The Journal of Clinical Endocrinology & Metabolism, 2024, **109**, 3293–3305
https://doi.org/10.1210/clinem/dgae462
Advance access publication 8 August 2024
Meta-Analysis

Increased Prevalence of Binge Eating Disorder and Bulimia Nervosa in Women With Polycystic Ovary Syndrome: A Systematic Review and Meta-Analysis

Laura G. Cooney,[1] Kaley Gyorfi,[1] Awa Sanneh,[1] Leeann M. Bui,[2] Aya Mousa,[3] Chau Thien Tay,[3,4] Helena Teede,[3,4] Elisabet Stener-Victorin,[5] and Leah Brennan[6]

[1]Department of Obstetrics and Gynecology, University of Wisconsin, Madison, WI 54562, USA
[2]Department of Obstetrics and Gynecology, Santa Clara Valley Medical Center, Santa Clara, CA 95128, USA
[3]Monash Centre for Health Research and Implementation, Monash University, Melbourne, 3800, Australia
[4]Endocrine and Diabetes Units, Monash Health, Cayton, 3168, Australia
[5]Department of Physiology and Pharmacology, Karolinska Institutet, 171 77, Stockholm, Sweden
[6]School of Psychology and Public Health, La Trobe University, Melbourne, 3086, Australia

Correspondence: Laura Cooney, MD MSCE, University of Wisconsin, 2365 Deming Way, Middleton, WI 54562, USA. Email: Lcooney2@wisc.edu.

Abstract

Context: Polycystic ovary syndrome (PCOS) is associated with disordered eating/eating disorders, but prior meta-analyses are limited by small numbers.

Objective: To inform the 2023 International PCOS Guideline, we performed a systematic review and meta-analysis evaluating the prevalence of disordered eating/eating disorders among women with and without PCOS.

Methods: Ovid MEDLINE, EMBASE, PsycInfo, and All EMB were searched from inception through February 1, 2024, for studies that compared prevalences of eating disordered/disordered eating in adolescent or adult women. Random effects meta-analyses were used to estimate the pooled odds ratios (OR) or standardized mean differences (SMD) of outcomes in women with PCOS compared to controls. Methodological quality was assessed by the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system, and included studies were assessed for risk of bias.

Results: Of 1352 articles identified, 20 were included, with a total of 28 922 women with PCOS and 258 619 controls. Individuals with PCOS had higher odds of any eating disorder (OR: 1.53 [1.29, 1.82], 8 studies), which persisted in studies where PCOS was diagnosed by Rotterdam criteria (OR: 2.88 [1.55, 5.34], 4 studies). Odds of bulimia nervosa, binge eating disorder, and disordered eating, but not anorexia nervosa, were increased in PCOS. Mean disordered eating scores were higher in PCOS (SMD: 0.52 [0.28, 0.77], 13 studies), including when stratified by normal and higher weight body mass index. Most included studies were of moderate quality, with no evidence of publication bias.

Conclusion: Our study informs the 2023 PCOS Guideline recommendations for consideration of the risk of disordered eating/ eating disorders in care of women with PCOS, regardless of weight, especially during providing lifestyle counseling.

Key Words: PCOS, eating disorders, disordered eating, binge eating disorder, bulimia

Abbreviations: BMI, body mass index; DSM, Diagnostic and Statistical Manual of Mental Disorders; EAT, Eating Attitudes Test; EDE, Eating Disorder Examination Questionnaire); GRADE, Grading of Recommendations, Assessment, Development and Evaluations; OSFED, other specified feeding or eating disorder; PCOS, polycystic ovary syndrome; SMD, standardized mean difference; UFED, unspecified feeding or eating disorder.

Polycystic ovary syndrome (PCOS) is the most common endocrine condition in women and is associated with significant reproductive, metabolic, and psychological comorbidities (1, 2). The associations between PCOS and mental health disorders, such as depression and anxiety, have been clearly established in multiple systematic reviews and meta-analyses (3), and international guidelines recommend screening all women with PCOS for depression and anxiety (4). However, the association between PCOS and other mental health conditions is still emerging.

Eating disorders are a broad category as diagnosed based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-V-TR) and include pica, rumination disorder, avoidant/restrictive food intake disorder, anorexia nervosa, bulimia nervosa, binge eating disorder, other specified feeding or eating disorder (OSFED), and unspecified feeding or eating disorder (UFED) (5) (Table 1). The lifetime prevalence of each eating disorder varies based on the population queried, ranging from less than 1% (bulimia nervosa and anorexia nervosa) (5) to 1% to 3% (binge eating disorder: 1.25% to 3.5% (6) and OSFED/UFED: 1.5% (7)). Many of these each have subcategories such as night eating syndrome, which is included under the category of OSFED (Table 1) (5). Standardized questionnaires to query patients on symptoms

Received: 30 March 2024. **Editorial Decision:** 3 July 2024. **Corrected and Typeset:** 8 August 2024
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Table 1. Diagnostic characteristics of eating disorders (5)

Pica	Persistent eating of nonnutritive, nonfood substances over the period of at least one month
Rumination disorder,	Repeated regurgitation of food over the period of at least 1 month, not attributable to gastrointestinal issues or other medical conditions
Avoidant/restrictive food intake disorder	Eating disturbance related to avoidance or lack of interest in food leading to failure to meet nutritional and/or energy needs
Anorexia nervosa	Restriction of energy intake leading to lower body weight as well as fear of gaining weight and a disturbed perception of body image and weight
Bulimia nervosa	Episodes of binge eating combined with compensatory behaviors to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, or other medications; fasting; or excessive exercise
Binge eating disorder	Eating a larger amount of food than most people would eat under similar circumstances that must occur, on average, at least once per week for 3 months
Other specified feeding or eating disorder (OSFED)	Presents symptoms of an eating disorder that cause clinically significant distress and impairment that do not meet all of the criteria of a specific eating disorder
Night eating syndrome (under category of OSFED)	Recurrent episodes of night eating characterized by eating after awakening from sleep or by excessive food consumption after the evening meal
Unspecified feeding or eating disorder (UFED)	Presents symptoms of an eating disorder that cause clinically significant distress and impairment where there is not insufficient information to make a full diagnosis

characteristic of eating disorders, such as the Eating Attitudes Test (EAT)-26 and EAT-40 and the Eating Disorder Examination Questionnaire (EDE-Q) (8-10), can be used for efficient in-clinic screening to identify patients at risk for disordered eating, although referral to a trained professional is always needed for the diagnosis of an eating disorder.

Concerns about a link between PCOS and eating disorders were first raised 3 decades ago, when a small study found increased scores on a disordered eating questionnaire in women with PCOS compared to women with other non-PCOS endocrinopathies (11). More recently, this has been confirmed in both clinic-based cross-sectional studies (12, 13), as well as studies using larger survey or insurance claims data (14, 15). This association is not surprising, as women with PCOS have many risk factors for disordered eating, including body image concerns (16) and the recommendation to lose weight as part of PCOS treatment, with accompanying difficulties in achieving adequate weight loss (4, 17). The importance of incorporating evaluation for disordered eating/eating disorders into comprehensive care for women with PCOS is highlighted by the reported concerns that a focus on weight management, exercise levels, and dietary restriction can contribute to disordered eating and interfere with recovery from eating disorders (18). Thus, inappropriate dietary counseling in women with both eating disorders and PCOS could worsen disordered eating symptoms, highlighting the challenges in treatment of PCOS symptoms in women with comorbid eating disorders.

