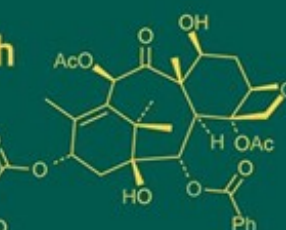


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Impact of structured nutrition education on women with polycystic ovary syndrome: A preventive and corrective approach

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ABSTRACT

Polycystic Ovary Syndrome (PCOS) is a common endocrine and metabolic disorder affecting women of reproductive age and is associated with menstrual irregularities, hyperandrogenism, metabolic disturbances, and lifestyle-related risk factors. Adequate nutrition, physical activity, and lifestyle modification are important components of PCOS management. The present study was undertaken to assess nutritional and lifestyle-related factors and evaluate the effect of structured preventive and corrective nutrition education among young women with PCOS. A comparative experimental design was adopted among 120 women aged 18–25 years diagnosed with PCOS in Guntur, Andhra Pradesh. Participants were purposively selected and equally allocated into experimental ($n = 60$) and control ($n = 60$) groups. Baseline and post-intervention assessments included dietary intake, nutrient intake, and physical activity level. Dietary intake was assessed using a three-day 24-hour dietary recall, and nutrient intake was calculated using the Indian Food Composition Tables and compared with ICMR-NIN recommendations. Physical activity was assessed using Physical Activity Ratio and Physical Activity Level (PAL). The experimental group received 15 structured nutrition education sessions over three months through an educational booklet, visual materials, demonstrations, and practical meal-planning guidance. Before intervention, both groups showed inadequate intake of selected micronutrients, particularly calcium, vitamin C, and vitamin D, while energy and several macronutrients were relatively high. Baseline nutrient intake was generally comparable between the groups. After intervention, significant between-group differences were observed in energy, protein, fat, carbohydrate, fibre, iron, calcium, vitamin C, folic acid, and vitamin D intake ($p < 0.05$). The proportion of moderately active participants increased from 66.7% to 95.0% in the experimental group, compared with 85.0% to 91.7% in the control group. The findings indicate that structured nutrition education was associated with improvements in selected dietary and physical activity indicators among young women with PCOS. Regular nutrition education, balanced dietary practices, adequate micronutrient intake, and appropriate physical activity should be encouraged as components of comprehensive PCOS management.

Keywords: Polycystic Ovary Syndrome (PCOS), Nutrition Education, Dietary Intake, Nutritional Status, Physical Activity, Lifestyle Modification

2.Introduction

Polycystic Ovary Syndrome (PCOS) is a common endocrine and metabolic disorder affecting women during the reproductive years. It is characterized by hormonal disturbances, impaired ovulation, hyperandrogenism, and, in some women, polycystic ovarian morphology. PCOS has important reproductive, metabolic, psychological, and cardiovascular consequences. According to the World Health Organization (WHO, 2026), approximately 10–13% of women of reproductive age worldwide are affected, with many remaining undiagnosed. In India, reported prevalence varies from 3.7% to 22.5% depending on diagnostic criteria and study population (Shanmugapriya *et al.*, 2024)^[1]. The condition develops through complex genetic, hormonal, metabolic, environmental, and lifestyle interactions, with insulin resistance and hyperinsulinemia contributing to hyperandrogenism and reproductive dysfunction (Teede *et al.*, 2023)^[2]. Common manifestations include menstrual irregularities, infertility, acne, hirsutism, and weight-related problems, while long-term risks include type 2 diabetes, dyslipidemia, hypertension, metabolic syndrome, cardiovascular disease, sleep apnoea, and endometrial abnormalities (WHO, 2026) (Teede *et al.*, 2023)^[3]. PCOS also affects psychological and social well-being, with women experiencing anxiety, depression, body image concerns, reduced self-esteem, and impaired quality of life. In India, urbanization, dietary changes, reduced physical activity, sedentary behaviour, stress, and altered sleep patterns may contribute to the increasing burden of PCOS (Pathak *et al.*, 2015)^[4].

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Lifestyle modification is a key component of PCOS management. The 2023 International Evidence-Based Guideline recommends healthy eating, regular physical activity, behavioural strategies, and appropriate weight management irrespective of body weight (Teede *et al.*, 2023)^[5]. Diets emphasizing nutrient-dense foods, adequate fibre, low-glycemic-index carbohydrates, healthy fats, and reduced refined sugars and saturated fats may support metabolic and reproductive health. In overweight women, modest weight reduction may improve menstrual regularity, ovulation, fertility, and metabolic risk factors (Faghfoori *et al.*, 2017)^[6] (Gautam *et al.*, 2025)^[7]. Despite increasing awareness, inadequate knowledge regarding PCOS, nutrition, physical activity, and long-term health risks remains a barrier to effective self-management. Structured, patient-centered education can improve knowledge, dietary practices, physical activity, treatment adherence, and confidence in managing PCOS (Mani *et al.*, 2015)^[8] (Teede *et al.*, 2023)^[9]. A multidisciplinary approach involving gynecology, endocrinology, nutrition, psychology, and exercise-related care is also important (Malik *et al.*, 2014)^[10]. However, further evidence is needed on the effectiveness of structured nutrition education and lifestyle interventions among young Indian women with PCOS. Therefore, the present study was undertaken to assess nutritional and lifestyle-related factors and evaluate the role of structured education in promoting healthier practices among young women with PCOS.

