An Interventional Study on the Effectiveness of Dietary Management among Women with Polycystic Ovarian Syndrome

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ABSTRACT

Polycystic ovary syndrome (PCOS) is a common endocrine and metabolic disorder affecting women of reproductive age and is frequently associated with obesity, insulin resistance, menstrual irregularities, and hyperandrogenism. Lifestyle modification, particularly dietary management and weight reduction, is considered the first-line therapy for overweight women with PCOS. The present prospective interventional study aimed to evaluate the effectiveness of dietary management on weight reduction, metabolic parameters, menstrual cyclicity, and quality of life among overweight women with PCOS.

The study was conducted over a period of 16 weeks among 25 overweight women aged 18–35 years diagnosed with PCOS. The dietary intervention was implemented in two phases: an initial 8-week meal replacement–based energy-restricted diet (1500 ± 150 kcal/day) for weight loss, followed by an 8-week weight maintenance phase involving either moderate carbohydrate restriction or moderate fat restriction, with emphasis on a low glycemic index diet. Anthropometric measurements, biochemical parameters, menstrual cycle, dietary intake, and quality of life were assessed at baseline and at regular intervals.

The results demonstrated a significant reduction in body weight, body mass index, waist circumference, waist–hip ratio, and mid-upper arm circumference over the study period ($p < 0.001$). Mean insulin levels showed a progressive decline, indicating improved insulin sensitivity. Menstrual cycle regularity improved, with a reduction in average cycle length from 37 days at baseline to 28 days at 16 weeks. The findings highlight that modest weight loss achieved through structured dietary intervention and physical activity significantly improves metabolic, hormonal, and reproductive outcomes in women with PCOS.

Keywords: Polycystic ovary syndrome, PCOS, dietary management, weight loss, insulin resistance, menstrual irregularity, lifestyle intervention

INTRODUCTION

Polycystic ovary syndrome (PCOS) is one of the most prevalent and complex endocrine disorders affecting women of reproductive age, with significant reproductive, metabolic, and psychological implications. It is classically characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology, although its clinical presentation is highly heterogeneous (Azziz et al., 2016; Escobar-Morreale, 2018). PCOS is increasingly recognized not only as a reproductive endocrinopathy but also as a chronic metabolic disorder with lifelong health consequences (Teede et al., 2010; Joham et al., 2022).

The reported prevalence of PCOS varies widely depending on diagnostic criteria, ethnicity, and study population. Community-based studies using different diagnostic frameworks, including the National Institutes of Health (NIH) and Rotterdam criteria, have reported prevalence estimates ranging from 4% to over 12% (March et al., 2010; Bozdag et al., 2016). This variability reflects both the heterogeneity of the syndrome and ongoing debate regarding optimal diagnostic definitions. Nevertheless, PCOS represents a substantial public health burden worldwide, with increasing recognition in younger populations.

The pathophysiology of PCOS is multifactorial and incompletely understood, involving a complex interplay between genetic susceptibility, neuroendocrine dysfunction, insulin resistance, and environmental factors (Escobar-Morreale, 2018; Dapas & Dunaif, 2022). Among these, hyperandrogenism and insulin resistance are considered central pathogenic mechanisms, present in approximately 60–80% and 50–80% of affected women, respectively (Azziz et al., 2016; Zeng et al., 2020). Insulin resistance plays a critical role by exacerbating ovarian androgen production and reducing sex hormone-binding globulin (SHBG) levels, thereby increasing circulating free androgens (Dunaif, 1997).

Obesity, particularly central or visceral obesity, is strongly associated with PCOS and significantly influences its clinical and biochemical expression. Although PCOS can occur in lean women, excess adiposity amplifies insulin resistance, hyperandrogenism, menstrual dysfunction, and infertility (Lim et al., 2019; Joham et al., 2022). The coexistence of obesity further increases the risk of metabolic complications, including impaired glucose tolerance, type 2 diabetes mellitus, dyslipidaemia, and cardiovascular disease (Teede et al., 2018; Lim et al., 2019). These findings underscore the metabolic vulnerability of women with PCOS, particularly in the presence of obesity.

In addition to metabolic disturbances, PCOS is associated with substantial reproductive morbidity, including anovulation, infertility, and pregnancy complications, as well as psychological sequelae such as anxiety, depression, and reduced quality of life (Teede et al., 2010; Joham et al., 2022). Longitudinal evidence suggests that PCOS is a lifelong condition, with manifestations evolving from menstrual irregularities and hyperandrogenism in adolescence to increasing metabolic and cardiovascular risk later in life (Azziz et al., 2016).

Recent advances have highlighted the contribution of genetic and epigenetic factors in the aetiology of PCOS, with genome-wide association studies identifying multiple susceptibility loci related to insulin signaling, gonadotropin action, and steroidogenesis (Dapas & Dunaif, 2022). However, genetic predisposition alone does not fully explain the rising prevalence of PCOS, suggesting an important role for environmental influences, lifestyle factors, and the global obesity epidemic (Escobar-Morreale, 2018; Joham et al., 2022).

Given the high prevalence, heterogeneity, and long-term health implications of PCOS, there is a growing emphasis on early diagnosis and integrated management strategies that address both reproductive and metabolic components of the disorder. International evidence-based guidelines now recommend lifestyle modification as a first-line intervention, particularly for overweight and obese women, due to its beneficial effects on insulin sensitivity, androgen levels, and reproductive outcomes (Teede et al., 2018). Despite these advances, gaps remain in understanding the full spectrum of PCOS phenotypes and their interaction with obesity and metabolic dysfunction, highlighting the need for continued research in diverse populations.

Objectives of the Study

1. To evaluate the effectiveness of a structured dietary intervention on body weight and body mass index (BMI) among overweight women with PCOS.

