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Research Article

Predictors of Body Mass Index among Women with Polycystic Ovarian Syndrome (PCOS) in Jordan

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ABSTRACT

The objective of this study is to assess the possibles determinants of body mass index among women with Polycystic Ovary Syndrome (PCOS) in Jordan. A cross-sectional study was conducted among 120 PCOS women aged between 18 to 45 years old in Jordan. The study included a structured questionnaire divided into six sections: demographic data, anthropometric measurements, medical history, dietary habits, physical activity, quality of life and mental health status. Binary logistic regression has been used to identify the predictors of body mass index. Among 120 participants, 37.5% were underweight or had normal weight, while 62.5% were overweight or obese. The median age was 28.0 years for the overweight/obese group and 27.0 years for the underweight/normal-weight group ($p<0.001$). Women with higher income and education levels were at lower risk of being overweight or obese ($p<0.05$). Overweight/obese women reported significantly lower levels of physical activity ($p<0.05$). Higher consumption of sugar, vitamin D, vitamin C, selenium, and iron was observed in underweight/normal-weight women compared to the overweight/obese group ($p<0.001$) based on Mann-Whitney test. Binary logistic regression analysis revealed that low education level (OR=0.359, 95% CI:0.142−0.908), good mental health status (OR=0.627, 95% CI:0.438−0.898) and greater waist circumference (OR=1.352, 95% CI:1.145−1.596) increased the risk of being overweight or obese. These findings suggest that socioeconomic, psychological, and central adiposity factors play important roles in the weight status of this population, highlighting the need for multifaceted approaches in obesity prevention and management.

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INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a heterogeneous endocrine disorder among women of reproductive age, characterized by reproductive and metabolic abnormalities and an increased risk of cardiovascular and psychological comorbidities (Huddleston *et al.* 2022). It is clinically manifested by hyperandrogenic features, subfertility, hirsutism, anovulation, irregular menstrual cycles, and pregnancy complications (Teede *et al.* 2018). Beyond reproductive manifestations, women with PCOS frequently experience depression, anxiety and reduced quality of life (Alessa *et al.* 2017). PCOS is related to other health consequences such as excessive weight gain, fatty liver, type 2 diabetes, cardiovascular risk, and an elevated risk of endometrial cancer, which might result from the immediate reproductive endocrine abnormalities caused by PCOS (Zeng *et al.* 2020). Globally, PCOS affects 6–15% of women in their reproductive years, with 50–70% of PCOS patients exhibit Insulin Resistance (IR). Excess body weight in PCOS is associated with obesity contributing substantially to metabolic dysfunction and cardiometabolic risk (Passarello *et al.* 2019; Barber & Franks 2013). Obesity exacerbates insulin resistance and hyperandrogenism, worsening reproductive and metabolic outcomes in PCOS (Barber *et al.* 2019).

Lifestyle management remains the first-line approach in PCOS care, with emphasis on diet, physical activity, and psychological well-being. Dietary patterns such as the Mediterranean diet have gained attention for their anti-inflammatory and insulin-sensitizing effects. Greater adherence to this dietary pattern has been associated with reductions in visceral adiposity and improved metabolic outcomes (Poulimeneas *et al.* 2020), while plant-based dietary components may enhance insulin action and reduce inflammation (Liaset *et al.* 2019). However, women with PCOS in Jordan have been reported to consume diets rich in energy, refined carbohydrates, and saturated fats, potentially contributing to an increased risk of metabolic complications (Radaideh & Ibrahim 2024). Emotional eating and stress-related eating behaviors have also been reported among obese women in Jordan (Sweiss *et al.* 2025).

Psychological health is another important factor influencing weight regulation and disease management in PCOS. Depression and anxiety are more prevalent among young women with PCOS and may negatively influence lifestyle behaviors and treatment adherence (Rowlands *et al.* 2016). Overweight and obesity have been associated with increased depressive symptoms, while poor psychological well-being may hinder successful weight management (Cooney & Dokras, 2017). In contrast, regular physical activity can improve insulin resistance, reduce central adiposity, and alleviate symptoms of anxiety and depression even without substantial weight loss (Singh *et al.* 2023).

