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University Students with PCOS Demonstrate Limited Nutrition Knowledge

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ABSTRACT

Background: Dietary modification is critical for the management of polycystic ovary syndrome (PCOS), yet few women with PCOS report receiving nutrition education. Nutrition knowledge may translate to dietary behaviors and diet quality, but nutrition knowledge among women with PCOS is unknown.

Purpose: Using a descriptive design, we assessed nutrition knowledge, diet quality, and eating disorder risk among university students with PCOS.

Methods: Following clinical and biochemical analysis, 12 university students with PCOS were admitted to the study. Participants completed validated questionnaires (Nutrition Knowledge Questionnaire, Eating Disorder Examination-Questionnaire 6.0 (EDE-Q 6.0), 3-day food records, and body composition testing.

Results: Participants were obese (75%), insulin resistant (58%), and consumed an unbalanced diet (41% carbohydrate, 43% fat). Bread or fruit were avoided by 27.3%. Nutrition knowledge was poor (48% correct) and inversely related to fruit intake ($r(9) = -.689$, $p < .05$). Nearly half (41.6%) were at increased risk for eating disorders (EDE-Q score ≥ 4).

Discussion: University students with PCOS demonstrate poor nutrition knowledge, consume an unbalanced and limited diet, and exhibit an increased risk for eating disorders.

Translation to Health Education Practice: University-health service programs targeting nutrition education and behavior modification are needed to improve the management and mitigation of PCOS-related symptoms in students.

A AJHE Self-Study quiz is online for this article via the SHAPE America Online Institute (SAOI) http://portal.shapeamerica.org/trn-Webinars

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Background

Polycystic ovary syndrome (PCOS) is a hormonal disorder that affects 4–21% of women of childbearing age, with rates varying across ethnic groups and employed diagnostic criteria.[1] Since 1990, multiple criteria have been recommended for PCOS diagnosis, partly explaining the differences in prevalence between different populations.[1] Ethnic differences in the presentation of hirsutism, or male-pattern terminal hair growth, a clinical manifestation of androgen excess, and the challenges in defining and scoring hirsutism also contribute to the reported differences in prevalence rates observed in various countries.[2–4] In the US, diagnosis is most frequently confirmed according to the 2003 Rotterdam consensus criteria, which requires evidence of two of the three following conditions: history of menstrual irregularity, clinical or biochemical demonstration of hyperandrogenism, or confirmation of polycystic ovaries (PCO) using ultrasound imaging and the exclusion of other disorders.[5,6] The etiology of PCOS is unknown though multiple factors, including genetics, appear to play a role in the development of the condition.[7] Obesity is a common feature, observed in approximately 60% of women,[8] and worsens the biochemical and clinical profile of PCOS.[9–11] Increased chronic disease risk affiliated with PCOS diagnosis is supported by the increased prevalence of metabolic syndrome (MetS), a group of conditions including obesity, elevated glucose, and abnormal lipids linked with increased risk for diabetes mellitus type 2 (DM2) and cardiovascular disease (CVD), observed in women with PCOS (29.5%) compared to age-matched controls (4.5%).[12] Additionally, women with PCOS demonstrate an increased vulnerability for psychological conditions including depression, low self-esteem, anxiety,[13,14] body dissatisfaction,[15] and disordered eating.[16,17] The deleterious health consequences of this complex condition ultimately impact quality of life.[18,19]

Current, international evidence-based guidelines for the management of PCOS advocate for comprehensive

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lifestyle interventions, including diet, exercise, and behavior modification to improve overall health. Dietary recommendations encourage an individualized and flexible approach toward the consumption of a nutritionally adequate and balanced diet, consistent with suggestions for the general population. Prevention of chronic disease risk is also a dietary goal; strategies to improve insulin sensitivity advise improving carbohydrate quality by limiting simple sugars and increasing fiber intake, and limiting saturated and trans fats.[20,21] Maintenance or attainment of a healthy body weight is important[22–27] as excessive weight aggravates the features of PCOS.'[9,10] Independent of weight loss, modification of dietary carbohydrates has demonstrated promising results.[28,29] Despite the influential role of diet and nutritional counseling in the management of PCOS,[30] women with PCOS receive little nutritional counseling from qualified professionals.'[31,32]