2. To assess changes in anthropometric measurements, including waist circumference, waist–hip ratio (WHR), and mid-upper arm circumference (MUAC), following dietary management and lifestyle modification.

3. To determine the effect of dietary management and weight reduction on metabolic parameters, particularly fasting blood glucose and serum insulin levels, in women with PCOS.

METHODOLOGY

This was a prospective, interventional study conducted over a period of 16 weeks to evaluate the effectiveness of a meal replacement–based short-term weight loss strategy, followed by moderate carbohydrate or fat restriction, on weight maintenance and associated reproductive and metabolic parameters in overweight women with polycystic ovary syndrome (PCOS).

The study was conducted on an outpatient basis at Udbhava Multispeciality Hospital, Ring Road, Banashankari 3rd Stage, Bengaluru and Maruthua Ayurvedic Hospital, Katriguppe, Bengaluru. A total of 30 overweight women diagnosed with PCOS, aged 18–35 years and were initially recruited. A total of 25 participants completed the 16-week intervention and were included in the final analysis. A cross-sectional study was conducted with the written informed consent obtained from all the participants.

Dietary Intervention was conducted in two phases:

Phase 1: Weight Loss Phase (Weeks 0–8)

Participants followed a meal replacement–based energy-restricted diet, in which three major meals were replaced with five small meals per day, providing an average energy intake of 1500 ± 150 kcal/day.

Phase 2: Weight Maintenance Phase (Weeks 9–16)

Participants were advised either:

- Moderate carbohydrate restriction (<120 g/day), or
- Moderate fat restriction (<50 g/day)

Both dietary approaches emphasized a low glycemic index (GI) diet with reduced saturated fat intake. Dietary counselling was provided individually, and adherence was reinforced at follow-up visits.

Anthropometric assessments were conducted at baseline, week 8, and week 16. Body mass index (BMI) was calculated as weight (kg)/height² (m^2), Waist circumference was measured in triplicate at the midpoint between the lower rib margin and iliac crest using a non-stretchable tape. All instruments were calibrated before each measurement session.

Biochemical and Hormonal Assessment

Fasting venous blood samples were collected at Weeks 0, 4, 8, 12, and 16 for measurement of Fasting blood glucose, Serum insulin and Total testosterone

Assessment of Menstrual Cycle

Participants documented their menstrual cycles throughout the study period and for six months prior to enrolment. Improvement in menstrual cycle was defined as:

- Transition from an ovulatory to ovulatory cycles
- Change from irregular to regular cycles
- Reduction in inter-cycle variability

Dietary Assessment- Dietary intake was assessed using the 24-hour dietary recall method. Participants were interviewed using a standardized questionnaire to record all foods and beverages consumed in the preceding 24 hours. Standardized household measures (cups and spoons) were used to assist participants in estimating portion sizes. Nutrient intake data were compiled, and mean ± standard deviation (SD) values were calculated for the study group.

Quality of Life Assessment - Health-related quality of life was assessed using a validated PCOS-specific quality of life questionnaire, administered at baseline, week 8, and week 16.

Statistical Analysis- Data were analysed using parametric statistical methods. Continuous variables were expressed as mean ± SD. Changes in anthropometric and biochemical parameters at baseline, week 8, and week 16 were analysed using the paired Student's t-test. A *p*-value <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

23 subjects completed first phase of the study, which was for 8 weeks and 20 subjects completed the second and final phase of the study. The diet plan was prepared such that there was 500 Kcal reduction in their regular intake i.e., 1500+200 Kcal. This resulted in around 500 gms of weight loss every week for the subjects. At the end of study, on an average each subject had lost around 3Kgs of weight, as listed in Table 1. This resulted in 5% reduction in weight and around 5-10% reduction in PCOS symptoms. The initial anthropometric readings captured for each

Table 1: Anthropometric details of the subjects at the first visit (Week 0) subject.

Age Groups	No of Subjects	BMI (Mean±SD)	WHR(Mean±SD)	MUAC(Mean±SD)
15-20	2	30.53±0.03	0.837±0.007	31.0±0.7
20-25	5	29.0±2.06	0.94±0.08	31.5±2.0
25-30	12	28.89±2.36	0.91±0.07	31.2±2.33
30-35	6	2.2±2.16	0.90±0.10	30.4±1.28

During the study it was found that the socio-economic status of the subjects was a contributing factor for the acquiring PCOS. The diet pattern of subjects in different socio-economic levels was different and it resulted in their PCOS condition accordingly.