Variations in body weight result from the interaction of biological, socioeconomic, environmental, and lifestyle-related factors. While genetic predisposition and age are non-modifiable, modifiable factors such as dietary habits, physical activity, sedentary behavior, and socioeconomic conditions play critical roles in weight regulation (Fernández-Cardero *et al.* 2024). Lifestyle behaviors including high-fat food consumption, low physical activity, and prolonged sedentary time have been independently associated with weight gain and higher body mass index (Awoke *et al.* 2022; Barber & Franks 2021). In Jordan, the rising prevalence of obesity, diabetes, hypertension, and dyslipidemia highlights an increasing burden of metabolic disease among women (Khader *et al.* 2019). Despite growing awareness, knowledge about PCOS remains limited among Jordanian women (Muhaidat *et al.* 2023). Although the relationship between PCOS and excess body weight is well established, there is limited evidence examining the specific sociodemographic, lifestyle, dietary, and psychological factors influencing weight status among Jordanian women with PCOS.

Therefore, this study aims to investigate the factors associated with body weight status among women with PCOS in the country of Jordan.

METHODS

Design, location and time

A cross-sectional study was performed among women with PCOS in Amman and Al-Karak governorate in Jordan, with participants recruited from September 2022 to March 2023. This study received ethical approval from the Human Research Ethics Committee, Universiti Sains Malaysia (JEPeM), with the approval number of USM/JEPeM/22030167 on 23rd June 2022.

Sampling

This study was conducted in private dietitian clinics in Amman and Al-Karak governorate in Jordan. Subjects were recruited either by obtaining the list name of PCOS patients from the private clinics and via social media platform. Approximately 35 private clinics had been approached to recruit the potential participants. In addition, the information about this research had been circulated in various social media platforms. The participants were also conveniently recruited from several social media platforms, including Instagram, Facebook, and WhatsApp. The study included PCOS women aged between 18 and 45 years. For patients who were unable to come to the clinic, researchers conducted the data collection in the homes of the participants. Hundred twenty participants with PCOS were selected based on the single population proportion sample size formula. The required sample size was estimated using the prevalence of PCOS reported in a previous study conducted by Musmar *et al.* (2013) among Palestinian women. Assuming a confidence interval of 95%, z-score of 1.96, precision of 0.05 and prevalence of 7.3%, the minimum required sample for this study was 103 participants. With a 15% non-response rate, the final sample size was 120 participants.

Written informed consent was obtained from all participants prior to their enrolment in the study. The researcher provided detailed information about the study, including its purpose, procedure, benefits, and the participants' right to refuse participation.

Inclusion criteria were: (1) Women aged 18−45 years who were diagnosed with PCOS using the Rotterdam criteria, which include Antral Follicle Count (AFC) on ultrasound and clinical symptoms such as hirsutism, irregular menses, acne, weight gain, alopecia, and obesity (2) Diagnosis confirmed by a doctor and documented in the patient's medical records. (3) Ability to read and write in Arabic. Exclusion criteria were: (1) Pregnant or lactating women, (2) Women with kidney diseases, (3) Women with severe health conditions, such as psychiatric disorders. This study was conducted using a questionnaire, which consisted of six sections.

Data collection

Socio-demographic and smoking status. This section included age, number of children, sex, marital status, socioeconomic status (income), occupation, education level and religion. Smoking status was obtained by asking participants if they smoked either cigarettes, vape or cigar.

Anthropometric data. This included weight, height, Waist Circumference (WC) with abdominal obesity defined as WC>88 cm (Bosy-Westphal *et al.* 2010), Hip Circumference (HC), waist-to-hip ratio, and Body Mass Index (BMI). BMI was calculated by dividing weight (kg) by the square of height (m^2), according to the World Health Organization's criteria. BMI categories were as follows: BMI<18.5 kg/m^2 (underweight), BMI 18.5–24.9 kg/m^2 (normal weight), BMI 25–29.9 kg/m^2 (overweight), BMI 30–34.9 kg/m^2 (class I obesity), and BMI 35-39.9 kg/m^2 (class II obesity). Body composition (fat mass, muscle mass, extracellular and intracellular water, and minerals) was assessed using the bioelectrical impedance analysis (Tanita RD-545HR).

Medical history and supplement intake. This section included information about any existing diseases, such as diabetes mellitus, hypertension, hyperlipidaemia, menstrual irregularities, gastrointestinal problems, and other conditions. Duration of suffering from PCOS was also recorded. Participants were also asked about the medication intake for the comorbidities as well as information on supplement intake, including any vitamins, minerals, or herbal supplements.