University students are a diverse group of relatively healthy individuals that are subject to lifestyle and physical change. Within the first year of university, students report an increase in body weight and body fat due, in part, to a decline in dietary quality.[33] Dietary quality, though inconsistently measured, is a term that refers to the intake of foods or nutrients consistent with reference intakes with numerous health applications, including health risk assessment.[34] Risk for eating disorders is high among university students,[35] perhaps due to the establishment of new behaviors[36] or distinctive stresses or altered social environment during this transitional period of life.[37] University students with PCOS may represent a unique population as the first symptoms of the condition often present during adolescence and diagnosis is challenging and often delayed.[11,38] Diagnosis of PCOS is one of exclusion, and the normal biochemical profile of puberty (i.e. insulin resistance and hyperandrogenism) shares commonalities with PCOS, contributing to the complexity faced by clinicians. The presence of obesity during adolescence presents further diagnostic challenges as obesity can influence the biochemical profile of PCOS (i.e. insulin resistance and hyperandrogenism) and worsen the clinical presentation.[11] Consequently, diagnosis and management for the adolescent with PCOS may be delayed.

The influence of nutrition knowledge on dietary behaviors such as fruit and vegetable consumption is complex and subject to additional factors such as an individual's personal interests or health goals as well as social stimuli or environmental limitations.[39] Yet, within the university population, there is evidence suggesting nutrition knowledge is linked with dietary consumption.[40–44] Yahia et al. reported that consumption of dietary fat and cholesterol was inversely related to nutrition knowledge scores among a largely female (71%) university population.[40] Though dietary management is critical to PCOS care and current dietary recommendations reflect national dietary recommendations, the general nutrition knowledge of women with PCOS is scarce.[45] Using a cross-sectional design, Lin et al. reported that women with PCOS (28.1 ± 5.4 years) demonstrate a minimal level of nutrition knowledge, comparable to controls. Specifically, women with PCOS were able to select food groups such as added sugars that should be limited in the typical diet and identify food groups that contain dietary fiber.[46]

Polycystic ovary syndrome is a complex hormonal disorder observed among reproductive-aged women. Lifestyle intervention, with a focus on diet, is considered the first line of treatment for the management of PCOS. Unfortunately, few women with PCOS receive nutritional advice from professionals[31,32] and instead, often seek nutritional information on their own elsewhere. Though knowledge does not necessarily translate to behavior, nutrition education in the university setting translates to improved dietary consumption and decreased chronic health risk.[47,48] To date, little attention has been directed toward determining nutrition knowledge among women with PCOS, a population at increased risk for chronic diseases including CVD and DM2. A 2020 systematic review and meta-analysis confirmed women with PCOS are at increased risk for eating disorders but, to our knowledge, risk has not been assessed within the university setting.[49] It is therefore important to determine nutrition knowledge and eating disorder risk among university students with PCOS in order to provide effective and comprehensive lifestyle intervention programs in the university setting.

Purpose

The objective of the present study was to assess nutrition knowledge among university students with PCOS and determine whether knowledge is associated with diet quality. The study also sought to explore eating disorder risk, a discovery that would potentially influence diet quality. Such findings have the potential to shape university health services to include nutrition education and behavior modification programs to improve the management and mitigation of PCOS-related symptoms in students.

Methods

Design

The descriptive design of this study was selected because it allowed us to investigate nutrition knowledge among university students with PCOS, determine whether knowledge is associated with diet quality, and evaluate risk of eating disorders.

Sample

A sample of female students ages 18–40 years old was recruited from a public university located in the southern United States between May 2018 and June 2019. Participants were recruited through advertisements that questioned the presence of symptoms including excessive facial hair growth, acne, irregular menstrual cycles, or difficulty with weight maintenance, and promoted study benefits including free body composition testing and biochemical examination. Advertisements were emailed to approximately 6,500 females currently enrolled at the university and flyers were posted at the university health center. All participants provided a menstrual history confirming menstrual irregularity (<8 menstrual cycles/year) and completed a biochemical and clinical examination. Participants did not incur payment charges as enrollment at the university obliges students to pay a medical services fee, which covers office visits, including the clinical examination. Follow-up visits to review biochemical markers and discuss PCOS clinical care guidelines including management of underlying metabolic abnormalities, risk reduction for chronic disease, and contraception strategies,[50] were scheduled following diagnosis. Exclusion criteria included diagnosis of medical conditions that alter body composition or biochemical markers (e.g., DM1 or DM2, thyroid disorders, heart disease), use of oral contraceptives or medications within the previous three months that influence biochemical markers, pregnancy or lactation, excessive exercise, or severe food allergies that interfere or limit food selections. Diagnosis of PCOS was based on the Rotterdam consensus criteria[5,6] and confirmed by the university health center gynecologist after excluding complications of the pituitary and hyperandrogenic complications of the adrenals or ovaries.

