

Table 2 Baseline social parameters of both study groups

Variable	PCOS	Control	Comparison between groups, P value
Education			0.32
Post-secondary	65.6%	78.7%	
Secondary	29.2%	21.3%	
< Secondary	5.2%	0%	
Marital status			0.33
Single	42.7%	53.2%	
Married	56.3%	44.7%	
Divorced	1.0%	2.1%	
Living with a partner			0.61
Yes	73.7%	69.6%	
No	26.3%	30.4%	
Duration of relationship (years)	3.3 ± 0.2	2.9 ± 0.3	0.26
Children			0.29
Yes	19.8%	27.7%	
No	80.2%	72.3%	
Infertility treatment			< 0.0001
Yes	65.6%	4.3%	
No	34.4%	95.7%	

Table 3 Comparison of psychological test results from women with PCOS and from control subjects

Variable	PCOS	Control	Comparison between groups, *P* value
SS-P (physical sexual satisfaction)	38.6 ± 0.9	38.6 ± 1.2	0.97
SS-E (emotional sexual satisfaction)	11.6 ± 0.5	11.4 ± 0.5	0.73
SS-C (satisfaction with control)	21.7 ± 0.2	21.3 ± 0.6	0.58
Frequency of masturbation	1.8 ± 0.1	2.2 ± 0.2	0.13
Frequency of erotic dreams	2.2 ± 0.1	2.2 ± 0.2	0.78
Frequency of pain during intercourse	2.2 ± 0.1	2.0 ± 0.2	0.24
MSEI-GSE (global self-esteem)	30.4 ± 0.7	31.3 ± 1.0	0.45
MSEI-CMP (competence)	36.2 ± 0.6	37.0 ± 0.8	0.45
MSEI-LVE (lovability)	36.8 ± 0.7	35.8 ± 1.2	0.53
MSEI-LKE (likability)	34.5 ± 0.6	35.2 ± 0.8	0.50
MSEI-PWR (personal power)	33.0 ± 0.7	33.8 ± 0.8	0.49
MSEI-SFC (self-control)	31.8 ± 0.6	30.5 ± 1.1	0.29
MSEI-MOR (moral self-approval)	40.4 ± 0.6	38.6 ± 1.0	0.13
MSEI-BAP (body appearance)	27.8 ± 0.8	31.0 ± 1.1	0.02
MSEI-BFN (body functioning)	28.9 ± 0.8	30.9 ± 1.3	0.17
MSEI-IDN (identity integration)	32.4 ± 0.7	31.7 ± 0.9	0.52
MSEI-DEF (defensive self-enhancement)	52.2 ± 0.8	49.7 ± 1.2	0.08
STAI-1 (state anxiety)	42.9 ± 1.1	38.4 ± 1.3	0.02
STAI-2 (trait anxiety)	45.5 ± 1.0	42.3 ± 1.4	0.06
BDI (Sum)	10.1 ± 0.74	6.4 ± 0.8	< 0.001

SSS, Sexual Satisfaction Scales; *MSEI*, Multidimensional Self-Esteem Inventory; *STAI*, State-Trait Anxiety Inventory; *BDI*, Beck's Depression Inventory. Each value represents mean ± SEM

the frequency of masturbation, a conscious manifestation of sexuality, did not correlate with any of the androgens in the PCOS and the control groups. However, as presented in Table 4, in women with PCOS only, the frequency of masturbation correlated with symptoms of depression (BDI) and trait anxiety (STAI-2).

Evaluations of self-esteem were carried out using Multidimensional Self-Esteem Inventory (MSEI). As shown

Table 4 Correlations between parameters related to sexual function among women with or without PCOS