3. Materials and Methods

Study area and design

The study was carried out in Guntur, Andhra Pradesh, India. A comparative (experimental versus control) design was adopted. A total of 120 women aged 18–25 years with diagnosed PCOS were included, with 60 participants each in the experimental and control groups. A similar study was conducted by Wang *et al.* (2026)^[7, 11], who carried out a 6-month, single-centre, parallel-group randomized controlled trial among 120 female college students aged 18–22 years with PCOS, with 60 participants each allocated to the intervention and control groups. **sampling technique**

A purposive sampling technique was used to select 120 women aged 18–25 years who were diagnosed with PCOS and fulfilled the specified inclusion criteria. The selected participants were then allocated equally into the experimental group ($n = 60$) and control group ($n = 60$). A similar two-group allocation was reported by Abdelhafez *et al.* (2023)^[12], who included 124 women with PCOS and allocated them equally into an educational group ($n = 62$) and a control group ($n = 62$).

Inclusion criteria

Women aged 18–25 years, clinically diagnosed with PCOS, residing in Guntur, willing to participate in the study, and able to understand Telugu or English were included. Similar eligibility criteria for women with PCOS have been reported by Ganie *et al.* (2024)^[13, 14], who studied women aged 18–40 years with PCOS in a nationwide Indian study.

Exclusion criteria

Women who were pregnant or lactating, those with other major endocrine or metabolic disorders, those receiving intensive dietary or lifestyle intervention elsewhere, and those unwilling to participate or unable to complete the study were excluded. Similar exclusion criteria were reported by Srinivasan *et al.* (2024)^[15], who excluded pregnant women and women with diabetes, hypertension, endocrine or cardiovascular disorders, as well as those receiving medical management for PCOS or infertility treatment or following an existing exercise programme.

Study period

The study was conducted over a period of 3 months in Guntur, Andhra Pradesh, India. The study period included participant selection, baseline assessment, implementation of the nutrition education

intervention, follow-up assessment, and data collection. Similarly, Wang *et al.* (2024)^[16] conducted a structured lifestyle intervention among women with PCOS over a defined intervention period, with baseline and follow-up assessments to evaluate the intervention outcomes.

Ethical clearance

Ethical clearance was obtained from the Institutional Ethics Committee of before commencement of the study. The purpose and procedures of the study were explained to all participants, and written informed consent was obtained before data collection. Participation was voluntary, and confidentiality of the information provided by the participants was maintained throughout the study. Similarly, the study by Kaczmarek *et al.* (2024)^[17] was conducted after approval from the Bioethics Committee of the Poznan University of Medical Sciences, and informed consent was obtained from all participants before their enrolment.

Informed consent details

Before the commencement of the study, the purpose, procedures, potential benefits, and voluntary nature of participation were explained clearly to all eligible participants. The participants were informed that they had the right to participate or withdraw from the study at any time without any consequences. They were also assured that the information collected would be kept confidential and used only for research purposes. Written informed consent was obtained from each participant before enrolment and data collection. Participants were given an opportunity to clarify their doubts before providing consent. No personal information identifying the participants was disclosed in the research report. Similar informed-consent procedures were followed by Liu *et al.* (2024)^[18, 19], who obtained signed written informed consent, informed participants about the voluntary nature of participation and their right to withdraw, maintained privacy of the collected information, and used unique study identification numbers to protect participants' personal information.

Intervention

Describe the preventive and corrective nutrition education given to the experimental group

The experimental group received preventive and corrective nutrition education related to PCOS, while the control group received routine care without the structured nutrition education intervention during the study period.

The education programme covered PCOS and its causes and risk factors, healthy dietary practices, meal planning, low-glycaemic-index foods, adequate intake of vegetables, fruits, pulses, whole grains and other fibre-rich foods, appropriate protein and healthy-fat sources, limiting refined cereals, added sugars, sweets and unhealthy fats, appropriate portion sizes, hydration, regular physical activity, weight management and healthy lifestyle practices.

The intervention was delivered through individual/group nutrition education sessions using a structured educational booklet and visual teaching materials. The educational materials were presented in simple language, with Telugu explanations where required, to facilitate better understanding among the participants. Demonstrations and practical examples of healthy food choices and meal planning were also provided.

The nutrition education programme consisted of 15 sessions, conducted once per week, with each session lasting approximately 45 minutes, over a period of 3 months. Participants were followed up at regular intervals to reinforce the recommended dietary and lifestyle practices and to assess adherence to the intervention. A similar dietary intervention was reported by Foscolou *et al.* (2024)^[20], who provided personalized Mediterranean-diet plans to adolescent females with PCOS at regular intervals and evaluated dietary and health outcomes at baseline and after 3 months.