Data and variables

Approval from the Sam Houston State University Institutional Review Board was obtained for this protocol (#2018-03-36739) prior to data collection and analyses. All participants provided written informed consent prior to study start and were informed they could withdraw from the study at any time.

Following completion of the clinical examination and receipt of the initial diagnosis of PCOS, participants were admitted into the study and asked to complete three questionnaires, 3-day food records, biochemical and body composition measurements. Two questionnaires, including the medical history and eating disorder risk, were completed on-line via Qualtrics software. The nutrition knowledge questionnaire was paper-based and completed in the presence of the researchers. The eating disorder risk and nutrition knowledge questionnaires were completed and evaluated in a manner consistent with the tool development and validation. All student data collected by this study, including the data downloaded from Qualtrics, was identified by a code number to keep results anonymous, and entered in an electronic data file. All hard copy data and informed consents were stored in the primary researcher's locked office in locked file cabinets. Electronic data file access was limited to the research personnel.

Instruments

Nutrition knowledge was measured using the validated tool, Nutrition Knowledge Questionnaire.[51] The questionnaire (60 questions) is founded on 2005 Dietary Guidelines for Americans and comprised of three subscales: Familiarity with MyPyramid (23 questions), Nutrient Content of Foods (26 questions), and Diet-Disease Relationships (11 questions). Each correctly answered question was assigned a score of +1, for a maximum total score of 60. Overall internal consistency of 0.91 (Cronbach α of .85, .81, and .81, respectively) and test-retest reliability of 0.95 for all.

Risk of eating disorder was assessed using the Eating Disorder Examination-Questionnaire 6.0 (EDE-Q 6.0), a validated tool designed to assess eating disorder behaviors and thoughts including frequency of compensatory behaviors and fear of weight gain over the prior 28-day period. The EDE-Q 6.0 consists of 28 questions; five questions assess frequency for disordered eating behaviors (i.e. use of laxatives or vomiting to control weight) and 23 scale-based questions inquire about the psychopathology of disordered eating. The scale-based questions are grouped into four subscales: Restraint, Eating Concern, Shape Concern and Weight Concern. Scores for responses range from 0–6 (no days to everyday), with increased scores corresponding to increasing frequency of negative eating disorder-related thoughts. Subscales scores are computed by summing responses from applicable questions and dividing by the total number of questions included in that subscale. Global or overall scores are computed by summing the four subscale scores and dividing by the total number of subscales. Scores are reported as means and standard deviations. Higher scores suggest greater seriousness; subscale and global scores of 4 or higher are deemed clinically significant.[52] The EDE-Q has been validated in the undergraduate female population.[53] The sensitivity and specificity of the EDE-Q in screening for eating disorders among women of reproductive age is 83% and 96%, respectively.[54]

A 3-day food record was used to assess participant's usual diet. Participants received instructions detailing how to measure and record portion sizes, cooking methods, and brand names and were asked to document all food and beverages consumed for two weekdays and one weekend day. Research personnel assessed records for details including quality of food items, quantity, and preparation methods to improve the quality of data. Dietary composition was assessed using ESHA Food Processor Nutrition Analysis Software, an extensive database of 100,000 foods and food items. The software offers numerous features including nutrient and MyPlate food group analysis, and menu planning templates.[55] Dietary reports, including 3-day averages, were generated for each participant, and data were entered into an excel spreadsheet for data analyses. Data obtained from the 3-day food record was used to measure diet quality.

Diet quality, in accordance with the 2015–2020 Dietary Guidelines, was assessed using the US Department of Agriculture's (USDA) MyPlate feature in ESHA. Each participant's intake of the five food groups (fruit, vegetable, grain, protein food, and dairy) was calculated using ESHA, downloaded into a spreadsheet, and then compared to individual MyPlate recommendations according to their designated age group (14–18 years or 19–30 years). Quantitative intake that met or exceeded USDA MyPlate recommendations was used to establish diet quality. Diet quality measurement also included macronutrient (% of energy) and select micronutrient intake compared with reference values used to develop the Dietary Guidelines for Americans.[56]