Dietary intake and Mediterranean diet adherence. Assessment of dietary intake was conducted using three days 24-hour diet recall (for 2 weekdays and 1 weekend). The subjects of the study were contacted to obtain these details. They were asked the name, quantity of food or beverages consumed and the food preparation type. Visual aids were showed to the patients especially for meat-based food and legumes. Dietary intake was analyzed using the ESHA Food Processor Nutrition Analysis software 2010 version 10.6.30, a comprehensive tool widely used for nutritional assessments, recipe formulation, and dietary analysis. Dietary over- or underreporting were calculated using Energy Intake to Basal Metabolic Rate Ratio (EI: BMR) (Oliveira *et al.* 2022). On the other hand, adherence to the Mediterranean diet was assessed using the Arabic version of the Mediterranean Diet Adherence Screener (MEDAS) questionnaire. The MEDAS questionnaire comprises 14 items, which include 12 questions about the frequency of consumption of foods such as red meat, fruits, vegetables, and olive oil, and 2 questions about dietary habits. Each item has 2 response options (No=0, Yes=1). The questionnaire yields a total score between 0 and 14, with higher scores indicating better adherence to the Mediterranean diet. The scores of the MEDAS were presented in three categories namely low (0−5), moderate adherence (6−9) and high adherence (10−14) (Schröder *et al.* 2011).

Physical activity. Physical activity was assessed using the Arabic version of the short-form International Physical Activity Questionnaire (IPAQ), which consists of 9 items (Craig *et al.* 2003). IPAQ was categorized into three categories namely low activity, moderate activity, or high activity. Low activity was when no activity was reported, or activities done that did not meet criteria of moderate or high. Moderate activity was when the activities met one of the following three criteria: ≥3 days of vigorous activity for at least 20 minutes per day or ≥5 days of moderate-intensity activity or walking for at least 30 minutes or ≥5 days of any combination of walking, moderate, or vigorous activity achieving at least 600 MET-minutes/ week. On the other hand, high activity was when the participants meet one of these criteria: ≥3

days of vigorous-intensity activity accumulating at least 1,500 MET minutes/week or ≥7 days of any combination of walking, moderate, or vigorous activity achieving at least 3,000 MET-minutes/week.

Quality of life. Quality of life was determined using the WHO Quality of Life-BRIEF (WHOQOL-BRIEF) Arabic version (Ohaeri & Awadalla 2009). This questionnaire contains 24 items across four domains: physical (7 items), psychological (6 items), social relationships (3 items), and environment (8 items). Each item uses a 5-point Likert scale (1−5), with 2 additional questions about participants' health and quality of life. The Cronbach's alpha for the Arabic version of this questionnaire is 0.7.

Mental health status. The General Health and Quality of Life (GHQ-12) Arabic version consists of 12 items, each with a 4-point Likert scale (0−3). The total score ranges from 0 to 36, with a score of 36 indicating worse mental health conditions. The Cronbach's alpha for this version of the questionnaire is 0.86 (El-Rufaie & Daradkeh 1996).

Data analysis

IBM SPSS Statistics version 26.0 was used to perform all statistical analyses. The Chi-square test was used for analyzing categorical associations such as the association between socio-demographic data, physical activity, mental health status, dietary adherence with body mass index. An independent t-test was employed to compare the mean values of normally distributed continuous variables, according to BMI status. Meanwhile, was conducted to assess differences in medians among variables with non-normal distributions according to BMI status. Adjusted binary logistic regression as the multivariate test was performed to determine the factors associated with body weight, with a significance level set at $p<0.05$. The binary model was adjusted for age, physical activity and income. The variables for the multivariate model were chosen based on the statistically significant variables from the univariate analysis.

RESULTS AND DISCUSSION

One hundred and twenty women with PCOS were enrolled in the study. For analytical purposes, BMI was collapsed into two categories: underweight/normal weight and overweight/obese, to achieve more balanced group sizes. This approach was justified because only two participants (1.7%) were underweight, which would have limited meaningful subgroup comparisons. Overall, 45 participants (37.5%) were classified as underweight/normal weight and 75 (62.5%) as overweight/obese, indicating that excess body weight was common in this sample. This finding is consistent with previous evidence showing that overweight and obesity are highly prevalent among women with PCOS and may exacerbate metabolic and reproductive complications (Teede *et al.* 2018).

Table 1 presents the sociodemographic and lifestyle characteristics according to BMI category. Educational attainment differed significantly by BMI category. Tertiary education was more prevalent among underweight/normal weight women (95.6%) than overweight/obese women (65.3%) (p=0.001), while median years of education were also higher in the underweight/normal weight group [17.0 (0.0) vs. 15.0 (4.0), p=0.002]. This may suggest that higher educational attainment contributes to better health literacy, healthier lifestyle choices, and greater awareness of weight management strategies. Women with lower educational levels may have reduced access to nutrition knowledge or preventive healthcare, which could increase vulnerability to excess weight gain.