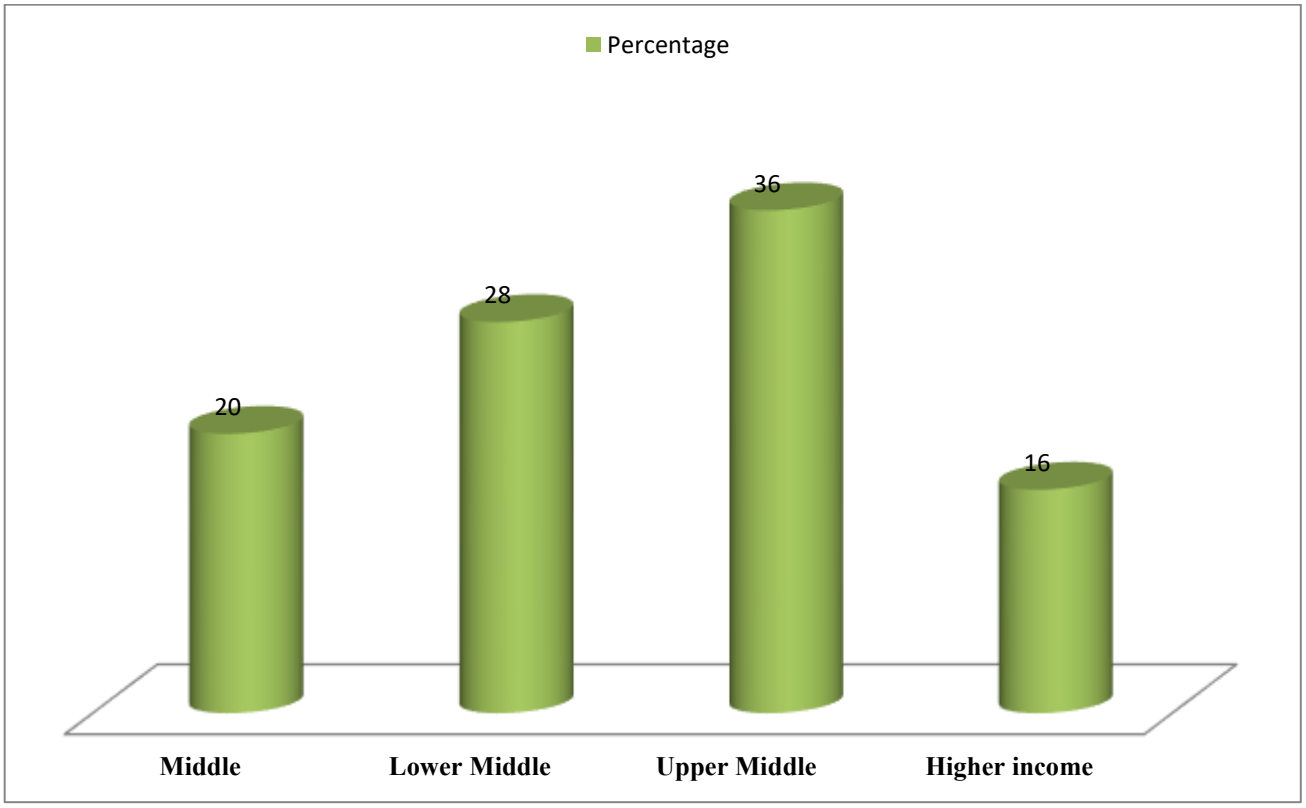

Figure 1: Distribution of subjects according to their socio-economic status.

The study shows that individuals with lower SES are more at risk for engaging in adverse health behavior including smoking, lack of physical activity and poor nutritional diet. Among women, obesity is associated with

low SES Figure-1. This is because the prevalence of PCOS is on the rise in developing nations like India, which are undergoing nutritional transitions doe to westernized diets and life style.

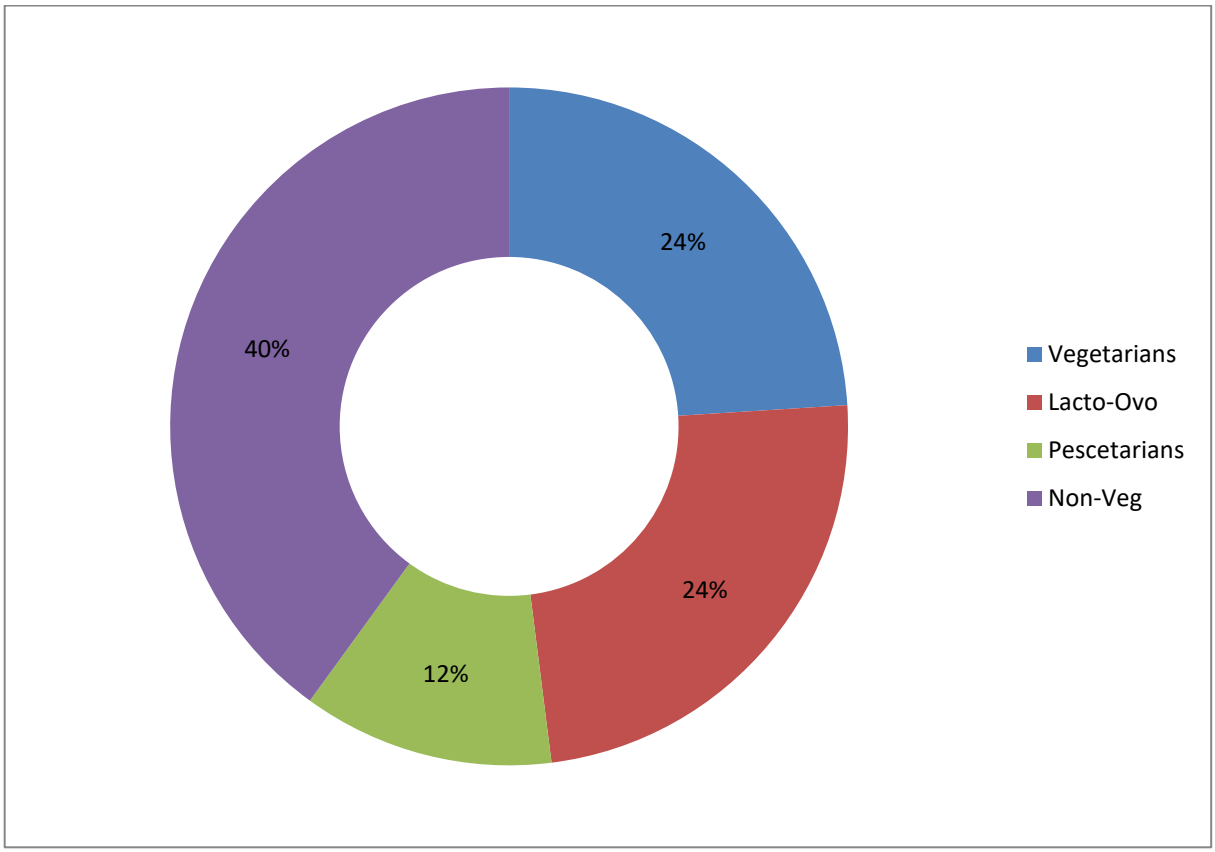

Figure 2: Dietary pattern of the subject.

