Abstract

Studies indicate that Polycystic Ovarian Syndrome (PCOS) features (e.g. insulin instability, food cravings, overproduction of androgens and menstrual irregularities) associate with increased appetite, impaired impulse control and feelings of body dissatisfaction. Counterintuitively, binge eating behaviors have been shown to reinforce PCOS symptomatology, precipitating concurrently body dissatisfaction, weight gain, insulin instability and overproduction of androgens. The present systematic literature review aspires to investigate the relationship between binge eating, in the broader context of eating disorder behaviors, and Polycystic Ovarian Syndrome (PCOS), taking into account shared characteristics between EDs (Eating Disorders) and PCOS. To address this aim the PRISMA guidelines are adopted (Moher, Liberati, Tetzlaff, & Altman, 2009). A total of 21 studies, which investigated the presence of binge eating in PCOS population and the presence of PCOS in EDs population, were synthesized. Findings suggested that an increased prevalence of binge eating has been reported in women with Polycystic Ovarian Syndrome (PCOS); and that women suffering from BN (Bulimia Nervosa) and BED (Binge Eating Disorder) are more likely to display polycystic ovaries. Further research on their shared liability is required in order to inform more efficient prevention and treatment initiatives for populations presenting with comorbid features.

Keywords: Binge Eating Disorder, Polycystic Ovarian Syndrome, Eating Disorders, Menstruation, Body Dissatisfaction, Menstrual irregularities.
Introduction

Binge eating is characterized by consuming an excessively large amount of food in a short period of time and experiencing a loss of control when these episodes occur. Binge eating constitutes a shared feature among various eating disorders (EDs) diagnoses, including Binge Eating Disorder (BED), Bulimia Nervosa (BN) and Otherwise not Specified Feeding and Eating Disorders (OSFED) [1, 2]. Binge eating has been envisaged as a debilitating [3] and a continuously expanding pathological behavior, with an estimated prevalence of 4.5% in women and 2.5% in men over the life course [4-6]. Interestingly, although individuals who present with binge eating manifestations can be of normal weight, they are more likely to be overweight and at a proportion of about 30% obese [7, 8].

On the other hand, polycystic ovary syndrome (PCOS) is considered a rather common endocrine condition in women, being interwoven with high levels of androgens and ovulatory dysfunctions. Specifically, more than 18% of women appear to be affected by PCOS, presenting concurrently with higher insulin resistance [9], and a greater risk of being overweight and obese compared with healthy controls (BMI >30 RR 2.77 (95% CI 1.88 to 4.10) [10]. In that line, several studies examined eating disorder behaviors among women with PCOS. Not surprisingly, findings revealed a higher prevalence of PCOS in patients with eating disorders [11, 12], especially for disordered eating and bulimia nervosa [13-15]. Nevertheless, relevant research presents inconsistent with some studies reporting insignificant findings [16]. In addition, an increased prevalence of depression and anxiety has been associated with PCOS compared to healthy controls [17, 18]. This appears important, given the contribution of negative emotions as a key predictor of binge eating behaviors [19, 20]. Furthermore,
Binge eating has been positively associated with hyperandrogenism [21] and amenorrhea, which have both been in turn linked with PCOS related dysfunctions [22].

Despite the comorbidity between binge eating and PCOS presentations being acknowledged by relevant findings, the extant literature appears (to the best of the authors knowledge) insufficient considering the interpretation of their association (e.g. direction of causality, bi-directional links). Hence, this review aspires to shed light on the co-existence of binge eating behaviors and PCOS. To achieve this goal (e.g. to summarize and expand the available evidence regarding the inter-relationship between binge eating and PCOS, taking into account the shared factors between the two conditions), the present work adopts an integrative theoretical conceptualization that embraces principles from metabolic, hormonal and psychological models (which have never before been combined, so as to provide a more holistic spectrum of understanding of the interrelation between binge eating and PCOS presentations). In the context of this hybrid theoretical framework, the current literature review aims to: 1.) critically review the studies that have assessed the overlap between these two conditions; 2.) illustrate/identify the strongest etiological links between PCOS and binge eating behaviors, through the lenses of metabolic, hormonal and psychological factors shared between the two conditions and; 3.) integrate and synthesize the available findings to inform a more comprehensive etiological model explaining the overlap between PCOS and binge eating behaviors, that could in turn pave future avenues for more targeted and effective research and clinical efforts in the field.