Variable	PCOS	Control
SS-P (physical sexual satisfaction) vs.		
Frequency of masturbation	− 0.20 (*P* = 0.07)	− 0.22 (*P* = 0.15)
Frequency of erotic dreams	0.09 (*P* = 0.43)	− 0.07 (*P* = 0.66)
Frequency of pain during intercourse	− 0.30 (*P* = 0.004)	− 0.42 (*P* = 0.005)
SS-E (emotional sexual satisfaction) vs.		
Frequency of masturbation	− 0.21 (*P* = 0.06)	0.03 (*P* = 0.86)
Frequency of erotic dreams	− 0.07 (*P* = 0.53)	− 0.12 (*P* = 0.46)
Frequency of pain during intercourse	− 0.11 (*P* = 0.32)	− 0.37 (*P* = 0.01)
SS-P (satisfaction with control) vs.		
Frequency of masturbation	− 0.23 (*P* = 0.03)	− 0.25 (*P* = 0.10)
Frequency of erotic dreams	− 0.03 (*P* = 0.77)	− 0.10 (*P* = 0.51)
Frequency of pain during intercourse	− 0.26 (*P* = 0.01)	− 0.34 (*P* = 0.02)
MSEI-BAP (body appearance) vs.		
Frequency of masturbation	− 0.18 (*P* = 0.09)	− 0.02 (*P* = 0.88)
Frequency of erotic dreams	− 0.04 (*P* = 0.70)	0.13 (*P* = 0.39)
Frequency of pain during intercourse	− 0.24 (*P* = 0.03)	− 0.40 (*P* = 0.008)
STAI-1 (state anxiety) vs.		
Frequency of masturbation	0.05 (*P* = 0.59)	0.01 (*P* = 0.95)
Frequency of erotic dreams	0.15 (*P* = 0.14)	− 0.09 (*P* = 0.57)
Frequency of pain during intercourse	− 0.01 (*P* = 0.95)	0.20 (*P* = 0.19)
STAI-2 (trait anxiety) vs.		
Frequency of masturbation	0.21 (*P* = 0.049)	− 0.11 (*P* = 0.50)
Frequency of erotic dreams	0.07 (*P* = 0.49)	− 0.05 (*P* = 0.76)
Frequency of pain during intercourse	0.15 (*P* = 0.15)	0.33 (*P* = 0.03)
BDI (sum) vs.		
Frequency of masturbation	0.20 (*P* = 0.05)	− 0.17 (*P* = 0.26)
Frequency of erotic dreams	0.11 (*P* = 0.28)	0.00 (*P* = 0.99)
Frequency of pain during intercourse	0.29 (*P* = 0.006)	0.23 (*P* = 0.14)