Although median income was numerically similar between groups, the analysis revealed a statistically significant difference (p=0.014), with the overweight/obese group demonstrating a narrower income distribution. Socioeconomic status may influence food choices, access to recreational facilities, healthcare utilisation, and lifestyle patterns, all of which may affect body weight. PCOS women of higher socioeconomic status has been reported to have sedentary lifestyle, increased consumption of junk food intake and poor sleep quality (Ferdous *et al.* 2024).

Physical activity levels showed a significant difference between BMI groups (p=0.002). Low physical activity was more common among overweight/obese women (54.7%) compared with underweight/normal weight women (37.8%), while high physical activity was substantially lower among overweight/obese women (9.3% vs. 35.6%). These findings support the established relationship between physical inactivity and excess body weight. Lower levels of physical

Table 1. Socio-demographic and lifestyle characteristics of PCOS women

Parameter	Underweight/normal n=45, n (%)	Overweight/obese n=75, n (%)	Total n=120, n (%)	*p*
Age (years)[a]	27.0 (8.0)	28.0 (9.0)	28.0 (8.8)	0.156
Marital status[b]				0.887
Single/Divorced	21.0 (46.7)	34.0 (45.3)	55.0 (45.8)	
Married	24.0 (53.3)	41.0 (54.7)	65.0 (54.7)	
Number of children[a]	0.0 (2.0)	0.0 (2.0)	0.0 (2.0)	0.830
Education level[b]				0.001*
Secondary	2.0 (4.4)	26.0 (34.7)	28.0 (23.3)	
Tertiary	43.0 (95.6)	49.0 (65.3)	92.0 (76.7)	
Education years[a]	17.0 (0.0)	15.0 (4.0)	17.0 (2.8)	0.002*
Religion[b]				0.269
Muslim	45.0 (100.0)	73.0 (97.3)	118.0 (98.3)	-
Christian	0.0 (0.0)	2.0 (2.7)	2.0 (1.7)	
Employment status				0.111
Housewife	20.0 (44.4)	43.0 (57.3)	63.0 (52.5)	
Government sector	6.0 (13.3)	14.0 (18.7)	20.0 (16.7)	
Private sector	19.0 (42.2)	18.0 (24.0)	37.0 (30.8)	
Income (JD)[a]	500.0 (400.0)	500.0 (250.0)	470.0 (300.0)	
Smoking[b]				0.014*
Yes	7.0 (15.6)	11.0 (14.7)	18.0 (15.0)	0.895
No	38.0 (84.4)	64.0 (35.3)	102.0 (85.0)	
Physical activity[b]				0.002*
Low	17.0 (37.8)	41.0 (54.7)	58.0 (48.3)	
Moderate	12.0 (26.7)	27.0 (36.0)	39.0 (32.5)	
High	16.0 (35.6)	7.0 (9.3)	23.0 (19.2)	

[a]Tested using Mann Whitney [median(IQR)]; [b]Tested using Chi Square (n(%)); *Significant at p<0.05; IQR: Interquartile Range; JD: Jordanian Dinar; PCOS: Polycystic Ovarian Syndrome

activity may contribute to worsening insulin resistance and increased weight gain in women with PCOS, whereas higher activity levels may support weight control and metabolic health. This highlights physical activity promotion as an important component of lifestyle management in PCOS (Teede *et al.* 2018).

A total of 120 participants were recruited, of whom 62.5% were classified as overweight or obese, indicating a high burden of excess body weight among women with PCOS. The overweight/obese group demonstrated significantly higher body weight [77.6 (16.0) kg] compared to the underweight/normal group [57.1 (10.3) kg] (p<0.001). These findings are consistent with previous evidence demonstrating a strong association between obesity and PCOS. Findings from a systematic review and meta-analysis in the Gulf Cooperation Council countries indicated a higher prevalence of PCOS in obese individuals compared to normal-weight counterparts (Alam *et al.* 2024). Furthermore, a meta-analysis involving 18 studies found that obese women had a 14% higher risk of developing PCOS compared to women with normal weight (Jayanti *et al.* 2022). Among women with PCOS, obesity is closely linked to insulin resistance, hyperandrogenism, and chronic low-grade inflammation, potentially worsening metabolic and reproductive disturbances.

The median vitamin D dosage was significantly lower among overweight/obese women [1,429 (110.0) IU/day] compared to underweight/normal women [7,140 (6,200.0) IU/day] (p<0.05). Vitamin D is essential for reproductive function, contributing to menstrual cycle regulation, decreased hyperandrogenism, and enhanced insulin sensitivity in women with PCOS. Vitamin D deficiency has also been associated with insulin resistance, inflammation, menstrual irregularities, and adverse metabolic outcomes among women with PCOS. A 12-week randomized controlled trial involving 30,000 IU/week vitamin D intervention for PCOS women reported reduction in testosterone level, improved ovarian morphology and regular menstrual cycle (Tóth *et al.* 2025). Therefore, the lower vitamin D intake observed among overweight/obese women in the present study may further contribute to metabolic dysregulation in this population.

