Diet and Exercise in the Management of Polycystic Ovary Syndrome: Practical Considerations for Person-Centered Care

Article *in* Seminars in Reproductive Medicine · December 2023

DOI: 10.1055/s-0043-1777116

3 authors, including:

Angelo Sabag
The University of Sydney
66 PUBLICATIONS **1,260** CITATIONS

SEE PROFILE

Diet and Exercise in the Management of Polycystic Ovary Syndrome: Practical Considerations for Person-Centered Care

Giorgia E. Colombo, MBChB[1] Stephanie Pirotta, BFNutrSc, MDiet, PhD[2]
Angelo Sabag, BHSc, MClinicalExPhysiol, PhD[3,4]

[1] Department of Obstetrics and Gynecology, Ospedale Regionale di Lugano, Lugano, Switzerland
[2] Health and Social Care Unit, School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[3] Discipline of Exercise and Sport Science, Faculty of Medicine and Health, The University of Sydney, Sydney, New South Wales, Australia
[4] Charles Perkins Centre, The University of Sydney, Sydney, New South Wales, Australia

Address for correspondence Angelo Sabag, BHSc, MClinicalExPhysiol, PhD, Discipline of Exercise and Sport Science, Faculty of Medicine and Health, The University of Sydney, Sydney, New South Wales 2006, Australia (e-mail: angelo.sabag@sydney.edu.au).

Semin Reprod Med 2023;41:26–36

Abstract

Polycystic ovary syndrome (PCOS) is a complex multisystem condition associated with life-long reproductive, metabolic, and psychological symptoms. Individuals with PCOS are at an increased risk of cardiovascular disease and type 2 diabetes, with approximately 70% of all PCOS cases presenting with insulin resistance. Lifestyle interventions have historically been recommended as first-line therapies for the management of PCOS-related cardiometabolic disorders. The term "lifestyle management" incorporates a multifaceted approach to dietary, exercise, and behavioral strategies, aiming to promote a healthy lifestyle. This approach has been commonly employed in practice, in particular through exercise and dietary modulation, due to its effect on cardiometabolic outcomes as well as its tolerability. Furthermore, there is evidence to suggest that combining dietary change with exercise may yield the greatest improvements in clinical outcomes. However, such practices require careful consideration and coordination, as there are instances where certain exercise and/or dietary prescriptions may compromise the effectiveness of the respective interventions. Thus, this review aims to provide practical guidance on diet and exercise planning in the routine care of PCOS. Such recommendations include emphasizing realistic and achievable goals, as well as minimizing barriers to lifestyle changes in order to increase the long-term sustainability of this treatment strategy.

Keywords
- polycystic ovary syndrome
- exercise
- diet
- lifestyle medicine
- realistic medicine

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder in females during reproductive years, affecting 2 to 20% of this population.[1,2] This condition is associated with life-long metabolic (impaired glucose tolerance, insulin resistance, type 2 diabetes mellitus, cardiovascular disease risk), reproductive (infertility, hirsutism, hyperandrogenism), and psychological symptoms (anxiety, depression, and worse health-related quality of life).[3] The updated 2023 International Evidence-based Guideline for the assessment and management of PCOS recommends the use of the revised Rotterdam criteria for the diagnosis of PCOS in adults: the presence of two of (1) clinical/

Issue Theme Polycystic Ovary Syndrome; Guest Editors, Chau Thien Tay, BMedSc, MBBS (Hons), FRACP, PhD and Mahnaz Bahri Khomami, MD

Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

DOI https://doi.org/10.1055/s-0043-1777116.
ISSN 1526-8004.

biochemical hyperandrogenism, (2) ovulatory dysfunction, and (3) polycystic ovaries on ultrasound or elevated antimullerian hormone (AMH) levels.[4,5] In adolescents, the diagnosis is made in the presence of hyperandrogenism and ovulatory dysfunction, with ultrasound and AMH levels not recommended.[4,5] A key characteristic of PCOS is insulin resistance, which affects 60 to 95% of individuals with the condition.[6] Beyond pathogenesis related to excess adiposity, it is thought that insulin resistance is exacerbated through interactions with hyperandrogenism.[7,8] In fact, hyperandrogenic PCOS phenotypes have the highest prevalence of insulin resistance: 80% in PCOS phenotypes with hyperandrogenism and oligomenorrhea and 65% in phenotypes with hyperandrogenism and polycystic ovaries, compared to 38% in normoandrogenic PCOS phenotypes.[9]

Lifestyle interventions, including dietary modulation and exercise, have historically been considered first-line therapies for the management of cardiometabolic risk factors in PCOS.[10,11] In this narrative review, we aim to provide practical guidance on nutrition and exercise planning in the routine care of PCOS, with an emphasis on realistic and achievable goals. While examining the evidence base underlying these management strategies, we present practical considerations for person-centered care, including identifying and minimizing barriers to lifestyle changes in order to increase the long-term sustainability of this treatment strategy.

Lifestyle Intervention: An Overview

Among the general population and those with metabolic disorders, exercise is critical for the prevention and treatment of chronic disease,[12] as well as for improving in quality of life.[13] In individuals with PCOS, exercise improves cardiorespiratory fitness, lowers central obesity,[14] increases insulin sensitivity,[10,15,16] and ameliorates psychological distress.[17] While intricately connected to the condition itself, insulin resistance, hyperinsulinemia, and central obesity have been shown to exacerbate the clinical manifestations of PCOS.[3,18] As a result, the current international evidence-based guidelines for exercise intervention in the management of PCOS specifically recommend a minimum of two sessions of muscle-strengthening activities and 150 to 300 minutes of moderate-intensity exercise per week or 75 to 150 minutes of vigorous exercise per week, aiming for 30 active minutes daily, for the prevention of weight gain and maintenance of overall well-being.[4,5] When aiming for weight loss or central obesity reduction, the guidelines recommend a minimum of 250 minutes per week of moderate-intensity exercise or 150 minutes per week of vigorous exercise, in addition to muscle-strengthening activities.[4,5] Additionally, limiting sedentary time is advised.[4,5] Given the lack of available evidence, the guidelines were unable to recommend one form of exercise training over another (►**Table 1**).[4,5,19] Furthermore, it is important to consider that these recommendations act as benchmarks and clinicians should consider an individualized exercise prescription, rather than a "one-size-fits-most" approach.

Currently, there is no evidence that a specific dietary composition is superior to others in individuals with PCOS.[4,5] The International Evidence-based Guideline for the assessment and management of PCOS recommends general healthy eating principles that tailor dietary recommendations to the individual in order to meet personal goals and PCOS presentation.[4,5] Although not highlighted in the guidelines, the evidence does show an anti-inflammatory nutrition pattern such as the Mediterranean diet may be effective in reducing chronic low-grade inflammation and the health problems that this induces in PCOS.[20] For instance, diets that follow anti-inflammatory principles are mostly plants and limit processed foods. Nevertheless, dietary modifications should be personalized to the individual according to personal goals and PCOS presentation. In some instances, an energy deficit of 30% or 500 to 750 kcal/day may be beneficial in individuals who are wanting to achieve weight loss (body mass index [BMI] $\geq$25 kg/m^2). Clinicians should consider the appropriateness of the prescription as patients with a history or risk of disordered eating and an unhealthy relationship with self and body may require a focus on behaviour-change goals as an alternative to a weight loss focus.[4,5,21,22] The input of a registered or accredited practicing dietitian, as part of the multidisciplinary team, may be helpful for the implementation of dietary changes.