Correlations were assessed using Spearman ρ test

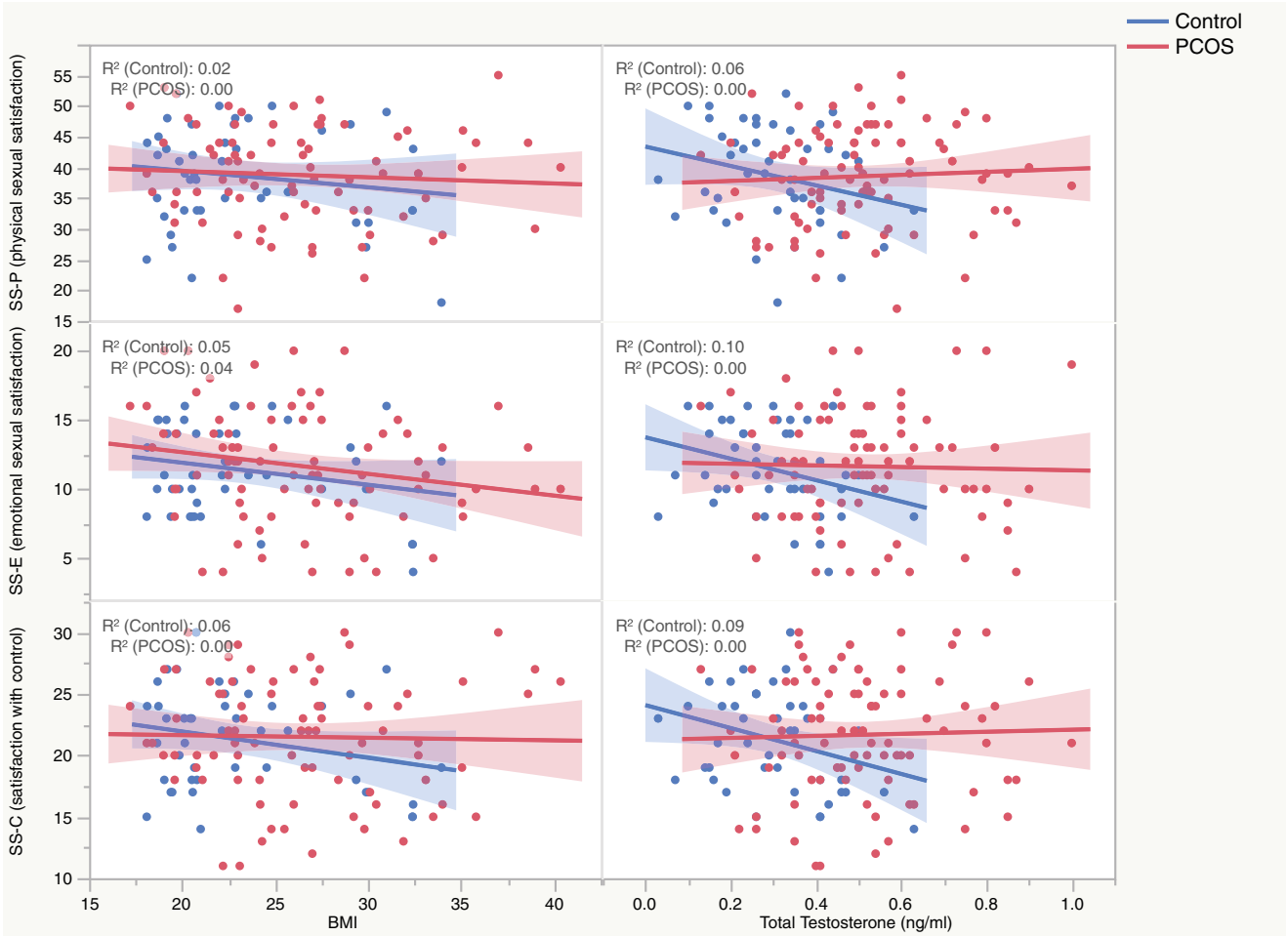

Fig. 1 Correlation of sexual satisfaction scores with BMI and total testosterone. Shaded areas represent 95% confidence intervals. A negative correlation of SS-E scores with BMI was statistically significant ($P = 0.02$); when accounting for BMI, the presence or the absence of PCOS had no significant effect. The strength (the slope) of the relationship of SS-E with BMI was comparable for subjects with and without PCOS. All remaining correlations presented in this figure were not statistically significant

in Table 3, women with PCOS differed significantly from control subjects only with regard to body appearance scale (MSEI-BAP). Bivariate correlations of scores in MSEI-BAP scale were significant for BMI ($P < 0.001$), fasting insulin ($P = 0.002$), and insulin sensitivity index ($P = 0.04$). In multivariate analysis, the effect of PCOS on MSEI-BAP was no longer significant ($P = 0.67$) when accounting for BMI ($P < 0.001$), total testosterone ($P = 0.02$), and DHEAS ($P = 0.004$). The relationship of MSEI-BPI with BMI and total testosterone is presented graphically in Fig. 2.

Women with PCOS had significantly higher STAI-1 (state anxiety) scores and borderline higher STAI-1 (trait anxiety) scores. Bivariate correlations of STAI-1 scores were associated with higher BMI ($P < 0.001$), hirsutism ($P = 0.01$), total testosterone ($P = 0.001$), free testosterone ($P < 0.001$), and lower HDL ($P = 0.03$). Multivariate analysis of STAI-1 demonstrated that the effect of PCOS disappeared ($P = 0.94$) when accounting for BMI ($P < 0.001$) and total testosterone ($P = 0.02$). Other clinical, endocrine, and metabolic parameters in the model did not significantly contribute to the model. Figure 3 illustrates the relationship of STAI-1 scores with BMI and total testosterone in PCOS and control groups. Bivariate correlations of STAI-2 scores revealed a positive association with BMI ($P < 0.001$) and total testosterone ($P = 0.03$). In multivariate analysis of STAI-1 2 (stepwise linear model), the effect of PCOS was not significant ($P = 0.87$) when accounting for BMI ($P < 0.001$) and LH ($P = 0.04$) while other parameters were not significant. The comparison of correlation coefficients between the PCOS and the control group revealed that the coefficients of erotic dreams and free testosterone were significantly different ($P = 0.03$); also, the coefficients of erotic dreams and DHEAS were significantly different ($P = 0.005$).

Women with PCOS had significantly greater depression scores (BDI) than control subjects (Table 3). Mild mood disturbance (BDI scores 11–16) was observed in 32.3% of women with PCOS and in 10.6% of control