A previously published meta-analysis by our group showed increased odds of any eating disorders and abnormal disordered eating scores in women with PCOS; however, the total number of participants was small (470 women with PCOS and 390 controls) and did not include any studies on adolescents (19). Thus, as part of the 2023 update of the International Evidence-based Guideline for the Assessment and Management of PCOS (4, 20), we performed an updated systemic review and meta-analysis to define the risk of any eating disorder, individual eating disorders, and disordered eating in adolescent and adult women with PCOS. To better evaluate the impact of PCOS diagnostic criteria and body mass index (BMI) on these risks, we performed subanalyses based on studies in which PCOS status was diagnosed by Rotterdam criteria and those in which mean disordered eating scores were stratified by BMI group.

Methods

This systematic review and meta-analysis was conducted as part of the 2023 update of the International Evidence-based Guidelines for the Assessment and Management of PCOS to answer the question "In women with PCOS, what is the prevalence and severity of disordered eating?"

Literature Search

An electronic literature search for articles on the prevalence of any eating disorder in women with PCOS was performed in the following databases, from inception to February 1, 2024: Ovid MEDLINE, EMBASE, PsycInfo, and All EMB. The search strategy and key words are provided in Supplementary Table S1 (21). In brief, we included search terms for PCOS (PCOS, polycystic ovary syndrome, anovulation, and hyperandrogenism) and either DSM-V eating disorder diagnoses (examples: anorexia nervosa, bulimia nervosa, and binge eating) or search terms related to disordered eating (examples: food cravings, binging, purging, and compulsive exercise). Data retrieval was limited to full-text English-language studies and humans.

Study Selection and Data Extraction

Citations were imported into Covidence (22). Two authors (K.G. and A.A.) independently screened all potential studies for eligibility. If there was any disagreement about possible inclusion of a study, an additional author (L.C. in conjunction with E.S.-V. and L.B.) would review the abstract or article to make a final determination. Data extraction was conducted in duplicate by 2 authors using a standardized extraction form (L.C. and either K.G., A.S., or L.M.B.).

Inclusion criteria

The inclusion criteria were developed using the Participants-Interventions-Comparisons-Outcomes (PICO) framework. We included all articles with comparisons of adolescent or adult women with PCOS and controls who were screened for any eating disorder or disordered eating using a validated screening tool or used diagnostic criteria based on the DSM-V.

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Disordered eating was defined as a score above the predefined cutoff from each specific screening tool's scoring criteria (8-10, 23-28) (Supplementary Table S2) (21). We included studies where PCOS was diagnosed using either the National Institutes of Health (NIH) (29) or Rotterdam (30) criteria and where PCOS diagnosis was made through patient self-report or hospital records. Studies that included nonstandard PCOS definitions (ie, BMI, luteinizing hormone/follicle-stimulating hormone ratio) or did not detail how PCOS was defined were excluded. Controls were women who did not have a diagnosis of PCOS. No restrictions were placed on the location of PCOS or control recruitment (community vs clinic). Articles without original data (eg, reviews, commentaries) or full text (eg, conference proceedings or no full-text access), and those which were not available in English were excluded.

Quality assessment

Studies were assessed for quality and bias at the study level using the Newcastle-Ottawa Quality Assessment Scale (NOS) with one adaptation. For selection of controls, 1 point was awarded if the subjects were all recruited from the same location (ie, controls were recruited from a clinic if PCOS subject were recruited from a clinic). This represents a change from the original scale, which awards 1 point for community controls. Other meta-analyses have suggested that recruitment from the same location may be superior to having controls recruited from the community if PCOS subjects are recruited from a hospital clinic (3, 31). Evidence quality at the outcome-level was assessed by the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system (32). The GRADE approach uses 5 considerations (risk of bias, inconsistency of effect, indirectness, imprecision, and other bias including publication bias). The evidence can be downgraded from "high quality" by 1 level for serious (or by 2 levels for very serious) limitations, depending on assessments of these domains.

Data extraction

The following data were extracted from each study that met inclusion criteria: name of first author, year of publication, setting, and criteria used for PCOS diagnosis. For both the control and PCOS groups we extracted total number of subjects, baseline age and BMI, prevalence of diagnosed eating disorder, mean scores and SD for screening tools, and prevalence of disordered eating (a score above the predefined cutoff on screening tool). If any relevant data were missing, the authors were contacted for additional information.

Data analysis

Outcomes of interest were prevalence of any eating disorder (composite of any DSM-IV eating disorder diagnosis) (Table 1), each individual eating disorder, disordered eating, and mean disordered eating scores. Random effects meta-analyses were used to estimate the pooled odds for categorical variables or standardized mean differences (SMD) for continuous variables in women with PCOS compared with controls. SMDs were used, as multiple different disordered eating questionnaires were used, each with their own normative ranges. Given the limitations of self-report and hospital records in PCOS diagnosis, we performed sensitivity analyses of studies where PCOS was diagnosed by Rotterdam criteria. To evaluate the impact of BMI, we also performed subgroup analysis comparing SMDs of disordered eating scores in those with BMI < 25 kg/m^2 and BMI ≥ 25 kg/m^2.

The "metan" command in STATA version 18 was used to construct forest plots for each outcome. When there were no events in either group, the study was excluded from the results of the meta-analysis (33). Chi-squared tests were used for the significance of the pooled odds ratio (OR); I^2 tests of heterogeneity were also applied. A funnel plot was created using the 'metafunnel' command, in which the log OR of each study was plotted against the standard error of the log OR, to assess the potential presence of publication bias. In constructing the funnel plot, to be consistent with the "metan" command, zero cells were similarly treated by adding 0.5 to all cells of the two-by-two table. In addition, publication bias was tested using the Egger regression method, with a P value $< .05$ suggesting the presence of bias ("metabias" command).

The meta-analysis was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (34) and using the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (35).

Results

Literature Search and Study Characteristics

A flow diagram of study selection is shown in Fig. 1. A total of 1359 records were identified through database searches. After removal of duplicates and screening of titles and abstracts, 80 studies underwent full-text review, 60 of which were excluded based on having the wrong study designs, control groups or outcomes measured, PCOS not being confirmed in the patient population, or the article not being available in English or in full text.

Twenty cross-sectional studies were included in the systematic review (Table 2), with a total of 28 922 women with PCOS and 258 619 women without PCOS. PCOS was diagnosed using Rotterdam criteria in 13 studies (12, 13, 36-46). In the other studies, PCOS was diagnosed based on self-report (15, 47-50), insurance claims data (51), or International Classification of Diseases (ICD) codes (14). Studies were conducted in Australia, Greece, Latvia, Netherlands, Saudi Arabia, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Newcastle-Ottawa Quality Assessment Scale assessment showed that 4 studies had a low risk of bias (14, 40, 45, 47), 12 had a moderate risk (12, 13, 36-39, 41-44, 46, 51), and 4 had a high risk (15, 48-50). Only one study restricted inclusion to adolescents (40), while a second study included both adolescents and young adults (age 15-24, mean age 19) (37). BMI was higher in the PCOS group in 8 of the studies (12, 15, 36, 38-40, 46, 48) and could not be compared between groups in 3 studies (13, 14, 51). GRADE assessments showed that evidence certainty was moderate for the outcome of any eating disorder and ranged from very low to moderate certainty for other outcomes. GRADE certainty was primarily influenced by the moderate to high risk of bias across the included studies as well as imprecision and potential publication bias for some outcomes (Table 3).