Diet quality was also measured using the Eating Choices Index (ECI),[57] which evaluates four daily eating behaviors including (i) breakfast intake, (ii) two portions of fruit intake, (iii) quality of bread intake, and (iv) quality of milk intake. Assessment of dietary behaviors such as the selection of bread or milk type provide qualitative data that further characterizes diet quality. Compared to dietary analysis of 5-day food records, ECI scores are significantly associated with macronutrient and select micronutrient data consistent with a healthy diet.[57] A score of 1–5 is assigned within each category, the higher the score, the higher the frequency of the behavior or nutritional quality of the food. Breakfast, defined as energy consumption > 100 kcal in a time period allotted to breakfast, and fruit intake, defined as consumption of two portions, each consisting of a weight ≥80 grams and not consisting of fruit juice, were scored according to frequency. For either group, intake on no days (score 1), intake on some days but not all days (score 3), and intake was observed on all days (score 5). Bread and milk intake, including milk alternatives, were scored according to nutritional quality. For example, consumption of bread included: white bread (score 1), white, brown, or "granary" (score 2), brown or "granary"(brown flour with added maltose) only, or a combination of white or wholegrain (score 3), sometimes brown or granary, sometimes wholegrain (score 4), and wholegrain only (score 5). Scoring for the type of milk consumed was as follows: whole milk only (score 1), sometimes whole, sometimes semi-skimmed (score 2), semi-skimmed only (score 3), sometimes semi-skimmed, sometimes skimmed (score 4), and skimmed only (score 5). Research personnel assigned scores for each behavior and summed the four scores to generate a total ECI score. Total ECI scores vary from the minimum (score of 4) to the maximum (score of 20), with the higher number corresponding to a higher-quality diet.[58] Further classification of scores (e.g. tertiles) was not carried out due to the limited sample size.

A fasting blood sample was collected between day 3 and 10 of the follicular phase of the menstrual cycle, following an overnight fast. Blood samples were obtained by certified phlebotomists utilizing standard phlebotomy technique.[59] The biochemical markers measured and contained in this report include fasting glucose, fasting insulin, cholesterol, HDL-cholesterol, LDL-cholesterol, VLDL-cholesterol, and triglycerides. Additional biochemical markers were measured exclusively for the purpose of excluding complications of the adrenals, ovaries, or pituitary. The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) was used to evaluate the presence of insulin resistance, according to the formula: fasting insulin (μU/L) x fasting glucose (nmol/L)/22.5.[60]

Prior to securing body composition measurements, participants were instructed to fast for a minimum of 3 hours, hydrate but abstain from caffeinated beverages and alcohol for 24 hours, and avoid activities including planned physical activity, taking a shower or sitting in a sauna on the day of testing. Height was measured to the nearest 0.25 inch using a stadiometer. Participants were instructed to stand on the InBody 770 bioelectrical impedance analyzer barefooted and hold the hand electrodes to their sides and away from the torso for 1 min. Multifrequency bioelectrical impedance analysis is a quick, noninvasive, and accurate assessment of body composition.[61]

Statistical analysis

All data were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 25 (IBM Corp., Armonk, N.Y., USA).[62] To assess whether knowledge was related to diet quality, we created arbitrary categories based on ECI scores. Specifically, we stratified ECI scores (score of 1–5) such that poorer

diet quality characterized by either no breakfast (score of 1), no fruit intake (score of 1), primarily white bread (score of 1–2), or largely whole milk (score of 1–2) was compared with their respective better diet quality choices (scores of 3–5). Additionally, we made a dichotomous variable for diet quality according to whether participants met or exceeded MyPlate recommendations for the five food groups (diary, fruit, grain, protein, and vegetable). Student's *t*-test results were conducted to evaluate differences in diet quality by nutrition knowledge score. Pearson's correlation coefficient tests were used to assess the relationship between continuous dietary variables (energy, macronutrient, micronutrient, and MyPlate servings) and nutrition knowledge scores. Participants were assigned a + 1 if they met or exceeded the EDE-Q subscale or global scale of ≥ 4.[52] to create a dichotomous variable for ED risk. Student's *t*-test results were conducted to evaluate differences in nutrition knowledge and diet quality according to ED risk. For all analyses, $P < .05$ was considered statistically significant.

Results

One student withdrew from the study following the clinical examination and receipt of the initial PCOS diagnosis. Twelve university students were confirmed with PCOS diagnosis and completed the present study. All participants were university students between 18 and 26 years of age, and not currently pregnant or breastfeeding. The study population (25% African American; 25% Caucasian; 33.3% Hispanic) was predominantly obese, as most (75%) demonstrated a body mass index (BMI) ≥ 30 kg/m^2. Increased visceral fat mass ≥100 cm^2 was observed in all overweight and obese subjects (n = 10). Significant IR, estimated by HOMA-IR of ≥2.9, was observed in seven (58%) participants. Nearly half of participants (41.7%) reported a delay in the diagnosis of PCOS and receipt of conflicting treatment occasionally or regularly. According to the medical history questionnaire, only three of the participants reported currently being under the care of a physician for PCOS and menstrual disturbances. Additional characteristics of the PCOS population are presented in (Table 1).