Table 2. Anthropometric data, medical problems and supplement intake of PCOS women

Parameter	Underweight/normal n=45, n (%)	Overweight/obese n=75, n (%)	Total n=120, n (%)	*p*
Height (cm)[a]	160.0 (8.0)	158.0 (8.0)	160.0 (7.0)	0.343
Weight (kg)[a]	57.1 (10.3)	77.6 (16.0)	70.9 (19.9)	0.001*
WC (cm)[a]	77.0 (14.5)	97.0 (15.0)	90.0 (18.0)	0.001*
HP (cm) (mean±SD)[b]	98.3±8.4	113.5±9.6	107.8±11.7	0.001*
WHR[a]	0.8 (0.1)	0.9 (0.01)	0.8 (0.01)	0.001*
BMI (kg/m^2)[a]	21.9 (2.9)	30.3 (6.0)	27.2 (9.7)	0.001*
Duration of PCOS (Months)[a]	14.0 (27.0)	36.0 (60.0)	24.0 (48.0)	0.003*
Diabetes[c]				0.408
Yes	1.0 (2.2)	5.0 (6.7)	6.0 (5.0)	
No	44.0 (97.8)	70.0 (93.3)	114.0 (95.0)	
Hypertension[c]				0.054
Yes	0.0 (0.0)	8.0 (10.7)	8.0 (6.7)	
No	45.0 (100)	66.0 (88.0)	111.0 (92.5)	
Not sure	0.0 (0.0)	1.0 (1.3)	1.0 (0.8)	
Hypercholesterolemia[c]				0.054
Yes	0.0 (0.0)	4.0 (5.3)	4.0 (3.3)	
No	45.0 (100.0)	66.0 (88.0)	111.0 (92.5)	
Not sure	0.0 (0.0)	5.0 (6.7)	5.0 (4.2)	
Kidney disease[c]				1.000
Yes	0.0 (0.0)	1.0 (1.3)	1.0 (0.8)	
No	45.0 (100.0)	74.0 (98.7)	119.0 (99.2)	
Gout[c]				N.A
No	45.0 (100.0)	75.0 (100.0)	120.0 (100.0)	
GI diseases[c]				0.077
Yes	8.0 (17.8)	14.0 (18.7)	22.0 (18.3)	
No	34.0 (76.5)	61.0 (81.3)	95.0 (79.2)	
Not sure	3.0 (6.7)	0.0 (0.0)	3.0 (2.5)	
Stroke[c]				N.A
No	45.0 (100.0)	75.0 (100.0)	120.0 (100.0)	
Supplement intake[c]				0.280
Yes	18.0 (60)	16.0 (78.7)	34.0 (71.7)	
No	27.0 (100.0)	59.0 (100.0)	86.0 (100.0)	
Dose multivitamins (Num of tablets)[a]	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	0.108
Dose vitamin D (IU)[a]	7,140 (6200.0)	1,429 (110.0)	2,000 (6142.0)	0.003*
Dose folic acid (µg)[a]	400.0 (0.0)	400.0 (0.0)	400.0 (0.0)	0.703
Dose omega 3 (mg)[a]	1,000.0 (0.0)	1,000.0 (430.0)	1,000.0 (430.0)	0.636
Dose calcium (mg)[a]	200.0 (0.0)	200.0 (0.0)	200.0 (0.0)	0.178
Dose iron (mg)[a]	50.0 (62.0)	40.0 (50.0)	45.0 (50.0)	0.058
Dose vitamin C (mg)[a]	75.0 (0.0)	75.0 (0.0)	75.0 (0.0)	0.052

BMI: Body Mass; HP: High Protein; GI: Glycaemic Index; N.A: Not Available; PCOS: Polycystic Ovarian Syndrome; SD: Standard Deviation; WC: Waist Circumference; WHR: Waist to Hip Ratio; a: Mann Whitney Test and data presented as median (interquartile range); b: Independent t test and data presented as mean (standard deviation); c: Chi-Square test and data presented as frequecy (percentage)