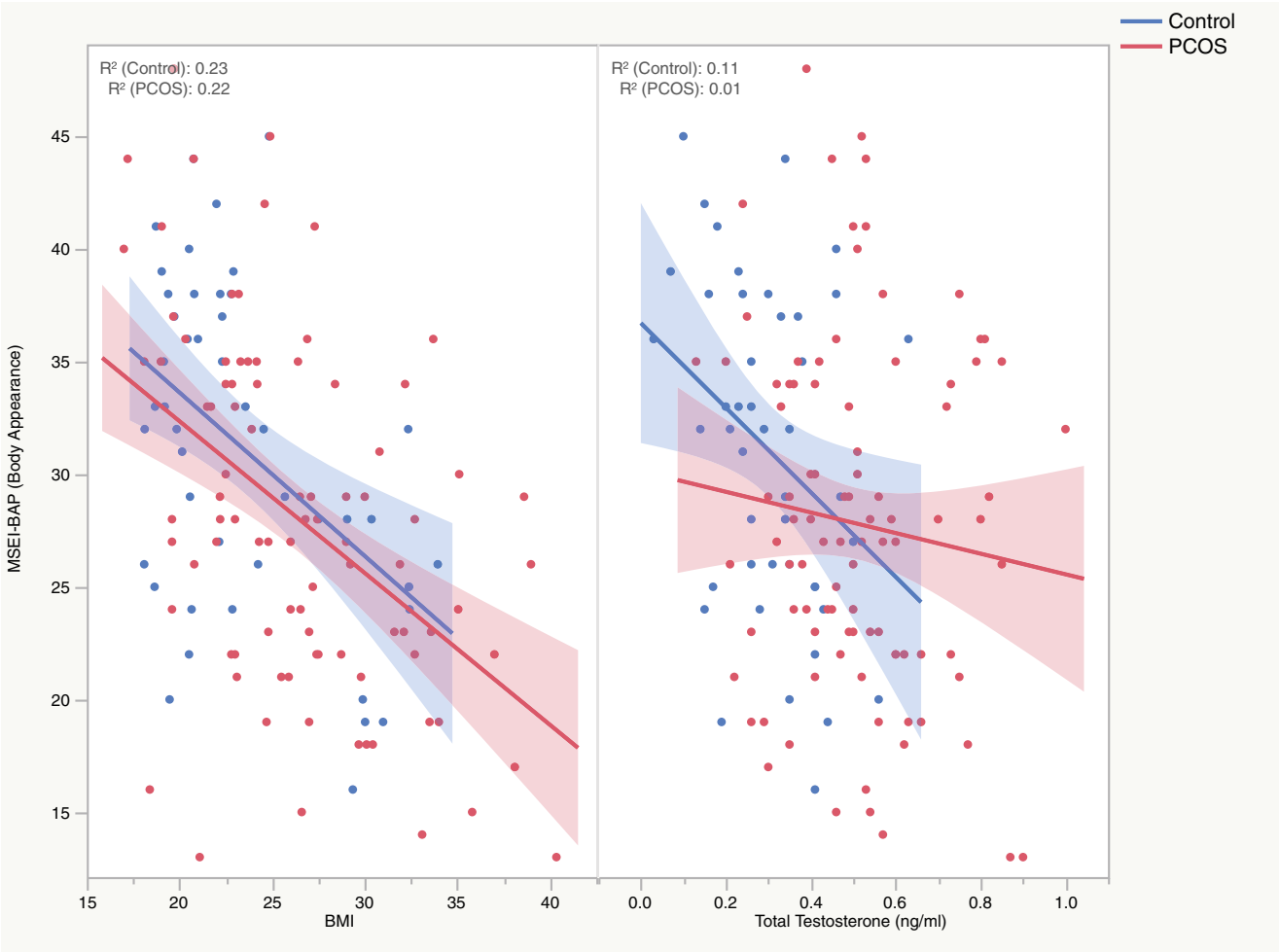

Fig. 2 Correlation of MSEI-BAP scores with BMI and total testosterone. Shaded areas represent 95% confidence intervals. MSEI-BAP correlated negatively with BMI ($P < 0.001$) and with total testosterone ($P = 0.02$) among women with PCOS and in Control subjects. When accounting for BMI and total testosterone, the presence or the absence of PCOS had no significant effect. The strength (the slope) of the relationship of MSEI-BAP scores with BMI and total testosterone was not significantly different among subjects with and without PCOS

subjects. Scores above 16 (borderline to severe depression) were noted in 12.5% of women in the PCOS group and in 6.4% of women in the control group. In bivariate analysis, BDI was associated with greater BMI ($P < 0.001$) and insulin ($P = 0.03$). In multivariate analysis, the effect of group (PCOS vs. control) remained significant ($P = 0.04$) when accounting for BMI ($P < 0.001$) and the correlation with total testosterone was borderline ($P = 0.06$), while other parameters did not significantly contribute to the model. However, the relationship of testosterone with depression scores was significantly different in the PCOS group vs. control group, whereby testosterone correlated strongly with depression scores only in the control group ($r = -0.42$). In contrast, women with PCOS had elevated depression scores irrespective of testosterone ($r = 0.00$). The relationships of BDI with BMI and total testosterone are illustrated in Fig. 4.

Discussion

The primary goal of this study was to comprehensively evaluate the impact of PCOS on psychosexual functions and in comparison with other psychological aspects of women's well-being: their self-esteem, anxiety, and depression. Women with PCOS differed significantly from the control group with regard to several characteristics including BMI, hyperandrogenism, endocrine profiles, lipids, and insulin sensitivity. Yet, at a first glance, all tested aspects of sexuality were comparable between women with and without PCOS. Upon closer inspection, however, psychosexual function of women with PCOS exhibited several important distinguishing characteristics. In PCOS, frequency of masturbation correlated positively with trait anxiety (STAI-2) and depression scores (BDI); such correlation was not found among women without PCOS. Since the relationship of increased interest in