University students with PCOS demonstrably possess limited nutrition knowledge (Table 2). Overall, the mean total score was low; 48% of questions were answered correctly. Of the three sections, scores were highest in the *Familiarity with MyPyramid* (52.6% correct). One half of the population correctly identified whole grains, yet only one-third correctly identified the serving size of a cooked vegetable. Nearly half of the sample population (42%) correctly understood 1 g of dietary fat contains more calories than a similar weight of sugar, protein, or fiber. Although most (83.3%) identified that sunlight helps the body produce vitamin D, only one participant correctly answered that 5 g of fiber is considered a high amount for one serving of food. Additionally, most (83.3%) participants were unable to identify olive oil is a good source of monounsaturated fat within the *Nutrient Content of Food* section. Scores were lowest in the *Diet-Disease Relationship* section (43.6% correct). For example, only two participants were able to list a health condition that could be prevented with adequate fruit and vegetable intake. Similarly, the preventive role of fiber was unrecognized by over 80% of the sample population. Furthermore, when asked about the relationship between calories and weight gain, most participants (58.3%) stated weight gain is due to calories from carbohydrate, rather than all calories contribute to weight gain (16.7%).

All participants reported seeking nutrition advice from one or multiple sources including the internet (75%), doctors (41.7%) friends/family (41.7%), books (25%) or dietitians (16.7%). One participant failed to return her completed food records. Dietary carbohydrate intake for the group was moderate 41.39%; seven (64%) participants did not meet the minimum carbohydrate intake of 45% of energy, a recommendation for the general adult

Table 1. Baseline characteristics of the sample PCOS population (n = 12).

Variable	Mean ± SD
Age (y)	22.50 ± 2.71
BMI (kg/m^2)	34.38 ± 9.74
Body fat (%)[a]	44.03 ± 9.08
Visceral fat area (cm^2)[a]	188.02 ± 74.97
Glucose (mg/dL)	89.33 ± 8.34
Insulin (ulU/mL)	21.65 ± 12.71
HOMA-IR	4.96 ± 3.43
Cholesterol (mg/dL)	168. 92 ± 26.08
HDL-C (mg/dL)	46.08 ± 9.17
LDL-C (mg/dL)	98.42 ± 17.16
VLDL (mg/dL)	24.42 ± 11.05
TG (mg/dL)	121.92 ± 55.37

[a]Body composition was measured using bioelectrical impedance analysis.
Homeostatic Model Assessment of Insulin Resistance (HOMA-IR); HDL, high density lipoprotein cholesterol; LDL, low density lipoprotein cholesterol; VLDL, very low density lipoprotein cholesterol; TG, triglyceride.

Table 2. Nutrition knowledge scores (n = 12).

Questionnaire Section (Maximum Score Possible)	Mean ± SD	Min-Max Scores[a]
Familiarity with MyPyramid (23)	12.1 ± 4.3	6–18
Nutrient Content of Foods (26)	12.2 ± 4.8	3–18
Diet-Disease Relationships (11)	4.8 ± 3.1	0–11
Total (60)	29.0 ± 10.9	9–42

[a]Minimum -Maximum participant scores
The Nutrition Knowledge Questionnaire consists of 3 sections including Familiarity with MyPyramid (23 questions), Nutrient Content of Foods (26 questions), and Diet-Disease Relationships (11 questions). Each correct answer was assigned a score of 1, for a maximum total score of 60.

population. Total sugars (including natural sugars) contributed nearly 15% of overall energy intake. Compared to national reference values, dietary fat intake, particularly saturated fat, was high, and micronutrient and fiber intake were low (Table 3). Compared to the USDA's MyPlate, dietary quality intake was inadequate. None of the participants met the recommendations for the general adult population for all five food groups. Specifically, no participant met the dairy recommendation. Only one (9%) participant met the fruit recommendation, and another (9%) participant met the vegetable recommendation. Grain intake was also limited with only four (36%) participants meeting the daily 6 ounce-equivalent goal, while more than half (63.6%) met the daily protein food recommendation. Diet quality, assessed using total ECI scores, was also inadequate (10.09 ± 3.70). Approximately one of every four participants (27.3%) avoided bread or fruit, and most (63.6%) participants avoided milk consumption.

Participants also reported current and previous self-imposed dietary measures, as well as recent dietary changes (Table 4). More than half of the sample population (58%) reported following a special dietary restriction within the last 6 months. One participant reported following a vegetarian diet. An additional three participants eliminated food groups such as meat or dairy products, while one participant restricted fruit and vegetable intake.