Association Between PCOS and Any Eating Disorder

Nine cross-sectional studies reported the prevalence of at least one eating disorder in adult women with PCOS compared with controls. One study had no events in either group and was not included in the meta-analysis. In the overall analysis,

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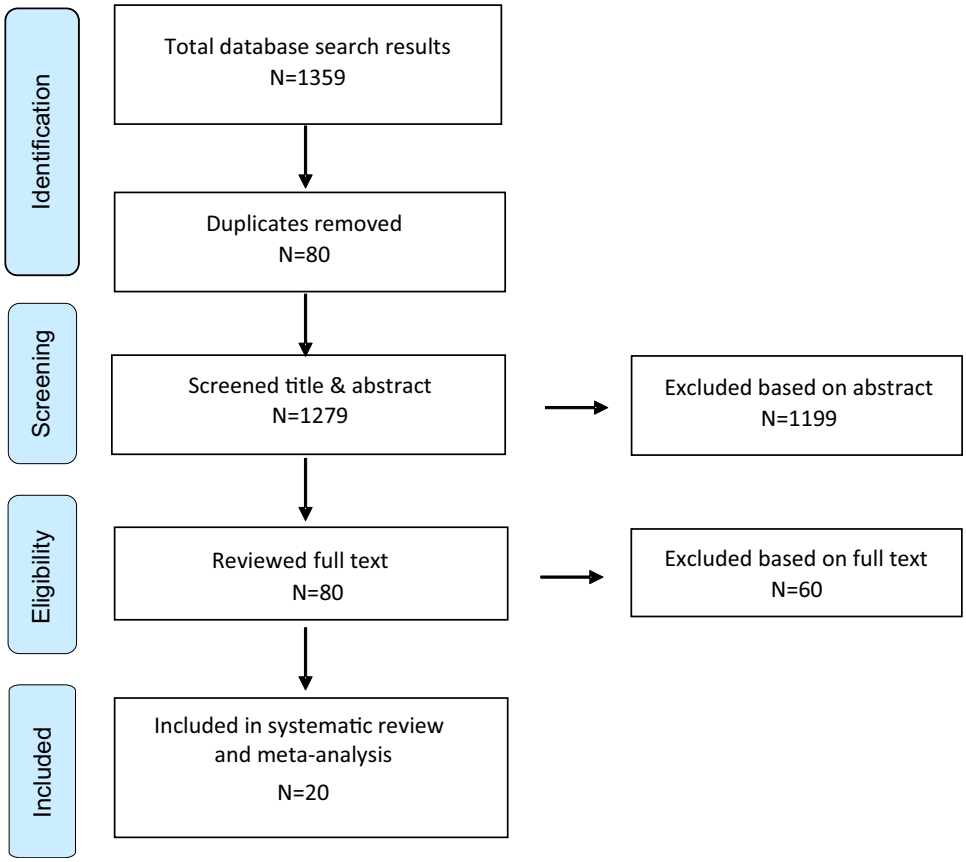

Figure 1. Flow diagram of study selection.

women with PCOS had higher odds of any eating disorder (OR: 1.53 [95% CI 1.29, 1.82]) (Table 3, Fig. 2). This remained significant in sensitivity analysis of 4 studies where PCOS diagnosis was diagnosed by Rotterdam criteria (OR: 2.88 [1.55, 5.34]) (Table 3, Supplementary Fig. S1) (52). One study reported the odds of any eating disorder in adolescents with PCOS and did not find a difference in prevalence (40).

Association Between PCOS and Individual Eating Disorders

In the overall meta-analysis, women with PCOS had higher odds of bulimia nervosa and binge eating disorder (OR: 1.34 [1.17, 1.54], 5 studies, and OR: 2.09 [1.18, 3.72], 4 studies, respectfully) but not anorexia nervosa (OR: 0.94 [0.69, 1.28], 3 studies) (Table 3, Fig. 2). No studies reported on pica, rumination disorder, avoidant/restrictive food intake disorder, or OSFED/UFED (other than night eating syndrome). Only one study reported prevalence of night eating syndrome and did not find a difference between groups (12). In the sensitivity analyses of studies where PCOS was diagnosed by Rotterdam criteria, only binge eating disorder remained significant (Table 3, Supplementary Fig. S1) (52). Only one study in this sensitivity analysis reported odds of anorexia nervosa (12) so no meta-analysis was done. This study did not find any events in either group.

Disordered Eating

Mean disordered eating scores and odds of disordered eating (disordered eating scores above questionnaire cutoff) were higher in women with PCOS compared with controls (SMD: 0.52 [0.28, 0.77], 13 studies) and (OR 2.84 [1.0, 8.04], 8 studies), respectfully (Fig. 3). Both of these findings persisted in the sensitivity analysis of studies where PCOS was diagnosed by Rotterdam criteria (Table 3, Supplementary Fig. S1) (21). In an additional subanalysis, mean night eating questionnaire scores were higher in women with PCOS (SMD: 0.29 [0.13, 0.46, 3 studies, Fig. 3). The 2 studies with mean age < 20 years did not show a higher prevalence of disordered eating in PCOS (37, 40).

Impact of BMI

Five studies reported mean disordered eating scores stratified by BMI. Scores were higher in the PCOS group in both the BMI < 25 kg/m^2 analysis (SMD: 0.36 [0.15, 0.58], 5 studies) and the BMI ≥ 25 kg/m^2 analysis (SMD: 0.68 [0.22, 1.13], 4 studies) (Fig. 3). No studies reported the prevalence of eating disorder diagnoses stratified by BMI. Of the 4 studies that performed multivariable regression analysis adjusting for BMI, 3 found that at least one eating disorder diagnosis or disordered eating variable remained higher in the PCOS group after controlling for BMI (12, 15, 38); whereas in the fourth, this association was attenuated after adjustment (48).