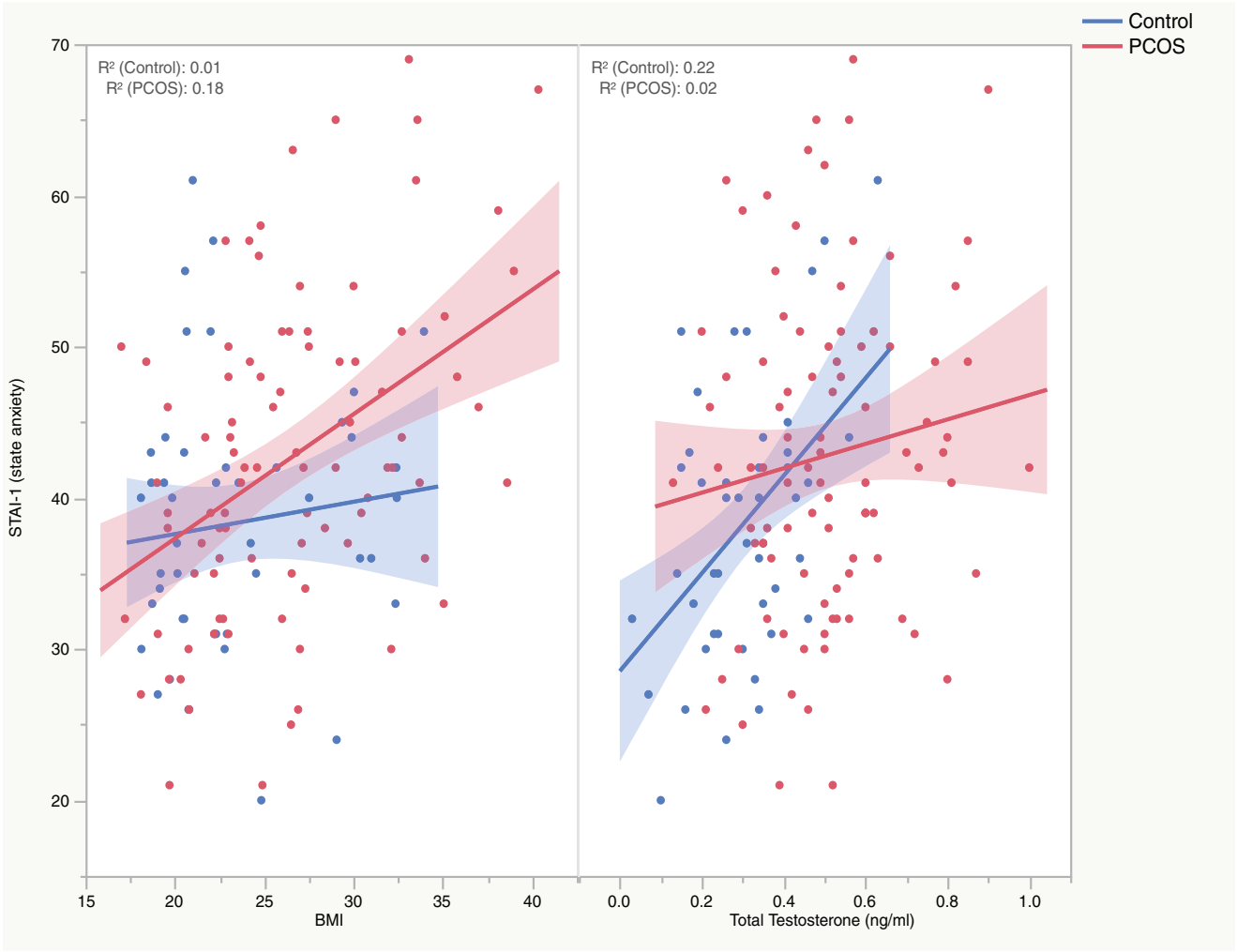

Fig. 3 Correlations of STAI-1 (state anxiety) scores with BMI and total testosterone in women with PCOS and in control subjects. Shaded areas represent 95% confidence intervals. When accounting for BMI and total testosterone, the presence or the absence of PCOS had no significant effect. Notably, there was a significant difference in the strength (the slope) of the relationship of BMI and STAI-1 scores ($P = 0.03$) in PCOS vs. control subjects. Similarly, there was a significant difference in the strength of the relationship of total testosterone and STAI-1 scores ($P = 0.03$) in PCOS and control subjects

masturbation among females with higher depression scores as measured by BDI was previously reported [34, 35], our present observations allow us to hypothesize that women with PCOS may use masturbation as a coping mechanism for mood regulation. The frequency of masturbation among these women was independent from their sexual satisfaction in partner relationship, suggesting that masturbation had another role, for example in mood regulation, rather than as compensation for poor dyadic satisfaction.

In the present study, in contrast to the frequency of masturbation, the frequency of erotic dreams (an unconscious aspect of sexual function) did not correlate with anxiety or depression scores. However, in the PCOS group, but not in the control group, the frequency of erotic dreams correlated positively with androgen levels (free testosterone and DHEAS). Such finding is unexpected since sexual interest is usually controlled by androgens in men but not in women [36]. Thus, elevated testosterone among women with PCOS may influence their spontaneous sex drive to a greater extent than in women without PCOS.