Figure-2 shows that the subjects selected for the study were of both vegetarians and non-vegetarians (24%), however 40% of them lacto-ovo and 24% were pescetarians that is who does not eat meat but eat fish.

Table 2: Prevalence of main clinical features in polycystic ovary syndrome.

Symptoms	Numbers	Percentage (%)
Multiple follicles on USG (Mf)+ Oligomenorrhea +Obesity	**10**	**40**
Mf USG+Oligomenorrhea +Obesity +Acanthosis	**2**	**8**
Mf on USG + oligomenorrhea +Obesity + Hirutism	**5**	**20**
Mf on USG+Hirutism	**2**	**8**
Only Mf on USG(without oligomenorrhea /obesity/AN/Hirutism)	**2**	**8**
Mf on USG+ Obesity +Acanthosis + Hirutism	**2**	**8**
Mf on USG+ Obesity	**2**	**8**

PCOS can present as conglomerate of various clinical features like multiple follicles on USG, oligomenorrhea, obesity, AN and hirsutism. These findings may be present alone or in various combinations with one another. Some of the common combinations and percentage of patients under these have been depicted in Table-2. Combination of multiple follicles with oligomenorrhea was the commonest presentation. More number of obese patients had co-presence of AN and/or hirsutism. Three or more features together were a common occurrence. Multiple follicles without any other clinical presentation was also observed and the prevalence was comparable with its combination with hirsutism.

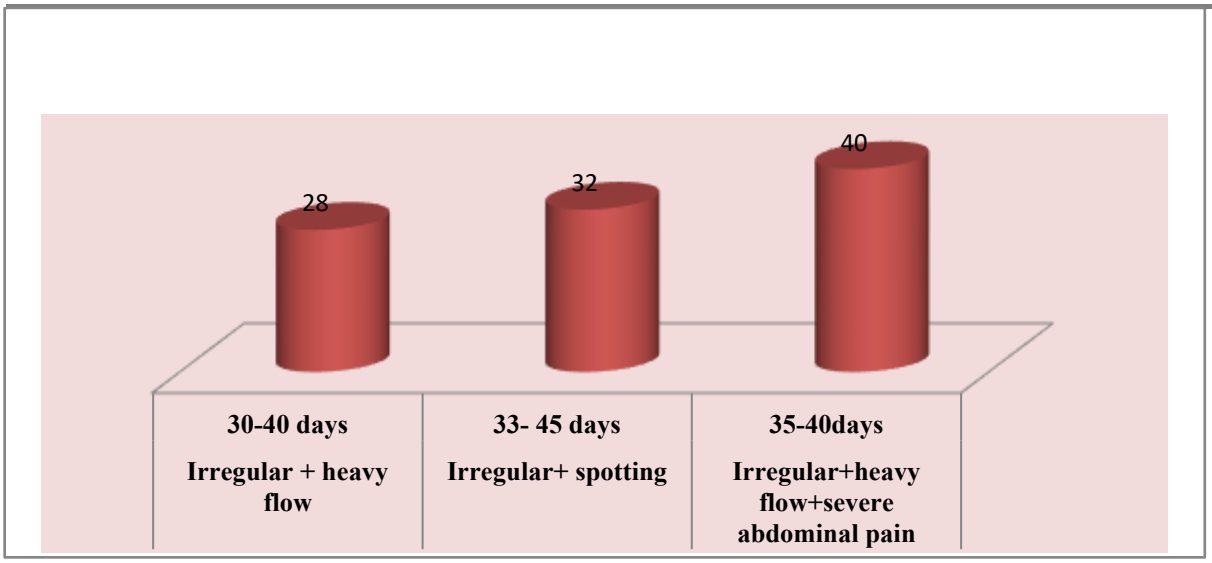

Figure 3: Menstrual status of the subjects at the first visit.

The changes in hormone levels described above cause the classic symptoms of polycystic ovary syndrome (PCOS), including absent or irregular and infrequent menstrual periods.
If ovulation does not occur, the lining of the uterus (called the endometrium) does not uniformly shed and regrow as in a normal menstrual cycle. Instead, the endometrium becomes thicker and may shed irregularly, which can result in heavy and/or prolonged bleeding. Figure-3 demonstrates the menstrual details of the study population as irregular (28%) with heavy flow (32%), irregular with only spotting (30%) and irregular with heavy flow and also severe abdominal pain (40%) respectively.
Polycystic ovary syndrome (or PCOS) is a common hormonal condition in which women produce a surplus of androgens. This causes irregular ovulation, or even a lack of ovulation. Excess androgen production also leads to irregular or absent ovulation, which women experience as irregular or absent menstrual periods. Because of the problems with ovulation, women with PCOS may have difficulty becoming pregnant. Women with PCOS are potentially at an increased risk of miscarriage and in pregnancy of they are at an increased risk of developing gestational diabetes, pregnancy-induced hypertension and pre-eclampsia.