Assessment of nutritional status

Nutritional status may be defined as the condition of health as influenced by the intake and utilization of nutrients. Methods used to assess nutritional status include dietary assessment, anthropometry, and clinical assessment. This is supported by **Locks et al. (2025)**^[21], who described dietary, anthropometric, biochemical, and clinical/physical assessments as commonly used approaches for evaluating nutritional status.

Dietary and nutrient intake

Dietary habits vary by socioeconomic status, regional customs, and cultural practices, and assessing dietary intake provides valuable information for evaluating nutritional status and the relationship between nutrient intake and the risk of deficiency and chronic disease. We assessed dietary intake using a 24-hour dietary recall. We conducted a baseline dietary survey over three non-consecutive days, including two weekdays and one weekend day. Standardized household measures, such as vessels, cups and paper discs, were used to estimate portion sizes. Participants recalled all foods and beverages consumed during the previous 24 hours, excluding fasting and feasting days. We recorded meal type (breakfast, lunch, snacks, and dinner), recipes, raw ingredients used in each preparation, and the total quantity of food prepared and consumed. We calculated each participant's average daily intake of raw food ingredients. This dietary assessment approach is supported by **Motwani et al. (2024)**^[22], who assessed dietary macronutrient and micronutrient intake among Indian adults using dietary recall methods and evaluated nutrient adequacy.

After verification, the completed schedules were coded and serially numbered for data processing. We quantified daily intake of the major food groups (cereals, pulses, milk and milk products, fruits, vegetables, oils, fats and sugars). We computed intake of energy, protein, fat, carbohydrates, dietary fiber, iron, calcium, vitamin C, folic acid, and vitamin D using the Indian Food Composition Tables. **Motwani et al. (2024)**^[23, 24] similarly evaluated macronutrient and micronutrient intake and used the Indian Food Composition Table (IFCT) as part of the dietary assessment methodology. We compared the computed intake with the Recommended Dietary Allowances (RDA) for adult women from the Indian Council of Medical Research–National Institute of Nutrition **ICMR (2020)**^[25]. **Motwani et al. (2024)**^[24] also assessed nutrient adequacy using Indian dietary reference values, supporting the comparison of calculated nutrient intake with recom-

mended requirements. Adequacy was expressed as the Nutrient Adequacy Ratio (NAR):

$$NAR(\%) = \frac{\text{Nutrient intake}}{RDA} \times 100$$

Adequacy of nutrient intake was categorized into four groups: 100% of RDA and above (group I), 75–99.9% (group II), 50–74.9% (group III) and below 50% (group IV).

Physical activity

Physical activity was assessed using a structured questionnaire on the self-reported type, frequency, duration and intensity of activities such as walking, running and swimming. We also collected information on occupational activities, including the nature of work, working hours, and level of physical exertion. We estimated the Physical Activity Ratio (PAR) for each activity performed over 24 hours and aggregated the PAR values to obtain each participant's Physical Activity Level (PAL). A similar approach was used in the ICMR–INDIAB survey-21, in which physical activity was assessed across occupational, household, transportation and leisure domains, with energy expenditure calculated using activity-specific Physical Activity Ratios and PAL derived from 24-hour energy expenditure relative to basal metabolic rate (**Anjana et al., 2025**)^[13]. PAR values were assigned according to the Indian Council of Medical Research recommendations for adult females. Participants were classified as sedentary (PAL 1.40–1.69) or moderately active (PAL 1.70–1.99) according to the WHO classification. The same PAL categories of 1.40–1.69 for sedentary activity and 1.70–1.99 for moderate activity were also applied in the ICMR–INDIAB survey-21 (**Anjana et al., 2025**)^[13].

Statistical analysis

Data are presented as mean±standard deviation. Mean nutrient intake with the RDA using a one-sample *t*-test, and we compared the experimental and control groups at each time point using an independent-samples *t*-test. We calculated change in intake as the post-intervention mean minus the pre-intervention mean for each group. We considered *p* < 0.05 statistically significant. And also data was analysed by using SPSS software.

4.Result and Discussion

Table 1. Comparison of mean daily nutrient intake with the Recommended Dietary Allowance (RDA) in the experimental and control groups before intervention

Nutrient	RDA	Experimental group	t-value	Control group	t-value
Energy (kcal)	1900	2558 ± 625.2	8.15	2389 ± 546.6	6.93
Protein (g)	46	54.97 ± 10.6	6.55	55.2 ± 14.4	4.92
Fat (g)	25	35.2 ± 11.1	7.12	45.0 ± 12.6	12.26
Carbohydrates (g)	285	385.5 ± 93.5	8.33	358.4 ± 81.9	6.93
Fibre (g)	30	38.9 ± 10.2	6.76	43.7 ± 9.6	11.0
Iron (mg)	29	21.6 ± 11.7	−4.90	31.2 ± 21.1	0.82
Calcium (mg)	1000	703 ± 151.4	−15.16	754 ± 214.3	−8.88
Vitamin C (mg)	65	49.6 ± 17.0	−6.95	58.9 ± 43.5	−1.07
Folic acid (µg)	220	353 ± 125.3	8.22	340 ± 178.6	5.22
Vitamin D (µg)	15	9.8 ± 4.0	−10.07	13.9 ± 9.6	−0.89

Values are mean±SD (*n* = 60 per group); *t*-values are from a one-sample *t*-test against the RDA.