Another important observation pertains to the results of the Multidimensional Self-Esteem Inventory. Exploration of the relationship of PCOS with different aspects of self-esteem is of importance since chronic health-related conditions may influence different aspects of self-perception and self-esteem [37, 38]. In this study, only one of the eleven scales was altered in women with PCOS: a decrease of self-esteem with regard to body appearance (MSEI-BAP scale). It appears that this effect was related to increased BMI and hyperandrogenemia (Fig. 2). Thus, while in PCOS the self-perception of body appearance is affected, other aspects of self-esteem are not significantly altered.

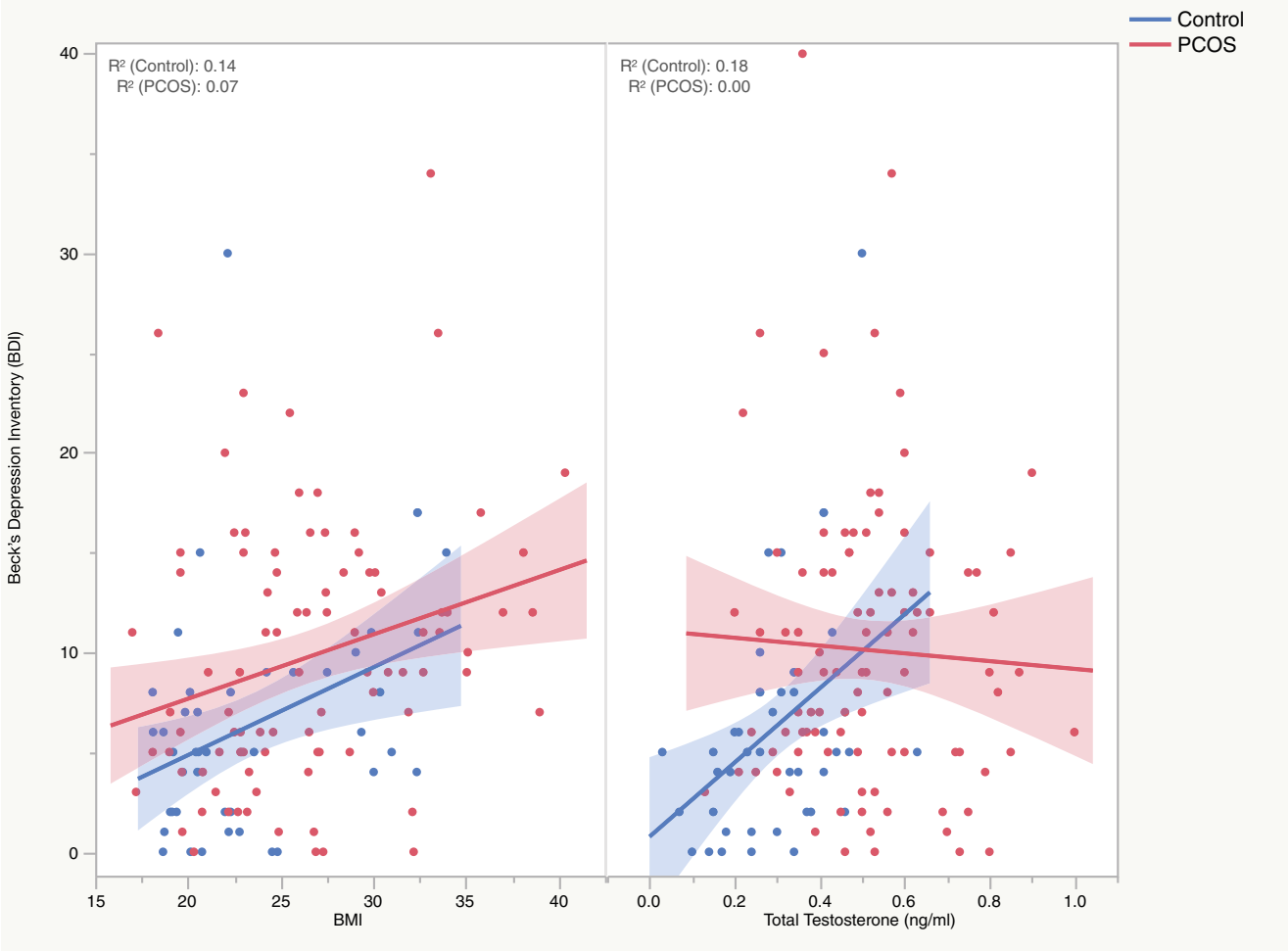

Fig. 4 Correlation of Beck's Depression Inventory (BDI) scores with BMI and total testosterone. Shaded areas represent 95% confidence intervals. The positive correlation of BDI with BMI was statistically significant ($P < 0.001$). When accounting for BMI, BDI scores were greater in the PCOS group than in the control group. The strength (the slope) of relationship of BDI scores with BMI was comparable in PCOS and control subjects. The correlation of BDI with total testosterone was borderline significant ($P = 0.06$) in analysis of both groups combined; furthermore, there was a significant difference in the strength (the slope) of the relationship of BDI between the PCOS and the control groups ($P = 0.02$). When analyzing these groups separately, BID correlated with total testosterone only in the control group ($P < 0.001$) and not in the PCOS group ($P = 0.20$)