Table 3 shows the participants' quality of life, mental health status, and adherence to the Mediterranean diet. At p<0.001, the median mental health score of underweight/normal individuals was 20.0 (3.5), significantly higher than that of overweight/obese individuals [17.0 (6.0)], indicating poorer mental health status among underweight/normal PCOS women. Underweight/normal women had significantly lower adherence to the Mediterranean diet [8.0 (17.8)] compared to overweight/obese women [19.0 (25.3)]. This finding may reflect greater dietary modification among overweight/obese women who are more likely to receive medical advice or actively adopting healthier eating patterns to manage weight and metabolic complications related to PCOS. Normal weight women with PCOS may perceive less urgency to modify dietary habits due to the absence of visible weight-related concerns. The Mediterranean diet

Table 3. Mediterranean diet adherence, quality of life and mental health status of PCOS women

Parameter	Underweight/normal n=45, n (%)	Overweight/obese n=75, n (%)	Total n=120, n (%)	*p*
Mental health score status[a]	20.0 (3.5)	17.0 (6.0)	18.0 (5.0)	0.001*
MD adherence[b]				0.001*
Low	8.0 (17.8)	19.0 (25.3)	27.0 (22.5)	
Moderate	21.0 (46.7)	52.0 (69.3)	73.0 (60.8)	
High	16.0 (35.6)	4.0 (5.3)	20.0 (16.7)	
WHOQOL (mean±SD)				
Physical[c]	64.3±21.4	67.9±17.9	67.9±21.4	0.349
Psychological[c]	58.3±20.8	62.5±16.8	60.4±16.7	0.800
Social relationships[c]	61.2±18.2	60.7±17.9	60.9±17.9	0.863
Environment[c]	58.5±15.3	55.6±15.4	56.8±15.4	0.349

[a]Tested using Mann Whitney (median (IQR); [b]Tested using Chi Square (n (%)); [c]Tested using Independent t-test (Mean±SD); *Significant at p<0.001; MD: Mediterranean Diet; PCOS: Polycystic Ovarian Syndrome; WHQOL: World Health Organization Quality of Life

is rich in antioxidants and may improve insulin resistance, reduce androgen levels, and regulate the menstrual cycle (Ajorlouie *et al.* 2025).

In table 4, the vitamin D, vitamin C, folic acid, iron, and calcium intake were the total intake from diet and dietary supplements. As for multivitamins, especially vitamin B, the majority of participants could not remember the multivitamin dosage. Thus, the B-vitamins intakes reported in Table 4 were just the data from dietary intake alone and not including supplementation. In addition, the current study reported an under-reporting prevalence of 80% and no over-reporting were recorded.

PCOS women who were underweight/normal-weight demonstrated significantly higher sugar intake (61±21 g) compared to overweight/obese women (49±25 g) (p<0.001). This may reflect greater dietary restriction among overweight/obese individuals, possibly due to weight management efforts or prior dietary counselling. Nevertheless, increased sugar consumption in lean women is clinically important, given that PCOS is commonly linked to insulin resistance regardless of BMI, and high intake of free sugars may exacerbate postprandial hyperglycaemia and increase long-term diabetes risk (Toosy *et al.* 2018).

For micronutrients, underweight/normal-weight women had significantly higher selenium intake [49.0 (37.0) µg], vitamin D intake [47.8 (1,020.1) IU], iron intake [11.0 (28.0) mg], and vitamin C intake [47.8 (86.7) mg] compared to overweight/obese women (all p<0.001). These differences may reflect overall better diet quality among lean women with PCOS. Selenium is primarily obtained from nuts (particularly Brazil nuts), seafood, eggs, and whole grains, and functions as an essential component of antioxidant enzymes such as glutathione peroxidase, which may help reduce oxidative stress implicated in PCOS-related metabolic dysfunction (Dobrzynska *et al.* 2023). Vitamin D intake is mainly derived from fortified dairy products, fatty fish, eggs, and supplements, and plays a role in insulin sensitivity and hormonal regulation, both of which are commonly impaired in PCOS (Argano *et al.* 2023). Iron is obtained from red meat, poultry, fish, legumes, and fortified cereals, and is essential for oxygen transport and energy metabolism, however, excessive or inadequate iron status may contribute to oxidative stress and metabolic disturbances. Vitamin C is found in fruits and vegetables such as citrus fruits, guava, berries, peppers, and leafy greens, and contributes to antioxidant defence and may improve insulin sensitivity (Argano *et al.* 2025). Overall, these findings suggest that women with lower BMI demonstrated relatively higher intake of key micronutrients associated with antioxidant activity and metabolic regulation. However, despite these differences, the median intakes of several micronutrients particularly vitamin D and vitamin C remain below recommended dietary allowances in both BMI groups, indicating that overall intake is still suboptimal in this PCOS population.