The **table 1** presents the comparison of mean daily nutrient intake with the Recommended Dietary Allowance (RDA) among the experimental and control groups before intervention. In the experimental group, the mean intake of energy (2558 ± 625.2 kcal), protein (54.97 ± 10.6 g), fat (35.2 ± 11.1 g), carbohydrates (385.5 ± 93.5 g), fibre (38.9 ± 10.2 g), and folic acid (353 ± 125.3 µg) was higher than the respective RDA values, whereas iron (21.6 ± 11.7 mg), calcium (703

± 151.4 mg), vitamin C (49.6 ± 17.0 mg), and vitamin D (9.8 ± 4.0 µg) were below the recommended levels. Similarly, in the control group, energy (2389 ± 546.6 kcal), protein (55.2 ± 14.4 g), fat (45.0 ± 12.6 g), carbohydrates (358.4 ± 81.9 g), fibre (43.7 ± 9.6 g), iron (31.2 ± 21.1 mg), and folic acid (340 ± 178.6 µg) were higher than the RDA, while calcium (754 ± 214.3 mg), vitamin C (58.9 ± 43.5 mg), and vitamin D (13.9 ± 9.6 µg) were lower than the recommended levels. These findings are comparable with **Ganie et al.**

(2019)^[14, 26], who reported variations in energy and macronutrient intake among Indian women with PCOS according to dietary patterns. Vitamin D intake was particularly inadequate, with the experimental group consuming 9.8 ± 4.0 µg/day compared with the RDA of 15 µg/day ($t = -10.07$), while the control group consumed 13.9 ± 9.6 µg/day ($t = -0.89$). Thus, both groups had lower vitamin D intake than recommended, with a greater difference observed in the experimental group. (Ganji *et al.*, 2012)^[27] similarly reported a high prevalence of vitamin D insufficiency among women with PCOS, highlighting the importance of adequate vitamin D status in this population.

Overall, the pre-intervention findings indicate an imbalanced nutrient intake in both groups, characterized by relatively higher energy and macronutrient intake and inadequate intake of selected micronutrients, particularly calcium, vitamin C, and vitamin D. These findings emphasize the need for appropriate dietary education and corrective nutritional intervention among women with PCOS.

Values are mean±SD ($n = 60$ per group); Significant, $p < 0.05$; very significant, $p < 0.01$; highly significant, $p < 0.001$.

The table 2 presents the comparison of mean nutrient intake between the experimental and control groups at pre-test. The mean energy intake was 2558 ± 625.2 kcal in the experimental group and 2389 ± 546.6 kcal in the control group ($t = 1.50$, $p = 0.117$), while protein intake was 54.97 ± 10.6 g and 55.3 ± 14.4 g, respectively ($t =$

-0.1577 , $p = 0.8749$). Similarly, no statistically significant differences were observed in fat, carbohydrates, and fibre intake ($p > 0.05$), indicating comparable macronutrient intake between the groups at baseline. (Huber-Buchholz *et al.* 2006)^[28] similarly reported generally comparable energy and macronutrient intakes among women with PCOS and controls.

No statistically significant differences were observed in micronutrient intake between the groups. Mean iron intake was 21.6 ± 11.7 mg in the experimental group and 31.2 ± 21.1 mg in the control group ($p = 0.1031$), calcium intake was 703 ± 151.4 mg and 754 ± 214.3 mg ($p = 0.1380$), and vitamin C intake was 49.6 ± 17.0 mg and 58.9 ± 43.5 mg ($p = 0.1272$), respectively. Folic acid intake was 353.1 ± 125.3 µg in the experimental group and 340.4 ± 178.6 µg in the control group ($p = 0.6508$), while vitamin D intake was 9.8 ± 4.0 µg and 13.9 ± 9.6 µg, respectively ($p = 0.2612$). These findings are consistent with (Barrea *et al.*, 2019)^[29], who reported generally similar dietary and nutrient intake patterns among women with PCOS and comparison groups.

Overall, none of the assessed nutrients showed a statistically significant difference between the experimental and control groups at pre-test ($p > 0.05$), confirming that the groups were comparable in baseline nutrient intake. This baseline similarity provides an appropriate basis for evaluating changes following the educational intervention also emphasized the importance of healthy dietary behaviours and dietary patterns in women with PCOS.