Our findings with regard to anxiety and depression are consistent with those of previous reports demonstrating increased anxiety and depression scores among women with PCOS [10–14]. As presented in Figs. 3 and 4, it is apparent that high BMI and testosterone are the most likely contributors to greater anxiety and depression scores. However, the pattern of relationships between these parameters is different among women with and without PCOS. In particular, we found that BMI had a significant impact on anxiety only among women with PCOS (Fig. 3). On the other hand, testosterone levels correlated with anxiety only among women without PCOS. A slightly different pattern was observed with regard to depression scores which, when accounting for BMI, correlated to a similar extent with BMI in women with and without PCOS. On the other hand, levels of testosterone correlated with depressive symptoms only among women in the control group while the level of depression scores was greater among women with PCOS even at lower levels of testosterone. Notably, depression scores, when accounting for BMI, remained significantly elevated in the PCOS group and yet this effect was not independently explained by any of the clinical, endocrine, or metabolic parameters tested in this study.

In summary, this study provided evidence of overall normal sexual satisfaction but altered relationships of several aspects of psychosexual function with clinical and endocrine profiles of women with PCOS. Furthermore, it is apparent that while BMI and testosterone are important contributors to psychological profiles of women with and without PCOS, their relationships differ with individual aspects of sexuality, self-esteem, anxiety, and depression.

Funding information This research was supported by intramural funding from Poznan University of Medical Sciences, Poznan, Poland.

Compliance with Ethical Standards

Ethical Approval Approval of the study was obtained from the Institutional Review Board at the Poznan University of Medical Sciences (709/12).