Table 1 General exercise recommendations based on the 2023 International Guideline for all people with PCOS[4,5]

Recommendation	Frequency and duration	Examples
Moderate intensity exercise	For the prevention of weight gain and maintenance of health: 150–300 min/wk	A brisk walk, cycling with light effort, playing tennis, mowing the lawn
	For modest weight loss and the prevention of weight re-gain: >250 min/wk	
Vigorous intensity exercise	For the prevention of weight gain and maintenance of health: 75–150 min/wk	Jogging, cycling fast, an exercise class at your local gym (e.g., circuits, spinning), playing soccer/basketball
	For modest weight loss and the prevention of weight re-gain: >150 min/wk	
Resistance training	Twice weekly	Bodyweight exercises (e.g., squats, lunges, push-ups, plank), free weights, pilates, plyometrics

Abbreviation: PCOS, polycystic ovary syndrome.

As a complex and multifaceted condition, the management of PCOS often relies on the multidisciplinary team.[23] While many healthcare professionals play an important role in the multidisciplinary management of PCOS, primary care providers are the first point of contact for an individual with PCOS,[24] and may take on a leadership role, particularly in contexts with limited resources, where balancing perspectives regarding allied health involvement could be considered.

Evidence-based practice involves considering the latest available evidence, the capacity and expertise of the clinician, and the individual desires and preferences to achieve optimal goals.[25] This approach will often involve using SMART goals (Specific, Measurable, Achievable, Relevant, and Time-Bound),[26] self-monitoring, problem-solving, and focusing on stimulus control, among other interventions.[11] However, it is important to note that while evidence-based practice involves using the guidelines and recommendations as a structured and evidence-based treatment framework, individual preferences should be taken into account to create a personalized and sustainable approach that leads to long-term behavior change.[11]

Body Composition in PCOS

Individuals with PCOS are at higher risk of weight gain compared to the general population, as demonstrated in multiple longitudinal studies.[27–29] Indeed, 40 to 60% of individuals with PCOS are classified as overweight or obese.[30] Despite adjusting for lifestyle and psychosocial factors, participants in a 19-year longitudinal study gained an excess of 4.62 kg compared to controls, suggesting an underlying cause of weight gain unrelated to these factors.[28] The driver of this disproportionate weight gain is unclear, but a greater daily energy intake and lower physical activity in individuals with PCOS may contribute.[31] Whether the weight gain results from physiological or psychological consequences of the conditions remains unclear. However, there is some evidence to suggest that postprandial thermogenesis, a reduced resting metabolic rate, and increased subjective hunger levels may contribute to this finding.[32–34]

Appetite regulation may be affected by PCOS, as previous reports have shown impaired levels of appetite hormones, including cholecystokinin and ghrelin, in people with this condition.[35,36] Other intrinsic hormonal abnormalities, including insulin resistance and hyperandrogenism, may contribute to the increased levels of adiposity in this group, as evidenced by a large population-based cohort study that found that these features were not related to adverse lifestyle behaviors such as poor dietary quality or a lack of physical exercise.[31]

Lifestyle Intervention: Important with or without Medical Therapy

The term "lifestyle management" incorporates a multifaceted approach to dietary, exercise, and behavioral strategies, aiming to promote a healthy lifestyle. This approach is recommended for all individuals diagnosed with PCOS due to its positive effects on metabolic health, quality of life, weight management, and body composition.[4,5] Higher weight exacerbates clinical features of PCOS, while weight loss ameliorates symptoms.[29] A 5% reduction in body weight is considered clinically significant weight loss; however, there is a significant variation in weight between individuals with different anthropometric parameters.[37] For the average Australian woman who is 161.8 cm tall and weighs 71.1 kg,[38] a clinically significant weight loss would be 3.5 kg. It has been suggested that this modest initial loss provides the greatest effect on the restoration of ovulation and fertility in obese individuals with PCOS,[39] and allows achievable and realistic goals to be set. Furthermore, the initial amount of weight lost by individuals does not affect the maintenance of weight loss long-term; the mean percentage of weight loss maintenance 1 year post-intervention was found to be 54% regardless of the initial weight loss.[40] Therefore, an approach balancing dietary modulation and exercise, perhaps at the expense of a greater initial weight loss, is beneficial in the long term. The approach to weight management should be determined in partnership with the individual, discussing whether they are interested in weight loss and avoiding weight stigma in the clinical setting.

The available evidence suggests that in the pursuit of weight loss, the greatest results are from the synergistic effects of dietary changes combined with exercise intervention.[10,12] A period of intense exercise is followed by a perceived decrease in appetite, and the energy expended by physical activity is not compensated by a change in dietary intake.[41] While exercise alone can elicit weight loss, this is seldom achieved without high volumes of exercise which may be unattainable for the average person[42]; however, when added to a low-calorie diet, it induces greater fat loss while preserving lean body mass.[43] Due to its weight loss-independent effects on metabolic health, physical capacity,[12,44–46] and psychological outcomes,[17] exercise is considered a cornerstone therapy for PCOS management. Among individuals with PCOS, exercise has been reported to improve cardiometabolic outcomes, including lipid profile,[47,48] fasting glucose levels,[47] systolic blood pressure,[47] and insulin sensitivity.[12,18,48] Body composition is also improved, with reduced waist circumference,[12,14,47,48] body fat percentage,[48] and improved cardiorespiratory fitness,[12,14,48] a clinical vital sign[49] associated with cardiometabolic health.[50] The greatest improvement in these anthropometric and metabolic outcomes is seen in individuals with PCOS who have a higher weight, compared to individuals with a BMI below 25 kg/m^2.[18,48] Exercise may also be beneficial for reproductive outcomes, including hormone profiles,[12,18,47] but the evidence on this is limited to a few small studies with heterogenous methodologies and varying magnitudes of effect.

When considering dietary interventions, no one dietary composition is superior to another for the management of PCOS.[11] However, a range of dietary patterns underpinned by general healthy eating principles are beneficial for PCOS management, independent of weight change.[51,52] The benefits are potentially due to the effects on the chronic low-grade inflammatory environment of PCOS, which is mediated by higher fat mass, insulin resistance, and high androgen concentration.[53] For example, the Mediterranean Diet (MedDiet) has

been found to be beneficial in PCOS populations,[20,54,55] as it reduces inflammatory markers, testosterone, and Ferriman-Gallwey score and improves insulin resistance and hyperandrogenemia.[56] Furthermore, adequate intake of omega-3 fatty acids may reduce liver fat concentrations and oxidative stress, and optimize lipid profiles and overall metabolic measures,[57–59] although not specifically recommended by the International Evidence-based Guideline for the assessment and management of PCOS.[4,5] Similarly, the use of probiotics for 8 to 12 weeks has been shown to decrease weight, improve insulin markers and lipid profiles, reduce inflammatory markers, and favor hormone changes and hirsutism scores in individuals diagnosed with PCOS,[60–62] but the evidence is limited to studies with small numbers of participants and therefore should be interpreted with caution.

Apart from their efficacy, lifestyle interventions are recommended for PCOS because of their tolerability. Increased physical activity has been demonstrated to not cause serious adverse effects or injuries over 1- to 2-year interventions.[63] Despite concerns that caloric restriction could lead to an increase in eating disorder symptoms, this hypothesis was not supported by a randomized controlled trial that demonstrated this intervention had benign or beneficial psychological and behavioral effects,[64] although screening for disordered eating or eating disorders using the SCOFF or EDE-Q 21 item is recommended early on in therapy to best guide appropriate care.[11] Furthermore, a consensus panel of experts agreed that the benefits of dieting for weight management outweigh potential negative side effects such as an increased risk of gallstone formation, loss of lean muscle mass, or electrolyte imbalance[65,66]; however, further empirical evidence is needed to confirm such statements. Additional benefits of lifestyle changes for PCOS management that are not specific to this condition include a reduced risk of cardiovascular disease and type 2 diabetes mellitus.[48] Lifestyle interventions have been demonstrated to decrease all-cause mortality in a population with impaired glucose tolerance,[67] which is highly prevalent in individuals with PCOS.[68] Improvements in cardiorespiratory fitness, measured using VO_2 max as a proxy, have been shown to reduce cardiovascular risk,[69] and are achievable through exercise in a PCOS population.[12,14,48]

Dietary Specifications in PCOS

An accredited practicing dietitian can contribute significantly to the management of all women with PCOS and should be offered if resources are available, independent of PCOS phenotype or presenting weight. Dietary management should focus on the immediate presenting needs and prevention of conditions associated with PCOS.[4,5] In doing so, dietary interventions should incorporate person-centered care to minimize attrition and promote long-term motivation and behavior change.[70] However, the evidence regarding specific dietary interventions is limited to studies with a small number of participants and moderate-to-high risk of bias; therefore, these specific recommendations serve as a guide but should be adapted to individual preference (►**Table 3**).