Method

A computer research has been conducted on ScienceDirect, PubMed, Google Scholar, Utas Library, University of Melbourne Library, and the following identifying terms were applied to detect relevant sources: Polycystic Ovarian Syndrome Eating,
Binge Eating Disorders, Bulimia Nervosa Polycystic, Anorexia Polycystic, BED Polycystic, binge eating PCOS, binge eating polycystic. All searches were limited to full text, peer reviewed articles, available in English, published between 1991 and 2016, which involved human participants. Studies have been selected in accordance with the following inclusion criteria (see relevant guidelines for identification and screening; PRISMA1; Moher, Liberati, Tetzlaff, & Altman, 2009): (i) studying PCOS in ED population, (ii) studying EDs/disordered eating in PCOS population, (iii) contain empirical data. A total of 21 studies were deemed eligible for this review on the basis of concurrently addressing all the above criteria.

**Results**

Table 1 and 2 provides a summary of the 21 studies reviewed in this paper, including demographic information and the major findings reported in each study.

Results revealed that PCOS is associated with a higher number of psychological symptoms, including depression, anxiety, body image dissatisfaction, eating and sexual disorders, and low life satisfaction [23-27]. In that line, women with PCOS are known to have disturbed appetite regulation [28], which has been therefore argued to explain their increased risk of developing binge eating behaviors [29].

The frequent observation of PCOS features, such as obesity, menstrual imbalance, hyper-androgenism and anovulation, in populations that present with binge eating behaviors [11] suggests a potential relationship between binge eating and PCOS. In that context, studies that have focused on the co-existence of binge eating and PCOS are presented in Table 1, while studies that have focused on the presence of PCOS in EDs population are presented in Table 2.

Considering Table 1, a total of 14 studies have assessed eating behavior features in PCOS populations, highlighting an increased incidence of binge eating among
women with PCOS [16]. Specifically, approximately 50% of women with PCOS seem to struggle with binge and comfort eating manifestations, compared to 32% of controls [30]; with a survey of 60 women with PCOS resulting to a binge eating prevalence of 23% [31]. In consensus with the above, 30% to 50% of women with PCOS appear prone to display overeating, emotional eating, eating without feeling of hunger and/or EDs [32, 33]. In addition, women with PCOS appear more likely to have hyperinsulinemia and to obtain higher scores on the Binge Eating Scale (BES), which however tend to improve with a controlled diet [34, 35]. Nevertheless, one study did not confirm the mutual presence of the two conditions, concluding that scores for dieting and overall ED symptoms in the polycystic ovary group were not significantly higher than those for women with normal ovaries [16].

Counterintuitively, when examining the presence of PCOS symptomatology in EDs population, 7 studies revealed an increased incidence of polycystic ovaries among women with EDs (see Table 2), with approximately 30% of the ED samples inclining to display PCOS related dysfunctions [12, 36-38]. In that line, further studies have shown that bulimic women have higher relevant dysfunction scores among PCOS subjects [39], with McCluskey (1992) concluding that 76% of bulimic women (based on the study sample, N=34) present with polycystic or multifollicular ovaries [40]. On that basis, one could argue that a significant proportion of the extant literature advocates the overlap between EDs and PCOS (especially binge eating related behaviors) [32, 41]. However, a clearer understanding about the inter-relation between the two conditions (PCOS and binge eating) is recommended to inform future research and clinical work in the field.
Discussion

An etiological link between PCOS and Binge Eating Behavior

Research reviewed here, has revealed that, metabolical [42], hormonal [43] and psychological [44] factors are relevant to both binge eating and PCOS, and could therefore be implicated in the shared etiology between the two conditions.