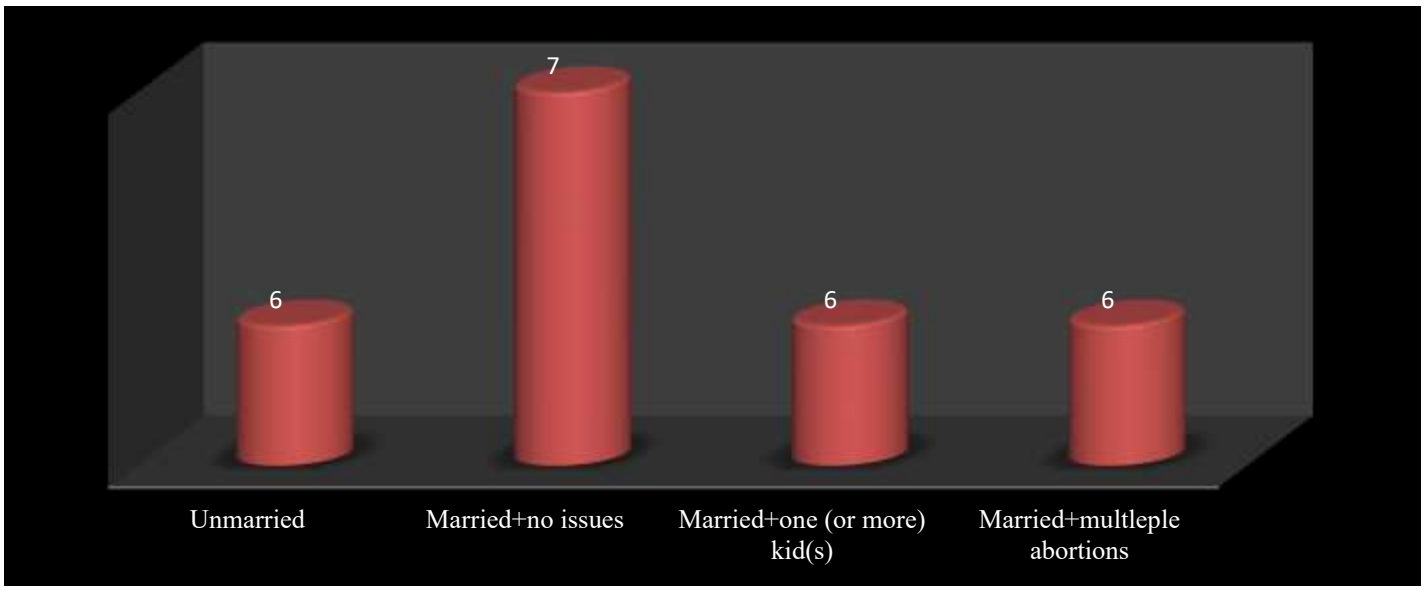

Figure 4: Marital Status of the subjects.

A detail of the Marital Status of the subjects is indicated in figure -4, the distribution of subjects by marital status was relatively uniform across categories. Among the participants, six were unmarried, while seven were married with no children. Additionally, six subjects were married with one child, and another six were married with more

than one child. Overall, the sample showed minimal variation between marital-status groups, indicating a balanced representation across categories.

Table 3: Approximate nutrient intake using 24-hour recall method.

Nutrients	Mean ± SD
Energy(kcal)	2495±169.78
Carbohydrates(gms)	313.09±71.76
Proteins(gms)	48.56±9.96
Energy(gms)	62.62±14.35

Table- 3 shows the results of analysis of 24-hour dietary recalls revealed that subjects had a high average energy intake of approximately 2495 kcal/day, with carbohydrates contributing the largest proportion of macronutrients. Protein intake averaged 48.56 g/day, while fat intake contributed an average of 62.62 g/day. These findings indicate that the habitual diet of the study population was energy-dense and carbohydrate-rich, which may be associated with the prevalence of obesity and metabolic disturbances observed in the subjects.