Overall, individuals with PCOS exhibit poorer intake of grains, fruits, vegetables, proteins, nuts, seeds, and dairy when compared to those without PCOS.[71] Plant-based diets are rich in dietary fiber and abundant in phytochemicals that promote glycemic control, reduce hyperglycemia, and enhance acute insulin response and sensitivity.[72,73] Plant-based eating patterns such as the MedDiet are primarily based on sufficient intake of wholefoods, particularly green leafy vegetables, fruits, whole grains, legumes, lentils, and seafood, with moderate amounts of poultry and dairy, and limited red meat consumption (►**Table 3**).

The MedDiet emphasizes 60 mL/day of extra virgin olive oil, incorporates full fat or low-fat dairy, and limits alcohol to no more than 2 glasses per day of wine.[56] Interestingly, individuals with PCOS report lower consumption of extra virgin olive oil, legumes, fish, and nuts when compared to those without PCOS.[56] Greater emphasis on these food groups may elicit improvements in various cardiometabolic risk factors among individuals with PCOS. For people with minimal improvements in insulin sensitivity after following traditional MedDiet principles over 12 weeks, a low carbohydrate ($<$100 g/day) MedDiet may be beneficial to help reduce anthropometric measures, LH to FSH ratios, insulin resistance, and lipid profiles.[74] Clinicians may find it useful to use the PREDIMED 14-item questionnaire as a tool to monitor adherence to the MedDiet and highlight dietary recommendations.[75]

Table 2 Recommended nutrition behaviors for the general population, applicable to PCOS

1. Eat small more frequent meals (3 main meals, 1–2 snacks per day)
2. Couple protein with carbohydrate sources in each meal and snack
3. Consume the majority of energy during the day and less at night time, particularly after 8 pm
4. Aim for a 12–16-h fasting window between finishing dinner and having breakfast
5. Incorporate vegetables in each main meal
6. Incorporate green leafy vegetables in main meals, when possible
7. Aim for at least 3 different vegetable colors in each meal
8. Enjoy all vegetables, with greater emphasis on those with lower glycemic index (e.g., artichokes, Brussels sprouts, asparagus, bean sprouts, celery, cucumber, eggplant, mushrooms, onions, leafy greens, spinach, tomato, turnips, zucchini, cauliflower, cabbage, broccoli, capsicums, and tomato).
9. Enjoy all fruit, with particular emphasis on lower glycemic index varieties (e.g., berries, strawberries, raspberries, blackberries, citrus fruits—tangerines, oranges, lemons, grapefruit, cherries, pears, plums, peaches).
10. Enjoy a variety of nuts and seeds—almonds, walnuts, pumpkin seeds, sunflower seeds, sesame seeds, poppy seeds
11. Recommended to limit alcohol and avoidance is best if taking metformin[142]

Abbreviation: PCOS, polycystic ovary syndrome.

Table 3 General dietary recommendations based on the Mediterranean Diet

Recommendation	Serve	Additional information
EVOO	(60 mL or ≥4 T/d)	Add when cooking, to salad dressings and cooked vegetables
Nuts	3–5 serves/wk	Particularly include walnuts and almonds. 1 serve = 30 g
Fresh fruit	2–4 serves/d	
Vegetables	5 serves/d	Consume with every meal—particular focus on green leafy vegetables and tomatoes
Fish or seafood	2–3 serves/wk	Fatty fish best, e.g., salmon, sardines, mackerel, tuna
Legumes	≥3 serves/wk	E.g., soups, casseroles, vegetarian burgers, falafels, curries
Whole grains	6–8/d	
Dairy	2–4/d	Reduced fat
Tomato-based meals	≥3 serves/wk	Sauce made from tomatoes, onions, garlic, and herbs simmered in EVOO
White meat	2 serves/wk	e.g., chicken, turkey, pork, or rabbit without skin
Limit		
Red and processed meats	<1 serving/d	Lean and small portions
Carbonated beverages and sugary drinks	<1/d	
Commercial bakery products, sweets, pastries, biscuits, processed savory snacks	<2/wk	
Fat spreads and cream	<1 serving/d	

Abbreviation: EVOO, extra virgin olive oil.
Source: Adapted from Estruch et al.[143]

An important consideration for dietary therapies is the overall intake and type of protein, with emphasis on both plant (e.g., tofu, tempeh, beans and legumes, and nuts) and animal-based (e.g., lean red meats, chickens, pork, turkey, fish, and dairy) sources, contributing 20 to 30% of total daily energy intake.[76] Individuals wishing to increase lean muscle mass may combine resistance training with higher protein intake at 2.2 g per kg of body weight per day.[77] Attention should also be placed on adequate omega-3 fatty acid intake, aiming for 2 g/day of supplemented or at least 400 mg/day of omega-3 through food for a minimum of 6 months, in order to meet daily requirements.[71] Other nutrients of focus are calcium,[78] selenium,[79] chromium,[80] zinc,[81] carotenoids, vitamin D,[82] vitamin E,[83] and magnesium,[84] due to their positive effects on PCOS management. This is imperative in individuals with PCOS and metabolic syndrome who consume lower amounts of these nutrients when compared to leaner people with PCOS.[85] While all dietary recommendations should meet macronutrient reference values (protein 20–30%, carbohydrates 45–65%, fat 20%, saturated fat <20% total daily energy intake), an individualized person-centered approach will likely allow for greater long-term sustainability and health,[86] while correcting nutrient deficiencies, in particular those often deficient in individuals with PCOS.

Gastrointestinal dysbiosis is hypothesized to play a significant role in the pathogenesis of PCOS due to less microbial diversity, changed microbiota composition, and damaged mucosal barrier when compared to individuals without PCOS.[87] Interestingly, changes in structure and composition of gut microflora occur irrespective of insulin resistance in people with PCOS,[88] contributing to the manifestations of hyperandrogenism, insulin resistance, chronic inflammation, and abnormal levels of brain–gut peptides.[89–91] As dysbiosis is associated with irritable bowel syndrome (IBS),[92] and IBS is reported to impact the quality of life in 21 to 27% of those diagnosed with PCOS,[93] focusing on interventions to treat dysbiosis through prebiotics, probiotics, and synbiotics is an important part of PCOS nutritional care. Probiotics are thought to stabilize the hormonal imbalance through the gut–brain axis, leading to a reduction in the LH/FSH ratio in PCOS populations.[94] Beneficial probiotics over 8 to 12 weeks include *Lactobacillus rhamnosus GGs*, *Bacillus coagulans*, *Bacillus indicus*, *Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium bifidum*, *Lactobacillus rhamnosus*, *Lactobacillus bulgaricus*, *Bifidobacterium breve*, and *Streptococcus thermophilus*, commonly coupled with inulin as a probiotic.[60–62,95] To partner with probiotics, nutrition recommendations include a high-fiber diet (incorporating 28–30 g of soluble and insoluble fiber per day), reduced saturated fat intake, meeting hydration needs, and limiting gastrointestinal irritants such as spicy, deep-fried foods, carbonated beverages, caffeine, and alcohol.[96] If these dietary recommendations lead to unsatisfactory results, following the three phases of the low fermentable oligosaccharides, disaccharides, and monosaccharides and polyols (FODMAP) diet can be beneficial in reducing IBS symptoms.[97]