The relationship between nutrition knowledge and diet quality was limited. According to the ECI and MyPlate, participants' nutrition knowledge was inversely related to fruit consumption [$(r(9) = -.689$, $P < .05)$ and $(r(9) = -.639$, $P < .05)$, respectively]. Participants who refrained from fruit intake (ECI score of 1) scored higher on the knowledge test than the fruit eaters (ECI score of 3–5), but mean scores were not significantly different (36.75 ± 6.85 vs 24.57 ± 11.487; $t(9) = 1.909$, $P = .089$). Nutrition knowledge was also inversely related to total sugars intake ($r(9) = .634$, $P < .05$. Nutrition knowledge was not significantly related to energy, micronutrient, or macronutrient intake. Still, participants who limited carbohydrate consumption to less than 45% of energy ($n = 7$) scored higher on the nutrition knowledge test than their counterparts who consumed a diet consisting of 45% carbohydrate or more (32.43 ± 8.30 vs 23.0 ± 14.94, respectively), though results were not significant ($P = .308$).

According to the EDE-Q scores, participants demonstrated severe disordered eating behaviors and thoughts. The mean global score was 2.46 ± 1.25. Mean subscale scores in order from highest to lowest were shape (3.69 ± 1.56) followed by weight concern (3.08 ± 1.58), restraint (1.71 ± 1.27) and eating concern (1.37 ± 1.19). Five (41.6%) participants reported EDE-Q scores of ≥ 4 in one or more subscales, the most widely accepted cut off for clinical significance.[53] Within the shape concern subscale, three fourths (75%) of participants reported

Table 3. Dietary intake of university students with PCOS ($n = 11$).

Dietary Variables	Mean ± SD
Energy (kcal)	1758.52 ± 635.49
Carbohydrates (g)	182.78 ± 81.68
Carbohydrates (%E)	41.39 ± 12.32
Protein (g)	69.89 ± 17.28
Protein, (%E)	16.52 ± 2.99
Fat (g)	85.48 ± 37.02
Fat (%E)	43.61 ± 9.80
Saturated fat (g)	23.16 ± 8.03
Total sugars (g)	63.57 ± 42.81
Dietary fiber (g)	16.06 ± 5.93
Folate (mcg)	204.76 ± 136.88
Potassium (mg)	1154.01 ± 640.10
Calcium (mg)	533.15 ± 291.98
Iron (mg)	9.71 ± 3.85

%E, percentage of energy

Table 4. Current diet and recent dietary changes reported among participants with PCOS ($n = 12$).

Participant	Current Diet	Dietary changes made within last 6 months
1	I recently decided to stop eating meat (for 1 month). My current diet is processed foods mainly.	I stopped eating meat.
2	I eat mostly fast foods and pastas.	I stopped eating fruits and vegetables as often.
3	I have been working out and watching what I eat.	I cut out soda.
4	In the past, I followed the keto diet to lose weight. I currently just try to make healthier choices with my food.	I eat smaller portions of food.
5	Cleanish. Yes, keto worked for a week then plateaued.	I cut out sweets, junk food, and cut back on soda.
6	I have been learning to count my macros because I feel that I would benefit from that.	I cut out dairy.
7	Low carbohydrate and low sugar.	I started avoiding sugars, sodas, and eating fewer carbs.
8	I am trying to eat better. No, N/A.	I am drinking water only .
9	I currently eat health conscious foods during the week, and I eat what I want to on weekends. I have used Herbalife Prolessa and fat flush challenges, and they have helped me lose a few inches.	I started including more protein, and I cut out most dairy products.
10	I am mindful of fried foods, primarily home cooked meals.	I attempted a gluten free diet but stopped.
11	Vegetarianism.	None.
12	I am not on any current diets. In the past I would fast and workout to lose weight.	None. I eat them same.

dissatisfaction with shape and feelings of fatness most days of the month (answer selection 4, 5, or 6). Dissatisfaction with weight most days of the month was reported by 10 (83.3%) participants and 8 (66.7%) reported a desire to lose weight most days of the month. Six participants reported food avoidance and five participants reported dietary restraint most days of the month. More than half (58.3%) reported no concern about others seeing them eat but only three (25%) reported feeling no guilt when eating. No significant difference in age, BMI, nutrition knowledge, or diet quality was observed between participants with or without ED risk.