Publication Bias

Funnel plots for the main analyses are shown in Supplementary Fig. S2 (53). Based on the Egger regression method, the following analyses did not have publication bias: the overall group for any eating disorder ($P = .06$), bulimia nervosa ($P = .8$), anorexia nervosa ($P = .5$), and disordered eating ($P = .4$) and the Rotterdam subanalysis for binge eating ($P = .3$) and disordered

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Table 2. Study characteristics

Author, year (country) Risk of bias	ED screening tool	PCOS criteria/ recruitment location	N		Age (y), mean ± SD	BMI (kg/m^2), mean ± SD	ED score mean ± SD; Prevalence of abnormal screening score n (%)		Prevalence of specific ED diagnoses n (%)	
			PCOS	Control			PCOS	Control	PCOS	Control
Hollinrake et al, 2007 (USA) Moderate	PRIME-MD PHQ	Rotterdam P: university reproductive infertility clinic C: university gynecology clinic, seen for annual exam	103	103	P: 29.8 ± 6.2 C: 30.7 ± 8.5	P: 34.9 ± 8.5* C: 25.4 ± 4.7*	Not reported	Not reported	BED: 13 (12.6)**	BED: 2 (1.9)**
Mansson et al, 2008 (Sweden) Moderate	MINI[b]	Rotterdam P: university outpatient clinic C: born on the same day from population registry	49	49	P: 35.9 ± 10.4 C: 35.9 ± 10.4	P: 29.1 ± 7.4** C: 23.5 ± 3.0**	Not reported	Not reported	Any ED[b] 10 (21)* BN: 6 (12)	Any ED: 2 (4)* BN: 2 (4)
Karacan et al, 2014 (Turkey)[a] Moderate	EAT-26	Rotterdam P, C: University hospital, ob/gyn clinic, all lean	42	52	P: 19.1 ± 2.3 C: 19.7 ± 2.1	P: 22.4 ± 3.8 C: 21.4 ± 3.82	EAT-26: 46.6 ± 17.0 Abnormal EAT Score: 15 (35.7)	EAT-26: 48.2 ± 17.6 Abnormal EAT Score: 16 (30.8)	Not reported	Not reported
Sirmans et al, 2014 (USA) Moderate	Louisiana Medicaid claims data	Paid claim for PCOS or oligo/amenorrhea plus hirsutism P, C: Louisiana Medicaid claims data Matched on age and race	1689	5067	P: 25.24 C: 25.23	Not available for analysis or report	Not reported	Not reported	All ED: 7 (0.4)	All ED: 15 (0.3)
Larsson et al, 2015 (Sweden) Moderate	EAT-40 TFEQ–R21; DSM-IV survey for BN	Rotterdam P, C: Recruited via community advertisements	72	30	P: 30.2 ± 4.4** C: 27.8 ± 3.6**	P: 28.5 ± 7.2** C: 24.6 ± 5.0**	EAT-40: 16.4 ± 10.1** Abnormal EAT-40 Score: 6 (8.3) TFEQ Cognitive restraint: 41 ± 23 Uncontrolled eating: 42 ± 20 Emotional eating: 44 ± 28	EAT-40: 7.8 ± 6.7** Abnormal EAT-40 Score: 1 (3.3) TFEQ Cognitive restraint: 37 ± 23 Uncontrolled eating: 39 ± 15 Emotional eating: 37 ± 19	BN: 0 (0)	BN: 0 (0)
Cesta et al, 2016 (Sweden) Low	ICD codes	Swedish National Patient Register (NPR), C: Matched on birth year and country of residence	24 385	243 850	Matched on age but mean not reported	BMI not available in dataset	Not reported	Not reported	Any ED: 598 (2.5)* AN:139 (0.6) BN: 179 (0.73)*	Any ED: 4223 (1.7)* AN: 1504 (0.6) BN:1331 (0.55)*
Jeanes et al, 2016 (UK) Low	BITE	Self-report of PCOS diagnosis by a healthcare professional P, C: Recruited via community advertisements Matched on age and BMI (all lean)	45[c]	40	P: 31.3 ± 5.6 C: 28.3 ± 8.5	P: 22.5 ± 1.8 C: 21.8 ± 1.6	BITE: 10.9 ± 7.8* Abnormal BITE score: 16 (36)*	BITE: 7.4 ± 6.0* Abnormal BITE score: 5 (12)*	Not reported	Not reported
Lee et al, 2016 (USA) [a] Moderate	EDE-Q NEQ, and DSM survey	Rotterdam P: PCOS center C: university gynecology clinic	148	106	P: 28.1 ± 5.2** C: 31.9 ± 8.1**	P: 33.9 ± 9.9** C: 26.8 ± 7.5**	EDE-Q Global: (overall) 2.38 ± 1.31** BMI < 25 kg/m^2 (N = 28) 1.16 ± 1.0 BMI ≥ 25 kg/m^2 (N = 120) 2.7 ± 1.20** Abnormal EDE-Q Score (overall):	EDE-Q Global: (overall) 1.29 ± 1.09** BMI < 25 kg/m^2 (N = 58) 0.76 ± 0.79 BMI ≥ 25 kg/m^2 (N = 48) 1.92 ± 1.61** Abnormal EDE-Q Score (overall)	Any ED: 42 (28.4) AN: 0 (0) BN: 9 (6.1) BED: 26 (17.6) NES: 19 (12.9)	Any ED: 20 (18.9) AN: 0 (0) BN: 6 (5.7) BED: 11 (10.4) NES: 13 (12.4)