Table 2. Comparison of mean nutrient intake between the experimental and control groups before intervention

Nutrient	Experimental group	Control group	t-value	p-value	Significance
Energy (kcal)	2558 ± 625.2	2389 ± 546.6	1.50	0.117	NS
Protein (g)	54.97 ± 10.6	55.2 ± 14.4	-0.157	0.874	NS
Fat (g)	35.2 ± 11.1	45.0 ± 12.6	-1.918	0.057	NS
Carbohydrates (g)	385.5 ± 93.5	358.4 ± 81.9	1.575	0.117	NS
Fibre (g)	38.9 ± 10.2	43.7 ± 9.6	-0.660	0.510	NS
Iron (mg)	21.6 ± 11.7	31.2 ± 21.1	-1.642	0.103	NS
Calcium (mg)	703 ± 151.4	754 ± 214.3	-1.492	0.138	NS
Vitamin C (mg)	49.6 ± 17.0	58.9 ± 43.5	-1.53	0.127	NS
Folic acid (µg)	353 ± 125.3	340 ± 178.6	0.45	0.650	NS
Vitamin D (µg)	9.8 ± 4.0	13.9 ± 9.6	1.128	0.261	NS

Table 3. Comparison of post-intervention mean daily nutrient intake with the Recommended Dietary Allowance (RDA) in the experimental and control groups

Nutrient	RDA	Experimental group	t-value	Control group	t-value
Energy (kcal)	1900	2007 ± 35.47	23.48	1847 ± 314.62	-1.29
Protein (g)	46	56.34 ± 1.75	45.72	51.98 ± 14.59	3.17
Fat (g)	25	25.15 ± 8.70	0.13	29.31 ± 12.56	2.65
Carbohydrates (g)	285	301.12 ± 5.32	23.46	277.12 ± 47.19	-1.29
Fibre (g)	30	36.55 ± 2.56	19.73	34.41 ± 2.72	12.53
Iron (mg)	29	31.14 ± 1.58	10.49	29.87 ± 0.65	10.26
Calcium (mg)	1000	989.76 ± 22.99	-3.44	1000 ± 13.98	0.12
Vitamin C (mg)	65	82.94 ± 2.77	50.13	79.88 ± 1.65	69.79
Folic acid (µg)	220	298 ± 10.72	56.66	298 ± 7.74	78.41
Vitamin D (µg)	15	16.99 ± 2.66	5.80	15.04 ± 0.70	0.44

Values are mean±SD ($n = 60$ per group); t-values are from a one-sample t-test against the RDA.

The findings showed that the experimental group had a mean energy intake of 2007 ± 35.47 kcal/day, which was higher than the stated RDA of 1900 kcal/day ($t = 23.49$), while the control group had 1847 ± 314.62 kcal/day, slightly below the reference value ($t = -1.29$). Protein intake was above the stated RDA in both groups, with 56.34 ± 1.75 g/day in the experimental group and 51.98 ± 14.59 g/day in the control group. Fat intake was 25.15 ± 8.70 g/day in the experimental group, close to the RDA of 25 g/day, compared with 29.31 ± 12.56

g/day in the control group. Carbohydrate intake was 301.12 ± 5.32 g/day in the experimental group and 277.12 ± 47.19 g/day in the control group, compared with the reference value of 285 g/day. These findings indicate variation in energy and macronutrient intake between the groups. Similar observations were reported by (Toscani *et al.* 2019)^[30], who found variations in dietary energy and macronutrient composition among women with PCOS and controls.

Dietary fibre intake was above the stated RDA of 30 g/day in both groups, with 36.55 ± 2.56 g/day in the experimental group and 34.41 ± 2.72 g/day in the control group. This relatively higher fibre intake

may support satiety, bowel function and postprandial glucose regulation. (Kazemi *et al.*, 2018)^[31] similarly highlighted the importance of increased dietary fibre through a pulse-based dietary pattern in women with PCOS. Iron intake was also above the stated RDA of 29 mg/day in both groups, with 31.14 ± 1.58 mg/day in the experimental group and 29.87 ± 0.65 mg/day in the control group.

Calcium intake was close to the recommended level, measuring 989.76 ± 22.99 mg/day in the experimental group and 1000 ± 13.98 mg/day in the control group, compared with the RDA of 1000 mg/day. Vitamin C intake was above the stated RDA of 65 mg/day in both groups, at 82.94 ± 2.77 mg/day in the experimental group and 79.88 ± 1.65 mg/day in the control group.

Folic acid intake was also above the stated RDA of 220 µg/day, with 298 ± 10.72 µg/day in the experimental group and 298.41

± 7.74 µg/day in the control group. Vitamin D intake was 16.99 ± 2.66 µg/day in the experimental group and 15.04 ± 0.70 µg/day in the control group, compared with the reference value of 15 µg/day. Although dietary vitamin D intake was adequate, intake alone does not establish vitamin D status, for which serum 25-hydroxyvitamin D is the appropriate biochemical indicator, while (Yao *et al.*, 2026)^[32] reported a high prevalence of vitamin D deficiency among women with PCOS, particularly in Asian populations.