Weight Loss, a Byproduct but Not Goal of Lifestyle Intervention

As higher weight, which is highly prevalent in PCOS, exacerbates PCOS symptoms, it is natural to focus on weight loss as a therapeutic goal. However, the benefits of lifestyle changes in managing PCOS have been shown to be independent of weight loss.[12,44–46] Given that sustained weight loss is seldom achieved, shifting the focus from weight loss, particularly when trying to commence healthy lifestyle behaviors, may be beneficial. Concentrating instead on the outcomes recognized to improve with exercise, such as cardiorespiratory fitness and physical capacity, may allow these individuals to appreciate the effects of lifestyle intervention notwithstanding the absence of weight loss.[12,14] Beyond physical changes, individuals with PCOS who undertake healthy behaviors will likely see improvements in psychological and patient-reported outcomes such as quality of life.[98]

"Diet failure" is often accompanied by weight cycling or "yo-yo dieting" in which periods of weight loss and regain occur.[99] Weight cycling leads to excess fat and decreased muscle mass. During the period of intentional weight loss, muscle mass is lost along with fat, and in the subsequent period of weight gain, the muscle mass is not recovered while fat mass increases.[100,101] This pattern increases all-cause mortality by 41% and cardiovascular mortality risk by 36%, due to reduced resting metabolic rate[102] and lean muscle mass, and changes in the use of brown adipose tissue.[103] Each weight cycle results in 20 to 25% of loss in brown fat and lean muscle mass,[104] contributing to insulin resistance,[105] increased abdominal fat,[106] elevated triglycerides,[107] chronic inflammation,[108] and overall sarcopenic obesity over multiple weight cycles.[109] Adaptive thermogenesis makes maintaining newly suppressed weight highly difficult, needing to employ rigid dietary habits so as to not exceed lower daily energy requirements (e.g., $\leq$1,500 cal/day) compared to 2,000 cal/day in those without weight cycling behaviors.[109]

Body recomposition, a concomitant increase in skeletal muscle mass and decrease in fat mass, is a strategy that can address this phenomenon in weight cycling and is a goal in clinical and nonclinical settings.[110,111] Maintenance of skeletal muscle is an important consideration in PCOS patients, as it is associated with improvements in insulin resistance.[112] Muscle is one of the main targets of insulin, and the metabolic effects of insulin and insulin resistance partially depend on the quality and quantity of muscle mass.[113] Resistance training and dietary strategies, such as whey protein supplementation, can preserve muscle mass during a weight loss program,[114,115] but also increase the relative proportion of protein intake to fat and carbohydrates. Rather than aiming for overall weight loss, lifestyle intervention in individuals with PCOS may focus on body recomposition, which can occur without a change in BMI.[114]

Continuously restricting dietary intake and linking thinness as a value of self-worth leads to greater psychological distress,[116] increases weight over time, reduces physical activity, and increases binge eating[117] in those who weight cycle. There is an overall increased risk of eating disorders when compared to people who remain weight stable.[118] Individuals with PCOS are at increased risk of cardiovascular disease,[119] disordered eating, eating disorders,[120,121] low self-esteem, and overall psychological distress.[122] Therefore, coupled with the weight stigma commonly experienced from patients when seeking help to manage PCOS,[123] weight management should be one of, but not the central treatment goal in cases where it has the capacity to worsen PCOS psychopathology. In such instances, focusing on other outcomes such as insulin sensitivity, cardiorespiratory fitness, and behavioral goals such as increased physical activity may lead to greater long-term effects.

Barriers to Lifestyle Intervention

Lifestyle changes are most effective if they are realistic and adapted to meet the health goals of the individual. Unfortunately, many people with PCOS experience barriers to sustained lifestyle change due to feeling discouraged by a lack of results, lack of time, feeling embarrassed, and financial costs,[124] resulting in an average attrition rate of 47.1%.[125] These findings coincide with other metabolic conditions affecting women such as gestational diabetes mellitus,[126] for which PCOS is a significant risk factor.[127] Therefore, part of realistic lifestyle intervention is identifying and minimizing the barriers to change. An important barrier to lifestyle intervention includes patients' perception that they are not achieving their health goals through diet and exercise changes, and this remains a common theme when considering dietary intervention.[124] A study found that more than 82% of participants had modified their diet for health reasons; however, a third of participants did not achieve their health goals or any positive effect from dietary changes.[128] A lack of adequate information may be a contributor. Individuals with PCOS report dissatisfaction with the information provided at the time of diagnosis, including details on lifestyle interventions.[129]

Weight stigmatization is an often overlooked contributor to negative health outcomes and behaviors.[130] The phenomenon of weight stigma and the associated negative stereotyping of obese individuals has been documented by multiple studies.[131,132] The resulting stress leads to depleted self-regulation and low self-esteem.[133] Weight stigma extends to healthcare settings, with a patient's weight affecting how they are viewed and treated by physicians.[134] The negative attitudes toward higher weight displayed by healthcare providers can act as a barrier to the management of medical conditions.[135,136] Even the language utilized can be detrimental; using person-first language, an evidence-based terminology that puts the person in front of the condition can help address the stigma.[137] While it is well established that higher weight leads to adverse health outcomes[65] and exacerbates PCOS symptoms,[29] and therefore weight loss plays a role in the management of this condition, it can be counterproductive and stigmatizing to focus on weight reduction as the main pillar of PCOS management. Instead, adopting a balanced and individualized approach

that focuses on the specific goals of treatment relevant to the individual, uses person-first language, and shifts the focus of management from weight loss to behavioral change and body recomposition may be a more appropriate therapeutic strategy.[138]

The management of PCOS should be practical through positive psychology, motivational interviewing, open-ended questions, active listening, tools for behavior change, and positive communication, with the responsibility of self-care and behavior change falling on the individual.[139] Providing a non-judgmental, shame-free space, and being aware of weight stigmatizing beliefs and attitudes which may unconsciously drive lifestyle suggestions is the duty of health practitioners. Individual preferences, including not wishing to discuss weight as part of therapy, should be respected.[139] Identifying weight stigmatizing beliefs in the individual and working through these is also important. The use of weight-neutral approaches such as basic nutritional therapy information, mindful eating, body image work, hunger-fullness work, building self-esteem, and understanding diet cycles have the same weight loss outcomes as prescribed dietary therapies over 12 months[140] while motivating sustainable healthy behaviors.

Conclusion

Lifestyle interventions in PCOS lead to improvements in anthropometric, metabolic, reproductive, and psychological outcomes,[12,14,31] and should incorporate psychology, nutrition, and movement, using person-centered approaches to facilitate self-determined health goals and empower long-term change.[141] A personalized approach, focusing on the individual's specific goals rather than a one-size-fits-most approach, is essential in the management of this condition. Another key element in the management of PCOS through lifestyle changes is shifting the focus from weight loss to behavioral change and body recomposition. Setting realistic goals and minimizing barriers to lifestyle intervention will increase the long-term sustainability of this management strategy.

Funding
There was no source of funding for this study.

Conflict of Interest
The authors report no conflict of interest.