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Table 2. Continued

Author, year (country) Risk of bias	ED screening tool	PCOS criteria/ recruitment location	N		Age (y), mean ± SD	BMI (kg/m^2), mean ± SD	ED score mean ± SD; Prevalence of abnormal screening score n (%)		Prevalence of specific ED diagnoses n (%)	
			PCOS	Control			PCOS	Control	PCOS	Control
							18 (12.2)* NEQ: 16.67 ± 6.18 Abnormal NEQ Score: 19 (12.9)	3 (2.8)* NEQ: 14.88 ± 5.43 Abnormal NEQ Score: 7 (6.6)		
Maher et al, 2018 (USA) [a] Moderate	EAT-26	Rotterdam P, C: Recruited through print advertisements, matched on weight	8	8	P: 32.9 ± 3.5 C: 35.0 ± 4.5	P: 30.8 ± 2.1 C: 30.8 ± 3.0	EAT-26 score: 6.38 ± 1.18 Abnormal EAT-26 score: 0 (0)	EAT-26 score: 3.88 ± 1.6 Abnormal EAT-26 score: 0 (0)	Not reported	Not reported
Pirotta et al, 2019 (Australia)[c] High	EDE-Q and DSM criteria	Self-report of prior PCOS diagnosis, PCOS status not evaluated in controls P, C: Recruited via online and community advertisements	501	398	P: 30.5 ± 5.9** C: 22.8 ± 5.5**	P:33.6 ± 9.3** C:24.3 ± .6.0**	EDE-Q Global 2.30 ± 1.12* Abnormal EDE-Q Score: 36 (7.2)**	EDE-Q Global 2.08 ± 1.42* Abnormal EDE-Q Score: 53 (13)**	Any ED: 310 (62) AN: 0 (0) BN: 26 (5.2) BED: 143 (29)	Any ED: 223 (56) AN: 5 (1.3) BN: 18 (4.5) BED: 92 (23)
Tay et al, 2019 (Australia) High	Self-report on survey	Self-report on survey P, C: Australian Longitudinal Study on Women's Health (ALSWH)	875	7592	P: 24.8 ± 1.7* C: 24.6 ± 1.8*	P:29.2 ± 7.9** C:25.3 ± 5.8**	Not reported	Not reported	Any ED: 96 (11)** AN: 31 (3.5) BN: 30 (3.4) Other ED: 56 (6.4)**	Any ED: 575 (7.6)** AN: 258 (3.4) BN:195 (2.6) Other ED:257 (3.4)**
Asdaq et al, 2020 (Saudi Arabia) Moderate	Binge eating questionnaire	Rotterdam P, C: Tertiary care centers	116	378	Age ≥ 30 85.1% of overall group	Normal BMI: 61% of overall group	Not reported	Not reported	BED: 108 (93.1)**	BED: 312 (82.5)**
Başar Gökcen et al, 2020 (Turkey) Moderate	EDE-Q, TFEQ-R21	Rotterdam P, C: university gynecology clinic	40	40	P: 25.3 ± 4.8 C: 24.8 ± 3.2	P: 27.2 ± 6.6 C: 25.4 ± 4.1	EDE-Q Global (overall) 2.32 ± 1.45** BMI < 25 kg/m^2 (N = 17) 1.08 ± 0.79 BMI ≥ 25 kg/m^2 (N = 23) 3.23 ± 1.11** TFEQ (overall) Cognitive restraint: 55.1 ± 29.0* Uncontrolled eating: 49.9 ± 21.0* Emotional eating: 56.3 ± 33.5**	EDE-Q Global (overall) 1.29 ± 1.07** BMI < 25 kg/m^2 (N = 20) 0.79 ± 0.79 BMI ≥ 25 kg/m^2 (N = 20) 1.79 ± 1.20** TFEQ (overall) Cognitive restraint: 40.6 ± 19.9* Uncontrolled eating: 32.2 ± 19.7* Emotional eating: 44.6 ± 29.2**	Not reported	Not reported
Wang et al, 2021 (Netherlands) Moderate	DEBQ	Rotterdam P, C: cross-sectional analysis of the LIFEstyle study, all subjects had BMI >29 kg/m^2	170	321	P: 28.0 ± 4.2** C: 30.8 ± 4.4**	P: 36.0 ± 3.5 C: 36.0 ± 3.3	Emotional eating 34.6 ± 11.2 External eating 27.7 ± 6.3 Restricted eating 32.3 ± 5.9	Emotional eating 34.1 ± 11.3 External eating 27.5 ± 5.8 Restricted eating 31.7 ± 6.1	Not reported	Not reported
Cetik et al, 2022 (Turkey) [a] Moderate	TFEQ-R18, NEQ, FCQ-T	Rotterdam (Phenotype A only) P, C: endocrinology clinic; Matched on age and BMI	44	36	P: 21.7 ± 2.8 C: 21.9 ± 2.8	P: 24.6 ± 5.3 C: 22.7 ± 2.9	TFEQ score 42.4 ± 7.3 NEQ score 14.8 ± 6 FCQ-T score 111.8 ± 31.8	TFEQ score 40.0 ± 4.6 NEQ score 12.9 ± 4.2 FCQ-T score 113.4 ± 46.2	Not reported	Not reported
Eyupoglu et al, 2022	TFEQ-R18	Self-report P, C: Google forms survey	232	157	P: 23 (IQR: 21-25) C:23 (IQR: 20-25)	P: 21.9 ± 2.6 C: 21.5 ± 2.9	TFEQ score 28.5 ± 5.1	TFEQ score 27.3 ± 4.9	Not reported	Not reported

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Table 2. Continued

Author, year (country) Risk of bias	ED screening tool	PCOS criteria/ recruitment location	N		Age (y), mean ± SD	BMI (kg/m^2), mean ± SD	ED score mean ± SD; Prevalence of abnormal screening score n (%)		Prevalence of specific ED diagnoses n (%)	
			PCOS	Control			PCOS	Control	PCOS	Control
Switzerland High										
Lidaka et al, 2022 (Latvia) Low	BES	Rotterdam (ESHRE 2018) P, C: pediatric gynecology clinic, P: presenting with oligomenorrhea, C: presenting for contraception or routine care, Matched on age	63	66	P: 16 (2)[d] C: 17 (1)[d]	P: 89.9 (46.7)[d]** C:46.9 (46.3)[d]**	BES score: 12 (IQR: 14.5)	BES score: 12 (IQR: 17.0)	Any BED: 23 (37.7) Mild to moderate BED: 15 (24.6) Severe BED: 8 (13.1)	Any BED: 23 (35.9) Mild to moderate BED: 11 (17.2) Severe BED: 12 (18.8)
Derrigo et al, 2023 (United States) High	mYFAS	Self-report on survey P, C: Recruited using Amazon's Mechanical Turk (MTurk)	181	184	P: 36.1 ± 9.33 C: 37.5 ± 9.4	P: 28.1 ± 9.7 C: 26.7 ± 6.83	mYFAS 6.2 ± 3.8** Abnormal mYFEAS score 94 (51.9%)**	mYEAS 2.5 ± 3.4** Abnormal mYFEAS score 31 (16.8)**	Not Reported	Not Reported
Stefanaki et al, 2023 (Greece) Low	EAT-26, FCQ-T-r	Rotterdam P, C: gynecology clinic, age, and BMI matched	49	32	P: 26.8 ± 4.4 C: 27.7 ± 4.6	P: 25.6 ± 4.5 C: 25.7 ± 4.5	EAT-26 (overall) 16.5 ± 7.8 BMI < 25 kg/m^2 (N = 26) 15.2 ± 8.3 BMI ≥ 25 kg/m^2 (N = 23) 18 ± 7 FCQ-T BMI < 25 kg/m^2 (N = 26) 29.3 ± 8.9 BMI ≥ 25 kg/m^2 (N = 23) 47.6 ± 9.9	EAT-26 (overall) 17.3 ± 9.5 BMI < 25 kg/m^2 (N = 14) 16.3 ± 11.1 BMI ≥ 25 kg/m^2 (N = 18) 18.2 ± 8.3 FCQ-T BMI < 25 kg/m^2 (N = 14) 35.1 ± 15.8 BMI ≥ 25 kg/m^2 (N = 18) 45.5 ± 15.7	Not Reported	Not Reported
Yuksel et al 2023 (Turkey) Moderate	EDE-Q, NEQ	Rotterdam P, C: gynecology	110	110	P: 21.1 ± 2.3 C: 21.4 ± 2.4	P: 25.7 ± 5.3** C: 21.6 ± 3.1**	EDE-Q (overall) 3.0 ± 1.6** BMI < 25 kg/m^2 (N = 53) 1.74 ± 1.49 BMI ≥ 25 kg/m^2 (N = 57) 3.68 ± 1.17** Abnormal EDE-Q score (overall group) 28 (25.5%)** NEQ: 25.70 ± 11.23 Abnormal NEQ score: 53 (48.2%)	EDE-Q (overall) 1.6 ± 1.1** BMI < 25 kg/m^2 (N = 95) 1.31 ± 0.95 BMI ≥ 25 kg/m^2 (N = 15) 2.58 ± 1.20** Abnormal EDE-Q score (overall group) 3 (2.7%)** NEQ: 23.09 ± 8.95 Abnormal NEQ score 46 (41.8%)	Not Reported	Not Reported

P: PCOS group C: control group
Eating disorder abbreviations: AN, anorexia nervosa; BED, binge eating disorder; BN, bulimia nervosa; ED, eating disorder; NES, night eating syndrome.
Scales abbreviations: BES, Binge Eating Scale (BES); BITE, Bulimic Investigatory Test, Edinburgh; DEBQ, Dutch Eating Behavior Questionnaire; EAT, Eating Attitudes Test; EDE-Q, Eating Disorder Examination Questionnaire; FCQ-T, Food Craving Questionnaire-Trait; FCQ-T-r, Food Craving Questionnaire-Trait reduced; mYFAS, modified Yale Food Addiction Scale; NEQ, Night Eating Questionnaire; PRIME-MD PHQ, Primary Care Evaluation of Mental Disorders Patient Health Questionnaire; TFEQ, Three-Factor Eating Questionnaire.
*$P < 0.05$, **$P < 0.01$
[a]Author provided unpublished information.
[b]MINI based on DSM-IV includes AN, BN, and AN binge/purge type.
[c]Only lean PCOS participants were included in this table.
[d]Age and BMI reported as median percentile (interquartile range).