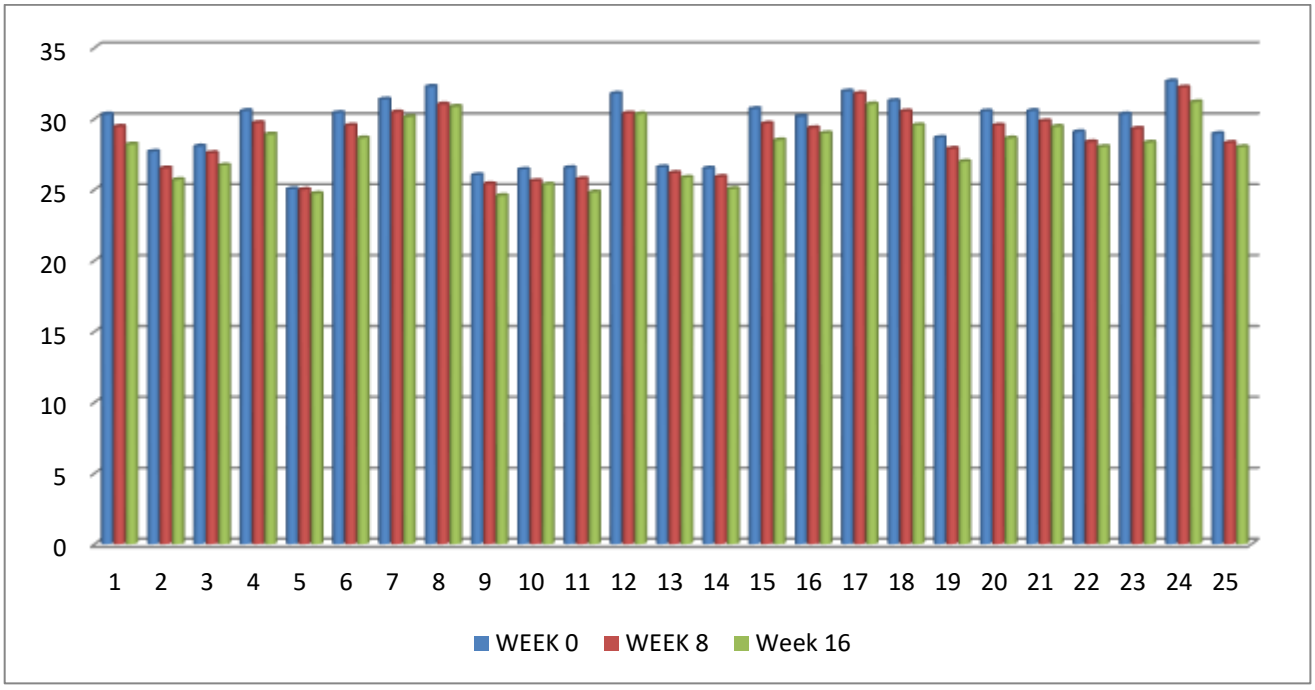

Figure 5: BMI of the subjects over the study period.

Considering their diet intake the diet chart was prepared aiming to reduce 500kcal intake (1500±200). This resulted in all subjects reducing around 500gms per week. At the end of 8th and 16th week BMI was calculated again and is represented in figure-5.

The dietary management of obesity consists of achieving and maintaining a reduced body weight and preventing further weight gain. Weight loss through life style changes, preferably a low calorie diet, should be the first line treatment in overweight/ obese women with PCOS.

Paired t-test Results (n = 23) for Week 0 vs Week 8 showed t (22) = 15.76, $p < 0.0001$, indicating statistically significant decrease from Week 0 to Week 8. Week 8 vs Week 16, t (22) = 10.99, $p < 0.0001$, also revealed statistically significant decrease from Week 8 to Week 16. Week 0 vs Week 16, t (22) = 21.21, $p < 0.0001$, highly significant overall decrease from baseline to Week 16. In conclusion, the study showed a statistically significant

reduction in values from Week 0 to Week 8, Week 8 to Week 16, and Week 0 to Week 16 ($p < 0.001$ for all comparisons), indicating a consistent and progressive decline over time.

WHR Comparisons of the subjects

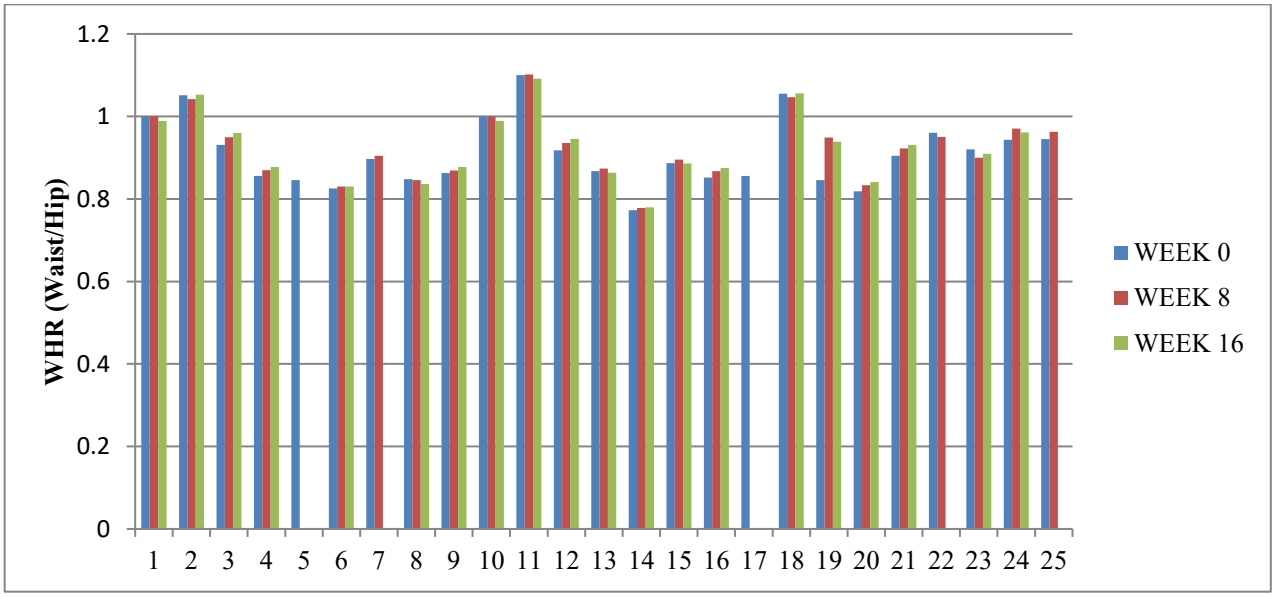

Figure 6: WHR of the subjects before and after intervention

The effect of diet control and exercise (30 -60 mins of brisk walk) on WHR can be measured as below. The measurements are taken initially (week 0), at 8th week and at 16th week. These values are compared against each other and results are as shown in figure -6.

For all the subjects, during the initial anthropometric data collection, Waist and Hip readings are collected and WHR is calculated. All the subjects are advised regular exercise along with the diet plan. The same values are collected after 8th week and 16th week. As the effect of following the diet plan and regular exercise, we can see the Waist and Hip readings have decreased, contributing to the improvement of PCOS condition of the subjects.

Paired t-test analysis showed a statistically significant increase in waist–hip ratio (WHR) from Week 0 to Week 8, Week 8 to Week 16, and Week 0 to Week 16 ($p < 0.01$), indicating a progressive change in WHR over time.