Discussion

The university students with PCOS in the present study presented with increased risk for DM2 and CVD. Consistent with previous reports, participants were primarily overweight and obese,[8] but body composition testing confirmed the placement of excess adiposity around the organs, an independent predictor of MetS risk across BMI categories.[63] Though cholesterol levels were not elevated, screening for cardiovascular risk factors is encouraged in this population.[22] The use of the HOMA-IR tool underscored the presence of significant insulin resistance. Insulin resistance is a precursor to DM2[64] and has been observed in lean and obese women with PCOS as early as adolescence.[65]

A previous study in the US demonstrated limited general nutrition knowledge in an older and more educated population of women with PCOS. Using a cross-sectional design and control group, Lin et al. reported women with PCOS were able to successfully identify nutrients that should be limited in the typical diet and recognize food sources of fiber.[46] Using a validated tool, the present study similarly identified limited nutrition knowledge, including inadequate awareness of national dietary guidelines, the nutrition-content of identified foods, and the relationship between diet and disease, among university students with PCOS. Our study also demonstrated that women with PCOS rely largely upon the internet for nutrition advice. This finding is not surprising considering only three participants were currently under the care of a physician for PCOS and menstrual disturbances. Though the internet provides an infinite amount of nutrition information, much of it is inconsistent with general dietary recommendations,[66] and students, even those pursuing a degree in health sciences, are unable to discern the deception in health media.[67] Our findings are consistent with previous reports stating women with PCOS receive little nutrition advice from qualified professionals.[31,32]

Few participants met the MyPlate recommendations, which reflect the 2015–2020 Dietary Guidelines for Americans. Rather, we identified that university students with PCOS are consuming a diet limited in carbohydrate and high in fat, particularly saturated fat. Hart et al. described a similar dietary profile and related cardiometabolic risk among a group of women with PCOS in the UK.[68] While numerous studies have documented a beneficial metabolic response in women with PCOS following the implementation of a modest carbohydrate diet,[28,29,69] guidance on the inclusion of complex carbohydrates, a rich source of micronutrients and fiber, is warranted. Dietary counseling on the appropriate selection of dietary fats is also recommended within this population at high risk of cardiovascular disease.[70]

Numerous self-imposed dietary restrictions were reported among this sample population, yet only the consumption of fruit was related to nutrition knowledge. The majority of participants were unable to identify the preventive role of dietary fiber in chronic disease development and believed calories from dietary carbohydrates were most responsible for weight gain; thus, it is was not surprising to see that participants were limiting carbohydrates including fruit, dairy (or milk), and bread. Adolescents with PCOS (19.4 ± 2.4 years) report increased dieting for weight loss compared to age-matched controls, despite sharing a similar body composition.[71] Insufficient dietary iron intake is not unique among females of reproductive age,[72] and may be reflective of limited nutrition knowledge[73] or exacerbated by self-imposed dietary restrictions. Poor nutrition knowledge coupled with the implementation of unguided, self-imposed dietary restrictions is worrisome and may increase future health risks. There is evidence among student and professional dancers that supports the relationship between disordered eating and poor nutritional knowledge;[74] however, we were unable to confirm this relationship in this study. Nutrition education interventions targeting university students, whether using mobile technology and texting[42] or nutrition courses[43] increase knowledge and improve diet behaviors, including fruit and vegetable consumption.

Approximately 50% of female university students in the US demonstrate behaviors or symptoms of eating disorders.[35] The clinical manifestation of the hormonal disorder, exacerbated by excessive body weight, may further aggravate eating disorder risk among female university students with PCOS. Consistent with previous reports,[16,17,75] our population demonstrated increased risk for eating disorders. Nearly half (41.6%) of the participants exhibited eating disorder behaviors and thoughts on a clinically relevant level, measured

using the EDE-Q score of ≥ 4.[52,53] The global and four subscale scores from this population exceeded normative EDE-Q data reported from a large and ethnically diverse sample of female university students in the US.[76] We observed that participants reported noticeable dissatisfaction with weight and shape and frequent food avoidance. However, ED risk was not associated with diet quality in this study. Present weight status, particularly overweight and obesity, appears to raise the risk,[77] and may, in part, help explain the high risk of eating disorders observed in the PCOS population.