Overall, the experimental group showed intake above the stated reference values for most nutrients, with calcium slightly below the specified level, while the control group also had adequate intake for most nutrients but slightly lower energy intake. The findings indicate variation in dietary intake according to food choices, lifestyle and dietary patterns.

Table 4. Comparison of post-intervention mean nutrient intake between the experimental and control groups

Nutrient	Experimental group	Control group	t-value	p-value	Significance
Energy (kcal)	2007 $\pm$ 35.47	1847 $\pm$ 314.62	3.91	< 0.001	Highly significant
Protein (g)	56.34 $\pm$ 1.75	51.98 $\pm$ 14.59	2.30	0.023	Significant
Fat (g)	25.15 $\pm$ 8.70	29.31 $\pm$ 12.56	-2.11	0.037	Significant
Carbohydrates (g)	301.12 $\pm$ 5.32	277.12 $\pm$ 47.19	3.91	< 0.001	Highly significant
Fibre (g)	36.55 $\pm$ 2.56	34.41 $\pm$ 2.72	4.44	< 0.001	Highly significant
Iron (mg)	31.14 $\pm$ 1.58	29.87 $\pm$ 0.65	5.76	< 0.001	Highly significant
Calcium (mg)	989.76 $\pm$ 22.99	1000.23 $\pm$ 13.98	-3.01	0.003	Significant
Vitamin C (mg)	82.94 $\pm$ 2.77	79.88 $\pm$ 1.65	7.35	< 0.001	Highly significant
Folic acid (µg)	298 $\pm$ 10.72	298.41 $\pm$ 7.74	-2.27	0.024	Significant
Vitamin D (µg)	16.99 $\pm$ 2.66	15.04 $\pm$ 0.70	5.49	< 0.001	Highly significant

Values are mean $\pm$ SD ($n = 60$ per group); independent-samples t -test ($df = 118$). NS, not significant; significant, $p < 0.01$; highly significant, $p < 0.001$.

The table 4 presents the comparison of mean nutrient intake between the experimental and control groups after intervention. The experimental group showed significantly higher mean energy intake (2007 ± 35.47 kcal/day) than the control group (1847 ± 314.62 kcal/day), with $t = 3.92$ and $p = 0.000151$. Protein intake was also significantly higher in the experimental group (56.34 ± 1.75 g/day) than in the control group (51.98 ± 14.59 g/day), with $t = 2.29$ and $p = 0.023314$. In contrast, fat intake was lower in the experimental group (25.15 ± 8.70 g/day) than in the control group (29.31 ± 12.56 g/day), with $t = -2.10$ and $p = 0.037378$. Carbohydrate intake was significantly higher in the experimental group (301.12 ± 5.32 g/day) compared with the control group (277.12 ± 47.19 g/day), with $t = 3.92$ and $p = 0.000151$. These findings indicate differences in macronutrient intake between the groups following the intervention. Similar observations regarding dietary energy and macronutrient patterns in women with PCOS were reported by (Toscani *et al.* 2019)^[33], (Sorensen *et al.*, 2012)^[34].

Dietary fibre intake was significantly higher in the experimental group (36.55 ± 2.56 g/day) than in the control group (34.41 ± 2.72 g/day), with $t = 4.40$ and $p < 0.001$. Similarly, iron intake was higher in the experimental group (31.14 ± 1.58 mg/day) than in the control group (29.87 ± 0.65 mg/day), with $t = 5.76$ and $p < 0.001$. The higher fibre intake may reflect greater consumption of whole grains, vegetables, fruits and legumes, while the difference in iron intake may indicate improved consumption of iron-rich foods. Kazemi *et al.* (2018)^[31] highlighted the importance of fibre-rich, pulse-based dietary patterns in women with PCOS.

Calcium intake was slightly lower in the experimental group (989 ± 22.99 mg/day) than in the control group (1000.23 ± 13.98 mg/day), with a significant difference ($t = -3.01$, $p = 0.003175$), although both groups were close to the reference value. Vitamin C intake was significantly higher in the experimental group (82.94 ± 2.77 mg/day) than in the control group (79.88 ± 1.65 mg/day), with $t = 7.36$ and $p < 0.001$, possibly reflecting greater consumption of fruits and vegetables. Folic acid intake showed a statistically significant difference be-

tween the groups (298 ± 10.72 vs. 298.41 ± 7.74 µg/day; $t = -2.28$, $p = 0.024665$), although the difference in mean values was very small.

Vitamin D intake was significantly higher in the experimental group (16.99 ± 2.66 µg/day) than in the control group (15.04 ± 0.70 µg/day), with $t = 8.77$ and $p < 0.001$. This may indicate improved intake of vitamin-D-containing or fortified foods following the intervention. However, dietary intake alone cannot establish vitamin D status, which is more appropriately assessed using serum 25-hydroxyvitamin D. (Guo *et al.*, 2020)^[35] reported evidence regarding the relevance of vitamin D in women with PCOS and its association with metabolic health.