MUAC Comparison of the subjects

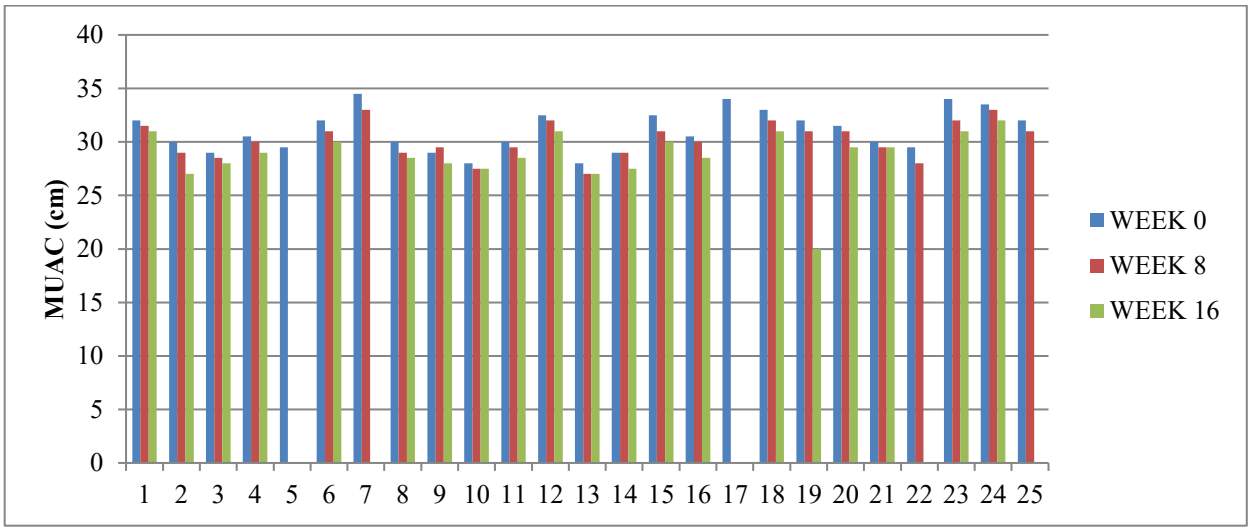

Figure 7: The MUAC of the subjects before and after intervention

From figure 7 The MUAC graph indicates the effect of diet plan and exercise on the subjects. The effect of diet control and exercise (30 -60 mins of brisk walk) on MUAC measured as below. The values are recorded at week 0, week 8 and week 16 and are compared against each other. The MUAC metric was recorded initially. The reading was taken again after the completion of 8th week and 16th week. We could see marked improvement in MUAC reading.

By following the diet plan and exercising i.e 30 to 60 mins of brisk walk as advised, there was an average reduction of 2 to 5% in MUAC for all the subjects this indicates that the advised diet therapy resulted in overall body fat reduction foe all the subjects. Statistical analysis indicated that statistically significant reduction in MUAC after 8 weeks $p < 0.0001$. After 16 Weeks with $t(24) = 12.21$, $p < 0.0001$, highly significant reduction in MUAC was evident. Paired t-test analysis showed a statistically significant decrease in mid-upper arm circumference (MUAC) from baseline to 8 weeks and from baseline to 16 weeks ($p < 0.001$), indicating a progressive reduction in MUAC over the study period.

Studies of obese women with menstrual abnormalities have demonstrated that cycles can potentially normalize and fertility is re-established following weight loss. Traditionally, sex steroids and thyroid hormones have been considered to be the major regulators of SHBG concentration, but dietary factors may be a more important consideration.

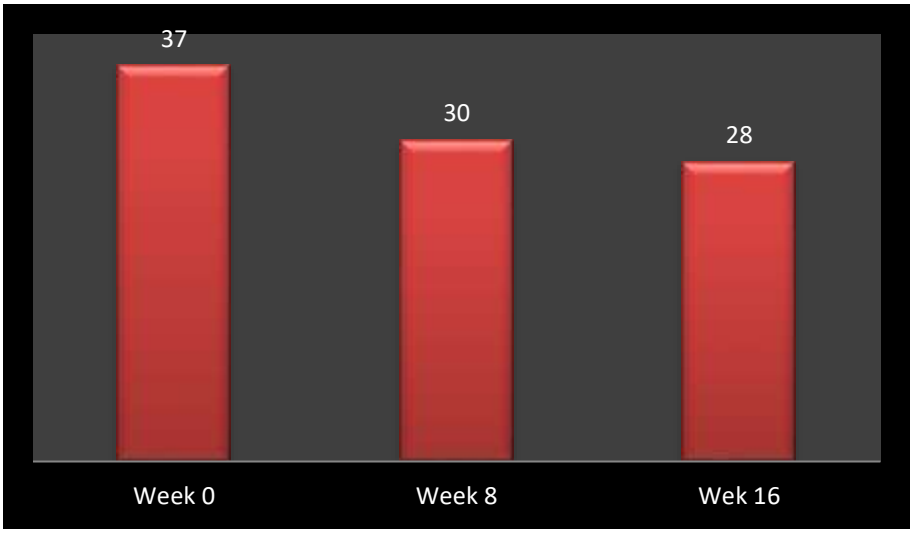

Figure 8: Comparative study of menstrual irregularity.

The study revealed through figure -8, that an average menstrual cycle length decreased from 37 days at baseline to 30 days at 8 weeks and further to 28 days at 16 weeks, demonstrating an improvement in menstrual cycle regularity over the study period.

Experimental evidence has indicated that the typical western diet, which is high in fat and refined carbohydrate and low in fiber, induces insulin resistance and precedes obesity.

The lower the glycemic index, the smaller the effect of the carbohydrate on postprandial glucose and insulin values. Because of the correlation between PCOS and hyperinsulinemia, a low glycemic diet could potentially decrease hyperinsulinemia with greater regulation of FFAs postprandial.