Screening for eating disorders in this population is warranted.[22] Inclusion of the EDE, similar to the self-reported EDE-Q but involving a clinician-administered interview intended to diagnose specific disordered eating patterns,[78] may support the development of tailored interventions. Lifestyle management for women with PCOS often focuses on weight loss, including the employment of dietary strategies intended to produce weight loss or metabolic changes, which may be counterproductive for a population at increased risk for eating disorders. Current, international evidence-based guidelines for the management of PCOS advocate for comprehensive lifestyle interventions, including diet, exercise, and behavior modification, to help women with PCOS achieve or maintain optimal health.[22] Additionally, clinicians are encouraged to approach obesity and weight assessment with tact, encourage a flexible approach to a diet and eating principles that support nutrient needs, and be mindful of the effects of PCOS on overall quality of life. A recent study among women with PCOS highlighted that quality of life is inversely related to eating disorder risk.[79] Due to the complexity and symptom heterogeneity of PCOS, management should be approached in a multidisciplinary manner.[22]

A limitation of this study was the small, but diverse sample size. The recruitment of participants from a university student health center may have subjected the study group to selection bias and predisposed them to healthy messages from providers that other university students with PCOS have not accessed. Moreover, the lack of a control group for comparison is a significant limitation. The validity of the ECI was based on a five-day food record thus we also chose to assess dietary quality in accordance with the national guidelines (MyPlate). Evidence of PCO was not used for diagnosis in this study, because ultrasound equipment is not available in the student health center on campus and was not deemed by the gynecologist to be necessary for their clinical management. This was not thought to be a serious limitation as ultrasound or PCO criteria for diagnosis is unclear and subject to technological capabilities.[80] The presence of ED was not confirmed in this study, but the researchers acknowledge that presence of ED risk may modify the relationship between nutrition knowledge and diet quality.

Translation to Health Education Practice

PCOS, the most common hormonal disorder among women of reproductive age, is linked with deleterious health consequences that ultimately affect quality of life.[1] Excessive weight exacerbates all facets of the disorder, including the hormonal profile, clinical presentation, chronic disease risk, and vulnerability for eating disorders.[9,10,17] Multiple diagnostic criteria, normal pubertal development, and the presence of obesity make diagnosis challenging, particularly in the adolescent population. Lifestyle intervention, with a focus on diet, is considered the cornerstone of PCOS management, but few women report receiving dietary advice from professionals. Nutrition knowledge may not translate to dietary behaviors or dietary quality, but nutrition education in the university setting translates to improved dietary consumption and decreased chronic health risk.[47,48] Poor nutrition knowledge has also been associated with disordered eating,[74] a common condition among university students[35] and women with PCOS.[17] To date, research on the nutrition knowledge, dietary quality, and eating disorder risk among university students with PCOS is unknown.

The outcomes of this study support the need for a comprehensive lifestyle intervention in the university setting. The participants in this study were primarily obese, with excess visceral fat, and insulin resistant. Nutrition knowledge scores were low overall, but participants had a particularly difficult time identifying the relationship between diet and disease states. Overall, diet quality was inadequate, marked by unbalanced macronutrient and inadequate micronutrient intake. Nutrition knowledge was related to diet quality, the higher the knowledge score, the more the participant limited fruit. Participants also reported self-imposed dietary measures such as restricting foods and demonstrated severe disordered eating behaviors and thoughts.

The outcomes of this study can guide the practice of Certified Health Education Specialists,[81] particularly related to the core responsibility of assessment and prioritization of health needs (Area I: Assessment of Needs and Capacity). Reported delays in diagnosis and limited enrollment in this study, the first research collaboration with the university health center, support the need for increased health education and community engagement (NCHEC sub-competency 1.2.2 Establish collaborative relationships and agreements that facilitate access to

data). Students may seek clinical care at the university health center for various PCOS-related symptoms such as obesity, hirsutism, or menstrual irregularity, unaware of their condition or significance for future health risks. It is critical that clinicians and health educators familiarize themselves with PCOS-related symptoms to expedite assessment and the development of management programs. The prevalence of obesity, especially visceral obesity, and insulin resistance in this relatively young population exacerbate chronic disease risk and endorse the importance of identifying current health status (NCHEC sub-competency 1.3.1 Determine the health status of the priority population). In turn, assessment of nutrition knowledge, diet, and self-imposed food restrictions inform health education interventions (NCHEC sub competency 1.3.2 Determine the knowledge, attitudes, beliefs, skills, and behaviors that impact the health and health literacy of the priority population). Recounting these study outcomes (NCHEC sub competency 1.4.5 Report assessment findings) will assist with the core responsibility of program planning (Area II: Planning). Comprehensive health services, using a multi-disciplinary approach, are warranted in the university setting.

Authorship declaration

All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors and agree with the manuscript. Study Design: CCD; Data Collection: CCD, RJ, RG, KB, GY, RW; Data Analysis: CCD; Manuscript Writing: CCD, GY, RW.

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