References

1. Azziz R, Woods KS, Reyna R, Key TJ, Knochenhauer ES, Yildiz BO. The prevalence and features of the polycystic ovary syndrome in an unselected population. J Clin Endocrinol Metab. 2004;89(6):2745–9.
2. Boyle JA, Cunningham J, O'Dea K, Dunbar T, Norman RJ. Prevalence of polycystic ovary syndrome in a sample of indigenous women in Darwin, Australia. Med J Aust. 2012;196(1):62–6.
3. March WA, Moore VM, Willson KJ, Phillips DI, Norman RJ, Davies MJ. The prevalence of polycystic ovary syndrome in a community sample assessed under contrasting diagnostic criteria. Hum Reprod. 2010;25(2):544–51.
4. Yildiz BO, Bozdag G, Yapici Z, Esinler I, Yarali H. Prevalence, phenotype and cardiometabolic risk of polycystic ovary syndrome under different diagnostic criteria. Hum Reprod. 2012;27(10):3067–73.
5. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome. *Fertil Steril.* 2004;81(1):19–25.
6. Dunaif A, Givens JR, Haseltine F, Merriam GR. The polycystic ovary syndrome. Cambridge: Blackwell Scientific; 1992.
7. Pelusi B, Gambineri A, Pasquali R. Type 2 diabetes and the polycystic ovary syndrome. Minerva Ginecol. 2004;56(1):41–51.
8. Wang ET, Calderon-Margalit R, Cedars MI, et al. Polycystic ovary syndrome and risk for long-term diabetes and dyslipidemia. Obstet Gynecol. 2011;117(1):6–13.
9. Baldani DP, Skrgatic L, Ougouag R. Polycystic ovary syndrome: important underrecognised cardiometabolic risk factor in reproductive-age women. Int J Endocrinol. 2015;2015:786362.
10. Jedel E, Waern M, Gustafson D, et al. Anxiety and depression symptoms in women with polycystic ovary syndrome compared with controls matched for body mass index. Hum Reprod. 2010;25(2):450–6.
11. Blay SL, Aguiar JV, Passos IC. Polycystic ovary syndrome and mental disorders: a systematic review and exploratory meta-analysis. Neuropsychiatr Dis Treat. 2016;12:2895–903.
12. Dokras A, Stener-Victorin E, Yildiz BO, et al. Androgen Excess-Polycystic Ovary Syndrome Society: position statement on depression, anxiety, quality of life, and eating disorders in polycystic ovary syndrome. Fertil Steril. 2018;109(5):888–99.
13. Damone AL, Joham AE, Loxton D, Earnest A, Teede HJ, Moran LJ. Depression, anxiety and perceived stress in women with and without PCOS: a community-based study. Psychol Med. 2018:1–11.
14. Cooney LG, Lee I, Sammel MD, Dokras A. High prevalence of moderate and severe depressive and anxiety symptoms in polycystic ovary syndrome: a systematic review and meta-analysis. Hum Reprod. 2017;32(5):1075–91.
15. Mącik D. Loss of attributes of femininity, anxiety and value crisis. Women with polycystic ovary syndrome compared to women after mastectomy and in menopause. Health Psychology Report. 2016;4(2):159–69.
16. Acmaz G, Albayrak E, Acmaz B, et al. Level of anxiety, depression, self-esteem, social anxiety, and quality of life among the women with polycystic ovary syndrome. ScientificWorldJournal. 2013;2013:851815.
17. Himelein MJ, Thatcher SS. Depression and body image among women with polycystic ovary syndrome. J Health Psychol. 2006;11(4):613–25.
18. Annagur BB, Tazegul A, Akbaba N. Body image, self-esteem and depressive symptomatology in women with polycystic ovary syndrome. Noro Psikiyatr Ars. 2014;51(2):129–32.
19. Karacan E, Caglar GS, Gursoy AY, Yilmaz MB. Body satisfaction and eating attitudes among girls and young women with and without polycystic ovary syndrome. J Pediatr Adolesc Gynecol. 2014;27(2):72–7.
20. Bazarganipour F, Ziaei S, Montazeri A, Foroozanfard F, Kazemnejad A, Faghihzadeh S. Health-related quality of life in patients with polycystic ovary syndrome (PCOS): a model-based study of predictive factors. J Sex Med. 2014;11(4):1023–32.
21. Morotti E, Persico N, Battaglia B, et al. Body imaging and sexual behavior in lean women with polycystic ovary syndrome. J Sex Med. 2013;10(11):2752–60.
22. Elsenbruch S, Hahn S, Kowalsky D, et al. Quality of life, psychosocial well-being, and sexual satisfaction in women with polycystic ovary syndrome. J Clin Endocrinol Metab. 2003;88(12):5801–7.
23. Stovall DW, Scriver JL, Clayton AH, Williams CD, Pastore LM. Sexual function in women with polycystic ovary syndrome. J Sex Med. 2012;9(1):224–30.
24. Benetti-Pinto CL, Ferreira SR, Antunes A Jr, Yela DA. The influence of body weight on sexual function and quality of life in women with polycystic ovary syndrome. Arch Gynecol Obstet. 2015;291(2):451–5.
25. Rellini AH, Stratton N, Tonani S, Santamaria V, Brambilla E, Nappi RE. Differences in sexual desire between women with clinical versus biochemical signs of hyperandrogenism in polycystic ovarian syndrome. Horm Behav. 2013;63(1):65–71.
26. Ercan CM, Coksuer H, Aydogan U, et al. Sexual dysfunction assessment and hormonal correlations in patients with polycystic ovary syndrome. Int J Impot Res. 2013;25(4):127–32.
27. group TREA-SPcw. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). Hum Reprod 2004;19(1):41–47.
28. Kolodziejczyk B, Duleba AJ, Spaczynski RZ, Pawelczyk L. Metformin therapy decreases hyperandrogenism and hyperinsulinemia in women with polycystic ovary syndrome. Fertil Steril. 2000;73(6):1149–54.
29. Matsuda M, DeFronzo RA. Insulin sensitivity indices obtained from oral glucose tolerance testing: comparison with the euglycemic insulin clamp. Diabetes Care. 1999;22(9):1462–70.
30. Davis D, Shaver PR, Widaman KF, Vernon ML, Follette WC, Beitz K. "I can't get no satisfaction": insecure attachment, inhibited sexual communication, and sexual dissatisfaction. Pers Relat. 2006;13(4):465–83.
31. O'Brien EJ, Epstein S. MSEI: The Multidimensional Self-esteem Inventory. Odessa: Psychological Assessment Resources, Inc.; 1987.
32. Spielberger CD, Ward CH, Mendelson M, Mock J, Erbaugh J. STAI: Manual for the State-Trait Anxiety Inventory. Palo Alto: Consulting Psychologists Press; 1970.
33. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry. 1961;4:561–71.

34. Frohlich P, Meston C. Sexual functioning and self-reported depressive symptoms among college women. J Sex Res. 2002;39(4):321–5.
35. Cyranowski JM, Bromberger J, Youk A, Matthews K, Kravitz HM, Powell LH. Lifetime depression history and sexual function in women at midlife. Arch Sex Behav. 2004;33(6):539–48.
36. Bancroft J. Human sexuality and its problems. Churchill Livingstone: Edinburgh; 2009.
37. Eklund V-A, MacDonald ML. Descriptions of persons with multiple sclerosis, with an emphasis on what is needed from psychologists. Prof Psychol Res Pract. 1991;22(4):277–84.
38. Katz MR, Rodin G, Devins GM. Self-esteem and cancer: theory and research. Can J Psychiatr. 1995;40(10):608–15.