The dietary management of obesity consists of achieving and maintaining a reduced body weight and preventing further weight gain. In obese individuals, energy restriction and weight loss improve glycemic control dyslipidemia, hyperinsulinemia and IR and reduce blood pressure. Acute energy restriction decreases human endogenous cholesterol synthesis, improves central and peripheral insulin sensitivity and glycemic control due to an enhancement of non-oxidative glucose disposal, a reduction in insulin secretion or reduced hepatic glucose production.

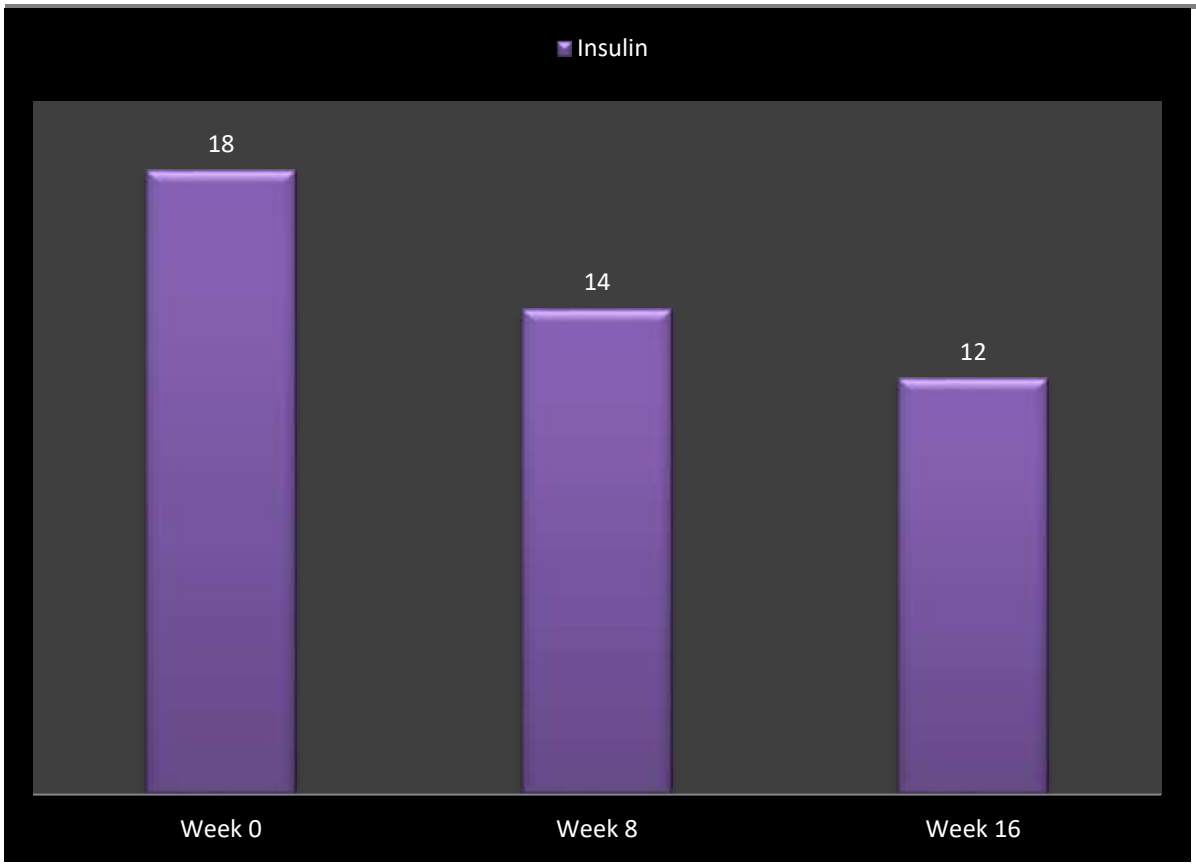

Figure 9: Comparative study of insulin value.

The present study showed a consistent decline in insulin levels from baseline to 8 weeks, with a further reduction by 16 weeks. This trend suggests an improvement in insulin sensitivity and better metabolic control as the study progressed. Mean insulin levels showed a progressive decline from 18 µIU/mL at baseline to 14 µIU/mL at 8 weeks and further to 12 µIU/mL at 16 weeks, indicating a significant improvement in insulin regulation over the study duration (Figure 9).

SUMMARY

The study evaluated the effect of a structured dietary intervention and exercise on women with PCOS over 16 weeks. Twenty-five subjects completed the first phase, and 20 completed the full study. A calorie-restricted diet (1500 ± 200 kcal/day) combined with 30–60 minutes of daily brisk walking led to an average weight loss of ~3 kg per subject, corresponding to a 5% reduction in body weight.

Anthropometric measures, including BMI, waist–hip ratio (WHR), and mid-upper arm circumference (MUAC), showed statistically significant reductions over 16 weeks ($p < 0.001$). Menstrual cycle regularity improved, with average cycle length decreasing from 37 to 28 days. Metabolic parameters, particularly insulin levels, also showed progressive improvement, indicating enhanced insulin sensitivity. Socio-economic status influenced dietary patterns and risk for PCOS, with lower SES associated with higher obesity and adverse health behaviors.

Clinical features such as multiple ovarian follicles, oligomenorrhea, obesity, AN, and hirsutism were commonly observed, often in combination, with weight reduction contributing to improvement in these symptoms.

CONCLUSION

A combined intervention of calorie-restricted diet and regular exercise effectively reduced body weight, improved anthropometric measures, enhanced menstrual regularity, and improved metabolic profiles in women with PCOS. Socio-economic factors influenced the prevalence and severity of PCOS, highlighting the importance of tailored lifestyle interventions. Overall, lifestyle modification remains a first-line, non-pharmacological strategy to manage PCOS and its associated metabolic and reproductive complications.

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