References

1 Okoroh EM, Hooper WC, Atrash HK, Yusuf HR, Boulet SL. Prevalence of polycystic ovary syndrome among the privately insured, United States, 2003-2008. Am J Obstet Gynecol 2012;207(04): 299.e1–299.e7
2 Deswal R, Narwal V, Dang A, Pundir CS. The prevalence of polycystic ovary syndrome: a brief systematic review. J Hum Reprod Sci 2020;13(04):261–271
3 Teede H, Deeks A, Moran L. Polycystic ovary syndrome: a complex condition with psychological, reproductive and metabolic manifestations that impacts on health across the lifespan. BMC Med 2010;8(41):41
4 Teede H, Tay CT, Laven J et al. International Evidence-based Guideline for the Assessment and Management of Polycystic Ovary Syndrome 2023. Monash University, Melbourne, August 2023. Published online 2023 Doi: 10.26180/24003834.v1
5 Teede HJ, Tay CT, Laven J, et al; International PCOS Network. Recommendations from the 2023 International Evidence-based Guideline for the Assessment and Management of Polycystic Ovary Syndrome. Fertil Steril 2023;120(04):767–793
6 Armanini D, Boscaro M, Bordin L, Sabbadin C. Controversies in the pathogenesis, diagnosis and treatment of PCOS: focus on insulin resistance, inflammation, and hyperandrogenism. Int J Mol Sci 2022;23(08):4110
7 Stepto NK, Cassar S, Joham AE, et al. Women with polycystic ovary syndrome have intrinsic insulin resistance on euglycaemic-hyperinsulaemic clamp. Hum Reprod 2013;28(03):777–784
8 Rodriguez Paris V, Bertoldo MJ. The mechanism of androgen actions in PCOS etiology. Med Sci (Basel) 2019;7(09):89
9 Moghetti P, Tosi F, Bonin C, et al. Divergences in insulin resistance between the different phenotypes of the polycystic ovary syndrome. J Clin Endocrinol Metab 2013;98(04):E628–E637
10 Thomson RL, Buckley JD, Noakes M, Clifton PM, Norman RJ, Brinkworth GD. The effect of a hypocaloric diet with and without exercise training on body composition, cardiometabolic risk profile, and reproductive function in overweight and obese women with polycystic ovary syndrome. J Clin Endocrinol Metab 2008;93(09):3373–3380
11 Teede HJ, Misso ML, Costello MF, et al; International PCOS Network. Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. Fertil Steril 2018;110(03):364–379
12 Patten RK, Boyle RA, Moholdt T, et al. Exercise interventions in polycystic ovary syndrome: a systematic review and meta-analysis. Front Physiol 2020;11(July):606
13 Sabag A, Chang CR, Francois ME, et al. The effect of exercise on quality of life in type 2 diabetes: a systematic review and meta-analysis. Med Sci Sports Exerc 2023;55(08):1353–1365
14 Breyley-Smith A, Mousa A, Teede HJ, Johnson NA, Sabag A. The effect of exercise on cardiometabolic risk factors in women with polycystic ovary syndrome: a systematic review and meta-analysis. Int J Environ Res Public Health 2022;19(03):1386
15 Palomba S, Giallauria F, Falbo A, et al. Structured exercise training programme versus hypocaloric hyperproteic diet in obese polycystic ovary syndrome patients with anovulatory infertility: a 24-week pilot study. Hum Reprod 2008;23(03): 642–650
16 Bruner B, Chad K, Chizen D. Effects of exercise and nutritional counseling in women with polycystic ovary syndrome. Appl Physiol Nutr Metab 2006;31(04):384–391
17 Thomson RL, Buckley JD, Lim SS, et al. Lifestyle management improves quality of life and depression in overweight and obese women with polycystic ovary syndrome. Fertil Steril 2010;94 (05):1812–1816
18 Shele G, Genkil J, Speelman D. A systematic review of the effects of exercise on hormones in women with polycystic ovary syndrome. J Funct Morphol Kinesiol 2020;5(02):14–33
19 Colombo GE, Dafauce X, Patten RK, et al. Comparison of selected exercise training modalities in the management of PCOS : a systematic review and meta-analysis to inform evidence-based guidelines. JSAMS Plus 2023;2(April):100024
20 Çıtar Dazıroğlu ME, Acar Tek N. The effect on inflammation of adherence to the Mediterranean diet in polycystic ovary syndrome. Curr Nutr Rep 2023;12(01):191–202
21 Ciao AC, Loth K, Neumark-Sztainer D. Preventing eating disorder pathology: common and unique features of successful eating disorders prevention programs. Curr Psychiatry Rep 2014;16 (07):453
22 Clifford D, Ozier A, Bundros J, Moore J, Kreiser A, Morris MN. Impact of non-diet approaches on attitudes, behaviors, and

health outcomes: a systematic review. J Nutr Educ Behav 2015; 47(02):143–55.e1
23 Wolf WM, Wattick RA, Kinkade ON, Olfert MD. The current description and future need for multidisciplinary PCOS clinics. J Clin Med 2018;7(11):395
24 Sherif K, Coborn J, Hoovler A, Gill L. Medical journey of patients with polycystic ovary syndrome and obesity: a cross-sectional survey of patients and primary care physicians. Postgrad Med 2023;135(03):312–320
25 Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ 1996;312(7023):71–72
26 Bovend'Eerdt TJH, Botell RE, Wade DT. Writing SMART rehabilitation goals and achieving goal attainment scaling: a practical guide. Clin Rehabil 2009;23(04):352–361
27 Ollila MME, Piltonen T, Puukka K, et al. Weight gain and dyslipidemia in early adulthood associate with polycystic ovary syndrome: prospective cohort study. J Clin Endocrinol Metab 2016;101(02):739–747
28 Awoke MA, Earnest A, Joham AE, et al. Weight gain and lifestyle factors in women with and without polycystic ovary syndrome. Hum Reprod 2021;37(01):129–141
29 Teede HJ, Joham AE, Paul E, et al. Longitudinal weight gain in women identified with polycystic ovary syndrome: results of an observational study in young women. Obesity (Silver Spring) 2013;21(08):1526–1532
30 Moran LJ, Pasquali R, Teede HJ, Hoeger KM, Norman RJ. Treatment of obesity in polycystic ovary syndrome: a position statement of the Androgen Excess and Polycystic Ovary Syndrome Society. Fertil Steril 2009;92(06):1966–1982
31 Moran LJ, Ranasinha S, Zoungas S, McNaughton SA, Brown WJ, Teede HJ. The contribution of diet, physical activity and sedentary behaviour to body mass index in women with and without polycystic ovary syndrome. Hum Reprod 2013;28(08): 2276–2283
32 Moran LJ, Noakes M, Clifton PM, et al. Ghrelin and measures of satiety are altered in polycystic ovary syndrome but not differentially affected by diet composition. J Clin Endocrinol Metab 2004;89(07):3337–3344
33 Georgopoulos NA, Saltamavros AD, Vervita V, et al. Basal metabolic rate is decreased in women with polycystic ovary syndrome and biochemical hyperandrogenemia and is associated with insulin resistance. Fertil Steril 2009;92(01):250–255
34 Robinson S, Chan S-P, Spacey S, Anyaoku V, Johnston DG, Franks S. Postprandial thermogenesis is reduced in polycystic ovary syndrome and is associated with increased insulin resistance. Clin Endocrinol (Oxf) 1992;36(06):537–543
35 Hirschberg AL, Naessén S, Stridsberg M, Byström B, Holtet J. Impaired cholecystokinin secretion and disturbed appetite regulation in women with polycystic ovary syndrome. Gynecol Endocrinol 2004;19(02):79–87
36 Moran LJ, Noakes M, Clifton PM, et al. Postprandial ghrelin, cholecystokinin, peptide YY, and appetite before and after weight loss in overweight women with and without polycystic ovary syndrome. Am J Clin Nutr 2007;86(06):1603–1610
37 Williamson DA, Bray GA, Ryan DH. Is 5% weight loss a satisfactory criterion to define clinically significant weight loss? Obesity (Silver Spring) 2015;23(12):2319–2320
38 Australian Bureau of Statistics. Australian Health Survey: First Results, 2011–12. 2011;(1):1–61. Accessed November 10, 2023 at: https://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/1680ECA402368CCFCA257AC90015AA4E/$File/4364.0.55.001.pdf
39 Haqq L, McFarlane J, Dieberg G, Smart N. The effect of lifestyle intervention on body composition, glycemic control, and cardiorespiratory fitness in polycystic ovarian syndrome: a systematic review and meta-analysis. Int J Sport Nutr Exerc Metab 2015;25 (06):533–540
40 Barte JCM, ter Bogt NCW, Bogers RP, et al. Maintenance of weight loss after lifestyle interventions for overweight and obesity, a systematic review. Obes Rev 2010;11(12):899–906
41 Schubert MM, Desbrow B, Sabapathy S, Leveritt M. Acute exercise and subsequent energy intake. A meta-analysis. Appetite 2013;63:92–104
42 Swift DL, Johannsen NM, Lavie CJ, Earnest CP, Church TS. The role of exercise and physical activity in weight loss and maintenance. Prog Cardiovasc Dis 2014;56(04):441–447
43 Snel M, Gastaldelli A, Ouwens DM, et al. Effects of adding exercise to a 16-week very low-calorie diet in obese, insulin-dependent type 2 diabetes mellitus patients. J Clin Endocrinol Metab 2012; 97(07):2512–2520
44 Patten RK, McIlvenna LC, Levinger I, et al. High-intensity training elicits greater improvements in cardio-metabolic and reproductive outcomes than moderate-intensity training in women with polycystic ovary syndrome: a randomized clinical trial. Hum Reprod 2022;37(05):1018–1029
45 Hutchison SK, Stepto NK, Harrison CL, Moran LJ, Strauss BJ, Teede HJ. Effects of exercise on insulin resistance and body composition in overweight and obese women with and without polycystic ovary syndrome. J Clin Endocrinol Metab 2011;96(01):E48–E56
46 Benham JL, Booth JE, Corenblum B, et al. Exercise training and reproductive outcomes in women with polycystic ovary syndrome: a pilot randomized controlled trial. Clin Endocrinol (Oxf) 2021;95(02):332–343
47 Benham JL, Yamamoto JM, Friedenreich CM, Rabi DM, Sigal RJ. Role of exercise training in polycystic ovary syndrome: a systematic review and meta-analysis. Clin Obes 2018;8(04): 275–284
48 Kite C, Lahart I, Kyrou I, Broom D, Randeva H, Afzal I. Exercise or exercise and diet for the management of polycystic ovary syndrome (PCOS): a systematic review and meta-analysis. Natl Inst Heal Res 2017:1–6
49 Ross R, Blair SN, Arena R, et al; American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health Council on Clinical Cardiology Council on Epidemiology and Prevention Council on Cardiovascular and Stroke Nursing Council on Functional Genomics and Translational Biology Stroke Council. Importance of assessing cardiorespiratory fitness in clinical practice: a case for fitness as a clinical vital sign: a scientific statement from the American Heart Association. Circulation 2016;134(24):e653–e699
50 Sabag A, Keating SE, Way KL, et al. The association between cardiorespiratory fitness, liver fat and insulin resistance in adults with or without type 2 diabetes: a cross-sectional analysis. BMC Sports Sci Med Rehabil 2021;13(01):40
51 Xenou M, Gourounti K. Dietary patterns and polycystic ovary syndrome: a systematic review. Maedica (Buchar) 2021;16(03): 516–521
52 Bykowska-Derda A, Kaluzna M, Ruchała M, Ziemnicka K, Czlapka-Matyasik M. The significance of plant-based foods and intense physical activity on the metabolic health of women with PCOS: a priori dietary-lifestyle patterns approach. Appl Sci (Basel) 2023;13(04):2118
53 Germani A, Vitiello V, Giusti AM, Pinto A, Donini LM, del Balzo V. Environmental and economic sustainability of the Mediterranean diet. Int J Food Sci Nutr 2014;65(08):1008–1012
54 Azadi-Yazdi M, Karimi-Zarchi M, Salehi-Abargouei A, Fallahzadeh H, Nadjarzadeh A. Effects of dietary approach to stop hypertension diet on androgens, antioxidant status and body composition in overweight and obese women with polycystic ovary syndrome: a randomised controlled trial. J Hum Nutr Diet 2017;30(03):275–283
55 Foroozanfard F, Rafiei H, Samimi M, et al. The effects of dietary approaches to stop hypertension diet on weight loss, anti-Müllerian hormone and metabolic profiles in women with