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Table 3. GRADE summary and findings

No. studies	Quality assessment						No. participants		Effect estimate: OR [95% CI], M-H random	Favors	Certainty	Importance
	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	PCOS	Control				
Outcome: Any eating disorder: All studies												
8	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	no serious imprecision	none	27 938	257 573	1.53 (1.29, 1.82)	PCOS	⨁⨁⨁◯ MODERATE	IMPORTANT
Outcome: Any eating disorder: PCOS diagnosis confirmed by Rotterdam criteria												
4	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	no serious imprecision	serious risk for publication bias [c]	488	666	2.88 (1.55, 5.34)	PCOS	⨁⨁◯◯ LOW	IMPORTANT
Outcome: Bulimia Nervosa: All studies												
5	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	no serious imprecision	serious risk for publication bias [c]	26 030	252 025	1.34 (1.17, 1.54)	PCOS	⨁⨁◯◯ LOW	IMPORTANT
Outcome: Bulimia Nervosa: PCOS diagnosis confirmed by Rotterdam criteria												
3	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	serious imprecision[b]	serious risk for publication bias [c]	269	185	1.56 (0.56, 4.36)	Neither	⨁◯◯◯ VERY LOW	IMPORTANT
Outcome: Binge eating disorder: All studies												
4	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	No serious imprecision	none	868	985	2.09 (1.18, 3.75)	PCOS	⨁⨁⨁◯ MODERATE	IMPORTANT
Outcome: Binge eating disorder: PCOS diagnosis confirmed by Rotterdam criteria												
3	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	no serious imprecision	none	367	587	2.70 (1.47, 4.97)	PCOS	⨁⨁⨁◯ MODERATE	IMPORTANT
Outcome: Anorexia Nervosa: All studies												
4	Cross-sectional	Serious[a]	no serious inconsistency	no serious indirectness	no serious imprecision	none	25 909	251 946	0.94 (0.69, 1.28)	Neither	⨁⨁⨁◯ MODERATE	IMPORTANT
Outcome: Disordered eating: All studies												
8	Cross-sectional	Serious[a]	serious inconsistency[d]	no serious indirectness	serious imprecision[b]	none	1107	928	2.84 (1.00, 8.04)	PCOS	⨁◯◯◯ VERY LOW	IMPORTANT
Outcome: Disordered eating: PCOS diagnosis confirmed by Rotterdam criteria												
5	Cross-sectional	Serious[a]	serious inconsistency[d]	no serious indirectness	serious imprecision[b]	none	380	306	3.66 (1.15, 11.63)	PCOS	⨁◯◯◯ VERY LOW	IMPORTANT

[a]Downgraded once as the majority of evidence is at moderate risk of bias.
[b]Downgraded once due to imprecision as CIs were wide.
[c]Downgraded once due to serious risk of publication bias.
[d]Downgraded once due to statistical heterogeneity.

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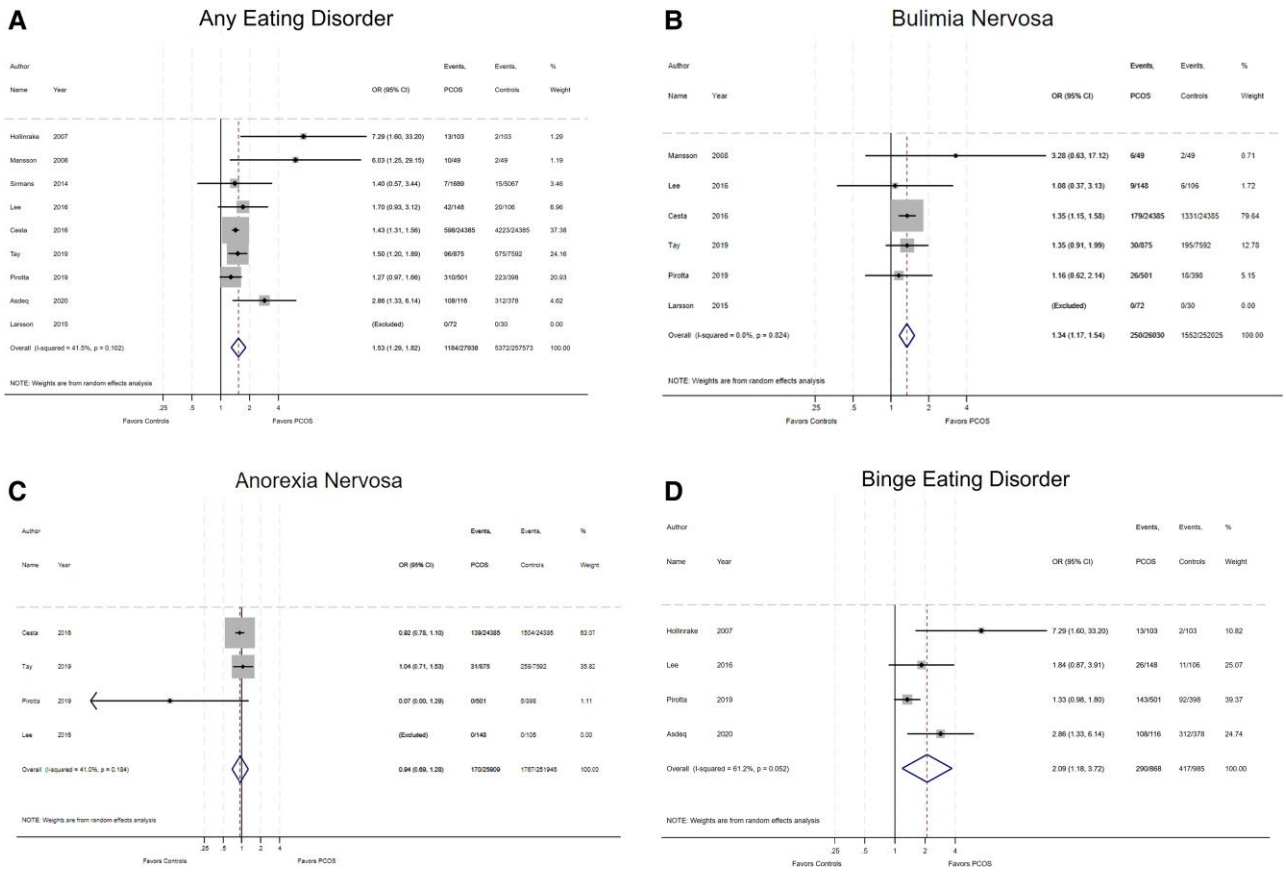

Figure 2. Forrest plots of the odds of eating disorders in women with PCOS compared to controls. Random effects meta-analysis used for all analyses. A, Odds of having any eating disorder diagnosis; B, Odds of bulimia nervosa; C, Odds of binge eating disorder; D, Odds of anorexia nervosa.

eating ($P = .6$). There was insufficient data to run the Egger regression model for the Rotterdam subanalysis for bulimia or anorexia nervosa. The remaining 2 analyses, overall group for binge eating and Rotterdam subanalysis for any eating disorders, had significant publication bias ($P < .05$).