Considering common metabolical factors, previous literature confirms that women with PCOS are more likely to suffer from insulin resistance compared to healthy women of a similar body mass index (BMI) [45]; with insulin resistance having been described as one of the “subtle symptoms” of PCOS [46]. Insulin resistance tendencies impede body cells to be stimulated by insulin, thus constituting them unable to respond to it as effectively, that in turn precipitates blood sugar spikes [47]. Because of this, a significant proportion of women with PCOS are prone to experience increased cravings and desires to eat a particular food, usually high in carbohydrates [48]. In that context, researchers have postulated that food cravings play an important role in the development and maintenance of binge eating due to a combination of psychological and physiological effects [49, 50]. Specifically, high carbohydrate meals are responsible for boosting blood sugar levels, prompting the pancreas to produce more insulin to handle the excess glucose [51], being responsible for raising serotonin levels, which cause fluctuations considering one’s sense of wellbeing [52]. On the other hand, the subsequent abrupt drop of blood sugar and serotonin levels (after the utilization/consumption of glucose precipitates sudden feelings of hunger and craving behaviors [53], as well as the potential return of a state of anxiety [54], by inducing brain mitochondrial and dopaminergic dysfunctions [55].
The mood state typical of insulin-resistant individuals has been described as "tense-tiredness" [30]. Accordingly, the likelihood of experiencing food cravings and mood swings is elevated among women with PCOS compared to that of healthy controls [56]. Moreover, given that binge eating involves the ingestion of large quantities of carbohydrate and fat food during the episodes, a vicious cycle of mutual exacerbation of cravings, insulin resistance and binge eating could be induced [57].

Considering hormonal factors, a high androgenic predisposition/ biological inclination could additionally explain the shared ground between PCOS and binge eating behaviors. Androgens are well known for accounting for differences in food intake and body weight between males and females [42]. In particular, testosterone seems to be responsible for increasing food intake in males [58]. In that line, to highlight how that appetite might be affected by hormone profile abnormalities, studies showed that testosterone replacement could increase meal frequency in male rodents [59], whereas anti-androgenic drug therapy was found to reduce meal-related hunger in women with bulimia [36].

In that line, androgens in females appear to play an important role in regulating insulin: in conditions of extreme insulin resistance, such as mutations of the insulin receptor and in PCOS, high insulin levels seem to stimulate theca cells in ovaries to produce more androgens [60]. Therefore, androgen excess might contribute to insulin resistance in women with PCOS, potentially setting up a vicious cycle whereby hyperinsulinemia might promote the production of androgens, which in turn contributes to insulin resistance [61]. Due to high androgen levels being responsible for increasing appetite, in conjunction with insulin resistance and the subsequent frequent cravings, women with PCOS could to be more susceptible to develop a binge eating pattern [62].
Overall, research and clinical management of PCOS have primarily been focused on the physiological consequences of the disorder [63]. However, as a result of the numerous physical and metabolic changes, women with PCOS may also be at high risk for psychological problems, such as depression, decreased satisfaction with life and EDs [64, 65].