polycystic ovary syndrome: a randomized clinical trial. Clin Endocrinol (Oxf) 2017;87(01):51–58
56 Barrea L, Arnone A, Annunziata G, et al. Adherence to the Mediterranean diet, dietary patterns and body composition in women with polycystic ovary syndrome (PCOS). Nutrients 2019; 11(10):2278
57 Khani B, Mardanian F, Fesharaki SJ. Omega-3 supplementation effects on polycystic ovary syndrome symptoms and metabolic syndrome. J Res Med Sci 2017;22(01):64
58 Cussons AJ, Watts GF, Mori TA, Stuckey BGA. Omega-3 fatty acid supplementation decreases liver fat content in polycystic ovary syndrome: a randomized controlled trial employing proton magnetic resonance spectroscopy. J Clin Endocrinol Metab 2009;94(10):3842–3848
59 Amini M, Bahmani F, Foroozanfard F, et al. The effects of fish oil omega-3 fatty acid supplementation on mental health parameters and metabolic status of patients with polycystic ovary syndrome: a randomized, double-blind, placebo-controlled trial. J Psychosom Obstet Gynaecol 2018:1–9
60 Shamasbi SG, Ghanbari-Homayi S, Mirghafourvand M. The effect of probiotics, prebiotics, and synbiotics on hormonal and inflammatory indices in women with polycystic ovary syndrome: a systematic review and meta-analysis. Eur J Nutr 2020;59(02): 433–450
61 Tabrizi R, Ostadmohammadi V, Akbari M, et al. The effects of probiotic supplementation on clinical symptom, weight loss, glycemic control, lipid and hormonal profiles, biomarkers of inflammation, and oxidative stress in women with polycystic ovary syndrome: a systematic review and meta-analysis of randomized controlled trials. Probiotics Antimicrob Proteins 2022;14(01):1–14
62 Cozzolino M, Vitagliano A, Pellegrini L, et al. Therapy with probiotics and synbiotics for polycystic ovarian syndrome: a systematic review and meta-analysis. Eur J Nutr 2020;59(07): 2841–2856
63 Leblanc ES, O'Connor E, Whitlock EP, Patnode CD, Kapka T. Effectiveness of primary care-relevant treatments for obesity in adults: a systematic evidence review for the U.S. Preventive Services Task Force. Ann Intern Med 2011;155(07):434–447
64 Williamson DA, Martin CK, Anton SD, et al; Pennington CALERIE Team. Is caloric restriction associated with development of eating-disorder symptoms? Results from the CALERIE trial. Health Psychol 2008;27(1S):S32–S42
65 National Task Force on the Prevention and Treatment of Obesity. Overweight, obesity, and health risk. Arch Intern Med 2000;160 (07):898–904
66 Pi-Sunyer FX. Short-term medical benefits and adverse effects of weight loss. Ann Intern Med 1993;119(7, Part 2):722–726
67 Li G, Zhang P, Wang J, et al. Cardiovascular mortality, all-cause mortality, and diabetes incidence after lifestyle intervention for people with impaired glucose tolerance in the Da Qing Diabetes Prevention Study: a 23-year follow-up study. Lancet Diabetes Endocrinol 2014;2(06):474–480
68 Moran LJ, Misso ML, Wild RA, Norman RJ. Impaired glucose tolerance, type 2 diabetes and metabolic syndrome in polycystic ovary syndrome: a systematic review and meta-analysis. Hum Reprod Update 2010;16(04):347–363
69 Sabag A, Little JP, Johnson NA. Low-volume high-intensity interval training for cardiometabolic health. J Physiol 2022;600(05): 1013–1026
70 Pirotta S, Joham AJ, Moran LJ, Skouteris H, Lim SS. Implementation of evidence-based PCOS lifestyle management guidelines: perceived barriers and facilitators by consumers using the Theoretical Domains Framework and COM-B Model. Patient Educ Couns 2021;104(08):2080–2088
71 Kazemi M, Kim JY, Wan C, et al. Comparison of dietary and physical activity behaviors in women with and without polycystic ovary syndrome: a systematic review and meta-analysis of 39471 women. Hum Reprod Update 2022;28(06):910–955
72 Aryaeian N, Sedehi SK, Arablou T. Polyphenols and their effects on diabetes management: a review. Med J Islam Repub Iran 2017;31(01):134
73 Aleksandrova K, Koelman L, Rodrigues CE. Dietary patterns and biomarkers of oxidative stress and inflammation: a systematic review of observational and intervention studies. Redox Biol 2021;42:101869
74 Mei S, Ding J, Wang K, Ni Z, Yu J. Mediterranean diet combined with a low-carbohydrate dietary pattern in the treatment of overweight polycystic ovary syndrome patients. Front Nutr 2022;9:876620
75 Martínez-González MA, García-Arellano A, Toledo E, et al; PREDIMED Study Investigators. A 14-item Mediterranean diet assessment tool and obesity indexes among high-risk subjects: the PREDIMED trial. PLoS One 2012;7(08):e43134
76 Moran LJ, Ko H, Misso M, et al. Dietary composition in the treatment of polycystic ovary syndrome: a systematic review to inform evidence-based guidelines. J Acad Nutr Diet 2013;113 (04):520–545
77 Morton RW, Murphy KT, McKellar SR, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. Br J Sports Med 2018;52 (06):376–384
78 Asemi Z, Foroozanfard F, Hashemi T, Bahmani F, Jamilian M, Esmaillzadeh A. Calcium plus vitamin D supplementation affects glucose metabolism and lipid concentrations in overweight and obese vitamin D deficient women with polycystic ovary syndrome. Clin Nutr 2015;34(04):586–592
79 Zhao J, Dong L, Lin Z, et al. Effects of selenium supplementation on polycystic ovarian syndrome: a systematic review and meta-analysis on randomized clinical trials. BMC Endocr Disord 2023; 23(01):33
80 Jamilian M, Zadeh Modarres S, Amiri Siavashani M, et al. The influences of chromium supplementation on glycemic control, markers of cardio-metabolic risk, and oxidative stress in infertile polycystic ovary syndrome women candidate for in vitro fertilization: a randomized, double-blind, placebo-controlled trial. Biol Trace Elem Res 2018;185(01):48–55
81 Nasiadek M, Stragierowicz J, Klimczak M, Kilanowicz A. The role of zinc in selected female reproductive system disorders. Nutrients 2020;12(08):2464
82 He C, Lin Z, Robb SW, Ezeamama AE. Serum vitamin D levels and polycystic ovary syndrome: a systematic review and meta-analysis. Nutrients 2015;7(06):4555–4577
83 Heidari H, Hajhashemy Z, Saneei P. A meta-analysis of effects of vitamin E supplementation alone and in combination with omega-3 or magnesium on polycystic ovary syndrome. Sci Rep 2022;12(01):19927
84 Babapour M, Mohammadi H, Kazemi M, Hadi A, Rezazadegan M, Askari G. Associations between serum magnesium concentrations and polycystic ovary syndrome status: a systematic review and meta-analysis. Biol Trace Elem Res 2021;199(04):1297–1305
85 Zaeemzadeh N, Jahanian Sadatmahalleh S, Ziaei S, et al. Comparison of dietary micronutrient intake in PCOS patients with and without metabolic syndrome. J Ovarian Res 2021;14(01):10
86 Care D of H and A. Nutrient Reference Values for Australia and New Zealand Macronutrient balance. Published 2023. Accessed November 10, 2023 at: https://www.eatforhealth.gov.au/nutrient-reference-values/chronic-disease/macronutrient-balance
87 Lindheim L, Bashir M, Münzker J, et al. Alterations in gut microbiome composition and barrier function are associated with reproductive and metabolic defects in women with polycystic ovary syndrome (PCOS): a pilot study. PLoS One 2017;12(01): e0168390