Overall, the experimental group showed statistically significant differences from the control group for all assessed nutrients. The experimental group had higher mean intake of energy, protein, carbohydrate, fibre, iron, vitamin C, and vitamin D, while the control group had higher fat and calcium intake. These findings suggest that the dietary intervention was associated with improved differences in nutrient intake between the experimental and control groups. Similar evidence regarding dietary patterns and nutritional management in women with PCOS has been reported by (Moran *et al.*, 2003)^[36].

Table 6. Distribution of mean physical activity level (PAL) according to activity category before intervention

Group	Activity level (n)	Mean PAL	t-value
Experimental	Sedentary (20)	1.52 $\pm$ 0.08	-9.07
	Moderate (40)	1.94 $\pm$ 0.19	-11.5
Control	Sedentary (9)	1.51 $\pm$ 0.06	-7.8
	Moderate (51)	1.99 $\pm$ 0.18	-14.83
Total	Sedentary	1.52 $\pm$ 0.07	-12.46
	Moderate	1.97 $\pm$ 0.19	-18.41

Values are mean $\pm$ SD. Significant at 5%.

The baseline Physical Activity Level (PAL) of women with PCOS is presented in Table 6. The experimental group comprised 20 sedentary (33.3%) and 40 moderately active (66.7%) participants, while the

control group included 9 sedentary (15.0%) and 51 moderately active (85.0%) participants. Mean PAL among sedentary participants was 1.52 ± 0.08 in the experimental group and 1.51 ± 0.06 in the control group, whereas moderately active participants had mean PAL values of 1.94 ± 0.19 and 1.99 ± 0.18 , respectively. Overall, the mean PAL was 1.52 ± 0.07 for sedentary and 1.97 ± 0.19 for moderately active participants.

The observed PAL values were consistent with the FAO/WHO/UNU classification, with values around 1.40–1.69 representing sedentary/light activity and 1.70–1.99 representing moderate activity. Thus, the mean PAL values corresponded appropriately to the respective activity categories. The higher standard deviations among moderately active participants (0.18–0.19) compared with sedentary participants (0.06–0.08) suggest greater individual variation in the nature and intensity of daily activities.

The findings demonstrate variation in physical activity among women with PCOS. The experimental group had a higher proportion of sedentary participants (33.3%) than the control group (15.0%), while moderate activity was more common in the control group (85.0%) than the experimental group (66.7%). This baseline difference should be considered when interpreting subsequent intervention-related changes. (Kite *et al.* 2019)^[37] highlighted the importance of lifestyle interventions incorporating physical activity and dietary modification in improving anthropometric and metabolic outcomes in women with PCOS.

The present findings are also consistent with (Kazemi *et al.* 2022)^[18, 38], who reported significantly lower physical activity among women with PCOS compared with women without PCOS, although substantial heterogeneity was observed across studies. (Butt *et al.* 2024)^[39, 40] similarly reported differences in physical activity levels between women with PCOS and healthy controls. Differences between studies may partly reflect variations in assessment methods, as the present study used PAL whereas (Butt *et al.* 2024)^[6] used the IPAQ.

Overall, the baseline findings indicate two distinct activity patterns among the participants, with mean PAL values of approximately 1.51–1.52 among sedentary women and 1.94–1.99 among moderately active women. The higher proportion of sedentary participants in the experimental group represents an important baseline characteristic when evaluating subsequent changes following the intervention.

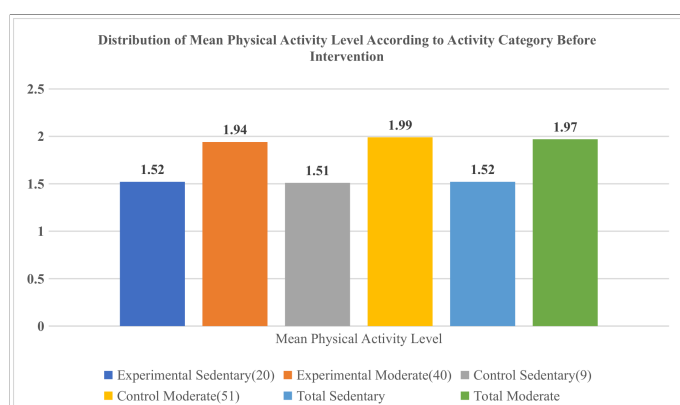


Figure 1. Distribution of Mean Physical Activity Level According to Activity Category Before Intervention

Table 7. Distribution of young women according to physical activity level (PAL) category after intervention

Group	Activity level (n)	Mean PAL	t-value
Experimental	Sedentary (3)	1.52 ± 0.08	-9.07
	Moderate (57)	1.94 ± 0.19	-11.5
Control	Sedentary (5)	1.48 ± 0.04	-8.42
	Moderate (55)	2.02 ± 0.14	-19.59
Total	Sedentary	1.44 ± 0.07	-11.94
	Moderate	2.07 ± 0.14	-21.21

Values are mean $\pm$ SD.