Discussion

Our study shows that women with PCOS have a higher odds of eating disorders, disordered eating, binge eating disorder, and bulimia nervosa, which persists in some sensitivity analyses of studies where PCOS is diagnosed using Rotterdam criteria rather than self-report or claims data.

When evaluating the contribution of BMI to the association between PCOS diagnosis and risk of disordered eating, we found that women with PCOS had higher mean disordered eating scores than controls in both the normal and the higher weight categories, suggesting an influence of PCOS diagnosis on disordered eating independent of BMI. There are few longitudinal studies looking at changes in rates of eating disorders over time in women with PCOS. Greenwood et al (54) found that in women with PCOS, higher baseline BMI and weight gain over the study period were both associated with elevated disordered eating scores at follow-up (median 5 years) (54). Conversely, another study found that, after 2 years, rates of binge eating disorder in women with PCOS were high, but unchanged (25% vs 22%), although this study did not analyze rates in the context of baseline BMI or changes in weight (36). Karacan et al (37) found that BMI explained 14% of the variance in EAT scores in the PCOS group but only 1% in the control group. These studies support our findings that even if BMI plays a role in this association, it is unlikely to be the sole contributor.

Recognition that eating disorders are common throughout the BMI spectrum is particularly important in this population, given that lifestyle modifications, including physical activity, healthy diet, and behavior modifications, are recommended as the mainstay of treatment for PCOS, regardless of weight (4). While healthy lifestyle advice can improve cardiometabolic health in the general population, applying generic advice to those with PCOS and concurrent eating disorders may be counter-effective (55, 56). Restricted diets can be a significant contributor to disordered eating and a focus on weight loss can worsen disordered eating and increase psychological distress in women with PCOS who already have an eating disorder (18). Further, as traditional lifestyle interventions, including nutrition and physical activity, evolve to include anti-obesity medications, there is a need to ensure that future studies evaluate the impact of these medications on eating disorder risks. In the general population, binge eating behaviors may be improved with medications such as glucagon-like peptide-1 receptor (GLP1R)-agonists (57-59). Data are encouraging in women with PCOS, but numbers are low (60). A treatment plan focused on a "weight neutral approach" which prioritizes mindful eating and self-care rather than dietary restriction could be helpful to balance these risks (17). However, this has not been studied specifically in women with PCOS.

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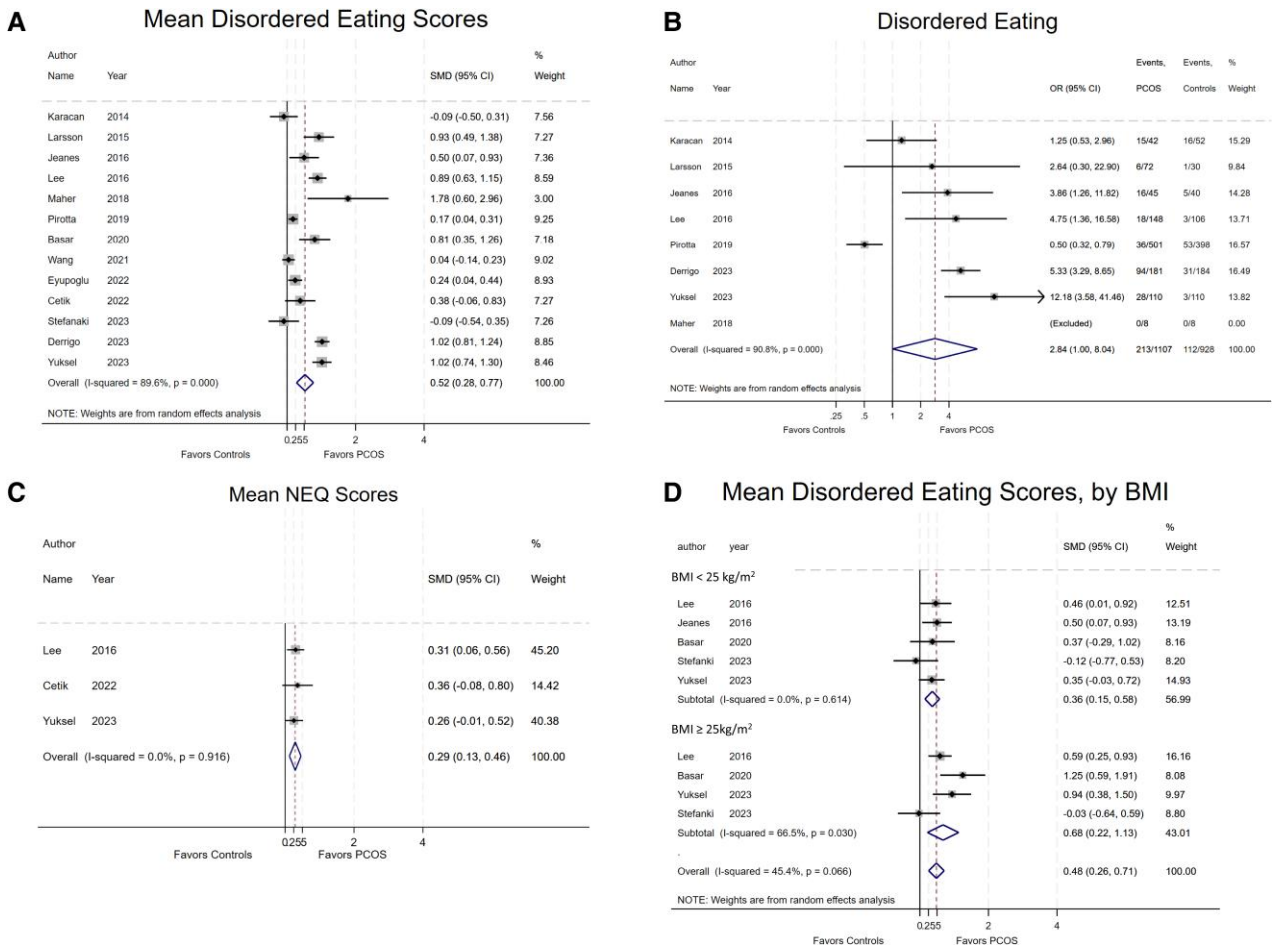

Figure 3. Forrest plots of disordered eating scores in women with PCOS compared to controls. Random effects meta-analysis used for all analyses. A, Standardized mean difference (SMD) of disordered eating scores; B, Odds of disordered eating (ie, abnormal ED score); C, SMD of Night Eating Questionnaire (NEQ) scores; D, SMD of disordered eating scores stratified by BMI < 25 kg/m^2 and BMI ≥ 25 kg/m^2.