After adjusting for age, income and physical activity, there was significance differences in education years (OR= 0.359, 95% CI:0.142–0.908, p=0.030). Higher education years lowers the risk of being in the overweight/obese category. Besides that, mental health status assessed using GHQ-12 showed worsening mental health in the underweight and normal group (OR=0.627, 95% CI:0.438–0.898, p=0.011). Furthermore, higher

Table 4. Dietary intake according to BMI categories of PCOS women

Parameter	Underweight/normal n=45, n (%)	Overweight/obese n=75, n (%)	Total (n=120), n (%)	*p*
Calories intake[a]	1,391 (688)	1,337 (499)	1,343 (550)	0.740
Carbohydrate (g)[a]	213 (128)	194 (92)	195 (82)	0.860
Protein (g)[a]	60 (55)	53 (26)	55 (33)	0.121
Fat (g)[a]	39 (22)	34 (28)	36 (23)	0.584
Sugars (g) (mean±SD)[b]	61±21	49±25	53±24	0.010*
Fiber(g)[a]	15 (12)	13 (10)	13 (10)	0.890
Vitamin A (IU)[a]	483 (1384)	587 (1321)	580 (1320)	0.786
Vitamin E (mg)[a]	0.9 (0.7)	0.9(0.8)	1.0 (0.8)	0.591
Vitamin K (mcg)[a]	6.1 (11.5)	6.5 (8.2)	6.2 (10.2)	0.916
Vitamin B1 (mg)[a]	0.7 (0.6)	0.6 (0.5)	0.6 (0.5)	0.106
Vitamin B2 (mg)[a]	0.6 (0.4)	0.6 (0.4)	0.7 (0.4)	0.231
Vitamin B3 (mg)[a]	12.1(10.4)	10.1 (7.9)	10.9 (8.7)	0.051
Vitamin B6 (mg)[a]	0.5 (0.5)	0.3 (0.6)	0.4 (0.5)	0.136
Vitamin B12 (mcg)[a]	0.6 (1.3)	0.9 (1.3)	0.9 (1.3)	0.263
Potassium (mg)[a]	725.4 (241.9)	713.9 (511.0)	714.9 (479.3)	0.743
Sodium (mg) (mean±SD)[b]	3,304.4±1,679.3	2,525.9±1,161.0	2,813.7±1,419.7	0.080
Zinc (mg)[a]	3.6 (2.6)	2.6(3.0)	3.1 (2.6)	0.264
Cholesterol (mg)[a]	91 (111)	1324 (186)	96 (165)	0.382
Selenium (mcg)[a]	49.6 (37.0)	40.6 (34.8)	43.6 (32.9)	0.046*
Vitamin D (IU)[a]	47.8 (1020.1)	24.4 (35.8)	31.9 (119.5)	0.029*
Iron (mg)[a]	11.0 (28.2)	9.6 (10.1)	9.7 (12.0)	0.029*
Calcium (mg)[a]	310.9 (313.9)	277.7 (240.1)	278.8 (280.8)	0.336
Folic acid (mcg)[a]	232.3 (264.2)	205.9 (175.8)	222.0 (202.5)	0.193
Vitamin C (mg)[a]	47.8 (86.7)	20.9 (40.0)	25.7 (88.7)	0.015*

[a]Tested using Mann Whitney [Median (IQR)]; [b]Tested using Independent t-test (Mean±SD); *Significant at p<0.001; g: Gram; PCOS: Polycystic Ovarian Syndrome; SD: Standard Deviation, IU: International Unit, mg: Milligram; mcg: Microgram; Total indicated the total intake from diet and supplement

waist circumference significantly increased the odds of being overweight or obese (OR=1.352, 95% CI:1.145–1.596, p<0.001). PCOS women with higher education have better awareness of the dietary recommendations, engage in regular physical activity and adopt healthier eating behaviours. In addition to that, better mental health may promote healthier eating behaviours, improved motivation for physical activity, and reduced emotional eating in the overweight/obese group. In contrast, higher waist circumference, reflecting abdominal obesity, increased the risk of being overweight/obese (OR=1.352, 95% CI:1.145–1.596), indicating a risk factor. This may be explained by the close relationship between central adiposity, insulin resistance, metabolic dysfunction, and hormonal imbalance commonly observed in women with PCOS (Table 5).

The current study demonstrated that higher education was associated with a reduced likelihood of overweight and obesity. This finding is consistent with a large cross-sectional study in Saudi Arabia found that individuals with lower educational levels had a greater risk of obesity than those with college education. Individuals with lower educational attainment, particularly illiterate participants or those with only primary education, were more likely to be obese than their counterparts with higher education levels (Mosli *et al.* 2020). Similarly, a cross-sectional online survey among female students at two universities in northern Jordan found that higher education levels were associated with a lower likelihood of weight gain. Increasing awareness and disseminating information about PCOS is essential to ensure that women with PCOS are better informed and can manage their health more effectively (Alshdaifat *et al.* 2021).