88 Zeng B, Lai Z, Sun L, et al. Structural and functional profiles of the gut microbial community in polycystic ovary syndrome with insulin resistance (IR-PCOS): a pilot study. Res Microbiol 2019; 170(01):43–52

89 Gu Y, Zhou G, Zhou F, et al. Gut and vaginal microbiomes in PCOS: implications for women's health. Front Endocrinol (Lausanne) 2022;13:808508

90 Zhang M, Hu R, Huang Y, et al. Present and future: crosstalks between polycystic ovary syndrome and gut metabolites relating to gut microbiota. Front Endocrinol (Lausanne) 2022;13:933110

91 Duan L, An X, Zhang Y, et al. Gut microbiota as the critical correlation of polycystic ovary syndrome and type 2 diabetes mellitus. Biomed Pharmacother 2021;142:112094

92 Kim G-H, Lee K, Shim JO. Gut bacterial dysbiosis in irritable bowel syndrome: a case-control study and a cross-cohort analysis using publicly available data sets. Microbiol Spectr 2023;11 (01):e0212522

93 Bazarganipour F, Taghavi S-A, Asemi Z, et al. The impact of irritable bowel syndrome on health-related quality of life in women with polycystic ovary syndrome. Health Qual Life Outcomes 2020;18(01):226

94 Zhang J, Sun Z, Jiang S, et al. Probiotic *Bifidobacterium lactis* V9 regulates the secretion of sex hormones in polycystic ovary syndrome patients through the gut-brain axis. mSystems 2019;4(02):e00017-19

95 Miao C, Guo Q, Fang X, Chen Y, Zhao Y, Zhang Q. Effects of probiotic and synbiotic supplementation on insulin resistance in women with polycystic ovary syndrome: a meta-analysis. J Int Med Res 2021;49(07):3000605211031758

96 Fang Q, Yu L, Tian F, Zhang H, Chen W, Zhai Q. Effects of dietary irritants on intestinal homeostasis and the intervention strategies. Food Chem 2023;409:135280

97 Black CJ, Staudacher HM, Ford AC. Efficacy of a low FODMAP diet in irritable bowel syndrome: systematic review and network meta-analysis. Gut 2022;71(06):1117–1126

98 Patten RK, Pascoe MC, Moreno-Asso A, Boyle RA, Stepto NK, Parker AG. Effectiveness of exercise interventions on mental health and health-related quality of life in women with polycystic ovary syndrome: a systematic review. BMC Public Health 2021;21(01):2310

99 Brownell KD, Rodin J. Medical, metabolic, and psychological effects of weight cycling. Arch Intern Med 1994;154(12): 1325–1330

100 Mehta T, Smith DL Jr, Muhammad J, Casazza K. Impact of weight cycling on risk of morbidity and mortality. Obes Rev 2014;15 (11):870–881

101 Lee JS, Visser M, Tylavsky FA, et al; Health ABC Study. Weight loss and regain and effects on body composition: the Health, Aging, and Body Composition Study. J Gerontol A Biol Sci Med Sci 2010; 65(01):78–83

102 Müller MJ, Enderle J, Pourhassan M, et al. Metabolic adaptation to caloric restriction and subsequent refeeding: the Minnesota Starvation Experiment revisited. Am J Clin Nutr 2015;102(04): 807–819

103 Shu L, Hoo RLC, Wu X, et al. A-FABP mediates adaptive thermogenesis by promoting intracellular activation of thyroid hormones in brown adipocytes. Nat Commun 2017;8(01): 14147

104 Weiss EP, Racette SB, Villareal DT, et al; Washington University School of Medicine CALERIE Group. Lower extremity muscle size and strength and aerobic capacity decrease with caloric restriction but not with exercise-induced weight loss. J Appl Physiol 2007;102(02):634–640

105 Anastasiou CA, Yannakoulia M, Pirogianni V, Rapti G, Sidossis LS, Kavouras SA. Fitness and weight cycling in relation to body fat and insulin sensitivity in normal-weight young women. J Am Diet Assoc 2010;110(02):280–284