Non-weight-related contributors to the increased eating disorder risk in PCOS have not been fully elucidated but could include metabolic (hyperandrogenemia or insulin resistance) or other psychological (depression, anxiety, or body dysmorphic disorder) factors. Women with PCOS have more weight loss attempts and more frequently report a perception of having overweight even at normal BMIs, compared to women without PCOS (61), which could contribute to disordered eating behaviors. In the above-mentioned longitudinal study by Greenwood et al, both biochemical hyperandrogenism and screening positive for depression were predictors of higher EDE-Q scores at follow-up. Elevated 2-hour glucose and high-sensitivity C-reactive protein (hsCRP) levels were also correlated with disordered eating, but this relationship was attenuated after controlling for BMI (54). Clearly, future studies are needed to better identify risk factors for disordered eating in women with PCOS.

Diagnosing PCOS in adolescents is both controversial and challenging (62); thus, it is not surprising that good quality studies on eating disorder risk in PCOS in this age group are lacking. The paucity of data in adolescents may also contribute to our overall findings of no increased odds of anorexia nervosa in PCOS. Anorexia nervosa often develops in the adolescent/early adult years (63, 64); and although the overall incidence of anorexia nervosa has been stable over time, rates of anorexia have increased in the youngest age ranges (< 15 years) (64). A diagnosis of anorexia nervosa at this age might precede a diagnosis of PCOS, or even menarche, and make it difficult to differentiate an adolescent who has oligomenorrhea solely due to disordered eating and/or low body weight and one who might otherwise be at risk for PCOS. Until more data emerge, it is important to maintain a high index of suspicion for any disordered eating pathology in someone who is being evaluated for PCOS.

The new 2023 International PCOS guidelines highlight that weight stigma is a common experience for women with PCOS and that it is detrimental to mental health, including risk of disordered eating (4). In the general population, a meta-analysis showed a moderate correlation between perceived weight stigma and mental health outcomes, including dysfunctional eating, body image dissatisfaction, and symptoms of depression and anxiety (r between −0.33 and −0.39 for all comparisons with $P < .001$) (65). The 2023 guidelines recommend that health care professionals utilize weight-inclusive practices which "promote acceptance of and respect for body size diversity" (4). In addition, these guidelines focus on the importance of encouraging healthy lifestyle changes for health benefits without a singular focus on intentional weight loss. The challenges of managing weight loss in the setting of disordered eating habits is highlighted by a recent 12-month prospective study of women with and without PCOS who were on a 12-week liquid very low-energy diet (VLED) followed by slow meal-by-meal

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reintroduction of solid foods. They found equivalent weight loss in both the PCOS and non-PCOS groups, but improvements in disordered eating, specifically reductions in uncontrolled eating and emotional eating and increased cognitive restraint eating, were only seen in women without PCOS (66).

An additional reason for incorporating eating disorder screening into PCOS care is that mental health conditions can impact patient adherence to lifestyle and medical therapy. Studies in the general population have found that depressed patients were more likely to be nonadherent to medical treatment recommendations (67) and less likely to adhere to lifestyle intervention programs (68). Similarly, in women with PCOS and a higher weight, baseline depression symptoms were associated with increased dropout of weight loss studies (69). There are no studies that have specifically evaluated the interaction between disordered eating/eating disorders and dropout in women with PCOS undergoing lifestyle interventions, and this should be an area of future research.

This study has significantly advanced our understanding of the relationship between PCOS and disordered eating, building on our group's 2019 meta-analysis which showed an increase in overall eating disorders and disordered eating but was not powered to detect differences in individual eating disorders and did not perform subanalyses based on BMI (19). Our use of broader inclusion criteria allowed for analysis of both large database studies necessary for the identification of rare outcomes and exploration of subgroups and smaller studies with Rotterdam-diagnosed PCOS to minimize misclassification bias. Using these analyses, we were able to confirm the increased risk of specific eating disorders, including binge eating disorder and bulimia nervosa, and demonstrate that risks of disordered eating are higher in PCOS regardless of BMI group, which has not been evaluated in a meta-analysis before.

Nevertheless, some limitations should be noted. Due to time and resource constraints for the guideline, non-English-language studies were excluded and there is a possibility of publication bias, as evident in our publication bias assessments for some outcomes. The studies were observational in nature, and we were not able to account for potential confounders, with the exception of BMI. The cross-sectional nature of the included studies precluded us from identifying whether the PCOS diagnosis or disordered eating symptoms started first. There was a limited number of studies in adolescents and no studies on pica, rumination disorder, avoidant/restrictive food intake disorder or OSFED/UFED (other than night eating syndrome), highlighting important literature gaps. Most studies had moderate risk of bias and thus, many of the included analyses had low levels of certainty in the effect estimate. Although studies from 10 different counties were included, there were limited data from developing or Asian countries limiting generalizability to these regions. Finally, some of our data relied on eating disorder scales, which are useful for screening, but we acknowledge that true diagnosis is best made using clinical interviews conducted by mental health professionals.

Overall, our study informs the 2023 PCOS Guideline recommendations for consideration of the risk of eating disorders and disordered eating in care of women with PCOS, regardless of weight (4). Care for women with PCOS should be individualized and contextualized with the knowledge of the negative impact of weight stigma or weight management in the setting of eating disorders. Future studies should focus on the longitudinal assessment of risk factors for disordered eating in both adolescents and adults, evaluation of changes in disordered eating/eating disorders after standard PCOS treatment regimens, and analysis of the impact of disordered eating/eating disorders on PCOS outcomes.

Author Contributions

K.G. and A.S. independently screened all potential studies for eligibility, supported by L.C., E.S.-V., and L.B. L.C. and K.G., A.S., or L.M.B. performed data extraction.

A.M. and C.T.T. led the Evidence Team for the guideline, overseeing the review process and providing expertise on meta-analysis and systematic review methodologies. H.T. was the guideline lead and, with E.S.-V. and L.B., were senior experts in the guideline development group, providing input into conceptualization, study design, methods, and analysis. All authors reviewed and edited the manuscript contributing substantial intellectual input in line with ICMJE criteria for authorship and approved the final version for publication.

Funding

This manuscript was conducted to inform recommendations of the 2023 International Evidence-based Guideline in PCOS, which was funded by the Australian National Health and Medical Research Council (NHMRC) through the Centre for Research Excellence for Women's Health in Reproductive Life (CRE-WHiRL) (APP1171592) and the CRE in Polycystic Ovary Syndrome (CRE-PCOS) (APP1078444) led by Monash University, Australia, and partner societies including The American Society for Reproductive Medicine, the Endocrine Society, the European Society of Endocrinology and the European Society of Human Reproduction and Embryology. The primary funders, NHMRC, were not involved in the development of the guideline and have not influenced the scope. They set standards for guideline development and, based on independent peer review, approve the guideline process. C.T.T. is supported by the CRE-WHiRL. H.T. and A.M. are supported by fellowships provided by the Australian NHMRC.

Disclosures

The authors have nothing to disclose.

Data Availability

Some or all datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

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