Women with PCOS who were underweight or of normal BMI were more likely to have poor mental health status. Although obesity is commonly linked with depression, this finding suggests that psychological distress in PCOS is not solely dependent on excess body weight. One possible explanation is that women with PCOS who are not overweight may still experience pronounced hyperandrogenic symptoms such

Table 5. Factors associated with body mass index among PCOS women

Parameters	SE	*p*	OR (95% CI)
Years of education	0.474	0.030*	0.359 (0.142−0.908)
Mental health status	0.183	0.011*	0.627 (0.438−0.898)
Mediterranean diet adherence[a]	0.244	0.107	0.675 (0.418−1.089)
Duration of PCOS disease	0.012	0.360	1.011 (0.988−1.035)
Vitamin D	0.000	0.151	0.999 (0.999−1.000)
Selenium	0.017	0.144	0.973 (0.931−0.009)
Iron	0.088	0.246	0.903 (0.760−1.073)
Sugar	0.025	0.715	0.991 (0.945−1.040)
Waist circumference	0.085	0.001*	1.352 (1.145−1.596)

*Significance level: p<0.05; SE: Standard Error; CI: Confidence Interval; GHQ12: General Health Questionnaire; MEDAS: Mediterranean Diet Adherence Screener; IPAQ: International Physical Activity Questionnaire; PCOS: Polycystic Ovary Syndrome; OR: Odd Ratio

as hirsutism, acne, alopecia, and menstrual irregularities, which can negatively affect body image, femininity perception, and self-esteem. These visible symptoms may contribute to psychological distress regardless of body weight status. Evidence from previous studies indicates that clinical symptoms of PCOS, particularly those impacting appearance and reproductive function are strongly correlated with diminished quality of life, as well as elevated anxiety and depressive symptoms (Guidi *et al.* 2018; Sarwer *et al.* 2019). In addition to PCOS-specific symptoms, general psychosocial stressors such as academic pressure, financial strain, or family-related challenges may further exacerbate psychological distress (Li *et al.* 2024). However, the present findings suggest that the burden of visible PCOS symptoms and reproductive concerns may play a more central role than body weight alone in influencing mental well-being.

Our study found that women who are overweight/obese have a greater Waist Circumference (WC) than women who are underweight/normal. Waist circumference is an indicator of abdominal obesity (Bhattacharya *et al.* 2021). Adipose tissue, which secretes a variety of adipokines that affect metabolism, tissue sensitivity to insulin, and reproductive function, is another significant and active endocrine organ. There is strong evidence that women with PCOS have significantly lower adiponectin levels than healthy women, irrespective of obesity status (Chen *et al.* 2014). Other adipokines with abnormal concentrations in women with PCOS include leptin and resistin, which are found in higher concentrations and exacerbate obesity-related conditions such as insulin resistance (Gupta *et al.* 2017).

The strength of this study is that it comprehensively examines factors associated with body weight status among women with PCOS. Given the limited regional data on PCOS-related obesity and its determinants, this study provides important baseline epidemiological evidence that can inform future intervention and prevention strategies. On the other hand, the limitations of this study include the lack of biochemical assessments such as hormonal profile, lipid parameters and insulin resistance. These biomarkers are important in understanding the metabolic and endocrine mechanism underlying body weight status among women with PCOS. Besides that, the dietary intake and physical activity data can be subjected to potential under-or-over reporting.

CONCLUSION

Abdominal obesity was associated with increased BMI in overweight and obese women with PCOS, potentially leading to various non-communicable diseases. Moreover, low education and good mental health status were the factors leading to weight gain among the overweight and obese PCOS women. Holistic management strategies for PCOS should extend beyond psychological distress to include lifestyle behaviours, health literacy, and dietary practices, even among those with good mental health. Given the observed relationship between dietary intake and BMI status, nutrition interventions should emphasize improving overall diet quality, increasing intake of nutrient-dense foods, and promoting balanced energy consumption to support healthy weight management. Future studies should develop intervention programs that integrate dietary behaviour modification, physical

activity promotion, health literacy enhancement, and long-term metabolic risk reduction to prevent excessive weight gain among women with PCOS.

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DECLARATION OF CONFLICT OF INTEREST

The authors declared no conflict of interest.

DECLARATION OF GENERATIVE AI IN SCIENTIFIC WRITING

AI was not used for writing this manuscript. Authors only used Grammarly software for checking mistakes in grammar after completing the manuscript writing.

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