The table 7 indicated the distribution of young women in the experimental and control groups according to Physical Activity Level (PAL) after the nutrition intervention. In the experimental group, 57 (95.0%) participants were moderately active with a mean PAL of 1.94 ± 0.19 , while 3 (5.0%) remained sedentary with a mean PAL of 1.52 ± 0.08 . In the control group, 55 (91.7%) participants were moderately active with a mean PAL of 2.02 ± 0.14 , while 5 (8.3%) remained sedentary with a mean PAL of 1.48 ± 0.04 . The pooled mean PAL was 1.44 ± 0.07 for the sedentary category and 2.07 ± 0.14 for the moderate category. The within-group t-values were significant at the 5% level, indicating significant improvement in PAL.

The persistence of a small sedentary subgroup in both groups is consistent with (McVeigh *et al.* 2016)^[41], who reported that young women spent more than 60 percent of waking wear time in sedentary behavior and accumulated less than 40 minutes of moderate-to-vigorous physical activity per day. The predominance of moderate PAL in the present study is also supported by (Moitra, Madan and Verma 2021)^[42], who found that behaviour-focused nutrition education significantly improved activity-related knowledge, attitudes, and practices among Indian adolescents.

The post-intervention mean PAL values of 1.94–2.07 are noteworthy in relation to the classification reported by (Oshita and Myotsuzono 2021)^[43], who categorized PAL of 1.6–1.9 as moderate and values above 1.9 as high, with moderate-to-high PAL associated with better skeletal muscle mass index. The significant improvement observed in the control group should, however, be interpreted cautiously.

The findings are further supported by (Karmore, Ukey, and Sharma 2023)^[44], who reported significant improvements in activity-related and dietary outcomes following a combined diet and physical-activity intervention among young Indian adults. Similarly, (Sliwicka *et al.*, 2024)^[45] demonstrated that a 24-week physical activity programme in previously sedentary women improved body composition and glycolipid metabolism.

Overall, the findings indicate a favorable shift from sedentary to moderate physical activity after the intervention, with a slightly higher proportion of participants achieving moderate activity in the experimental group. The small proportion remaining sedentary highlights the need for continued individualized follow-up and reinforcement of healthy lifestyle practices to sustain improvements in physical activity.

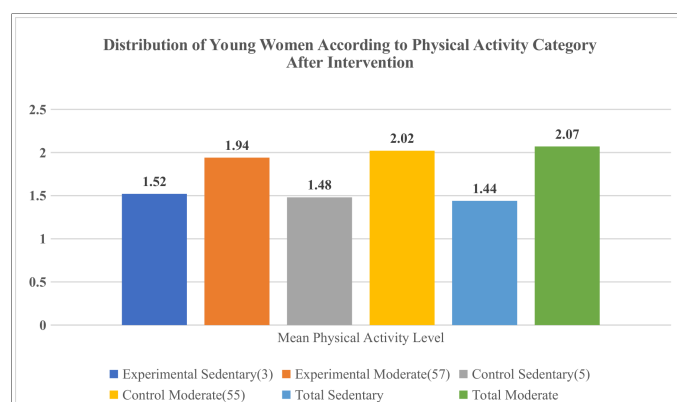


Figure 2. Distribution of Young Women According to Physical Activity Category After Intervention

5. Conclusion

The present study assessed dietary nutrient intake and physical activity among young women with PCOS and evaluated the role of structured nutrition education. Before the intervention, both groups showed an imbalanced nutrient intake, particularly inadequate calcium, vitamin C, and vitamin D intake, while the groups were generally comparable at baseline. Following the three-month nutrition education programme, significant differences were observed between the experimental and control groups in the intake of energy, protein, fat,

carbohydrates, fibre, iron, calcium, vitamin C, folic acid, and vitamin D. The experimental group showed higher intake of several important nutrients, particularly fibre, iron, vitamin C, and vitamin D. Physical activity also improved, with the proportion of moderately active participants increasing from 66.7% to 95.0% in the experimental group and from 85.0% to 91.7% in the control group. Overall, the findings suggest that structured nutrition education was associated with improvements in dietary intake and physical activity among young women with PCOS. Regular nutrition education focusing on balanced meals, adequate micronutrients, fibre-rich foods, appropriate portion sizes, and regular physical activity may support healthier lifestyle practices in women with PCOS. Long-term studies with larger samples and biochemical assessment are recommended to assess the sustainability of these improvements.

6. Recommendations

Regular nutrition education focusing on balanced dietary intake, adequate micronutrients, and appropriate physical activity should be provided to women with PCOS. Long-term follow-up studies with larger samples and biochemical assessment of nutritional status are recommended to evaluate the sustainability of these improvements.

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