In that context, and considering potential significant psychological factors that could explain the PCOS and binge eating overlap, a considerable number of women with PCOS present with a psychiatric disorder during their lifetime; with preliminary work undertaken by Annagur (2015) estimating the prevalence of comorbidity between PCOS and psychiatric disorders to approach 50% (based on a clinical sample of 44 women suffering from PCOS) [66]. Similarly, other work (based on a sample of 60 women with PCOS) showed an overall prevalence rate of 40% for depression, 57% for mood disorders, 12% for anxiety syndromes and 23% for BED [31] with 60% of women with PCOS reporting painful emotions and high sense of insecurity, confusion and ambivalence, low self-esteem and anxiety. In addition, these women presented less able to tolerate frustration, often behaving impulsively [67]. In line with these, one could assume that due to common physical consequences of PCOS, such as hirsutism, acne and weight gain, females with PCOS tend to experience feelings of deviance from idealized cultural norms, which in turn influence self-esteem and cultivate feelings of body dissatisfaction [68], that could in turn precipitate and perpetuate psychopathological manifestations. Interestingly, body dissatisfaction and the feeling of shame towards the body might prompt dieting in order to improve physical appearance. Due to high levels of impulsivity in PCOS women, dieting could result in the development of a binge eating behaviors that further exacerbate feelings of shame.
and body dissatisfaction, increasing the attempts to lose weight with intensified dieting, which in turn worsens binge eating behaviors [69].

*An integrative conceptual model of binge eating and PCOS*

As previously demonstrated, PCOS and binge eating show shared characteristics. Hence, the aim of the current paragraph is the integration of the outlined perspectives in a model that provides a novel context for the mutual relationship between PCOS and binge eating behaviors. Figure 1 outlines this integrative model, showing the possible link between these two conditions.

---Insert figure 1 here---

Overweight and obesity may result to insulin resistance. This leads to high blood sugar levels, which is in turn addressed by increasing the pancreatic insulin production. Moreover, high levels of insulin are responsible for boosting androgen levels. Androgens promote insulin resistance and the development of cysts on ovaries, which excrete more androgens [70]. Due to the high level of androgens, women with PCOS may experience hirsutism and weight gain and subsequent feelings of body dissatisfaction. On the other hand, androgens increase appetite and impulsivity, making women with PCOS more vulnerable to experiencing cravings [62]. Cravings could be further intensified by dieting behaviors often adopted to improve body image and reduce feelings of body dissatisfaction [71]. The cycle of dieting-cravings (suggested here) promotes binge eating behaviors, which, besides reinforcing weight gain and feelings of body dissatisfaction [72], may generate insulin spikes and sudden drops that intensify insulin resistance, androgen production and PCOS symptomatology, in a cycle of mutual reinforcement (e.g. bi-directionality). These factors seem to cause an exacerbation of PCOS and binge eating at the same time, making PCOS women more susceptible to engaging and maintaining a binge eating pattern compared to their
healthy counterparts. Therefore, binge eating and PCOS presentations among women appear to share similar characteristics (see Table 3) that could imply/highlight the potential overlap between the generating mechanisms of two conditions.

Treatment implications

Provided that PCOS appear to have a significant negative impact on women’s eating behaviors, especially in relation to binge eating, early and effective management of PCOS, concurrently with emerging or established eating patterns, could be deemed as necessary to improve quality of life in adolescence and adulthood [73]. For this reason, screening for mental health-related issues in patients with PCOS, as well as screening for PCOS in ED sufferers (especially those with binge eating behavior), should constitute an inherent part of the initial evaluation.

Subsequently, a proactive approach to the treatment of psychological co-morbidity should be preferred, since psychological treatments in women with PCOS are considered to have a positive effect on binge eating patterns, weight management, insulin resistance and hormonal imbalances [74, 75]. In that context, it has been suggested that the best approach combines psychological and pharmacological interventions [30], with the psychological treatments aimed at improving eating, body image and comorbid psychopathology, and the pharmacological and hormonal interventions decreasing androgen levels and reducing PCOS symptomatology [76].

Conclusions

The present PRISMA systematic literature review reinforces the notion that binge eating behaviors and PCOS should not always be considered as distinct disorders; given their shared metabolic, hormonal and psychological risk factors. Therefore, further investigations on the links between PCOS and binge eating behaviors, as well
as their mechanisms of mutual reinforcement could be beneficial, leading to more effective treatment modalities for both conditions.

Declaration of interest

The authors declare there are no competing interests. This study received no funding.

References


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PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097