106 Rodin J, Radke-Sharpe N, Rebuffé-Scrive M, Greenwood MR. Weight cycling and fat distribution. Int J Obes 1990;14(04): 303–310

107 Cereda E, Malavazos AE, Caccialanza R, Rondanelli M, Fatati G, Barichella M. Weight cycling is associated with body weight excess and abdominal fat accumulation: a cross-sectional study. Clin Nutr 2011;30(06):718–723

108 Strohacker K, McFarlin BK. Influence of obesity, physical inactivity, and weight cycling on chronic inflammation. Front Biosci (Elite Ed) 2010;2(01):98–104

109 Rossi AP, Rubele S, Calugi S, et al. Weight cycling as a risk factor for low muscle mass and strength in a population of males and females with obesity. Obesity (Silver Spring) 2019;27(07): 1068–1075

110 Barakat C, Pearson J, Escalante G, Campbell B, De Souza EO. Body recomposition: Can trained individuals build muscle and lose fat at the same time? Strength Condit J 2020;42(05):7–21

111 Ribeiro AS, Oliveira AV, Kassiano W, Nascimento MA, Mayhew JL, Cyrino ES. Effects of resistance training on body recomposition, muscular strength, and phase angle in older women with different fat mass levels. Aging Clin Exp Res 2023;35(02): 303–310

112 Fukushima Y, Kurose S, Shinno H, et al. Importance of lean muscle maintenance to improve insulin resistance by body weight reduction in female patients with obesity. Diabetes Metab J 2016;40(02):147–153

113 Carmina E, Guastella E, Longo RA, Rini GB, Lobo RA. Correlates of increased lean muscle mass in women with polycystic ovary syndrome. Eur J Endocrinol 2009;161(04):583–589

114 Wright PJ, Corbett CF, Pinto BM, Dawson RM, Wirth M. Resistance training as therapeutic management in women with PCOS: What is the evidence? Int J Exerc Sci 2021;14(03):840–854

115 Frestedt JL, Zenk JL, Kuskowski MA, Ward LS, Bastian ED. A whey-protein supplement increases fat loss and spares lean muscle in obese subjects: a randomized human clinical study. Nutr Metab (Lond) 2008;5(01):8

116 Wott CB, Carels RA. Overt weight stigma, psychological distress and weight loss treatment outcomes. J Health Psychol 2010;15 (04):608–614

117 Field AE, Manson JE, Taylor CB, Willett WC, Colditz GA. Association of weight change, weight control practices, and weight cycling among women in the Nurses' Health Study II. Int J Obes Relat Metab Disord 2004;28(09):1134–1142

118 Samuels KL, Maine MM, Tantillo M. Disordered eating, eating disorders, and body image in midlife and older women. Curr Psychiatry Rep 2019;21(08):70

119 Zhang J, Xu JH, Qu QQ, Zhong GQ. Risk of cardiovascular and cerebrovascular events in polycystic ovarian syndrome women: a meta-analysis of cohort studies. Front Cardiovasc Med 2020; 7:552421

120 Lee I, Cooney LG, Saini S, Sammel MD, Allison KC, Dokras A. Increased odds of disordered eating in polycystic ovary syndrome: a systematic review and meta-analysis. Eat Weight Disord 2019;24(05):787–797

121 Pirotta S, Barillaro M, Brennan L, et al. Disordered eating behaviours and eating disorders in women in Australia with and without polycystic ovary syndrome: a cross-sectional study. J Clin Med 2019;8(10):1682

122 Tay CT, Teede HJ, Hill B, Loxton D, Joham AE. Increased prevalence of eating disorders, low self-esteem, and psychological distress in women with polycystic ovary syndrome: a community-based cohort study. Fertil Steril 2019;112(02):353–361

123 Lau GM, Elghobashy M, Thanki M, et al; PCOS SEva Working Group. A systematic review of lived experiences of people with polycystic ovary syndrome highlights the need for holistic care and co-creation of educational resources. Front Endocrinol (Lausanne) 2022;13:1064937

124 Lim S, Smith CA, Costello MF, MacMillan F, Moran L, Ee C. Barriers and facilitators to weight management in overweight and obese women living in Australia with PCOS: a qualitative study. BMC Endocr Disord 2019;19(01):106
125 Moran LJ, Noakes M, Clifton P, et al. Predictors of lifestyle intervention attrition or weight loss success in women with polycystic ovary syndrome who are overweight or obese. Nutrients 2019;11(03):492
126 Sabag A, Houston L, Neale EP, et al. Supports and barriers to lifestyle interventions in women with gestational diabetes mellitus in Australia: a national online survey. Nutrients 2023;15(03):487
127 Li X, Liu X, Zuo Y, Gao J, Liu Y, Zheng W. The risk factors of gestational diabetes mellitus in patients with polycystic ovary syndrome: What should we care. Medicine (Baltimore) 2021; 100(31):e26521
128 Arentz S, Smith CA, Abbott J, Bensoussan A. Perceptions and experiences of lifestyle interventions in women with polycystic ovary syndrome (PCOS), as a management strategy for symptoms of PCOS. BMC Womens Health 2021;21(01):107
129 Gibson-Helm M, Teede H, Dunaif A, Dokras A. Delayed diagnosis and a lack of information associated with dissatisfaction in women with polycystic ovary syndrome. J Clin Endocrinol Metab 2017;102(02):604–612
130 Puhl R, Suh Y. Health consequences of weight stigma: implications for obesity prevention and treatment. Curr Obes Rep 2015; 4(02):182–190
131 Carr D, Friedman MA. Is obesity stigmatizing? Body weight, perceived discrimination, and psychological well-being in the United States. J Health Soc Behav 2005;46(03):244–259
132 Puhl RM, Andreyeva T, Brownell KD. Perceptions of weight discrimination: prevalence and comparison to race and gender discrimination in America. Int J Obes 2008;32(06):992–1000
133 Major B, Eliezer D, Rieck H. The psychological weight of weight stigma. Soc Psychol Personal Sci 2012;3(06):651–658
134 Hebl MR, Xu J. Weighing the care: physicians' reactions to the size of a patient. Int J Obes Relat Metab Disord 2001;25(08): 1246–1252
135 Teixeira ME, Budd GM. Obesity stigma: a newly recognized barrier to comprehensive and effective type 2 diabetes management. J Am Acad Nurse Pract 2010;22(10):527–533
136 Wee CC, McCarthy EP, Davis RB, Phillips RS. Screening for cervical and breast cancer: is obesity an unrecognized barrier to preventive care? Ann Intern Med 2000;132(09):697–704
137 Johnson Dawkins D, Daum DN. Person-first language in healthcare: the missing link in healthcare simulation training. Clin Simul Nurs 2022;71:135–140
138 Mesa D. PCOS: a weight-inclusive and practical approach to lifestyle interventions. ADCES Pract 2022;10(04):24–28
139 Alimoradi Z, Golboni F, Griffiths MD, Broström A, Lin C-Y, Pakpour AH. Weight-related stigma and psychological distress: a systematic review and meta-analysis. Clin Nutr 2020;39(07): 2001–2013
140 Dugmore JA, Winten CG, Niven HE, Bauer J. Effects of weight-neutral approaches compared with traditional weight-loss approaches on behavioral, physical, and psychological health outcomes: a systematic review and meta-analysis. Nutr Rev 2020;78(01):39–55
141 Dayan PH, Sforzo G, Boisseau N, Pereira-Lancha LO, Lancha AH Jr. A new clinical perspective: treating obesity with nutritional coaching versus energy-restricted diets. Nutrition 2019; 60:147–151
142 Snyder BS. Polycystic ovary syndrome (PCOS) in the adolescent patient: recommendations for practice. Pediatr Nurs 2005;31 (05):416–421
143 Estruch R, Ros E, Salas-Salvadó J, et al; PREDIMED Study Investigators. Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med 2018;378(25):e34

